CPS
Cambridge Public Schools

The Department of
Human Service Programs
Cambridge, Massachusetts

APPENDIX
VOLUME 4a

JOHN M. TOBIN MONTESSORI SCHOOL

VASSAL LANE UPPER SCHOOL

DHSP CHILDCARE & COMMUNITY SCHOOL

PERKINS EASTMAN

JUNE 26, 2020

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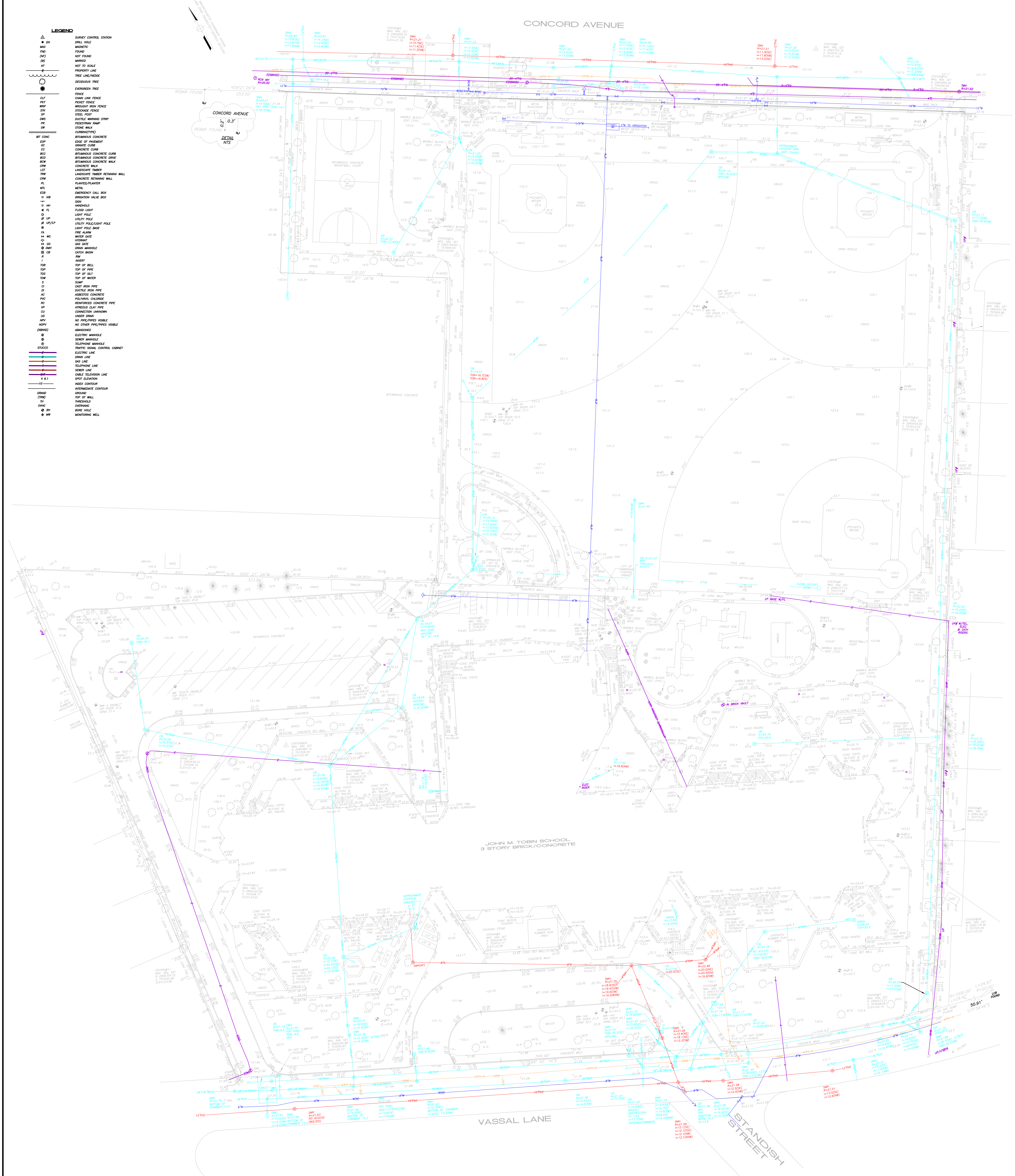
A1.0

LAND SURVEY

A1.1 OPEN SPACE SURVEY



NOTES

1. SUBSURFACE UTILITY LINES, AS SHOWN HEREON, WERE COMPILED ACCORDING TO AVAILABLE RECORD INFORMATION FROM THE REFERENCED COMPANIES AND PUBLIC AGENCIES, AND THEIR LOCATIONS ARE APPROXIMATE ONLY. ACTUAL LOCATIONS MUST BE DETERMINED IN THE FIELD. SMC ASSUMES NO RESPONSIBILITY FOR DAMAGES INCURRED AS A RESULT OF UTILITIES OMITTED OR INACCURATELY SHOWN.

GENERALLY THE LINES IN THE PUBLIC AND PRIVATE WAYS ARE SHOWN AND THE LATERAL CONNECTIONS SERVICING INDIVIDUAL USERS ARE NOT SHOWN. BEFORE DESIGNING FUTURE CONNECTIONS, THE APPROPRIATE UTILITIES MUST BE CONSULTED.

BEFORE CONSTRUCTION, ALL UTILITIES, PUBLIC AND PRIVATE MUST BE NOTIFIED (SEE MASSACHUSETTS GENERAL LAWS, CHAPTER 82 SECTION 40.) CALL "DIG SAFE" 1 (888) 344-7233 HTTP://WWW.DIGSAFE.COM

2. THE COORDINATES, IN FEET, ARE BASED UPON THE NORTH AMERICAN DATUM OF 1983 (NAD83/2011 EPOCH 2010.00) AS DEFINED BY THE KeyNet GPS VIRTUAL REFERENCE SYSTEM (VRS) NETWORK.

3. ELEVATIONS, IN FEET, ARE REFERRED TO THE CAMBRIDGE CITY BASE AS DERIVED FROM THE KeyNet GPS VIRTUAL REFERENCE SYSTEM (VRS) NETWORK.

VERTICAL DATUM RELATIONSHIP

NAVD88

11.66

CAMBRIDGE CITY BASE

UTILITY REFERENCES

1. JOHN M. TOBIN ELEMENTARY SCHOOL CAMBRIDGE, MASSACHSETTS GRADING AND UTILITIES PLAN
PREPARED BY PIETRO BELLUSCHI
SCALE: 1"=30' DATE: OCTOBER 25, 1968
REVISED JANUARY 20, 1969

2. CITY OF CAMBRIDGE, MASSACHUSETTS
HURON A SEWER SEPARATION PROJECT
CONTRACT NO. 8A
CIVIL-PLAN AND PROFILE FOR VASSAL LANE
STORM DRAIN (PROFILE 1) STA 9+50 TO STA 15+50
PREPARED BY KLEINFELDER
SCALE: 1"=20' DATE: SEPTEMBER 2012

3. CITY OF CAMBRIDGE, MASSACHUSETTS
CONCORD CONTRACT 9SEWER SEPARATION AND SURFACE IMPROVEMENTS PROJECTS
CIVIL-PLAN AND PROFILE FOR CONCORD AVE.
STA 3005+50 TO STA 3011+00
PREPARED BY KLEINFELDER
SCALE: 1"=20' DATE: JANUARY 27, 2014

4. CITY OF CAMBRIDGE, MASSACHUSETTS
HURON B SEWER SEPARATION PROJECT CONTRACT NO. 8B
CIVIL-PLAN AND PROFILE FOR VASSAL LANE
STA 3999+80 TO STA 11005+00
PREPARED BY MWH
SCALE: 1"=20' DATE: APRIL 17, 2013

5. EVERSOURCE GAS FACILITY MAP

6. EVERSOURCE ELECTRIC FACILITY MAP

7. CITY OF CAMBRIDGE DEPARTMENT OF PUBLIC WORKS WATER FACILITY MAP

8. VERIZON FACILITY MAPS

9. COMCAST FACILITY MAP

10. JOHN M. TOBIN ELEMENTARY SCHOOL
CAMBRIDGE, MASSACHUSETTS
UTILITY SITE PLAN
PREPARED BY PIETRO BELLUSCHI ARCHITECT
SCALE: 1"=30' DATE: OCT 25, 1968 REV. JAN 20, 1969

PROPERTY REFERENCES

1. PLAN OF LAND IN CAMBRIDGE, MASS.
SURVEYED FOR MARJORIE C. O'BRIEN
PREPARED BY W. A. MASON & SON CO.
SCALE: 1"=40' DATE: SEPTEMBER 20, 1926

2. SUBDIVISION OF BLOCK 1
LAND COURT PLAN NO. 12809
LAND IN CAMBRIDGE, MASS.
PREPARED BY W. A. MASON & SON CO.
SCALE: 1"=40' DATE: MARCH 13, 1933

3. SUBDIVISION OF PART OF BLOCK 1
SHOWN ON PLAN 12809A, FILED WITH CERT. OF TITLE NO. 27808, SOUTH REGISTRY DISTRICT OF MIDDLESEX COUNTY
LAND IN CAMBRIDGE
SCALE: 1"=50' DATE: NOVEMBER 15, 1929

4. ALPINE STREET FOR ACCEPTANCE
PREPARED BY DONALD J. REARDON
SCALE: 1"=60' DATE: FEBRUARY 21, 1929

5. SUBDIVISION OF PART OF BLOCK 1
SHOWN ON PLAN 12809A FILED WITH CERT. OF TITLE NO. 27808 SOUTH REGISTRY DISTRICT OF MIDDLESEX COUNTY
LAND IN CAMBRIDGE
SCALE: 1"=50' DATE: MARCH 13, 1933

6. PLAN OF LAND IN CAMBRIDGE, MASS.
PREPARED BY FRED A. JOYCE
SCALE: 1"=20' DATE: SEPTEMBER 20, 1946

7. PLAN OF LAND IN CAMBRIDGE, MASS.
PREPARED BY FRED A. JOYCE
SCALE: 1"=40' DATE: NOVEMBER 12, 1946

8. SUBDIVISION OF LOTS 4 TO 24 INCL. AND LOTS 3 AND 25, SHOWN ON PLANS 12809A AND 20208A, FILED WITH CERTIFICATE OF TITLE NO. 27808 AND 61175
SOUTH REGISTRY DISTRICT OF MIDDLESEX COUNTY
LAND IN CAMBRIDGE
PREPARED BY FRED A. JOYCE
SCALE: 1"=50' DATE: NOVEMBER 12, 1946

9. PLAN OF LAND IN CAMBRIDGE
PREPARED BY FRED A. JOYCE
SCALE: 1"=30' DATE: NOVEMBER 26, 1946
LCC #61175 BOOK 383 PAGE 509

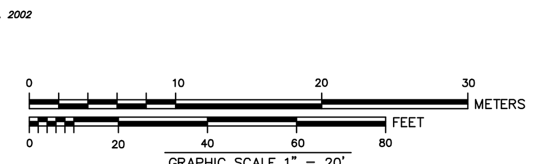
10. PLAN OF LAND FOR PROPOSED ARMORY SITE
CAMBRIDGE, MASS.
PREPARED BY EMMONS & FLEMING
SCALE: 1"=40' DATE: AUGUST, 1957
PLAN NO 1513 OF 1957 BOOK 9038 PAGE 388

11. SUBDIVISION PLAN IN CAMBRIDGE, MASS.
PREPARED BY WENDELL H. MASON
SCALE: 1"=50' DATE: AUGUST 31, 1998

12. PLAN SHOWING EASEMENT TAKINGS FOR ROADWAY IMPROVEMENTS, FRESH POND PARKWAY & CONCORD AVE.
CAMBRIDGE, MASSACHUSETTS
PREPARED BY HARRY R. FELDMAN, INC.
SCALE: 1"=20' DATE: JULY 7, 1998
SHEETS 4-6 OF 8

13. PLAN SHOWING ACTIVITY & USE LIMITATION
TOBIN SCHOOL, CAMBRIDGE, MASS.
PREPARED BY HARRY R. FELDMAN
SCALE: 1"=50' DATE: FEBRUARY 4, 1999

14. PLAN OF LAND
450 CONCORD AVENUE, CAMBRIDGE, MA 02138
(MIDDLESEX COUNTY)
PREPARED FOR THE COMMONWEALTH OF MASSACHUSETTS
MILITARY DIVISION STATE QUARTERMASTERS OFFICE
50 MAPLE STREET, MILFORD, MA 01757
BY COLER & COLANTONIO
SCALE: 1"=30' DATE: AUGUST 12, 2002



Revised:	OCTOBER 2, 2017
Date:	SEPTEMBER 5, 2017
Job No.:	2017136.00
Drawn By:	SKH
Checked By:	JBW/KH
Calc'd By:	JBW
Drawing No.:	201713600WS.dwg
Sheet:	2 OF 2

ATTACHMENT 1

325 WOOD ROAD
SUITE 109
BRAINTREE MA 02184
(781)380-7766
FAX (781)380-7757
SMC SURVEYING AND MAPPING CONSULTANTS

EXISTING CONDITIONS SURVEY
JOHN M. TOBIN SCHOOL
VASSAL LANE
CAMBRIDGE, MA

PREPARED FOR: CDM SMITH, INC.

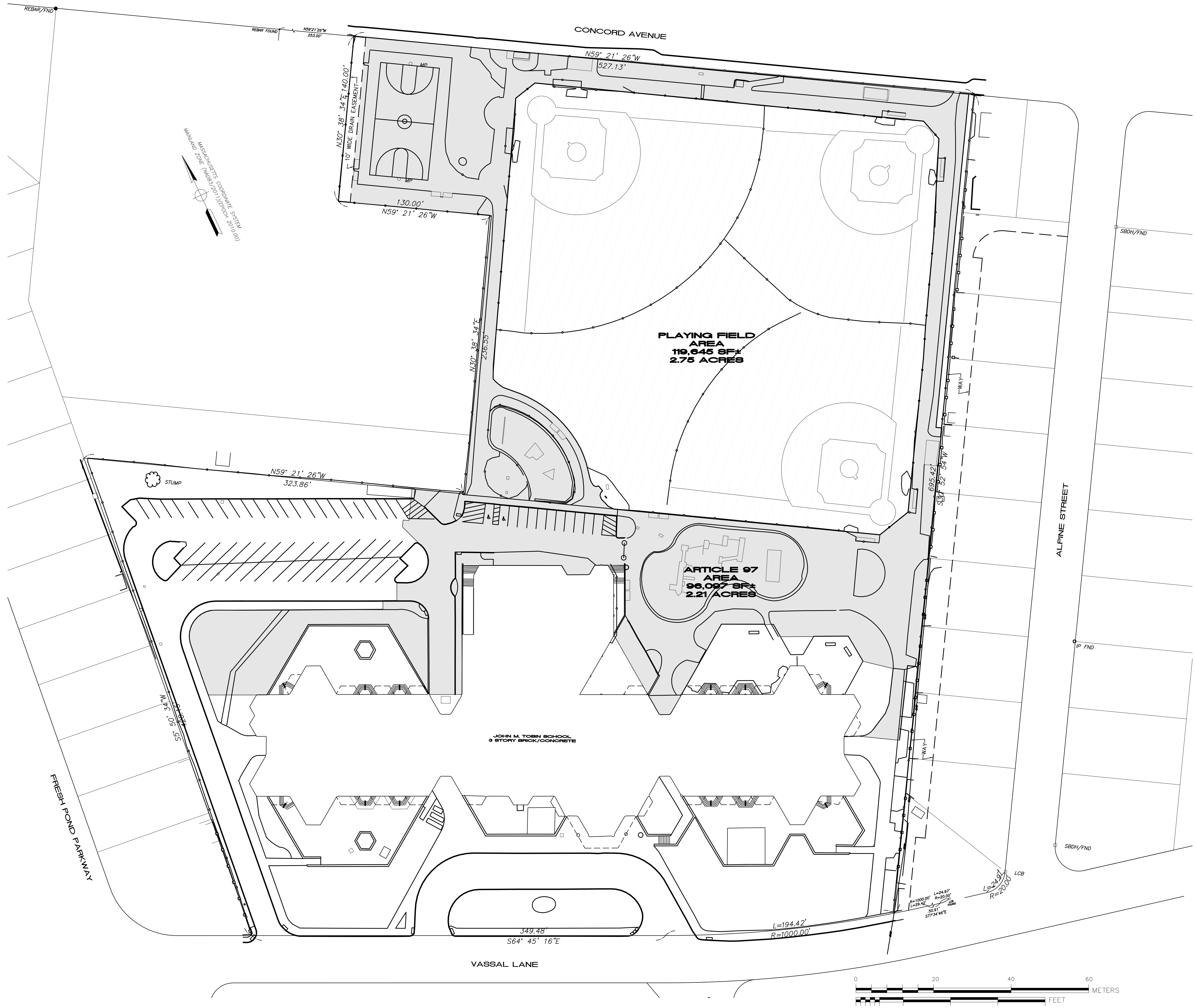
SCALE: 1"=20'

REVISED: OCTOBER 2, 2017
DATE: SEPTEMBER 6, 2017

KEVIN HANLEY, PLS
MASSACHUSETTS REG. No. 31313

SMC DWG. NO. 201713600WS.DWG

SHEET 1 OF 1



THIS PLAN HAS BEEN PREPARED IN CONFORMANCE WITH THE RULES AND REGULATIONS OF THE REGISTERS OF DEEDS OF THE COMMONWEALTH OF MASSACHUSETTS.

PRELIMINARY

KEVIN HANLEY, PLS
MASSACHUSETTS REG. No. 31313

325 WOOD ROAD
SUITE 109
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FAX (781)380-7757
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ARTICLE 97 AREAS
JOHN M. TOBIN SCHOOL
VASSAL LANE
CAMBRIDGE, MA

PREPARED FOR: CDM SMITH, INC.

SCALE: 1"=40' DATE: JANUARY 15, 2020

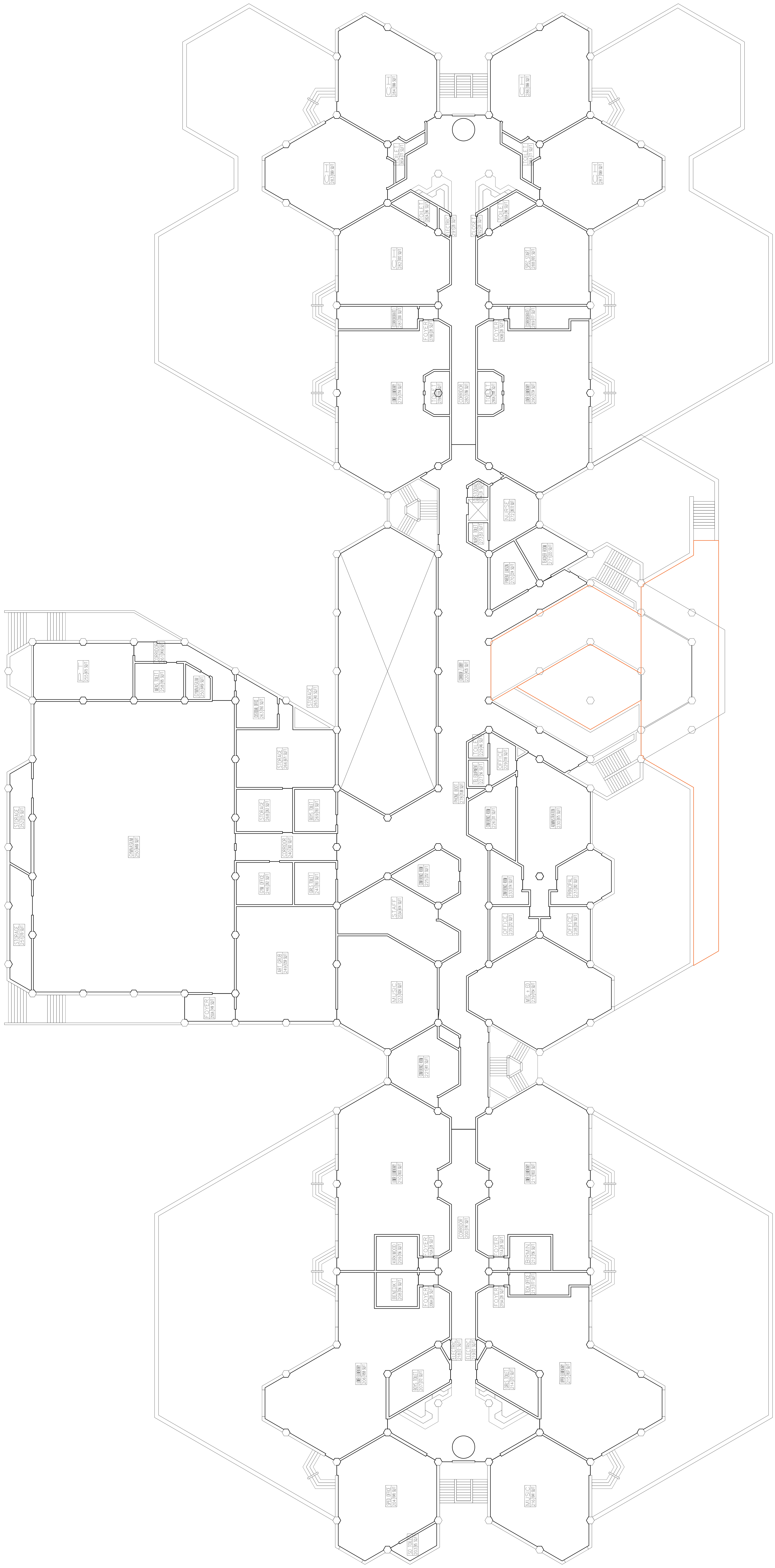
GRAPHIC SCALE 1" = 40'
METERS: 0 20 40 60
FEET: 0 40 80 120 160

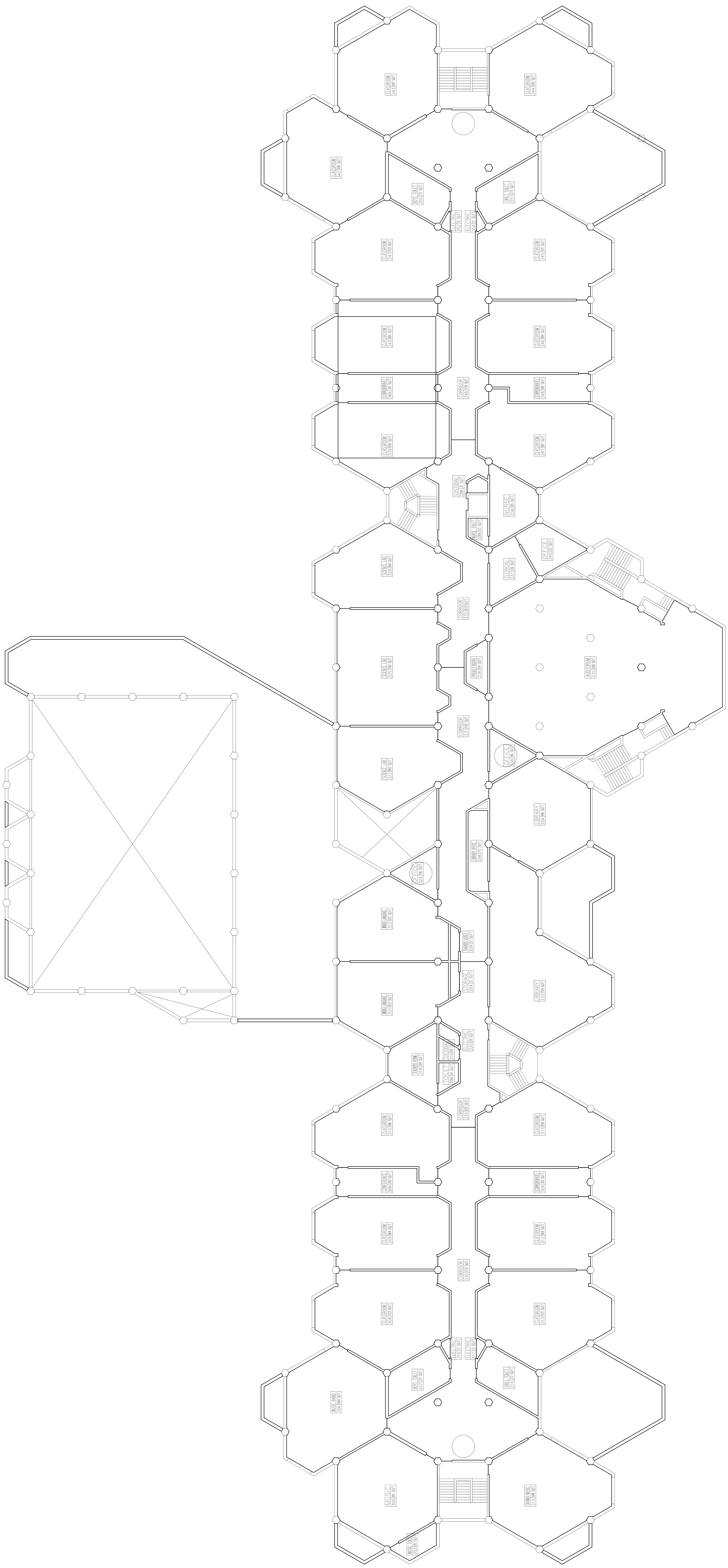
SMC DWG. NO. 200013WS.DWG SHEET 1 OF 1

Date:	JANUARY 15, 2020
Job No.:	200013
Drawn By:	JBW
Checked By:	JBW/KH
Calc'd By:	JBW
Drawing No.:	200013WS.dwg
Sheet:	1 OF 1

A2.0

EXSITING FLOOR PLANS





A3.0

COMMISSIONING

A3.1 DRAFT OPR: OWNER'S PROJECT REQUIREMENTS

A3.2 COMMISSIONING PLAN

City of Cambridge

Tobin Montessori & Vassal Lane Upper Schools

OWNER'S PROJECT REQUIREMENTS

STEPHEN TURNER INC.
Building Better Performance

OPR Documentation

Draft Submitted: March 12, 2020

317 Hope Street
Providence, Rhode Island, 02906
401.273.1935
www.greenbuildingcommissioning.com

Table of Contents

EXECUTIVE SUMMARY

The Owner's Project Requirements (OPR) effort seeks to document answers to this question: What are the measurable performance criteria that will determine if this project is a success? Through the development of the feasibility study, the project team identified several project goals and requirements that are rooted in one or more of the following key criteria:

1. USGBC LEED Certification – The goal of the City is for the project to achieve LEED Certification at the Gold level or higher.

2. Net Zero Energy/Net Zero Emissions – Prior to the feasibility phase, the project team established the initial goal of achieving net zero energy and emissions operation. Net zero emissions was confirmed during the feasibility phase as a requirement. The net zero energy potential of the project is still being assessed as of the end of the feasibility phase.

3. Operations and Maintenance Requirements – On the Martin Luther King Jr. School and the King Open Cambridge Street Upper School and Community Center projects the City of Cambridge determined critical Operation and Maintenance (O&M) requirements, which have been applied to the Tobin Montessori & Vassal Lane Upper Schools (Tobin School) project. Comprehensive requirements for Operations and Maintenance manuals, as well as rigorous owner training for all MEP equipment, kitchen equipment and security equipment are requirements of the City's to facilitate the owner's ability to operate and maintain the building. Simplification and standardization of building systems should be considered while not sacrificing system performance or energy efficiency.

4. Resiliency – As the site is located in a flood plain, the new facility must meet the City's requirements for flood resiliency. These include installation of an underground water storage tank and location of any electrical equipment above a certain elevation.

INTRODUCTION

This Owner's Project Requirements (OPR) has been developed by Stephen Turner Inc. for the City of Cambridge to document the owner's requirements for the Tobin School project as they relate to the commissioning process. The goal of this LEED-required document is to summarize the commissioning-related project outcomes required by the owner that were responded to by the feasibility study. These outcomes are captured here as a reference for the commissioning process throughout the project, including the first year of operation. The OPR document is intended as a mutually beneficial tool to the entire project team by documenting key project requirements, supporting an integrated approach to project design and delivery and supporting commissioning evaluation of outcomes in the final built project.

Ultimately, the commissioning process seeks to verify and document that the final built project satisfies all the documented elements of the Owner's Project Requirements. This documentation is a narrative description of what the owner views as a successful project, which in turn helps the project team deliver just that—by utilizing this document throughout the commissioning process.

Site Description

From the feasibility study: The Tobin Montessori and Vassal Lane Upper School is located at 197 Vassal Lane, east of Fresh Pond Reservation and Park in West Cambridge. The once active clay pit for New England Brick Company is surrounded by mainly residential neighborhoods along Vassal Lane, Alpine

Street, and Concord Ave. The neighbors actively visit the Father Callanan Park towards the northern part of the site. Parallel to Concord Avenue, three baseball fields and basketball court serve as a community outdoor activity space and a pedestrian friendly buffer from ongoing traffic. The building site has historical significance, as it was once an active clay pit for New England Brick Company.

General Project Description

From the feasibility study: The City of Cambridge in collaboration with the Cambridge Public Schools (CPS) and the Department of Human Service Programs (DHSP) has begun the process of renewing the Tobin School campus. Currently the site of the Tobin Montessori, a JK to 5th grade lower school program, and the 6th to 8th grade Vassal Lane Upper School, the campus is being reprogrammed and redesigned to support the City's vision for the education of the children of Cambridge. It will include a public preschool and will also be designed to enhance the opportunities for community recreation provided by Father Callanan Park which shares the site.

The design will create high performance learning environments that are healthy, supportive and sustainable. These environments will enhance the preschool, lower, and upper school's programs and support extended learning opportunities with active community use of the campus after school hours. As a center of community the renewed campus will feature a building and outdoor open space that will together create an appropriate "civic presence," symbolically representing the value the Cambridge places on education, on community, on sustainability, and on health and wellness.

When complete, the new school building will accommodate up to 979 students as follows: 336 students in the lower school (grade JK-5th), 450 students in the upper school (6th – 8th, including 75 SEI students); 68 students in the ASD Program spanning the two schools, 45 students in Special Start, and 80 children in the Department of Human Services Programs (DHSP) Preschool. To provide high performance learning environments for this diversity of programs, the Preferred Option calls for the demolition of the existing school building and the construction of a new building of approximately 300,000 gross square feet.

Overall Environmental & Sustainability Goals

The City of Cambridge seeks to lead by example in reducing and minimizing greenhouse gas emissions and other environmental impacts of its facilities. The City is committed to meeting their environmental, sustainable, and "green" building goals related to energy efficiency, indoor environmental quality, and resource efficiency.

The Tobin School Project will be designed and constructed using applicable industry best practices to achieve its environmental goals and ultimately provide a safe and healthy environment for building occupants with minimal negative impact on the local, regional and global environment. The project is pursuing a LEED Gold rating based on the LEED v4 for BD+C: Schools scorecard provided in the feasibility narratives. Key high-performance building goals that have been defined for the project include:

- Superior indoor environmental quality
- Superior community connectivity
- School to be used as a teaching tool
- Net Zero Emissions
- Net Zero Energy Goal
- LEED v4 for BD+C: Schools Certification - February 27, 2020 scorecard indicates:
    - A minimum 42% site energy use reduction

- Onsite renewable energy systems
- A minimum 35% potable water use reduction

Building Enclosure

The building enclosure will need to be airtight and meet all national and Massachusetts standards for air barrier systems to provide a good boundary condition for the building's HVAC system. The building shall maximize energy efficiency and cost effectiveness though the design and installation of an efficient building enclosure optimized for energy use based on glazing and cladding systems. Assembly R-values shall be higher than code. Additional assemblies and R-values shall be documented here as design progresses.

Exterior Component	R-Value
Roof	40
Solid Wall	30
Other Assemblies	TBD

PERFORMANCE CRITERIA & OBJECTIVES

General

1. *OUTDOOR DESIGN CONDITIONS*

Per ASHRAE weather data tables and IECC 2018 Climate Zone 5A

Winter:	0°F (db)
Summer:	91°F (db) | 73°F (wb)
Heating Degree Days:	To be confirmed in energy model
Cooling Degree Days:	To be confirmed in energy model
Weather Data:	TMY3 Boston Logan Int'l Airport

2. *INDOOR DESIGN CONDITIONS*

Occupied mode design setpoints were provided in the feasibility study. Unoccupied mode setpoints and setback values are assumed based on prior City of Cambridge school projects.

Indoor Heating:	70°F +/- 2°F (occupied)
	60°F +/- 2°F (unoccupied)
Indoor Cooling:	75°F +/- 2°F (occupied) (50% RH)
	85°F (unoccupied)

3. *HOURS OF OPERATION*

An occupancy schedule was not provided in the feasibility study. The below schedule is based on previous City of Cambridge school projects and will be updated based on the energy model inputs.

Tobin Montessori School (M-F):	7:30am – 2:55pm
Vassal Lane Upper School (M-F):	7:30am – 2:55pm
Human Services After School (M-F):	2:55pm – 6:00pm
Pre-K (year-round):	7:00am – 6:00pm
General Building Hours:	6:00am – 11:00pm
Summer Building Hours:	8:00am – 5:30pm

4. *Systems Design*

The project goal of Net Zero Energy, combined with the requirement for superior indoor environmental quality, result in the need for high performance HVAC systems. The design team developed three system concepts in the feasibility study. As the preferred system option is selected and the BOD narratives are developed in depth, the CxA shall work with the City and design team to align the design and these owner's requirements.

Systems Redundancy & Emergency Power:
Redundancy requirements for previous City projects are detailed below. These recommendations may be adjusted as design progresses.

Central Heating Plant Systems = N+1 @ 50%
Primary Air Handling Systems Fans = N+1 @ 50% (i.e., two 5,000 CFM fans for a 10,000cfm unit)
Domestic Hot Water System = N+1 @ 100%
Secondary equipment = N+0 (i.e., no redundancy requirement)

An emergency generator will be provided for life safety loads. Additional emergency power loads are expected to include the elevator, any geothermal heat pumps and circulation pumps, refrigeration equipment, and communications systems.

Systems & Equipment Lifecycle Cost Evaluation:
System type selection and design and equipment selection are to be evaluated based on providing optimum building operation and equipment service life over the lifecycle of the building. The City of Cambridge has determined on previous projects the requirement of a minimum life expectancy of 50 years for new facilities. Systems and equipment evaluation shall consider the following: first cost, annual energy costs, annual operations and maintenance costs, replacement costs and possible rebates and incentives.

Systems & Equipment Capacity:
During the design phase, the design team shall evaluate and determine when and how diversity may be used in determining the capacity for central plant systems. The diversity recommendation shall be approved by the City and included in the Basis of Design to indicate when diversity is used in determining system capacity and the assumed diversity rate.

Systems Controllability:
A new DDC automatic temperature control and building energy management system shall be installed to control and monitor building HVAC systems. Full compatibility and integration with the existing city wide BMS is required. Energy metering shall also be installed to monitor energy usage of the building HVAC systems and utilities. Use of Original Equipment Manufacturer's (OEM) controls shall be reviewed and approved by the owner.

Systems Operations & Maintenance:
Similar to recent Cambridge School projects, the City of Cambridge requires detailed electronic and paper O&Ms, as well as detailed as-built documentation. Rigorous owner training shall also be provided for all MEP equipment, kitchen equipment, and security equipment to facilitate the owner's ability to operate and maintain the building.

5. PROJECT TURNOVER REQUIREMENTS

The following items will be required at project turnover to ensure the Owner and property management staff possesses the information and knowledge necessary to operate and maintain the building for optimum energy efficiency and performance. Turnover items will include:

- As-built drawings
- Building Operations and Maintenance Manual
- Training on building systems for Owner's facilities management staff

6. WARRANTY REQUIREMENTS

The Tobin School project will have an industry standard one-year warranty period from the date of substantial completion. Specific material and equipment warranties have not been defined for the project.

Indoor Environmental Quality

1. VENTILATION & INDOOR AIR QUALITY

In addition to meeting code and good engineering practice, the project will comply with LEED BD+C Indoor Environmental Quality prerequisite Minimum Indoor Air Quality Performance per the requirements of ASHRAE Standard 62.1 and smoking will be prohibited in the building in accordance with LEED BD+C Indoor Environmental Quality prerequisite Environmental Tobacco Smoke Control. CO_2 monitoring for all densely occupied spaces will be provided to meet the requirements of LEED BD+C credit Enhanced Indoor Air Quality Strategies Option 2.

2. CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT

The contractor will be required to develop and adhere to a Construction Indoor Air Quality Management Plan to meet the requirements of LEED BD+C Indoor Environmental Quality credit Construction Indoor Air Quality Management Plan during the construction period. The plan shall include provisions to meet control measures per SMACNA IAQ guidelines, protection of absorptive building materials and protection of air handling systems to be used during construction.

3. THERMAL COMFORT

The project will be designed to comply with the requirements of LEED BD+C credit Thermal Comfort regarding thermal comfort design. Heating, ventilation and air conditioning systems as well as the building enclosure will be designed to meet the requirements of ASHRAE Standard 55-2010. The resulting operative temperatures are listed in the table below:

Project Space Type	Winter (Heating)			Summer (Cooling)			CO_2 Control
	Occupied	Unoccupied	RH Control	Occupied	Unoccupied	RH Control	
Auditorium	70°F	60°F	None	75°F	85°F	50%	Yes
Gym	70°F	60°F	None	75°F	85°F	50%	Yes
Cafeteria	70°F	60°F	None	75°F	85°F	50%	Yes
Kitchen	70°F	60°F	None	75°F	85°F	50%	CO detection
Multi-Purpose Room/Lobby	70°F	60°F	None	75°F	85°F	50%	Yes
Classrooms	70°F	60°F	None	75°F	85°F	50%	Yes
Pre-K Classroom	70°F	60°F	None	75°F	85°F	50%	No
Administration and Nurse Areas	70°F	60°F	None	75°F	85°F	50%	No

4. *NATURAL LIGHT*
   The project will provide windows in regularly occupied spaces to provide views to the exterior and promote occupant health and wellbeing to meet the requirements of LEED BD+C Indoor Environmental Quality credit Daylight and/or Quality Views.

5. *LIGHTING SYSTEMS & CONTROLS*
   The project will provide lighting controllability in conformance with LEED BD+C Indoor Environmental Quality credit Interior Lighting. The lighting controls shall have BACnet gateway for DDC input functions. Levels at all spaces will be designed in accordance with IESNA standards while reducing light power densities by a minimum of 60% compared to the IECC 2009 baseline as part of the project's overall energy use reduction strategy as it relates to LEED BD+C Energy and Atmosphere credit Optimize Energy Performance. Lighting levels will be approximately 30 foot candles in classrooms and offices. The daylight dimming foot candle level will be in compliance with LEED BD+C Indoor Environmental Quality credit Daylight.

6. *ACOUSTICS*
   The project will comply with LEED BD+C Indoor Environmental Quality prerequisite Minimum Acoustic Performance for acoustic performance levels for all school, preschool and after school programs. The design team will ensure that all classrooms meet the Sound Transmission Class (STC), background noise and reverberation time requirements of ANSI Standard S12.60-2010. Mechanical and electrical equipment adjacent to core learning spaces shall be designed to produce a maximum of 40 dBA background sound level. All core learning spaces and learning commons will be designed to the following standards:

Room Type	STC Rating
Core Learning Space	STC 50
Corridor	STC 45
Stair	STC 50
Toilet Room	STC 53
Office/Conference Room	STC 50
Music/Auditorium/Gym/Cafeteria/Mech.	STC 60

Energy Efficiency/Net Zero Potential

1. *ENERGY USE REDUCTION*
   The project was designed to comply with the IECC 2018 including Massachusetts amendments and seeks to reduce its predicted site energy use by at least 42% when compared to its ASHRAE 90.1-2010 compliant baseline. The 42% site energy use reduction goal shall be achieved without including the production of any onsite renewable energy systems. The production of onsite renewable energy systems will be included in calculations and credit templates to demonstrate compliance with LEED BD+C Energy and Atmosphere prerequisite Minimum Energy Performance and credit Optimize Energy Performance.

2. *BUILDING LEVEL & END USE ENERGY METERING*
   Metering shall be provided for utility electric and water to comply with LEED BD+C Energy and Atmosphere prerequisite Building-Level Energy Metering. Submetering is to be provided for each floor's lighting, mechanical equipment, kitchen equipment, elevators and plug loads with a BACNet interface for connection to either the BMS or a building dashboard system to comply with LEED BD+C Energy and Atmosphere credit Advanced Energy Metering.

The expected project commissioning scope includes Option 1 Path 2, Enhanced and Monitoring Based Commissioning. This project goal shall be met via the development of a First Year Monitoring Based Commissioning (MBCx) Plan and execution of this plan during the first year of occupancy. This MBCx plan is included as an attachment to the Commissioning Plan. The commissioning authority will ensure that the identified monitoring requirements are reflected accurately in the engineer's BOD, controls sequences, commissioning specifications, contractor submittals, and verify that selected system trends are set up at the completion of functional performance testing.

3. *Renewable Energy Production*

To help achieve the City and school's Net Zero energy goals the project seeks to offset as much of its electrical site energy use as possible by incorporating a roof mount photovoltaic system. As of the feasibility study, the specifics of the PV systems are still under development.

The project is expected to exceed the requirements for LEED BD+C Energy and Atmosphere credit Renewable Energy Production, producing more than 10% of the buildings' annual energy by cost.

Water Efficiency

1. *Indoor Water Use Reduction*

The project seeks to reduce overall water usage by a minimum of 35% (not including irrigation) from baseline flow fixture performance of the EPA Energy Policy Act of 1992 per LEED BD+C Water Efficiency prerequisite Indoor Water Use Reduction and credit Indoor Water Use Reduction. Potable water use will be reduced using a combination of low and ultra-low-flow plumbing fixtures and a rainwater reclamation system. This system will harvest and store rainwater from roof areas and will be used for flushing of water closets and urinals as well as the irrigation of plantings on the site.

Enhanced Commissioning Requirements

In order to meet the requirements of LEED v4 BD+C, Stephen Turner Inc. has included all enhanced commissioning tasks to be performed in the OPR below:

Option 1 Path 1 - Enhanced Commissioning

- Develop systems manual scope and format
- Develop training requirements
- Ensure enhanced Cx scope items are included in construction documents
- Review contractor submittals
- Deliver post-construction commissioning documents
- Verify operator and occupant training delivery and effectiveness
- Perform seasonal testing
- Review building operations 10 months after substantial completion
- Develop an ongoing commissioning plan

Option 1 Path 2 - Monitoring Based Commissioning

- Update Cx Plan to include MBCx requirements
- Confirm that MBCx is fully incorporated into enhanced Cx
- Implement MBCx Plan

Stephen Turner Inc. has developed detailed measures to carry out these enhanced commissioning requirements for the Tobin School project, which can be reviewed in the Commissioning Plan developed for the project.

SCHEDULE & LIMITATIONS

Stephen Turner Inc.'s understanding of the current project schedule and milestones is detailed below:

Feasibility Study Phase Complete	March 12, 2020
Schematic Design Documents	March 23, 2020 – September 18, 2020
Design Development Phase	September 28, 2020 – June 4, 2021
Construction Documents Phase	June 14, 2021 – February 25, 2022
Construction Phase	July 2017 – June 2019
Substantial Completion	August 15, 2024
First Year Occupancy Phase	August 15, 2025
Warranty End Review	October 15, 2025

COMMISSIONING PLAN

CITY OF CAMBRIDGE

TOBIN MONTESSORI & VASSAL LANE UPPER SCHOOLS

197 Vassal Lane

Cambridge, MA, 02138

Draft submitted: March 12, 2020

STEPHEN TURNER INC.
Building Better Performance

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TABLE OF CONTENTS

INTRODUCTION

Commissioning is a systematic quality process to ensure that building systems operate according to the design intent and meet the Owner's operational needs. This Commissioning Plan is intended to help guide the project team members through the commissioning process and to inform them of commissioning activities, responsibilities, and milestones. The tasks carried out during the commissioning process are tailored to incorporate the Owner's requirements. The process is highly customized for the project, meeting or exceeding all the commissioning guidance in ASHRAE Guideline 0-2013 *The Commissioning Process*, ASHRAE Guideline 1.1-2007 *The HVAC Commissioning Process*.

Stephen Turner Inc. led the commissioning team during the feasibility phase and has developed this Commissioning Plan to be used for the entirety of the project. Throughout the course of the project, the Commissioning Authority (CxA) updates this Commissioning Plan and submits the revised plan to the owner, the contractor, and the design team as appropriate.

The Commissioning Plan contains the list of the systems to be commissioned, the level of rigor for each system, and a summary of the commissioning process scope including a list of expected written deliverables and a schedule of activities. The Commissioning Plan summarizes roles and lines of communications for each member of the project team to help ensure proper communications.

LEED v4 requires this Commissioning Plan as part of the Energy & Atmosphere Prerequisite 1.

The City of Cambridge is committed to commissioning this facility to ensure that all commissioned systems are well designed, complete and functioning properly. Commissioning helps verify that the new facility design fulfills the functional and performance requirements of the owner, occupants, and the operations & maintenance (O&M) personnel. The commissioning process establishes and documents requirements for overall project goals, system function, performance, and maintainability; as well as verifies and documents compliance with these criteria throughout the design, construction, start-up, and the initial period of operation.

As the design and construction phases of the project proceed, the CxA develops and continuously updates the commissioned systems list to reflect design options and revisions to the commissioning scope.

PROJECT BACKGROUND

The City of Cambridge is planning a major renovation of the Tobin Montessori and Vassal Lane Upper Schools. The City of Cambridge has retained Perkins Eastman Architects for feasibility and design services, including a preliminary site assessment and project Feasibility Study. Commissioning services to support the Tobin School Project are being provided in two phases. Phase I commissioning services will support the efforts of the design team in preparing the Feasibility Study. A Phase II proposal will be provided in March 2020 for the remaining commissioning services required by the City of Cambridge and USGBC LEED v4 BD+C from design phase through post-occupancy. The Tobin School project's substantial completion is currently anticipated to occur in August of 2024.

The project consists of construction of a new school for preschool through eighth grade including Human Services After School and Community School spaces. The City is committed to meeting their environmental, sustainable, and "green" building goals related to energy efficiency, indoor environmental quality, and resource efficiency. The intent of the City's environmental goals is to provide a safe and healthy environment for building occupants with minimal negative impact on the local, regional, and global environment. The City's goal is to construct and/or renovate the building to achieve the U.S. Green Building Council's LEED v4.0 BD+C Gold Certification. The goal of the Feasibility Study is to provide the City a recommended option for this school and community space that will meet its programmatic and environmental goals, including Net Zero energy potential.

COMMISSIONING SCOPE

OVERVIEW

This section of the plan details each commissioning task from the beginning to the end of the commissioning process. Stephen Turner Inc. acts as the Commissioning Authority and commissioning team leader for the feasibility phase of the project. The commissioning work is performed in collaboration with the owner's team, the design team, the construction manager, and the contractors, all of whom collectively form the commissioning team.

During the Feasibility Study process, Stephen Turner Inc. will help verify that the new facility design concept options will fulfill the functional and performance requirements of the City of Cambridge, building occupants, and Operation & Maintenance (O&M) personnel. The commissioning process proposed will establish and document the City's Project Requirements for overall project goals, system function, performance, and maintainability; as well as verify and document compliance with these criteria throughout the Phase I Feasibility Study.

Stephen Turner Inc. continues to refine our specialized commissioning approach in order to accomplish the project goals. This customized commissioning approach is primarily defined by three elements: the *project schedule,* which drives the commissioning schedule; the *commissioned systems list,* which defines the extent of building systems included in the commissioning effort; and the *commissioning process,* which determines the degree of rigor applied to the various commissioned systems and components. The commissioning process complies with the requirements and with ASHRAE Guidelines 0-2013 *The Commissioning Process* and 1.1-2007 *The HVAC Commissioning Process*.

PHASE I – FEASIBILITY STUDY WORK PLAN

During the feasibility phase, the following are the commissioning tasks for the Tobin School project:

FEASIBILITY STUDY SUPPORT

Stephen Turner Inc. supported the efforts of the design team in preparing the Feasibility Study. Stephen Turner Inc. worked with the design team and the City to document key project requirements, provide recommendations on system concepts, and develop Phase II commissioning requirements to ensure the vision of the City and the Cambridge Public Schools Innovation Agenda are met. Stephen Turner Inc. participated in five (5) project meetings during the Feasibility Study phase. This feasibility study identifies recommendations for the City to make project design decisions, while supporting the overall project goals.

COMMISSIONING PLANNING AND LEED COMMISSIONING DOCUMENTATION

Stephen Turner Inc. follows the plan in coordinating and directing the commissioning activities, updates the plan, and reports on progress as implementation progresses. This commissioning plan is developed to support the commissioning process throughout the entire project, and initially focused on commissioning as it relates to the Phase I Feasibility Study.

At the end of Phase I the Commissioning Plan was expanded to include:

- A brief overview of the commissioning process
- A list of all commissioning features and systems
- Identification of primary commissioning participants and their responsibilities
- A description of the management, communication, and reporting in the commissioning process
- An outline of commissioning process scope including submittal review, observation, startup, testing, training, O&M documentation and warranty period activities
- A list of expected written deliverables
- A schedule of activities

Stephen Turner Inc.'s commissioning plan summarizes roles and lines of communications for each member of the project team to help ensure proper communications. The systems list was developed throughout the Feasibility Study Phase and documented in the OPR and Commissioning Plan.

Development of a Commissioning Plan is required by LEED v4 Energy & Atmosphere Prerequisite 1 Fundamental Commissioning and Verification.

OWNER'S PROJECT REQUIREMENTS AND BASIS OF DESIGN DOCUMENTATION

In support of the Phase I Feasibility Study, Stephen Turner Inc. will help develop the written Owner's Project Requirements (OPR) document. If needed, Stephen Turner Inc. will facilitate a single half-day or two two-hour OPR workshops to identify and document key project requirements based on input and information provided by the team and key stakeholders. These key requirements will be used to develop the OPR document, which will be the foundation of the entire commissioning process.

The OPR will document key project goals to help support opportunities for integrated, cost-effective design and construction strategies that maximize value to the City. Stephen Turner Inc. will use our knowledge and experience of high performance buildings and systems to ensure key requirements regarding energy efficiency, carbon footprint, life-cycle assessment, material quality, indoor environmental quality, water efficiency, turnover requirements, operational strategies, budget considerations, and innovative approaches for design concepts are discussed and documented in the OPR. Commissioning will focus on delivering operable, maintainable systems to the facilities team for the school. The requirements of the building users – the administration, faculty, students, and parent stakeholders – will be incorporated into the OPR as they relate to commissioned systems.

Stephen Turner Inc. will review preliminary passive and active system option narratives and provide observations and recommendations pertaining to feasibility of meeting the OPR. Stephen Turner Inc. will also review the Basis of Design document (BOD) including the engineers' schematic narratives of the preferred system option to ensure that the design intentions meet the OPR. The BOD will be incorporated into the final commissioning report.

The OPR and the BOD are LEED-required documents that help clarify how commissioning-related goals will be met. Stephen Turner Inc. will update the OPR throughout the project's Feasibility Study in preparation for use in Phase II and incorporation into the final commissioning report.

Development and review of the OPR and the BOD documents are required by LEED v4 Energy & Atmosphere Prerequisite 1 Fundamental Commissioning and Verification.

Phase II – Design Phase Work Plan

Upon completion of the feasibility phase, the following commissioning tasks will be performed by the CxA selected for the Tobin School project:

Feasibility Phase Documentation Updates

As the project design progresses, the CxA shall update the systems list, commissioning plan, and OPR as necessary to reflect the current understanding of the City's requirements and how they are being met. Updates may be required based on the LEED commissioning credits being sought. These updates shall continue throughout the construction phase and occupancy phase as needed.

Design Documents Reviews

The review process shall be tailored to support the project schedule and to address the delivery process as implemented on this project. Design reviews are part of the City's commissioning requirements, which exceed the LEED-required single design review and backcheck. As on previous new construction projects for the City of Cambridge, five commissioning design reviews and a backcheck are expected, at the following design milestones:

- 100% Schematic Design
- 50% Design Development
- 100% Design Development
- 60% Construction Documents
- 90% Construction Documents
- 100% Construction Documents (backcheck)

The CxA will provide these commissioning reviews of the drawings and specifications, participate in the design process, and comment on systems alternatives, first cost, and operating cost information. The CxA will help evaluate the impacts of innovation and added value recommendations on various building systems.

Formal commissioning reviews of the design and construction documents are performed in order to verify whether the City's project requirements are met in the project documents. Comments will be submitted to the Owner.

It is recommended that commissioning design reviews be incorporated into the design schedule to allow for time to address review comments prior to design document completion. Commissioning meetings may be held to address any comments identified during the design review process and to work toward resolution of design phase commissioning items. Design review comments that cannot be resolved are recorded and addressed through the commissioning issues log. The commissioning issues log is the central record of commissioning issues and their resolution by the commissioning team.

Commissioning design reviews are focused on:

- Facilitation of commissioning
- Sustainability
- Operations and maintenance, equipment accessibility
- Functionality

- Sequences of operation
- Building Automation System (BAS) specifications including trending and reporting features
- Test, Adjust, and Balance (TAB) specifications including adjustment, optimization, and flow rate setpoint determination procedures
- Specification requirements for contractor and vendor start-up, testing, operation and maintenance (O&M) documentation, and training
- Review of room tables including indoor design conditions, code minimum OA ventilation rate, design OA ventilation rate if higher, exhaust rate for toilets, trash rooms, etc.

Commissioning design reviews are required by LEED v4 Energy & Atmosphere Prerequisite 1 Fundamental Commissioning and Verification. If LEED v4 Enhanced Commissioning Option 1, Path 2 is selected, the CxA shall review items related to Monitoring-Based Commissioning requirements in the design documents.

COMMISSIONING SPECIFICATIONS

The CxA will develop project-specific commissioning specifications to be incorporated into the project manual. These commissioning specifications will detail the contractor requirements for participating in the commissioning process. The roles of the Architects and Engineers in the commissioning process are detailed in this Commissioning Plan. The CxA will coordinate the commissioning specifications with the other project specifications, in collaboration with the design team.

The commissioning specifications will be highly customized for the Tobin School project, meeting or exceeding the guidance in ASHRAE Guidelines 0-2013 *The Commissioning Process* and 1.1-2007 *The HVAC Commissioning Process*. As a result, the rigor of the commissioning specifications and process also meet or exceed all of the requirements of LEED v4 BD+C. The commissioning specifications provide details of and requirements for the contractors' activities related to:

- Commissioning Meetings Participation
- Submittals
- Pre-functional Checklists
- Start-up plans
- TAB execution plan
- Functional Performance Testing
- Commissioning Issues Resolution
- Training of project operating and maintenance personnel, users and occupants

Inclusion of commissioning requirements in the contract documents is required by LEED v4 Energy & Atmosphere Prerequisite 1 Fundamental Commissioning and Verification. If LEED v4 Enhanced Commissioning Option 1, Path 2 is selected, the CxA shall include Monitoring-Based Commissioning requirements in the commissioning specifications.

PHASE II – CONSTRUCTION PHASE WORK PLAN

The following tasks outline the commissioning process during the construction phase and meet the City of Cambridge's requirements as well as the requirements of LEED v4 BD+C for *Fundamental Commissioning and Verification* and *Enhanced Commissioning*.

Commissioning Coordination, Scheduling, Meetings, & Site Visits

After all trades have been bought out, the CxA will lead a construction phase commissioning kick-off meeting at which the appropriate members of the commissioning team are identified, their respective roles and responsibilities are discussed, and the commissioning process is reviewed. Emphasis will be placed on ensuring consistency between the design intent and the Owner's project goals and understanding how LEED requirements will be met to achieve LEED certification.

Regular meetings will be held throughout construction to coordinate commissioning. These meetings will be scheduled as needed prior to construction start and through early construction phases. The CxA will coordinate with the construction manager so they can ensure that all necessary contractors are represented at commissioning meetings. Commissioning team meetings are more effective if they regularly include the owner and periodically include the engineers. Early participation by Operations and Maintenance personnel is strongly encouraged and substantially smooths handover of the building upon completion.

In conjunction with the commissioning meetings, the CxA will perform site visits, observe system installation, and evaluate equipment installation. The CxA typically conducts site visits periodically through early construction phases and more frequently as start-up preparations occur and commissioned systems are brought on-line.

A project-specific commissioning schedule will be developed that shows the enabling construction activities and commissioning tasks. This schedule will be customized for the Tobin School project. The CxA will assist the construction manager and owner's project manager with incorporating the commissioning activities into the overall construction schedule. Construction and commissioning schedules will be reviewed regularly at commissioning meetings, and recommendations are offered on improvements to show realistic timeframes for commissioning activities.

Throughout this phase, the CxA will develop and maintain a Commissioning Issues Log carrying any open issues discovered during this time.

Commissioning meetings and site visits are required by LEED v4 Energy & Atmosphere Prerequisite 1 Fundamental Commissioning and Verification.

Contractor Submittal Review

The CxA will review selected subcontractor submittals for commissioned systems to verify that the submitted equipment in the commissioning scope conforms to the Owner's Project Requirements and the Basis of Design. The submittals to be reviewed are determined in accordance with LEED v4, ASHRAE Guidelines 0-2013 *The Commissioning Process* and 1.1-2007 *The HVAC Commissioning Process* and will be indicated by division or by equipment on a submittals log provided by the construction manager.

The commissioning submittals review is not typically on the critical path of the formal submittals action process, except for the Building Automation System submittal and certain other key submittals. The CxA will receive the selected submittals in parallel with the owner and the project team and will review them concurrently. Issues identified by the commissioning review will be documented in the commissioning submittal review log and brought to the attention of the owner and the project team for consideration in developing their own formal submittals action.

A project-specific Testing, Adjusting, and Balancing submittal, including an execution plan, will be required for commissioning review. This TAB execution plan will be closely reviewed and changes or improvements to the plan recommended as necessary.

Submittals for packaged and skid-mount equipment with on-board OEM controls will be required to include detailed, commissionable sequences of operation. For these and other key submittals, including the Building Automation System submittal, a commissioning review meeting is recommended to ensure that commissioning review comments are addressed as deemed appropriate by the City, the engineer, and the rest of the reviewing team before formal submittals actions are finalized. Submittal review comments that cannot be resolved will be recorded and addressed through the commissioning issues log. During the construction phase, this is the central record of commissioning issues and their resolution by the commissioning team. The CxA will update it throughout the commissioning effort.

In addition to reviewing product submittals early in construction, The CxA will review formal commissioning-related submittals throughout the project, such as warranty statements and as-built documentation. The CxA will review warranty statements to ensure that the owner's responsibilities during the warranty period for routine maintenance are clearly defined.

Commissioning review of contractor submittals is required by LEED v4 Energy & Atmosphere Credit 1 Enhanced Commissioning. If LEED v4 Enhanced Commissioning Option 1, Path 2 Enhanced and Monitoring-Based Commissioning (MBCx), is selected for this project, the CxA shall ensure that MBCx-related submittals are incorporated into the commissioning review process.

INSTALLATION VERIFICATION

The CxA will develop and provide pre-functional checklists (PFCs) for major components of commissioned systems, including controls. The checklists will be customized for the Tobin School project to ensure proper equipment installation and startup, and to identify potential issues prior to functional performance testing. The CxA will review all completed checklists for issues or deviations from the construction documents and submittals. To reduce any potential for duplication of work by the trade contractors, these checklists will be coordinated with any sub-contractor or manufacturer start-up forms provided to the CxA in advance of developing the checklists.

The CxA will provide the pre-functional checklists to the trade contractors for completion by their installation personnel and will assist the trade contractors in completing their first checklists in the field. Through the commissioning specifications, the trade contractors are responsible, along with the construction manager, for completing all checklists. The checklists are required to be complete prior to functional performance testing.

Before equipment deliveries begin, the CxA will lead a meeting on-site with the construction manager and the sub-contractors to coordinate their pre-functional checklist efforts. Issues identified through the checklists will be reviewed with the contractors at regularly scheduled commissioning progress meetings and tracked in the commissioning issues log.

For most system types, pre-functional checklists are separated into individual parts for each trade contractor and each phase of installation. A single component has as many as three parts on separate forms: one for delivery (nameplate information), one for installation (piping and mounting), and one for electrical power connections. Controls installation will be verified through partial witnessing of the controls contractor's point-to-point checkout and review of their point-to-point checkout sheets.

In addition to the component level pre-functional checklists completed by the trade contractors, the CxA may use Systems Checklists during site visits and start-up activities to verify systems level aspects of commissioned systems installation and inter-system arrangements such as Controls interfaces with Life Safety systems. The pre-functional checklists are undertaken for verification of installation and performance for energy consuming systems in the project. Their timely completion helps the commissioning team monitor and document progress towards start-up and functional performance testing.

For water and air-side Test, Adjust, and Balance (TAB), commissioning personnel will witness, and field verify, an appropriate sample of TAB work. TAB reports will then be closely reviewed to ensure that witnessed results are correctly reported, and that key findings are clearly reported to the owner and designers. The construction manager will be responsible for ensuring TAB contractor attendance at commissioning meetings, proper and timely TAB reporting, and coordination with the CxA in advance of scheduled TAB work.

For third party testing as may be required by the Engineer of Record in the construction documents, The CxA will track, review, and record the progress report submittals and final report submittals in the commissioning submittal review log.

Installation verification is required by LEED v4 Energy & Atmosphere Credit 1 Enhanced Commissioning. If LEED v4 Enhanced Commissioning Option 1, Path 2 Enhanced and Monitoring-Based Commissioning (MBCx), is selected for this project, the CxA shall ensure that MBCx-related checklists are developed and completed.

FUNCTIONAL PERFORMANCE TESTING

The CxA will develop and provide functional performance tests to evaluate the functional performance of the commissioned systems. Project designs related to commissioned systems, and received by the CxA, including Bulletins, ASIs, RFIs and Change Orders, as well as contractor-provided submittals, start-up plans, and draft O&M manuals, will be used to develop the functional performance test procedures. The CxA will work with the subcontractors and comment on their proposed start-up plans. The CxA will review control system programs with the controls contractor, and witness start-up of major equipment.

Checklist: Delivery *Contractor:*
Pre-Functional Checklist *Item:*

Note: Checklist to be completed upon arrival of equipment Serial Number: ______________

Inspected By: ______________ Date checklist completed: __________ Location: ______________

ITEM	SPECIFIED	SUBMITTED	ACTUAL
Manufacturer			
Model Number			
Water Side GPM			
Steam PPH			
Steam Supply Pressure (PSI)			
Inlet Water Temperature			
Outlet Water Temperature			
.			

Additional observations & notes: ____

Stephen Turner Inc. Blank Checklist

The commissioning specifications to be developed for this project will require the construction manager and the trade contractors to ensure that each commissioned system is fully ready for testing including completion of pre-functional checklists, documentation of point-to-point checks of all Building Automation System components, preliminary controls programming, start-up plan completion, Test, Adjust, and Balance (TAB), and final controls values entered into programs based on TAB results. The construction manager will be required to complete a Contractor's Affidavit of Readiness for Testing to confirm pre-requisite completion and/or document any outstanding work items.

The CxA will conduct a commissioning team meeting to develop the detailed functional performance-testing schedule. The contractor will perform the functional performance testing per the specifications. The Commissioning Authority's role is to set the testing requirements; direct and witness the testing; review, document, and analyze the testing results; and assist with resolution of issues. The CxA will track testing issues until corrected according to the process outlined in the Commissioning Plan.

If at any point frequent failures are occurring and testing is becoming more troubleshooting than verification, the Commissioning Authority may stop the testing and require the contractor to perform and document a checkout of the remaining units prior to continuing with functional performance testing of the remaining units. If subsequent retesting of equipment or systems fails, additional retesting will be provided as an additional service.

Deferred seasonal functional performance testing will be led by the CxA and performed with the installing contractors. The CxA will work with the construction manager to coordinate trade contractors' participation in deferred seasonal testing. See the *Occupancy Phase Work Plan* section for more detail for deferred seasonal testing.

The CxA may witness a sampling of piping tests, flushing procedures, ductwork tests, and any cleaning procedures to be confident that proper procedures were followed. Documentation of these tests and procedures is reviewed regularly during construction.

The CxA will document and include evidence of proper testing of the aforementioned systems in the commissioning Systems Manual. The CxA will notify the Owner's Project Manager in writing of any deficiencies in results or procedures and will record such instances in the commissioning issues log for resolution by the commissioning team. The commissioning issues log shall indicate clearly what system or assembly has the issue. Completion of functional and deferred seasonal performance testing related to each system or assembly, and the absence of open issues in the commissioning issues log for that system or assembly, constitutes successful verification. This, along with receipt of all documentation required by the Plans and Specifications and responses to any commissioning comments issued on the documentation, constitutes successful commissioning documentation. Verification and documentation that the system meets the Owner's Project Requirements is the overall goal of the commissioning process, per ASHRAE Guideline 0-2013 *The Commissioning Process*.

The functional performance tests fulfill the remaining LEED requirements for verification of installation and performance for energy consuming systems in the project. The CxA will compile and maintain commissioning documentation for the verification and testing process. See the *Commissioning Report* section for more detail for the commissioning report.

Functional performance testing is required by LEED v4 Energy & Atmosphere Credit 1 Enhanced Commissioning. If LEED v4 Enhanced Commissioning Option 1, Path 2 Enhanced and Monitoring-Based Commissioning (MBCx), is selected for this project, the CxA shall ensure that MBCx-related functional test procedures are developed and performed following construction but prior to occupancy.

Operations & Maintenance Documentation, Training, and As-Built Verification

The CxA will review operation and maintenance documentation provided by the contractor. The CxA will develop a centralized commissioning document that defines the required O&M, as-built, and other commissioning-related deliverables with references to the construction specifications. This activity includes verifying that equipment warranties are in place and that operation and maintenance documentation is complete, correct, and clearly stated. The CxA will work with the construction manager to schedule and conduct a meeting with the contractors and O&M supervisors to schedule the equipment training sessions along with witnessing the systems training for commissioned systems. Upon project completion, The CxA will verify that the requirements for training operating personnel and space occupants have been met. The CxA will also review the as-built documentation for commissioned systems prepared by the contractors.

O&M, as-built, and training verification is required by LEED v4 Energy & Atmosphere Credit 1 Enhanced Commissioning. If LEED v4 Enhanced Commissioning Option 1, Path 2 Enhanced and Monitoring-Based Commissioning (MBCx), is selected for this project, the CxA shall ensure that MBCx-related trainings are developed and completed.

Commissioning Report

To document the commissioning process, the CxA will develop a commissioning report to be submitted within six weeks after occupancy that compiles all commissioning documentation including completed checklists, forms, and related project documentation provided. This report will include an executive summary, pre-functional checklists, functional performance tests, open issues, site visit reports, findings, and other relevant information. A supplement will be provided at the end of the first year monitoring period that incorporates collected energy use and trend data information as well as updates to commissioning issues during the first year of systems operation.

A commissioning summary report is required by LEED v4 Energy & Atmosphere Credit 1 Enhanced Commissioning.

Phase II – Occupancy Phase Work Plan

First Year Monitoring/Monitoring-Based Commissioning

Throughout the first year, the CxA will visit the building monthly, assist the Tobin School with operational issues, and optimize the operation of the building systems. As part of this progressive optimization process, the CxA will work with the controls contractor to set and collect trend logs for monitoring and analysis. Data collected over time will inform recommendations to the Operations staff.

If LEED v4 Enhanced Commissioning Option 1, Path 2 Enhanced and Monitoring-Based Commissioning (MBCx) is selected, the CxA shall develop a detailed MBCx Plan to guide these first year efforts. This MBCx Plan shall be developed as the design phase progresses and reviewed with the project team. The MBCx Plan shall be incorporated into the First Year Monitoring Plan, and shall include the following LEED-required elements:

- Defined analysis procedures, including frequency during year one
- Evaluation process and procedure for handling system conflicts, usage profiles, and out-of-sequence operations
- Preventive planning and maintenance procedures necessary to meet performance goals

- Measurement requirements and whether predictive algorithms can be used in conjunction with metered points

First year optimization will also include:

- The monthly collection of building energy use and benchmark data to compare against predicted energy use and an average comparable school building in the Northeast.
- A quarterly review and analysis of operations trend data for select commissioned systems to verify continued proper systems operation.
- A quarterly review and analysis of space temperature and CO2 trend data for a sampling of building spaces to verify satisfactory indoor environments.
- Quarterly meetings with O&M staff to review findings from review and analysis of building energy use, commissioned systems and space trend data. These quarterly meetings will also be used to discuss any specific questions or concerns the O&M staff.

DEFERRED SEASONAL TESTING

The CxA will verify that the new energy using systems meet the Owner's Project Requirements in heating and cooling modes. This seasonal testing will be led by the CxA and performed with the installing contractors in the manner detailed in the section on *Functional Performance Testing* above. This testing is intended to verify that the project requirements of commissioned systems are tested under design conditions in both heating and cooling modes. Since the completion of the project is expected to occur in the cooling season, the building will be initially commissioned in cooling. Then, the CxA will return to the project within 6 months and leads commissioning functional performance testing of the building in the winter mode.

Deferred seasonal testing is required by LEED v4 Energy & Atmosphere Credit 1 Enhanced Commissioning.

SYSTEMS MANUAL, CURRENT FACILITIES REQUIREMENTS, AND OPERATIONS & MAINTENANCE PLAN

The CxA will provide an electronic systems manual to meet LEED requirements for systems operation documentation. This master document will fulfill all LEED requirements for the systems manual, Current Facilities Requirements, and Operations and Maintenance plan. It will contain all necessary information related to operating, maintaining, and improving the performance of the commissioned systems. This systems manual will include additional information gathered during commissioning, a brief overview of the design intent for each commissioned system, and a summary of unique findings and special knowledge for use by O&M personnel. The BAS set points and related configuration settings for control systems microprocessors provided by the BAS contractor will be included in the systems manual for use in operation and maintenance. The systems manual will also include a preventive maintenance schedule, ongoing commissioning tasks and schedule, and as-built drawings and controls sequences.

The systems manual, Current Facilities Requirements, and Operations & Maintenance Plan are required by LEED v4 Energy & Atmosphere Credit 1 Enhanced Commissioning. If LEED v4 Enhanced Commissioning Option 1, Path 2 Enhanced and Monitoring-Based Commissioning (MBCx), is selected for this project, the CxA shall include MBCx-related operations into the manual.

Ten-Month Warranty Review

Near the end of the warranty period, ten months after move-in, the CxA will visit the project to review building operation with the O&M and facility staff. At this time, the CxA will review the status of issues related to the original commissioning process that may still be outstanding. The CxA will provide suggestions for improvements and identify equipment issues that may be covered under Contractors' or Manufacturers' warranty. The CxA will assist the facilities staff in developing reports, documents, and requests for services to remedy open commissioning issues. The ten-month review is conducted at appropriate times in conjunction with the first year optimization meetings detailed above.

Ten-month warranty review is required by LEED v4 Energy & Atmosphere Credit 1 Enhanced Commissioning.

First Year Supplement

At the end of the first year monitoring period, the CxA will provide a supplement that incorporates collected deferred seasonal testing results, energy use and trend data information as well as updates to commissioning issues during the first year of systems operation.

A supplemental commissioning report is required as part of LEED v4 Energy & Atmosphere Credit 1 Enhanced Commissioning.

Commissioned Systems

Systems required to be commissioned by LEED that are expected to be in the project at this time are listed below. The commissioning process will be applied to the systems and components listed below in a manner that complies with the owner's and LEED requirements. The commissioned systems and equipment types for the project will be refined as the project moves forward and the Cx Plan is updated.

Commissioned Building Systems	Pre-Functional Checklists	Functional Performance Testing*
HVAC Systems and Associated Controls		
Boilers	Yes	100%
Chillers	Yes	100%
Domestic Hot Water Heating Coils	Yes	100%
Hot Water Reheat Coils	Yes	100%
Heat Exchangers	Yes	100%
Pumps & Drives	Yes	100%
Air Handler Systems	Yes	100%
Rooftop Units	Yes	100%
Heating & Ventilating Units	Yes	100%
Induction Units	Yes	30%
Unit Ventilators	Yes	30%
Cabinet Unit Heaters	Yes	30%
Fan Coil Units	Yes	30%
Unit Heaters	Yes	30%
Radiant Panels	Yes	30%

Commissioned Building Systems	Pre-Functional Checklists	Functional Performance Testing*
Fin Tube Radiation	Yes	30%
Convectors	Yes	30%
VAV/CAV	Yes	30%
Exhaust Fans	Yes	30%
Ductless Split AC Units	Yes	100%
Make-Up Air Unit	Yes	100%
Heat Recovery Systems	Yes	100%
TAB Spot Check	N/A	10%
Building Automation System	Yes	100%
Plumbing Systems		
Domestic Water Booster Pump	Yes	100%
Domestic Water Heaters	Yes	100%
Domestic Hot Water System	Yes	100%
Recirculation Pumps	Yes	100%
Solar Thermal System	Yes	100%
Safety Shower/Eyewash Stations	Yes	100%
Mixing Valves	Yes	100%
Irrigation Systems	Yes	100%
Electrical Power Systems		
Electrical Service and Switchboard	Yes	100%
Electrical Distribution System	Yes	30%
Dry Type Transformers	Yes	100%
Generator	Yes	100%
Automatic Transfer Switches	Yes	100%
Lighting and Lighting Controls	Yes	30%
Photovoltaic Systems	Yes	100%
Connections to Equipment in Section 019113	Yes	Support
Life Safety Systems		
Division 21:		
Fire Suppression Systems	N/A	Documentation & Testing Review – 100%
Fire Pump Systems	N/A	Documentation & Testing Review – 100%
Division 23:		
Egress Pressurization Systems	Yes	100%
Division 26:		
Egress Lighting	Yes	100%
Division 28		
Security Systems	Yes	100%

Commissioned Building Systems	Pre-Functional Checklists	Functional Performance Testing*
Fire Alarm Systems	Yes	Documentation & Testing Review – 100%

COMMISSIONING TEAM

Commissioning Team Communication (Contact Information)

Team Member	Contact Names	Company Information
Owner	Brendon Roy Construction Project Manager broy@cambridgema.gov	City of Cambridge 795 Massachusetts Ave. Cambridge, MA, 02139 617.349.4000
Feasibility Phase Commissioning Authority	Stephen Turner Principal-in-Charge stephen@sturnerinc.com Nate Taylor Project Manager nate@sturnerinc.com	Stephen Turner Inc. 317 Hope St. Providence, RI, 02906 401.273.1935
Architect	Carolyn Day Project Manager c.day@perkinseastman.com	Perkins Eastman 20 Ashburton Place, Floor 8 Boston, MA, 02110 617.449.4043
MEP/FP Engineer	Phil Whitton Senior Project Manager pwhitton@rfsengineering.com	RFS Engineering 50 Milk St., 16th Floor Boston, MA, 02109 617.494.1464
Construction Manager	Evan Moore emoore@wtrich.com	W.T. Rich 29 Crafts St., #300 Newton, MA, 02458 617.467.6010
Mechanical Contractor	TBD	TBD
Electrical Contractor	TBD	TBD
Plumbing Contractor	TBD	TBD
Controls Contractor	TBD	TBD

COMMISSIONING TEAM – DESCRIPTION OF ROLES AND RESPONSIBILITIES

Party	Function	Written Cx Products
Owner	Advocate the commissioning process across the project team and facilitate resolution of issues identified through the commissioning process. Define system performance criteria. Provide access to information relating to base building systems design, facility staff, and maintenance procedures. Provide input in to the quantity & type of training desired. Encourage User and Non-User representatives to participate in the commissioning process.	Owner's Project Requirements
Commissioning Authority (CxA)	Coordinate the Cx process. Review contractor submittals for commissioned systems listed Task 7 of this plan. Develop pre-functional checklists and coordinate Contractor completion. Periodically observe equipment and system installation during construction. Develop functional performance test procedures. Oversee, direct & document functional performance testing. Review O&M manuals for commissioned equipment and systems. Review Contractor-provided training. Document seasonal performance testing by Contractor. Conduct meetings with project and operations staff during warranty period & coordinate resolution of issues that arise.	Cx specifications Cx plan Selected submittal reviews Design reviews Functional performance test procedures Cx issues log Commissioning report Systems manual Near-warranty end review report
Design Team (A/E)	Define system functionality and performance characteristics. Specify start-up, testing, training, warranty, and documentation requirements. Periodically observe equipment / system installation during construction. Resolve questions relating to system design Review and approve the air and water balance report Approve O&M manuals.	Basis of Design Document
Construction Manager (CM)	Ensure tier contractors for commissioned systems provide specified level of quality and functionality, including Cx support. Integrate commissioning into the construction process and master schedule. Facilitate and support the Cx process. Participate in the Cx process and coordinate tier contractor participation.	Commissioning-related project deliverables
Tier Contractors (Subs)	Participate in the commissioning process and Cx meetings. Provide specified level of quality, functionality, and Cx support. Complete Pre-Functional Checklists. Provide Manufacturer startup reports. Execute Functional Performance Test procedures under the direction of the CxA; demonstrate proper system performance. Develop and provide training. Provide seasonal performance testing.	Commissioning-related project deliverables

SCHEDULE

Stephen Turner Inc. understands the schedule milestones for the Tobin School project to be as follows:

Phase I

Feasibility/Planning	Feb. 2019 – Mar. 2020

Phase II

Design Phase	Mar. 2020 – Feb. 2022
Schematic Design	Mar. 2020 – Sep. 2020
Design Development	Sep. 2020 – Jun. 2021
Construction Documents	Jun. 2021 – Feb. 2022
Construction Phase	Jul. 2020 – Jul. 2024
Substantial Completion	August 2024
Building Occupancy	September 2024

COMMISSIONING ACTIVITIES RELATED TO SCHEDULE

In order to minimize impact on the project schedule while maximizing the benefits of the commissioning process, it is important for the entire project team to understand how the commissioning tasks are incorporated into the project schedule.

During schedule development, the CxA coordinates with the project management team to incorporate critical commissioning activities into the schedule. Stephen Turner Inc. recommends providing sufficient detail in the schedule to clearly convey the activity dependencies, process flows, milestones related to commissioning, and the time impacts of specialized systems.

At a minimum, Stephen Turner Inc. recommends that the schedule identify three key activities:

- Pre-functional Checklist checkout of important equipment
- Functional Performance Testing
- Contractor-provided Training

PRE-FUNCTIONAL CHECKLISTS

Two types of Pre-Functional Checklists (PFCs) may be used by the Commissioning Team:

- Component-based PFCs – specific equipment Checklists for each major commissioned component
    - These are provided by the CxA for completion by the Trade supplying each major component
- Systems-based PFCs – not specific to individual components, broader assessment
    - These are completed by the CxA to monitor the quality and completion of each commissioned system

Functional Performance Testing

Final building systems and inter-system functional performance testing can impact the critical path of the schedule. Functional Performance Testing (FPT) can be started as systems are completed but MUST be preceded by the following:

- Contractor submission of draft equipment O&M manuals
- Completed equipment/system installation
- Contractor submission of completed Pre-Functional Checklists
- Completed equipment/system start-up
- Contractor-owned Testing, Adjusting, and Balancing (TAB)
- Completed installation of controls including point-to-point checks and final programming
- Completed Contractor's Affidavit of Readiness for Testing

Contractor-Provided Training

The Project Team and Contractors need to work together to establish the training schedule and any anticipated seasonal performance testing, so that the schedule impact can be identified early.


STAFF
NOTES
TIME SIGNATURES
SYMBOLS
PIANO 101
CASIO

A4.0

OTHER DESIGN OPTIONS

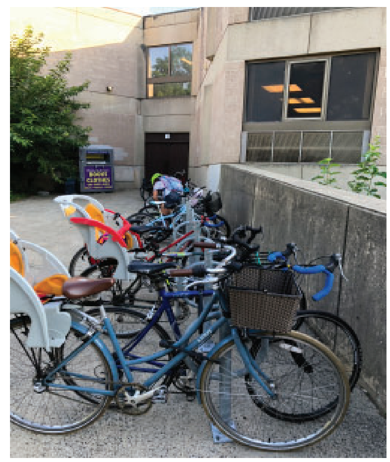
TRAVERSE
landscape architects

May 2019

EXISTING CONDITIONS ASSESSMENT
Building: John M. Tobin Elementary School
Schools: Tobin Montessori School and Vassal Lane Upper School
197 Vassal Lane, Cambridge, MA 02138

A. Site Access and Circulation

The Tobin Montessori and the Vassal Middle School are combined in one building facility at 197 Vassal Lane in Cambridge. The site is located near Fresh Pond and Fresh Pond Parkway to the west and Concord Avenue to the north. There is a mix of residential and commercial properties surrounding the school property. The property includes the building, drop off loop, parking lot, two playgrounds, three ball fields and two basketball courts used by both the school and the community.



Main vehicular access is the drop off/pick up loop coming in and out of Vassal Lane at the front of the school. The staff parking lot is also accessed off of Vassal Lane which also includes access to the service area.

Pedestrians access the site from both Concord Avenue to the north and Vassal Lane to the south by way of sidewalks on both streets connecting to the neighborhoods to the north, east and south as well as Fresh Pond Parkway to the west.

Public transit includes bus routes and a stop along Concord Avenue.

Designated bike paths are located throughout the neighborhood and specifically the AlewifeT/Minuteman Bike Path rund along Vassal Lane in front of the school. Bike racks are located throughout the school and park site including several near the main entrance to the school.

B. Parking, Paving, Service and Emergency Access

Parking is located in the back of the school building. The school is registered to have 60 spaces. This includes 2 accessible spaces. There is also access to a service area on the north side of the building. The lot is over capacity during the school days with cars parked in unmarked spaces, along edges and along the access driveway.

Emergency access is along the front drop-off loop as well as the parking lot which leads to Callanan Park. Further emergency access is along the bituminous path along the east property line.

C. Amenities

The project site has several noteworthy amenities including little league fields, basketball courts, playgrounds, walking paths, storage, drinking fountains, security fencing, landscaping, lighting, seating, receptacles and signage. The community uses the recreational amenities as well as the school.

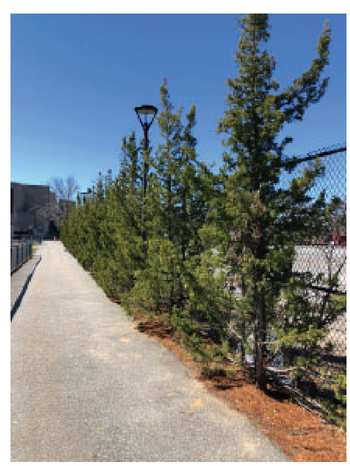
There are several amenities that serve the little league fields and two plaques identifying the main field as well as honoring all the fields. These are documented to the right. Other amenities are in good functional condition and include the following:

- bleachers
- storage
- fencing and safety guard
- flag pole
- irrigation
- fenced dugouts with benches
- backstops
- maintained skinned infields and baselines
- litter receptacles
- bike racks

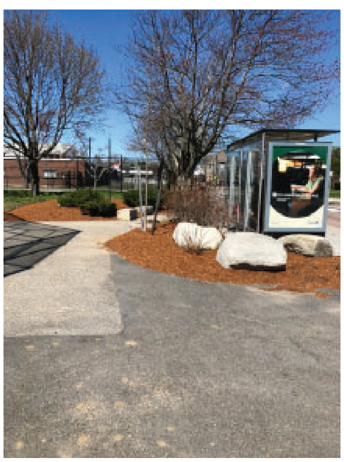
TRAVERSE
landscape architects

The overall park named Reverend Patrick H. Callanan Park is owned and maintained by the City of Cambridge. These items are functioning and in good condition and include the following:

- lighted path
- two basketball courts with benches and shade trees
- one picnic table
- tot lot with play equipment, seating and water play
- playground with play strucuture, pavement markings and hard court area
- benches
- stone seat blocks
- drinking fountain
- spot lights
- emergency call box



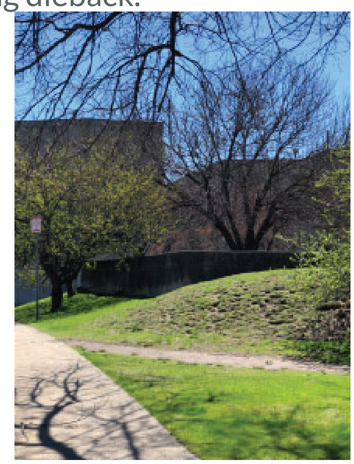
There are additional amenities along the Concord Avenue streetscape including bike racks, special paving, bus shelter, major crosswalk to Fern Ave, pedestrian safety islands, linkage to Danehy Park to the north, litter receptacles and generous sidewalks. These items are functioning and in good condition.

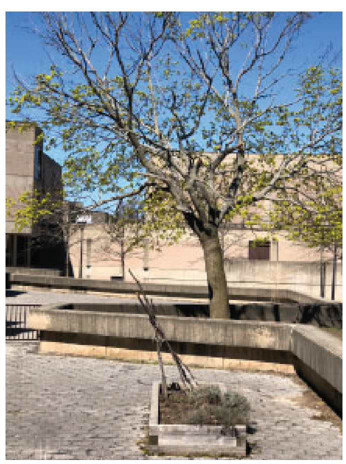


D. Landscape

There are a significant number of mature trees on the school and park property including Oak, Maple, Sycamore and Pine. Most of these significant trees are located along the perimeter of the property. There are younger species of Oak and Maple and Juniper around the playgrounds and improved park areas. There are a variety of ornamental trees of various sizes and ages located around the school.

Most of the vegetation has withstood excess compaction due to pavement and playground conditions and is not irrigated. There are a few trees showing more stress including the pines between the parking lot and the adjacent Armory property as well as some of the older ornamental trees surrounding the building. Additionally, some of the Maples around the basketball court are showing dieback.



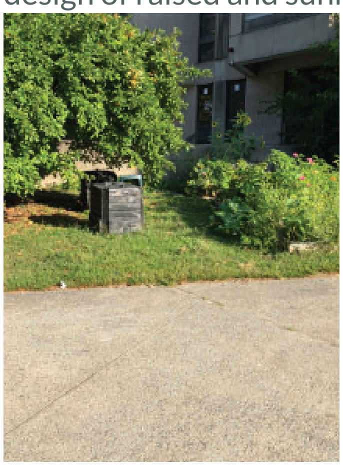


E. School Gardening and Outdoor Learning

The CitySprouts Program is a non-profit organization with a mission of advancing and promoting outdoor gardening and learning by supporting the students and the staff at the Pre-K through Grade 12 public schools in the City of Cambridge as well as the City of Boston.

CitySprouts provides teacher support to Tobin Montessori and Vassal Middle School teachers as well as run an after school club and summer programs. Tobin and Vassal share raised garden beds, storage shed and gardening equipment as well as provides teachers with specific lessons that support the academic goals of the classrooms.

The Tobin Montessori and Vassal Lane Upper School has several garden areas in the courtyards formed by the building's unique design of raised and sunken spaces.



F. Miscellaneous

The courtyards formed by the building design offer unique outdoor spaces that are enclosed by walls. They have been used in a variety of ways including outdoor play, murals, picnic tables and outdoor gardening and learning.

There is also a space created for parents away from the main school entrance which includes benches, planters and a painted rock garden.

Recently a commuter bike program has been installed along the school drop-off area.

There is a main entrance plaza off of the drop off loop which is a concrete sidewalk with a slope at the front doors that does not meet code for accessibility.

Carolyn Day
Perkins Eastman
20 Ashburton Place, Floor 8
Boston, MA 02108

Date: July 8, 2019

Memorandum

Project #: 14518.00

From: Sean Manning, PE, PTOE
Ashley Berthaume
Carl Giordano

Re: Tobin Montessori & Vassal Lane Upper School Existing Conditions Assessment

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On behalf of the City of Cambridge, Perkins Eastman is conducting a feasibility study for the construction of a new John M. Tobin Montessori School and Vassal Lane Upper School in Cambridge, MA. VHB Inc. is providing transportation engineering services to support the team in assessing the Project's viability on the existing school site and conducting an existing conditions assessment to help in the development of forthcoming conceptual design alternatives. The existing conditions assessment includes counts, observations and analysis of existing transportation conditions on site. This has included assessment of curbside operations to help identify future transportation infrastructure needs for parents, buses, vans and staff. We also studied parking conditions, bicycle use and infrastructure and pedestrian activity. Additionally, user group meetings were held with key school representatives and CPS staff to get their specific input and feedback about the elements of transportation that they believe work well or are currently challenged. The goal of this effort is to clearly understand and quantify current transportation conditions so that future transportation infrastructure needs can be articulated, quantified, and evaluated in the context of conceptual alternatives for both renovation and addition of the existing building and new buildings located on various locations of the site.

EXISTING CONDITIONS ASSESSMENT

Study Area

The Tobin Montessori School and the Vassal Lane Upper School are bounded by Vassal Lane to the south and by Concord Avenue to the north. The main entrance, drop-off/pick-up circle, staff parking lot, and loading bay are all accessed via Vassal Lane. The schools are accessed via walkways connecting to the staff parking lot and Vassal Lane via Concord Avenue. The schools also abut Fresh Pond Parkway (US Route 3) to the west, and Alpine Street to the east, but these two roadways do not provide direct access to the Schools. **Figure 1** illustrates the existing site access and egress.

Vassal Lane is a one-lane, one-way eastbound roadway that runs along the frontage of the Schools. The posted school zone speed limit within the vicinity of the Schools is 20 mph. Sidewalks are present along both sides of the roadway, and land use is primarily residential within the vicinity of the Schools. On-street Cambridge resident parking is provided on both sides of the street.

Concord Ave is an east-west, two-lane roadway that runs along the playing fields and the Cambridge Armory behind (north) the Schools. There is no posted speed limit along the roadway in the vicinity of the project area. Sidewalks are present along both sides of the roadway, and land use is primarily residential within the vicinity of the Schools.

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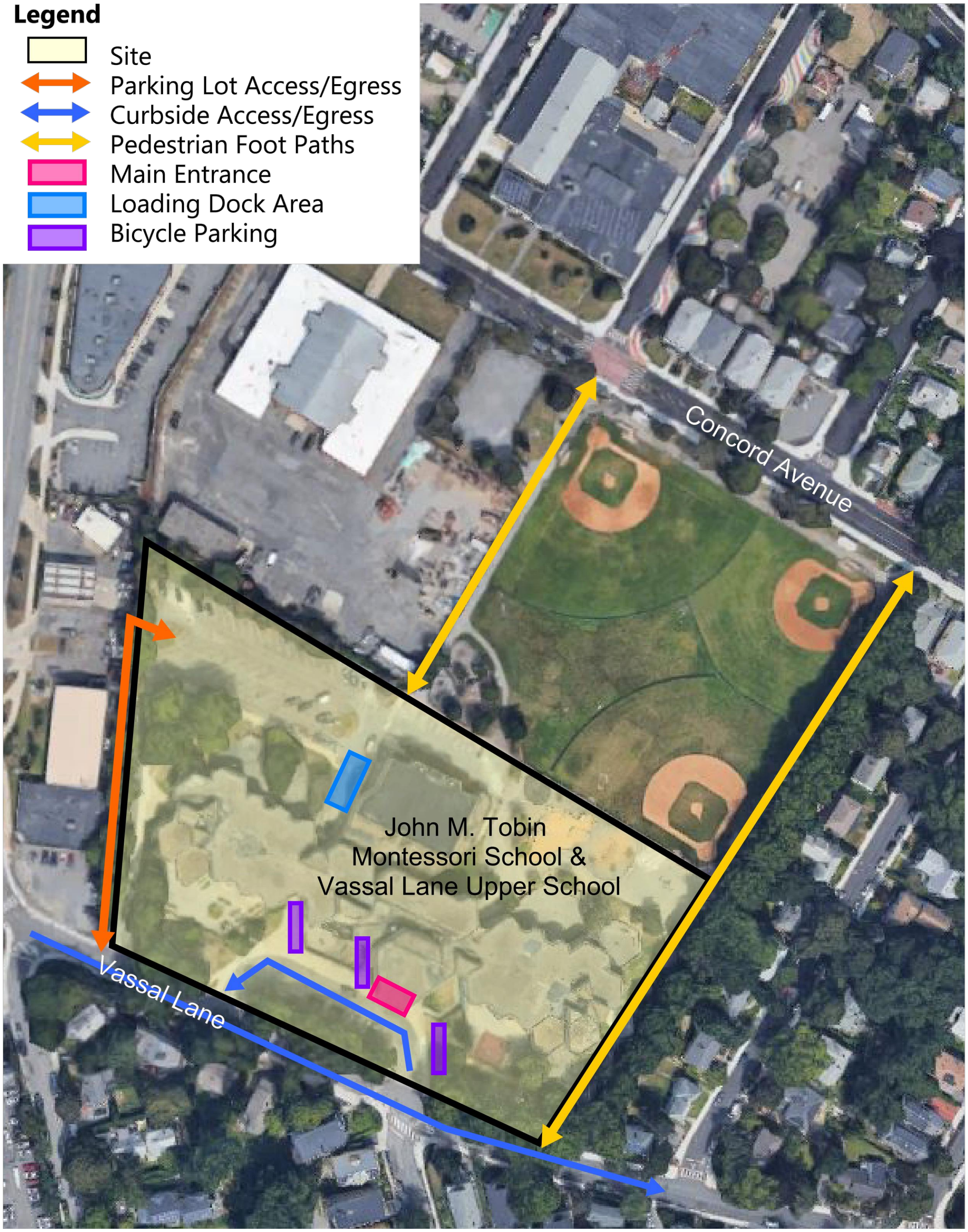

Figure 1

Site Access and Egress
Existing Conditions Assessment

Tobin Montessori School and
Vassal Lane Upper School Feasibility Study

Existing Site Operations

To understand operations related to site access, egress, and circulation for school buses and vans, parent pick-ups and drop-offs, walkers, bicyclists, and employees at the two Schools, along with curbside operations and on-site parking, VHB Inc. met with the Tobin Montessori School and Vassal Lane Upper School principals on February 26, 2019 prior to field observations to discuss arrival and dismissal activity. During the meeting, the principals highlighted areas that require the most improvement as well as areas that function well under existing daily activity.

Currently, buses and vans use the one-way circle off Vassal Lane to drop off and pick up students. Parents are requested to park along Vassal Lane to drop off and pick up students to ensure buses and vans have enough space to maneuver the circle, although some parents do choose to use the circle anyway. No drop-offs or pick-ups occur along Concord Avenue. Students who walk to school utilize the walkways as well as the sidewalks along Vassal Lane and adjacent neighborhood streets. Bicycle parking, as well as Blue Bikes, are provided at the main entrance. **Figure 1** illustrates the bicycle rack and Blue Bike locations, along with access and egress locations, as previously described.

Additionally, the principals outlined the following student and staff profiles:

Tobin Montessori School

- There are approximately 310 students ages 3 – 11 years old in Pre-K – Grade 5.
- Students begin to arrive at 7:15, when breakfast is provided by the school. The school day begins at 7:55 AM and ends at 1:55 PM.
- There are approximately 70 staff.
- Staff begin to arrive before 7:00 AM, but most arrive between 7:10 and 7:30. Most staff leave after the school day ends and their bus duties are finished.
- Afterschool program (through Cambridge Department of Human Service Programs (DHSP)) runs Monday – Friday from 1:55 PM to 6:00 PM.
- There are many parents who bring their students to school in cars, park, and walk their students into the school. This is required for students who are 3 years old only, although many parents of students ages 4 and older also park and walk their students in. At dismissal, parents wait for their students in the lobby.

Vassal Lane Upper School

- There are approximately 300 students ages 11 – 14 years old in Grades 6 – 8.
- Students begin to arrive at 8:15 AM, when breakfast is provided by the school. The school day begins at 8:55 AM and ends at 2:55 PM.
- There are approximately 53 staff.
- Most staff arrive between 8:15 and 8:30. Most staff leave after the school day ends and their bus duties are finished.

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- Afterschool activities take place Tuesday – Thursday from 2:55 PM to 4:30 PM.
- Students are not typically accompanied by parents into the school; vehicle congestion is therefore much lower compared to the Tobin Montessori School.

Each school has its unique challenges reflective of the range of student age groups. The principals noted the heaviest congestion occurs during arrival and dismissal of Tobin Montessori School students due to the larger volume of parent vehicles transporting younger students, and three additional buses serving those students.

DHSP Programs

- *Early Arrival* – Breakfast is provided to students starting at 7:15 for the Tobin Montessori School and 8:15 for Vassal Lane Upper School each morning, 40 minutes prior to the start of the school day.
- *After-School Program* – After-school activities are provided for Tobin Montessori School and Vassal Lane Upper School students, along with other students at nearby schools. There are 125 students currently enrolled, and daily attendance averages to about 80 students. There are about 12 – 17 staff that typically work for the program. The program starts at the end of the school day at 1:55, and students are typically picked up by parents from 4 – 6:00 PM. Parents must accompany students out of the school for pick-ups.
- *Summer Camp Program* – During summer break, a day camp is provided for students. There are 125 students who are currently enrolled. The program runs from 8:00 AM to 5:30 PM. Staffing is similar to that of the After-School Program. About 4 times each week, students participate in field trips off-site, requiring up to 4 buses each trip. Parents must accompany students into and out of the school for pick-ups and drop-offs.

Site Observations and Data Collection

Overview

VHB conducted field observations and data collection on Tuesday, March 5, 2019 during school day arrival, dismissal, and after school dismissal to observe the concerns discussed with the Schools' principals, to quantify the volume of activity during the busiest times of the day, to quantify where the activity takes place, to assess parking demand and supply in the staff parking lot, and to document other noteworthy transportation/access/circulation activity. The field work helped form a picture of daily arrival and dismissal activity at the Tobin Montessori School and the Vassal Lane Upper School to provide a basis for the development of conceptual design alternatives.

During field observations, all pedestrian, bicycle, bus, van, and private car activity occurring at the curbside within the circle and along Vassal Lane was documented. "Drop-offs" and "pick-ups" were observed when parents did not get out of their cars and let their students walk in alone. This activity was distinguished from parents who parked their cars and walked their students into the school due to the greater traffic impact associated with the latter activity.

Field observations began prior to the arrival of the earliest Tobin Montessori School students at 7:15 AM, and lasted through late arrivals after the school day began at 7:55 AM. Observations for the Vassal Lane Upper School began soon after to capture early arrivals and ended after the school day began at 8:55 AM. Afternoon observations began

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prior to the arrival of the majority of parents picking up students at the Tobin Montessori School, and lasted through school dismissal at 1:55 PM for late pick-ups. Observations for the Vassal Lane Upper School began soon after and lasted through school dismissal at 2:55 PM. VHB staff remained on site to observe the Vassal Lane Upper School late bus dismissal, which occurred at 4:15 PM. Weather conditions were clear and cold with moderate snow banks along Vassal Lane from a recent storm, but travel conditions were good.

The cold, inclement weather in March, was not conducive for bicyclists, therefore additional, supplemental observations specifically related to bicycle operations were conducted on Wednesday, May 8, 2019 from 7:00 AM to 9:30 AM. It was assumed the reverse bicycle activity would occur during afternoon dismissal.

Below is an overview of findings from the arrival and dismissal observations:

General findings

- Tobin Montessori School arrival and dismissal activity was observed to be heavier and more challenging than that of the Vassal Lane Upper School due to the higher level of parent involvement during these times, which is driven primarily by the younger age profile of those students. Many Tobin Montessori School parents park their cars and walk their students in, creating congested traffic conditions both in the drop-off area as well as along Vassal Lane. Few Vassal Lane Upper School students were walked in by parents, and many students walked by themselves and with other students, creating less congested traffic conditions.
- Staggered Tobin Montessori School and Vassal Lane Upper School arrival and dismissal times were highly important to the functionality of traffic operations.

Buses and vans

- Buses were observed to have limited space within the circle, frequently driving over the curb, maneuvering forwards and backwards to make the turn into the circle, or having to wait in Vassal Lane for other vehicles in the circle to clear.
- Buses were also observed to move very slowly along narrow sections of Vassal Lane where cars were parked on both sides of the street.
- Bus arrivals were spread out through each arrival and dismissal period, which limited long queues of buses.

Walkers

- The crossing guard was effective helping pedestrians cross at the intersection of Vassal Lane and Standish Street during peak activity levels.

Bicyclists

- The majority of bicyclists were observed coming from the neighborhoods to the south and east of the school. Younger students tended to be accompanied by parents, while older students traveled to school alone.
- The Bluebike station was observed being used for traveling to and leaving the school.

Parking and Loading

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- The staff parking lot is heavily used; demand exceeds the supply of 64 striped spaces (includes 2 handicap spaces). Cars were observed to be parked in any available space, including along the lot driveway. The number of cars parked in the lot was approximately 80.
- According to the City of Cambridge, the school is registered for 60 institutional parking spaces (provided by a 1990 parking inventory).
- Although parking spaces are not striped within the circle at the front entrance, signage indicates there are approximately five accessible parking spaces. As many as 12 cars plus 2 buses were observed to be parked in the circle at one time.
- The loading dock has space to accommodate one vehicle at a time. Cars were observed to park along the sidewalk along the loading dock driveway.

Morning Student Arrival

A summary of the data collection for the morning arrival period is presented in **Table 1 and Table 2**. The data were broken down into 10 or 15 -minute intervals and were categorized by the type of activity (bus, drop off, walking, bicycle, et cetera). One count was treated as one family unit (for example, one drop-off equals one parent car dropping off students, and one walker equals either one family walking together, or one student walking by themselves if not accompanied by an adult). Bus and van arrivals were counted as each vehicle arrived.

A summary of the distribution/location of activity is presented in **Table 1** for each type of activity, shown as a percentage of observations (for example, 90% and 75% of morning student drop-offs for the Tobin Montessori School and Vassal Lane Upper School, respectively, occurred within the circle, followed by drop-offs occurring along Vassal Lane immediately in front of the school).

Below are the key findings for the morning arrival observation period:

Parent drop-offs and parents who park and walk students in

- Morning drop-offs occurred mostly in the circle and were spread throughout the 20-30 minutes prior to the start of the school day.
  - Tobin Montessori School: 45 total drop-offs occurring primarily in the circle.
  - Vassal Lane Upper School: 43 total drop-offs occurring mostly in the circle, but about 20% occurring along Vassal Lane in front of the School.
- Many Tobin Montessori School parents (68 total) parked their cars, mostly along Vassal Lane but also within the circle, and walked their students in, with the most observations (34) occurring during the 10 minutes prior to the start of the school day. These parents typically remained parked for 10 – 20 minutes.
- Only five (5) Vassal Lane Upper School parents parked and walked in with their students.

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Walkers

- Many Vassal Lane Upper School students (66) walked to school without parents, coming from multiple directions, primarily during the 20 minutes prior to the start of school.
- A much smaller volume of Tobin Montessori School students with parents (12) walked in the morning.

Bicyclists

- During the March 2019 observations,
    - One (1) Vassal Lane Upper School student was observed to bike to school, coming from the west.
- During the May 2019 morning observations,
    - A total of nine (9) Tobin Montessori School students rode bicycles to school accompanied by parents, with the majority arriving between 7:30 and 7:45. At least five (5) parents were observed leaving the school on bikes after dropping students off.
    - Twelve (12) Vassal Lane Upper School students biked to school without parents, primarily arriving between 8:30 and 8:45.
    - In total, four (4) teachers arrived by bicycle.
    - In total, three (3) adults left the school grounds on Bluebikes. One (1) adult arrived at the school on a Bluebike and entered the school after 9:00.
    - Several bicyclists not associated with the school were observed travelling in both directions along Vassal Lane.
    - It was observed that the Tobin Montessori School students tended to enter the school via the main entrance, while many Vassal Lane Upper School students tended to enter the school via the western entrance.

Figures 2 and 3 provide a graphical representation of the data presented in **Table 1. Figure 2** shows volumes of vehicles as they arrived, and Figure 2 shows the maximum number of vehicles dwelling at once during a given time period. Drop-offs were broken down to represent the activity occurring in the circle versus the activity occurring along the street. These include parents who parked and walked with their students.

Figure 3 illustrates, in the 10 minutes prior to the start of the Tobin Montessori School day, the maximum number of vehicles parked at the same time in the study area is approximately 26 cars along all of Vassal Lane, 12 vehicles along the circle, and 2 buses along the circle. During this time period, the circle was observed to be at or over capacity. Cars were observed to park along the near side of the circle causing buses to wait for them to move, and along the far side and ends of the circle, creating difficult maneuvering conditions for buses. At the same time, all parking spaces along Vassal Lane were observed to be occupied. Families parked directly across from the School on Vassal Lane were observed to cross the street outside of crosswalks, but all other pedestrians typically used crosswalks and sidewalks.

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Cars were not observed to double-park along Vassal Lane. Many families arrived on foot after having parked east of the School on Vassal Lane, or nearby side streets, such as Standish Street.

During all other time periods, arrival conditions were observed to be less challenging. Based on the field observations the time period prior to the start of the Tobin Montessori School would drive discussions on improving morning arrival operations.

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Table 1 Morning Arrival Activity at Tobin Montessori and Vassal Lane Upper School

Tobin Montessori	**Bus Arrivals** In Circle	**Van Arrivals** In Circle	**Drop-Offs**	**Parent Parks and** Walks Child In	**Walkers**
7:15 - 7:25 AM	2	0	6	2	4
7:25 - 7:35 AM	2	0	9	4	2
7:35 - 7:45 AM	3	2	11	18	3
7:45 - 7:55 AM	1	0	13	34	3
7:55 - 8:05 AM	0	0	6	10	0
Totals	**8**	**2**	**45**	**68**	**12**
			90% Circle 5% Vassal Ln in Front of School 5% Standish St	40% Vassal Ln in Front of School 25% Circle 25% Vassal Ln East of School 10% Standish St	33% Vassal Ln East of School 25% Standish St 25% Pathway 17% Staff Lot or West of School
Vassal Lane Upper					
8:15 - 8:25 AM	1	0	4	1	7
8:25 - 8:35 AM	2	1	11	2	14
8:35 - 8:45 AM	1	1	15	1	28
8:45 - 8:55 AM	1	1	13	1	17
Totals	**5**	**3**	**43**	**5**	**66**
			75% Circle 20% Vassal Ln in Front of School 5% Standish St	60% Circle 40% others	40% Staff Lot or West of School 30% Pathway 20% Vassal Ln East of School 10% Standish St

- Note: walking students accompanied by parents coming from Vassal Lane east of the school, and from Standish Street, where it was not possible to see if they drove and parked first, were assumed to have driven and parked before walking to the school.
- One bicyclist (student) arrived at 8:50AM travelling eastbound on Vassal Lane.

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Figure 2 | Morning Drop-Off Curbside Volume

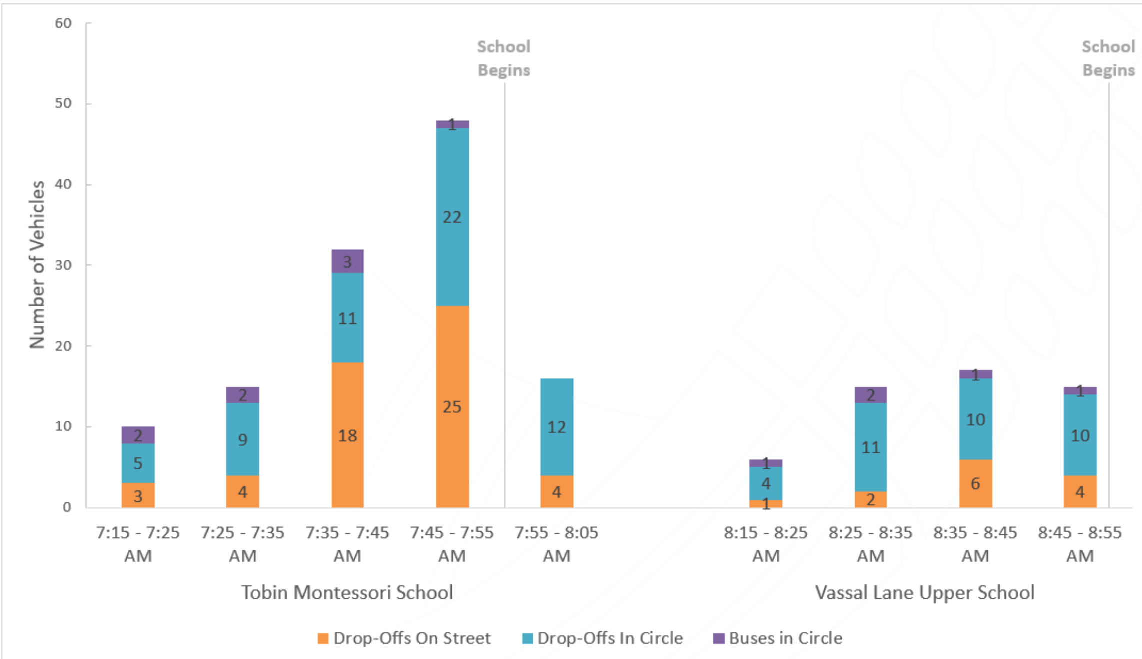

Figure 3 | Morning Drop-Off Curbside Accumulation

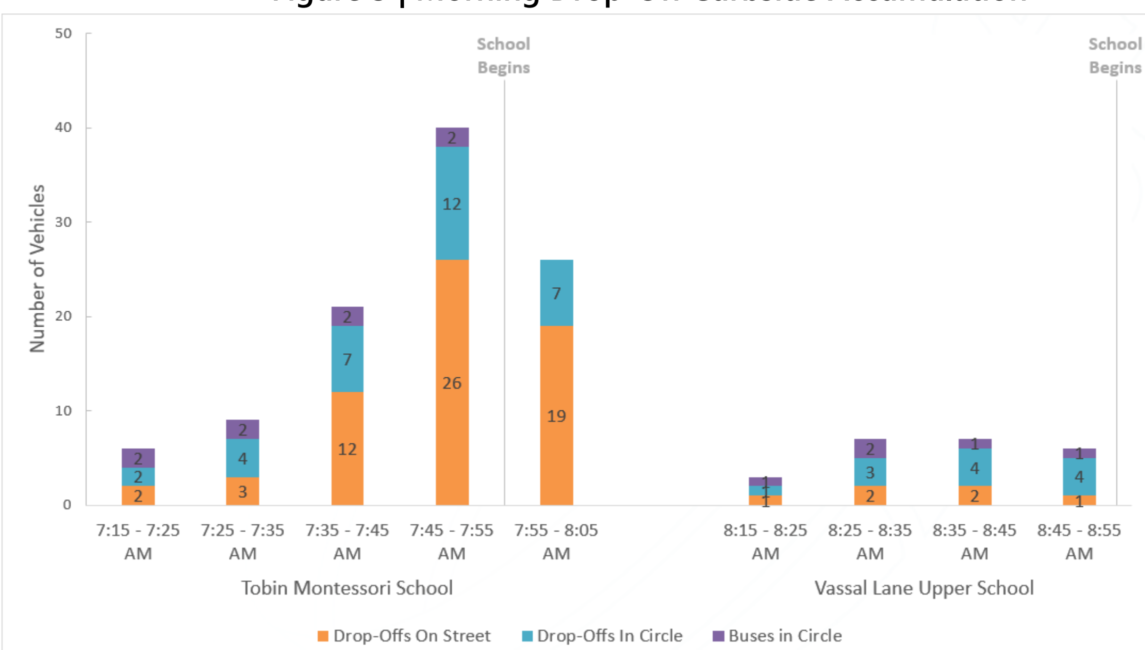

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Table 2 Morning Bicycle Arrival Activity at Tobin Montessori and Vassal Lane Upper School

Tobin Montessori	**Bicycle Arrivals** Parent with Child	**Bicycle Arrivals** Student without Parent	**Bicycle Arrivals** Teacher
7:00 - 7:15 AM	0	0	0
7:15 – 7:30 AM	0	0	1
7:30 - 7:45 AM	3 parents/ 5 students	1	1
7:45 – 8:00 AM	1 parent/ 2 students	0	1
8:00 - 8:15 AM	1 parent / 1 student	0	0
Totals	**5 parents/ 8 students**	**1**	**3**
Vassal Lane Upper			
8:15 - 8:30 AM	0	3	0
8:30 - 8:45 AM	0	6	0
8:45 – 9:00 AM	0	2	0
9:00 – 9:15 AM	0	1	1
Totals	**0**	**12**	**1**

- Observations conducted in May 2019.
- Note: Some parents accompanied multiple students, and therefore counts for both groups are reported.

Afternoon Student Dismissal

A summary of the data collection for the afternoon dismissal period is presented in **Table 2**. In the afternoon, there were occasional student drop-offs, likely for after school programs through DHSP. Pick-ups (when the parent waited in the car for the student to come out by themselves) and parents who parked, walked into the school, and walked out of the school with their students to their cars, were grouped together due to the similar vehicle dwelling time associated with each activity.

Below are the key findings for the afternoon dismissal observation period:

Parent pick-ups

- Tobin Montessori School pick-ups (43) gradually arrive within the half-hour prior to the end of the school day. These occurred primarily along Vassal Lane, both directly in front of the school and to the east of the school. Very few pick-ups occurred in the circle, allowing buses to pick up students.
- Vassal Lane Upper School pick-ups (20) gradually arrive within the half-hour prior to the end of the school day, although a greater portion occurred in the circle. The lower volume of pick-ups created a less congested condition compared to the Tobin Montessori School dismissal.

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Walkers

- Many Vassal Lane Upper School students (36) walked off-site by themselves, almost entirely within the 10 minutes after the school day ended, with large portions walking down Standing Street and Vassal Lane to the east.

Bicyclists

- During the March 2019 observations, three (3) Vassal Lane Upper School students were observed to leave the school on bikes, two to the west and one to the east on Vassal Lane.

Figures 4 and 5 provide a graphical representation of the data presented in **Table 3**, in the same format of those figures presented previously. Pick-ups were broken down to represent the activity occurring in the circle verse the activity occurring along the street. These include parents who parked and walked in to get their student.

Figure 5 illustrates, in the 10 minutes prior to the end of the Tobin Montessori School day, the maximum number of vehicles parked at the same time in the study area is approximately 39 cars along all of Vassal Lane, only one car along the circle, and 4 buses along the circle. During this time period, many parents were observed to be waiting in the lobby for their students. Parents did not typically park in the circle to allow buses and vans to wait in queue; instead parents parked along Vassal Lane, occupying all available spaces. At 1:55 PM, a rush of families exited the School, walking across the circle, across Vassal Lane directly in front of the School, and down Vassal Lane and Standish Street, as students boarded buses. Many parent vehicles left at the same time. During all other time periods, dismissal conditions were observed to be milder.

VHB developed a presentation based on the field observations findings to facilitate discussion about existing transportation and associated challenges with the Project team on March 18, 2019.

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Table 3 Afternoon Dismissal Activity at Tobin Montessori and Vassal Lane Upper School

Tobin Montessori	Bus Arrivals In Circle	Van Arrivals In Circle	Drop-Offs	Pick-Ups/Parent Walks with Child to Car	Walkers
1:25 - 1:35 PM	0	1	0	13	0
1:35 - 1:45 PM	1	0	0	13	0
1:45 - 1:55 PM	3	1	0	14	0
1:55 - 2:05 PM	2	1	0	2	1
2:05 - 2:15 PM	2	0	1	1	0
Totals	**8**	**3**	**1**	**43**	**1**
			Vassal Ln in Front of School	45% Vassal Ln in Front of School 35% Vassal Ln East of School 15% Standish St 5% Circle	Vassal Ln East of School
Vassal Lane Upper					
2:35 - 2:45 PM	0	0	0	6	1
2:45 - 2:55 PM	3	1	2	11	0
2:55 - 3:05 PM	2	0	1	2	31
3:05 - 3:15 PM	0	0	0	1	4
Totals	**5**	**1**	**3**	**20**	**36**
			67% Vassal Ln in Front of School 33% Circle	65% Vassal Ln in Front of School 30% Circle 5% Standish St	35% Standish St 30% Vassal Ln East of School 20% Staff Lot or West of School 15% Pathway

- Note: walking students accompanied by parents coming from Vassal Lane east of the school, and from Standish Street, where it was not possible to see if they drove and parked first, were assumed to have driven and parked before walking to the school.
- Three bicyclists (students) left at 2:55PM: two westbound and one eastbound on Vassal Lane.

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Figure 4 | Afternoon Pick-Up Curbside Volume

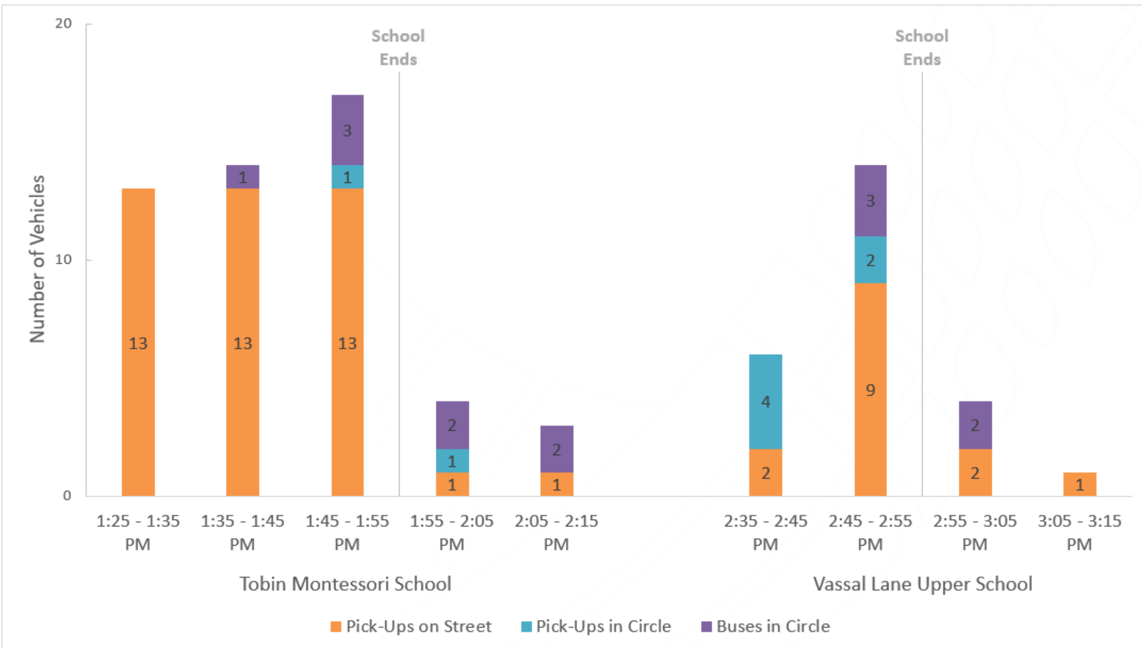
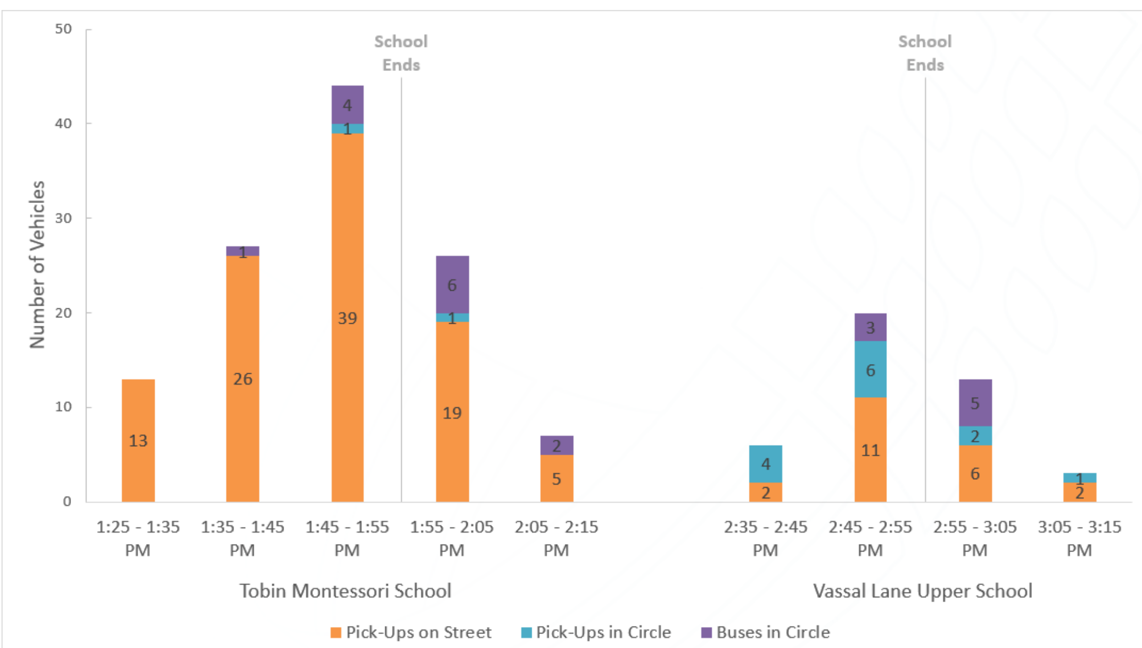


Figure 5 | Afternoon Pick-Up Curbside Accumulation



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DISCUSSIONS WITH SITE USER GROUPS

In addition to the February 26, 2019 meeting with the Tobin Montessori School and Vassal Lane Upper School principals, VHB Inc. participated in the following meetings with other site user groups in the facilitation of the school feasibility study.

Transportation Focus Group – March 12, 2019

This meeting was held to discuss existing bus operations and transportation needs for the Tobin Montessori School and Vassal Lane Upper School. In attendance was Cambridge Public Schools (CPS) department transportation manager and a representative from Eastern Bus. The goal of this effort was to have an open discussion to better understand the curbside operations from the bus and van driver's perspective. It was highlighted that different operations (buses, parent cars, and walkers) should be separated, and that the current alignment of the bus circle is difficult to maneuver.

Site Transportation Focus Group – March 18, 2019

This meeting was held to discuss existing site traffic operations and transportation needs for the Tobin Montessori School and Vassal Lane Upper School. The goal of this effort was to bring the many parties, such as representatives from the city, CPS, Department of Human Services Programs (DHSP), Department of Public Works (DPW), Community Development Department (CDD), engineering, traffic, parking, and transportation, involved with the new school project together to better understand the existing and future transportation needs for the schools' campus. VHB Inc. led a presentation, included in the memorandum attachments, detailing the findings from the existing conditions assessment. Perkins Eastman (PE) facilitated an open discussion of preliminary concepts from their interview as a reference for discussion for future conceptual designs.

Cambridge Department of Human Service Programs (DHSP) – March 28, 2019

This meeting was held to discuss existing and planned programs through the City of Cambridge DHSP at the Tobin Montessori School. The goal of this effort was for VHB to understand how current DHSP programs at the Tobin Montessori School and other schools throughout the city operate, how additional future programs will impact the school transportation and curbside operations, and what the transportation and access needs associated with the future programs will be.

A new DHSP preschool program is proposed and still in the developmental stages. It could potentially include +/- 8 classrooms, with 140 – 160 kids age 2.9 – 5 years old from 7:30 or 8:00 AM to 5:30 or 6:00 PM. This would have significant traffic impacts because these students would not be eligible for buses and would need to be walked in and out by a parent. Additionally, morning drop-off could coincide with the current timing of the Tobin Montessori School or Vassal Lane Upper School. Other schools that were discussed that may be similar in function but much smaller in scale include the King School, Peabody School, Morse School, Haggerty School, and Windsor Street School.

The existing DHSP community school program that takes place when the Tobin Montessori School day ends was discussed. It is likely the +/- 125-enrolled-student program will increase to 175 – 200 enrolled students.

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CONCLUSIONS AND NEXT STEPS

VHB has conducted an evaluation of the existing operations at the Tobin Montessori School and Vassal Lane Upper School. The evaluation of existing operations showed the most significant operational impact was during the ten minutes prior to the start of the Tobin Montessori School day, and in the ten minutes prior to the end of the Tobin Montessori School day. The observed and quantified demand of buses, vans, parent vehicles, bicyclists, and walkers outlined in this memorandum will guide the development of design concepts moving forward.

VHB is currently assisting in developing a mode share survey to assist informing the feasibility study about current employee commuting behavior at the two schools. The resulting response data will help guide transportation planning and design concepts in the development of the new school.

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Attachments

- Additional Field Observations Notes
- March 18, 2019 Presentation: Existing Condition Transportation Operations Analysis

Additional Field Observations Notes

Additional observation notes from March 5, 2019, in chronological order:

Morning arrival:

- 7:00 - 7:15 1 TNC (Uber, Lyft) dropped off an adult in the circle. 2 adult walkers enter the school.
- 7:15 Walkers - 2 families (5 people) walk in from the direction of the Parkway.
- 7:15 – 7:25 Drop offs in circle - parents help their kids out of the car; 1 car pulled up and parked in the circle for 10 minutes after; 1 car had 2 kids.

  2 cars parked in the circle.
- 7:23 Bus – a bus could not pull into the circle all the way because of a car dropping off a student.
- 7:25 – 7:35 Parked in circle - 1 parent parked and walked their child in and left their car running.

  Drop offs - 1 car had 3 kids, 1 car had 2 kids.

  Parked on Vassal Lane – 1 car parked on the street and walked in.

  Traffic guard arrived at 7:29.

  A bus arrived at a bus stop for another school (younger students) and picked up on the corner of Standish Street and Vassal Lane.
- 7:30 Parked on Standish St – 1 car parked along Standish St and walked student in, leaving car for 20 minutes.
- 7:34 1 car pulled into the circle and parked.
- 7:35 2 cars in front of the circle dropping off students block 1 bus and 1 van from pulling in, which had to wait in the street for space in the circle.
- 7:36 Van – a van arrived and remained in the circle for 22 minutes.
- 7:38 A bus pulled up and remained in the circle for at least 10 minutes.
- 7:43 Walkers – rush of walkers entered the school.
- 7:44 Parked in circle - 2 cars parked on the far side of circle and walked kids in.
- 7:45 – 7:55 Drop offs in circle - 1 car had 3 kids, 1 car had 2 kids.
- 7:48 Parked in circle - 2 cars parked on the front side of the circle, 2 parked on the far side and walked kids in.

  Cars dwelled 5-10 minutes, making it difficult for a bus to enter.
- 7:51 – 7:52 Parked in circle - 5 cars parked on the far side of the circle and walked kids in.
- 7:55 Parked in circle - 1 car parked on the far side of the circle and walked kid in.
- 7:56 Parked in circle - 1 car parked by the entrance of the circle and walked kid in.
- 8:00 – 8:15 Parked in circle - 3 late families from Tobin Montessori School walked in.

- 8:15 Bus arrived at a bus stop for another school (older students) on the corner of the sidewalk just east of the Tobin circle entrance.
- 8:15 – 8:25 Walkers – 5 from parkway area (west).
- 8:25 Parked in circle - 1 car parked on the far side of the circle and walked in to drop off something; 1 car parked on the far side of the circle and walked a late Tobin Montessori School student in.
- 8:31 Bus - Because a van and a bus were parked at the front of the circle, an arriving bus had to stop at the entrance, pull up and shut off its engine.
- 8:39 Parked in circle - 1 car parked on the far side of the circle and walked in.
- 8:42 Cars dropping off students were still parked at the front of the circle as bus pulled in.
- 8:45 Bus - pulled up and turned off engine.
- 8:51 Parked in circle - 1 car parked on the far side of the circle and walked in.
- 8:57 5 cars parked on the far side of the circle.
  1 parked on the front side of the circle to run a student's bag in.

Afternoon dismissal:

- 1:30 4 cars parked on the far side of the circle.
  1 van parked at the circle entrance.
  3 - 4 parents waiting in the lobby inside the school.
  No more parents entered the school until 1:40.
  5 cars with parents already waiting on Vassal Lane in front of the school.
- 1:40 – 1:50 Parked on Vassal Lane - 2 cars park and parents walk in; 5 cars park and wait.
  6 parents walk into the school from Vassal Lane east of the school.
  2 parents walk into the school from Standish Street.
- 1:50 – 1:55 Parked in circle - 1 car parked on the far side of the circle and walked in.
  3 parents walk into the school from Standish Street.
  8 parents walk into the school from Vassal Lane east of the school.
- 2:03 Bus - buses leave.
- 2:05 Bus - arrives at 2:05 and leaves at 2:07. Another bus arrives at 2:07.
- 2:09 Parked in circle - 1 car parked at the circle entrance and remained parked for 7 minutes.
- 2:10 Kids from another school were dropped off via bus at Vassal and Standish (not circle) and

entered the school.

- 2:16 Activity calmed.

  2 cars parked on the far side of the circle.
- 2:30 Pick up in circle - 1 car pick up in the circle.

  No more parents waiting in the lobby.
- 2:35 Parked in circle - 1 car parked with flashers on at the end of the circle for 2 minutes.

  Parked on Vassal Lane - 1 car already waiting in the street in front of the school; 1 car parked and the parent entered the school.
- 2:37 Parked in circle - 1 car parked in the circle for 12 minutes.
- 2:39 1 car parked on far side of circle.
- 2:45 Drop off on Vassal Lane - 1 car drop off on the street in front of the school.
- 2:47 Parked in circle - 1 car parked on the far side of the circle.
- 2:49 Van – a van parked on the far side of the circle and remained there for 13 minutes.
- 2:50 Drop off in the circle.
- 2:52 Parked in circle - 1 car parked on the far end of the circle and remained there for 6 minutes.
- 2:55 Bus – a bus dropped off 1 student in the circle and then left.
- 3:04 Bus – buses leave.

  2 cars remain parked along the far side of the circle.

After school activity:

- 3:35 10 cars remain parked in the circle.

  7 cars remain parked in front of the school along Vassal Lane.

  Parked in circle - 3 families leave the school and walk to cars in the circle.

  Pick up in circle - 1 student is picked up in the circle.

  Walkers - One family walks toward the east along Vassal Lane.
- 3:45 Bus – the late bus arrives.

  4 cars remain in the circle.
- 3:50 Bus – a second late bus arrives.
- 4:15 – 4:25 5 cars remain in the circle.

  Students begin to exit the school.

  24 students board the two buses.
- 4:24 Bus – late buses leave.

- 4:25 Bus – a bus drops off one kid in the circle.

  6 cars remain in the circle.

March 18, 2019 Presentation: Existing Condition Transportation Operations Analysis

John M. Tobin Montessori School
Vassal Lane Upper School

City of Cambridge, Massachusetts

Existing Condition
Transportation Operations Analysis

Presented by
VHB Inc. | March 18, 2019

Study Overview

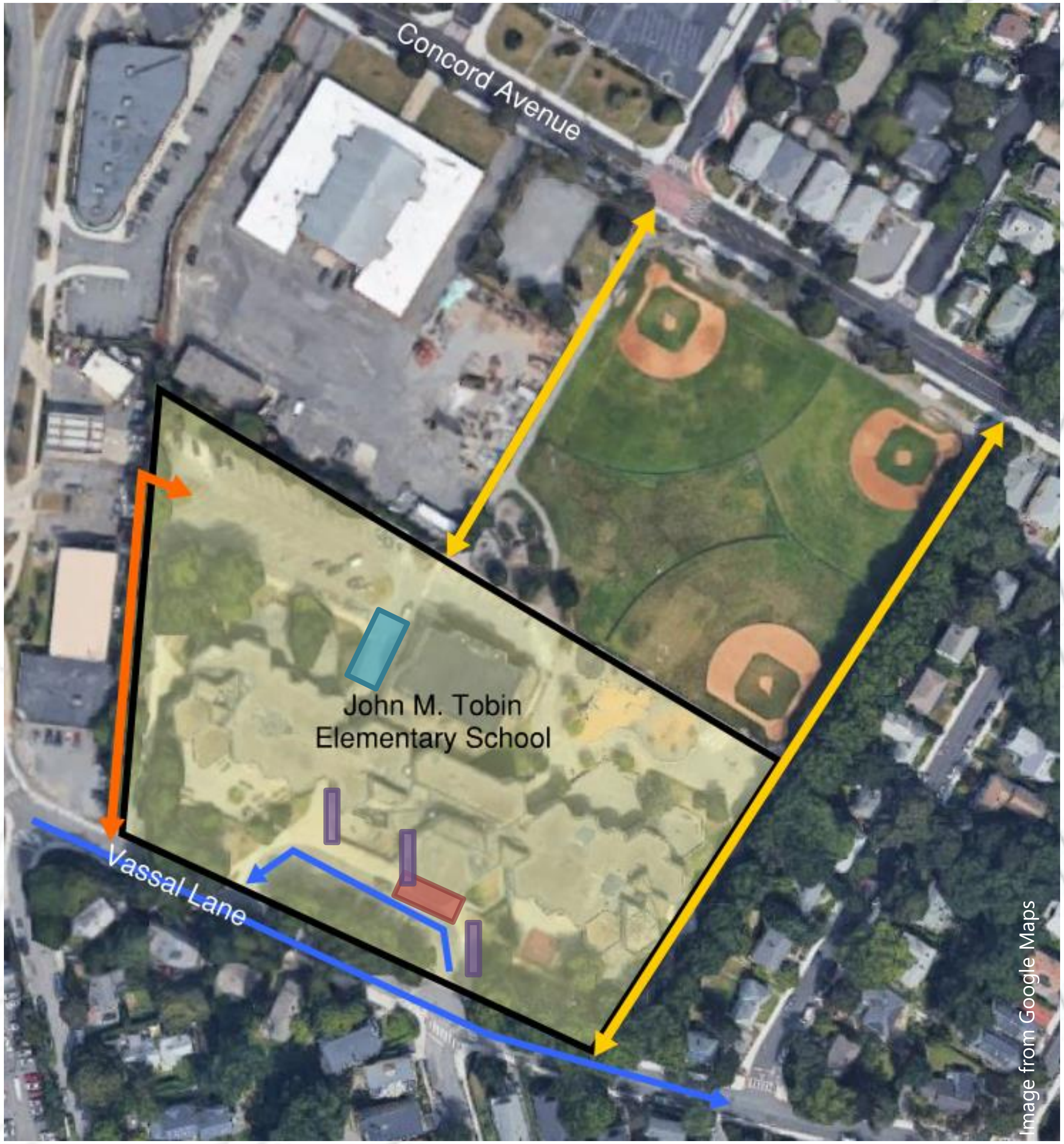
- Understand Existing Site Operations
  - Curbside Operations
    - Student Arrival and Dismissal
      - Drop-off/Pick-Up
      - School Buses/Vans
      - Walkers/Cyclists
    - Access/Egress
  - On-Site Parking (Staff Parking)
    - Lot Size/Capacity
    - Access/Egress
- Future Transportation Infrastructure Ideas

Existing Student and Staff Profile

- **Tobin Montessori School**
  - Day Begins at 7:55 AM, Ends at 1:55 PM
  - Pre-K – Grade 5
  - Ages 3-11 yrs
  - Approximately 300 students
  - Approximately 70 employees
  - Afterschool program Monday-Friday from 1:55 PM to 6:00 PM
- **Vassal Lane Upper School**
  - Day Begins at 8:55 AM, Ends at 2:55 PM
  - Grade 6 – 8
  - Ages 11-14 yrs
  - Approximately 315 students
  - Approximately 53 employees
  - Afterschool program Tuesday-Thursday from 2:55 PM to 4:30 PM

Existing School Access/Egress

- Site
- Parking Lot Access/Egress
- Curbside Access/Egress
- Pedestrian Foot Paths
- Main Entrance
- Bicycle Parking
- Loading Dock Area



- Parent Drop-Off/Pick-Up
  - At Curbside (in the circle)
  - Along Vassal Lane
- Bus Drop-Off/Pick-Up
  - At Curbside (in the circle)
- Building Access/Egress at Main Entrance

Arrival/Dismissal Observations

- Tuesday, March 5, 2019
  - Arrival: 7:00-9:00 AM
  - Dismissal: 1:30-4:30 PM
- Observations
  - Curbside Access/Egress
    - Parent Pick-Up/Drop-Off
    - Buses/Vans
    - Pedestrians (walkers and bicyclists)
  - Volume
    - Parent vehicles
    - Pedestrians
  - Pedestrian Patterns
  - Bicycle Accommodations
  - What areas of on-street parking are parents using?
  - Infrastructure challenges

Morning Student Arrival

- Overall Activity
  - Activity occurred primarily in the circle and along Vassal Lane
  - Buses, vans, private autos, and pedestrians shared the circle and street
  - Tobin Montessori School: drop-off activity
    - Starts as early as 7:10 AM
    - Continues until about 8:00 AM
  - Vassal Lane Upper School: drop-off activity
    - Starts as early as 8:10 AM
    - Continues until about 9:00 AM

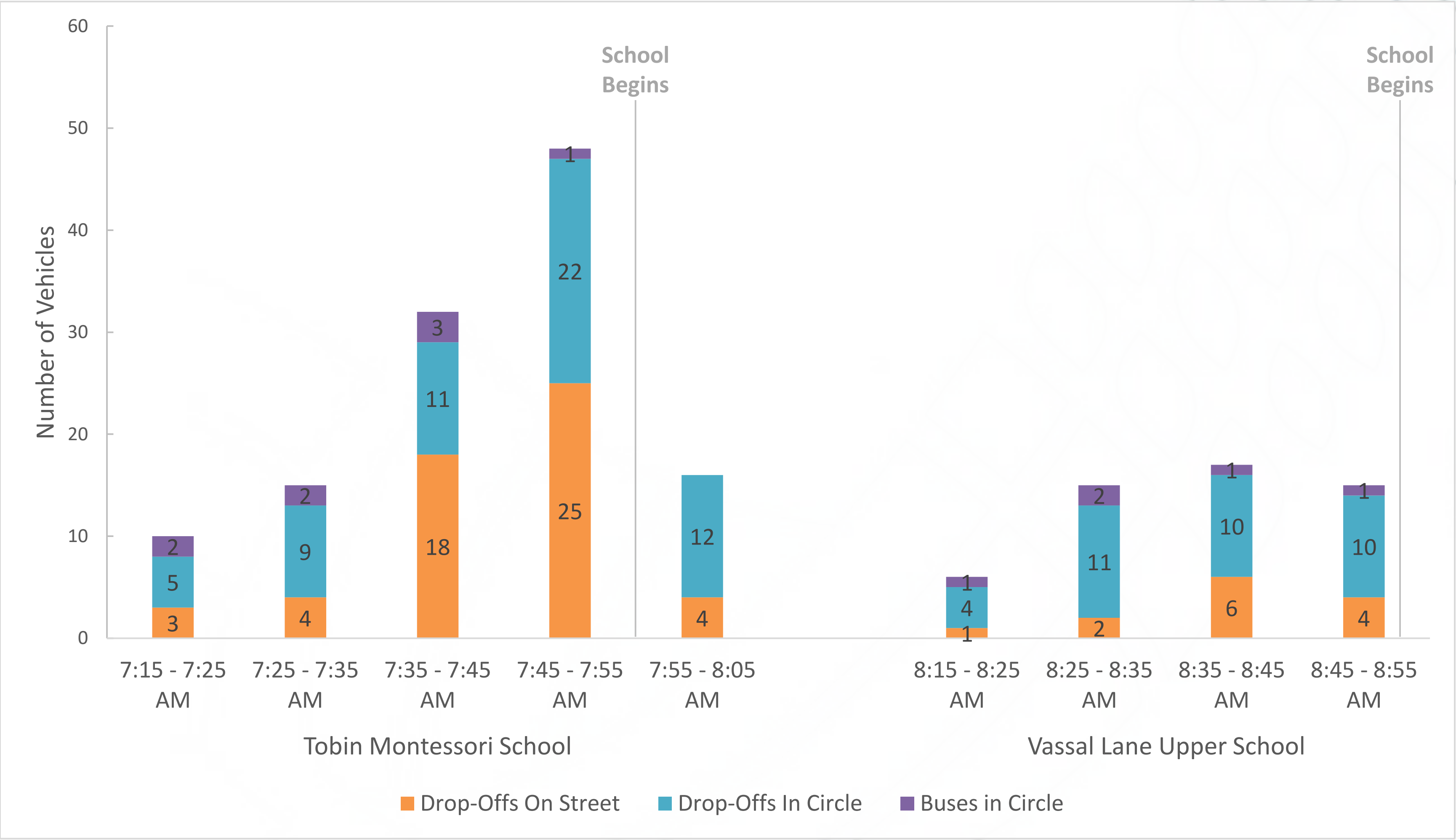
Summary of Morning Arrival Activity

Tobin Montessori	Bus Arrivals In Circle	Van Arrivals In Circle	Drop-Offs	Parent Parks and Walks Child In	Walkers
7:15 - 7:25 AM	2	0	6	2	4
7:25 - 7:35 AM	2	0	9	4	2
7:35 - 7:45 AM	3	2	11	18	3
7:45 - 7:55 AM	1	0	13	34	3
7:55 - 8:05 AM	0	0	6	10	0
Totals	*8*	*2*	*45*	*68*	*12*
			90% Circle 5% Vassal Ln in Front of School 5% Standish St	40% Vassal Ln in Front of School 25% Circle 25% Vassal Ln East of School 10% Standish St	33% Vassal Ln East of School 25% Standish St 25% Pathway 17% Staff Lot or West of School

Vassal Lane Upper School	Bus Arrivals In Circle	Van Arrivals In Circle	Drop-Offs	Parent Parks and Walks Child In	Walkers
8:15 - 8:25 AM	1	0	4	1	7
8:25 - 8:35 AM	2	1	11	2	14
8:35 - 8:45 AM	1	1	15	1	28
8:45 - 8:55 AM	1	1	13	1	17
Totals	*5*	*3*	*43*	*5*	*66*
			75% Circle 20% Vassal Ln in Front of School 5% Standish St	60% Circle 40% others	40% Staff Lot or West of School 30% Pathway 20% Vassal Ln East of School 10% Standish St

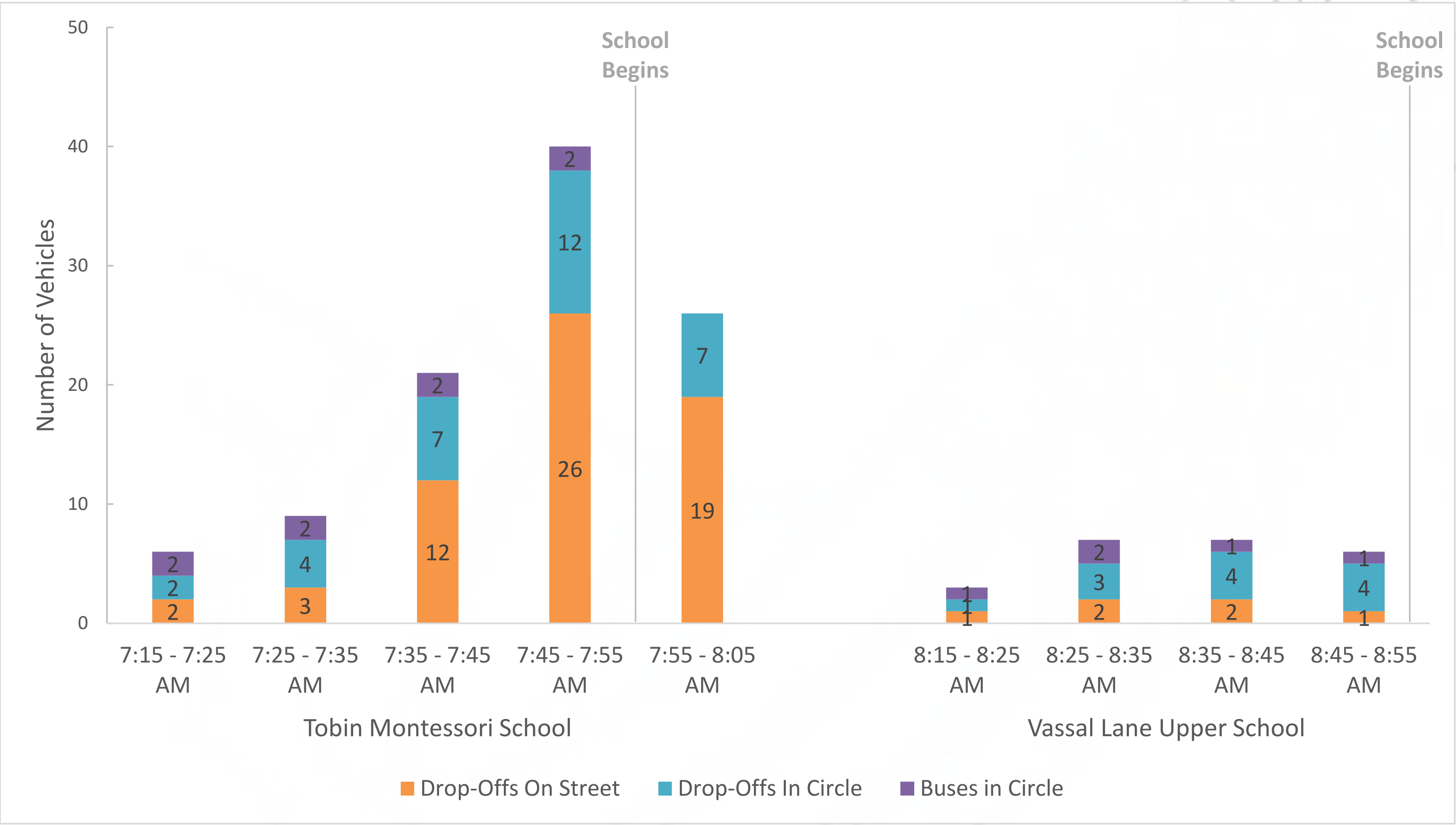
Morning Student Arrival

- Parent Vehicle & Bus Drop-Off ***Totals***



Morning Student Arrival

- Parent Vehicle & Bus Drop-Off ***Accumulations***



Morning Student Arrival

- Parent Drop-Off
  - Tobin Montessori School: students were dropped off in the circle
  - Vassal Lane Upper School: students were also dropped off on Vassal Lane
  - More traffic is associated with the Tobin Montessori School than the Vassal Lane Upper School
  - Of all Tobin Montessori School Private Auto drop-offs, approximately 60% of parents park and accompany students into the school (10 – 20 minutes)

Image from Google Maps

Morning Student Arrival

- Pedestrian Activity
  - Tobin Montessori School: approximately 10% of observed families walk, 90% arrive by car
  - Vassal Lane Upper School: approximately 60% of observed students walk, 40% arrive by car drop-off
  - One entrance/exit to the school collects all walkers
  - Peak parent vehicle drop-offs occur alongside peak students/families walking in

Morning Student Arrival

- School Bus Activity
  - Tobin Montessori School:
    - Arrived starting at 7:20 AM
    - Continued until 7:50 AM
    - 8 total buses, 2 vans
  - Vassal Lane Upper School:
    - Arrived starting at 8:20 AM
    - Continued until 8:50 AM
    - 5 total buses, 3 vans
  - Bus maneuvers are challenging due to tight turns, narrow street space, and conflicts with parent vehicles

Afternoon Student Dismissal

- Overall Activity
  - Activity primarily occurred along Vassal Lane and within the circle
  - Similar level of bus and van activity compared to morning arrival
  - Tobin Montessori School: parents parked mostly along Vassal Lane starting as early as 1:30 PM
  - Vassal Lane Upper School: half as many students were picked up, mostly on Vassal Lane or in the circle
  - More traffic is associated with the Tobin Montessori School than the Vassal Lane Upper School

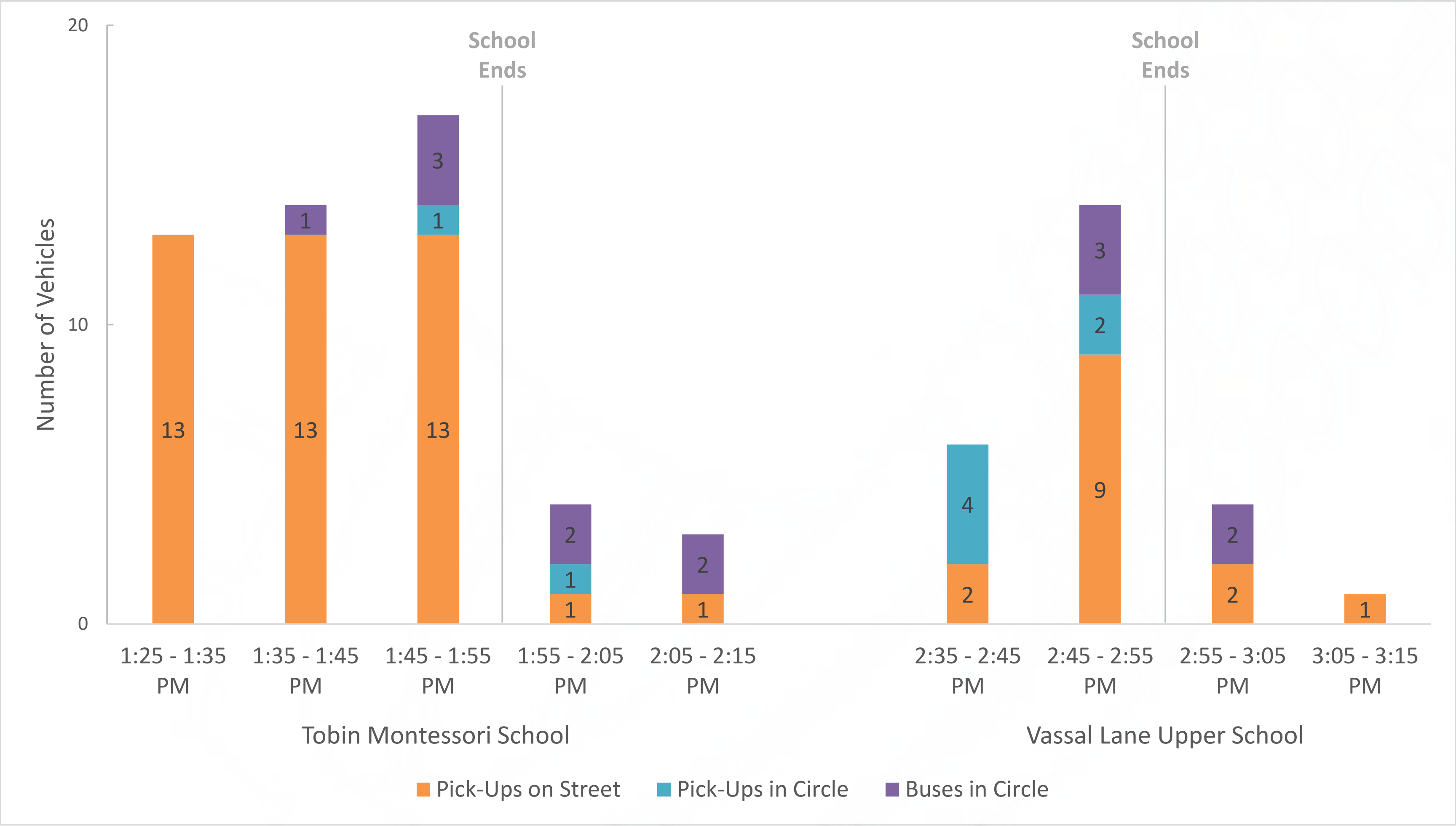
Summary of Afternoon Dismissal Counts

Tobin Montessori	Bus Arrivals In Circle	Van Arrivals In Circle	Drop-Offs	Pick-Ups/Parent Walks with Child to Car	Walkers
1:25 - 1:35 PM	0	1	0	13	0
1:35 - 1:45 PM	1	0	0	13	0
1:45 - 1:55 PM	3	1	0	14	0
1:55 - 2:05 PM	2	1	0	2	1
2:05 - 2:15 PM	2	0	1	1	0
Totals	*8*	*3*	*1*	*43*	*1*
			Vassal Ln in Front of School	45% Vassal Ln in Front of School 35% Vassal Ln East of School 15% Standish St 5% Circle	Vassal Ln East of School

Vassal Lane Upper School	Bus Arrivals In Circle	Van Arrivals In Circle	Drop-Offs	Pick-Ups/Parent Walks with Child to Car	Walkers
2:35 - 2:45 PM	0	0	0	6	1
2:45 - 2:55 PM	3	1	2	11	0
2:55 - 3:05 PM	2	0	1	2	31
3:05 - 3:15 PM	0	0	0	1	4
Totals	*5*	*1*	*3*	*20*	*36*
			67% Vassal Ln in Front of School 33% Circle	65% Vassal Ln in Front of School 30% Circle 5% Standish St	35% Standish St 30% Vassal Ln East of School 20% Staff Lot or West of School 15% Pathway

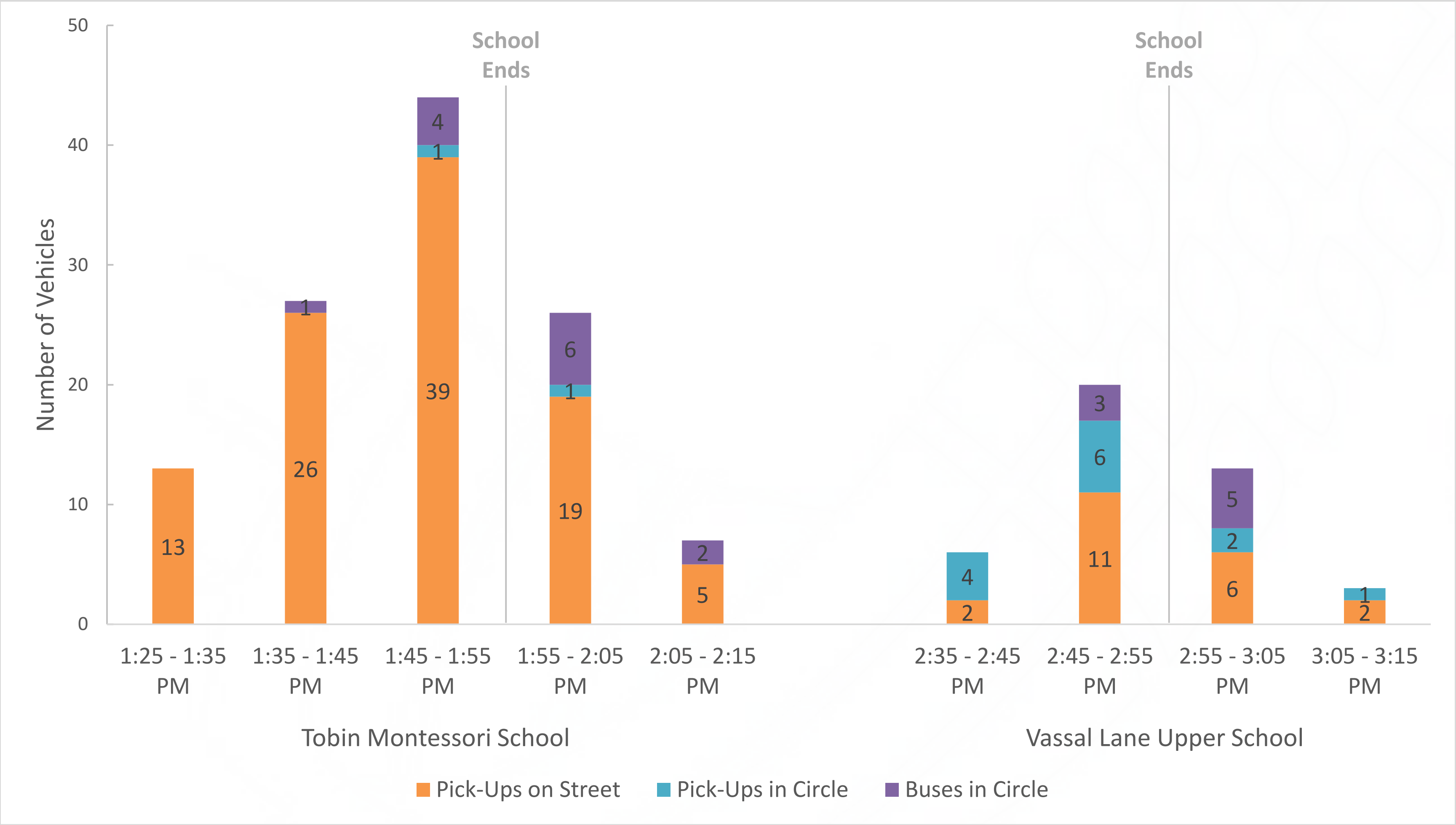
Afternoon Student Dismissal

- Parent Vehicle Pick-Up ***Totals***



Afternoon Student Dismissal

- Parent Vehicle Pick-Up ***Accumulations***



Afternoon Student Dismissal

- Parent Pick-Up
  - Tobin Montessori School: parents typically parked along Vassal Lane and walked in
  - Vassal Lane Upper School: students were picked up on Vassal Lane and in the circle
  - More traffic is associated with the Tobin Montessori School than the Vassal Lane Upper School
  - Parent vehicles typically remained parked for 10 – 15 minutes

Afternoon Student Dismissal

- Pedestrian Activity
  - Tobin Montessori School:
    - Parents arrive as early as 1:30 PM
    - Activity calms by 2:15 PM
    - 26 parents were observed to wait in the lobby for students
  - Vassal Lane Upper School:
    - Most students exit the school at 2:55 PM
    - Disperse through the neighborhood
- Bus Activity
  - Tobin Montessori School:
    - Arrived starting at 1:40 PM
    - Left at 2:03 PM
    - 8 total buses, 3 vans
  - Vassal Lane Upper School:
    - Arrived starting at 2:50 PM
    - Left at 3:04 PM
    - 5 total buses, 1 van

Parking Conditions

- Staff Parking Lot
  - Driveway used for parallel parking
  - Vehicles parked wherever there was room—not only in painted spaces
  - Heavily used
  - Approximately 80 total available parking spaces
- Street Parking
  - Cambridge resident parking

Transportation Infrastructure Observations

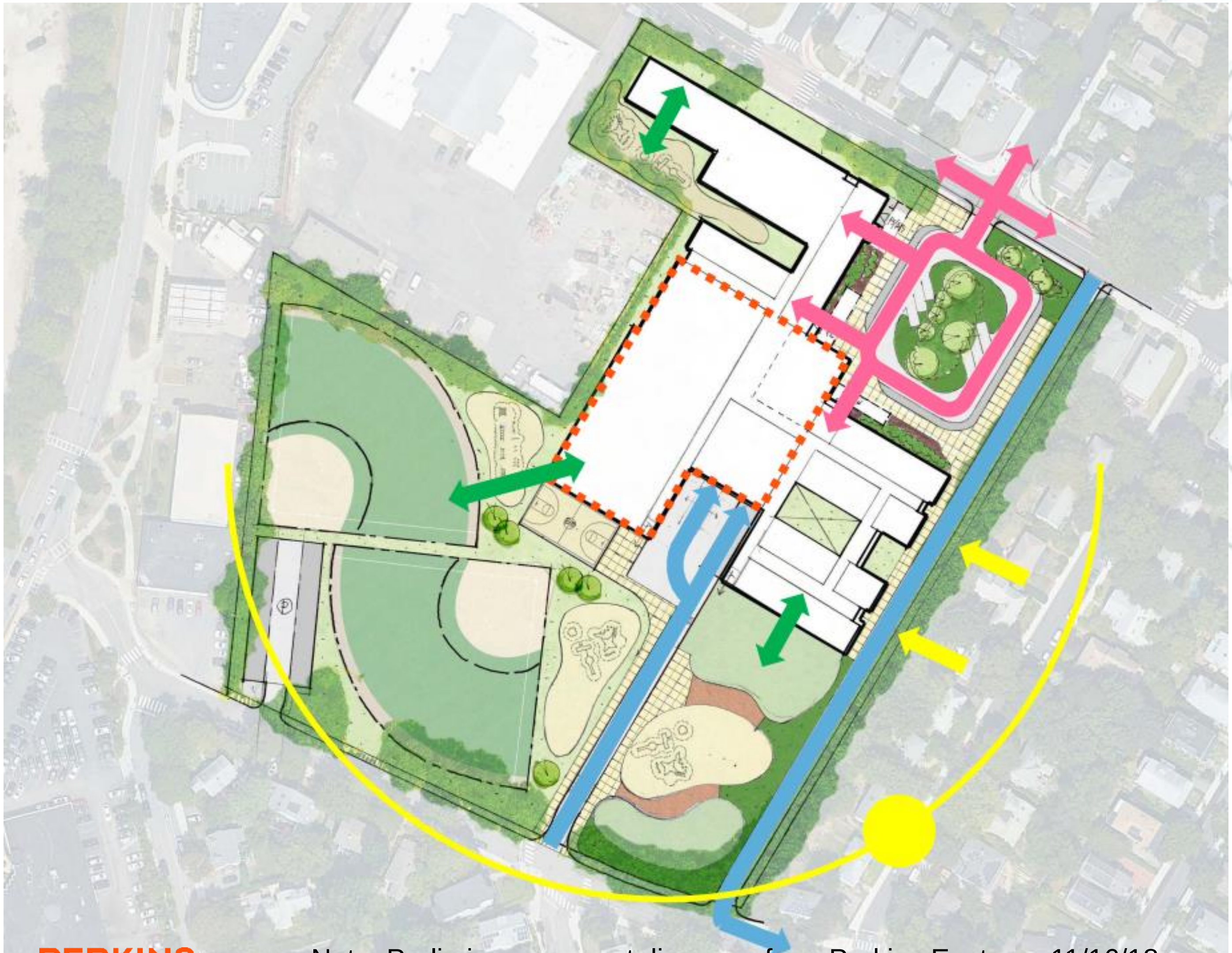
- Challenging areas and improvement locations
  - Bus maneuver challenges
  - Parent drop-off/pick-up space
  - Improved/widened pedestrian space

Concept – Facing Concord Avenue

PERKINS EASTMAN

Note: Preliminary concept diagrams from Perkins Eastman 11/16/18 Interview presented for transportation discussion purposes **ONLY**.

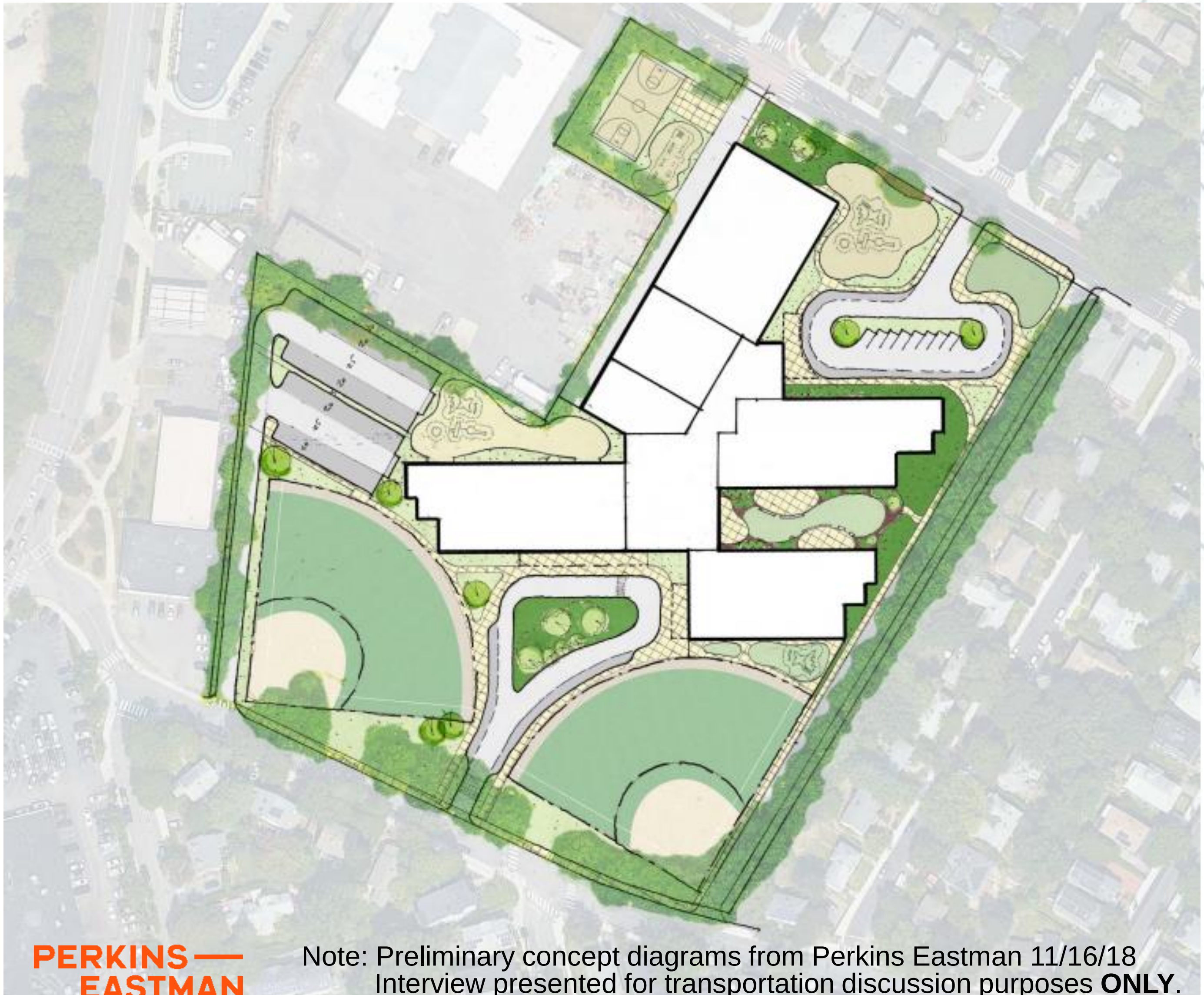
Concept – Facing Concord Avenue



PERKINS EASTMAN

Note: Preliminary concept diagrams from Perkins Eastman 11/16/18 Interview presented for transportation discussion purposes **ONLY**.

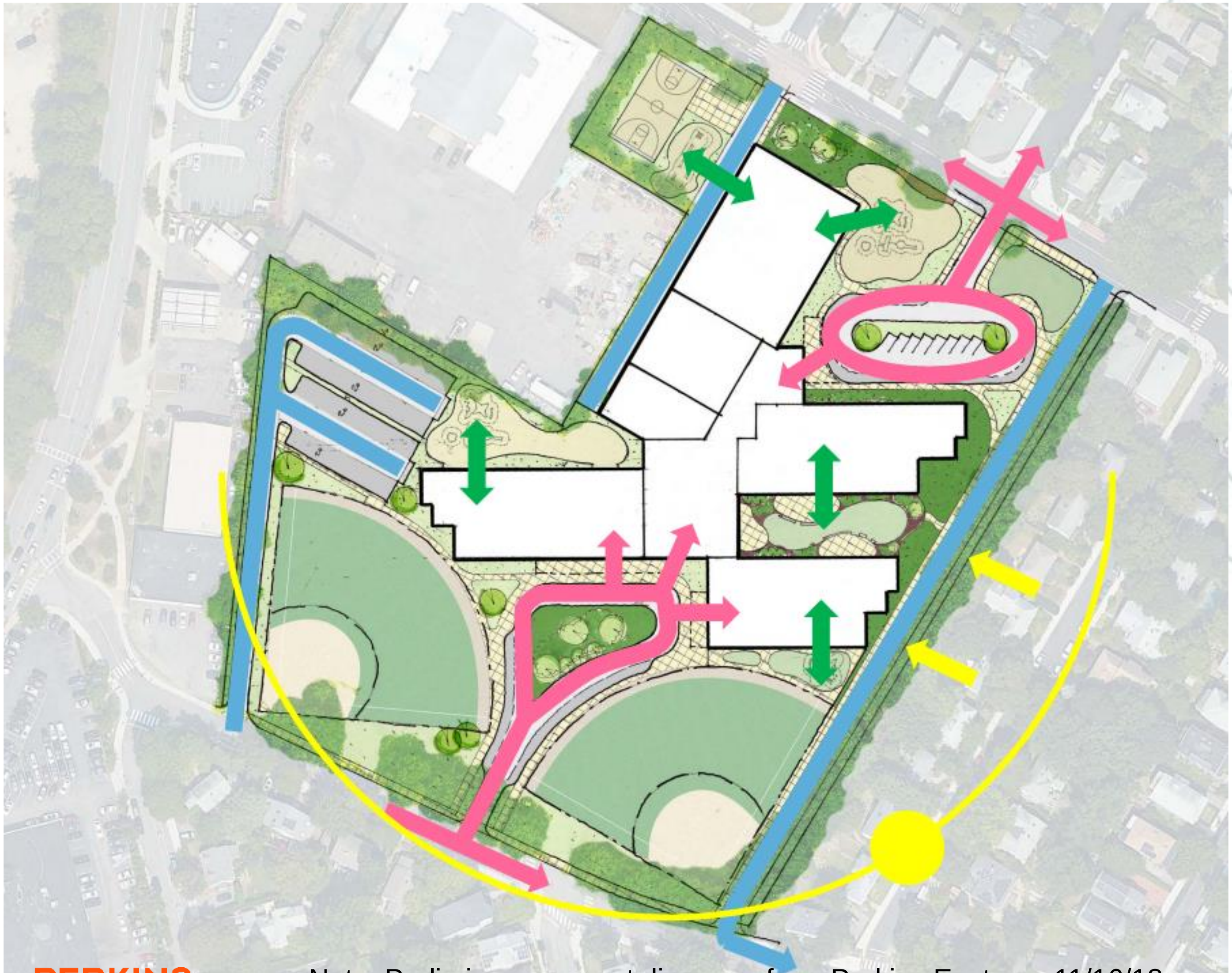
Concept – Facing The Sun



PERKINS EASTMAN

Note: Preliminary concept diagrams from Perkins Eastman 11/16/18 Interview presented for transportation discussion purposes **ONLY**.

Concept – Facing The Sun



PERKINS — EASTMAN

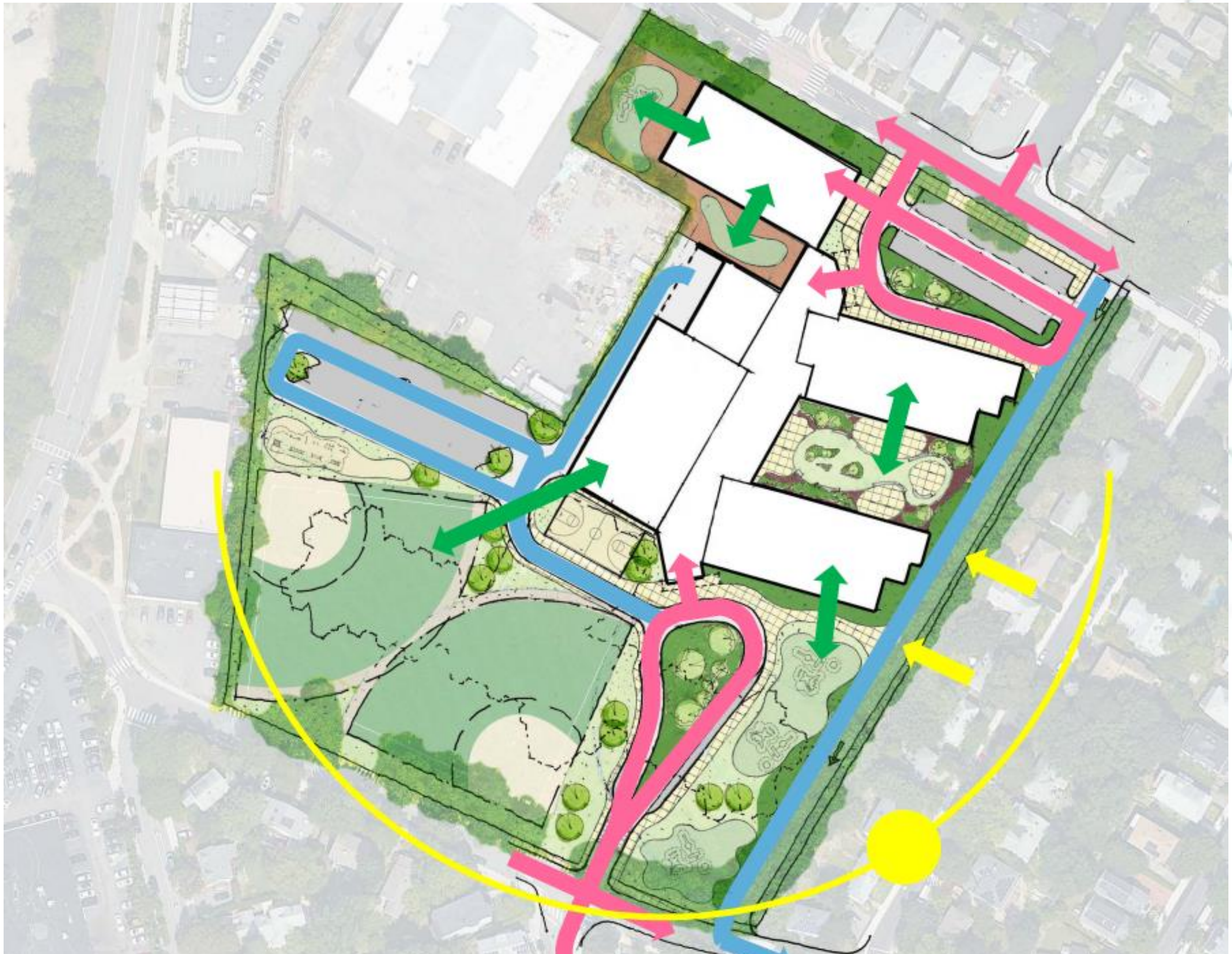
Note: Preliminary concept diagrams from Perkins Eastman 11/16/18 Interview presented for transportation discussion purposes **ONLY**.

Concept – Hybrid

PERKINS EASTMAN

Note: Preliminary concept diagrams from Perkins Eastman 11/16/18 Interview presented for transportation discussion purposes **ONLY**.

Concept – Hybrid



PERKINS — EASTMAN

Note: Preliminary concept diagrams from Perkins Eastman 11/16/18 Interview presented for transportation discussion purposes **ONLY**.

Q & A

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Employee Transportation Mode Survey Results for the Tobin Montessori and Vassal Lane Upper School Feasibility Study

June 26, 2019

Response Rates

Institution	# Survey Recipients	# Responses	Response Rate
Tobin Montessori School	77	60	78%
Vassal Lane Upper School	58	40	69%
DHSP	21	9	43%
General Tobin Building		2	
Other CPS Employees*		4	
Total	156	115	74%

*As described by survey participants, this includes Office of Related Services, Office of Student Services, Special Start, and Tobin/Haggerty/Cambridgeport employees.

What is your home city/town?

Answer Choices	%	Count
Cambridge	28.3%	32
Boston	10.6%	12
Arlington	8.0%	9
Medford	6.2%	7
Bedford	3.5%	4
Newton	3.5%	4
Somerville	3.5%	4
Belmont	2.7%	3
Billerica	2.7%	3
Woburn	2.7%	3

- Plus 32 more responses from 24 other cities/towns.

Answered	113
Skipped	2

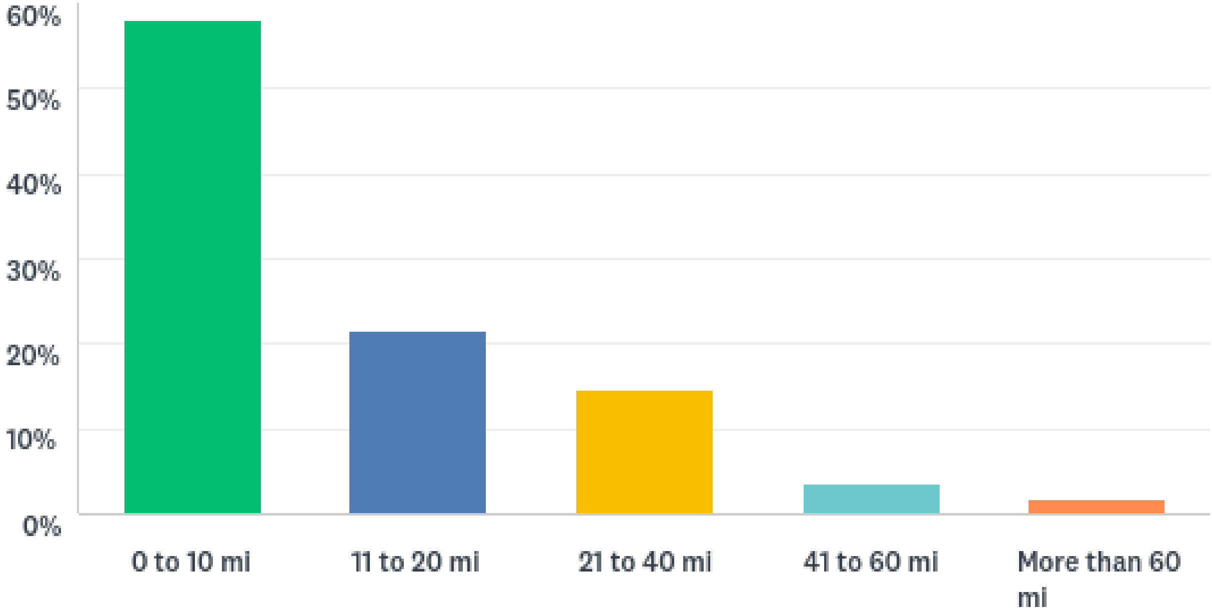
Which institution do you work for?

Answer Choices	%		Count
Tobin Montessori School	52%		60
Vassal Lane Upper School	35%		40
Department of Human Service Programs	8%		9
General building	2%		2
Other CPS Employees*	3%		4

*Office of Related Services
District-wide OSS employee
Tobin, Haggerty, Cambridgeport
Tobin Montessori/VLUS/Special Start

Answered	115
Skipped	0

How many miles (one way) do you travel from home to work on a typical day?



Answered	115
Skipped	0

Please indicate how you commuted TO work each day the week of May 13th

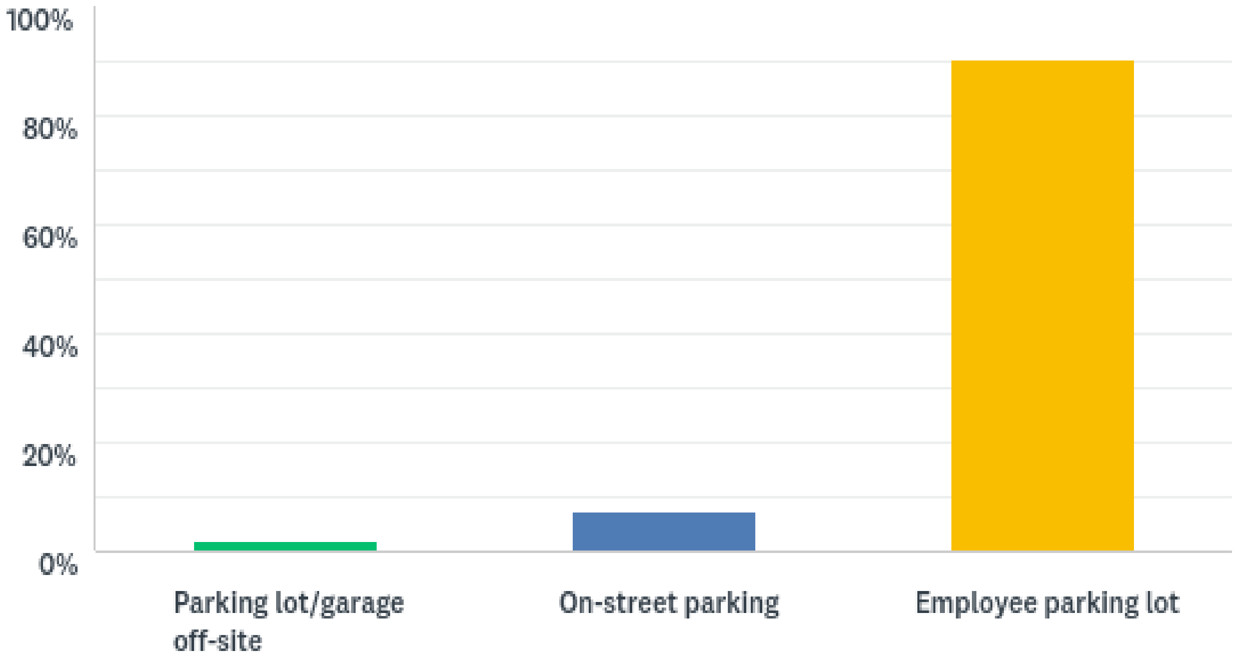
Mode Choice	Average
d) Drove alone the entire way	**70.1%**
f) Public transportation + walked	**8.9%**
a) Walked the entire way	**8.0%**
b) Rode personal bicycle the entire way	**4.9%**
j) Carpool (two- to seven-person)	**3.8%**
m) Took taxi/Uber/Lyft by yourself	**1.0%**
o) Don't work this day/flextime/compressed work week	**1.0%**
q) Other (scooter skateboard, etc.)	**0.9%**
c) Rode Blue Bikes bikeshare the entire way	**0.5%**
p) Sick/vacation/personal time, business trip, or jury duty	**0.5%**
e) Drove + rode bicycle (park & pedal)	**0.2%**
l) Took taxi/Uber/Lyft WITH other passengers	**0.2%**
Total	100%

Answered	115
Skipped	0

Cambridge and Boston Residents' Mode Choice

	Boston Residents			**Cambridge Residents**				
Travel Mode	Employee parking lot	Did not drive	Total	Employee parking lot	On-street parking	Did not drive	Total	Grand Total
a) Walked the entire way						8	8	8
b) Rode personal bicycle the entire way						5	5	5
c) Rode Blue Bikes bikeshare the entire way						1	1	1
d) Drove alone the entire way	9		9	11	2		13	22
f) Public transportation + walked		3	3			2	2	5
j) Carpool (two- to seven-person)				1		1	2	2
m) Took taxi/Uber/Lyft by yourself						1	1	1
Grand Total	**9**	**3**	**12**	**12**	**2**	**18**	**32**	**44**

If you drive the entire way to work, where is the vehicle usually parked?



Answered	96
Skipped	19

When you drive alone, why? (Mark all that apply)

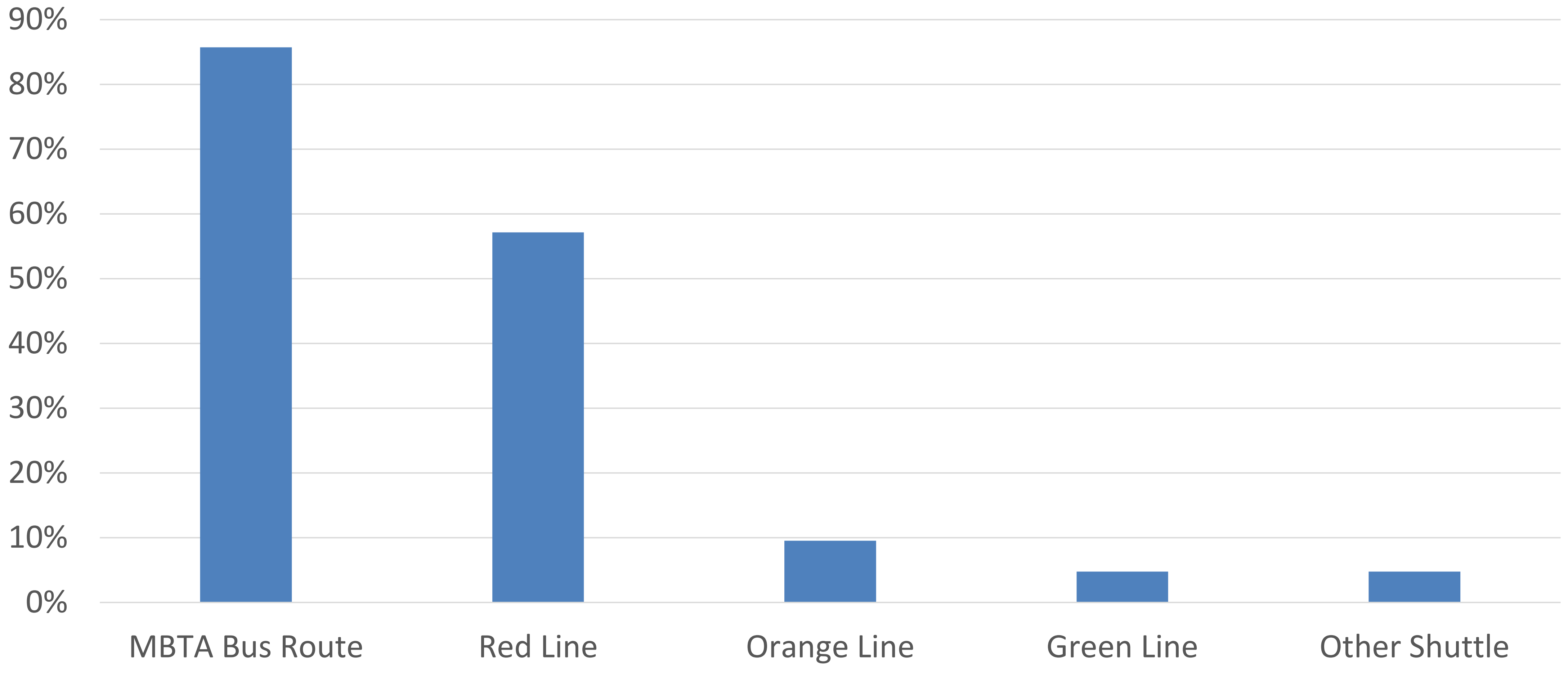
Answer Choices	%	Count
Most convenient way to commute	73%	71
Need a car for errands before/after work	64%	62
Fastest way to commute	62%	60
I have a lot of things to carry with me	42%	41
Transit schedule or routes do not work for me	41%	40
Need car in case of emergencies	40%	39
Free/cheap parking at work	39%	38
Take children to school or daycare or afterschool activities	37%	36
Need car for work-related trips	30%	29
Enjoy my privacy, prefer driving alone	25%	24
Transit is unreliable	20%	19
Concerned about bad weather	18%	17
Safest way to commute	16%	16
Other (please explain):	16%	16
Difficulty finding others to carpool with	13%	13
Cheapest way to commute	12%	12
Work hours are irregular	12%	12
Physical disability	3%	3

Answered	97
Skipped	18

Other responses

- I Have a second job,and I need my car to get there
- Workout prior to school at 5:15am in Burlington and need car after.
- I live in New Hampshire - there is no public transportation that brings to Cambridge.
- child care pick up and drop off.
- I leave very early 5:00am and leave later than most 4:00 or after
- I am a single parent who needs to bring my child to daycare in another town.
- I have tried Public transit multiple times and it took over 2 hour one way. This is not sustainable.
- Usually have appointments after school. Also, I wish it was easier to commute from JP via public transit but it more than doubles my time and is not direct at all.
- my son and I would love to take public transportation, but the route from East Boston to VLUS is very inconvenient
- I come in early (6 am each day) and often leave late, between 4 and 5 pm
- I drive to part-time job after work and also I transport a lot of work-related materials back and forth
- difficulty walking long distances
- Location
- Walking

If you took public transportation for all or part of your commute, which route(s) did you use? (Please check all used)



When you walk/bike/take transit/carpool, why? (Mark all that apply)

Answer Choices	%	Count
Most convenient way to commute	51%	26
Fastest way to commute	41%	21
Cheapest way to commute	39%	20
Better for the environment	31%	16
For exercise	29%	15
No access to private car for commute	22%	11
Other (please explain):	22%	11
Most fun way to commute	20%	10
Safest way to commute	14%	7
Too much traffic on streets and highways	14%	7
Transit schedules or routes do not work for me	14%	7
Driving is too stressful	12%	6
Transit is unreliable	10%	5
Take kids to school or daycare or afterschool activities	8%	4
Work hours are irregular	4%	2
Can get things done on train/bus	4%	2
Parking is expensive at work	0%	0
Easy to find others to carpool with	0%	0

Answered	51
Skipped	64

Other responses

- live across from school
- I have a second job after school I need to go to Boston and the bus do not run every hour
- Can’t drive
- I need to have a second job and I have to drive there after school. My second job is not accessible by public transportation.
- I am driving my partner back to Somerville/Cambridge on the way.
- I take public transit rarely, when my family is picking me up from school on our way out of town.
- Can’t drive
- Person I work with doesn’t have a car and she lives along my route to school
- Walking

Nitsch Engineering

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MEMORANDUM

TO: Perkins Eastman

FROM: Nitsch Engineering

DATE: May 6, 2019

RE: Existing Conditions Memo – Tobin Montessori and Vassal Lane Upper School

Nitsch Engineering performed research of the existing site utility conditions for the Tobin Montessori and Vassal Lane Upper School (the School) located at 197 Vassal Lane in Cambridge, Massachusetts. Nitsch Engineering's research included site visits in the fall of 2018 and spring of 2019 and review of Geographic Information System (GIS) information and record plans, including:

- Cambridge GIS, accessed 09/04/2018;
- MassGIS, accessed 09/04/2018;
- City of Cambridge Flood Viewer, accessed 5/6/2019; and
- Existing Conditions Survey, prepared by SMC, dated 09/06/2017 (attached as Appendix A).

A summary of our observations and initial findings are listed below.

SITE DESCRIPTION

The School is located at 197 Vassal Lane within the Fresh Pond area of Cambridge. The parcel is approximately 9.1 acres and includes the School building, an existing parking lot, and a drop-off driveway along Vassal Lane (Figure 1). Callanan Park is in the northern portion of the parcel along Concord Road. The parcel is bounded by Vassal Lane to the south, residential houses on Alpine Street to the east, Concord Avenue to the north, and commercial properties on Fresh Pond Parkway to the west.

Figure 1: Aerial Locus (Google imagery)

SITE UTILITIES

Storm Drainage

Immediately surrounding the School, the site is substantially developed with significant impervious areas, including the school building, parking area, loading dock, walkways, plazas, and drop-off driveway. Within these areas, there are multiple existing closed drainage systems that are comprised of drainage inlets, manholes, and underground piping that discharges to the municipal drainage mains located in Vassal Lane and Concord Avenue. Ultimately, the School site drainage system discharges into the Alewife Brook that is a tributary to the Mystic River.

Based on Cambridge GIS and the Existing Conditions Survey (Appendix A), most of the parcel appears to be collected in a closed drainage system that discharges to the south and into the system in Vassal Lane. The southern portion of the site, including the existing school building roof, parking lots, and driveways, are collected into a closed drainage system and directed to the several drain lines in Vassal Lane. Currently, it does not appear as if there are any stormwater quantity or quality improvements located within the Tobin School site drainage systems.

The eastern portion of the site runoff is directed to the 54-inch trunk line in the center of Vassal Street. The roof runoff is piped to a 20-inch drain which discharges to a 36-inch drain in Vassal Lane and bypasses to the 54-inch. Both the 54-inch, the 36-inch, and an additional 36-inch drain combine at a drainage vault to the southwest of the existing school.

Stormwater runoff in the northern portion within Callanan Park are collected in a series of underdrains and 12-inch pipes that discharge into a 48-inch drainage line in Concord Avenue.

The Vassal Lane and Concord Avenue drainage systems combine at the intersection of Fresh Pond Parkway and Concord Avenue. Stormwater continues in two parallel systems through a series of drainage vaults and box culverts before discharging to an 8-foot by 4-foot box culvert in Wheeler Street and a 60-inch combined wastewater pipe in the Cambridge Park Drive area. The system outlets to a 42-inch and a 66-inch combined wastewater outfall to the Little Brook (Figure 2), a tributary to the Alewife Brook.

Drainage System Design Considerations:

- To meet City of Cambridge stormwater design requirements, the project will be required to improve the existing conditions by:
    - Reducing the proposed development peak flow rate from the 25-year storm event to be equal to or less than the peak flow from the 2-year storm event under existing conditions; and
    - Reducing the phosphorus from the proposed site runoff by 65%.
- Nitsch Engineering will meet with the Cambridge Department of Public Works to determine if the Surface Water Protection and the Outstanding Resource Water classifications are applicable.
- If the proposed project requires perimeter foundation drains and under slab drainage to be installed under the lower levels of the proposed building, note that the City of Cambridge does not allow collected groundwater (from under slab drainage and/or perimeter drainage systems) to be discharged to its municipal storm water system. Therefore, any groundwater that is collected in these types of systems will need to be discharged on-site and not allowed to find its way to the municipal storm drains. Infiltration BMP’s (if feasible) and/or rainwater harvesting and reuse are ways to accomplish this requirement.

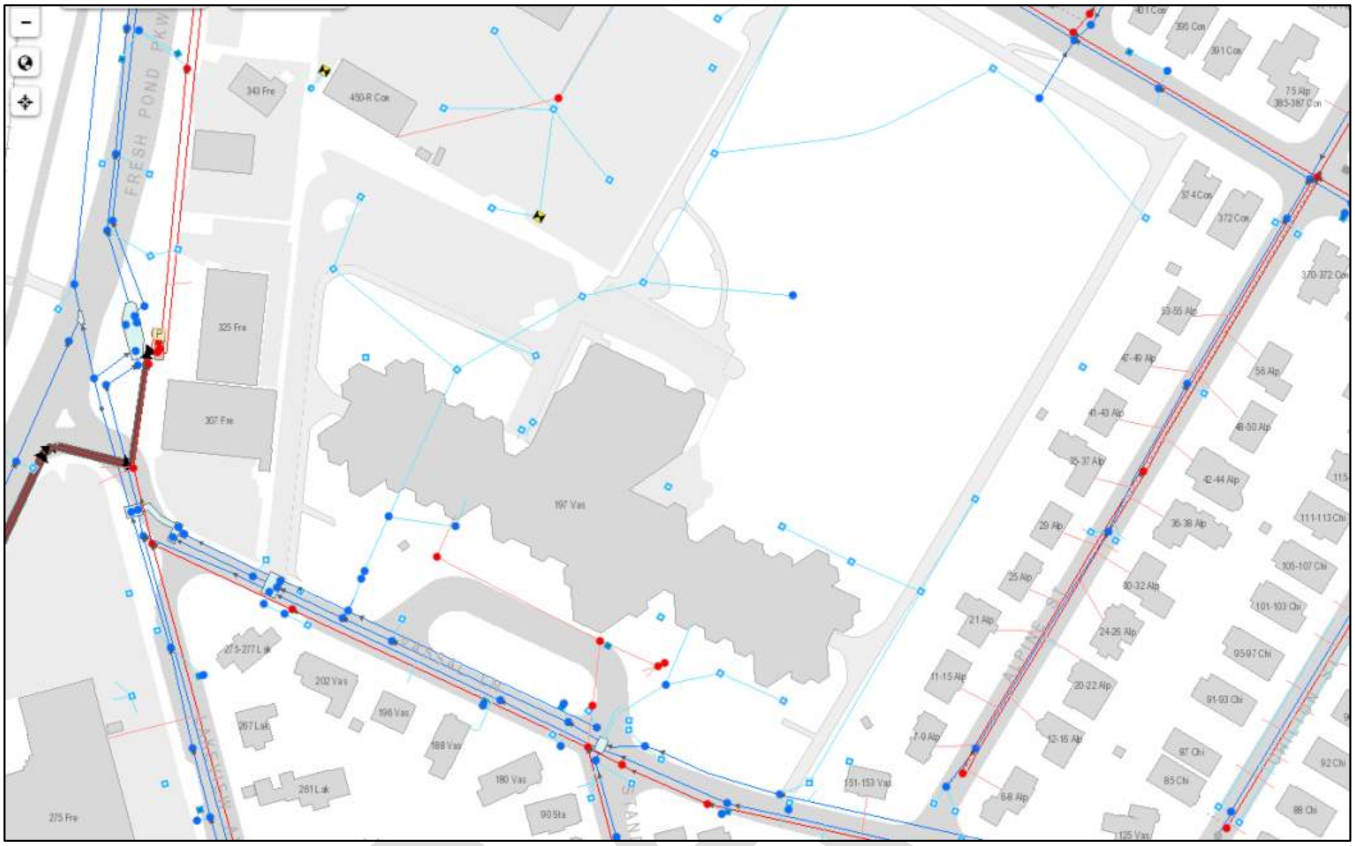


Figure 2: Cambridge GIS – Sewer and Drain at Project Site

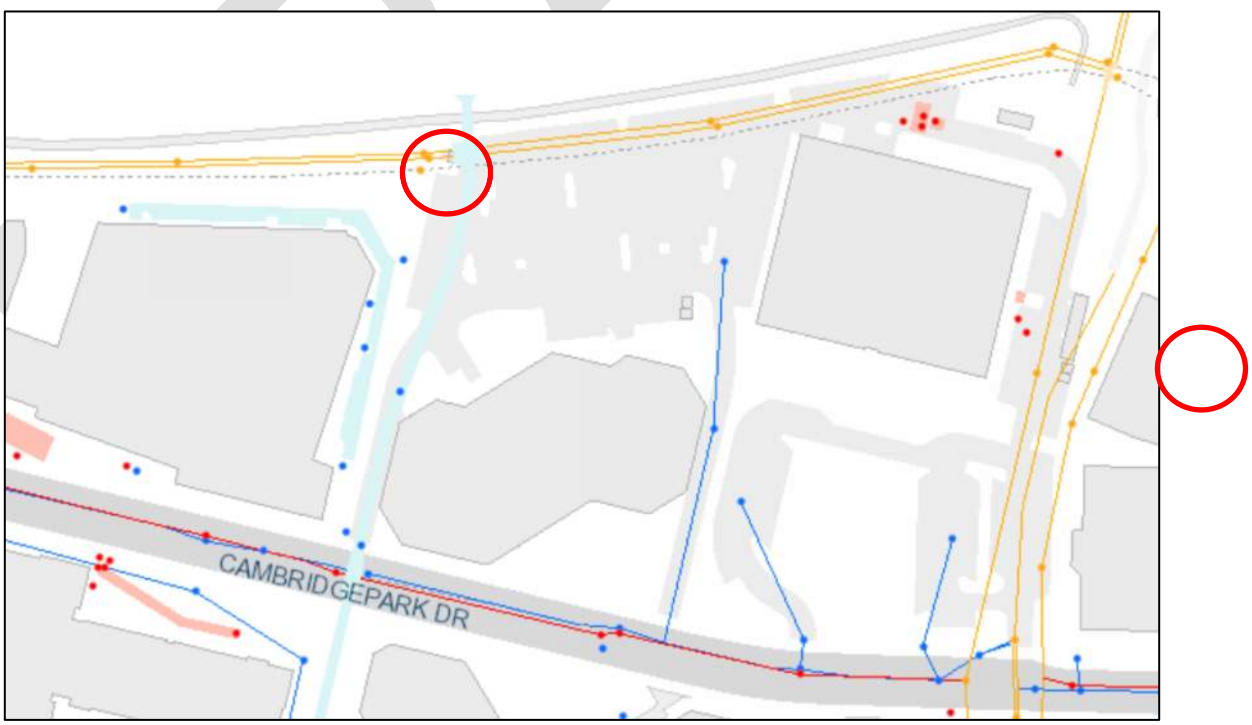


Figure 3: Cambridge GIS – Sewer and Drain Outfalls

Domestic Water and Fire Protection

The domestic water service for the existing school is 8-inch and is fed from the 12-inch main in Concord Avenue (Figure 4). A 6-inch hydrant service branches off the 8-inch domestic. Nitsch Engineering assumes the fire protection system for the existing school building is also serviced from the 8-inch water service. Refer to the Existing Conditions Survey provided as Attachment A for additional information.

Figure 4: Cambridge GIS Water System Distribution Map

There is also an existing 8-inch water main in Vassal Lane that does not appear to supply the School.

Water System Design Considerations:

- Nitsch Engineering will coordinate the fire protection services and domestic water services with the MEP Engineers and the Cambridge Water Department.
- Once the design is confirmed, Nitsch Engineering will coordinate with the Cambridge Water Department for their review and approval of the water plot plans.

Sanitary Sewer

The 8-inch sanitary sewer service for the Tobin School currently exits the building along the south face of the building and connects to the 18-inch sewer main in Vassal Lane (Figure 2). The 18-inch main connects to a “Sewer Flush Vault” which then pumps via a 4-inch force main and an 18-inch overflow pipe to another “Sewer Flush Vault”. The sewer flush vault directs sewer flow to a 24-inch pipe which ultimately ends up in the Massachusetts Water Resource Authority’s (MWRA) jurisdiction. Refer to the Existing Conditions Survey provided as Attachment A for additional information.

Sanitary Sewer Design Considerations:

- The project team will need to determine if the sewer flows from the proposed building increase from existing conditions and if the existing sewer infrastructure can adequately the increase in flow.
- If sewer flow is increased, infiltration and inflow (I/I) calculations will be required for mitigation with the Cambridge Department of Public Works.

Gas Service

The School is currently serviced by a gas line (size unknown) that connects to the existing 4-inch gas main located in Vassal Lane. The existing gas line connects to the School building in the vicinity of the intersection of Vassal Lane and Standish Street. Refer to the Existing Conditions Survey provided as Attachment A for additional information.

Site Electrical

The School is currently serviced by multiple electrical services (size unknown) from Vassal Lane. At the westernmost driveway, which serves as access to the parking lot, an underground electrical service extends from a manhole in Vassal Lane into another manhole in the parking lot, before connecting into the western side of the existing school building. Along the eastern parcel boundary, overhead wires extend into the site from the overhead wires located along the south side of Vassal Lane. This electrical connection appears to service lighting located behind the school building. Refer to the Existing Conditions Survey provided as Attachment A for additional information.

PRELIMINARY PERMITTING CONSIDERATIONS

City of Cambridge Stormwater Control Permit

The project is required to obtain a Stormwater Control Permit because it currently exceeds the following standards, as outlined in Section 3.1 of the Wastewater and Stormwater Management Guidance document:

- The project will disturb one (1) or more acres of land;
- The project will exceed 50,000 square feet of Gross Floor Area;
- The project parcel(s) equals or exceeds one (1) acre in size; and
- A Special Permit is required for the project by the Planning Board.

The City of Cambridge requires the peak flow rate associated with the 25-year storm from proposed developments not to exceed the peak flow rate associated with the 2-year storm under existing conditions and 65% of phosphorus is removed from stormwater generated by proposed site redevelopment on an annual basis.

Surface Water Supply Protection (310 CMR 22.20)

The Massachusetts Department of Environmental Protection (DEP) ensures the protection of surface waters used as sources of drinking water supply from contamination by regulating land use and activities within critical areas of surface water sources and tributaries and associated surface water bodies to these surface water sources.

Massachusetts GIS indicates that the site is within a Surface Water Protection Zone A and Zone C (Figure 5) and an Outstanding Resource Water Area (Figure 6) due to its proximity to the Fresh Pond. However, based on the site survey and Cambridge GIS information, the majority site runoff is collected in a closed drainage system that discharges to the Alewife Brook, rather than overland and Fresh Pond. Additional coordination with the City of Cambridge will be needed to confirm if the Surface Water Protection Zones and Outstanding Resource Water designation are applicable to the site.

Figure 5: MassGIS Surface Water Protection

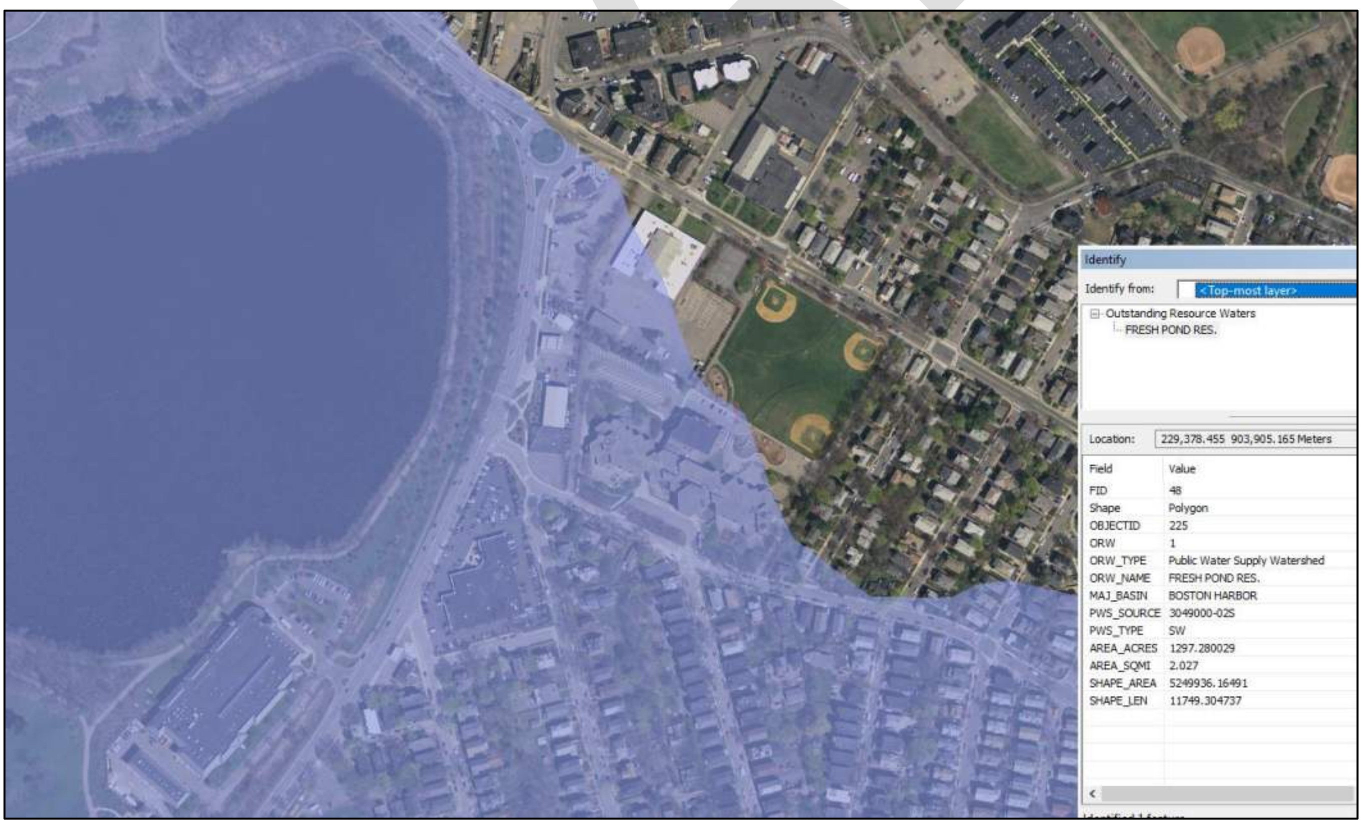


Figure 6: MassGIS Outstanding Water Resource Area

<u>FEMA Floodplain</u>
Based on the Flood Insurance Rate Map (FIRM), Community Panel Number 25017C 0419E, dated June 4, 2010, it appears that portions of the project site falls within a shaded Zone X. Zone X is described as areas of 0.2% annual chance of flood; areas of 1% annual chance flood with average depths of less than one (1) foot or with the drainage areas less than one (1) square miles; and areas protected by levees from 1% annual chance of flood.

<u>City of Cambridge Climate Change Vulnerability Assessment (CCVA)</u>
The Tobin School site was identified as an area of concern in the Cambridge CCVA mapping. The adjacent roadway shows flooding depths of one (1) inch to three (3) inches during the 100-year projected storm for 2030 (Figure 3). These depths increase for the 2070 100-year design storm. The site driveway to the parking lot shows a 1-inch flood depth.

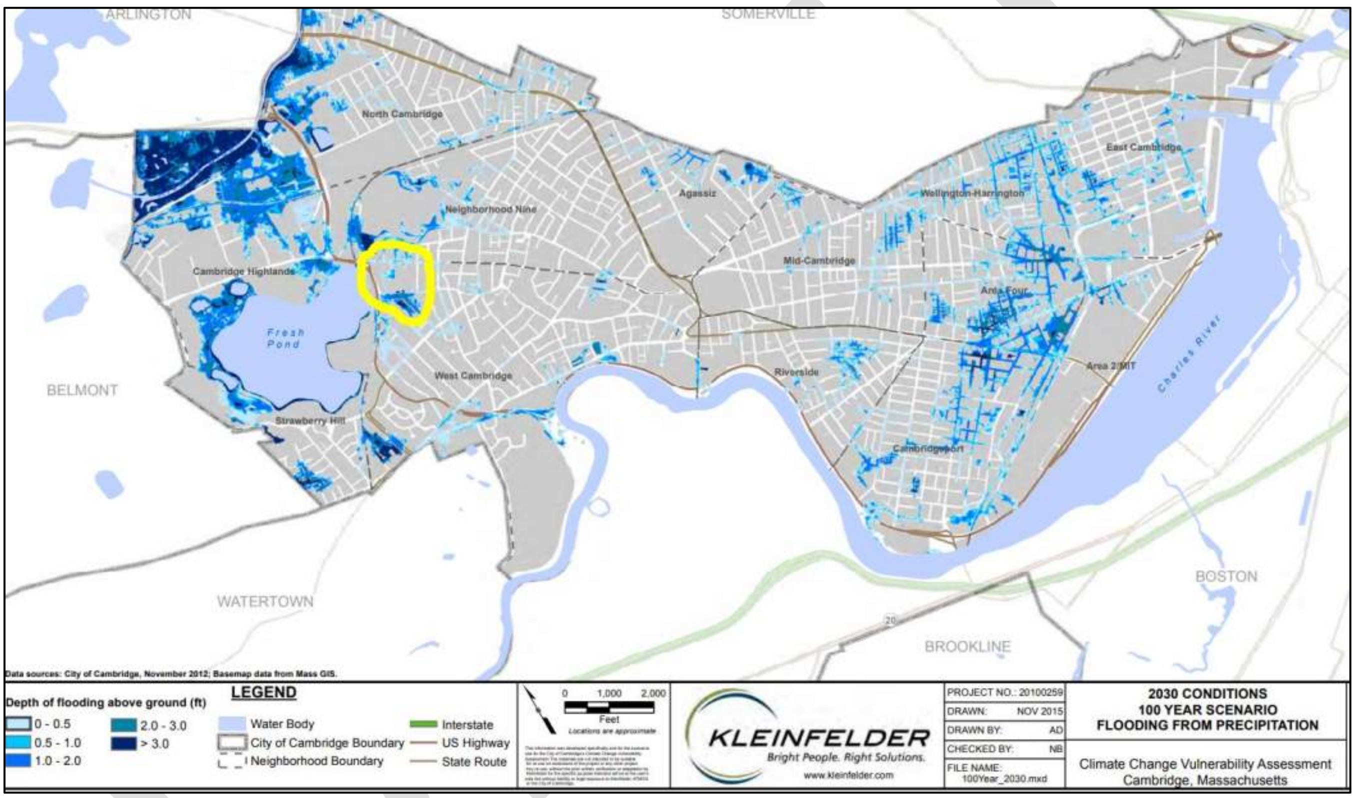


Figure 7: Climate Change Vulnerability Assessment for 100-year 2030 condition

The City of Cambridge Flood Viewer indicates that the present day 100-year flood elevation on the School parcel is at 23.9 feet, with the anticipated 100-year flood elevation in 2070 up to elevation 24.1 feet (Figure 8). The City should be consulted to determine the design standards for these elevations and to confirm if the proposed stormwater tank will modify these elevations.

Nitsch Engineering understands that the neighborhood flooding issue in the area is the driver of the 1.5-million-gallon stormwater storage tank. Nitsch will continue to coordinate with the City and their consultant team to integrate the surface and subsurface drainage improvements required into the overall site drainage design.

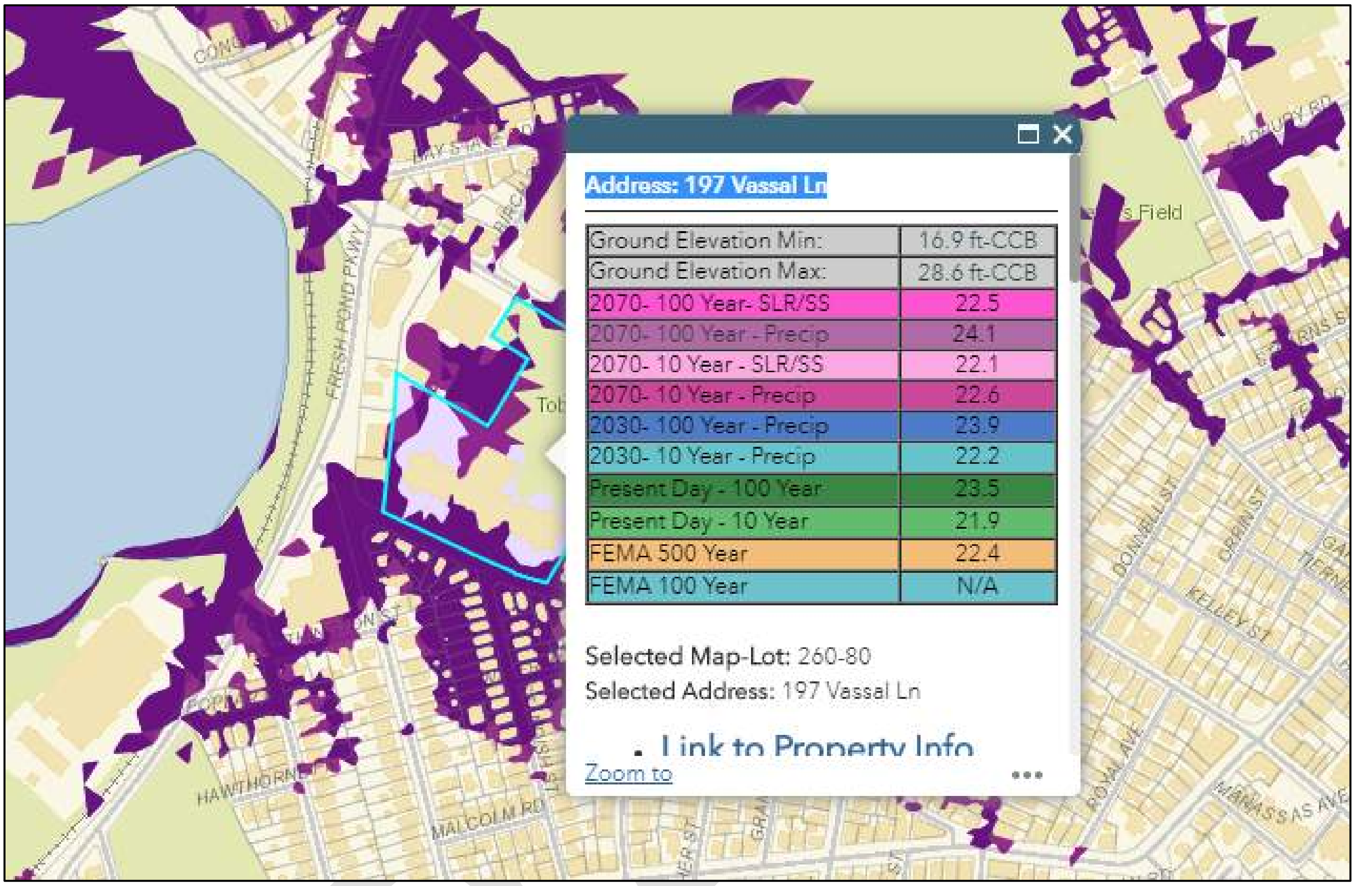


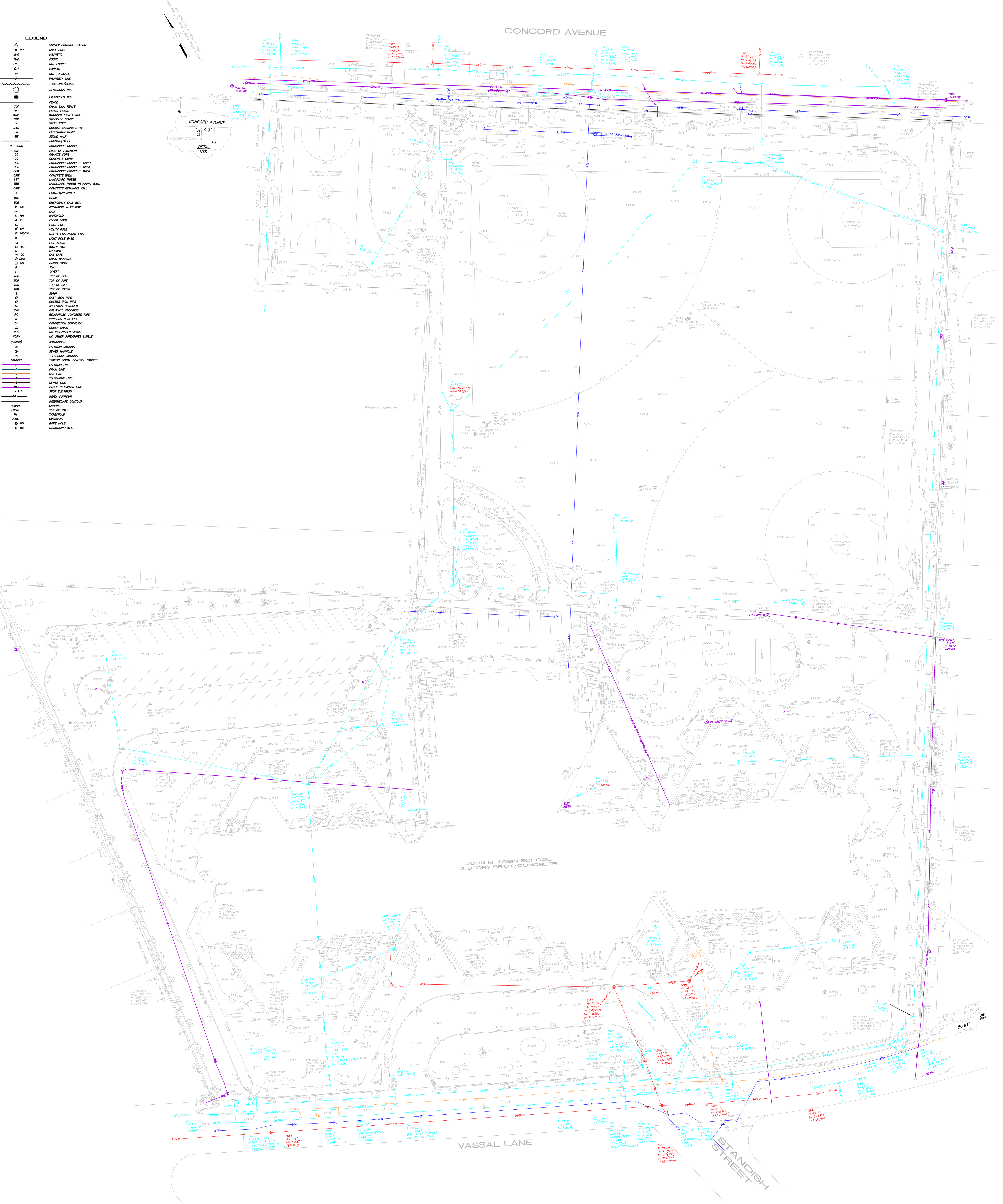
Figure 8: Cambridge Flood Viewer

EPA NPDES Construction General Permit

Construction activities that disturb more than one (1) acre are regulated under the United States Environmental Protection Agency's (EPA) National Pollution Discharge Elimination System (NPDES) Construction General Permit Program. In Massachusetts, the EPA issues a NPDES CGP to owners and operators of regulated construction sites. Regulated projects are required to develop and implement stormwater pollution prevention plans in order to obtain permit coverage. The project is anticipated to disturb more than one (1) acre and is anticipated to require this permit.

Natural Heritage & Endangered Species Program

A review of the 13th Edition of the Massachusetts Natural Heritage Atlas prepared by the Natural Heritage and Endangered Species Program (NHESP), dated October 1, 2008, indicates that the Tobin School site is NOT located within a Priority Habitat of Rare Species or an Estimated Habitat of Rare Wildlife.



NOTES

1. SUBSURFACE UTILITY LINES, AS SHOWN HEREON, WERE COMPILED ACCORDING TO AVAILABLE RECORD INFORMATION FROM THE REFERENCED COMPANIES AND PUBLIC AGENCIES, AND THEIR LOCATIONS ARE APPROXIMATE ONLY. ACTUAL LOCATIONS MUST BE DETERMINED IN THE FIELD. SMC ASSUMES NO RESPONSIBILITY FOR DAMAGES INCURRED AS A RESULT OF UTILITIES OMITTED OR INACCURATELY SHOWN.

GENERALLY THE LINES IN THE PUBLIC AND PRIVATE WAYS ARE SHOWN AND THE LATERAL CONNECTIONS SERVICING INDIVIDUAL USERS ARE NOT SHOWN. BEFORE DESIGNING FUTURE CONNECTIONS, THE APPROPRIATE UTILITIES MUST BE CONSULTED.

BEFORE CONSTRUCTION, ALL UTILITIES, PUBLIC AND PRIVATE MUST BE NOTIFIED (SEE MASSACHUSETTS GENERAL LAWS, CHAPTER 82 SECTION 40.) CALL "DIG SAFE" 1 (888) 344-7233 HTTP://WWW.DIGSAFE.COM

2. THE COORDINATES, IN FEET, ARE BASED UPON THE NORTH AMERICAN DATUM OF 1983 (NAD83/2011 EPOCH 2010.00) AS DEFINED BY THE KeyNet GPS VIRTUAL REFERENCE SYSTEM (VRS) NETWORK.

3. ELEVATIONS, IN FEET, ARE REFERRED TO THE CAMBRIDGE CITY BASE AS DERIVED FROM THE KeyNet GPS VIRTUAL REFERENCE SYSTEM (VRS) NETWORK.

VERTICAL DATUM RELATIONSHIP
NAVD88
11.66
CAMBRIDGE CITY BASE

UTILITY REFERENCES

1. JOHN M. TOBIN ELEMENTARY SCHOOL CAMBRIDGE, MASSACHSETTS GRADING AND UTILITIES PLAN
PREPARED BY PIETRO BELLUSCHI
SCALE: 1"=30' DATE: OCTOBER 25, 1968
REVISED JANUARY 20, 1969

2. CITY OF CAMBRIDGE, MASSACHUSETTS
HURON A SEWER SEPARATION PROJECT
CONTRACT NO. 8A
CIVIL-PLAN AND PROFILE FOR VASSAL LANE
STORM DRAIN (PROFILE 1) STA 9+50 TO STA 15+50
PREPARED BY KLEINFELDER
SCALE: 1"=20' DATE: SEPTEMBER 2012

3. CITY OF CAMBRIDGE, MASSACHUSETTS
CONCORD CONTRACT 9SEWER SEPARATION AND SURFACE IMPROVEMENTS PROJECTS
CIVIL-PLAN AND PROFILE FOR CONCORD AVE.
STA 3005+50 TO STA 3011+00
PREPARED BY KLEINFELDER
SCALE: 1"=20' DATE: JANUARY 27, 2014

4. CITY OF CAMBRIDGE, MASSACHUSETTS
HURON B SEWER SEPARATION PROJECT CONTRACT NO. 8B
CIVIL-PLAN AND PROFILE FOR VASSAL LANE
STA 3999+80 TO STA 11005+00
PREPARED BY MWH
SCALE: 1"=20' DATE: APRIL 17, 2013

5. EVERSOURCE GAS FACILITY MAP

6. EVERSOURCE ELECTRIC FACILITY MAP

7. CITY OF CAMBRIDGE DEPARTMENT OF PUBLIC WORKS WATER FACILITY MAP

8. VERIZON FACILITY MAPS

9. COMCAST FACILITY MAP

10. JOHN M. TOBIN ELEMENTARY SCHOOL
CAMBRIDGE, MASSACHUSETTS
UTILITY SITE PLAN
PREPARED BY PIETRO BELLUSCHI ARCHITECT
SCALE: 1"=30' DATE: OCT 25, 1968 REV. JAN 20, 1969

PROPERTY REFERENCES

1. PLAN OF LAND IN CAMBRIDGE, MASS.
SURVEYED FOR MARJORIE C. O'BRIEN
PREPARED BY W. A. MASON & SON CO.
SCALE: 1"=40' DATE: SEPTEMBER 20, 1926

2. SUBDIVISION OF BLOCK 1
LAND COURT PLAN NO. 12809
LAND IN CAMBRIDGE, MASS.
PREPARED BY W. A. MASON & SON CO.
SCALE: 1"=40' DATE: MARCH 13, 1933

3. SUBDIVISION OF PART OF BLOCK 1
SHOWN ON PLAN 12809A, FILED WITH CERT. OF TITLE NO. 27808, SOUTH REGISTRY DISTRICT OF MIDDLESEX COUNTY
LAND IN CAMBRIDGE
SCALE: 1"=50' DATE: NOVEMBER 15, 1929

4. ALPINE STREET FOR ACCEPTANCE
PREPARED BY DONALD J. REARDON
SCALE: 1"=60' DATE: FEBRUARY 21, 1929

5. SUBDIVISION OF PART OF BLOCK 1
SHOWN ON PLAN 12809A FILED WITH CERT. OF TITLE NO. 27808 SOUTH REGISTRY DISTRICT OF MIDDLESEX COUNTY
LAND IN CAMBRIDGE
SCALE: 1"=50' DATE: MARCH 13, 1933

6. PLAN OF LAND IN CAMBRIDGE, MASS.
PREPARED BY FRED A. JOYCE
SCALE: 1"=20' DATE: SEPTEMBER 20, 1946

7. PLAN OF LAND IN CAMBRIDGE, MASS.
PREPARED BY FRED A. JOYCE
SCALE: 1"=40' DATE: NOVEMBER 12, 1946

8. SUBDIVISION OF LOTS 4 TO 24 INCL. AND LOTS 3 AND 25, SHOWN ON PLANS 12809A AND 20208A, FILED WITH CERTIFICATE OF TITLE NO. 27808 AND 61175
SOUTH REGISTRY DISTRICT OF MIDDLESEX COUNTY
LAND IN CAMBRIDGE
PREPARED BY FRED A. JOYCE
SCALE: 1"=50' DATE: NOVEMBER 12, 1946

9. PLAN OF LAND IN CAMBRIDGE
PREPARED BY FRED A. JOYCE
SCALE: 1"=30' DATE: NOVEMBER 26, 1946
LCC #61175 BOOK 383 PAGE 509

10. PLAN OF LAND FOR PROPOSED ARMORY SITE
CAMBRIDGE, MASS.
PREPARED BY EMMONS & FLEMING
SCALE: 1"=40' DATE: AUGUST, 1957
PLAN NO 1513 OF 1957 BOOK 9038 PAGE 388

11. SUBDIVISION PLAN IN CAMBRIDGE, MASS.
PREPARED BY WENDELL H. MASON
SCALE: 1"=50' DATE: AUGUST 31, 1998

12. PLAN SHOWING EASEMENT TAKINGS FOR ROADWAY IMPROVEMENTS, FRESH POND PARKWAY & CONCORD AVE.
CAMBRIDGE, MASSACHUSETTS
PREPARED BY HARRY R. FELDMAN, INC.
SCALE: 1"=20' DATE: JULY 7, 1998
SHEETS 4-6 OF 8

13. PLAN SHOWING ACTIVITY & USE LIMITATION
TOBIN SCHOOL, CAMBRIDGE, MASS.
PREPARED BY HARRY R. FELDMAN
SCALE: 1"=50' DATE: FEBRUARY 4, 1999

14. PLAN OF LAND
450 CONCORD AVENUE, CAMBRIDGE, MA 02138
(MIDDLESEX COUNTY)
PREPARED FOR THE COMMONWEALTH OF MASSACHUSETTS
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SCALE: 1"=30' DATE: AUGUST 12, 2002

GRAPHIC SCALE 1" = 20'

Revised:	OCTOBER 2, 2017
Date:	SEPTEMBER 5, 2017
Job No.:	2017136.00
Drawn By:	SKH
Checked By:	JBW/KH
Calc'd By:	JBW
Drawing No.:	201713600WS.dwg
Sheet:	2 OF 2

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APPENDIX A

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EXISTING CONDITIONS SURVEY
JOHN M. TOBIN SCHOOL
VASSAL LANE
CAMBRIDGE, MA

PREPARED FOR: CDM SMITH, INC.

SCALE: 1"=20'
REVISED: OCTOBER 2, 2017
DATE: SEPTEMBER 6, 2017

SMC DWG. NO. 201713600WS.DWG

SHEET 1 OF 1

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<u>TOBIN MONTESSORI AND VASSAL LANE UPPER SCHOOL</u>
Cambridge, Massachusetts

<u>EXISTING CONDITIONS STRUCTURAL REPORT</u>
March 29, 2019

<u>INTRODUCTION</u>

Foley Buhl Roberts & Associates, Inc. (FBRA) is collaborating with *Perkins Eastman (PE)* in the review and evaluation of the Tobin Montessori and Vassal Lane Upper School in Cambridge, Massachusetts. The purpose of this *Existing Conditions Structural Report* is to identify and describe the structural systems of the facility and to comment on the structural issues/conditions observed. General comments relating to potential renovations, alterations and additions to the building (governed by the Existing Building Code of Massachusetts (MEBC - 9^{th} Edition)) are presented as well.

The Tobin Montessori and Vassal Lane Upper School is located at 197 Vassal Lane in Cambridge. The building was constructed in 1971 on a generally flat site. The site is bordered by residential neighborhoods to the south and east, the Callahan Park/Playground to the northeast, the Cambridge Armory (former National Guard Organizational Maintenance Shop) to the northwest, and by commercial buildings including a gas station to the west. The site includes the school building, courtyards, playgrounds, and the school parking lots. The building footprint is a "bow-tie" shape and consists of Units A, B, and C. Units A and C are symmetrical two-story classroom wings with their lowest level at the 2^{nd} floor, above a crawl space. Unit B is at the middle of the "bow-tie" and is partly a three-story wing and partly a one-story wing, with its lowest level at the 1^{st} floor, partially below grade. A partial 4^{th} level in Unit B is unoccupied. Unit B includes the Gymnasium, Auditorium, Cafeteria, and Library. An additional crawl space (used for outdoor storage) is located beneath the Gymnasium. There have been no significant additions or renovations made to the original building.

The Tobin Building currently houses both the Tobin Montessori School for pre-K to 5^{th} grade students and the Vassal Lane Upper School for 6^{th} to 8^{th} grade students. The building was not originally designed for the two separate school facilities but the school district reorganized its structure in 2012 resulting in a sharing of the space. The layout of the existing building is not compatible for the separate areas needed for the two schools.

The total building (floor) area is 135,600+/- SF.

The current enrollment is approximately 270 students in the Vassal Lane Upper School and 300 students in the Tobin Montessori School.

The building is a reinforced concrete structure with non-load-bearing ground-face masonry block exterior walls. The gymnasium roof is framed with open web steel joists. Exposed concrete columns and beams are common at both the building interior and exterior. The interior partition walls are typically concrete block (CMU) construction (running bond). The roofs are flat with a built-up, ballasted EDPM membrane. The roof membrane is the original 1971 installation, with local repairs as needed throughout the years.

The location is the site of a former clay mining facility. After the mining activities ended, the clay pit was used as an uncontrolled waste pit (from the 1930's to the 1950's). As such, a sub-slab depressurization and venting system was installed in the 1990's to prevent migration of waste material and land-filled gas to the school building's indoor air. The school and neighboring Callahan Field are regulated under the Massachusetts Contingency Plan (MCP), and there is an Activity and Use Limitation (AUL) in place.

Structural conditions at the Tobin Montessori and Vassal Lane Upper School were reviewed at the site (where accessible and exposed) by FBRA on February 22, 2019.

The following documents were reviewed in the preparation of this Existing Conditions Structural Report:

> *John M. Tobin Elementary School - Cambridge, Massachusetts:* Architectural Drawings A1-A14, A21, prepared by Pietro Belluschi (Principal Architect) and Sasaki, Dawson, DeMay Associates, Inc. (Associate Architect) - Watertown, Massachusetts, dated October 25, 1968, Revised January 20, 1969.

> *John M. Tobin Elementary School - Cambridge, Massachusetts:* Structural Drawings S1-S17, prepared by LeMessurier Associates - Boston, Massachusetts, dated October 25, 1968, Revised January 20, 1969.

No exploratory demolition or structural materials testing was conducted in conjunction with this study**.** Soil borings were available from the original building (included in Attachment B of CDM Smith's Tobin School Phase 2 Comprehensive Data Report, dated July 17, 2018).

I. STRUCTURAL SYSTEMS DESCRIPTION

The existing building is a reinforced concrete structure with structural slabs and pile foundations. The structural slabs are supported by reinforced concrete columns and beams. The gymnasium roof is framed with open web steel joists.

Original Structural Drawings for this building were available for preparation of this report. The information presented below is based on the original Structural Drawings and conditions observed on site by FBRA.

Structural Materials: Structural concrete strengths are noted on the original Structural Drawings (S1) as the following:

Concrete:

Piles:	4,000 psi compressive strength
Columns, Beams, Slabs, and all Concrete Exposed to the Weather:	4000 psi compressive strength
Roof Fill:	2000 psi compressive strength
All Other Unless Noted Otherwise:	3000 psi compressive strength

Steel Reinforcing (deformed bars):

Column Vertical Bars, Beam Longitudinal Bars	60,000 psi yield strength
All Other Bars	40,000 psi yield strength

Welded Wire Fabric Reinforcing:	ASTM A 185

Design Loads:

Design live load information was noted on the original Structural Drawings (S1), as listed below.

Roof (Snow):	30 psf (no provisions for snow drift)
Classrooms, Corridors (Including Partitions):	100 psf
Gymnasium, Auditorium, Kitchen:	100 psf
Mechanical Spaces:	150 psf
Transformer Room:	150 psf Min. (or Equipment Load)

Design wind load information was noted on the original Structural Drawings (S1), as listed below:

Wind:	
0 to 30'	20 psf
30' to 50'	25 psf

Representative structural calculations generally confirm these design live loads. Floor design loads are appropriate and meet or exceed present Building Code requirements. The current, minimum flat roof snow load required by the 9th Edition of the Massachusetts State Building Code for a school building in Cambridge is 30.8 psf; typical (non-drift) roof areas most likely meet this requirement. Snow drifting areas require further review.

The building appears to have performed satisfactorily over time under the current use. There are no apparent indications of structural overstress or failure. A comprehensive investigation and evaluation of the floor and roof structural capacity is beyond the scope of this report. However, it should be noted that reinforced concrete structures constructed in the 1960's and 1970's were designed under codes which were more conservative than current codes.

With respect to lateral (wind and seismic) loads, the building was presumably designed for the wind loads noted above. The current wind load required by the 9th Edition of the Massachusetts State Building Code for a school building with Exposure Category C is 43 psf ultimate or 25.8 psf service load. The existing structure may meet this requirement. As the design and construction of this facility preceded the introduction of the Massachusetts State Building Code, it was not designed for seismic loads and would not meet current Code requirements in that regard.

Story Heights: Story heights are as follows:

First Floor to Second Floor:	10'-8"
Second Floor to Third Floor:	10'-8"
Third Floor to Fourth Floor / Low Roof:	10'-8"
Fourth Floor / Low Roof to Main Roof:	10'-8"
Main Roof to Penthouse Roof:	10'-8"

Expansion Joints: There is reference to a ½" expansion joint along Gridline H at the Third Floor of Unit B, at the roof of the locker rooms (see Section 3-4 on S15). This expansion joint does not appear to track down to the Second Floor of Unit B. Elsewhere, in lieu of expansion/contraction joints, 3'-0" wide shrinkage strips/bays (infilled after main concrete placement has been allowed to shrink), were specified. These occur at the east and west ends of Unit B, at each level.

Structural Bays/Spans: The structural bay sizes vary throughout the building. The classrooms are situated in a pseudo-honeycomb arrangement and therefore are not rectangular. At Units A and C the classroom bays are roughly 25' to 30' x 34'. Typically there are columns at both sides of the central corridor.

Penthouse Roof Construction (Unit B): Penthouse roof construction at Unit B (Elevation 72'-0") consists of an 8" flat slab spanning to 16" wide x 32" deep concrete perimeter beams. The beams are supported by hexagonal concrete columns.

Roof Construction (Unit B): Roof construction at the Gymnasium (Elevation 61'-4") consists of 3" deep, 20 gage metal roof deck, spanning to 48LJ16 open web steel joists. The steel joists are spaced at 9'-9" and the top chord slopes to achieve the 1/8"/ft roof pitch. Steel joists are supported by concrete beams 16" wide x 32" deep, spanning to hexagonal concrete columns.

Roof construction at the Auditorium (Elevation 61'-4") consists of a one-way 6" slab supported by 16" wide x 32" deep concrete roof beams spaced at 9'-9" on center. The roof beams are supported by concrete roof girders spanning to hexagonal concrete columns.

Additional main roof areas at Unit B (Elevation 61'-4") consist of 8" flat slabs spanning to 16" wide x 32" deep concrete beams, which are supported by hexagonal concrete columns.

Roof Construction (Units A and C): Roof construction at Units A and C classroom wings (Elevation 50'-8") is a flat slab, typically 8" thick, supported by concrete beams spanning between hexagonal concrete columns. The beams are typically 16" wide x 32" deep. There are trapezoidal shaped balconies cantilevered along the perimeter. Concrete fill is added at the roof to achieve the required pitch for roof drainage.

Above the stairway at Units A and C is a 6" Penthouse Roof slab (Elevation 61'-4") supported by concrete beams and hexagonal concrete columns.

Fourth Floor Roof Construction (Unit B): Typical Fourth Floor roof construction at Unit B (Elevation 50'-8") consists of an 8" thick, flat slab supported by 16" wide x 32" deep concrete beams spanning to hexagonal concrete columns. Along the perimeter are trapezoidal shaped balconies, cantilevered from the main slab.

Low Roof Construction (Unit B): Low roof construction at the locker rooms adjacent to the Gymnasium (Elevation 40'-0") consists of 6" concrete joists spaced at 3'-0" on center, with a 4" minimum concrete topping. At the east side of the Gymnasium where the joist span is 19'-6", the joists are 8" deep. At the south side of the Gymnasium where the joist span is roughly 33'-9", the joists are 12" deep. The joists frame into concrete beams supported by hexagonal concrete columns. The concrete topping thickness varies in order to achieve the required pitch for roof drainage.

Third Floor Construction (Unit B): Typical Third Floor construction at Unit B (Elevation 40'-0") consists of a 9" thick, flat slab supported by 16" wide x 32" deep concrete beams and hexagonal concrete columns. At the corridor the slab is reduced to 8" thickness. At the Science Laboratory the slab is increased to 13" thickness. At the Auditorium the slab is sloped to accommodate the tiered seating. At select locations along the perimeter are trapezoidal shaped balconies, cantilevered from the main slab.

Third Floor Construction (Units A and C): Typical Third Floor construction at Units A and C (Elevation 40'-0") consists of a 9" thick, flat slab supported by 16" wide x 32" deep concrete beams and hexagonal concrete columns. At the corridor the slab is reduced to 8" thickness.

There are trapezoidal sections of slab cantilevered along the perimeter at balcony locations. Concrete fill is added at the low roof areas to achieve the required pitch for roof drainage.

Second Floor Construction (Unit B): Typical Second Floor construction at Unit B (Elevation 29'-4") consists of an 8" thick, flat slab supported by hexagonal concrete columns and 16" wide x 32" deep concrete beams. The base reinforcement in both the north-south and east-west direction is #5 bars at 9" on center bottom and #5 bars at 16" on center top. Additional reinforcement is added at certain locations. The main entrance to the school occurs at this level at the south side of the building at Elevation 23'-10 ¼". There are ramps up and down from the main entry area to access the Second Floor slab at 29'-4" and the First Floor slab at Elevation 18'-8". There is an opening in the slab to allow for a double-height space at the Cafeteria. At two locations along the perimeter are trapezoidal shaped balconies, cantilevered from the main slab.

Second Floor Construction (Units A and C): Typical Second Floor construction at Units A and C (Elevation 29'-4", the lowest occupied level at these units) consists of a flat slab, 8" or 12" in thickness, supported by hexagonal concrete columns and piles. The base reinforcement is #5 continuous bars at 12" on center bottom each way. Additional reinforcement is added at certain locations. There are 16" wide concrete grade beams at the perimeter. Below this structural slab is a crawl space (roughly 6'-0" high) with a 2½" concrete mud mat at the floor above 4" of gravel.

First Floor Construction (Unit B): Typical First Floor construction at Unit B (Elevation 18'-8", the lowest occupied level) consists of an 8" thick, flat slab supported by piles. The base reinforcement in both the north-south and east-west direction is #5 bars at 9" on center bottom and #5 bars at 16" on center top. Additional reinforcement is added at certain locations. There are 16" wide concrete grade beams at the perimeter. At the northern portion of the Unit B first floor (below the Gymnasium slab) is a crawl space (used for outdoor storage; 6'-8"+/- height), with a concrete mud mat at the floor pitched to drain. At the southern portion of the Unit B first floor are two 'sunken gardens' or courtyards, separated from the higher adjacent grade with retaining walls supported by wood piles.

Exterior Wall Construction: Typical exterior wall construction is non-load bearing ground-face CMU block in between the cast-in-place concrete superstructure (beams and columns).

Interior Wall Construction: Interior walls are typically non-load bearing ground-face CMU.

Stair Construction: Stairs are cast-in-place concrete construction.

Subsurface Soils/Foundations: No information is given on the Structural Drawings for the subsurface soil conditions or pile capacities. The building is supported on concrete end bearing piles typically, with some wood friction piles at Unit B. A 'Pile Location Plan' is included with the Structural Drawings on sheet S2, in addition to the pile cap details. Columns and perimeter grade beams are supported on pile caps, and there are also intermediate, single-pile pile caps providing additional support for the lowest level slab.

Drainage: The existing Structural Drawings do include a typical detail for foundation and underslab drainage, and the underslab drainage is shown on the First Floor plan for Unit B.

Fire Resistance: The cast-in-place concrete structure has an inherent resistance to fire. The rating for the majority of the existing building would likely be over 1½ hours, given the structural slab thicknesses, concrete cover to reinforcing, etc. The unprotected steel joists at the Gymnasium roof have no fire resistance; however, the bottom of the steel roof joists is over 20 feet above the floor.

Lateral Load Resistance: As previously mentioned, the Structural Drawings note the design wind loads; presumably, the building was designed to resist these noted wind loads. While there is no explicit mention of shear walls or lateral frames on the Structural Drawings, it is implied that the overall concrete frame (beams and columns) was designed to resist the lateral wind load. The current Code design wind load is slightly higher than that noted on the Structural Drawings; hence, further analysis would be needed to determine whether the existing frame can meet current wind load requirements. As the design and construction of this facility preceded the introduction of the Massachusetts State Building Code, it was not designed for seismic loads and would not meet current Code requirements in that regard.

II. STRUCTURAL CONDITION/COMMENTS

Structural Conditions at the Tobin Montessori and Vassal Lane Upper School were reviewed (where accessible and exposed) on February 22, 2019. Generally speaking, floor and roof construction appear to be performing satisfactorily; there is no apparent evidence of structural distress that would indicate significantly overstressed, deteriorated or failed structural members.

Foundations appear to be performing adequately; there are no signs of significant total or differential settlements.

Where visible, floor and roof construction appear to have been constructed in accordance with the original Structural Drawings.

Structural/structurally related conditions observed during the February 22, 2019 site visit are noted below (Refer to photographs in the Appendix at the end of this report):

1. The condition of non-load bearing interior masonry corridor walls and partitions is generally satisfactory; minimal (shrinkage related) cracking was observed.

2. It appears that cementitious parging has been applied to structural concrete walls in some locations. Parging on the west wall of the Gymnasium in Unit B has debonded (See Photo 1). Cosmetic repair required.

3. Corroded reinforcing was observed in some locations on the building exterior, where bars were located too close to the exposed concrete surface. The expansion of the corroded reinforcing has resulted in local concrete spalling (see Photos 2, 3, 4 and 5). These conditions do not present an immediate structural concern; however, periodic monitoring is recommended to ensure that these areas remain stable. Any loose concrete should be removed.

4. Exterior, exposed concrete surfaces have deteriorated in a number of locations around the building (see Photos 6, 7 and 8). These conditions do not present an immediate structural concern; however, further review and monitoring is recommended.

5. Exterior (non-load bearing) masonry walls show signs of deterioration, efflorescence and discoloration at numerous areas around the building. Efflorescence is visible on interior wall surfaces at some locations as well. These conditions appear to be moisture related (absorption, wall/structure joint deficiencies, roof leaks, etc.). See Photos 9, 10, 11 and 12).

6. The outside face of exterior (non-load bearing) masonry walls has spalled in a number of locations at the upper levels of the building, and at base of the building, adjacent to

walkways. These conditions are due to the wetting of the masonry and freeze-thaw action. See Photos 13, 14, 15 and 16.

7. According to school maintenance personnel, wind-driven rains penetrate the exterior envelope in certain locations.

8. There is a significant roof leak in Unit B over the central (east-west) corridor (near the Library; Room 333). Water travels down through the entire building. There are also roof leaks in the Auditorium, the Gymnasium and elsewhere in the building. FBRA noted that the stone ballast on the roof was missing in a number of locations.

9. According to school maintenance personnel, there are no groundwater related issues at the lowest level floor slabs (note that the slabs in Units A and C are constructed over a crawl space). Underslab drainage was provided below the Unit B structural slab on grade. There are no moisture related issues with flooring.

10. The (minimal) expansion joint along Column Line H in Unit B does not appear to be functioning as intended at Column H-23 (See Photo 17). The details of this joint are not clear in the original documents; further review is recommended.

11. The entry stair on the south side of Unit C is showing signs of deterioration (See Photo 18).

12. Sidewalk construction has been damaged and displaced (likely due to frost heave) in some locations, resulting in a tripping hazard (See Photo 19).

13. Metal exterior doors have rusted at their base in a number of locations.

Note: Refer to the Architectural Report and those of the other consultants for additional information regarding the condition of the building envelope (exterior walls, roofing, windows, etc.), and recommendations for the repair, rehabilitation and/or replacement of these systems.

III. RENOVATIONS AND ADDITIONS - MEBC REQUIREMENTS

General comments relating to potential renovations, alterations, and additions to the Tobin Montessori and Vassal Lane Upper School are presented in this section. Renovations, alterations, repairs, and additions to existing buildings in Massachusetts are governed by the provisions of the Massachusetts State Building Code (MSBC; 780 CMR - 9th Edition) and the Existing Building Code of Massachusetts (EBCM; 780 CMR - 9th Edition, Chapter 34.00). These documents are based on amended versions of the *2015 International Building Code (IBC)* and the *2015 International Existing Building Code (IEBC)*, respectively.

Section 104.2.2.1 of the EBCM requires that the existing building be investigated and evaluated in sufficient detail as to ascertain the effects of the proposed work on the structural systems (both gravity load carrying elements and lateral force (wind and seismic) resisting elements).

The EBCM defines three (3) compliance methods for the repair, alteration, change of occupancy, addition, or relocation of an existing building. The method of compliance is chosen by the Design Team (based on the project scope and cost considerations) and cannot be combined with other methods.

The *Prescriptive Compliance Method* (IEBC Chapter 4) prescribes specific minimum requirements for construction related to additions, alterations, repairs, fire escapes, glass replacement, change of occupancy, historic buildings, moved buildings, and accessibility. If the impact of the proposed alterations and additions to structural elements carrying gravity loads and lateral (wind and seismic) loads is minimal (less than 5% and 10%, respectively), structural/seismic reinforcing of an existing building is not required. Provided that not more than 50% of the spaces in the building are reconfigured, seismic hazards such as bracing the tops of interior masonry walls and partitions, anchorage of floor and roof diaphragms to the exterior walls, bracing of parapets and chimneys, etc. would not be required by code, but could be addressed on a voluntary basis. If the area of reconfigured spaces exceeds 50% of the gross floor area, these seismic hazards must be addressed to meet the provisions of the EBCM.

The *Work Area Compliance Method* (IEBC Chapters 5 through 13) is based on a proportional approach to compliance, where upgrades to an existing building are triggered by the type and extent of work. The Work Area Compliance Method includes requirements for three levels of alterations, in addition to requirements for repairs, changes in occupancy, additions, historic buildings, or moved buildings. A complete seismic evaluation of the existing building is required under the following conditions: Level 2 alterations where the demand (mass/seismic force) to capacity (lateral force resistance) ratio of lateral load resisting elements has been increased by more than 10%, all Level 3 alterations, a change in occupancy to a higher category (not applicable here), and where structurally attached additions (vertical or horizontal) are planned. Provided that not more than 50% of the spaces in the building are reconfigured, renovations would be classified as *Level 2*. Assuming that modifications to the existing masonry walls and the existing concrete frame (each providing a degree of lateral force resistance) will not be significant (i.e. less than 10% reduction in capacity), seismic upgrades or seismic strengthening of the building would not be required by code. However, seismic hazards such as bracing the tops of interior masonry walls and partitions, anchorage of floor and roof diaphragms to the exterior masonry walls, bracing of chimneys, etc. could be addressed on a voluntary basis. In a *Level 3* alteration (more than 50% of the building reconfigured), these seismic hazards must be addressed by code.

The *Performance Compliance Method* (IEBC Chapter 14) provides for evaluating a building based on fire safety, means of egress and general safety (19 parameters total). This method allows for the evaluation of the existing building to demonstrate that the altered building, while not complying with the code requirements for new construction, will maintain or improve the level of compliance that existed prior to the alterations. A structural investigation and analysis of the existing building is required to determine the adequacy of the structural systems for the proposed alteration, addition or change of occupancy. A report of the investigation and evaluation, along with proposed compliance alternatives, must be submitted to the code official for approval.

Additions - General Comments - EBCM

The design and construction of any addition to the Tobin Montessori and Vassal Lane Upper School would be conducted in accordance with the Code for new construction. New additions should be structurally separated from the existing, adjacent construction by an expansion (movement) joint to avoid an increase in gravity loads or lateral loads to existing structural elements.

Renovations/Alterations - General Comments - EBCM

Where proposed alterations to existing structural elements carrying gravity loads result in a stress increase of over 5%, the affected element will need to be reinforced or replaced (if necessary) to comply with the Code for new construction.

Proposed alterations to existing structural elements that are resisting lateral loads (which are not explicitly identified in the Structural Drawings) that result in an increase in the lateral force demand to capacity ratio of over 10% (due to a capacity reduction) should be avoided, if possible. Essentially, this means that removal of masonry walls resisting lateral forces (or creating large openings in these walls) and/or removing sections of the existing slab, beam, and column framing that may be providing lateral force resistance should be avoided; otherwise, seismic strengthening of the building, as well as additional seismic upgrades, may be triggered.

End of Existing Conditions Structural Report

APPENDIX – PHOTOGRAPHS

Photo 1: Debonded Parging

Photo 2: Corroded Reinforcing/Spalled Concrete Cover

Photo 3: Corroded Reinforcing/Spalled Concrete Cover

Photo 4: Corroded Reinforcing/Spalled Concrete Cover and Surface Deterioration

Photo 5: Corroded Reinforcing/Spalled Concrete Cover

Photo 6: Crack in Concrete Spandrel Beam

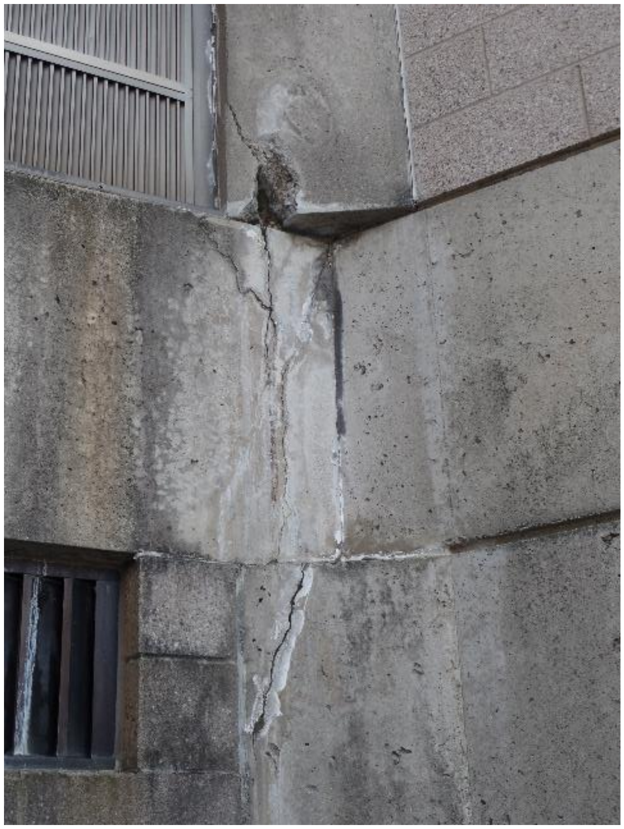

Photo 7: Corrosion/Spalled Concrete Cover and Cracking/Deterioration

Photo 8: Corrosion/Spalled Concrete Cover and Cracking/Deterioration

Photo 9: Exterior Masonry Wall - Moisture Damage

Photo10: Efflorescence on Interior Face of Exterior Wall

Photo 11: Exterior Masonry Wall - Moisture Damage

Photo 12: Exterior Masonry Wall -Moisture Damage

Photo 13: Exterior Masonry Wall - Surficial Damage at Walkway

Photo 14: Exterior Masonry Wall - Surficial Damage

Photo 15: Exterior Masonry Wall - Surficial Damage

Photo 16: Exterior Masonry Wall - Surficial Damage

Photo 17: Expansion Joint South of the Gymnasium

Photo 18: Unit C South Entry Stair

Photo 19: Cracked/Frost-Heaved Sidewalk

Tobin & Vassal Lane Upper Schools

Cambridge, MA

Existing Conditions Assessment

For

Perkins Eastman Architects
20 Ashburton Place, Floor 8
Boston, Massachusetts 02108

RFS 18-8795.001

March 11, 2020

Rist-Frost-Shumway Engineering, P.C.
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Tobin & Vassal Lane Upper Schools
Cambridge, MA
Existing Conditions Assessment

Table of Contents

A. INTRODUCTION

This report describes the existing conditions assessment of the mechanical, electrical, plumbing, fire protection, telecommunications and security systems for the Tobin Montessori and Vassal Lane Upper Schools in Cambridge, MA.

B. MECHANICAL SYSTEMS

1. General

The building heating, ventilating and air conditioning (HVAC) systems utilize electric type heating and cooling equipment.

The main building control system is equipped with pneumatic controls.

With the exception two (2) indoor air handling units and the associated roof-mounted air cooled condensing units which appear to have been installed approximately 10 years ago, the HVAC systems are at or near their estimated service life. The following table lists the average (median) estimated service life (ESL) in years according to the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) 2015 Fundamentals Handbook.

EQUIPMENT DESCRIPTION	MEDIAN YEARS
Unit Ventilators	20
Rooftop Heating and Ventilating Units	20
Electric Heating Coils	15
Exhaust Fans	25
Pneumatic Controls	20
Electric Motors	18
Motor Starters	17

2. Air Handling Units and Condensing Units

There are nine (9) air handling units serving various spaces within the building.

Existing air handling unit AC-1, located in a level 1 mechanical room, provides heating ventilation and air conditioning for the kitchen and some small office areas. An associated split air cooled condensing unit located on the roof provides mechanical cooling for the unit. AC-1 and the associated condensing unit appear to have been replaced approximately 10 years ago. The refrigeration system utilizes R-410A refrigerant. The unit is equipped with an electric heating coil connected to the unit supply air discharge ductwork. Duct-mounted electric heating coils provide individual space heating control.

Existing air handling unit AC-2, located in a level 1 mechanical room, provides heating ventilation and air conditioning for the cafeteria and some small office areas. An associated split air cooled condensing unit located on the roof provides mechanical cooling for the unit. AC-2 and the associated condensing unit appear to have been replaced approximately 10 years ago. The refrigeration system utilizes R-410A refrigerant. The unit is equipped with an electric heating coil connected to the unit supply air discharge ductwork. Duct-mounted electric heating coils provide individual space heating control.

Existing air handling unit AC-3, located in a mechanical penthouse, provides heating ventilation and air conditioning for the auditorium and the main building entry space. An associated split air cooled condensing unit located on the roof provides mechanical cooling for the unit. AC-3 and the associated condensing unit appear to be original equipment.

Existing air handling unit HV-1, located in a level 1 mechanical room, provides heating and ventilation for the level 1 storage area. HV-1 appears to be original equipment.

Existing air handling unit HV-2, located in a level 1 mechanical room, provides tempered make-up air for the kitchen hoods. HV-2 appears to be original equipment.

Existing air handling unit HV-3, located in a mechanical mezzanine space near the west side of the gymnasium provides heating and ventilation for the original locker room areas on the south side of the gymnasium. An associated in-line fan located on the mechanical mezzanine provides exhaust air for these spaces. HV-3 and the associated in-line fan appear to be original equipment.

Two (2) existing air handling units HV-4 and HV-5 located in mechanical mezzanine spaces near the north side of the gymnasium provide heating and ventilation for gymnasium. Each unit is provided with an in-line fan which provides exhaust air for the gymnasium. HV-4, HV-5 and the associated in-line fans appear to be original equipment.

Existing air handling unit HV-6, located in a mechanical space near the east side of the gymnasium provides heating and ventilation for the original locker room areas on the east side of the gymnasium. An associated roof-mounted fan provides exhaust air for these spaces. HV-3 and the associated roof-mounted fan appear to be original equipment.

3. Space Mounted Heating, Ventilating and Air Conditioning Units

Heating, ventilation and air conditioning for the classroom spaces is provided by self-contained type unit ventilators located around the perimeter of the building. The units are equipped with electric heating coils and packaged direct expansion cooling. Each unit is provided with an outside air intake louver through the wall which provides ventilation air. Exhaust air for the classrooms is provided by several exhaust fans located at various locations throughout the building. It has been reported by the school that the original unit ventilators were replaced in 1992.

Additional unit ventilators similar to the equipment described above are also provided for the cafeteria.

4. Ancillary Mechanical Systems

Dedicated exhaust fans are provided for the toilet room areas, kitchen hoods and laboratory fume hoods.

The kiln located in the art classroom is provided with a dedicated exhaust system.

C. PLUMBING SYSTEMS

1. Domestic Water Service

The existing 6-inch domestic water service enters the storage area beneath the gymnasium and is provided with a 6-inch gate valve and is immediately reduced to 3-inch in size. The 3-inch domestic water meter is provided with a remote read and is located in the ground level plumbing shop. It has been reported the existing copper water pipe located throughout the building experiences pin-hole leaks which frequently requires replacement.

Hot water is currently provided by a simplex electric water heater with integral storage. The heater was manufactured by Patterson Kelley in 1970. Water is heated to 140-degrees and mixed down to 120-degrees with a Leonard thermostatic mixing valve to serve the domestic plumbing fixtures. 140-degrees is piped to serve the kitchen equipment. The 120-degree domestic hot water is fully circulated back to the heater with the use of a Bell & Gossett circulation pump. There are visible signs of corrosion at the existing thermostatic mixing valve and on the water heater insulation jacket.

2. Sanitary Drainage

Sanitary piping collects waste from the domestic plumbing fixtures located on the second and third levels and discharge it to the municipal sanitary sewer located in Vassal Lane by gravity. An 8-inch sanitary sewer exits the west crawl space and a 5-inch sanitary sewer exits the east crawl space. The sanitary waste collected from level 1 fixtures is piped to a duplex sewage ejector located in the west crawlspace. The sewage ejector discharges into the existing 8-inch sanitary sewer and appears to be in fair condition. The visible sanitary waste pipe located in the crawlspaces is in fair condition. There are several locations where the piping is severely corroded and will require replacement.

Grease waste generated from the triple-bowl pot sink located in the kitchen is provided with a recessed grease interceptor. The outlet of this interceptor is piped directly to the sanitary sewer. There are no grease interceptors serving the kettles and there is no exterior grease interceptor as required by the Cambridge sewer department. All fixtures and equipment generating grease laden-waste shall be piped to a PDI approved grease interceptor as required by the Massachusetts Plumbing Code.

The sinks located at the third floor science classrooms are provided with acid-resistant waste piping but there are no pH neutralization systems in place. All waste is piped directly to the sanitary sewer. Laboratory sinks shall be provided with a waste neutralization system as required by the Massachusetts Plumbing Code.

3. *Storm Drainage*

The building is provided with conventional roof drains at the main level of flat roof. The use of scupper drains and downspouts were observed at architectural features that extend higher than the main roof level. The roof drains are piped down through the building and discharge to the municipal storm sewer in Vassal Lane by gravity. A 12-inch sanitary sewer exits the west crawl space and a 12-inch sanitary sewer exits the east crawl space. There was no observed secondary overflow roof drain system or scupper drains at the main roof level.

A duplex sump pump is located in the west crawl space and collects storm water from area drains located outside of the building. The sump pump discharges into the existing 12-inch storm sewer and appears to be in fair condition.

4. *Plumbing Fixtures*

Plumbing fixtures in public toilet rooms consist of wall-mounted water closets with manual flush valves, wall-mounted urinals with manual flush valves and wall-mounted china lavatories with manual faucets. It appears some of the water closets have been updated with 1.6 gallons per flush units and some lavatory faucets have been replaced. Plumbing fixtures located at the classrooms in the Vassal Lane Upper School consist of floor mounted water closets with manual flush valves and counter mounted lavatories with manual faucets. It appears many of the lavatory sinks and faucets have been replaced.

Drinking fountains are a combination of recessed or surface mounted and are generally in fair condition. A new combination drinking fountain and bottle filer is provided in the cafeteria. Janitors closets consist of floor-mounted molded stone basins and faucets with vacuum breakers which are in fair condition. Classroom sinks are stainless steel with manual faucets and appear to be in fair condition.

The third floor science classrooms are provided with emergency showers and eyewashes. Tepid water is supplied to the fixtures by point-of-use thermostatic mixing valves. The fixtures and valves appear to be in good condition. Science classroom sinks include epoxy basins and faucets with integral vacuum breakers. General classroom sinks are stainless steel with manual faucets.

5. Natural Gas

A natural gas service enters the site near the main entrance along Vassal Lane. The 2-inch line is installed along the exterior of the building and enters the east crawl-space above grade. The gas meter is located within the east crawlspace. Natural gas was originally installed in the building to serve the generator, classroom cooking stoves and gas turrets in the science classrooms which have all since been removed.

D. FIRE PROTECTION SYSTEMS

1. General

The building currently does not have an automatic sprinkler system. There are no standpipes within the egress stairwells or at the auditorium stage.

E. ELECTRICAL SYSTEMS

1. Electrical Distribution

The Tobin Montessori and Vassal Lane Upper Schools primary electric service originates underground from a utility manhole on Vassal Lane. An electric transformer vault room is located inside the building and hosts the utility-owned transformer with a secondary service of 480/277-volt. From the transformer a 3000A, 3Ø, 4 Wire bus duct is providing power to a 3000A, 480/277V, 3Ø, 4 Wire Main Switchboard.

Satellite electrical rooms are located on each wing and floor. Each room accommodates 480/277-volt panelboards and three-phase dry-type transformers providing 120/208-volt power to local electrical consuming loads.

Generally, much of the electrical infrastructure appears to be original to the building and is beyond typical service life. It is generally accepted that the maximum life of an electrical system is thirty (30) years. Beyond that point, it becomes increasingly difficult to cost effectively maintain the system. Wire insulation and equipment failure becomes more common as the system ages, with an increase in outage longevity due to the design of the system and the availability of replacement parts. Often new systems need to be installed to bypass the old system without the benefit of a comprehensive plan designed for the needs of the system. The following is a list of typical life expectancies of equipment.

EQUIPMENT	EXPECTED LIFE (YEARS)
LV molded case circuit breakers	17
LV power circuit breakers	20
Dry-type transformers	25-30
Liquid filled transformers	30
LV and MV cables	20
Motors and motor starters	20-30

References used to evaluate the electrical, lighting and fire alarm systems include:

- Occupational Safety and Health Act (OSHA).
- Massachusetts Electrical Code (MEC).
- National Electrical Safety Code (NESC).
- National Electrical Manufacturers' Association (NEMA).
- National Fire Protection Association (NFPA).
- Institute of Electrical and Electronics Engineers (IEEE).
- Illumination Engineering Society of North America (IESNA)

The panelboards are beyond their useful life and replacement parts are very difficult to find. Cable insulation failure within a panelboard can create a fire and safety hazard.
The ratings of the equipment are not listed on the equipment forcing this equipment to be replaced to ensure adequate ratings. With underrated equipment, a short circuit in the electrical system could create a catastrophic failure of the equipment and a potentially dangerous condition for anyone near the panelboard at the time of the failure. Beyond this, an arc flash incident energy model is required to the proper procedures and protective measures needed to operate and maintain equipment.

Electrical protective devices must be properly studied and adjusted to verify that emergency/life safety and elevator circuits are properly coordinated and code compliant. The coordination is essential to providing electrical systems that are more reliable when faults occur within the system. The coordination of devices will ensure that these systems stay energized and provide power that is utilized for the safety of the occupants.

2. Observations:

a. Most of the electrical rooms are used as storage.

b. Panelboards did not have a label indicating the wiring color code and associated voltages.

c. All panels did not have a label warning of arc flash hazard.

d. Panelboards were not marked to indicate the source of supply location.

e. Slots were found in panelboards with missing circuit breakers and no blank closure plates installed.

3. Emergency Power

The emergency power is provided by a 60 KW, 208Y/120-volt diesel generator from Katolight with a belly tank capacity of 105 gallons. The generator has a 200A breaker and it feeds a Generac automatic transfer switch. The generator and the automatic transfer switch have replaced the original generator and automatic transfer switch in 2003. Apart from this upgrade the original emergency power infrastructure appears to be original to the building and is beyond typical service life.

The current emergency power infrastructure is not code complaint. Code complaint emergency power distribution, including specialty cabling, separation of normal power and emergency power, separation of life safety and stand-by power, and properly rated rooms is required.

4. Lighting and Lighting Controls

In general, the lighting is fluorescent. Lighting levels, especially in the classrooms are not code compliant and appears to be below code compliant levels and recommendations given in the IES (Illuminating Engineering Society) handbook and Energy Star for vertical and horizontal illuminance levels required in a given space.

There are no automatic controls provided for all the other spaces in the building, including all the classrooms, meeting/conference rooms, restrooms and offices as required by the energy code.

There are no day-light controls for all spaces with natural light as required by the energy code.

There is no bi-level switching and/or dimming to achieve multiple light levels within in the offices, meeting/conference rooms, and classrooms as required by the energy code.

The corridor fixtures, site fixtures and building mounted fixtures appears to be controlled by time-clocks located in the electrical rooms.

The emergency lighting system is incorporated as part of the normal lighting system but there is no clear indication which fixtures are in emergency throughout the building.

There is no illuminated exit signs and emergency egress lighting provided in the required classrooms and all required means of egress.

5. Fire Alarm System

The existing fire alarm system panel is a FCI (Fire Control Instruments) and is located inside a room in the Main Office #230 The fire alarm system in general it appears to be serviceable and up to code.

The Tobin Montessori and Vassal Lane Upper School's primary Telecom service originates underground from a utility pole on Vassal Lane. The existing service entrance room for demarcation of voice, data, and CATV utilities is undersized and overcrowded. It is located at the rear of the art classroom on the basement level. The second telecom room on the third level has a vast amount of loose cable that may pose a fire hazard. A large mix of cable types including fiber and UTP run into this room to wall mounted switches. Much of this equipment is old and not suitable for reuse.

Low voltage cables were observed hanging unsupported, leaving them vulnerable to tampering and damage. Some of the conduits observed did not have bushings leaving the cable bundles vulnerable to damage. A mix of cabling technologies were observed representing a spectrum of performance capabilities including Category 5, Category 5e and Category 6 UTP were observed. For Tobin to support current and future technologies with adequate bandwidth, nothing less than Category 6 cable is appropriate. In some locations, water leaks in the ceiling were observed near active low voltage cabling.

No fire stopping was observed. Additionally, numerous instances of cables run through core holes in walls and floors without conduit or fire stopping. All of this is not code compliant.

A Simplex 2350 master time system is in use. School Smart digital clocks and analog clocks in most classrooms. These are operational and appear to meet current school needs. However, Tobin may wish to consider a newer, wireless, network-based system that will integrate with their current EdConnect platform.

6. Security Systems

The current system is Genetec head-end and operating system for access control/CCTV/Intrusion Detection. Although older technology, the system still serves the school's needs. However, it is limited in its ability to expand to provide service in additional areas and utilizes outdated endpoint technology (i.e., cameras, readers, monitoring, etc.) that may become increasingly difficult to replace or repair.

Mechanical

Electrical

Plumbing

Fire Protection

Civil

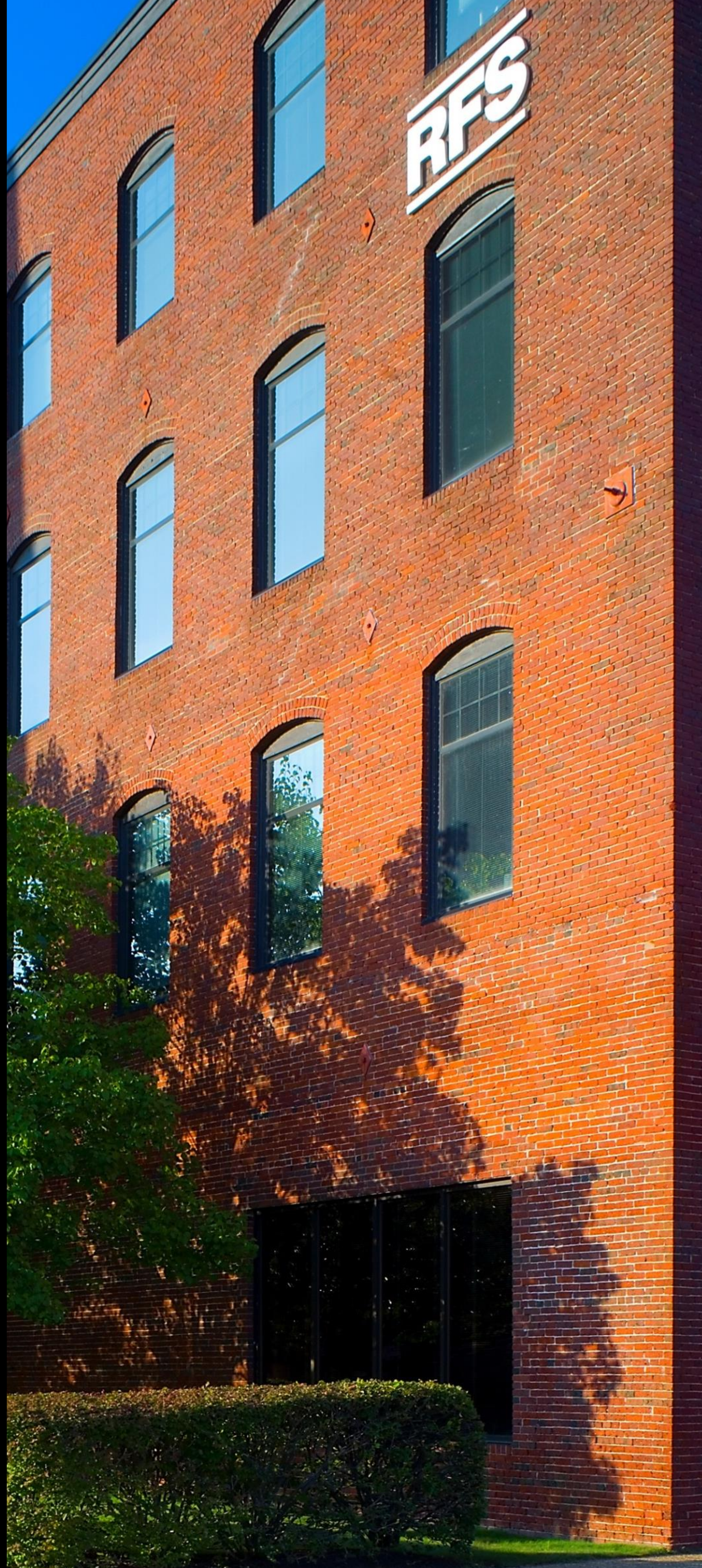
Structural

Technology

Lighting

Sustainability

Commissioning



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COMMUNITY NOISE STUDY

Tobin Montessori/Vassal Lane Upper Schools

Cambridge, Massachusetts

Submitted to Perkins Eastman Architects by Ioana Pieleanu, Acentech

Acentech Project # 631416 – August 20, 2019

Ambient Sound Measurements

We measured sound levels in 10-minute increments at three locations at the Tobin Montessori/Vassal Lane Upper School in Cambridge. Two measurements (locations 1 and 2) ran from Wednesday, July 3 at noon through the evening of Friday July 5, 2019, capturing both weekdays and a holiday. Another measurement (location 3) was conducted from August 9 at noon, through noon of August 13, capturing weekdays and a weekend. The locations of the meters are shown in Figure 1 below. All measurements were taken at street level. The results of our measurements are plotted in Figures 2 through 4. Consistent with industry standards, the graph shows L90 levels, i.e., the sound levels that are exceeded for 90% of each measurement period (in this case, 10 minutes).

The purpose of our measurements was to characterize the existing background sound levels, both as a benchmark for comparison to future levels in the community, as a result of the new school, and also as a reference to show compliance with applicable noise regulations.

Applicable Noise Regulations

The City of Cambridge's noise regulation limits noise levels at residential property lines to 60 dBA during the day on weekdays, and 50 dBA at night and on weekends/holidays.

Massachusetts DEP has a noise policy (310 CMR 7.10) that limits new noise levels to 10 dB above the existing ambient noise levels, and also prohibits tonal noises.

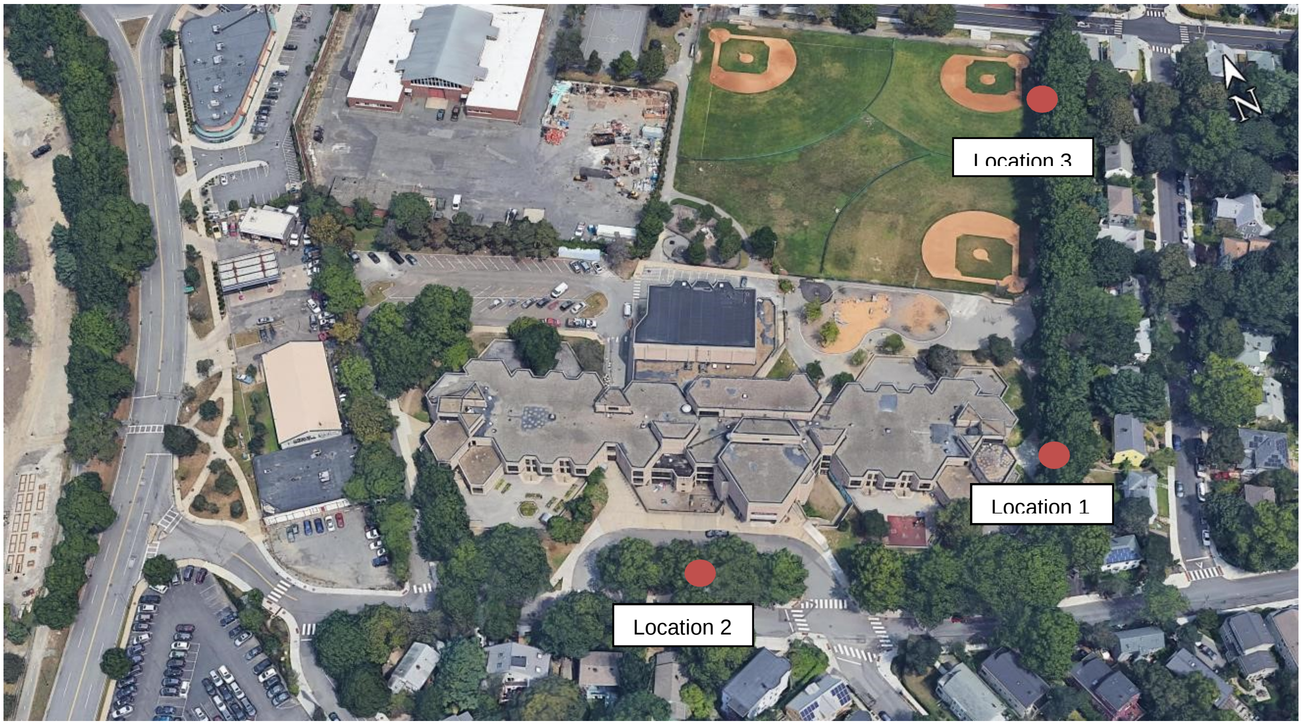
Results and Conclusions

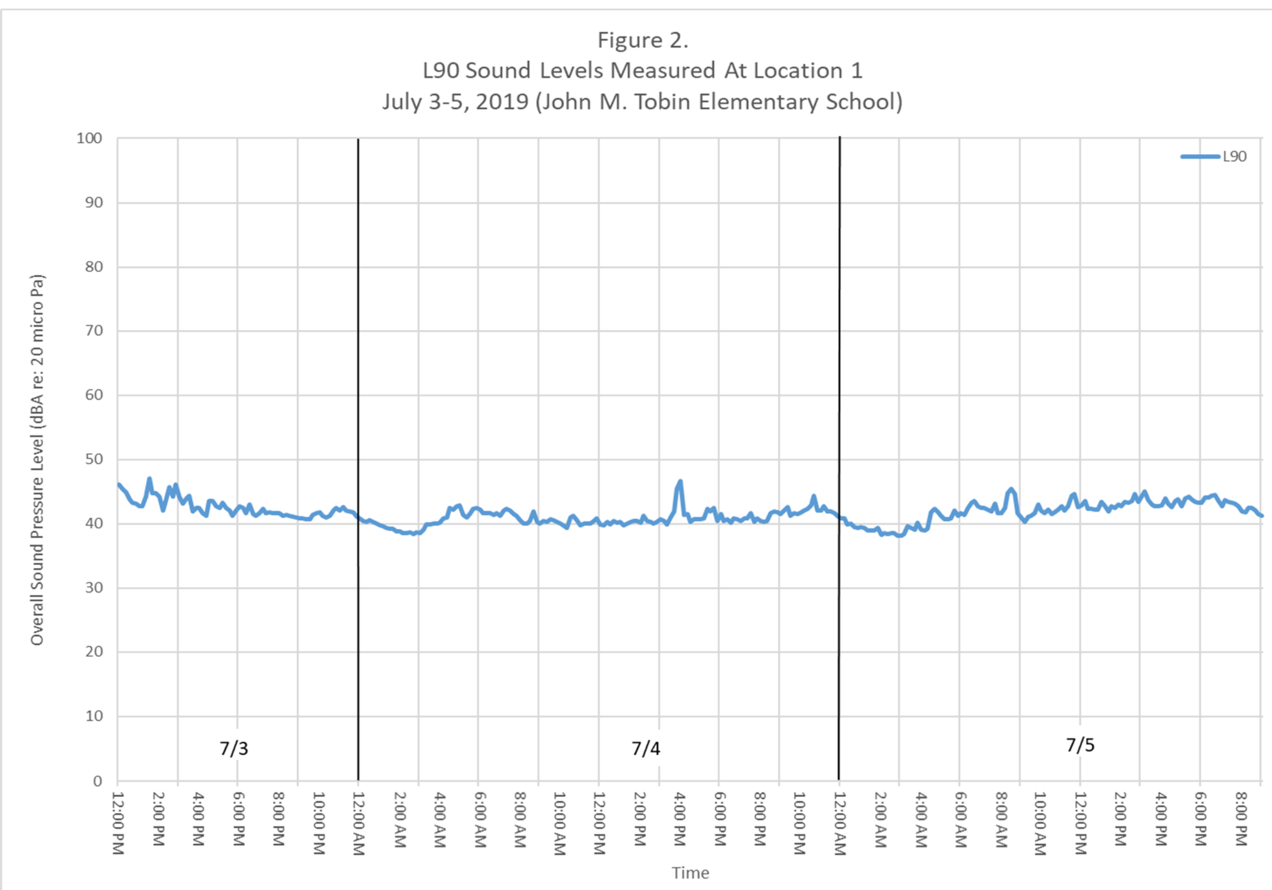
The quietest noise levels were measured at nighttime, at all locations. At Location #1, this level was 37 dBA, at Location #2 the quietest level was 42 dBA, and at Location #3 the quietest level was 46 dBA. They all comply with the Cambridge Noise Ordinance nighttime requirement of 50 dBA.

Noise levels observed during the day were local and distant traffic, voices, building mechanical systems, planes, birds. We note that at all locations, the loudest noise levels during daytime were quieter than the 60 dBA requirement, which means that the existing school appears to comply with the Cambridge Noise Ordinance.

Regarding the future design, based on these measurements, it appears that designing for a maximum noise level of 48 to 50 dBA at the property lines, will comply with both Cambridge Noise Ordinance and the MA-DEP guideline. In order to meet these goals, we will work with the design team (the architect and mechanical engineer), to select suitably quiet equipment, and if necessary, to plan for further sound attenuation using sound barriers around the equipment.

FIGURE 1. MEASUREMENT LOCATIONS





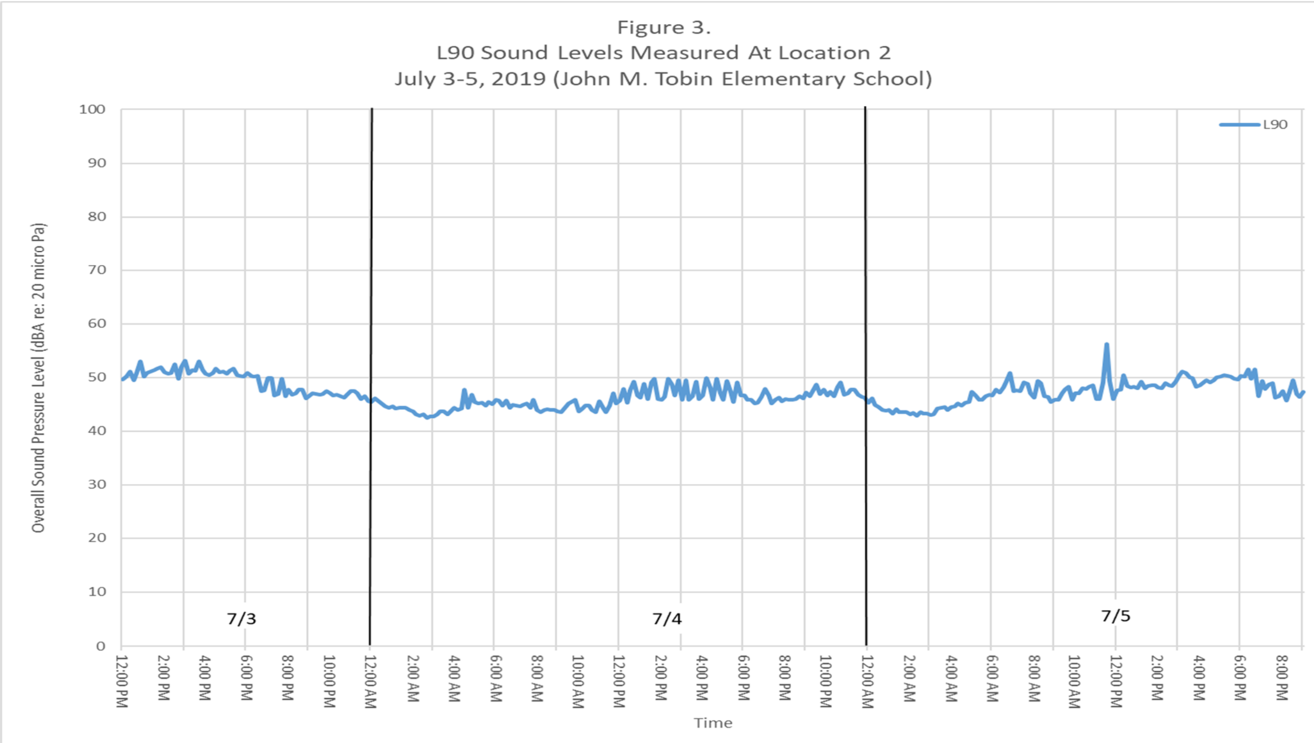


Figure 3.
L90 Sound Levels Measured At Location 2
July 3-5, 2019 (John M. Tobin Elementary School)

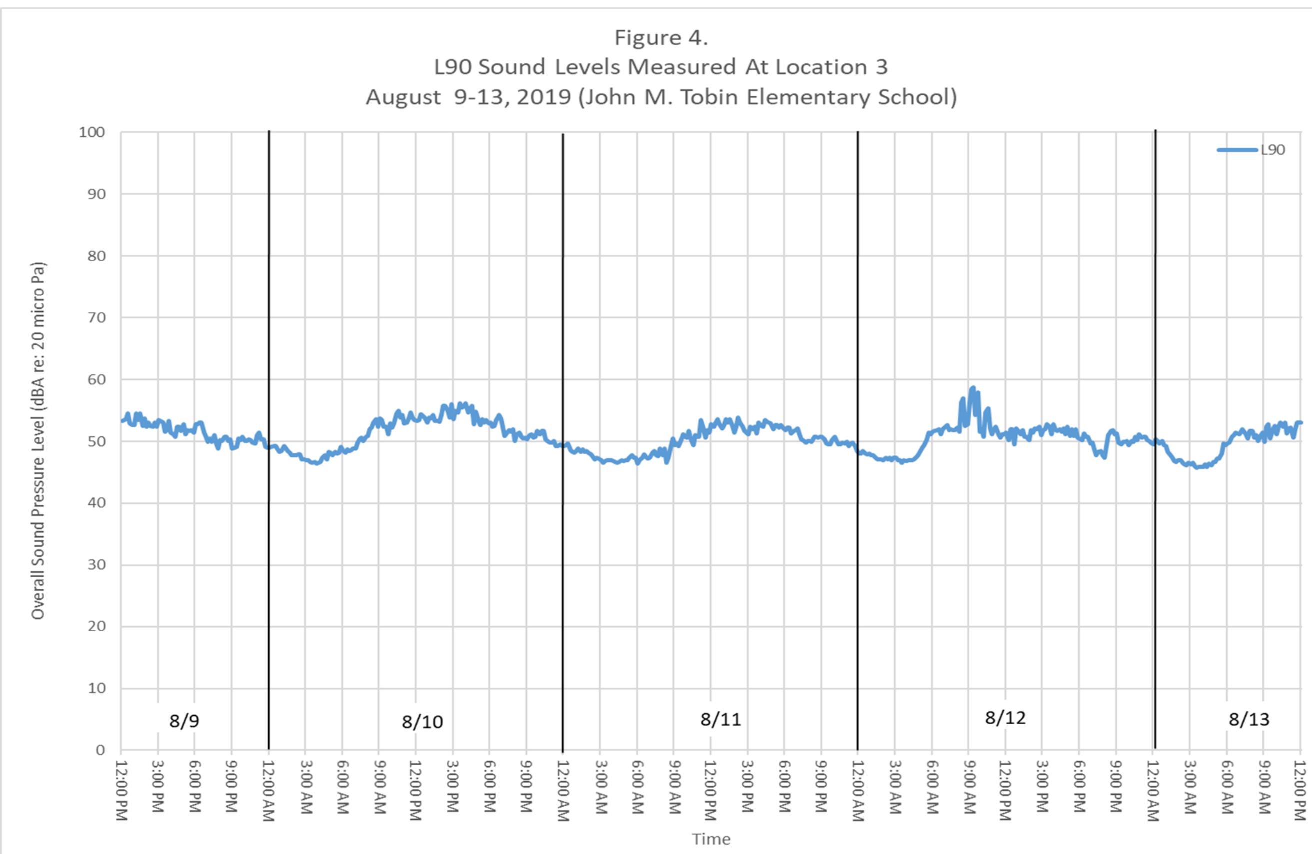


Figure 4.
L90 Sound Levels Measured At Location 3
August 9-13, 2019 (John M. Tobin Elementary School)

End of Narrative – Community Noise Study

Hazardous Building Materials
Visual Inspection

Tobin Montessori / Vassal Lane Upper Schools
197 Vassal Lane
Cambridge, Massachusetts

Perkins Eastman
Boston, Massachusetts

May 2019

FUSS & O'NEILL

Fuss & O'Neill, Inc.
108 Myrtle Street, Suite 502
Quincy, MA 02171

Project No. 20160717.A10

May 9, 2019

Ms. Alicia Caritano
Senior Associate
Perkins Eastman
20 Ashburton Place, Floor 8
Boston, MA 02108

RE: Hazardous Building Materials Visual Inspection
Tobin Montessori / Vassal Lane Upper Schools
197 Vassal Lane, Cambridge, MA
Fuss & O'Neill Project No. 20160717.A10
PEADPC Project No. 79130.00

Dear Ms. Caritano:

Enclosed is the hazardous building materials visual inspection report for the Tobin Montessori/Vassal Lane Upper Schools located at 197 Vassal Lane in Cambridge, Massachusetts.

On April 16, 2019, Fuss & O'Neill, Inc. state-certified Asbestos Inspectors performed a hazardous building materials visual inspection as part of a feasibility study. The visual inspection was limited to a visual inventory of the following: suspect asbestos-containing materials, suspect polychlorinated biphenyl-containing source building materials, suspect coated building materials (i.e., lead-based paint), fluorescent light ballasts, and mercury-containing equipment/materials.

The information summarized in this report is solely for the abovementioned materials only. The work was performed in accordance with our written scope of services dated February 19, 2019.

If you should have any questions regarding the contents of the enclosed report, please do not hesitate to contact me at 617-282-4675, extension 4703. Thank you for this opportunity to have served your environmental needs.

Sincerely,

Dustin A. Diedricksen
Associate/Environmental Department Manager

DD/rs
Enclosure

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1 Introduction

On April 16, 2019, Fuss & O'Neill, Inc. (Fuss & O'Neill) representatives, Ms. Heidi Keller and Mr. Robert Mallett, performed a hazardous building materials visual inspection as part of the feasibility study at the Tobin Montessori/Vassal Lane Upper Schools located at 197 Vassal Lane in Cambridge, Massachusetts (the "Site").

This Hazardous Building Materials Visual Inspection report is based upon observations from the Site, information attained from custodial staff, and information attained from the revised construction drawings dated January 20, 1969.

1.1 Scope of Work

The work was performed for Perkins Eastman (the "Client") in accordance with our written scope of services dated February 19, 2019. The scope of work included a visual inspection and inventory of the following:

- Suspect Asbestos-Containing Materials (ACM);
- Suspect Lead-Based Paint (LBP) Coated Building Components;
- Suspect Polychlorinated Biphenyl (PCB)-Source Building Materials; and
- Fluorescent Light Ballasts; and
- Mercury-Containing Equipment/Materials.

Fuss & O'Neill observed all accessible areas within the Site building, including the three crawlspace areas. Intrusive or destructive investigative techniques were not performed at the Site to access and to observe concealed or inaccessible areas. Sampling of suspect hazardous building materials was not performed during this inspection.

Fuss & O'Neill also reviewed construction drawings provided by the Client to reach certain conclusions regarding current Site conditions.

1.2 Building Description

The Site building is of concrete block and structural concrete construction; it was reportedly constructed in 1968-69. Exterior finishes include concrete block, steel window frames, and a stone-ballast "rubber" roofing system. The building is heated by electric heaters located within the maintenance space at the Unit B first floor. Heated air is distributed via insulated ducts that feed the entire building. The Site building includes three sections referred to as "Units" on the provided construction drawings (refer to Appendix B for a Building Overview).

Unit A consists of the westernmost extent of the building and includes two stories and a crawlspace. Unit A is predominantly used for classroom and educational spaces. Unit A interior finishes include concrete block walls, (splined) acoustical ceiling tile, 12" x 12" floor tile, vinyl baseboard, and gypsum board soffits.

Unit B consists of the "central" portion of the building and includes three stories and a partial crawlspace. Unit B includes school offices, teacher spaces, support services, Cafeteria, Kitchen, Gymnasium, Auditorium, and mechanical spaces. Unit B interior finishes include concrete block walls, (splined) acoustical ceiling tile, 12" x 12" floor tile, vinyl baseboard, and gypsum board soffits. The Gymnasium has poured resilient flooring and a corrugated-metal roof deck (with exposed, spray-applied fireproofing).

Unit C consists of the easternmost extent of the building and includes two stories and a crawlspace. Unit C is similar to Unit A in that it is predominantly used for classroom/educational spaces and has similar interior finishes.

The joints between dissimilar materials (e.g., concrete block to structural concrete, metal door frames to concrete surround, etc.) are caulked. The joints between window/door systems and the concrete surrounds are also caulked.

HVAC ducting and plumbing lines are concealed within gypsum board soffits and within concrete block walls. Plumbing lines also run throughout the three crawlspace areas. HVAC ducts are insulated with fiberglass, and hot/cold water lines are insulated with fiberglass and mudded insulation at the fittings and elbows.

1.3 Building Construction

Utilizing the Client provided construction drawings, Fuss & O'Neill has identified several materials and conditions that should be noted. Conditions that were noted during drawing review, but no observed during the visual inspection are as follows:

- According to construction drawing review and information attained from custodial staff, most classrooms and corridors were originally carpeted. Carpeting was reportedly replaced with floor tile at some point after the mid-1980s.
- Rigid insulation is noted at the void between the exterior concrete block wall and the interior concrete block wall (Sheet A-13, Detail 2). It is likely a rigid foam or Styrofoam insulation held in place with a mastic or glue. In addition, it is not clear whether or not a vapor or air barrier is present within the wall cavity.
- Fabric base flashing is noted at the exterior-concrete-wall-to-structural-beam joints (Sheet, A-13, Detail 2).
- Insulation is noted at the cantilevered sections (Sheet A-13, Detail 1).
- A 6-mil. vapor barrier is noted at Unit A and C crawlspaces beneath the mud slab (Sheet A-13, Detail 2).
- Dampproofing was noted (Sheet A-14, Detail 3) at the auditorium wall where concrete block extends over the structural concrete.
- A pipe trench is shown in the room across from the Auditorium (Sheet P-5, Unit B-Level 3).

2 Asbestos-Containing Materials (ACM)

A property owner or operator must ensure that a thorough asbestos inspection is performed prior to possible disturbance of suspect ACM during renovation or demolition activities. This is a requirement of the United States Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollutants (NESHAP) regulation located at Title 40 CFR, Part 61, Subpart M.

On April 16, 2019, Ms. Keller and Mr. Mallett of Fuss & O'Neill conducted the limited inspection of visible and accessible areas. Ms. Keller and Mr. Mallett are both Commonwealth of Massachusetts Department of Labor Standards (MADLS)-certified Asbestos Inspectors. Refer to Appendix C for copies of each Asbestos Inspector's state certification and EPA accreditation.

No samples were collected at the time of this inspection.

2.1 Results

All suspect ACM throughout the Site building are assumed to contain asbestos. Utilizing the EPA, OSHA, MADLS, and MassDEP protocols and criteria, the following materials are assumed to contain asbestos:

Interior

- 12" x 12" Floor Tile & Mastic;
- Vinyl Baseboard & Adhesive;
- Gypsum Board & Joint Compound Soffits;
- 1' x 1' Splined Ceiling Tile;
- Chalkboard & Adhesive;
- Top-of-Wall Joint Caulking;
- Wall-to-Column Joint Caulking;
- Sink Undercoating;
- Backsplash Adhesive Associated with Classroom Sinks;
- Classroom Bathroom Baseboard;
- Partition Wall Door Frame Caulking;
- Classroom Door Lite Glazing Compound;
- Corridor Firebreak Door Caulking;
- Corridor Firebreak Door Lite Glazing Compound;
- Ceramic Floor Tile Components;
- Quarry Tile Floor Components;
- Freezer Components;
- Cementitious Ceiling Plaster;
- Spray-Applied Fireproofing (Gymnasium);
- Poured Resilient Flooring Components (Gymnasium);
- Glue Daubs Associated with Rigid Insulation;
- Cantilevered Section Floor Insulation; and
- Crawlspace Slab Vapor Barrier.

HVAC & Plumbing

- Mudded-Fitting Insulation;
- Stick-Pin Adhesive Associated with Duct Insulation; and
- Vibration Isolators.

Exterior

- Concrete-Block-to-Beam Joint Caulking;
- Concrete-Block-to-Column Joint Caulking;
- Interior & Exterior Window Caulking;

- Window Glazing Compound (exterior windows);
- Through-Wall Flashing Fabric/Mastic;
- Louver Caulking;
- Interior & Exterior Door Caulking;
- Adhesive Associated with Rigid Insulation between Exterior & Interior Concrete Block Walls;
- Dampproofing Associated with Concrete Block and Poured Concrete Overlaps;
- Foundation Dampproofing; and
- Concealed Roofing.

Refer to Table 1, attached hereto, for the complete list of suspect ACM identified by material type, observed locations, and estimated quantities as part of this inspection.

2.2 Conclusions and Recommendations

Based on visual observations suspect ACM were identified at the Site.

Prior to disturbance, ACM that would likely be impacted by the proposed project must first be abated by a MADLS-licensed Asbestos Abatement Contractor. This is a requirement of MADLS, MassDEP, and EPA NESHAP regulations governing asbestos abatement.

3 Lead-Based Paint

On April 16, 2019, Mr. Keller and Mr. Mallett of Fuss & O'Neill performed a visual inspection of suspect LBP-coated building components.

3.1 Observations

Based on the age of construction, LBP-coated building materials may be present at the Site building.

3.2 Conclusions and Recommendations

Based on our visual assessment, LBP is likely present on coated building components within the Site building.

Contractors must be made aware that OSHA has not established a level of lead in a material below which OSHA Title 29 CFR, Part 1926.62 does not apply. Contractors shall comply with exposure assessment criteria, interim worker protection, and other requirements of the regulation as necessary to protect workers during any renovation and/or demolition activities that will impact LBP.

If disturbed by renovation or demolition activities, LBP-coated building components should be segregated from the general demolition waste stream for sample collection and analysis by TCLP to determine proper off-site waste disposal. If disturbed and managed off-site, non-porous LBP-coated building materials (i.e., metals) may be segregated and recycled as scrap metal. Metal LBP-coated building components cannot be subject to grinding, sawing, drilling, sanding, or torch cutting.

The building is currently characterized as a "child-occupied facility" due to the presence of the "Children's House" within the Tobin Montessori School; therefore, it is currently subject to lead safe renovation requirements. Note that a "change in use" or building vacancy may change this characterization.

4 Polychlorinated Biphenyls (PCBs) Source Building Materials

4.1 Background

On April 16, 2019, Ms. Keller and Mr. Mallett of Fuss & O'Neill completed an inventory of visible an accessible presumed PCB-containing source building materials.

Sample collection and analysis of building materials for PCBs is presently not mandated by the EPA. However, significant liability risk exists for improperly disposing of PCB-containing waste materials. Recent knowledge and awareness of PCBs within matrices such as caulking, glazing compounds, paints, adhesives and ceiling tiles has become more prevalent, especially among remediation contractors, waste haulers, and disposal facilities. The EPA recommends sample collection and analysis of caulking and glazing compounds installed between 1950 and 1980 to determine PCB concentration.

The EPA requirements apply and require removal of PCBs once identified, regardless of project intent as an unauthorized use of PCBs. Once it is determined that PCBs are present and a building is to remain for re-use, the EPA still requires PCB-containing material removal. If PCBs are present at certain concentrations, additional sampling and analysis of adjacent surfaces in contact with PCB sources, or which may have been contaminated from a source of PCBs (e.g., masonry, soil), must also be performed or remediated.

EPA requirements apply only if PCBs are present in concentrations above a specified level. Presently, PCB-containing materials at concentrations greater than or equal to (≥) 50 part per million (ppm), or equivalent units of milligrams per kilogram (mg/kg), are regulated. Note materials containing ≥ 1, ppm but less than (<) 50 ppm may also be regulated unless proven to be an "Excluded PCB Product". The definition of an Excluded PCB Product includes those products, or source of the products, containing < 50 ppm concentration PCBs that were legally manufactured, processed, distributed in commerce, or used before October 1, 1984.

4.2 Results

Utilizing the EPA guidelines, a presumed PCB-containing source building materials inventory by material type, location, and estimated quantity is included in Table 2 attached. Table 3 shows substrates and other materials that would require additional considerations for a demolition scenario.

4.3 Conclusions and Recommendations

Identified materials should be presumed to contain regulated concentrations (≥ 50 ppm) of PCBs until sample analysis indicates otherwise. These materials should be removed and disposed of at an EPA-approved facility as regulated PCB Bulk Product Waste.

The extent of PCB-source building material removal is heavily dependent upon the direction of the project. Renovation may be handled using a presumptive approach. This entails addressing worker protection and disposal requirements for caulking and window glazing compound that would be impacted by the renovation work. Sample collection would not be recommended for a renovation project.

If demolition is the selected option, PCB removal and remediation becomes much more involved. Past experiences with similar building construction (MLK/Amigos Project) required removal of all porous concrete block, removal of structural concrete at the caulk line (approximately 3"), and sandblasting of all painted interior structural components. The actual approach for demolition would require additional conversations among the Owner, the Client, and Fuss & O'Neill.

5 Fluorescent Light Ballasts & Mercury-Containing Equipment/Materials

5.1 Fluorescent Light Ballasts

Fluorescent light ballasts manufactured prior to 1979 may contain capacitors that contain PCBs. Light ballasts installed as late as 1985 may contain PCB capacitors. Fluorescent light ballasts that are not labeled as "No PCBs" must be assumed to contain PCBs unless proven otherwise by quantitative analysis. Capacitors in fluorescent light ballasts labeled as non-PCB-containing may contain diethylhexyl phthalate (DEHP). DEHP was the primary substitute to replace PCBs for small capacitors in fluorescent lighting ballasts in use until 1991. DEHP is a toxic substance, a suspected carcinogen, and is listed under RCRA and the Superfund Law as a hazardous waste. Therefore, Superfund liability exists for landfilling both PCB- and DEHP-containing light ballasts. These listed materials are considered hazardous waste under RCRA and require special handling and disposal considerations.

5.2 Mercury-Containing Equipment/Materials

Fluorescent lamps/tubes are presumed to contain mercury vapor, which is a hazardous substance to both human health and the environment. Thermostatic controls and electrical switch gear may contain a vial or bulb of liquid mercury associated with the control. Mercury-containing equipment is regulated for proper disposal by EPA RCRA regulations.

It should be noted that the poured resilient flooring in the Gymnasium may contain mercury. This type of flooring typically used a mercury additive to assist in the curing process. Our experience has been that this type of flooring may require additional remediation to address mercury removal and disposal activities.

5.3 Results

On April 16, 2019, Ms. Keller and Mr. Mallett of Fuss & O'Neill performed a visual inspection of representative fluorescent light fixtures to identify possible PCB-containing ballasts in the building. The inspection involved visually inspecting labels on representative light ballasts to identify manufacture dates and labels indicating "No PCBs". Ballasts manufactured after 1991 were not listed as PCB- or DEHP-containing ballasts and were not quantified for disposal. An in-place inventory of the fluorescent lamps/tubes and other mercury-containing equipment/materials was completed concurrently. Refer to Table 3, attached hereto, for an inventory of fluorescent light ballast and mercury-containing equipment/materials identified during the inspection.

5.4 Conclusions and Recommendations

DEHP-containing fluorescent light ballasts and mercury-containing equipment/materials were identified in the building during this inspection.

Fluorescent light ballasts marked as "No PCBs" with date labels indicating manufacture prior to 1991 are presumed to contain DEHP. DEHP-containing ballasts must be segregated for proper packaging, transporting, and disposal as non-PCB hazardous waste. Note that disposal requirements for DEHP-containing ballasts are slightly varied, and disposal costs are slightly less, when compared to PCB-containing light ballasts.

According to the EPA, mercury-containing equipment and materials are characterized as a hazardous waste, and mercury lamps/tubes are characterized as a Universal Waste. The mercury-containing equipment/materials and fluorescent lamps/tubes identified in the proposed renovation areas must be recycled, reclaimed, or disposed of as hazardous waste or Universal Waste prior to disturbance.

Report prepared by Environmental Analyst, Robert Mallett.

Reviewed by:

Dustin A. Diedricksen
Associate/Environmental Department Manager

FUSS & O'NEILL

Tables

Table 1
Suspect Asbestos-Containing Materials Laboratory Analytical Data Summary

Tobin Montessori / Vassal Lane Upper Schools
Cambridge, MA

Perkins Eastman
May 2019
Fuss & O'Neill Reference No. 20160717.A10

Material Type	Sample Location	Estimated Quantity
Building Interior		
12" x 12" Floor Tile & Mastic	Unit A, B, & C Classrooms, Conference Rooms, & Educaitonal Spaces	73,500 SF
Vinyl Baseboard & Adhesive	Unit A, B, & C Classrooms, Conference Rooms, & Educaitonal Spaces	8,750 LF
Gypsum Board & Joint Compound	Soffits within Unit A, B, & C Classrooms, Conference Rooms, & Educaitonal Spaces	18,000 SF
1' x 1' Splined Ceiling Tile	Unit A, B, & C Classrooms, Conference Rooms, & Educaitonal Spaces	14,500 SF
Chalkboard & Adhesive	Unit A, B, & C Classrooms, Conference Rooms, & Educaitonal Spaces	120 EA
Top-of-Wall & Wall-to-Column Joint Caulking	Throughout	12,000 LF
Sink Undercoating	Unit A, B, & C Classrooms	40 EA
Backsplash Adhesive	Unit A, B, & C Classrooms	350 LF
Bathroom Baseboards	Unit A & C Classroom Bathrooms	500 LF
Partition Wall Door Frame Caulking	Throughout	175 EA (~2,900 LF)
Classroom Door Lite Glazing Compound	Classroom Doors	175 EA
Firebreak Door Caulking	Unit A, B, & C Corridors	8 Systems (~200 LF)
Firebreak Door Lite Glazing Compound	Unit A, B, & C Corridors	16 EA
Ceramic Floor Tile Components	Unit B First Floor Bathrooms	130 SF
Quarry Tile Floor Components	Kitchen, Dish Room, Kithcen Corridor, & Main Entry Foyer	3,250 SF
Freezer Components	Kitchen	2 EA
Cementitious Ceiling Plaster	Kitchen, Dish Room, Kitchen Corridor, Boys & Girls Toilets near Gymnasium, Former Locker Room Areas	6,000 SF
Spary-Applied Fireproofing	Gymnasium	6,500 SF
Poured Resilient Flooring Components	Gymnasium	6,500 SF
Glue Daubs Associated with Rigid Insulation	Crawlspace Walls	4,500 SF
Cantilevered Section Floor Insulation	Cantilevered Sections	1,500 SF
Slab Vapor Barrier	Crawlspaces	20 CY
HVAC & Plumbing		
Mudded-Pipe Fitting Insulation	Throughout	1,000 EA

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Table 1
Suspect Asbestos-Containing Materials Laboratory Analytical Data Summary

Material Type	Sample Location	Estimated Quantity
Stick-Pin Adhesive Associated with Duct Insulation	Throughout	2,000 LF
Vibration Isolators	Throughout	15 EA
Building Exterior		
Concrete Block-to-Beam & Concrete Block-to-Column Joint Caulking	Exterior	6,250 LF
Interior & Exterior Window Caulking	Exterior	7,600 LF
Window Glazing Compound	Exterior	108 EA
Through-Wall Flashing Fabric/Mastic	Exterior	4,250 SF
Louver Caulking	Louvers	200 LF
Interior & Exterior Door Caulking	Exterior Doors	47 EA (~1,850 LF)
Adhesive Assocaited with Rigid Insulation	Cavity between Exterior Concrete Block & Interior Concrete Block	35,000 SF
Dampproofing	Exterior, Auditorium Wall	2,500 SF
Foundation Dampproofing	Exterior,Foundation	7,500 SF
Concealed Roofing	Exterior Roof	60,000 SF

CY = Cubic Yards, EA = Each, LF = Linear Foot, SF = Square Foot

Table 2
Suspect PCB-Containing Source Building Materials Summary

Material Type	Location	Estimated Quantity
Top-of-Wall & Wall-to-Column Joint Caulking	Throughout Interior	12,000 LF
Partition Wall Door Frame Caulking	Throughout	175 EA (~2,900 LF)
Classroom Door Lite Glazing Compound	Classroom Doors	175 EA
Firebreak Door Caulking	Unit A, B, & C Corridors	8 Systems 200 LF
Firebreak Door Lite Glazing Compound	Unit A, B, & C Corridors	16 EA
Interior Paint	Throughout	70,000 SF
Concrete Block-to-Beam & Concrete Block-to-Column Joint Caulking	Exterior	6,250 LF
Interior & Exterior Window Caulking	Exterior	7,600 LF
Window Glazing Compound	Exterior	108 EA
Louver Caulking	Exterior	200 LF
Interior & Exterior Door Caulking	Exterior	47 EA (~1,850 LF)

EA = Each, LF = Linear Feet

Table 3
Substrates & Other Materials Possibly Impacted by
Suspect PCB-Containing Source Building Materials Summary

Substrate	Material Type	Location	Estimated Remediation Quantity
Concrete Block & Structural Concrete Beams & Columns*	Top-of-Wall & Wall-to-Column Joint Caulking	Throughout Interior	~42 Tons of Structural Concrete & ~144 Tons of Adjacent Concrete Block
Concrete Block & Structural Concrete Beams & Columns*	Partition Wall Door Frame Caulking	Throughout	~12 Tons of Structural Concrete & ~26 Tons of Adjacent Concrete Block
Doors	Classroom Door Lite Glazing Compound	Classroom Doors	175 Doors

Substrate	Material Type	Location	Estimated Remediation Quantity
Concrete Block & Structural Concrete Beams & Columns*	Firebreak Door Caulking	Unit A, B, & C Corridors	0.75 Tons of Structural Concrete & ~ 1.5 Tons of Adjacent Concrete Block
Doors	Firebreak Door Lite Glazing Compound	Unit A, B, & C Corridors	16 Doors
Concrete Block & Structural Concrete Beams & Columns*	Interior Paint	Throughout	1,500 Tons of Concrete Block (all interior block) Note: did not account for sandblasting media for structural concrete blasting
Concrete Block & Structural Concrete Beams & Columns*	Concrete Block-to-Beam & Concrete Block-to-Column Joint Caulking	Exterior	~21 Tons of Structural Concrete & ~156 Tons of Adjacent Concrete Block
Concrete Block & Structural Concrete Beams & Columns*	Interior & Exterior Window Caulking	Exterior	~20 Tons of Structural Concrete & ~48 Tons of Adjacent Concrete Block
Windows	Window Glazing Compound	Exterior	108 Windows
Concrete Block & Structural Concrete Beams & Columns*	Louver Caulking	Exterior	~0.25 Tons of Structural Concrete & ~4 Tons of Adjacent Concrete Block
Concrete Block & Structural Concrete Beams & Columns*	Interior & Exterior Door Caulking	Exterior	~1.75 Tons of Structural Concrete & ~8 Tons of Adjacent Concrete Block

EA = Each, LF = Linear Feet

* Assumes 3” of Concrete removed on all sides of caulking joint

Table 4
Fluorescent Light Ballast & Mercury-Containing Equipment / Materials Inventory Summary

Type	Estimated Quantity
Presumed DEHP-Containing	1,750 EA
4' Light Tube	3,500 EA
Poured Resilient Flooring (presumed mercury-containing material)	6,500 SF

Appendix A

Limitations

APPENDIX A

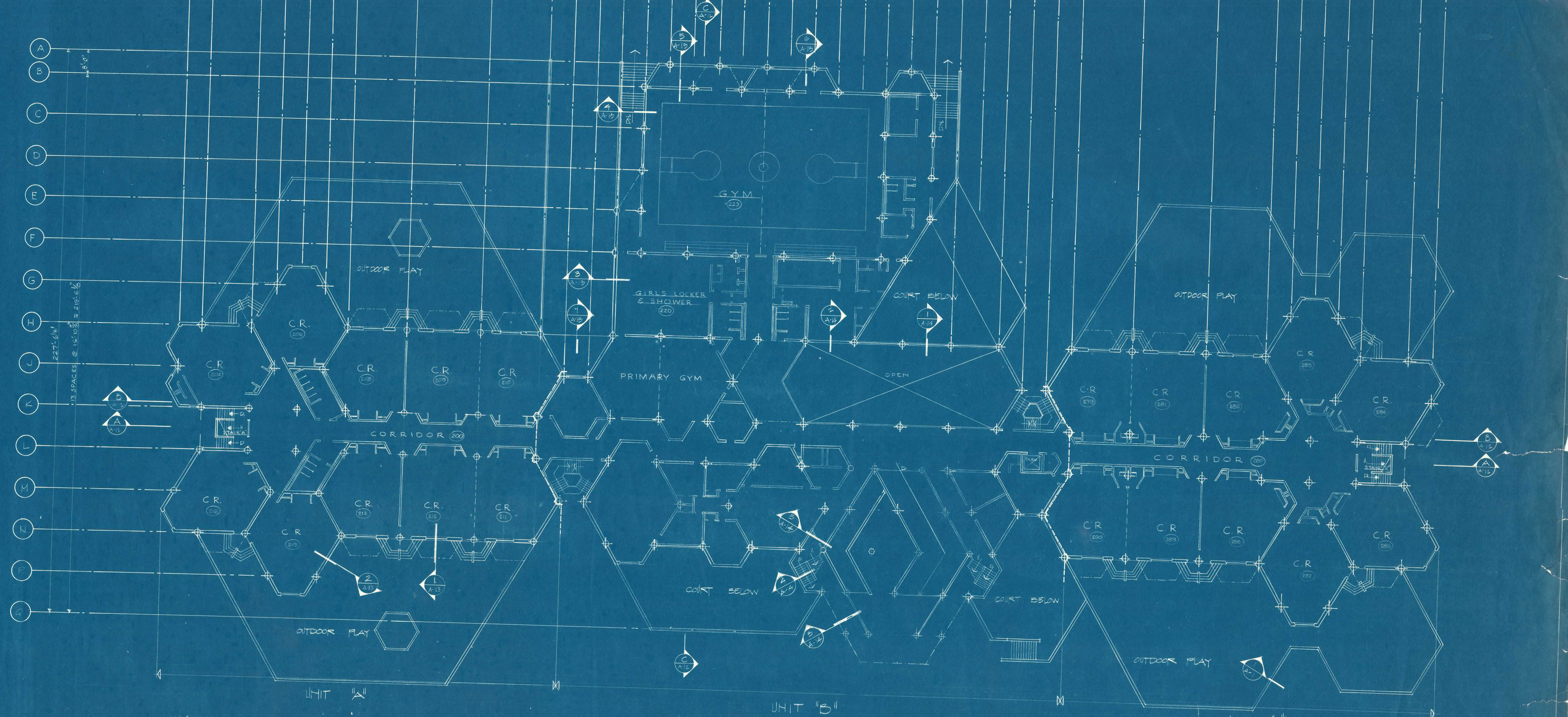
Tobin Montessori / Vassal Lane Upper Schools
Cambridge, Massachusetts

1. This environmental report has been prepared for the exclusive use of the Client, and is subject to, and is issued in connection with, the general terms and conditions of the original Agreement (February 19, 2019) and all of its provisions. Any use or reliance upon information provided in this report, without the specific written authorization of the Client and Fuss & O'Neill, shall be at the User's individual risk. This report should not be used as an abatement specification. All quantities of materials identified during this inspection are approximate.
2. Unless otherwise noted, only suspect hazardous materials associated within or located on the building (aboveground) were included in this inspection. Suspect hazardous materials may exist below the ground surfaces that were not included in the scope of work of this inspection. Fuss & O'Neill cannot guarantee all asbestos or suspect hazardous materials were identified within the areas included in the scope of work. Only visible and accessible areas were included in the scope of work for this inspection.
3. The findings, observations, and conclusions presented in this report are limited by the scope of services outlined in our original Agreement, which reflects schedule and budgetary constraints imposed by the Client. Furthermore, the assessment has been conducted in accordance with generally accepted environmental practices. No other warranty, expressed or implied, is made.
4. The conclusions presented in this report are based solely upon information gathered by Fuss & O'Neill to date. Should further environmental or other relevant information be discovered at a later date, the Client should immediately bring the information to Fuss & O'Neill's attention. Based upon an evaluation and assessment of relevant information, Fuss & O'Neill may modify the report and its conclusions.

FUSS & O'NEILL

Appendix B

Building Overview

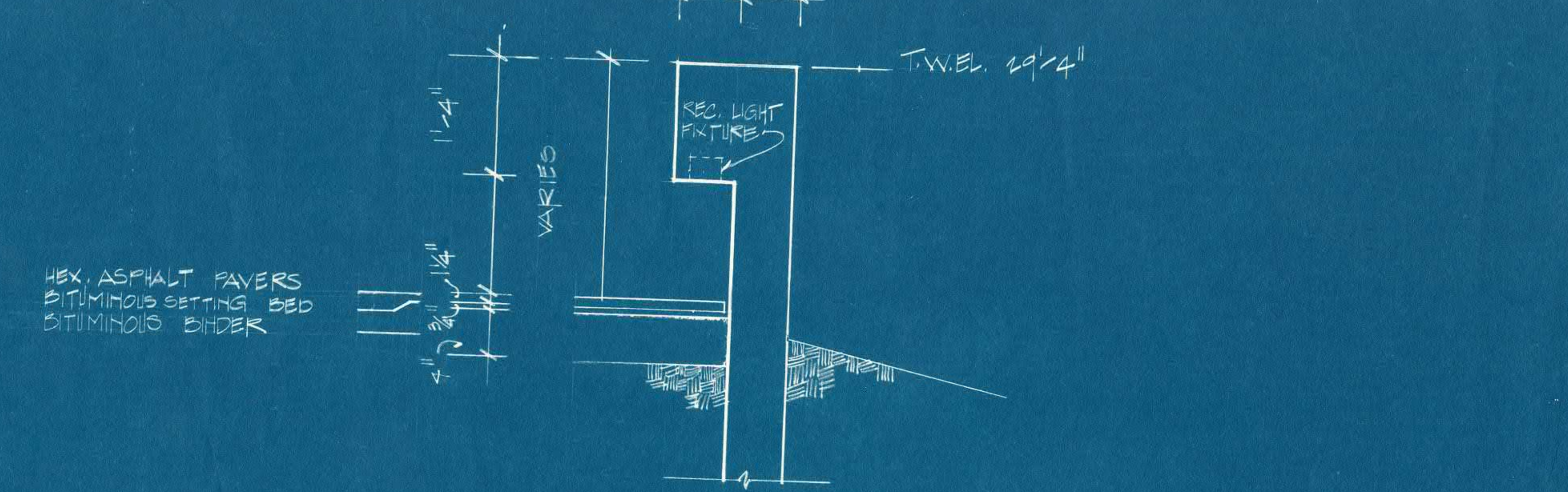


SYMBOLS

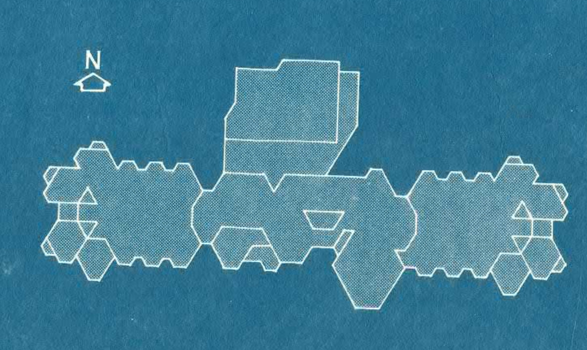
EARTH	RIGID INSULATION
BRICK	STEEL
CONCRETE BLOCK	MET. FLASHING (ELEVATION)
CONCRETE	STRUCTURAL TILE
ACOUSTIC TILE	PLASTER or PLASTER BD.
PLYWOOD	CUT STONE
ROUGH BLOCKING (CONT.)	GLASS
BLOCKING (As req'd)	URETHANE
FINISH WOOD	CERAMIC TILE

ABBREVIATIONS

ACT	ACOUSTIC TILE	HP	HIGH POINT
AL (ALUM)	ALUMINUM	LP	LOW POINT
AB	ANCHOR BOLT	MET	METAL
COL	COLUMN	MISC	MISCELLANEOUS
CLG	CEILING	PL	PLATE
CONC.	CONCRETE	RM	ROOM
C.BLK.	CONCRETE BLOCK	SECT	SECTION
C.J	CONSTRUCTION JOINT	S.F.	SEAMLESS FLOORING
CONT	CONTINUOUS	S.S	STAINLESS STEEL
DET	DETAIL	V.A.	VINYL ASBESTOS (TILE)
D.F.	DRINKING FOUNTAIN	V.B.	VINYL BASE
DN	DOWN	W.D	WOOD
E.J.	EXPANSION JOINT	S.G.	SPRAY GLAZE
EQ	EQUAL	CLO	CLOSET
F.D.	FLOOR DRAIN		
F.E.	FIRE EXTINGUISHER		
FIN	FINISH		
GL	GLASS		
H.M	HOLLOW METAL		



1 SECTION CONC. WALL @ OUTDOOR PLAY AREAS 3/4" = 1'-0"



JOHN M. TOBIN ELEMENTARY SCHOOL
Cambridge, Massachusetts

Pietro Belluschi
Principal Architect

Sasaki, Dawson, DeMay Associates Inc.
Associate Architect
Watertown, Massachusetts

LeMessurier Associates — Consulting Engineers
Boston, Massachusetts

Francis Associates — Consulting Engineers
Marion, Massachusetts

date: OCT. 25, 68
REV. JAN. 20, 69
scale: 1/16" = 1'-0"

SDDA no. 7054

REGISTERED ARCHITECT KENNETH DEMAY No. 1835 CONCORD, MASS. COMMONWEALTH OF MASSACHUSETTS

1/16" KEY PLAN

A-1

Appendix C

Fuss & O'Neill Asbestos Inspector State Certifications & EPA Accreditations

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF LABOR AND WORKFORCE DEVELOPMENT
DEPARTMENT OF LABOR STANDARDS

William D. McKinney,
Director

Asbestos Inspector

HEIDI KELLER

Eff. Date 02/27/19
Exp. Date 02/27/20

AI900730

20

Member of C.O.N.E.S.
BOSR **BOS-RENEW**

This is to certify that

Heidi Keller

has completed the requisite training, and has passed an examination for reaccreditation as:

Asbestos Inspector Refresher

pursuant to Title II of the Toxic Substance Control Act, 15 U.S.C. 2646

Course Location

Institute for Environmental Education
16 Upton Drive Wilmington, MA 01887

November 2, 2018
Course Dates

18-1207-106-267547
Certificate Number

November 02, 2018
Examination Date

November 02, 2019
Expiration Date

Training Director

16 Upton Drive, Wilmington, MA 01887 Telephone 978.658.5272 www.ieetrains.com

INSTITUTE FOR ENVIRONMENTAL EDUCATION

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF LABOR AND WORKFORCE DEVELOPMENT
DEPARTMENT OF LABOR STANDARDS

William D. McKinney,
Director

Asbestos Inspector

ROBERT C. MALLETT

Eff. Date 06/01/18
Exp. Date 06/01/19
AI900557
Member of C.O.N.E.S.
BOSR BOS-RENEW

19

This is to certify that

Robert C. Mallett

has completed the requisite training, and has passed an examination for reaccreditation as:

Asbestos Inspector Refresher

pursuant to Title II of the Toxic Substance Control Act, 15 U.S.C. 2646

Course Location

Institute for Environmental Education
16 Upton Drive Wilmington, MA 01887

January 7, 2019
Course Dates

19-2152-106-260110
Certificate Number

January 07, 2019
Examination Date

January 07, 2020
Expiration Date

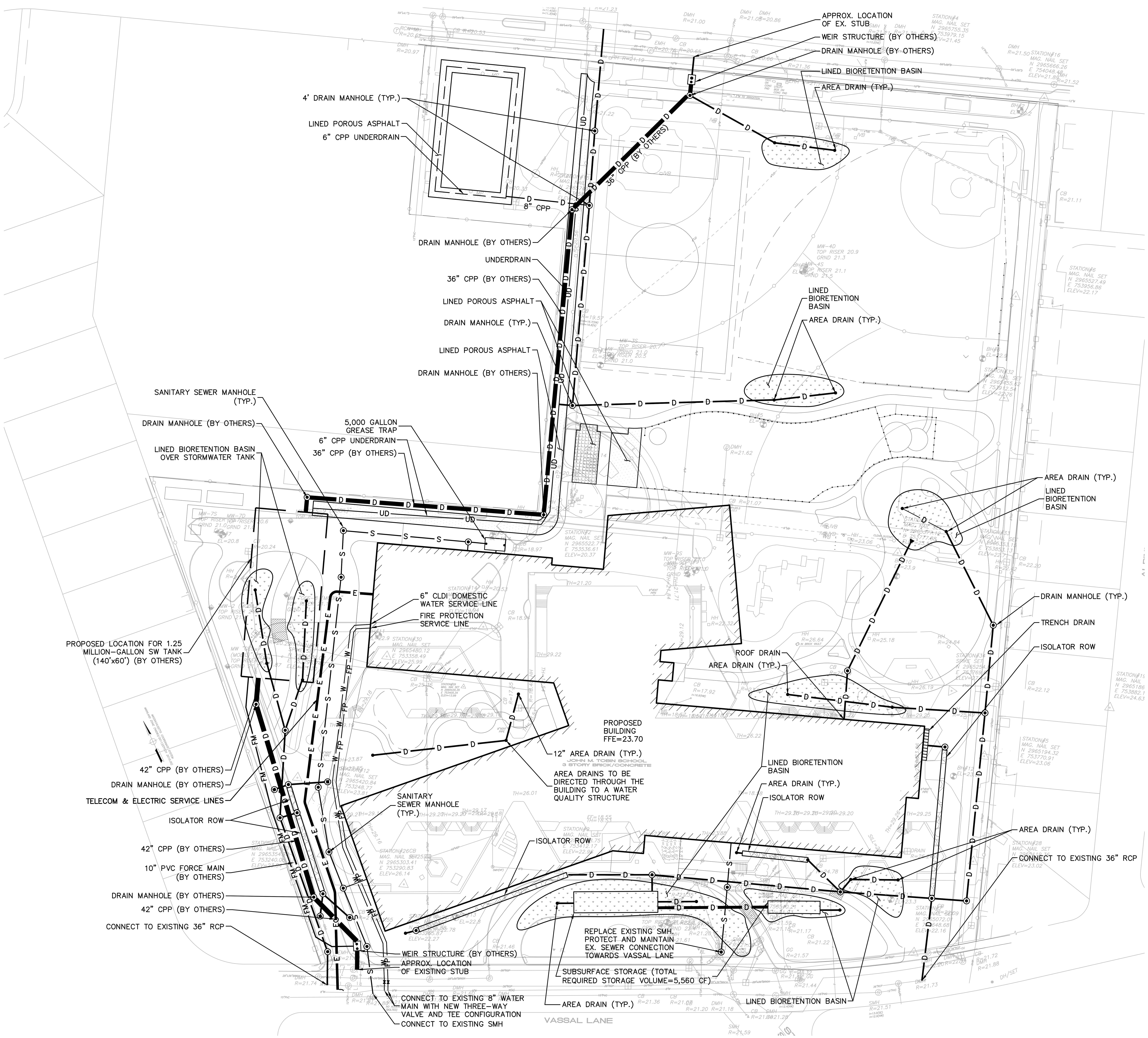
Training Director

16 Upton Drive, Wilmington, MA 01887 Telephone 978.658.5272 www.ieetrains.com

INSTITUTE FOR ENVIRONMENTAL EDUCATION

A5.0

OTHER DESIGN OPTIONS



PROPOSED LEGEND

(heavy line)	LIMIT OF WORK
W	DOMESTIC WATER PIPE
FP	FIRE PROTECTION PIPE
S	SANITARY SEWER PIPE
D	STORM DRAIN PIPE
G	GAS PIPE
E	ELECTRIC DUCTBANK
T/C	TELECOM DUCTBANK
	AREA DRAIN
	ACCESS BASIN
	DRAIN MANHOLE
Q	WATER QUALITY STRUCTURE
	CATCH BASIN
	SEWER MANHOLE
WV	WATER VALVE

ABBREVIATIONS

AB	ACCESS BASIN
AD	AREA DRAIN
CB	CATCH BASIN
CI	CAST IRON
CO	CLEANOUT
CPP	CORRUGATED POLYETHYLENE PIPE
DI	DUCTILE IRON PIPE CEMENT LINED
DMH	DRAIN MANHOLE
FFE	FINISHED FLOOR ELEVATION
INV	INVERT ELEVATION
LF	LINEAR FEET
LOW	LIMIT OF WORK
M&P	MAINTAIN AND PROTECT
OCS	OUTLET CONTROL STRUCTURE
PERF	PERFORATED
PVC	POLYVINYL CHLORIDE PIPE
RD	ROOF DRAIN
RIM	RIM ELEVATION
SMH	SEWER MANHOLE
SS	SEWER SERVICE
TYP	TYPICAL
UD	UNDERDRAIN
WQS	WATER QUALITY STRUCTURE
WV	WATER VALVE

NOTES:
1. REFER TO FEASIBILITY STUDY NARRATIVE FOR ADDITIONAL PRICING INFORMATION ON POROUS PAVEMENT, BIORETENTION, AND ISOLATOR ROW.
2. REFER TO MEP NARRATIVE AND PLANS FOR ADDITIONAL DETAIL ON TELECOM, ELECTRIC, WATER, AND SEWER INFORMATION.

SCALE:
1" = 40'
40 20 0 40 80

Nitsch Engineering
www.nitscheng.com
2 Center Plaza, Suite 430
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T: (617) 338-0063
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- Civil Engineering
- Land Surveying
- Transportation Engineering
- Structural Engineering
- Green Infrastructure
- Planning
- GIS

CONCEPTUAL UTILITY PLAN
JOHN M. TOBIN ELEMENTARY SCHOOL
197 VASSAL LANE, CAMBRIDGE, MA 02138

PREPARED FOR:
PERKINS EASTMAN
20 ASHBURTON PLACE, FLOOR 8, BOSTON, MASSACHUSETTS 02108

REV.	COMMENTS	DATE
	REVISIONS	

NITSCH PROJECT #	13102
FILE:	13102-CUT.DWG
SCALE:	1"= 40'
DATE:	03/11/2020
PROJECT MANAGER:	JLJ
SURVEYOR:	
DRAFTED BY:	MF
CHECKED BY:	BMV

SHEET:

CONCEPTUAL UTILITY PLAN

OF REV.

Stantec

Memo

To:	Catherine Woodbury City of Cambridge DPW	From:	Keith Gardner Stantec
File:	Tobin Stormwater Tank Conceptual Design Parameters and Location Analysis	Date:	February 25, 2020

Reference: Tobin Stormwater Tank Conceptual Design Parameters and Location Analysis

The Tobin School Stormwater Storage Tank (Tobin Stormwater Tank) is to be located at the site of the present Tobin Montessori and Vassal Lane Upper School at 197 Vassal Lane in Cambridge, Massachusetts. The tank will be integrated into the proposed Tobin Montessori and Vassal Lane Upper School Project (School Project).

The stormwater storage tank follows a series of recent stormwater network improvements undertaken by the City, known as the Alewife Sewer Separation Program, performed by the Kleinfelder-Stantec team. As part of these prior efforts, a March 2012 technical memorandum documented the findings of a hydraulic stormwater model for flood prevention system performance during major storm events. The proposed tank is intended to improve storm drain level of service for the most upstream portion of the CAM004 catchment (approximately 200 acres), particularly at the Standish Street / Vassal Lane intersection and low-lying areas near Concord Avenue.

To date, Stantec has performed hydraulic analysis and limited conceptual design services to assist with site coordination with the School Project. This memo is a summary of the conceptual design parameters identified to date as well as a high-level analysis of two potential siting locations for the tank identified at the February 19, 2020 Design Team Meeting (Design Team Meeting). This memo is not intended to be a basis of design report for the Tobin Stormwater Tank and all considerations made herein are subject to change in preliminary design.

All elevations listed are in Cambridge City Base (CCB)

STORMWATER STORAGE AND PUMPING

The purpose of the Tobin Stormwater Tank is to reduce inundation for the 10-year, 24-hour 2070 storm event at the Vassal Lane and Standish Street intersection and at the lower reaches of the Concord Avenue catchment. A hydraulic analysis was completed in March 2019 using the City's Infoworks ICM hydraulic model to evaluate flood reduction performance of different system storage configurations under the targeted storm events.

The selected configuration is 1.25 MG of below grade storage in conjunction with 100,000 gallons of surface storage. It is critical for the surface storage feature to be adjacent to the intersection of Vassal Lane and Standish Street for it to provide flood reduction benefits.

The tank concept would be cast-in-place concrete construction pitched towards the wet well that will contain a sump pit and submersible pumps.

Conceptually, the surface feature will be a combination of green infrastructure and surface storage that total 100,000 gallons. It is noted that because of site constraints, localized subsurface storage beneath the surface feature (separate from the tank) may be a consideration to achieve the required volume.

Further evaluation in preliminary design is required to refine sizing, configuration and consideration of discharge impacts on collection system features. The following assumptions were made for a tank similar in configuration to Alternative 1 (described below and shown in Figure 1):

- Two (2) 20-HP submersible pumps operating in a duty-standby configuration
- Flow rate of approximately 1,700 gpm for a 12-hour pump down, at 28-feet total dynamic head (TDH)
- 10-inch DI pipe discharging to Vassal Lane

Ventilation to atmosphere is required for make up air and typically accomplished using a PVC or DI gooseneck or mushroom cap stack. The height of the stack is dependent on being above the flood elevation and potential snow level. It may be possible to blend the vent stack in with landscaping or the adjacent building.

Electrical equipment includes a control panel, transformer, circuit breaker, automatic transfer switch, natural gas generator and natural gas meter. The equipment is estimated to require a space of 15-ft wide by 30-ft long and can be housed in an outdoor fenced electrical area or electrical room. Emergency standby power is a requirement of the Tobin Stormwater Tank to achieve design level of service during and immediately following a storm in the event of a power outage. At the Design Team Meeting the school design team stated that the building would include an emergency generator powered by biodiesel fuel with an on-site fuel tank. Provided adequate power and fuel storage can be allotted to the Tobin Stormwater Tank, consideration may be made to eliminate the separate natural gas generator. Elimination of the natural gas generator would significantly reduce the space required for the tank electrical equipment.

OPERATION AND MAINTENANCE REQUIREMENTS

Maintenance generally consists of exercising the pumps, removing the pumps for inspection and refurbishing, tank washdown and removal of debris that accumulates in the tank. The following list summarizes minimum operation and maintenance requirements for the tank.

- Access points for the tank and pump station:
  - Required at a minimum above each pump, one above the sump location(s), and a minimum of one at the upstream end of the tank for manned entry to assist with tank cleaning.
  - Increasing the width of the tank may require more access points to facilitate cleaning due to the increased quantity of intermediate column supports required.
  - Must be accessible at all times and cannot be buried or placed in an area where vehicles are parked on them.
- It is expected that the tank will need to be cleaned every 24 months. More frequent cleaning may be required depending on the use of the tank. The duration of the tank cleaning is typically 3 to 5 days.
- The pumps will need to be removed from the wet well by a small crane truck every 3 months for preventive maintenance. This maintenance will need to be performed during regular working hours M-F, 7:00am-3:00pm.
- Authorized DPW personnel will need unrestricted access to the control panel at all times.
- The pump station and all controls need to be connected to the DPW's telemetry system.
- If emergency repairs are needed, they will need to be completed immediately and cannot be scheduled around events at the school.

Reference: Tobin Stormwater Tank Conceptual Design Parameters and Location Analysis

TANK LOCATION ALTERNATIVE ANALYSIS

Two locations were identified at the Design Team Meeting: Alternative 1 – Bus Loop; and Alternative 2 – Parking Garage. The school facilities have undergone multiple design iterations and this memo uses the "Replacement v3 – Crossroads" alternative, presented at the February 12, 2020 Community Meeting, as the basis of the siting evaluation. The two alternatives are shown in Figure 1.

Alternative 1 for the tank location is beneath the bus loop in the west corner of the site. Review of design schematics provided at the Design Team Meeting indicate that this space is to be used as a school bus turnaround around a small green space as well as a route for the community path. It was noted that this location was a preferred location for upwards of 60 ground source heat pump (GSHP) wells.

Alternative 2 for the tank location was suggested by Perkins Eastman as being a way to preserve open space for GSHP wells. The tank is located primarily beneath the southwest section of the underground parking garage along Vassal Lane. The tank would be partially outside of the building envelop on the south side of the building to allow for access to the wet well for pump maintenance and cleaning. The height of the garage is too low for cleaning vehicles to perform maintenance activities from within the garage, requiring the access hatches for pump maintenance and wet well cleaning to be located outside of the building.

During the meeting it was suggested that the tank be located underneath the southeast wing of the garage. However, upon further review, that was determined to not be feasible as it was located beneath the ramp that would prohibit access to the tank for washdown from within the garage. If the location of the ramp was to be flipped to the southwest corner of the building, the location of Alternative 2 would flip to the southeast, accordingly.

Table 1 provides a summary of the Conceptual Design Parameters used to size the tanks and Table 2 provides a summary of the Tank Location Considerations. The colors used in Table 2 are intended to highlight the positive (green), neutral (gray) and negative (red) impacts of the various considerations.

Table 1 - Tank Conceptual Design Parameters

	Alternative 1 – Bus Loop	Alternative 2 – Parking Garage
Tank Volume	1.25 MG	
Tank Dimensions (LxW)	140' x 60'	200' x 168'
Tank Storage Depth	20 feet	5 feet
Assumed Grade	22.0'	
Top Slab TOC El.	18.5'	2.0'
Top Slab Thickness	18 inches	
Freeboard	2 feet	
Flooded Tank El.	15.5'	-1.5'
Tank Invert El.	-4.5'	-6.5'
Wet Well Invert El.	-6.5'	-8.0'
Cleaning Max Reach	28 feet	30 feet

Table 2 - Tank Location Considerations

	Alternative 1 – Bus Loop	Alternative 2 – Parking Garage
Design/Construction Schedule	Not on Critical Path	On Critical Path
Structural/Geotechnical	Disaggregated from school building structure and foundations.	Design considerations have not been considered for this evaluation.
Impact on Ground Source Heat Wells (GSHW) in Bus Loop Area	Limits or eliminates potential for GSHW beneath bus loop	Allows for GSHW in bus loop area.
Protection of Existing Trees	Routing of GI feature conveyance will need to carefully consider tree root impact.	Tree roots may be negatively impacted by tank SOE extending south of structure foundation.
Maintenance – Pumps	Drive up access in bus loop to access pumps.	Sidewalk path adjacent to Vassal Lane entrance will need to be widened to accommodate maintenance vehicles.
Maintenance – Cleaning	Wet well sump location at grade within line of sight of wash down access manhole at opposite end of tank. Yard hydrant can blend in with landscaping for wash down.	Wet well sump location outside at Vassal Lane entrance without line of sight to wash down access manhole at opposite end of tank. Yard hydrant located within parking garage for wash down. Max reach of City cleaning equipment. Many interior columns required significantly increasing potential for debris accumulation and complicates wash down procedure.
Maintenance – Safety	Safer alternative by having all access points within line of site and from grade.	Less safe alternative by limiting line of sight between access points and increasing the number of columns to clean around.
Conveyance of Diversion Flows	In driveway or community path. Not located within building footprint.	Pipes located within or beneath building foundation create difficult access for future maintenance, rehabilitation and/or repair.
GI Feature(s)	Longer route to convey flows to tank.	Tank dimensions may impact scale of GI feature(s).
Electrical and Control Cabinet	At grade above flood level, within line of site of all access points.	At grade above flood level, not within line of site of washdown access points.
Utility Service Connections	Potential minor conflicts, likely able to design out of conflict.	No known conflicts.
Confined Space Implications on adjacent structure(s)	No concerns	Study of potential impacts of cleaning operation on classification of basement level / undergound garage is required.

Summary

While further structural and geotechnical analysis may indicate that Alternative 2 is technically feasible to construct, it is not considered to be feasible to safely operate and maintain the tank and pump station as it has been conceived for Alternative 2.

Alternative 1 is the recommended location for the tank as it is easier to construct, operate and maintain. The tank design and construction move off the critical path schedule for the School Project. Alternative 1 provides a simpler and safer configuration to operate and maintain the tank and pump station facilities when compared with Alternative 2.

Note that geotechnical and structural design considerations of incorporating the tank into the building have not been considered for this analysis.

ADDITIONAL SITE ELEMENTS

There are several additional site elements that are integral to the Tobin Stormwater Tank including the diversion structures, weir structures, and conveyance conduits. The following is a general summary of key design considerations for these elements.

DIVERSION STRUCTURES

Two diversion structures exist within the storm drain network constructed as part of the Alewife Sewer Separation Program. These structures will divert high flows from the existing system during major storm events to the tank. The diversion structures are both located within the roadway on Concord Ave and Vassal Lane.

The diversion structure on Concord Avenue is located just east of Fern Street and has a 36-inch RCP pipe that extends to approximately back of sidewalk adjacent to the metal bleachers. The pipe has a masonry bulkhead at the end of the stub.

The diversion structure on Vassal Lane is in Drain Vault No. 2 which is located at the intersection of the school driveway. There is no stub connection at Vassal Lane which will require excavation within the edge of the roadway to make the connection. The overflow channel in the vault is approximately 6'-8" wide by 1'-8" tall and will require a transition chamber to be constructed adjacent to the vault to transition to a nominal pipe size.

WEIR STRUCTURES

Two new weir structures will be required to control the point at which flow is relieved from the collection system into the tank to prevent the tank from prematurely filling during a storm event. Both the Vassal Weir Structure and the Concord Weir Structure have been set at elevation 19.5' to optimize the timing at which the storm drains overflow into the tank to minimize flooding. The Concord Weir length is 4-ft. The Vassal Weir length is 8-ft. Each structure will have two access covers, one on each side of the weir. The access covers will be a minimum 24-inch diameter standard cast iron manhole frame and covers.

Depending on the exact location of the weir structures, pipe extensions may be required to connect to the diversion structure or stub pipe. At Concord Ave, the 36-inch RCP stub pipe will be continued in kind to reach the weir structure. At Vassal Lane, a 3'x4' precast concrete conduit is recommended between Drain Vault No. 2 and the weir structure. These conduits will be sloped upwards toward the weir structure so as not to trap water at the weir structures between storm events.

Reference: Tobin Stormwater Tank Conceptual Design Parameters and Location Analysis

CONSOLIDATION CONDUITS

The conduit from Vassal Lane is 42" diameter or equivalent capacity. The invert elevation is set at a minimum of one pipe diameter below the weir elevation to allow for free discharge resulting in a maximum invert elevation of 15.5'.

The conduit from Concord Lane is 36" diameter or equivalent capacity. The invert elevation is set at a minimum of one pipe diameter below the weir elevation to allow for free discharge resulting in a maximum invert elevation of 16.0'.

All bends in the pipe will be made with precast manholes with standard 24-inch cast iron manhole frame and covers. Pipes will be sloped downwards toward the tank with a minimum pitch of 0.5%.

Stantec

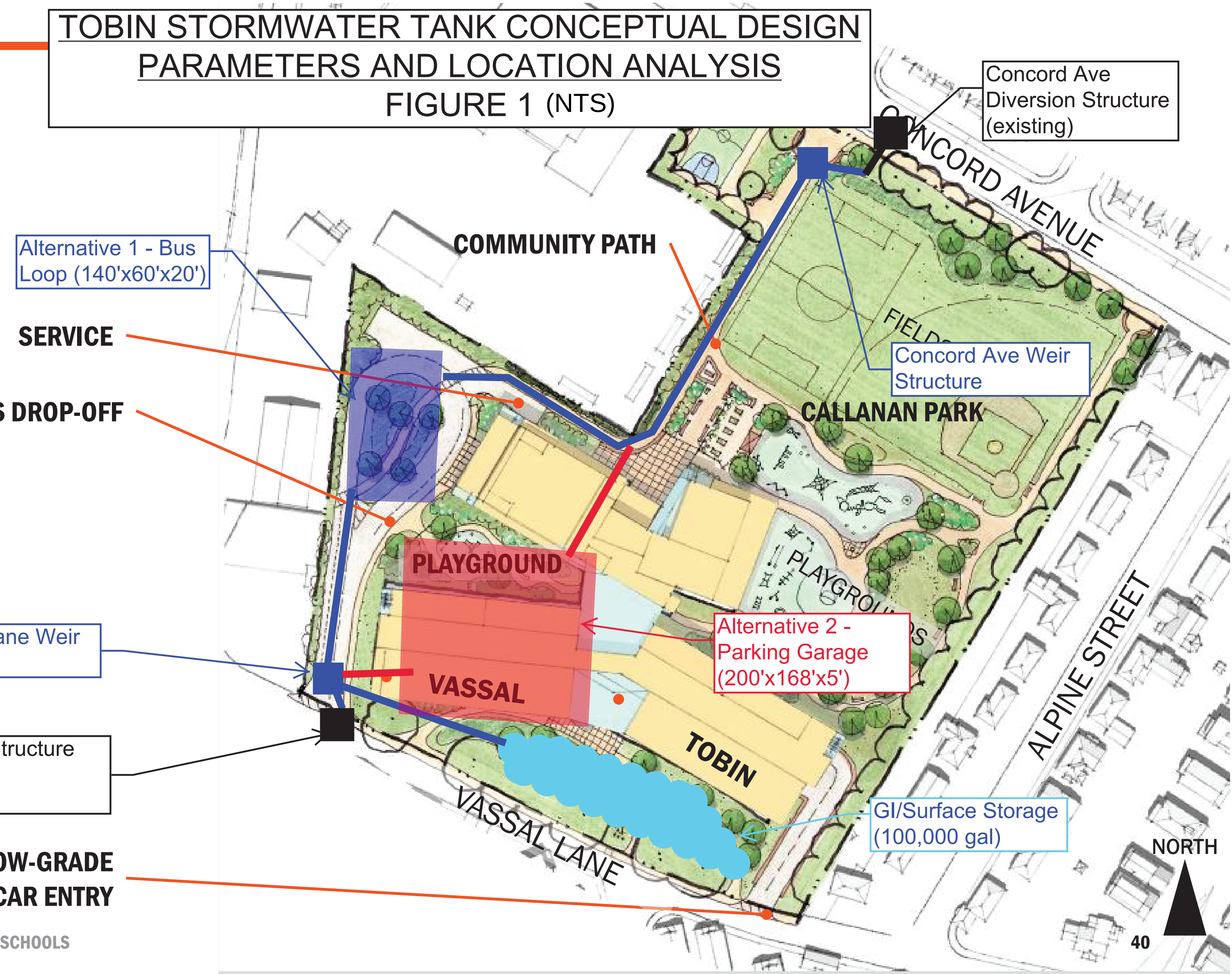
Keith Gardner PE, PMP
Keith.Gardner@stantec.com

Attachment: Figure 1

c. Charles Tripp, Kleinfelder

CROSSROADS

BUILDING AND SITE ELEMENTS



John M. Tobin Montessori School
Vassal Lane Upper School

City of Cambridge, Massachusetts

Preliminary Trip Generation Estimates

Presented by
VHB Inc. | February 6, 2020

Key Program Enrollment and Parking Assumptions

	Existing Condition *(# of students)*	**Full (Original) Program** *(# of students)*	**Reduced Program** *(# of students)*
Tobin Montessori	312	336	336
Vassal Lane Upper School	283	450	450
Special Programs	23 *(1/2 at Tobin; 1/2 at Vassal)*	139 *(69 at Tobin; 70 at Vassal)*	124 *(approx. 54 at Tobin; 70 at Vassal)*
Community School	0	160	80

	Existing Condition	**Full (Original) Program**	**Reduced Program**
Provided Staff Parking Spaces	80	100	100

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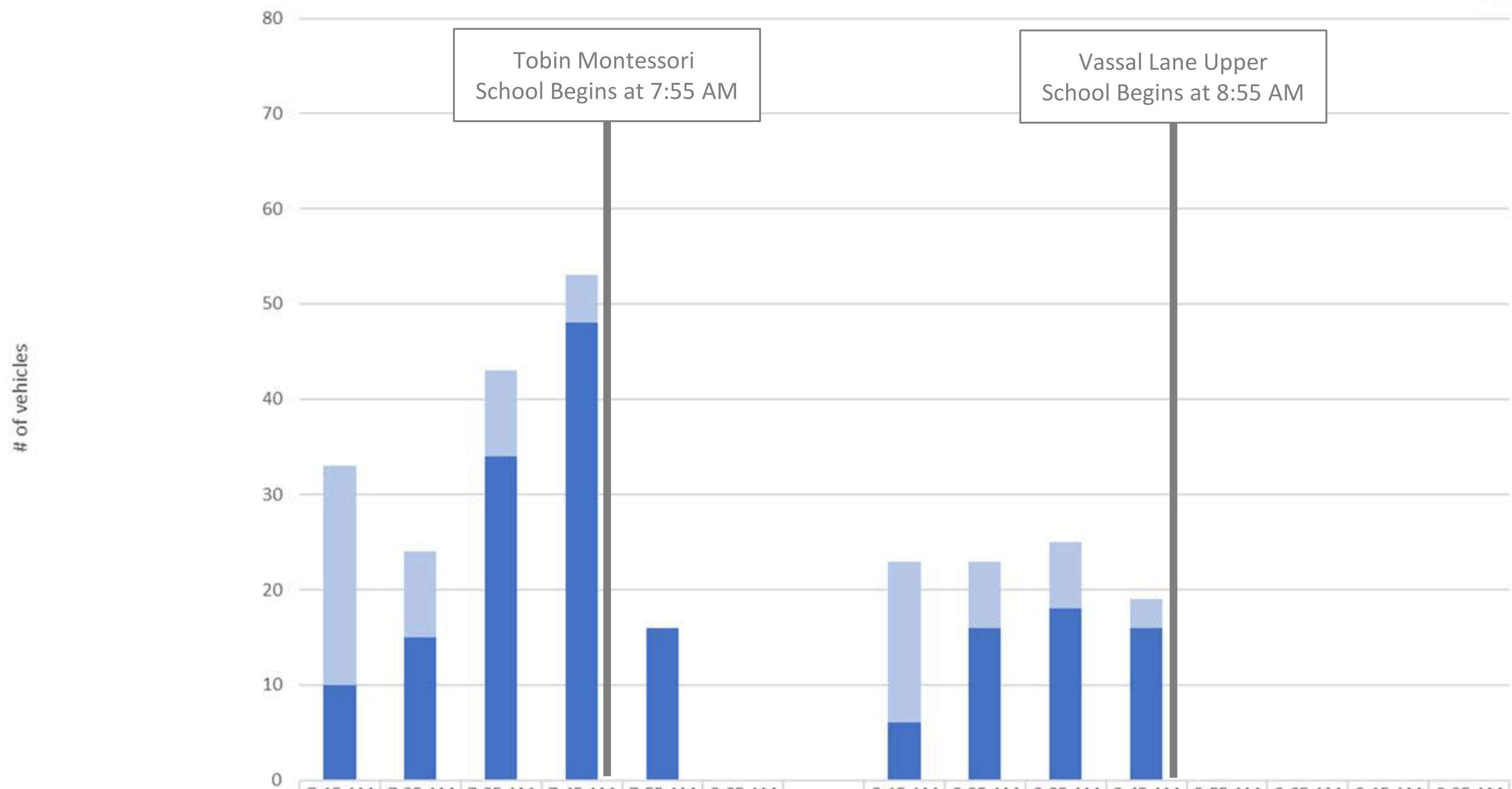
Existing Site Conditions
Morning Arrival Drop-off Profile

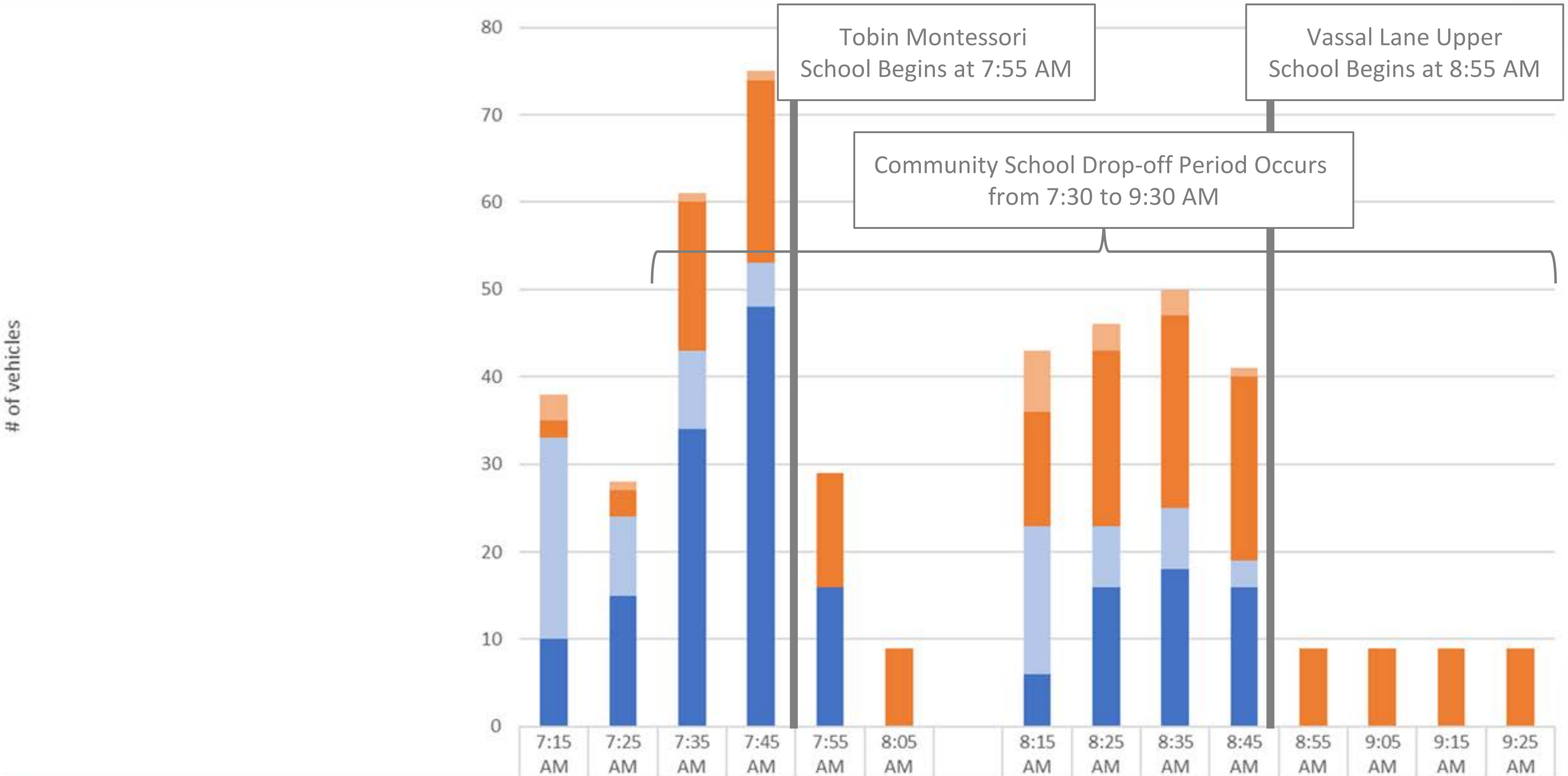


	7:15 AM	7:25 AM	7:35 AM	7:45 AM	7:55 AM	8:05 AM		8:15 AM	8:25 AM	8:35 AM	8:45 AM	8:55 AM	9:05 AM	9:15 AM	9:25 AM
Existing Staff Vehicles	23	9	9	5	0	0		17	7	7	3	0	0	0	0
Existing Parent and Bus Drop-off	10	15	34	48	16	0		6	16	18	16	0	0	0	0

10-minute period commencing

Analysis Notes:
- Existing trip generation is based on observations documented by VHB in 2019.

Future Site Conditions *(Full Original Program – January 2020)*
Morning Arrival Drop-off Profile



	7:15 AM	7:25 AM	7:35 AM	7:45 AM	7:55 AM	8:05 AM	8:15 AM	8:25 AM	8:35 AM	8:45 AM	8:55 AM	9:05 AM	9:15 AM	9:25 AM
Proposed Net-Increase of Staff Vehicles	3	1	1	1	0	0	7	3	3	1	0	0	0	0
Proposed Net-Increase of Parent and Bus Drop-off Vehicles	2	3	17	21	13	9	13	20	22	21	9	9	9	9
Existing Staff Vehicles	23	9	9	5	0	0	17	7	7	3	0	0	0	0
Existing Parent and Bus Drop-off	10	15	34	48	16	0	6	16	18	16	0	0	0	0

10-minute period commencing

Analysis Notes:

- Existing trip generation is based on observations documented by VHB in 2019.
- Assumes all Tobin and Vassal School program increases would exhibit similar commute patterns as the existing respective schools with the exception of bus trips. Analysis assumes all students arriving/departing by bus would be accommodated on existing fleet of vehicles arriving/departing schools.
- Community school activities are rough assumptions taking into consideration some part-time child participation/enrollment, absences, families with multiple children, carpooling, etc. – Assumed 70% of total would drop-off on a typical day
- Community school activities are assumed to be dispersed evenly throughout the entire 7:30 to 9:30 AM and 4:30 to 6:00 PM drop-off/pick-up periods.

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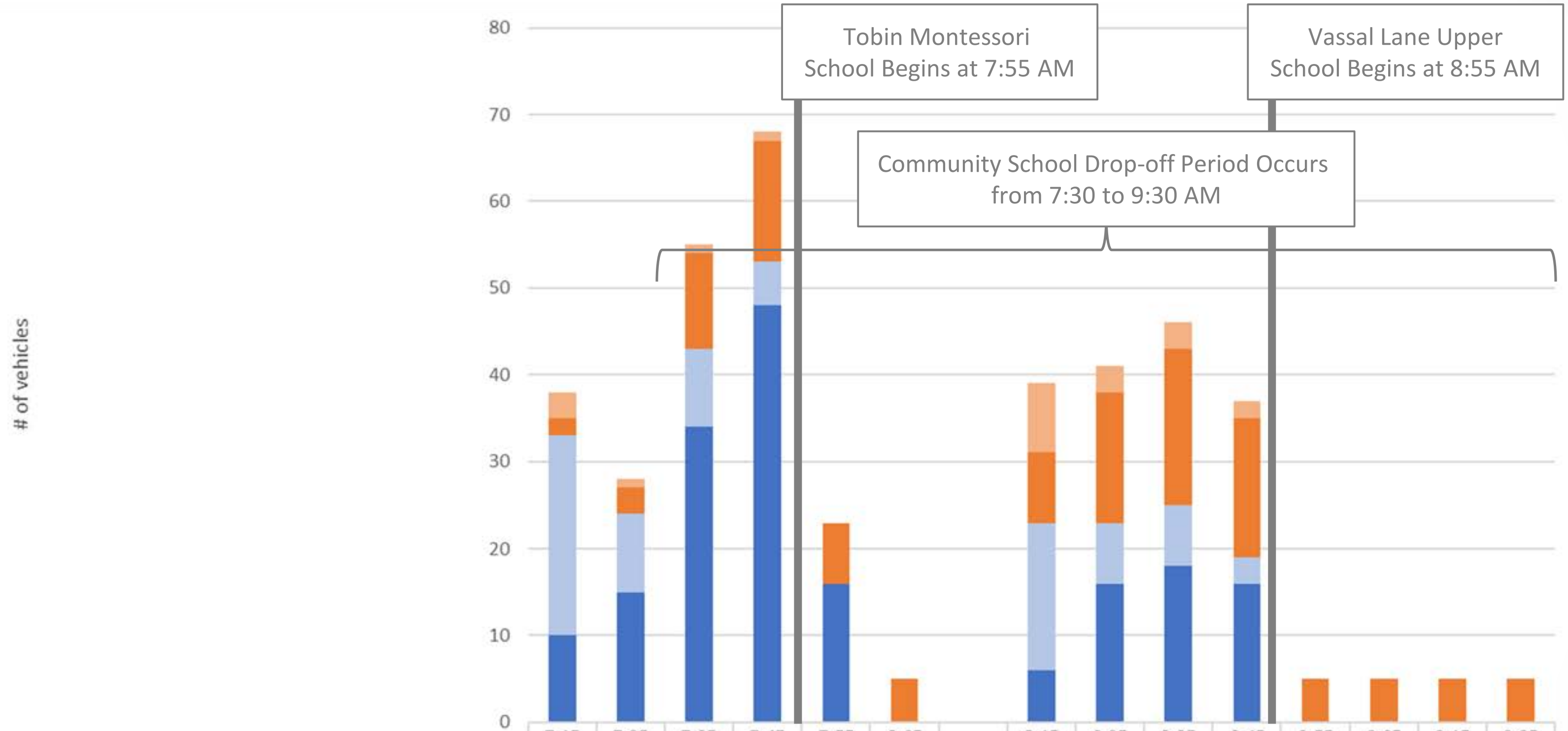
Future Site Conditions

(Reduced Community School and Special Start Program)

Morning Arrival Drop-off Profile



	7:15 AM	7:25 AM	7:35 AM	7:45 AM	7:55 AM	8:05 AM		8:15 AM	8:25 AM	8:35 AM	8:45 AM	8:55 AM	9:05 AM	9:15 AM	9:25 AM
Proposed Net-Increase of Staff Vehicles	3	1	1	1	0	0		8	3	3	2	0	0	0	0
Proposed Net-Increase of Parent and Bus Drop-Off Vehicles	2	3	11	14	7	5		8	15	18	16	5	5	5	5
Existing Staff Vehicles	23	9	9	5	0	0		17	7	7	3	0	0	0	0
Existing Parent and Bus Drop-off	10	15	34	48	16	0		6	16	18	16	0	0	0	0

10-minute period commencing

Analysis Notes:

- Existing trip generation is based on observations documented by VHB in 2019.
- Assumes all Tobin and Vassal School program increases would exhibit similar commute patterns as the existing respective schools with the exception of bus trips. Analysis assumes all students arriving/departing by bus would be accommodated on existing fleet of vehicles arriving/departing schools.
- Community school activities are rough assumptions taking into consideration some part-time child participation/enrollment, absences, families with multiple children, carpooling, etc. – Assumed 70% of total would drop-off on a typical day
- Community school activities are assumed to be dispersed evenly throughout the entire 7:30 to 9:30 AM and 4:30 to 6:00 PM drop-off/pick-up periods.

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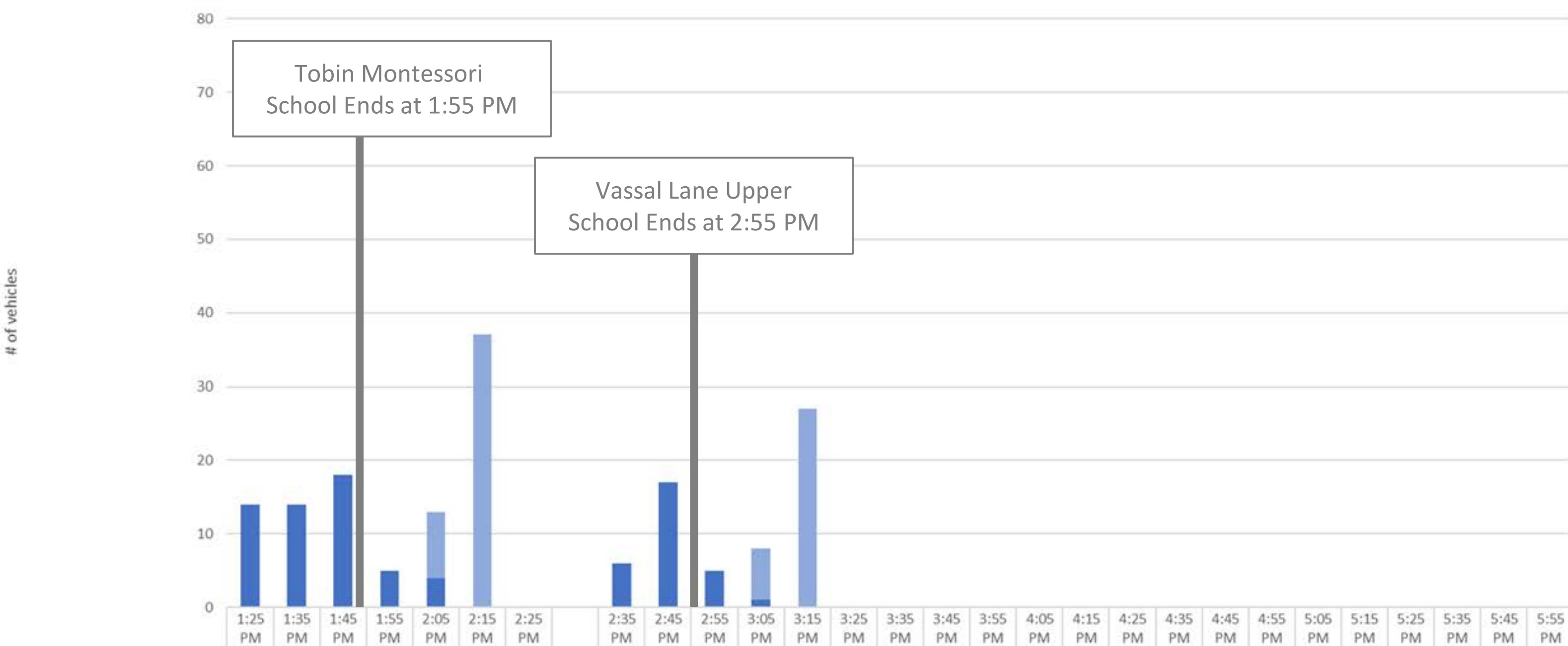
Existing Site Conditions
Afternoon Dismissal Pick-up Profile



	1:25 PM	1:35 PM	1:45 PM	1:55 PM	2:05 PM	2:15 PM	2:25 PM	2:35 PM	2:45 PM	2:55 PM	3:05 PM	3:15 PM	3:25 PM	3:35 PM	3:45 PM	3:55 PM	4:05 PM	4:15 PM	4:25 PM	4:35 PM	4:45 PM	4:55 PM	5:05 PM	5:15 PM	5:25 PM	5:35 PM	5:45 PM	5:55 PM
Existing Staff Vehicles	0	0	0	0	9	37	0	0	0	0	7	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Existing Parent and Bus Pick-up	14	14	18	5	4	0	0	6	17	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

10-minute period commencing

Analysis Notes:

- Existing trip generation is based on observations documented by VHB in 2019.
- Note late afternoon and evening school programs not studied in 2019 – those activities generate modest traffic impacts

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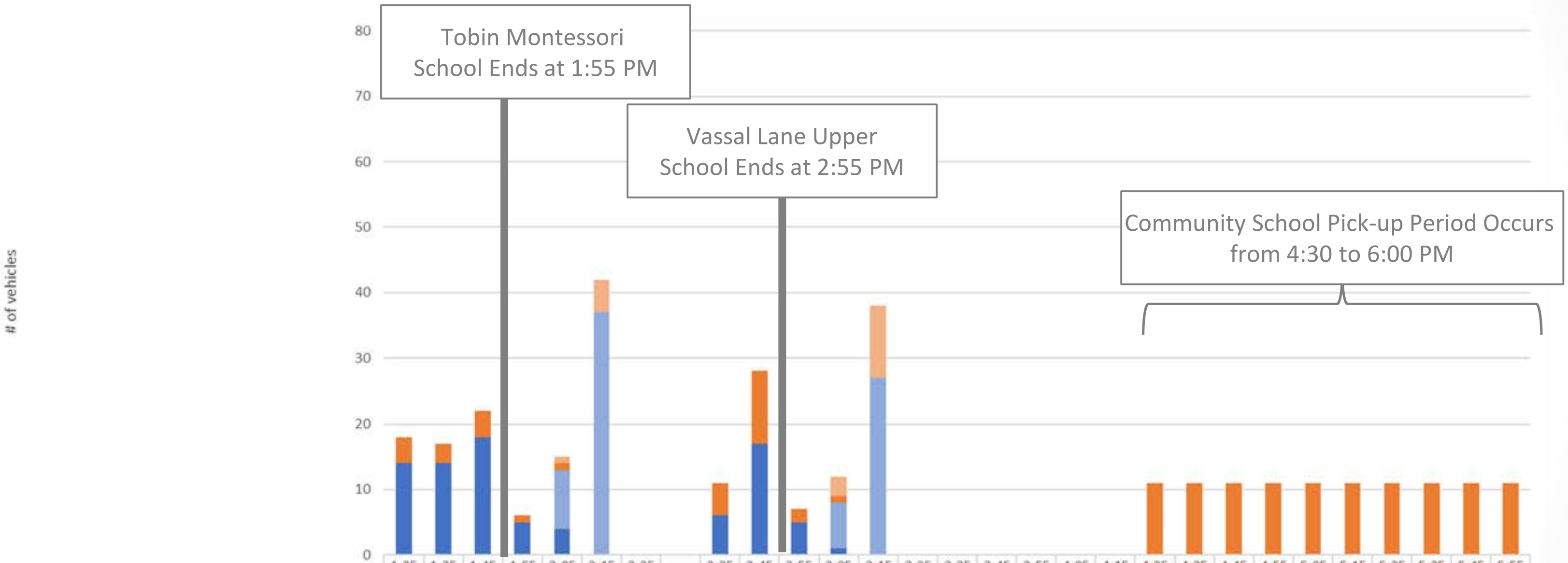
Future Site Conditions *(Full Original Program – January 2020)*
Afternoon Dismissal Pick-up Profile



	1:25 PM	1:35 PM	1:45 PM	1:55 PM	2:05 PM	2:15 PM	2:25 PM	2:35 PM	2:45 PM	2:55 PM	3:05 PM	3:15 PM	3:25 PM	3:35 PM	3:45 PM	3:55 PM	4:05 PM	4:15 PM	4:25 PM	4:35 PM	4:45 PM	4:55 PM	5:05 PM	5:15 PM	5:25 PM	5:35 PM	5:45 PM	5:55 PM
Proposed Net-Increase of Staff Vehicles	0	0	0	0	1	5	0	0	0	0	3	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Proposed Net-Increase of Parent and Bus Pick-up Vehicles	4	3	4	1	1	0	0	5	11	2	1	0	0	0	0	0	0	0	11	11	11	11	11	11	11	11	11	11
Existing Staff Vehicles	0	0	0	0	9	37	0	0	0	0	7	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Existing Parent and Bus Pick-up	14	14	18	5	4	0	0	6	17	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

10-minute period commencing

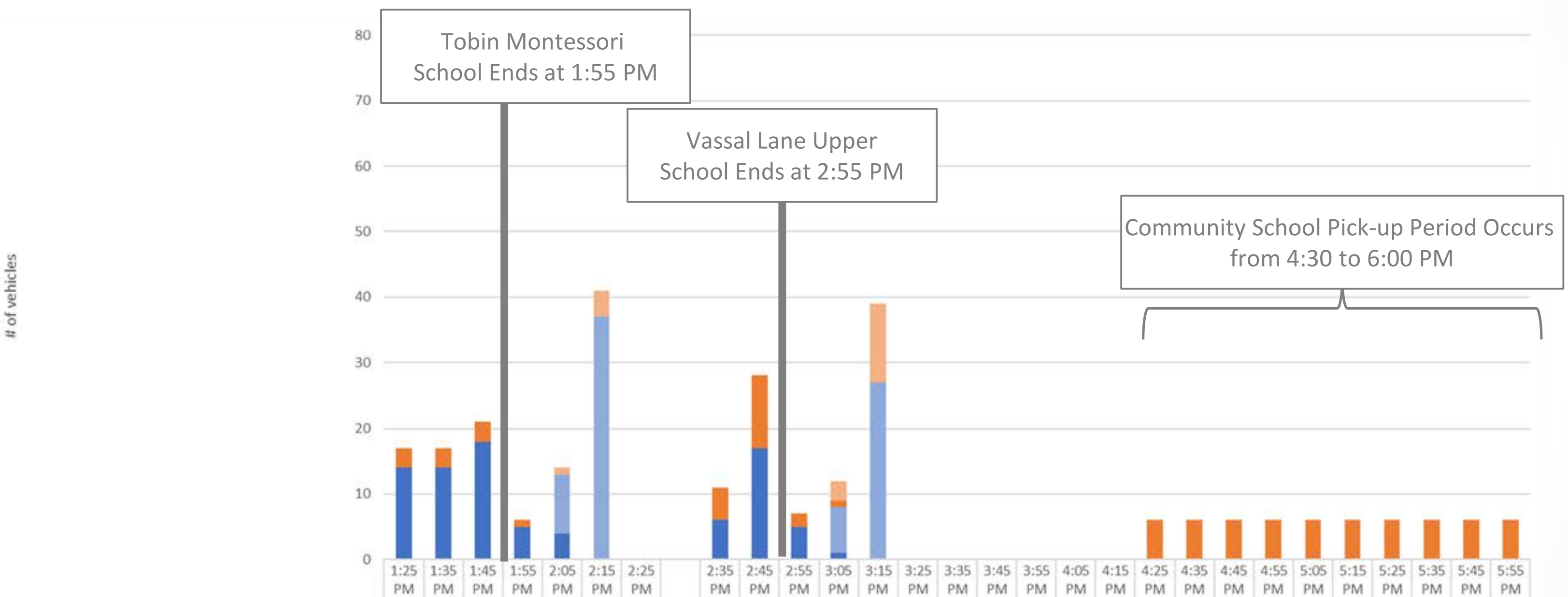
<u>Analysis Notes:</u>

- Existing trip generation is based on observations documented by VHB in 2019.
- Assumes all Tobin and Vassal School program increases would exhibit similar commute patterns as the existing respective schools with the exception of bus trips. Analysis assumes all students arriving/departing by bus would be accommodated on existing fleet of vehicles arriving/departing schools.
- Community school activities are rough assumptions taking into consideration some part-time child participation/enrollment, absences, families with multiple children, carpooling, etc. – Assumed 70% of total would drop-off on a typical day
- Community school activities are assumed to be dispersed evenly throughout the entire 7:30 to 9:30 AM and 4:30 to 6:00 PM drop-off/pick-up periods.

Future Site Conditions

(Reduced Community School and Special Start Program)

Afternoon Dismissal Pick-up Profile



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Proposed Net-Increase of Staff Vehicles	0	0	0	0	1	4	0	0	0	0	3	12	0	0
Proposed Net-Increase of Parent and Bus Pick-up Vehicles	3	3	3	1	0	0	0	5	11	2	1	0	0	0
Existing Staff Vehicles	0	0	0	0	9	37	0	0	0	0	7	27	0	0
Existing Parent and Bus Pick-up	14	14	18	5	4	0	0	6	17	5	1	0	0	0

	3:45 PM	3:55 PM	4:05 PM	4:15 PM	4:25 PM	4:35 PM	4:45 PM	4:55 PM	5:05 PM	5:15 PM	5:25 PM	5:35 PM	5:45 PM	5:55 PM
Proposed Net-Increase of Staff Vehicles	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Proposed Net-Increase of Parent and Bus Pick-up Vehicles	0	0	0	0	6	6	6	6	6	6	6	6	6	6
Existing Staff Vehicles	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Existing Parent and Bus Pick-up	0	0	0	0	0	0	0	0	0	0	0	0	0	0

10-minute period commencing

Analysis Notes:

- Existing trip generation is based on observations documented by VHB in 2019.
- Assumes all Tobin and Vassal School program increases would exhibit similar commute patterns as the existing respective schools with the exception of bus trips. Analysis assumes all students arriving/departing by bus would be accommodated on existing fleet of vehicles arriving/departing schools.
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- Community school activities are assumed to be dispersed evenly throughout the entire 7:30 to 9:30 AM and 4:30 to 6:00 PM drop-off/pick-up periods.

Vehicle Morning Arrival and Afternoon Departure Peak Hour Summary

	Existing Condition *(AM Peak Hour: 7:15 to 8:15 AM PM Peak Hour: 1:25 to 2:25 PM)*	**Full (Original) Program** *(AM Peak Hour: 7:35 to 8:35 AM PM Peak Hour: 1:25 to 2:25 PM)*		**Reduced Program** *(AM Peak Hour: 7:35 to 8:35 AM PM Peak Hour: 1:25 to 2:25 PM)*	
		Total Vehicles	***Net-Increase***	***Total Vehicles***	***Net-Increase***
Morning Peak Hour	169	263	+94 (+56%)	231	+62 (+37%)
Afternoon Peak Hour	101	120	+19 (+19%)	116	+15 (+15%)

Next Steps: Traffic Impact Study (TIS) Certification

- Required comprehensive engineering analysis of existing transportation infrastructure and anticipated impacts related to a proposed redevelopment project
- Traffic, Parking & Transportation (TP&T) Dept. is responsible for TIS review and certification prior to a project proponent going before the Cambridge Planning Board
- Conduct of TIS will include:
  - Study of neighborhood vehicle, pedestrian, and bicycle access and circulation
  - Continued opportunity for community input and feedback on transportation issues and concerns
  - Assess and implement improvements in connection with the Project.

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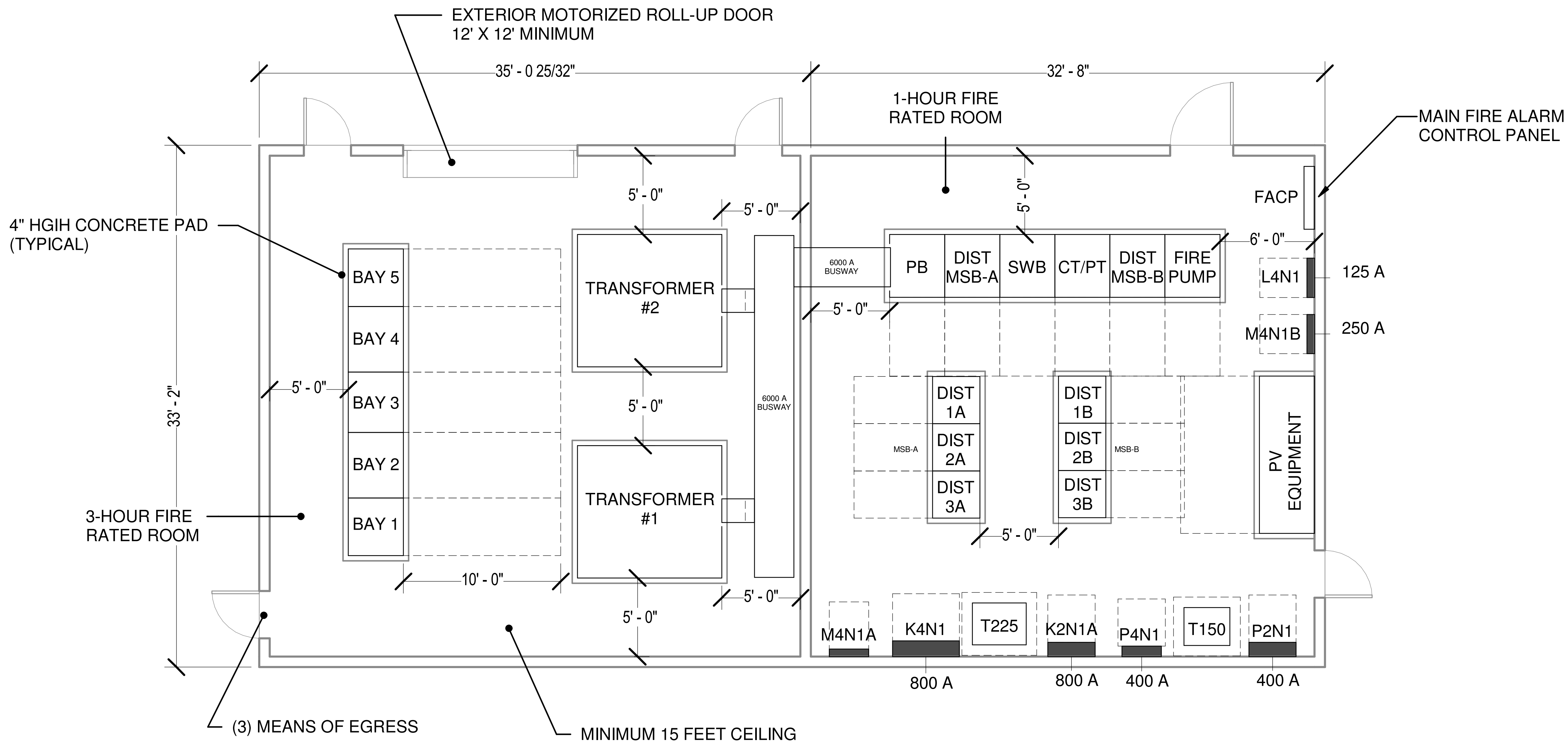
Next Steps: Parking & Transportation Demand Management (PTDM) Plan

- National model for improving mobility and access, reducing congestion and air pollution, and increasing safety by promoting walking, bicycling, public transit, and other sustainable modes.
- Required when non-residential parking is added to a site
- PTDM Plan requires the following key elements:
  - Single-occupancy vehicle mode-share commitment
  - Comprehensive set of transportation demand management (TDM) measures
  - Annual monitoring and reporting of:
    1. *Employee, visitor, and/or patron survey, including Single Occupancy Vehicle (SOV) rate*
    2. *Biennial counts of car and bike parking occupancy and driveway ins/outs*
    3. *Status of required TDM measures*



1 TRANSFORMER VAULT AND MAIN ELECTRICAL ROOM
1/8" = 1'-0"

PANELBOARD LABELING

D4N1A

- D = DISTRIBUTION
- M = MECHANICAL
- L = LIGHTING
- P = POWER / RECEPTACLE
- K = KITCHEN
- B = LAB / CLASSROOM
- A= AUDIO
- PV = PV SYSTEM

INDICATES VOLTAGE
2 = 208/120
4 = 480/277

N = NORMAL
E = EMERGENCY
S = STAND-BY

PANEL DESIGNATION
(ON FLOOR)

FLOOR LEVEL LOCATION
1 = FIRST FLOOR
2 = SECOND FLOOR
3 = THIRD FLOOR
4 = FOURTH FLOOR

Rist Frost Shumway
Engineering, P.C.
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Laconia, NH 03246
P: 603.524.4647
MA: 50 Milk St, 16th Floor
Boston, MA 02109
P: 617.494.1464
ME: 82 Hanover St, Suite 2
Portland, ME 04101
P: 207.761.4647
www.rfsengineering.com

**Tobin Montessori
Vassal Lane School**

Cambridge, MA

TRANSFORMER VAULT AND MAIN ELECTRICAL ROOM

Drawn By	AA
Checked By	PGW
Date	02/14/20
Project Number	8795.001
Scale	As indicated
Dwg. Reference	
Dwg.Number:	SKE1

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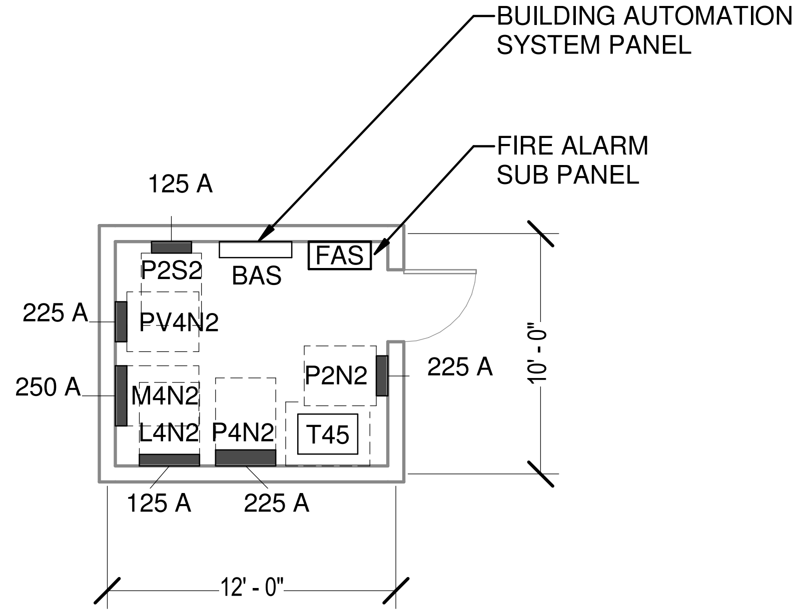
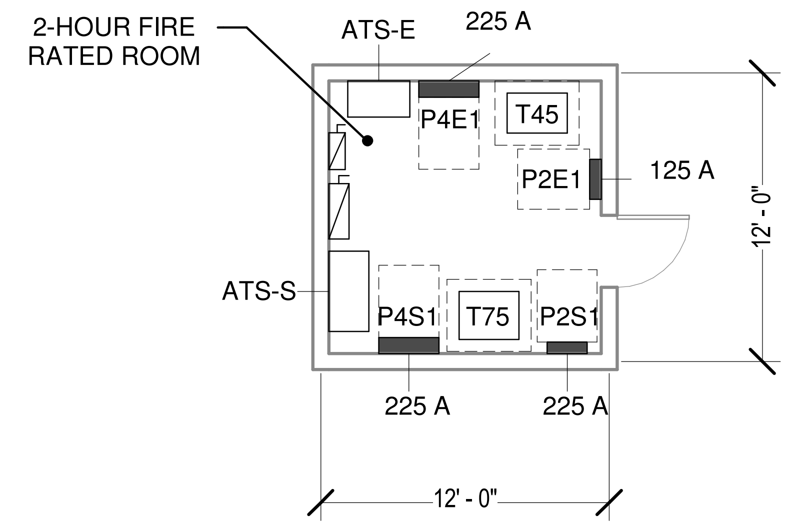
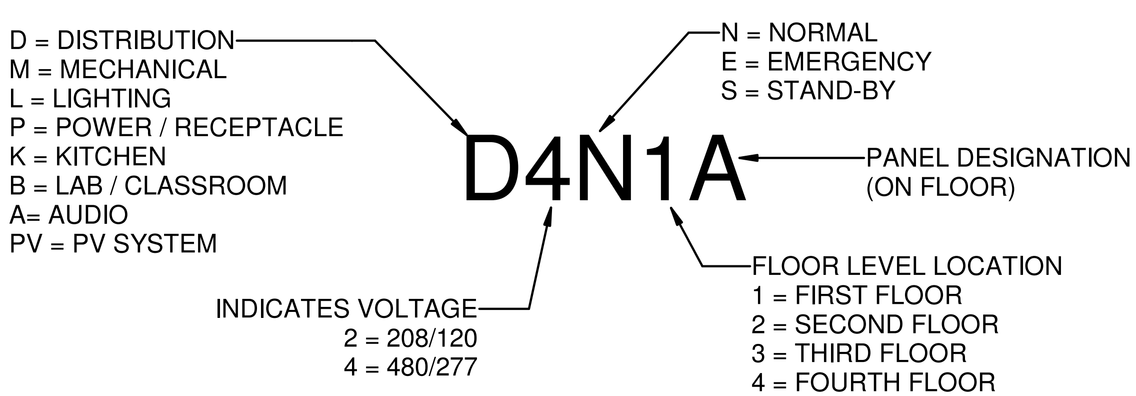


1 TYPICAL SATELLITE ELECTRICAL ROOM
1/8" = 1'-0"



2 MAIN EMERGENCY ROOM
1/8" = 1'-0"

PANELBOARD LABELING



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RFS engineering
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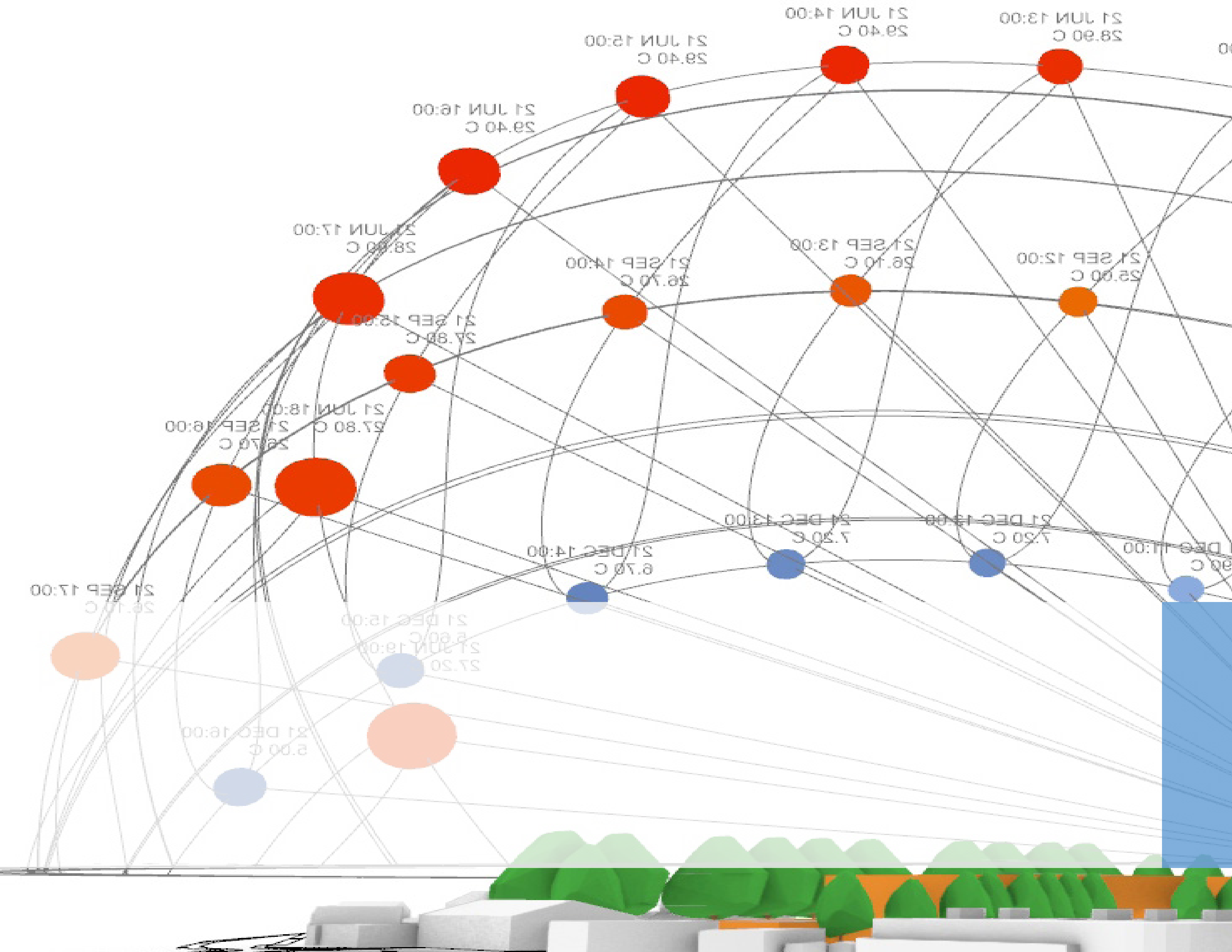
Tobin Montessori
Vassal Lane School

Cambridge, MA

TYPICAL SATELLITE ELECTRICAL ROOM & MAIN EMERGENCY ROOM

Drawn By	AA
Checked By	PGW
Date	02/14/20
Project Number	8795.001
Scale	As indicated
Dwg. Reference	
Dwg.Number:	SKE2



21 JUN 13:00
28.90 C
21 JUN 14:00
29.40 C
21 JUN 15:00
29.40 C
21 JUN 16:00
29.40 C
21 JUN 17:00
28.90 C
21 SEP 12:00
25.00 C
21 SEP 13:00
26.10 C
21 SEP 14:00
26.70 C
21 SEP 15:00
27.80 C
21 JUN 18:00
27.80 C
21 SEP 16:00
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21 DEC 12:00
7.20 C
21 DEC 13:00
7.20 C
21 DEC 14:00
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27.20
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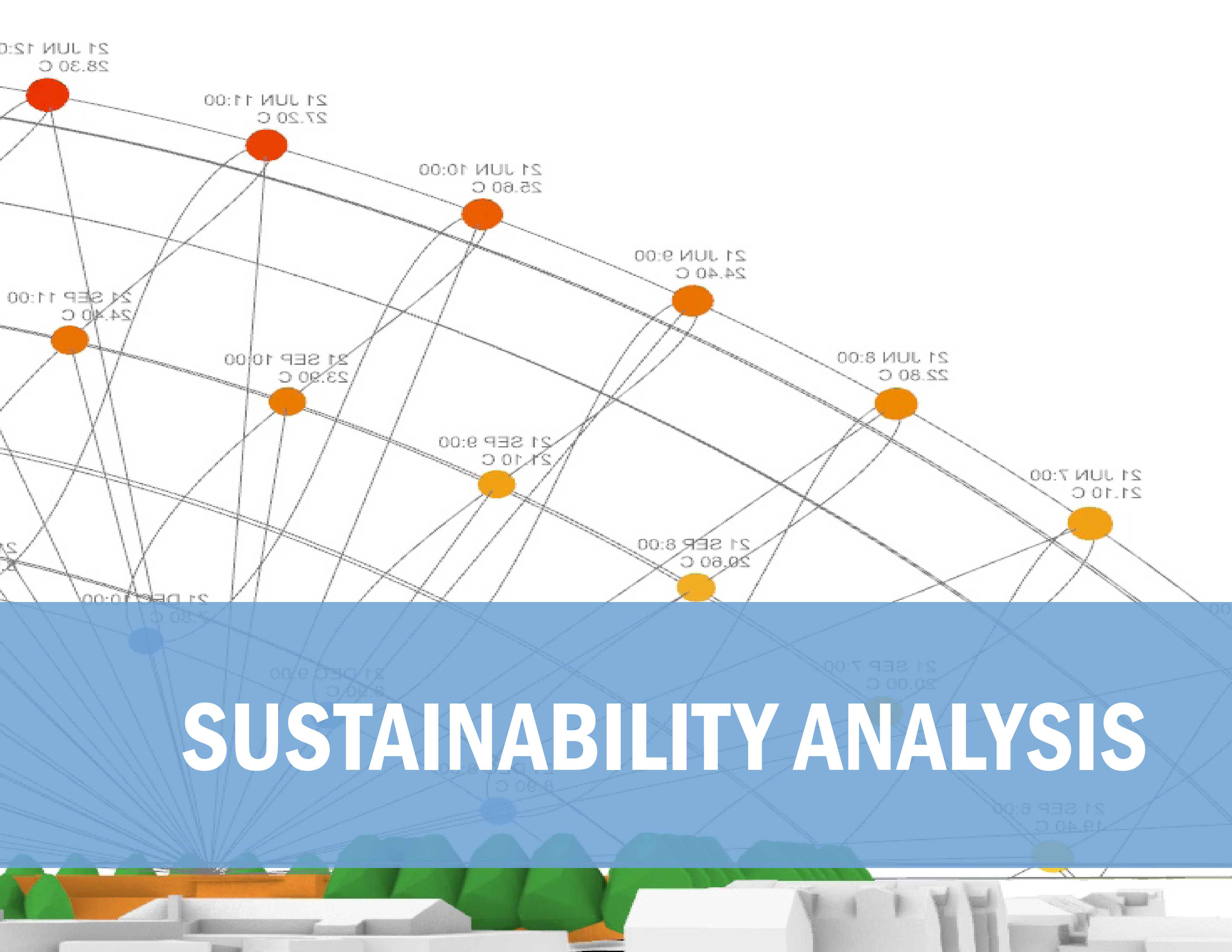
5.00 C

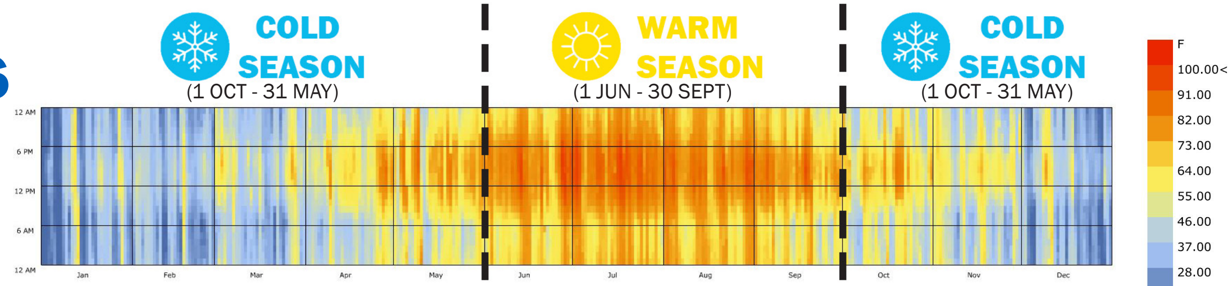


SUSTAINABILITY ANALYSIS

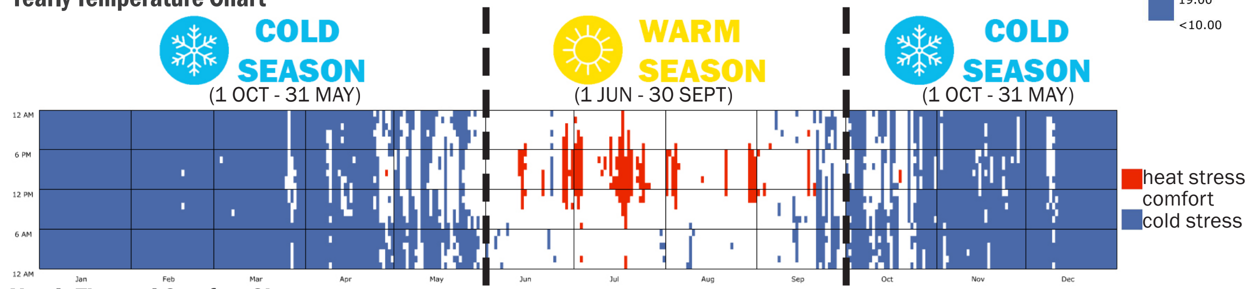
climate analysis

Bedford, MA experiences extreme weather swings, with hot humid summers and cold dry winters. It is therefore challenging to create a thermally comfortable outdoor environment, except in the swing seasons of spring and fall, but even including these seasons the outdoor environment is only comfortable around 5.3% of the year.

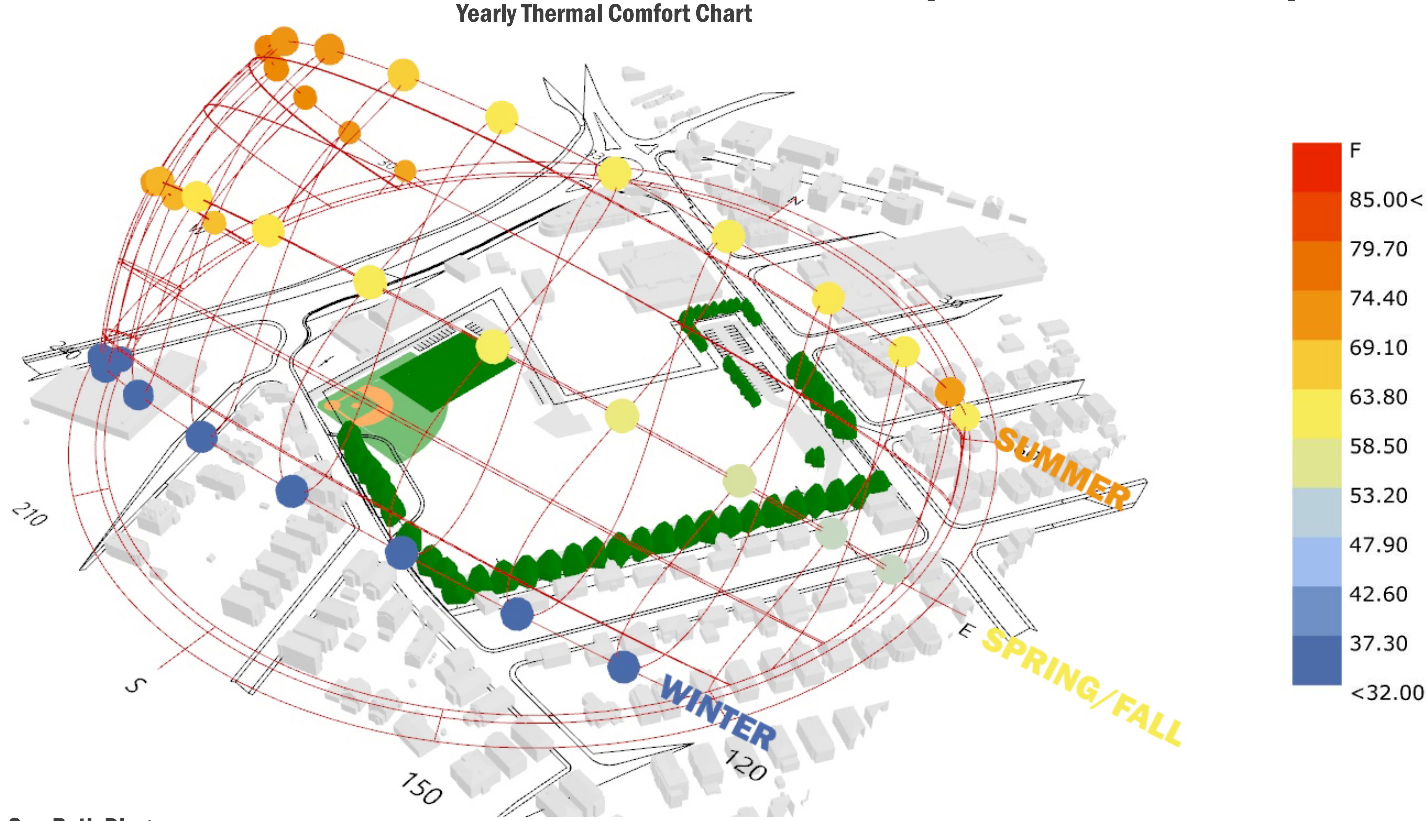
Additional measures for solar and wind control in outdoor spaces should therefore be employed to extend thermal comfort.



Yearly Temperature Chart

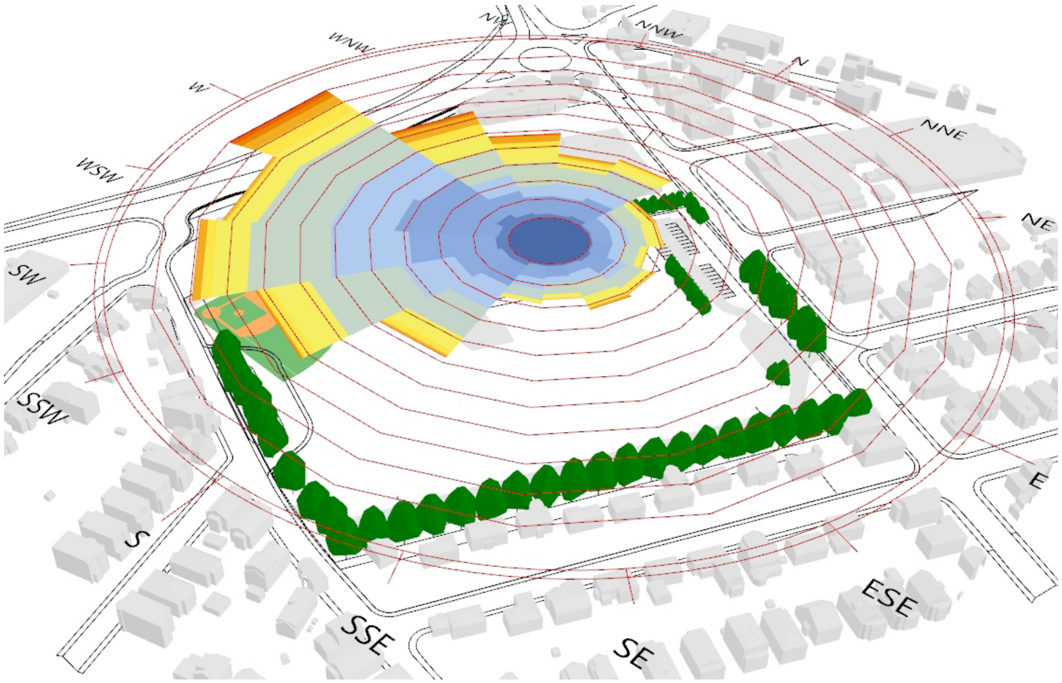


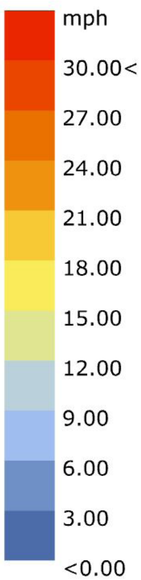
Yearly Thermal Comfort Chart



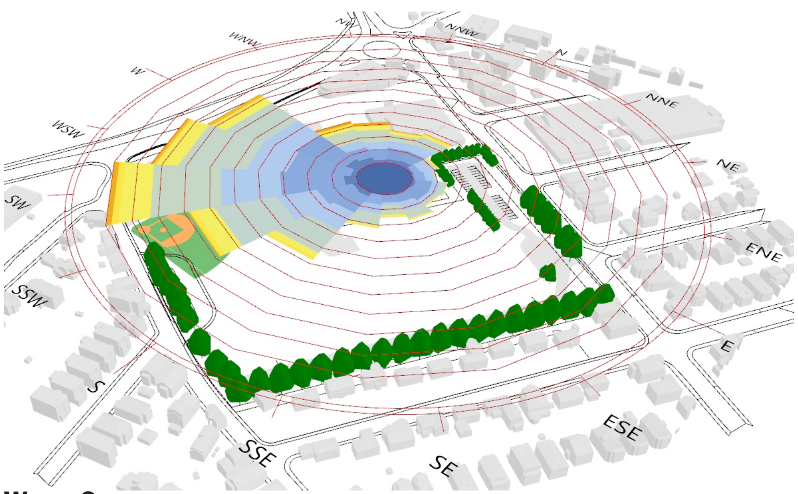
Sun Path Diagram

wind analysis

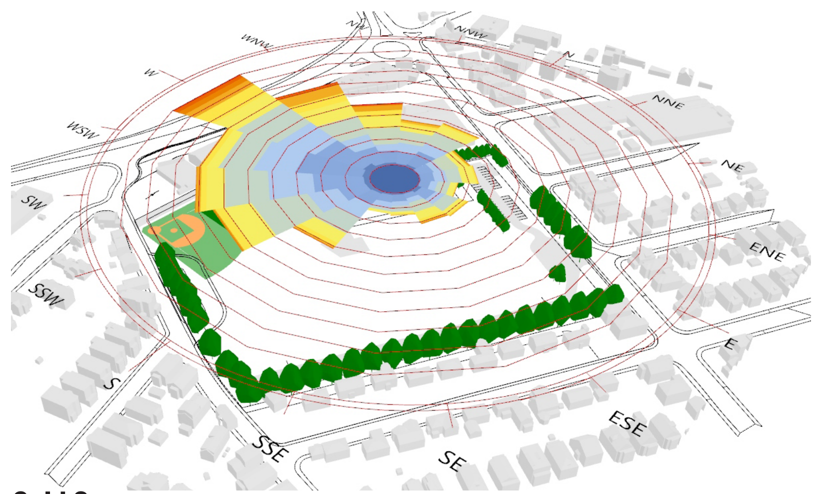




Yearly



Warm Season



Cold Season

In Bedford, MA, prevailing winds shift by season.

Cold winds tend to come from the west and north-west with relatively high velocity, making outdoor areas that face west relatively inhospitable.

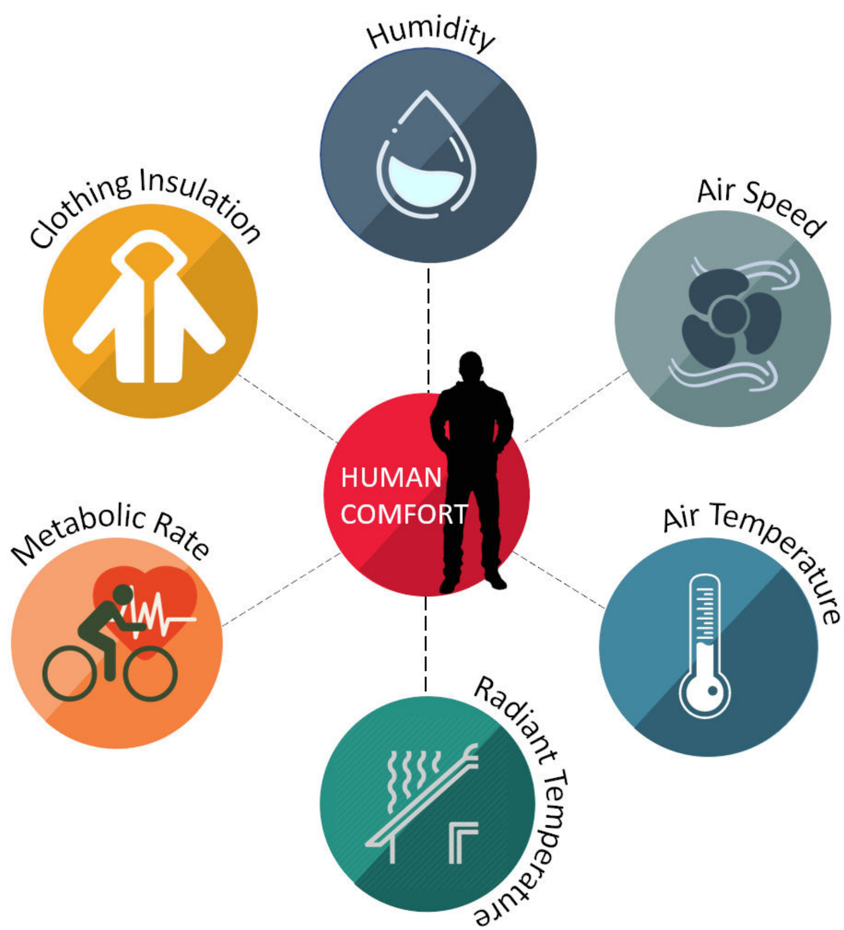
During the warm season, winds come from the south and south-west primarily, especially in the summer months. These breezes are more welcome for ventilation to extend comfort.

PERKINS EASTMAN

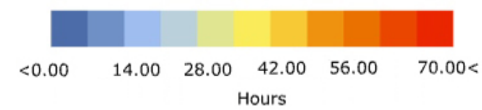
thermal comfort strategies

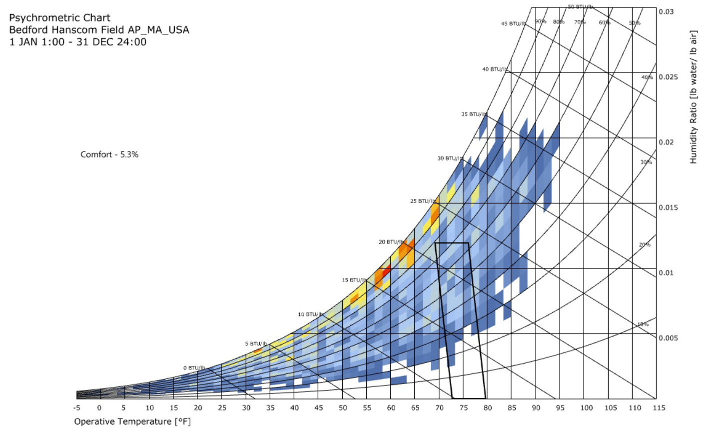
There are several factors that influence thermal comfort, and architecture can play a significant role. The way in which the building is laid out can impact elements such as wind speeds, mean radiant temperature, dry bulb temperature, and the overall thermal sensation of the environment. In a micro-climate urban map, like the one at Bedford, MA, 1°F temperature differentials can have a considerable impact in the thermal comfort of occupants, and affect the way in which they perceives that space throughout the year. It will be important to study options during schematic design for optimizing outdoor and indoor thermal comfort levels during the year to improve the use of the outdoor spaces.

Multiple passive design strategies can have a significant impact in the thermal comfort feeling both inside and outside the building, and might also represent saving in terms cooling and heating loads.

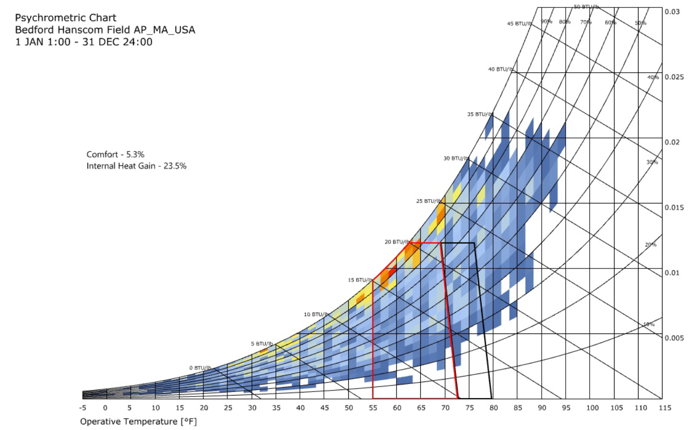


PASSIVE DESIGN STRATEGIES

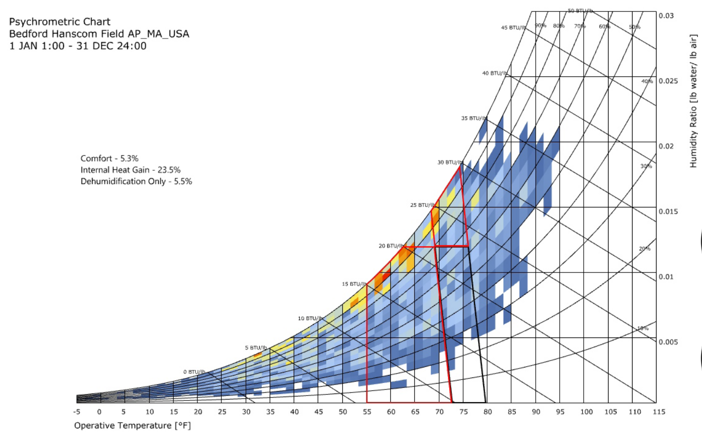




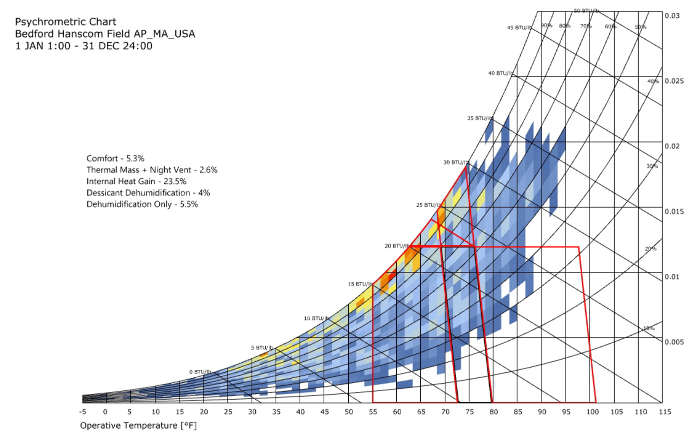
TOTAL THERMAL COMFORT: 5.3%



TOTAL THERMAL COMFORT: 28.10%



TOTAL THERMAL COMFORT: 34.7%



TOTAL THERMAL COMFORT: 36.92%

STRATEGIES LEGEND

- DEHUMIDIFICATION
- INTERNAL HEAT GAINS
- THERMAL MASS

PSYCHROMETRIC CHART

Although mechanical heating and cooling will still be needed to maintain indoor thermal comfort in this climate, passive design strategies can be employed to reduce the amount of mechanical cooling necessary. While passive cooling strategies such as evaporative cooling, cross ventilation, night ventilation, and the use of fans can reduce mechanical cooling needs, the climate predominantly requires heating, so focusing on passive heating strategies can have more impact on energy performance. Passive heating strategies such as utilizing a well insulated and airtight building envelope to capture internal heat gains can provide added comfort for 28% of the year, significantly reducing the need for mechanical heating.

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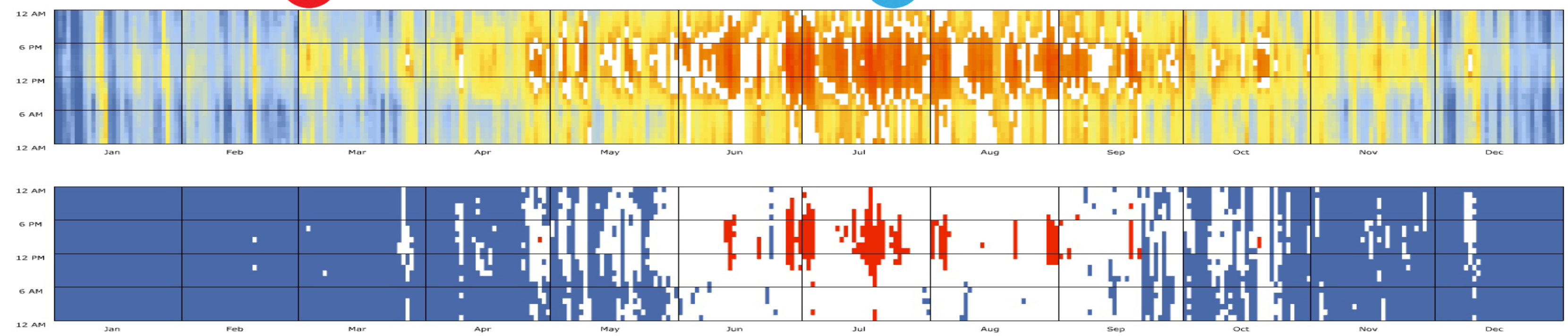
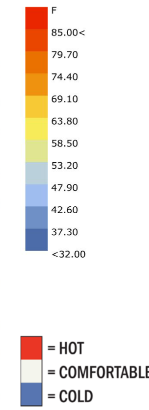
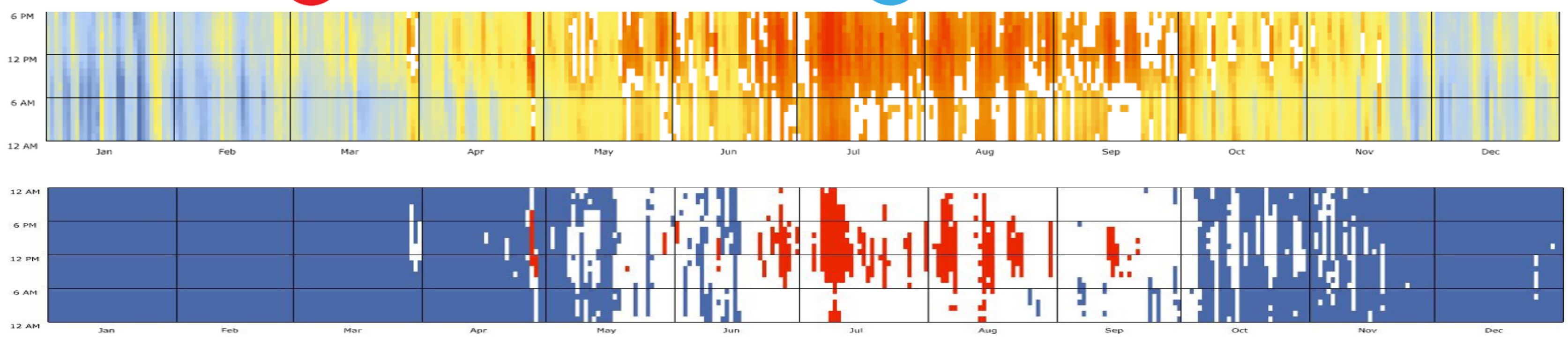
CLIMATE CHANGE CHARTS

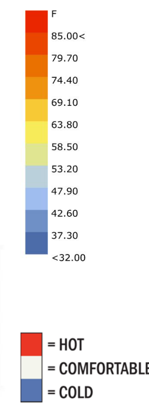
2020 HEAT STRESS: 1.4% COLD STRESS: 47.5%



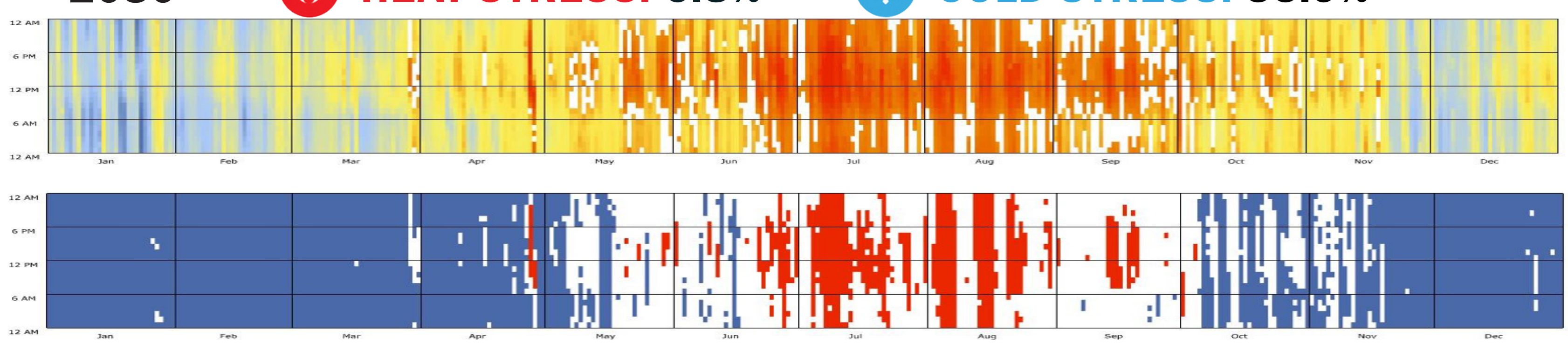


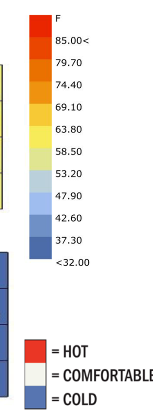
2050 HEAT STRESS: 2.8% COLD STRESS: 41.3%



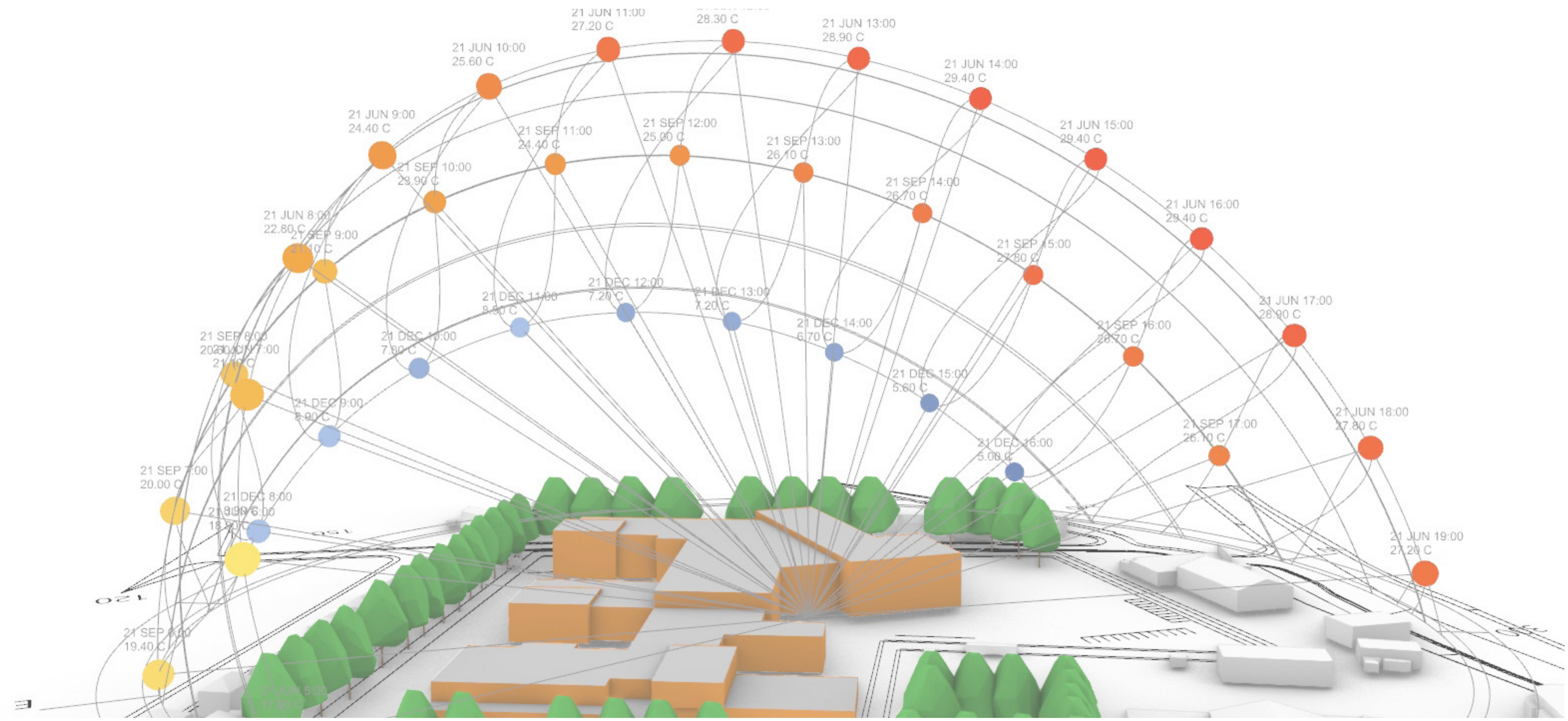


2080 HEAT STRESS: 6.8% COLD STRESS: 35.9%



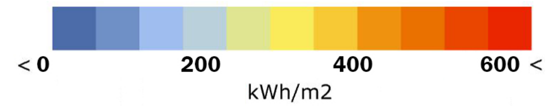


solar analysis

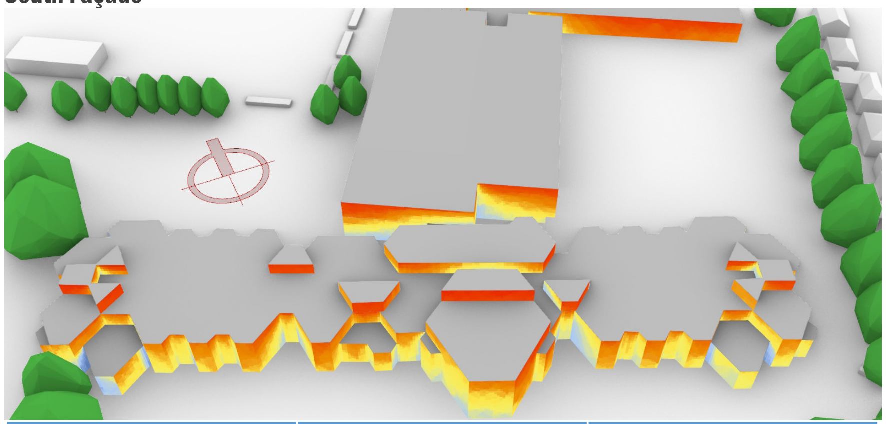


The amount of heat from the sun that impacts the building envelope will be a key factor in achieving net-zero energy. If solar heat gain through the building can be reduced during the warm season, and utilized during the cold seasons to provide passive heating, the building's mechanical system can be smaller and therefore will require less energy to maintain indoor comfort. In the outdoor play areas, solar heating in the winter and swing seasons will be desired to improve outdoor thermal comfort, while in the summers it should be avoided. Finally, the expanse of flat, unshaded roof area, and the amount of solar heat hitting this surface, provides the potential for energy generation through the placement of solar photo-voltaic panels or solar water heaters on the roof.

option 1-Renovation: exterior walls

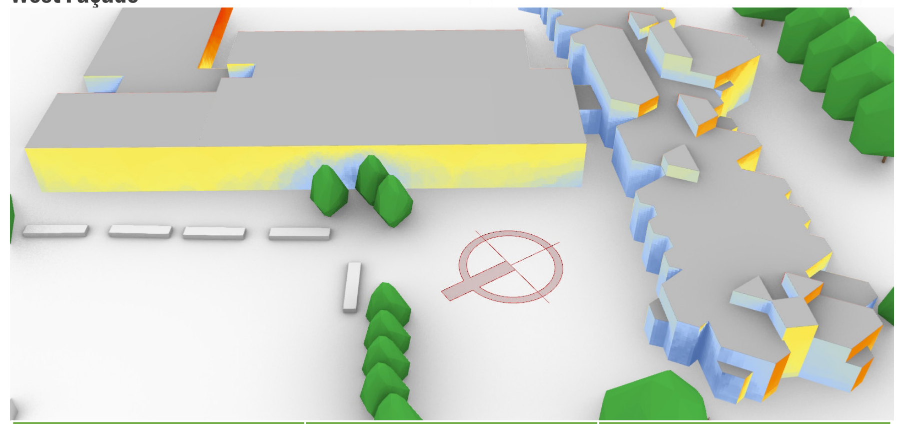


South Façade



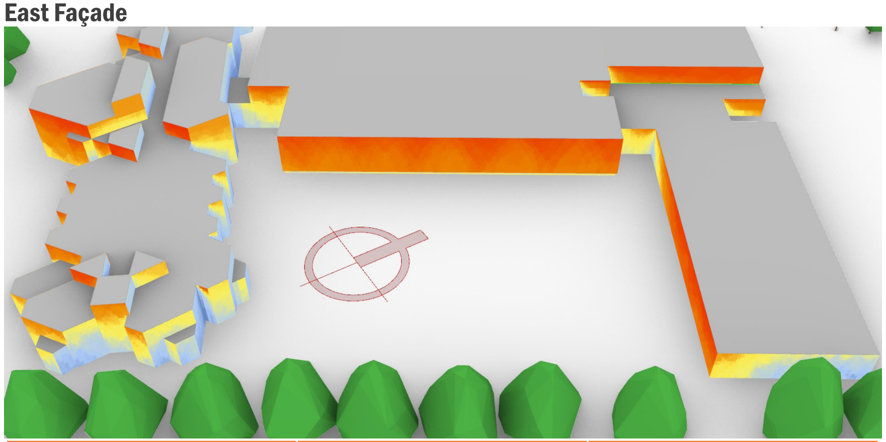
SEASON	TOTAL RADIATION	RADIATION X SQFT
COLD SEASON	1,265,100 kWh	33.77 kWh
WARM SEASON	742,992 kWh	19.83kWh
TOTAL YEARLY RADIATION: 2,008,092 kWh		
TOTAL YEARLY RADIATION PER SQFT: 53.60 kWh		

West Façade



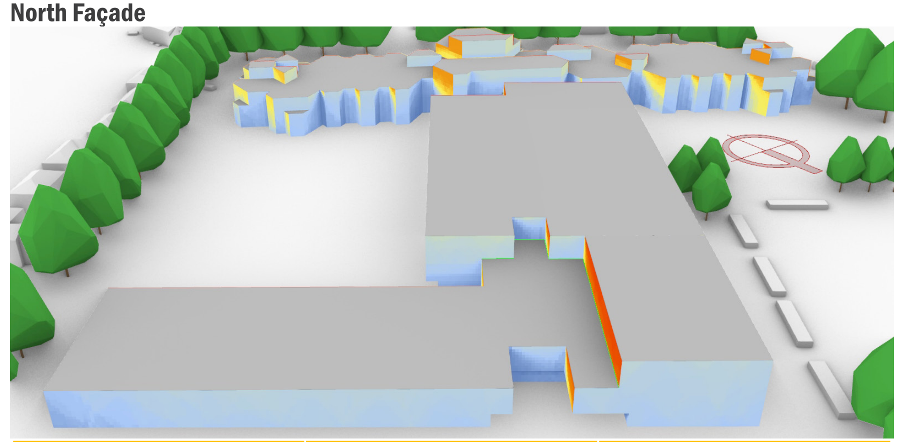
SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	550,758 kWh	20.14 kWh
WARM SEASON	490,957 kWh	17.96 kWh
TOTAL YEARLY RADIATION: 1,041,715 kWh		
TOTAL YEARLY RADIATION PER SQFT: 38.10 kWh		

East Façade



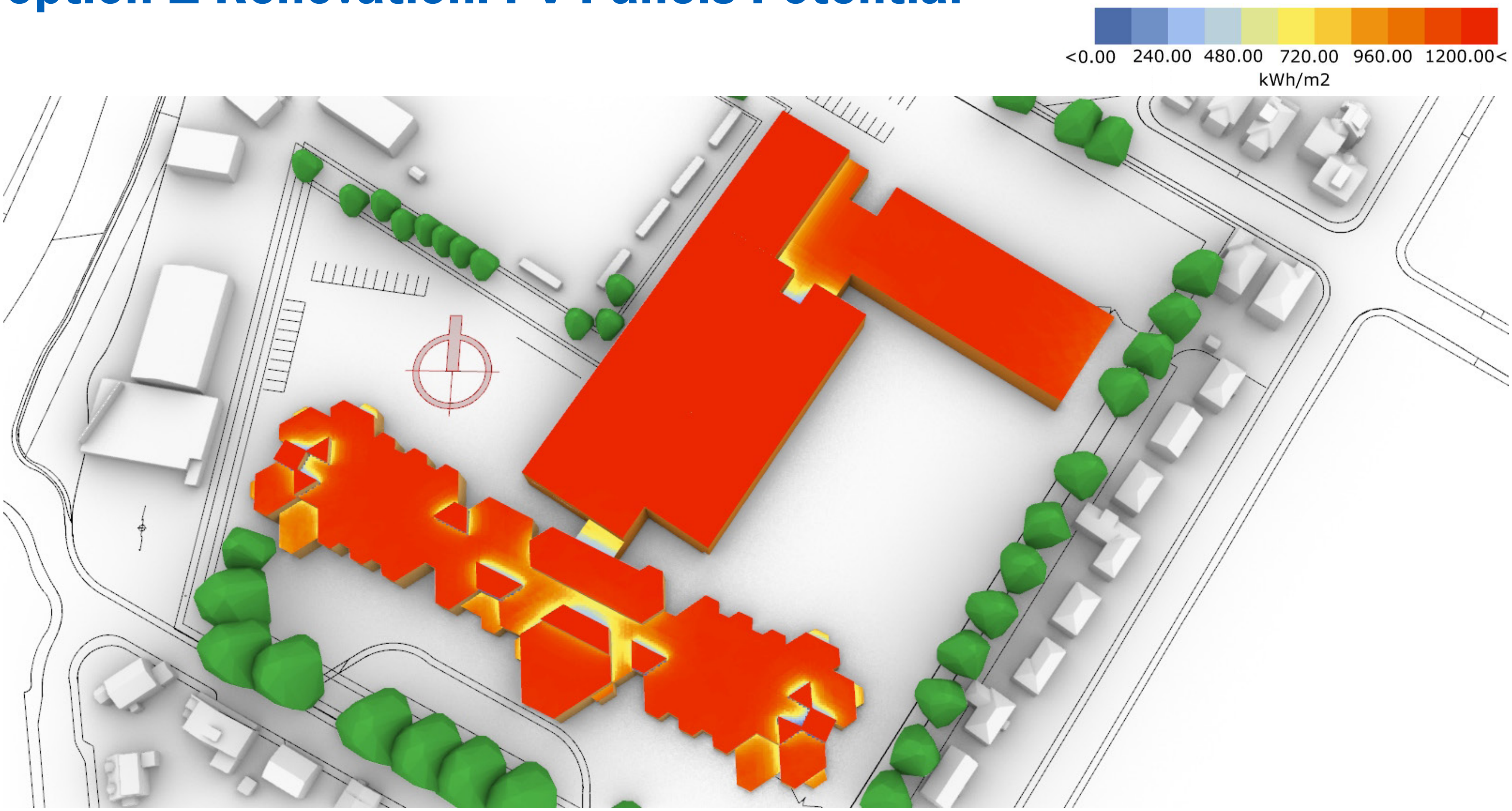
SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	802,155 kWh	31.92 kWh
WARM SEASON	478,921 kWh	19.05 kWh
TOTAL YEARLY RADIATION: 1,281,076 kWh		
TOTAL YEARLY RADIATION PER SQFT: 50.97 kWh		

North Façade



SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	464,602 kWh	11.27 kWh
WARM SEASON	438,871 kWh	10.64 kWh
TOTAL YEARLY RADIATION: 903,473 kWh		
TOTAL YEARLY RADIATION PER SQFT: 21.91 kWh		

option 1-Renovation: PV Panels Potential



SEASON	RADIATION	RADIATION X SQFT
WARM SEASON	6,835,900 kWh	55.16 kWh
COLD SEASON	8,019,000 kWh	64.71 kWh

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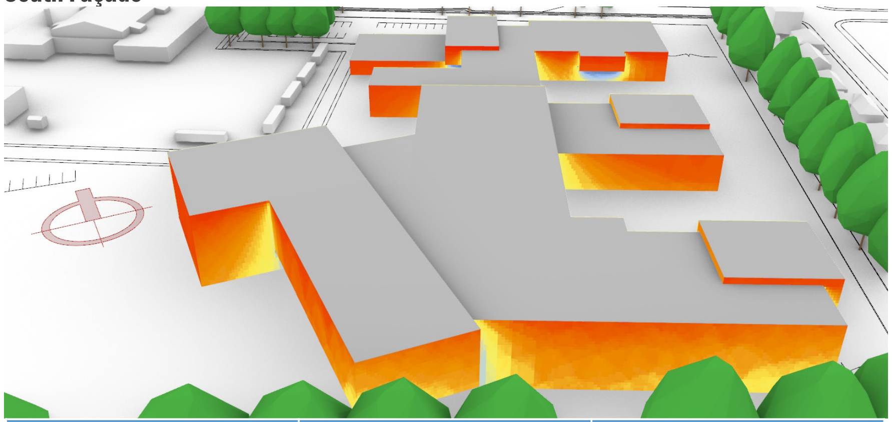
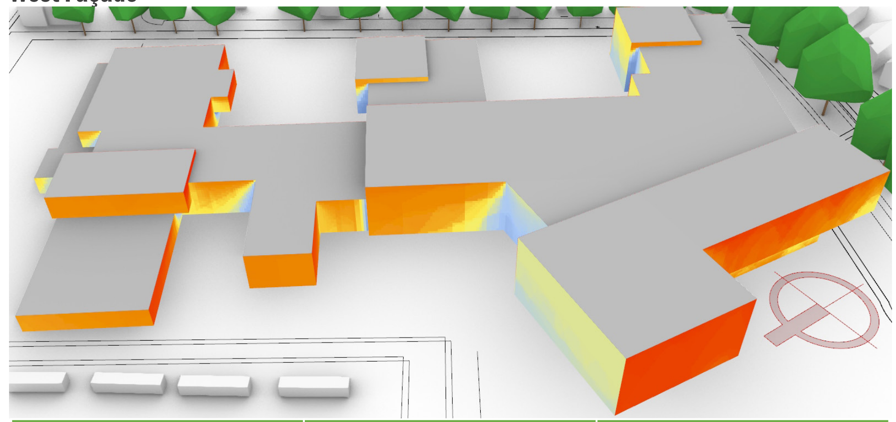
Option 2-Neighborhoods: Exterior Walls

South Façade



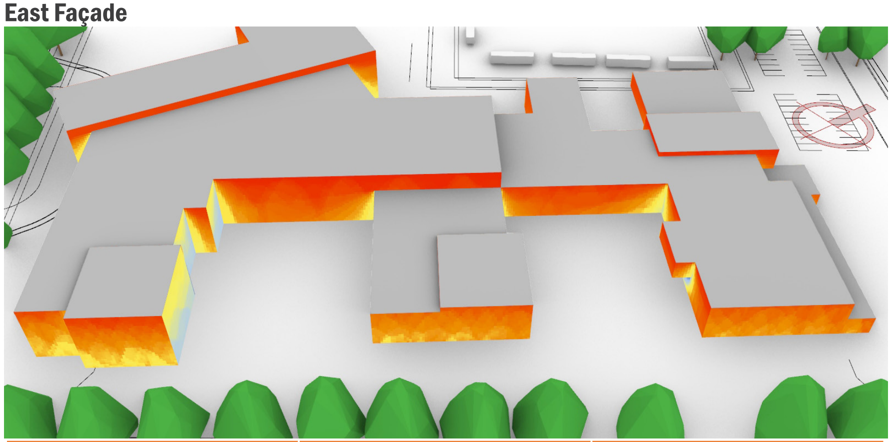
SEASON	TOTAL RADIATION	RADIATION X SQFT
COLD SEASON	789,671 kWh	36.60 kWh
WARM SEASON	426,898 kWh	19.78 kWh
TOTAL YEARLY RADIATION: 1,216,569 kWh		
TOTAL YEARLY RADIATION PER SQFT: 56.38 kWh		

West Façade



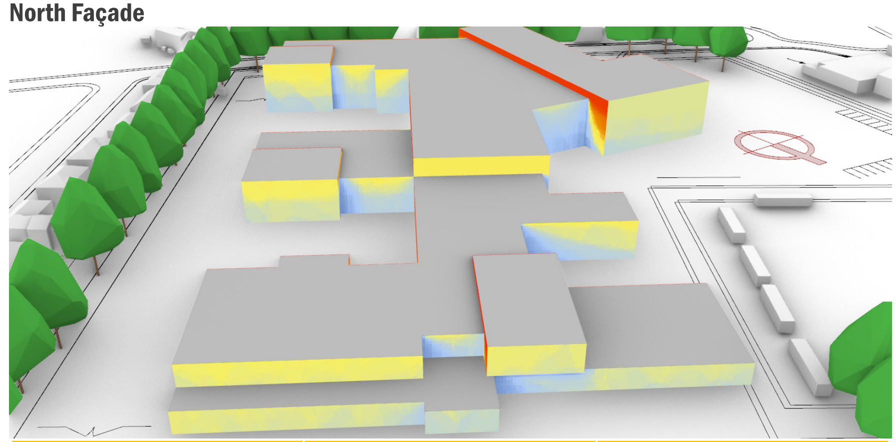
SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	519,111 kWh	22.66 kWh
WARM SEASON	467,112 kWh	20.39 kWh
TOTAL YEARLY RADIATION: 986,223 kWh		
TOTAL YEARLY RADIATION PER SQFT: 43.05 kWh		

East Façade



SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	792,107 kWh	34.88 kWh
WARM SEASON	515,287 kWh	22.69 kWh
TOTAL YEARLY RADIATION: 1,307,394 kWh		
TOTAL YEARLY RADIATION PER SQFT: 57.57 kWh		

North Façade



SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	295,406 kWh	10.03 kWh
WARM SEASON	280,919 kWh	9.54 kWh
TOTAL YEARLY RADIATION: 576,325 kWh		
TOTAL YEARLY RADIATION PER SQFT: 19.57 kWh		

Option 2-Neighborhoods: PV Panels Potential

SEASON	TOTAL RADIATION	RADIATION X SQFT
WARM SEASON	6,424,800 kWh	56.41 kWh
COLD SEASON	7,568,400 kWh	66.63 kWh

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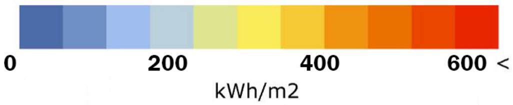
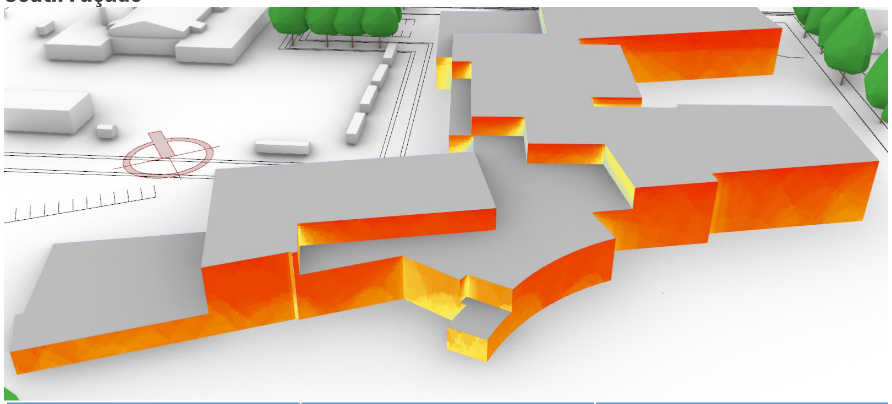
option 3-Grand Court: Exterior Walls

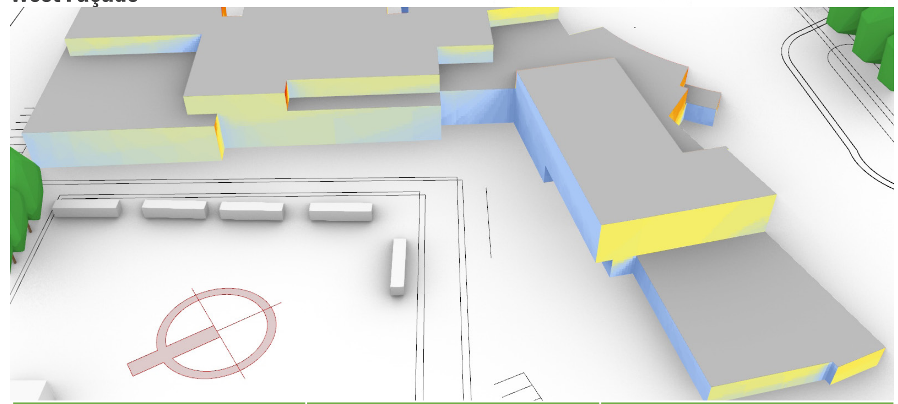


South Façade



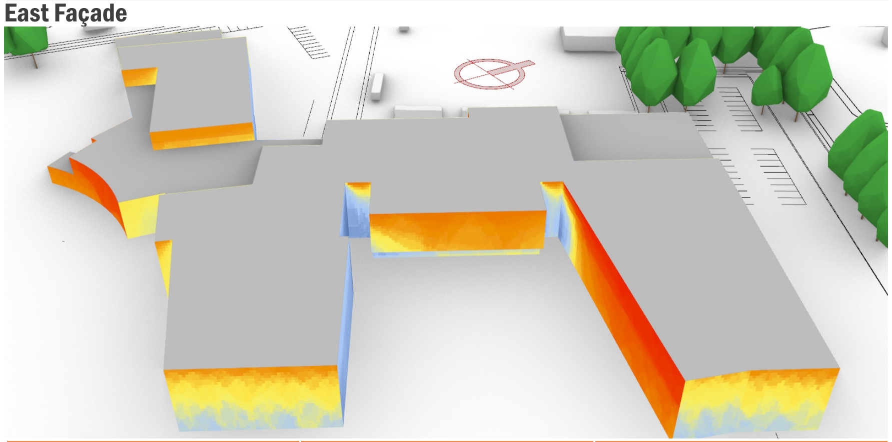
SEASON	TOTAL RADIATION	RADIATION X SQFT
COLD SEASON	1,432,200 kWh	52.05 kWh
WARM SEASON	653,289 kWh	23.74 kWh
TOTAL YEARLY RADIATION: 2,085,489 kWh		
TOTAL YEARLY RADIATION PER SQFT: 75.79 kWh		

West Façade



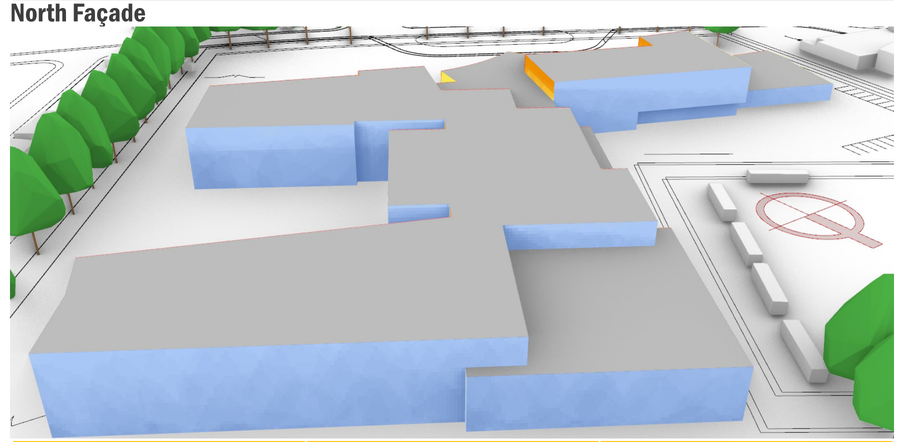
SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	575,703 kWh	24.21 kWh
WARM SEASON	496,420 kWh	20.88 kWh
TOTAL YEARLY RADIATION: 1,072,123 kWh		
TOTAL YEARLY RADIATION PER SQFT: 45.09 kWh		

East Façade



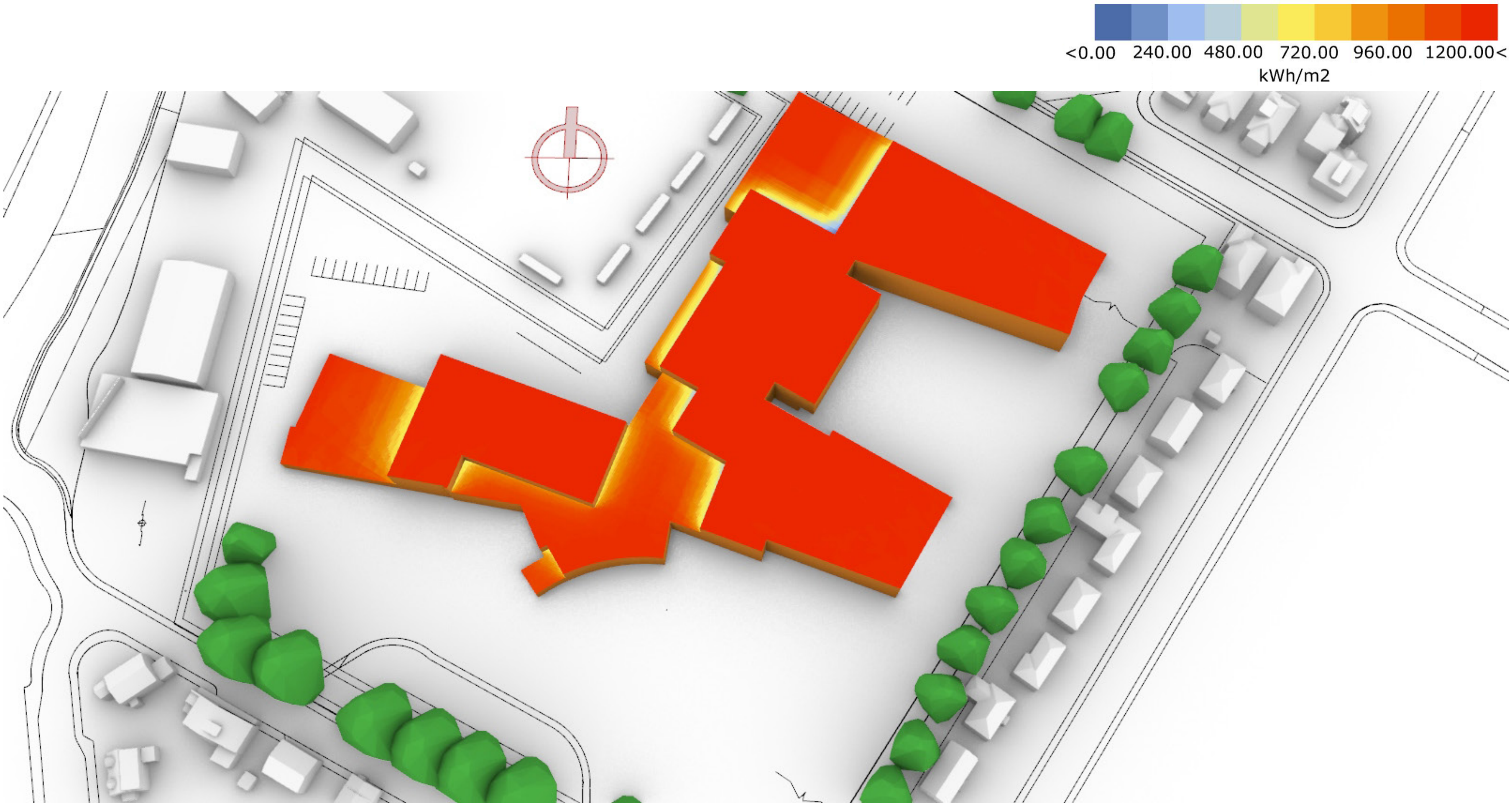
SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	521,638 kWh	28.76 kWh
WARM SEASON	339,012 kWh	18.69 kWh
TOTAL YEARLY RADIATION: 860,650 kWh		
TOTAL YEARLY RADIATION PER SQFT: 47.45 kWh		

North Façade



SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	320,376 kWh	10.88 kWh
WARM SEASON	309,060 kWh	10.50 kWh
TOTAL YEARLY RADIATION: 629,436 kWh		
TOTAL YEARLY RADIATION PER SQFT: 21.38 kWh		

option 3-Grand Court: PV Panels Potential



SEASON	RADIATION	RADIATION X SQFT
WARM SEASON	6,059,200 kWh	57.85 kWh
COLD SEASON	7,590,100 kWh	68.08 kWh

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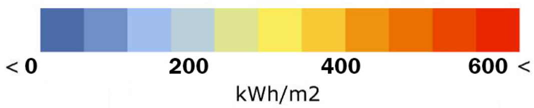
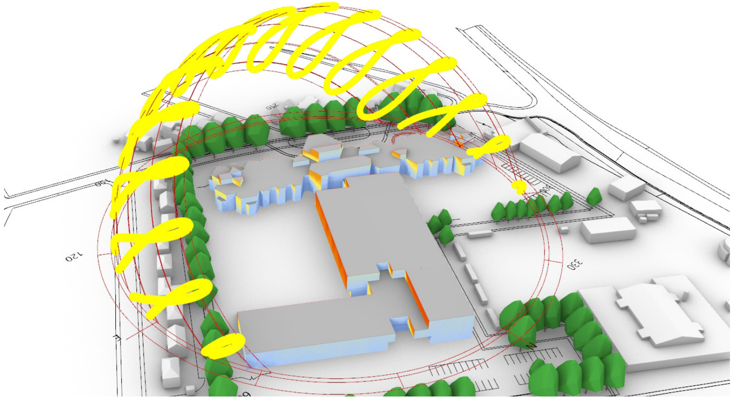
solar analysis: conclusions

Bedford is a predominantly cold city, and therefore solar heating should be prioritized during the cold season of the year. The “Renovation” option performs slightly better than the “Grand Court” option during the warm season of the year by limiting solar heat gain through self shading. The “Grand Court” option has, by far, the best performance during the cold season of the year, receiving more than 10% solar heat gains than the other 2 options. In terms of PV Potential, the “Renovation” option receives the highest solar incidence, making it slightly more suitable for solar energy generation than the other two options.

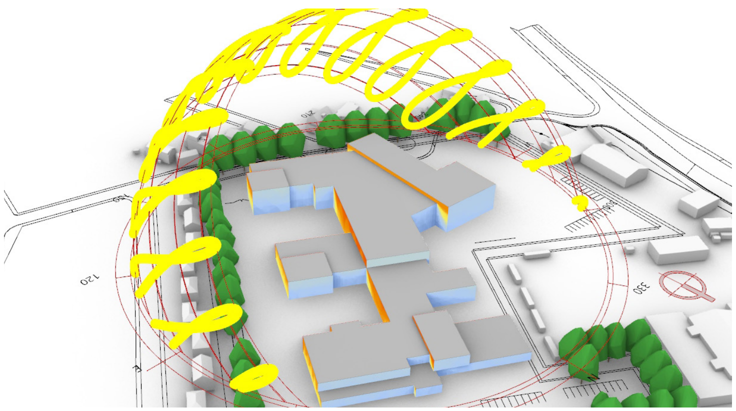




OPTION 1: RENOVATION

SEASON	TOTAL RADIATION	RADIATION/SQ.FT.	DIFFERENCE OPTION 2	DIFFERENCE OPTION 3
Cold	3,082,625 kWh	97.10 kWh	6.78% WORSE	16.2% WORSE
Warm	2,151,741 kWh	67.48 kWh	6.91% BETTER	8.51% BETTER

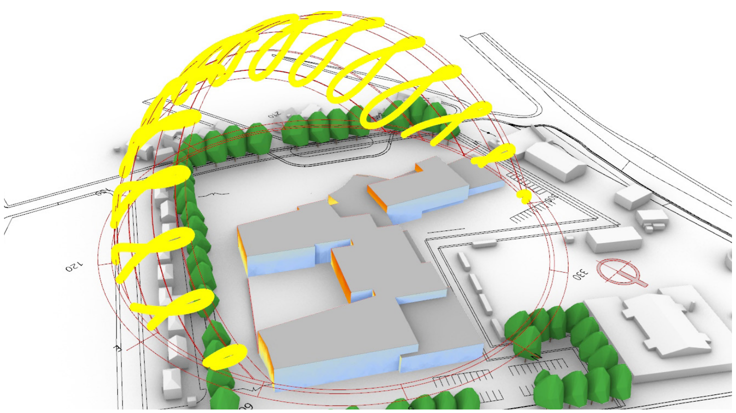
PV POTENTIAL	TOTAL RADIATION	RADIATION/SQ.FT.	DIFFERENCE OPTION 2	DIFFERENCE OPTION 3
YEARLY	14,854,900 kWh	119.87 kWh	2.57% WORSE	4.81% WORSE



OPTION 2: NEIGHBORHOODS

SEASON	TOTAL RADIATION	RADIATION/SQ.FT.	DIFFERENCE OPTION 1	DIFFERENCE OPTION 3
Cold	2,396,295 kWh	104.17 kWh	6.78% BETTER	10.12% WORSE
Warm	1,690,216 kWh	72.49 kWh	6.91% WORSE	1.78% WORSE

PV POTENTIAL	TOTAL RADIATION	RADIATION/SQ.FT.	DIFFERENCE OPTION 1	DIFFERENCE OPTION 3
YEARLY	13,993,200 kWh	123.04 kWh	2.57% BETTER	2.29% WORSE

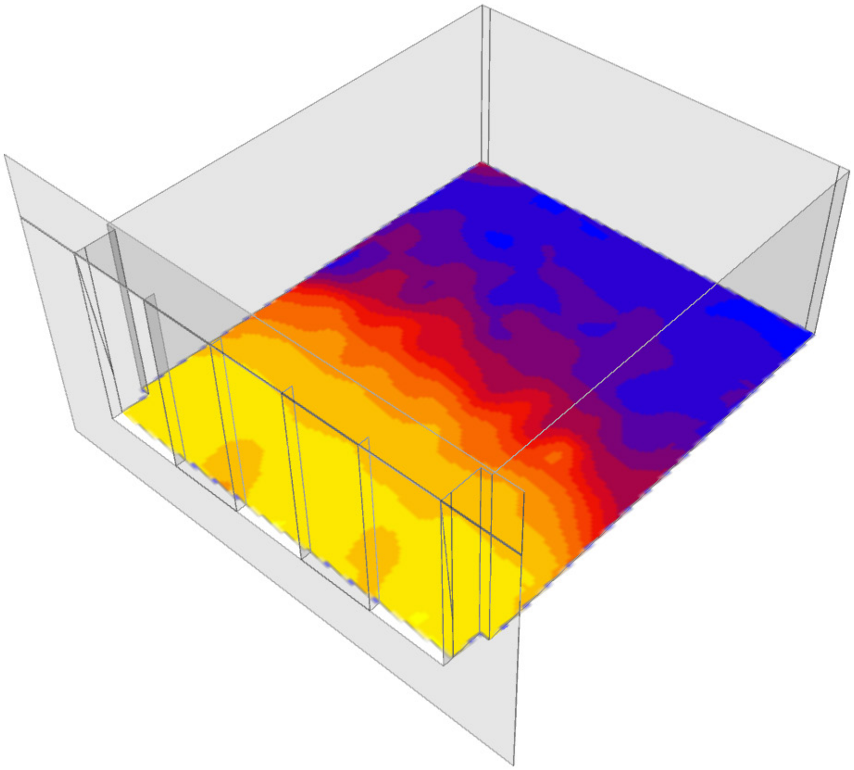


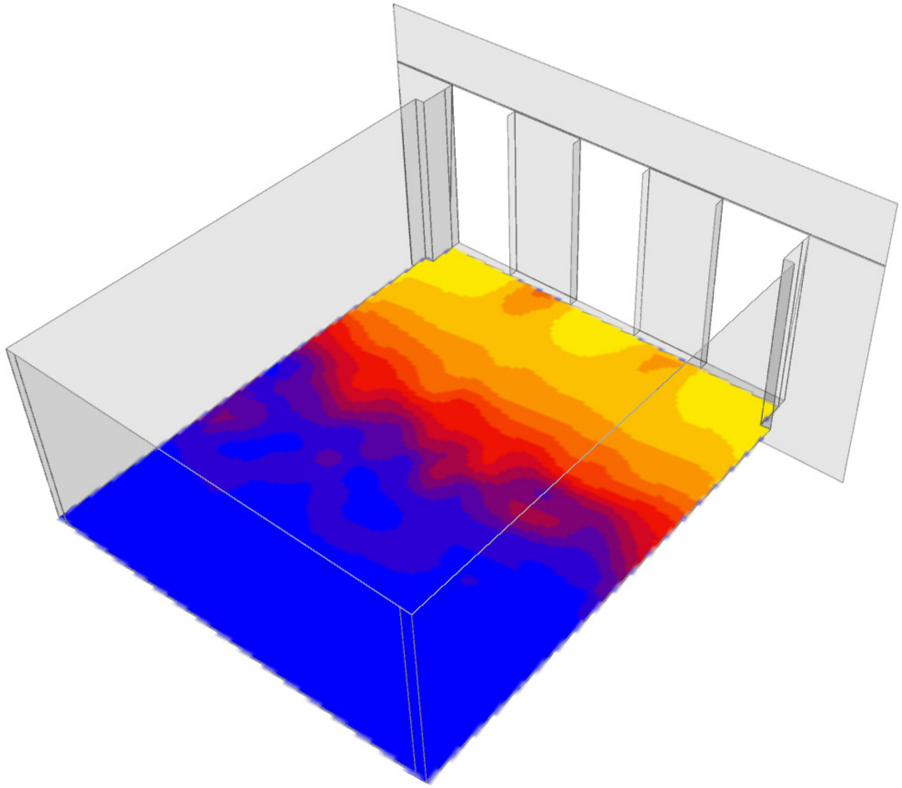
OPTION 3: GRAND COURT

SEASON	TOTAL RADIATION	RADIATION/SQ.FT.	DIFFERENCE OPTION 1	DIFFERENCE OPTION 2
Cold	2,849,917 kWh	115.90 kWh	16.2% BETTER	10.12% BETTER
Warm	1,797,781 kWh	73.81 kWh	8.51% WORSE	1.78% BETTER

PV POTENTIAL	TOTAL RADIATION	RADIATION/SQ.FT.	DIFFERENCE OPTION 1	DIFFERENCE OPTION 2
YEARLY	13,649,300 kWh	125.93 kWh	4.81% BETTER	2.29% BETTER

classroom analysis





Massing orientation is a key element to achieving our goal of Net-Zero-Energy. Making sure the building is oriented properly can improve the amount of useful daylight hours in core learning spaces, while reducing glare exposure. This can also lead to significant energy savings through reductions in heating and cooling loads. To achieve these targets, classrooms should be oriented facing North and South whenever possible.

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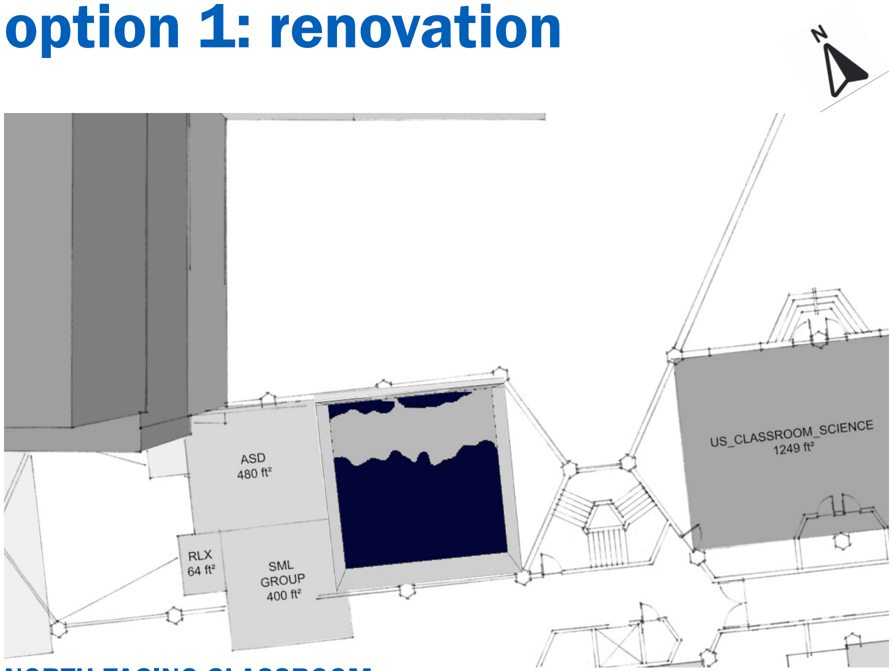
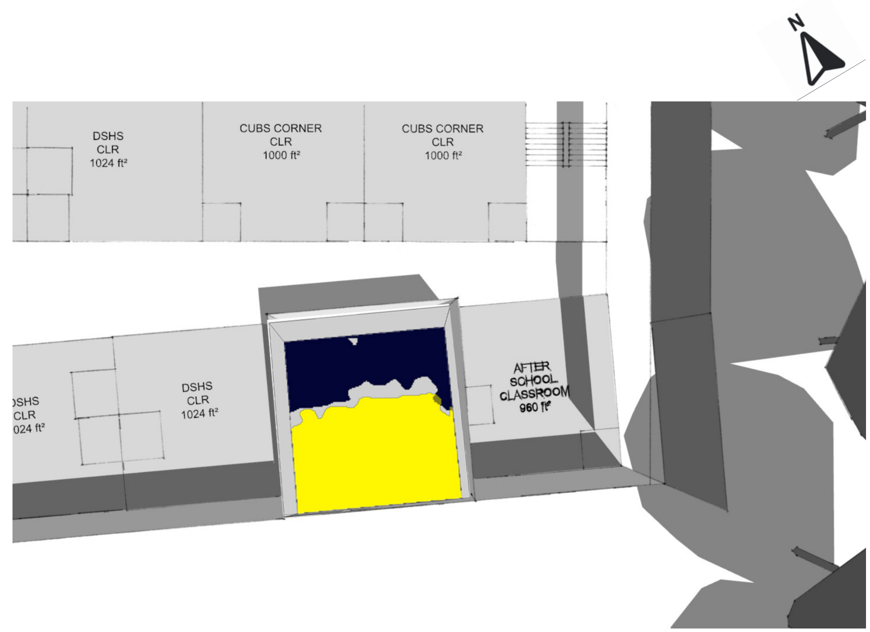
option 1: renovation

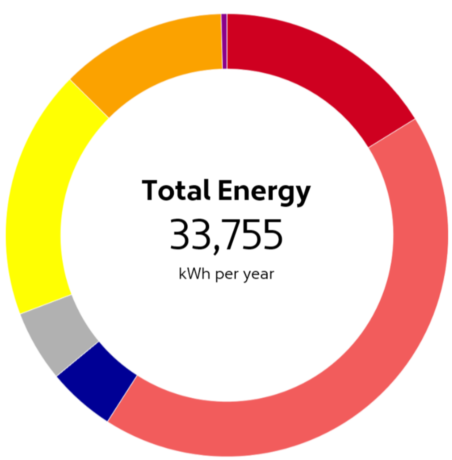


NORTH FACING CLASSROOM



SOUTH FACING CLASSROOM

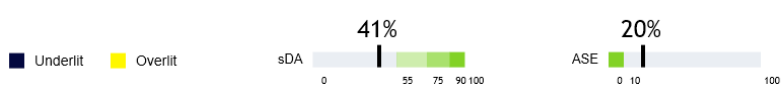
Annual Energy Use



Segment	kWh per year	% of total use
Heating	**19,942**	**59 %**
AHU	5,464	16 %
Zones	14,478	43 %
Humidification	0	0 %
Cooling	**1,664**	**5 %**
AHU	1,664	5 %
Heat Rejection	0	0 %
Zones	0	0 %
Fans	**1,756**	**5 %**
AHU	1,756	5 %
Zones	0	0 %
Interior	**10,250**	**30 %**
Lighting	6,150	18 %
Equipment	4,100	12 %
Pumps	**143**	**0 %**

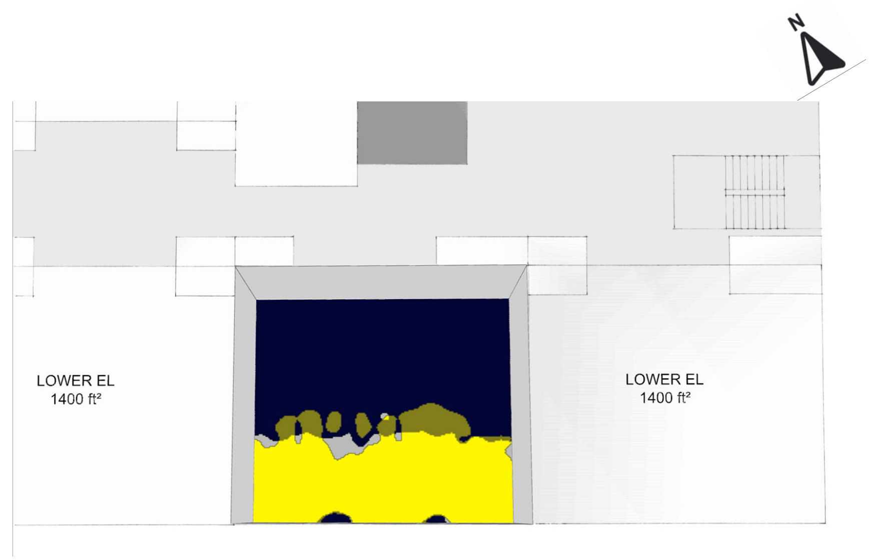
EUI:

54 KBTU/SQ FT/YEAR



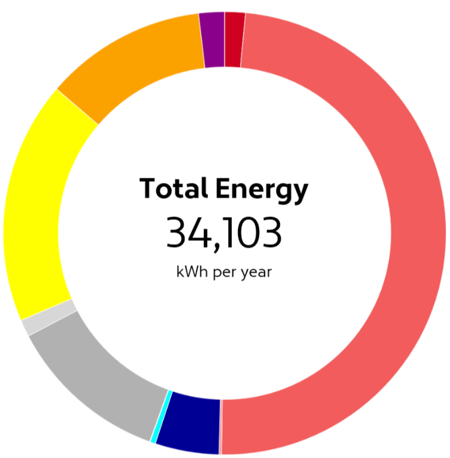
option 2: neighborhoods

NORTH FACING CLASSROOM



SOUTH FACING CLASSROOM

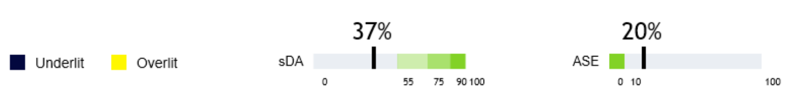
Annual Energy Use



Segment	kWh per year	% of total use
Heating	**17,189**	**50 %**
AHU	516	2 %
Zones	16,612	49 %
Humidification	61	0 %
Cooling	**1,737**	**5 %**
AHU	1,590	5 %
Heat Rejection	134	0 %
Zones	13	0 %
Fans	**4,455**	**13 %**
AHU	4,033	12 %
Zones	422	1 %
Interior	**10,080**	**30 %**
Lighting	6,048	18 %
Equipment	4,032	12 %
Pumps	**642**	**2 %**

EUI:

49 KBTU/SQ FT/YEAR



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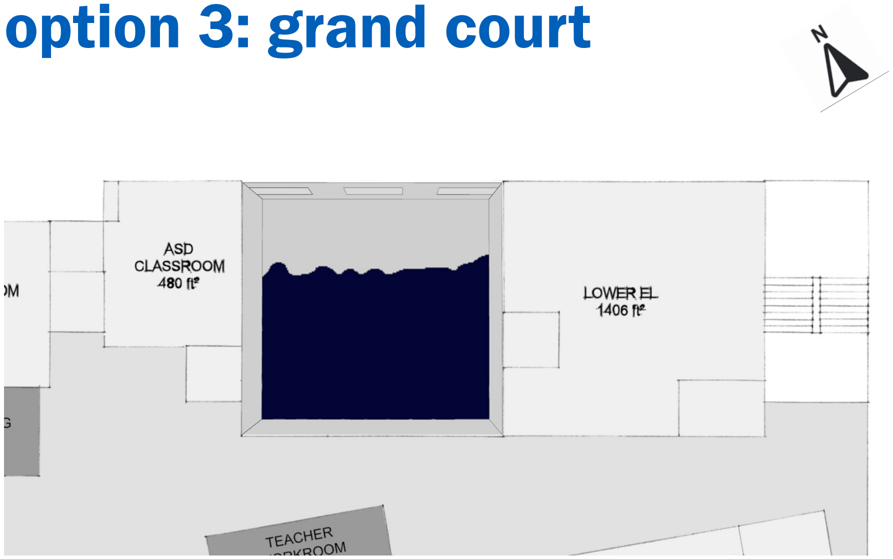
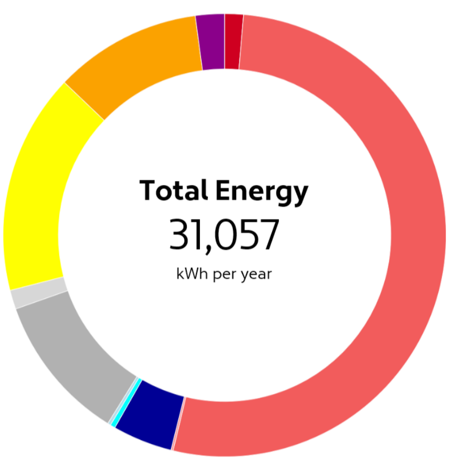
option 3: grand court



NORTH FACING CLASSROOM

SOUTH FACING CLASSROOM

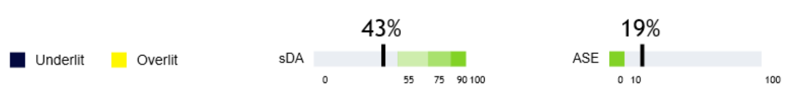
Annual Energy Use



Segment	kWh per year	% of total use
Heating	**16,739**	**54 %**
AHU	425	1 %
Zones	16,264	52 %
Humidification	50	0 %
Cooling	**1,535**	**5 %**
AHU	1,352	4 %
Heat Rejection	113	0 %
Zones	70	0 %
Fans	**3,773**	**12 %**
AHU	3,342	11 %
Zones	431	1 %
Interior	**8,352**	**27 %**
Lighting	5,011	16 %
Equipment	3,341	11 %
Pumps	**658**	**2 %**

EUI:

47 KBTU/SQ FT/YEAR

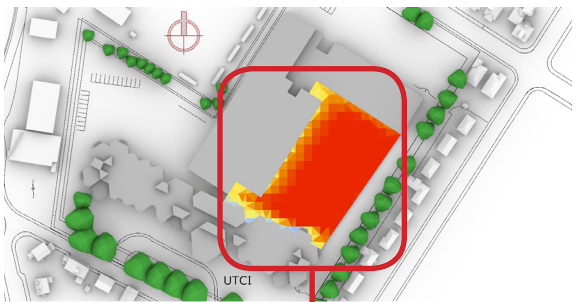


OUTDOOR THERMAL COMFORT:MICRO CLIMATE MAPS

Looking holistically at outdoor thermal comfort (taking into account wind and solar impacts), low temperatures are desired for the warm season of the year, while high temperatures are desired for the cold season of the year. The best combination between comfortable temperatures in both warm and cold seasons of the year happens in the “Grand Court” Option.

OPTION 1: Renovation

WARM SEASON



Thermal Sensation: 78.8°F

OPTION 2: Neighborhoods

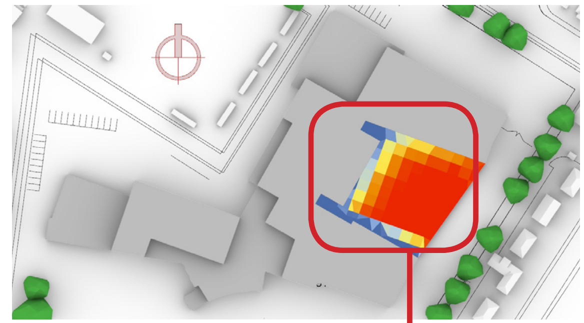
WARM SEASON

Thermal Sensation: 78.3°F

Thermal Sensation: 78.9°F

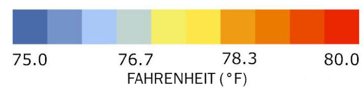
OPTION 3: Grand Court

WARM SEASON

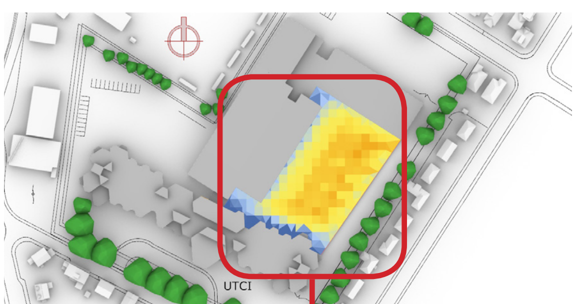


Thermal Sensation: 77.8°F

WARM SEASON TEMPERATURE SCALE:



COLD SEASON (Option 1)



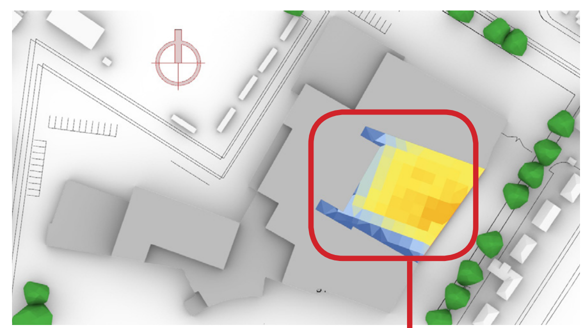
Thermal Sensation: 39.8°F

COLD SEASON (Option 2)

Thermal Sensation: 39.3°F

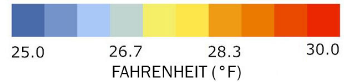
Thermal Sensation: 39.6°F

COLD SEASON (Option 3)



Thermal Sensation: 39.9°F

COLD SEASON TEMPERATURE SCALE:

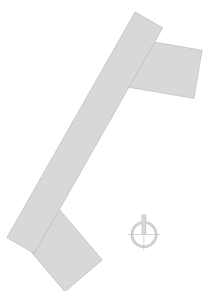


PERKINS — EASTMAN

CLASSROOM WINGS CONFIGURATION

RANKING	SOUTH WING ROTATION	NORTH WING ROTATION	DISTANCE BETWEEN WING	SOLAR RADIATION COLD SEASON / sqft	SOLAR RADIATION WARM SEASON / sqft
#1	20°	-20°	200 ft	66.57 kWh	113.02 kWh
#2	20°	-20°	160 ft	66.57 kWh	113.03 kWh
#3	20°	-20°	120 ft	66.52 kWh	112.93 kWh
#4	20°	-20°	80 ft	66.31 kWh	112.52 kWh
#5	20°	-20°	40 ft	65.98 kWh	112.04 kWh
#6	10°	-20°	200 ft	63.34 kWh	103.30 kWh
#7	10°	-20°	160 ft	63.33 kWh	103.31 kWh
#8	10°	-20°	120 ft	63.25 kWh	103.18 kWh
#9	10°	-20°	80 ft	62.99 kWh	102.76 kWh
#10	10°	-20°	40 ft	62.64 kWh	102.17 kWh

#1



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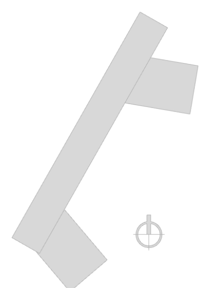

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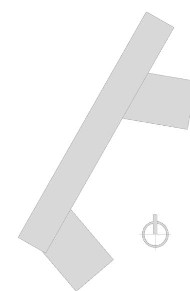

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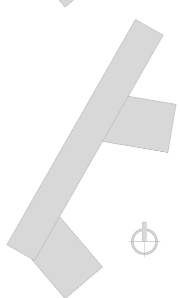

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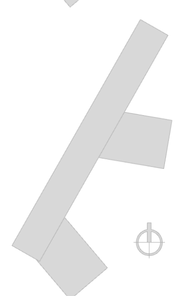

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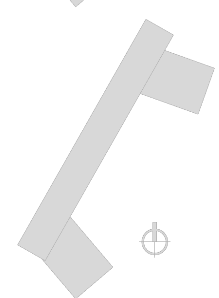
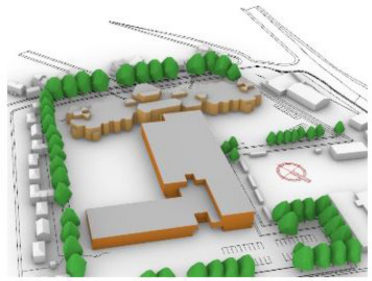
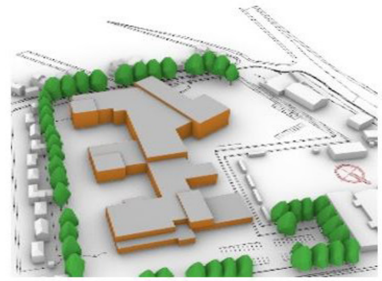
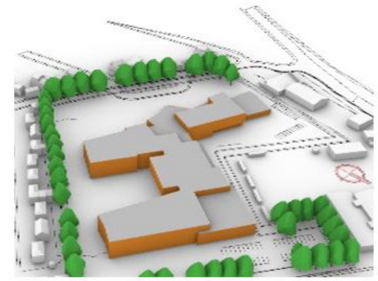


LINK TO INTERACT WITH GEOMETRY: http://tt-acm.github.io/DesignExplorer/?ID=BL_35uvO75

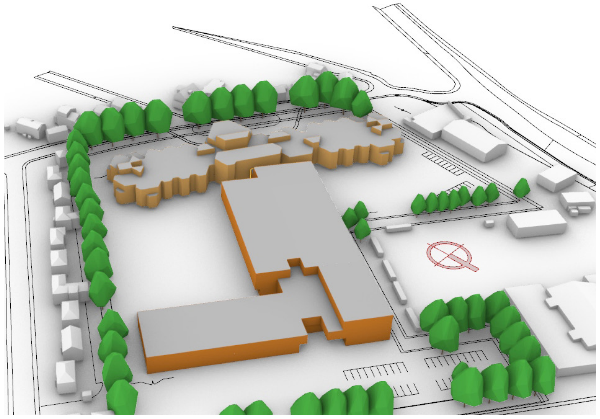
net zero potential - conclusions

LEGEND
Category Performance

● BEST
◐ BETTER
○ GOOD

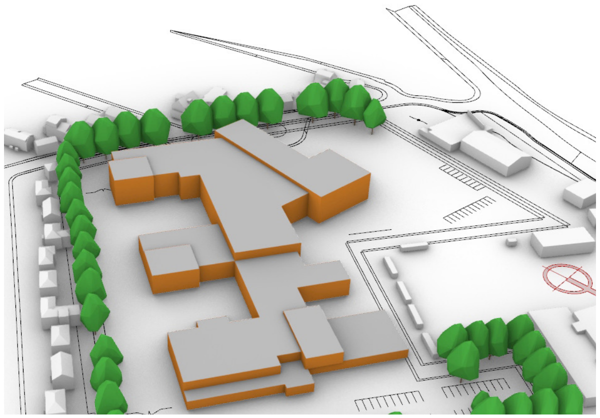
	 RENOVATION	 NEIGHBORHOODS	 GRAND COURT
Passive Heating Potential	○	◐	●
Passive Cooling Potential	●	○	◐
PV Generation Potential	○	◐	●
Outdoor Thermal Comfort	◐	○	●
Interior Daylight Performance	◐	○	●
Annual Energy Use	○	◐	●
Compact Building	○	◐	●

areas calculations



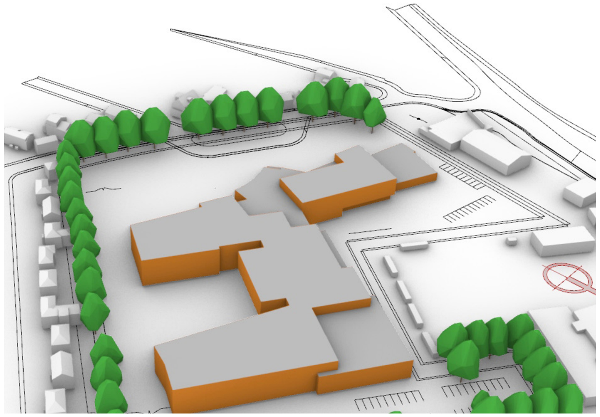
OPTION 1: RENOVATION

- ROOF AREA: 123,922 sq. ft.
- TOTAL FAÇADE AREA: 131,130 sq.ft
  - -SOUTH FAÇADE AREA: 37,458 sq. ft.
  - -WEST FAÇADE AREA: 27,335 sq. ft.
  - -EAST FAÇADE AREA: 25,127 sq. ft.
  - -NORTH FAÇADE AREA: 41,210 sq. ft.



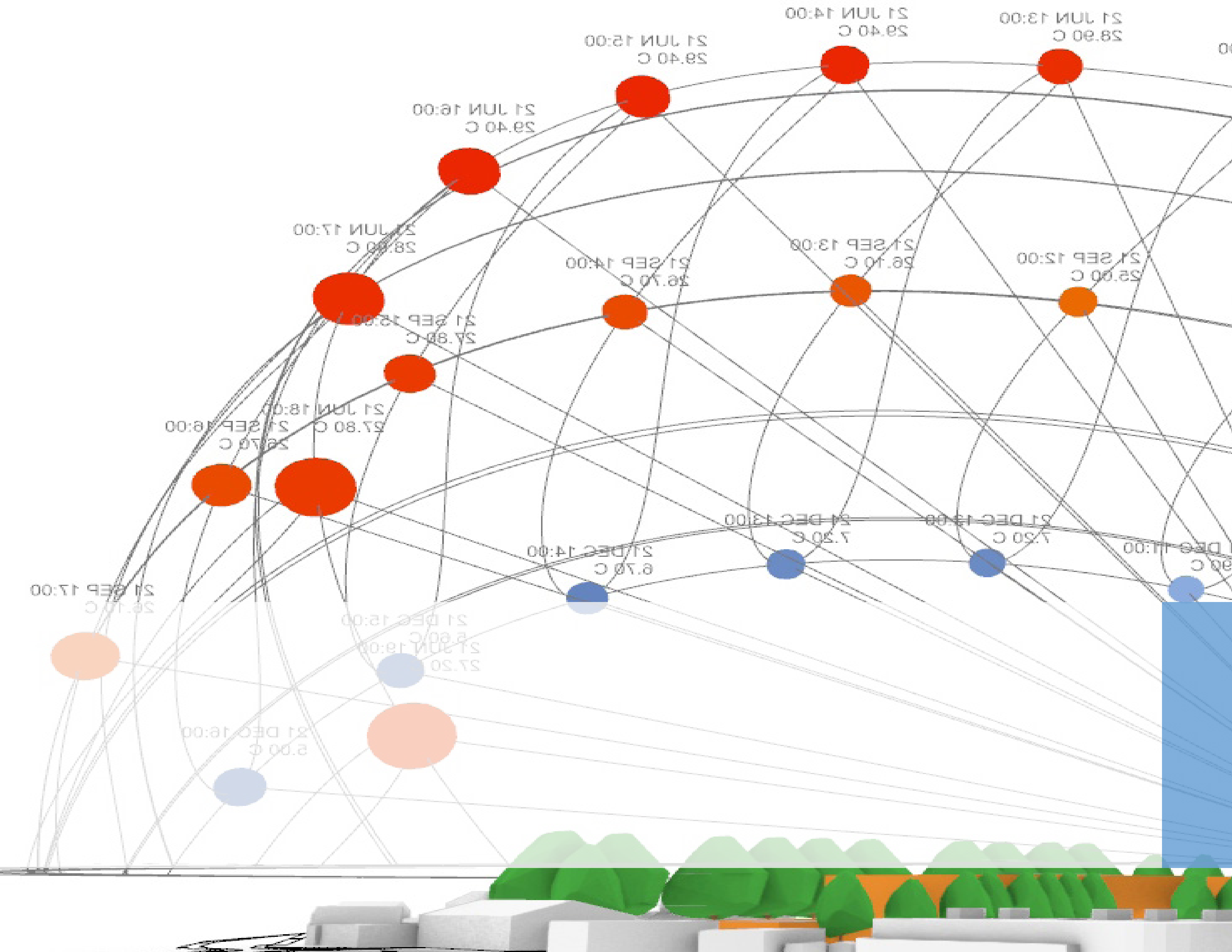
OPTION 2: NEIGHBORHOODS

- ROOF AREA: 111,892 sq. ft.
- TOTAL FAÇADE AREA: 97,319 sq. ft.
  - -SOUTH FAÇADE AREA: 21,573 sq. ft.
  - -WEST FAÇADE AREA: 22,902 sq. ft.
  - -EAST FAÇADE AREA: 22,708 sq.ft
  - -NORTH FAÇADE AREA: 30,134 sq. ft.



OPTION 3: GRAND COURT

- ROOF AREA: 106,578 sq. ft.
- TOTAL FAÇADE AREA: 98,851 sq. ft.
  - -SOUTH FAÇADE AREA: 27,515 sq. ft.
  - -WEST FAÇADE AREA: 23,772 sq. ft.
  - -EAST FAÇADE AREA: 18,135 sq. ft.
  - -NORTH FAÇADE AREA: 29,427 sq. ft.



21 JUN 14:00
29.40 C
21 JUN 13:00
28.90 C
21 JUN 15:00
29.40 C
21 JUN 16:00
29.40 C
21 JUN 17:00
28.90 C
21 SEP 14:00
26.70 C
21 SEP 13:00
26.10 C
21 SEP 12:00
25.00 C
21 SEP 15:00
27.80 C
21 JUN 18:00
27.80 C
21 SEP 16:00
26.70 C
21 DEC 13:00
7.20 C
21 DEC 12:00
7.20 C
21 DEC 14:00
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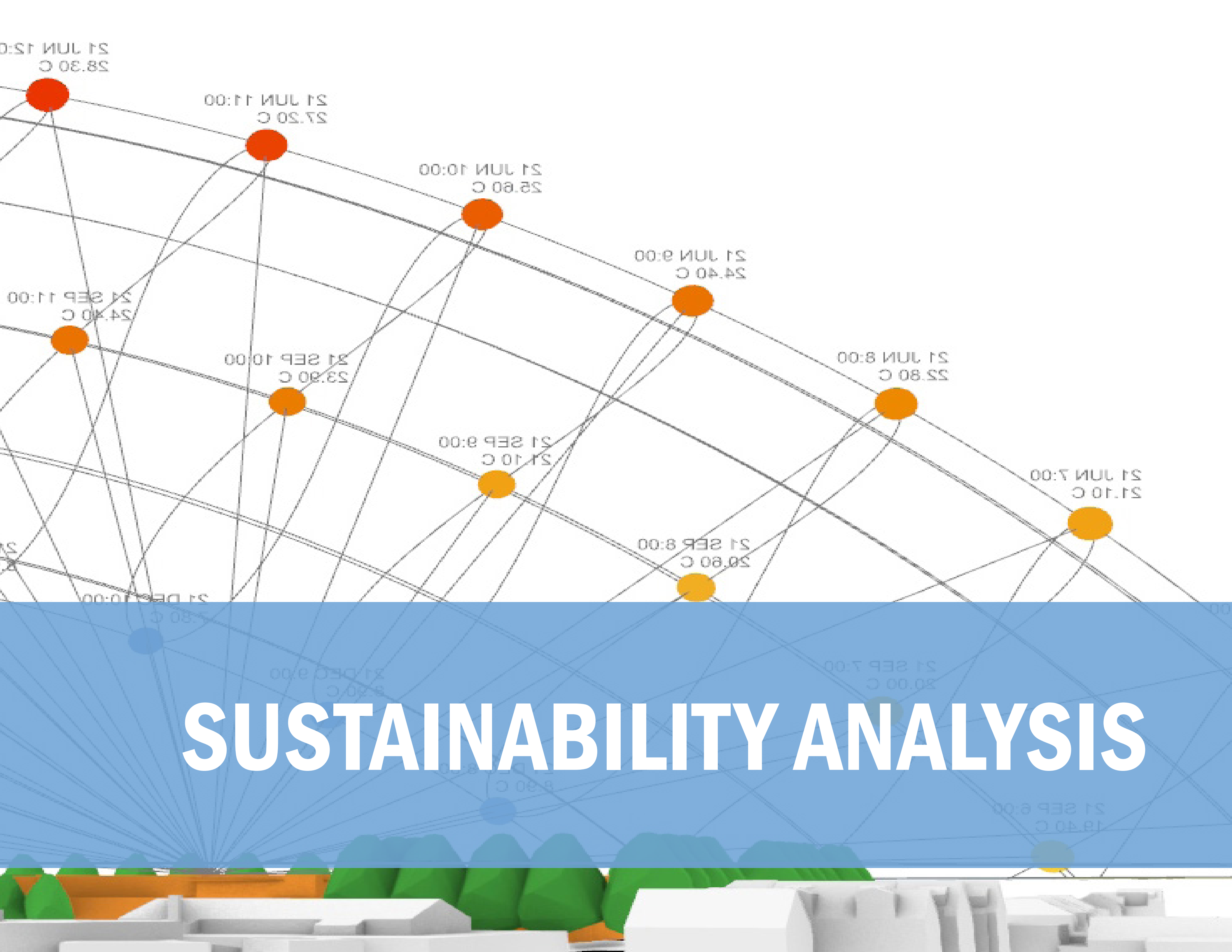
21 JUN 19:00
27.20 C
21 DEC 16:00
5.00 C

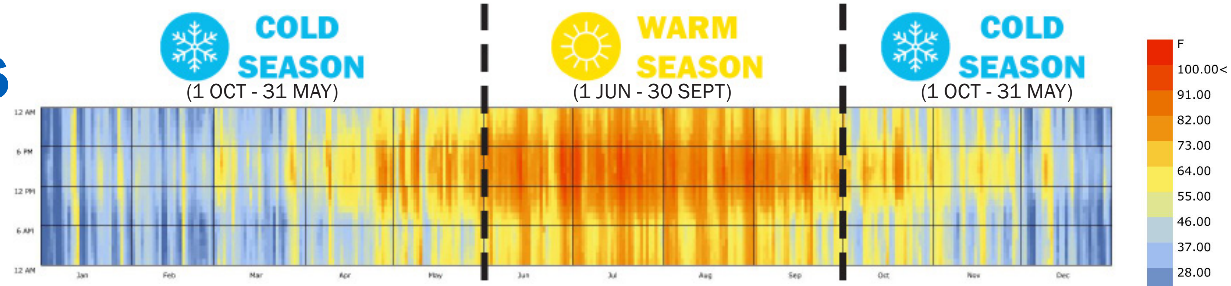


SUSTAINABILITY ANALYSIS

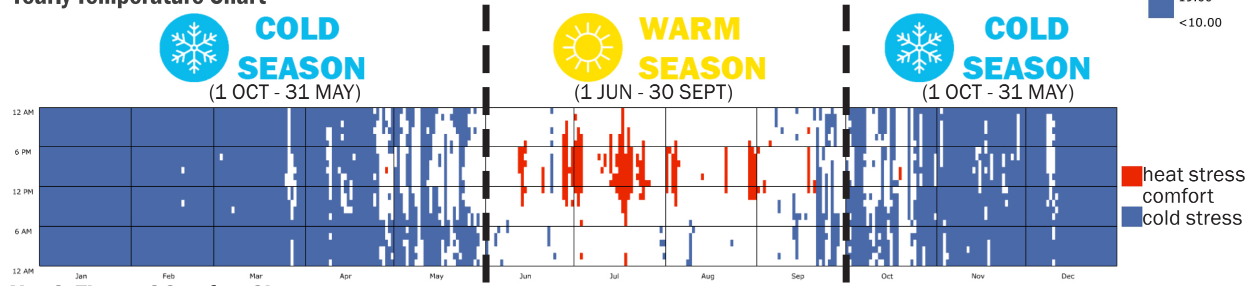
climate analysis

Bedford, MA experiences extreme weather swings, with hot humid summers and cold dry winters. It is therefore challenging to create a thermally comfortable outdoor environment, except in the swing seasons of spring and fall, but even including these seasons the outdoor environment is only comfortable around 5.3% of the year.

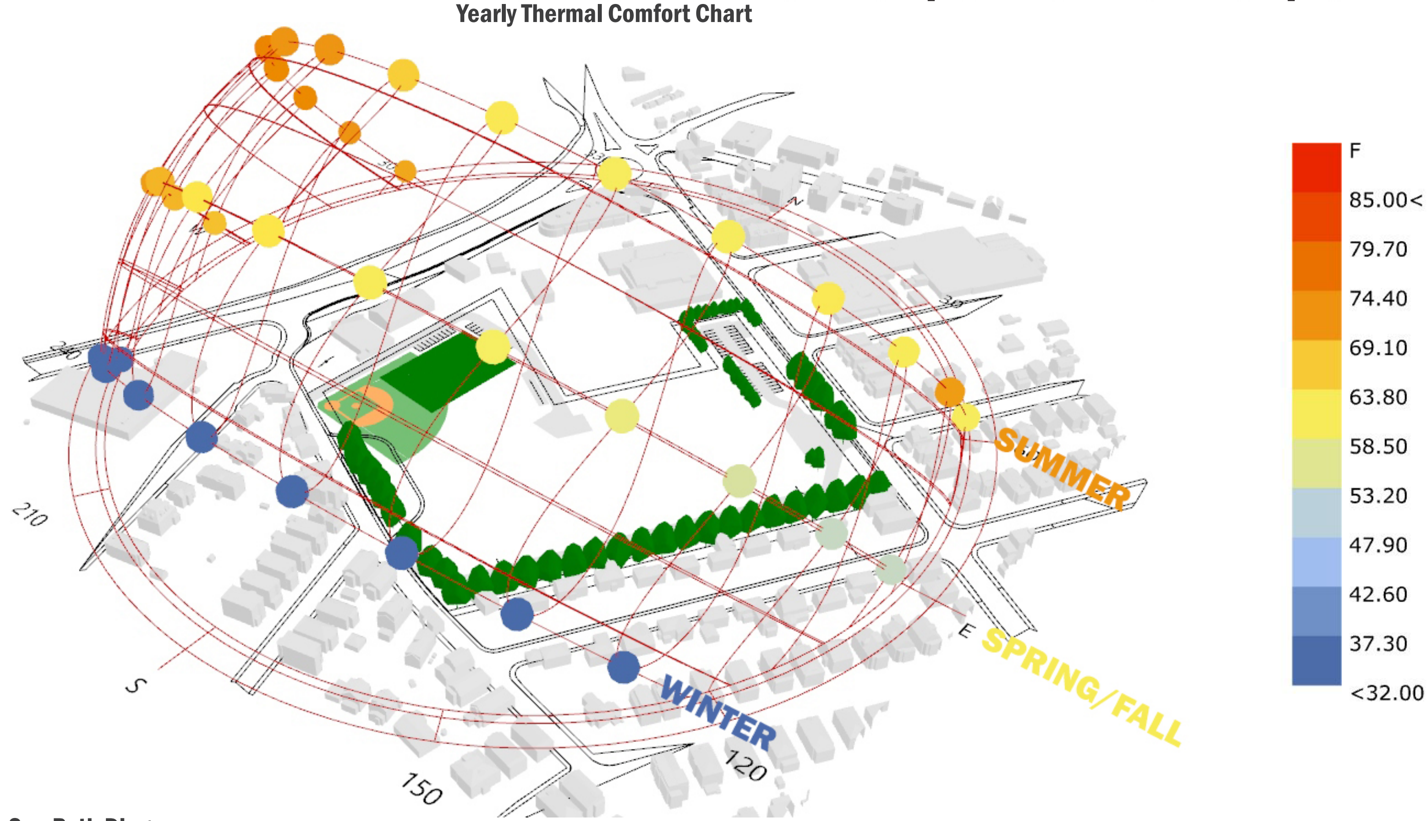
Additional measures for solar and wind control in outdoor spaces should therefore be employed to extend thermal comfort.



Yearly Temperature Chart



Yearly Thermal Comfort Chart



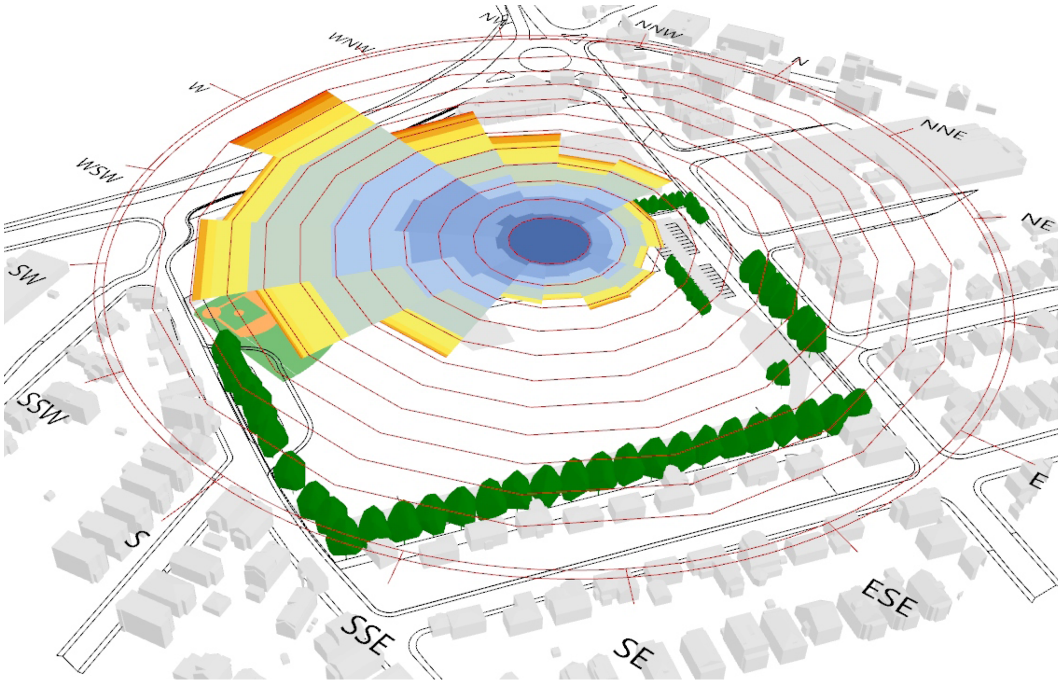
Sun Path Diagram

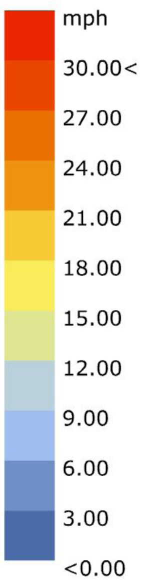
wind analysis

In Bedford, MA, prevailing winds shift by season.

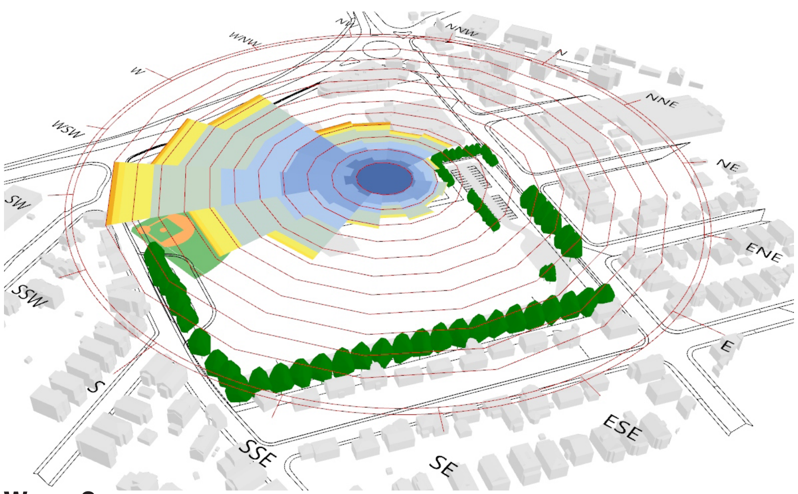
Cold winds tend to come from the west and north-west with relatively high velocity, making outdoor areas that face west relatively inhospitable.

During the warm season, winds come from the south and south-west primarily, especially in the summer months. These breezes are more welcome for ventilation to extend comfort.

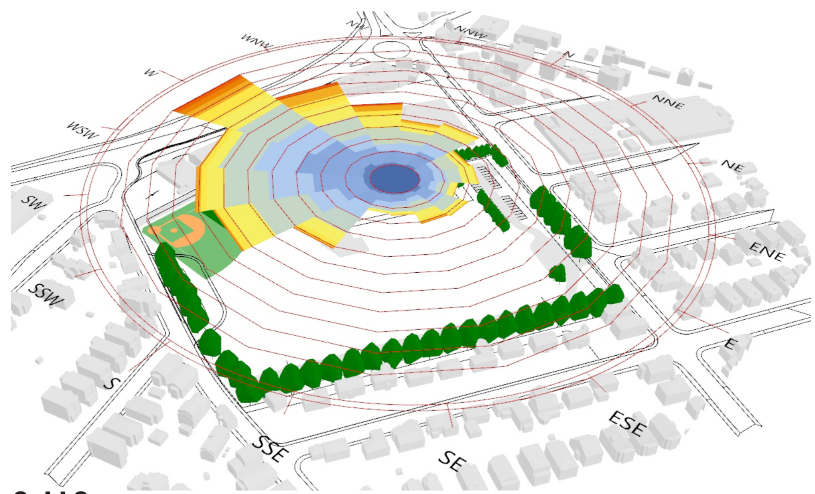




Yearly



Warm Season

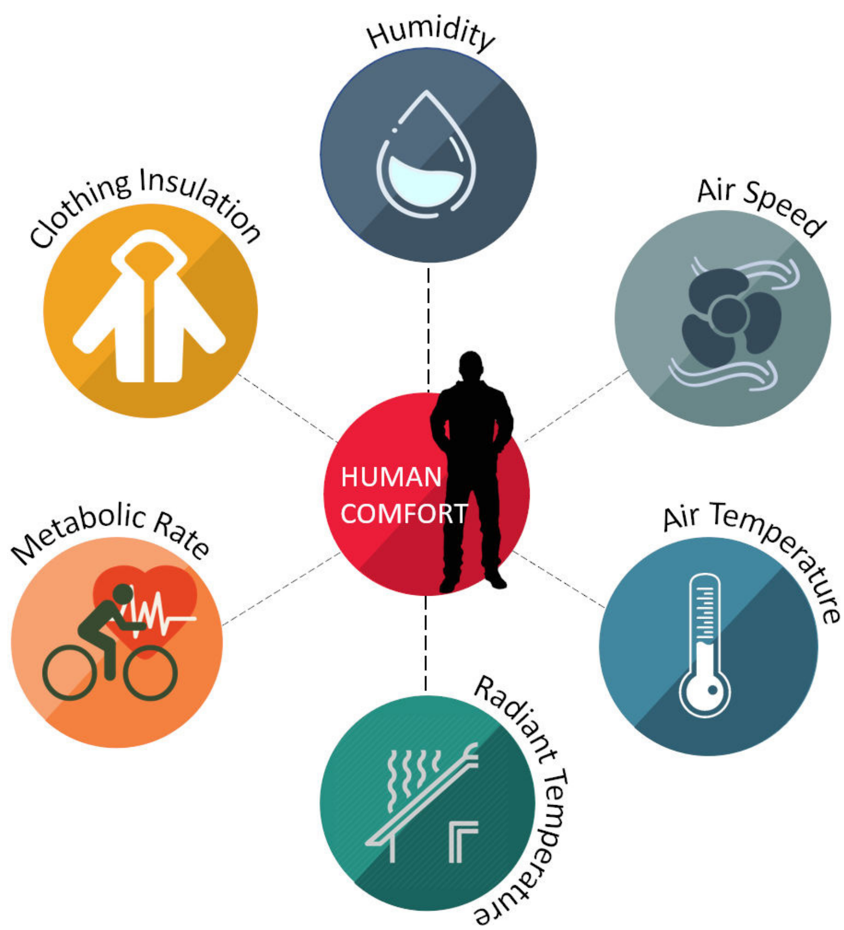


Cold Season

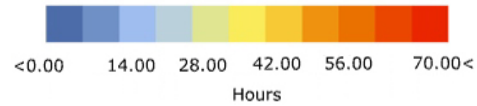
thermal comfort strategies

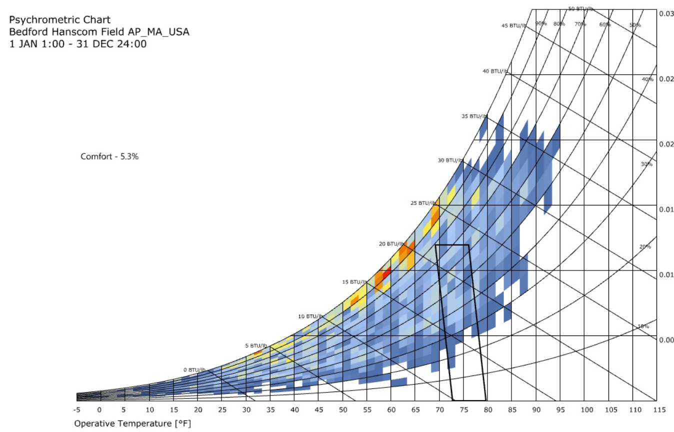
There are several factors that influence thermal comfort, and architecture can play a significant role. The way in which the building is laid out can impact elements such as wind speeds, mean radiant temperature, dry bulb temperature, and the overall thermal sensation of the environment. In a micro-climate urban map, like the one at Bedford, MA, 1°F temperature differentials can have a considerable impact in the thermal comfort of occupants, and affect the way in which they perceives that space throughout the year. It will be important to study options during schematic design for optimizing outdoor and indoor thermal comfort levels during the year to improve the use of the outdoor spaces.

Multiple passive design strategies can have a significant impact in the thermal comfort feeling both inside and outside the building, and might also represent saving in terms cooling and heating loads.

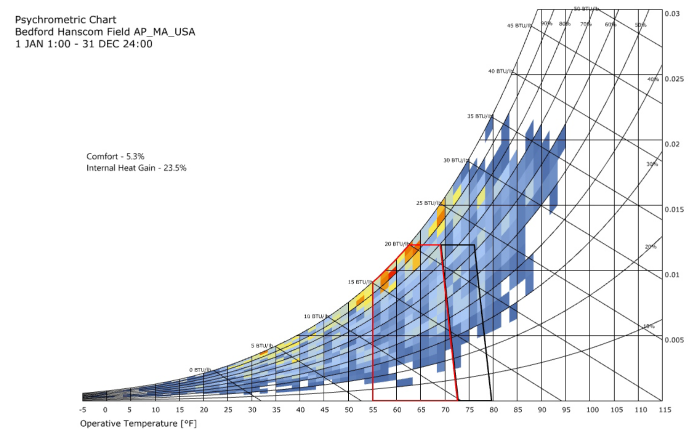


PASSIVE DESIGN STRATEGIES

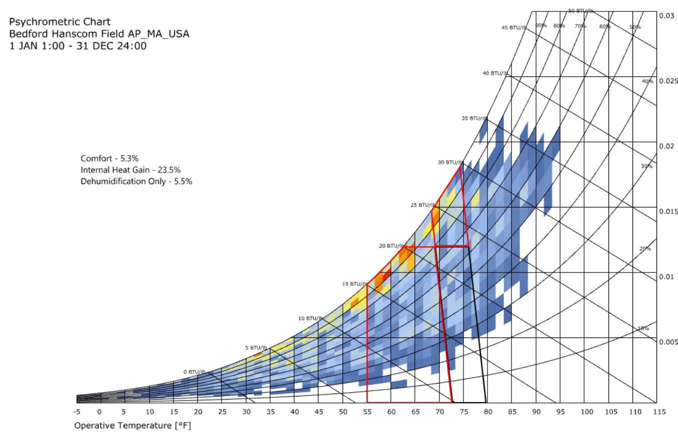




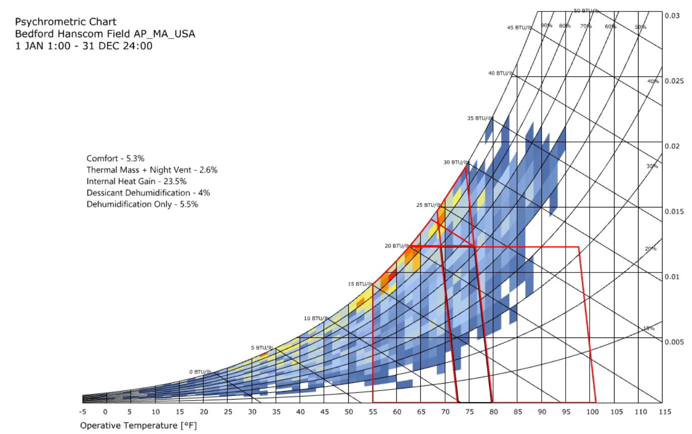
TOTAL THERMAL COMFORT: 5.3%



TOTAL THERMAL COMFORT: 28.10%



TOTAL THERMAL COMFORT: 34.7%



TOTAL THERMAL COMFORT: 36.92%

STRATEGIES LEGEND

- DEHUMIDIFICATION
- INTERNAL HEAT GAINS
- THERMAL MASS

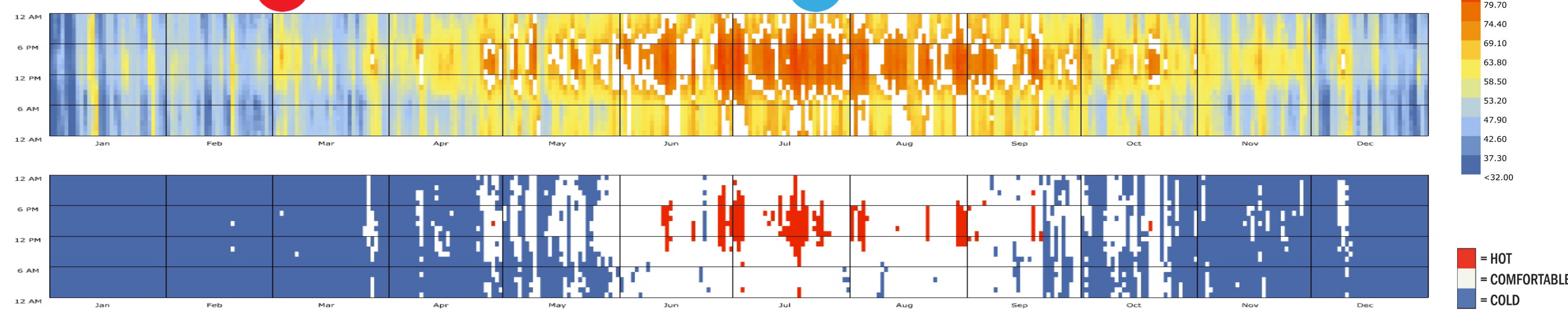
PSYCHROMETRIC CHART

Although mechanical heating and cooling will still be needed to maintain indoor thermal comfort in this climate, passive design strategies can be employed to reduce the amount of mechanical cooling necessary. While passive cooling strategies such as evaporative cooling, cross ventilation, night ventilation, and the use of fans can reduce mechanical cooling needs, the climate predominantly requires heating, so focusing on passive heating strategies can have more impact on energy performance. Passive heating strategies such as utilizing a well insulated and airtight building envelope to capture internal heat gains can provide added comfort for 28% of the year, significantly reducing the need for mechanical heating.

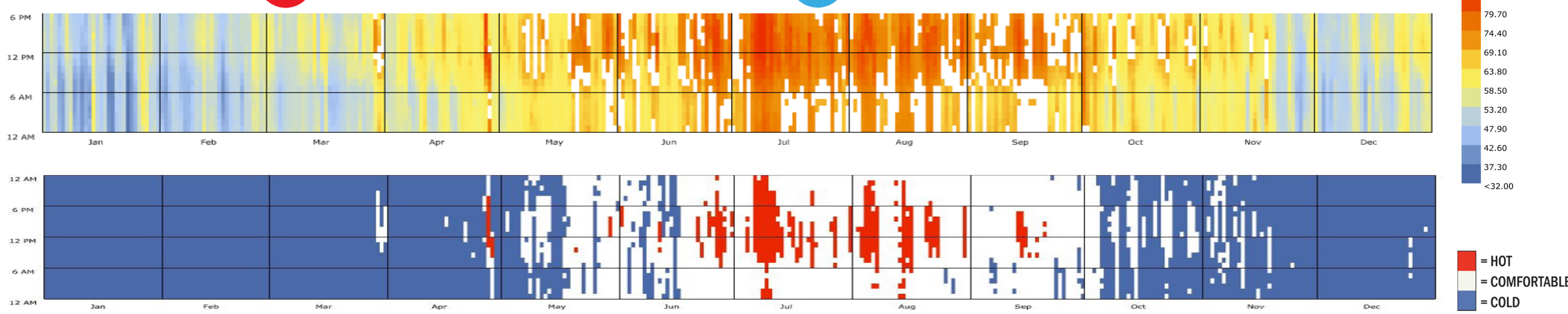
PERKINS — EASTMAN

CLIMATE CHANGE CHARTS

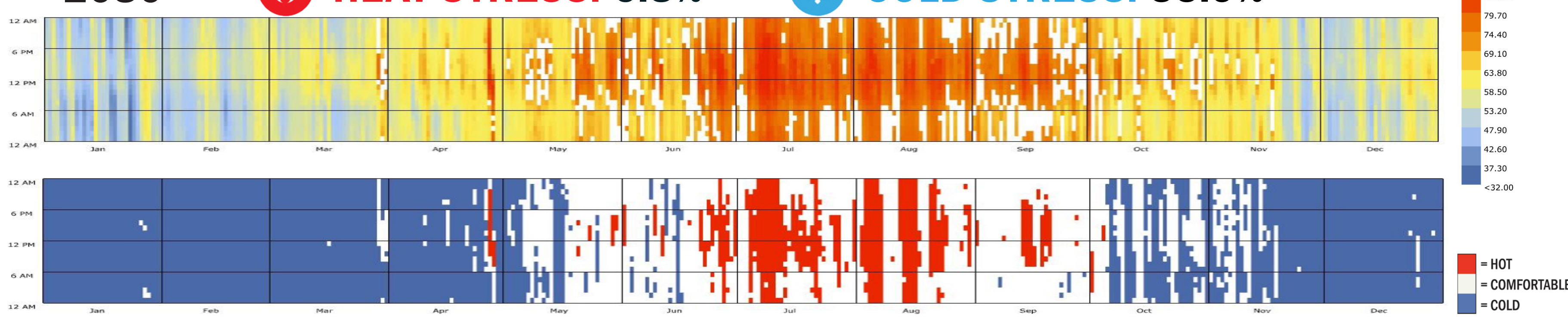
2020 HEAT STRESS: 1.4% COLD STRESS: 47.5%



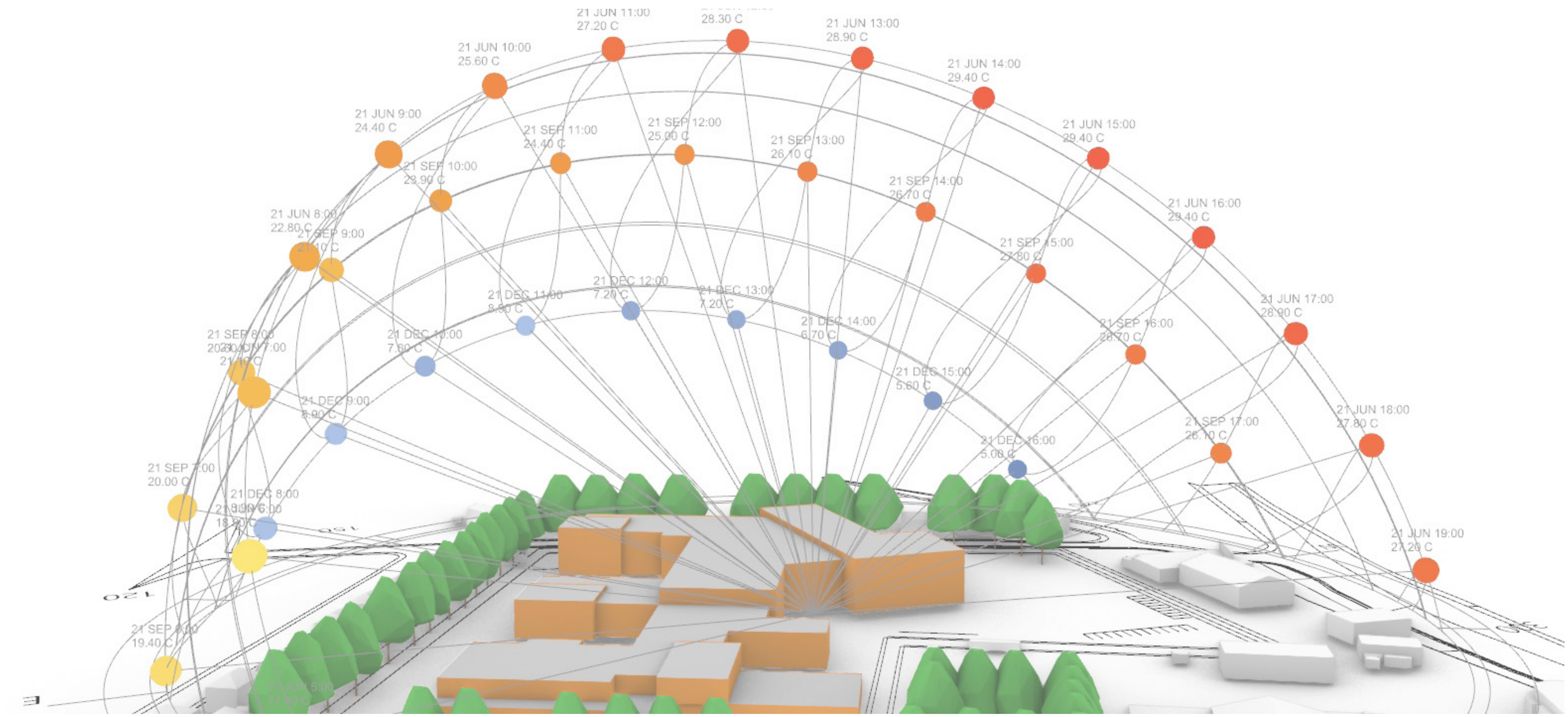
2050 HEAT STRESS: 2.8% COLD STRESS: 41.3%



2080 HEAT STRESS: 6.8% COLD STRESS: 35.9%



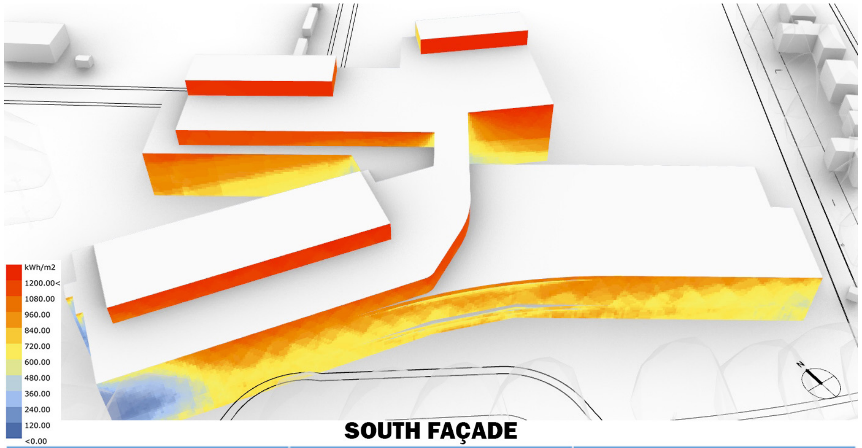
solar analysis



The amount of heat from the sun that impacts the building envelope will be a key factor in achieving net-zero energy. If solar heat gain through the building can be reduced during the warm season, and utilized during the cold seasons to provide passive heating, the building's mechanical system can be smaller and therefore will require less energy to maintain indoor comfort. In the outdoor play areas, solar heating in the winter and swing seasons will be desired to improve outdoor thermal comfort, while in the summers it should be avoided. Finally, the expanse of flat, unshaded roof area, and the amount of solar heat hitting this surface, provides the potential for energy generation through the placement of solar photo-voltaic panels or solar water heaters on the roof.

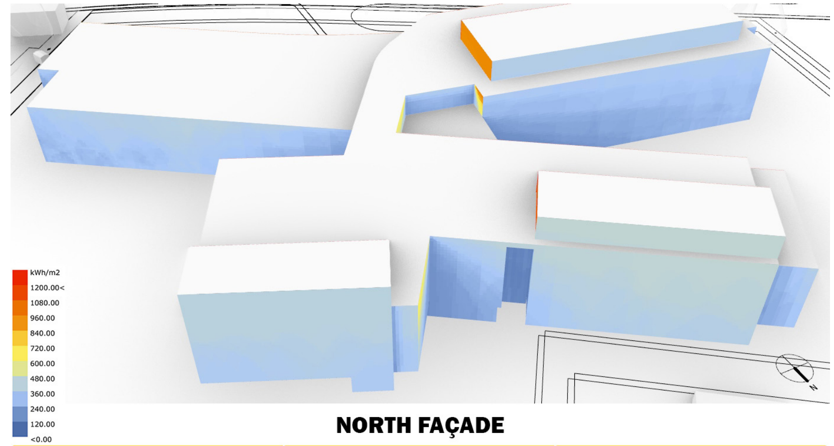
PERKINS — EASTMAN

Preferred Option – Crossroads



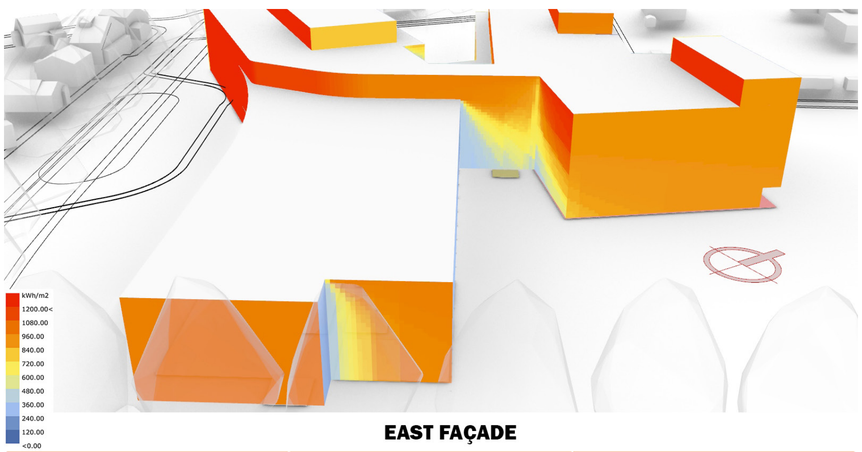
SOUTH FAÇADE

SEASON	TOTAL RADIATION	RADIATION X SQFT
COLD SEASON	1,349,200 kWh	61.98 kWh
WARM SEASON	588,786 kWh	27.05 kWh
TOTAL YEARLY RADIATION: 1,937,986 kWh		
TOTAL YEARLY RADIATION PER SQFT: 89.03 kWh		



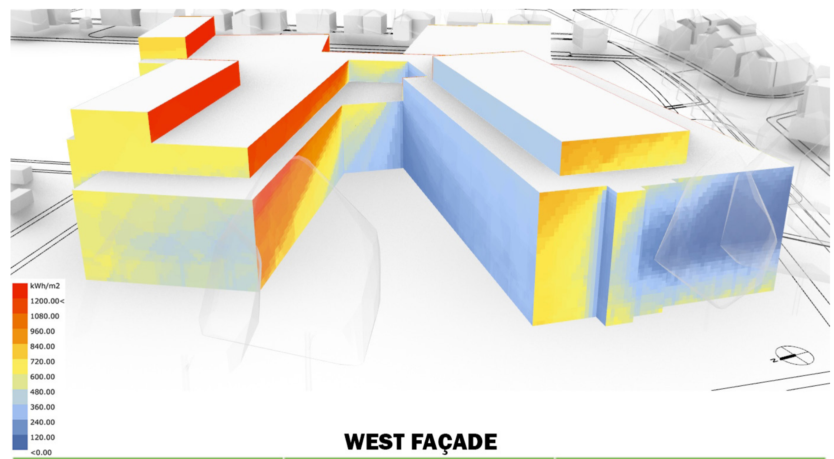
NORTH FAÇADE

SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	552,674 kWh	12.90 kWh
WARM SEASON	477,902 kWh	11.16 kWh
TOTAL YEARLY RADIATION: 1,030,576 kWh		
TOTAL YEARLY RADIATION PER SQFT: 24.06 kWh		



EAST FAÇADE

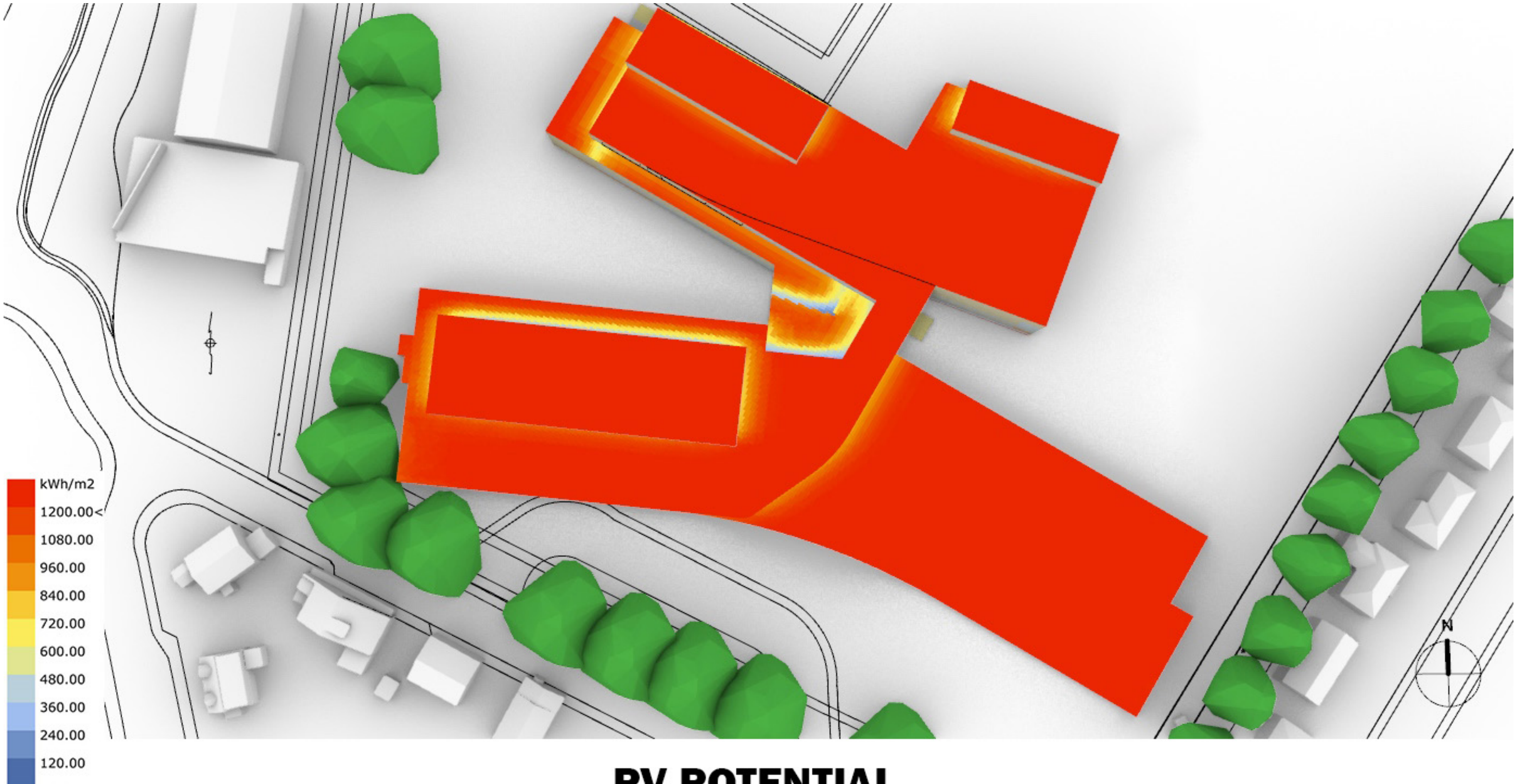
SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	770,824 kWh	43.52 kWh
WARM SEASON	471,326 kWh	26.61 kWh
TOTAL YEARLY RADIATION: 1,242,150 kWh		
TOTAL YEARLY RADIATION PER SQFT: 70.13 kWh		



WEST FAÇADE

SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	419,350 kWh	17.64 kWh
WARM SEASON	386,758 kWh	16.26 kWh
TOTAL YEARLY RADIATION: 806,108 kWh		
TOTAL YEARLY RADIATION PER SQFT:33.9 kWh		

Preferred Option – Crossroads

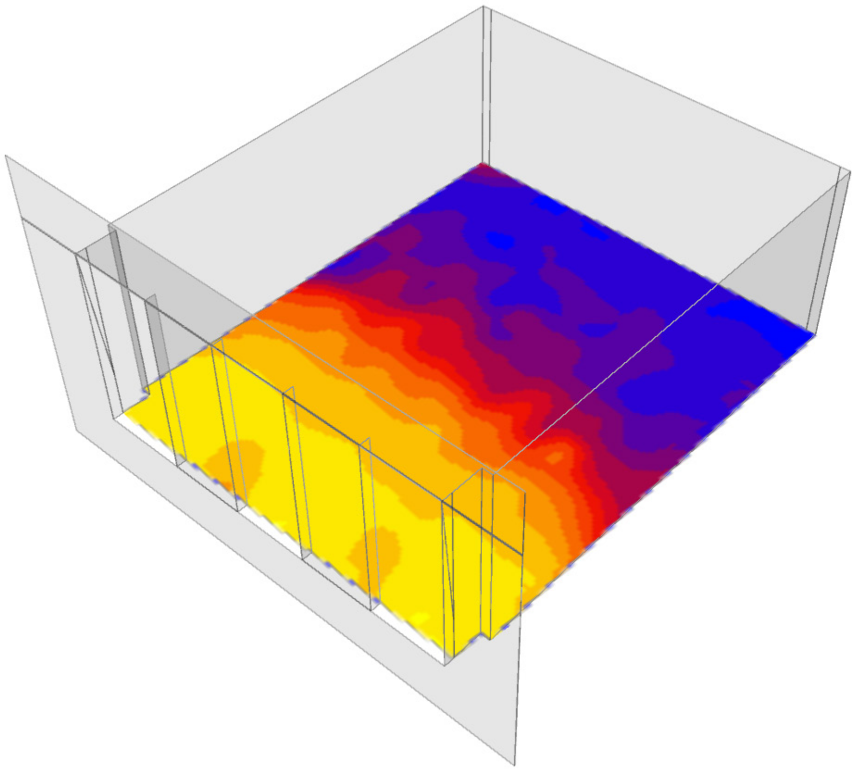


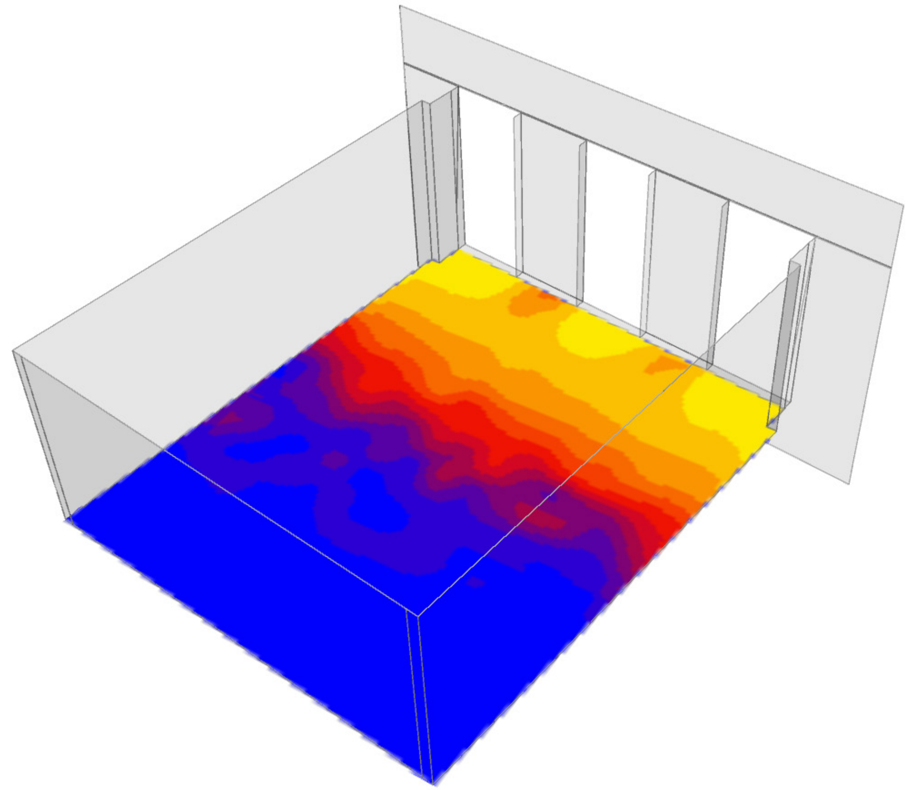
PV POTENTIAL

SEASON	RADIATION	RADIATION X SQFT
COLD SEASON	5,818,200 kWh	62.87 kWh
WARM SEASON	4,909,900 kWh	53.06 kWh
TOTAL YEARLY RADIATION: 10,728,100 kWh		
TOTAL YEARLY RADIATION PER SQFT: 115.93 kWh		

PERKINS EASTMAN

classroom analysis



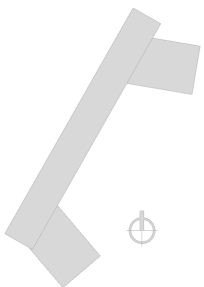


Massing orientation is a key element to achieving our goal of Net-Zero-Energy. Making sure the building is oriented properly can improve the amount of useful daylight hours in core learning spaces, while reducing glare exposure. This can also lead to significant energy savings through reductions in heating and cooling loads. To achieve these targets, classrooms should be oriented facing North and South whenever possible.

classroom analysis

RANKING	SOUTH WING ROTATION	NORTH WING ROTATION	DISTANCE BETWEEN WING	SOLAR RADIATION COLD SEASON / sqft	SOLAR RADIATION WARM SEASON / sqft
#1	20°	-20°	200 ft	66.57 kWh	113.02 kWh
#2	20°	-20°	160 ft	66.57 kWh	113.03 kWh
#3	20°	-20°	120 ft	66.52 kWh	112.93 kWh
#4	20°	-20°	80 ft	66.31 kWh	112.52 kWh
#5	20°	-20°	40 ft	65.98 kWh	112.04 kWh
#6	10°	-20°	200 ft	63.34 kWh	103.30 kWh
#7	10°	-20°	160 ft	63.33 kWh	103.31 kWh
#8	10°	-20°	120 ft	63.25 kWh	103.18 kWh
#9	10°	-20°	80 ft	62.99 kWh	102.76 kWh
#10	10°	-20°	40 ft	62.64 kWh	102.17 kWh

#1



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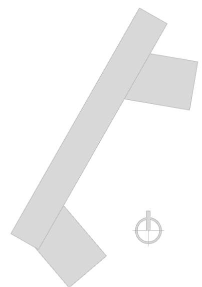

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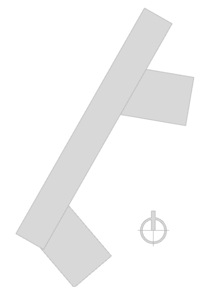

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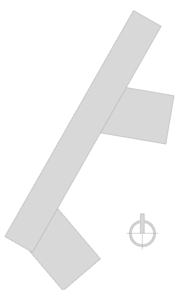

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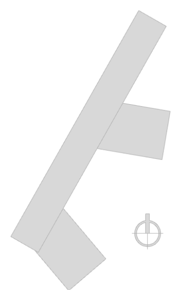

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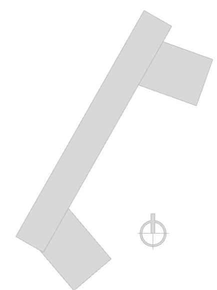
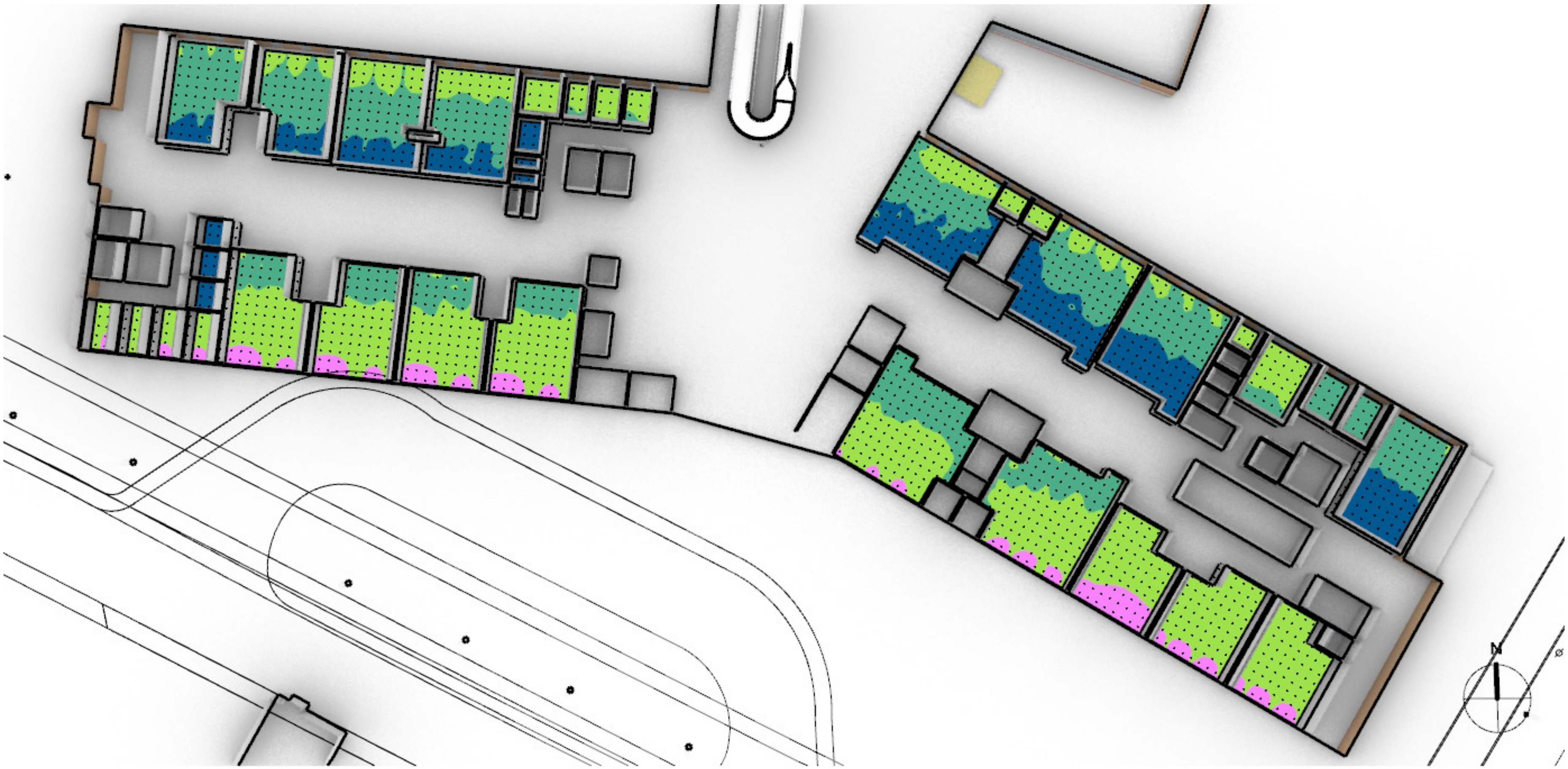


LINK TO INTERACT WITH GEOMETRY(OPEN WITH GOOGLE CHROME): http://tt-acm.github.io/DesignExplorer/?ID=BL_35uvO75

PERKINS EASTMAN

daylight analysis - classroom wing



28% **underlit** (0 lux-100 lux)

33% **supplemental** (100 lux-300 lux)

37% **autonomous** (300 lux-3000 lux)

2% **excessive** (>3000 lux)

Conceptual Energy Model & ECM Feasibility Study

Tobin Montessori & Vassal Lane Upper School
Cambridge, MA

March 12, 2020
AKF Project No. 197192

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1. EXECUTIVE SUMMARY

The Tobin Montessori Vassal Lane Upper Schools project is a new school building located in Cambridge, MA. The newly constructed five (4)-story building (plus a basement, below-grade parking garage and rooftop bulkhead) will replace the existing school located at the project site. The approximate building area is 320,000 square feet. The campus will serve up to 975 students and approximately 265 faculty/staff members.

A series of eQUEST Energy Models have been developed for the conceptual energy model report. A number a number of Energy Conservation Measures (ECMs) have also been provided, including different HVAC system types, including adjusted temperature setpoints, lighting power reduction, and envelope performance parameters. In addition, an ASHRAE-90.1-2013 Appendix G baseline model was developed, (current Massachusetts Stretch Code).

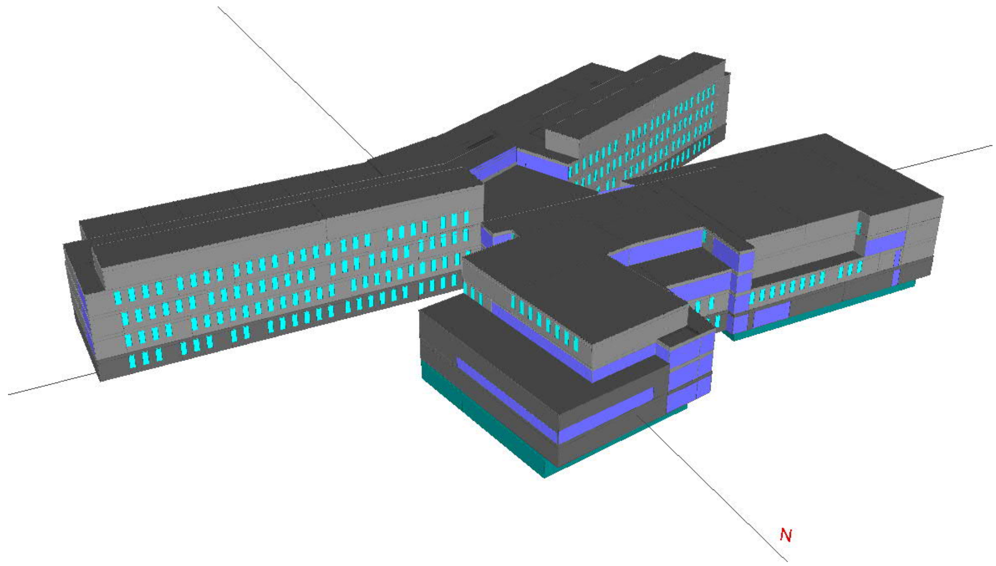
Except where otherwise noted, model input information is based on the 02-14-2020 Feasibility Study Cost Narrative as well as the Sketchup architectural model.

The below tables show annual energy end-use breakdowns by MMBtu, Electricity Consumption, and EUI for the proposed design, ECM's, and Baselines:

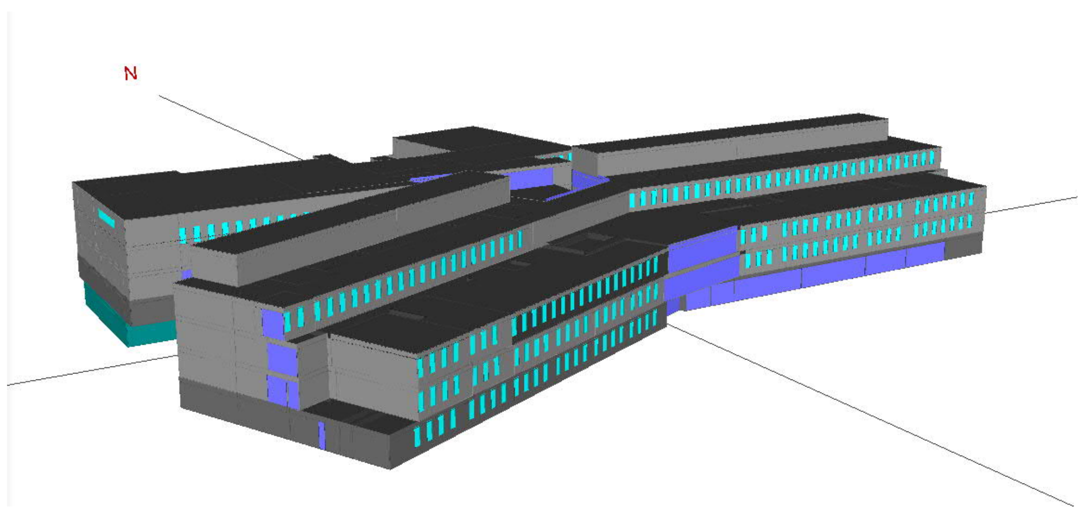
Energy Usage Summary	Electricity (kWh)	Annual Cost ($)	EUI (kBtu/sf/yr)	GHG Emissions (tons/sf/yr)
Proposed Design - without PV	2,411,547	$405,139	26.03	1,081.17
Proposed Design - with PV	1,597,547	$268,387	17.25	716.23
Ultra-High Performance Design - without PV	2,146,277	$360,574	23.17	962.24
Ultra-High Performance Design - with PV	1,332,277	$223,822	14.38	597.30

ECM Summary	EUI (kBtu/sf/yr)	Annual Energy Cost ($)	% EUI Change
PROPOSED DESIGN	26.034	$ 405,140	-
ECM-LTG-1	25.280	$ 394,069	3%
ECM-ENV-1	25.940	$ 403,759	0%
ECM-ENV-2	25.925	$ 403,537	0%
ECM-ENV-3	25.925	$ 403,539	0%
ECM-ENV-4	26.000	$ 404,632	0%
ECM-ENV-5	25.723	$ 400,577	1%
ECM-ENV-6	25.371	$ 395,404	3%
ECM-ENV-7	26.067	$ 405,623	0%
ECM-ENV-8	26.017	$ 404,885	0%
ECM-HVAC-ALT-1	24.661	$385,528	5%
ECM-HVAC-ALT-2	25.551	$ 398,820	2%
ECM-HVAC-1	25.764	$ 401,160	1%
ECM-HVAC-2	25.852	$ 402,462	1%
ECM-HVAC-3	25.845	$ 402,362	1%
ULTRA-HIGH-PERFORMANCE	23.170	$360,575	11%

Energy Model Images



Northeast Corner View



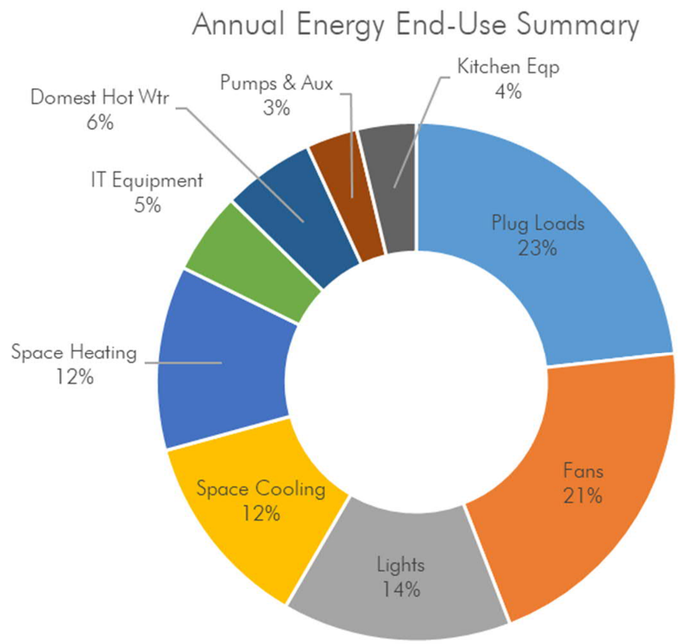
Southwest Corner View

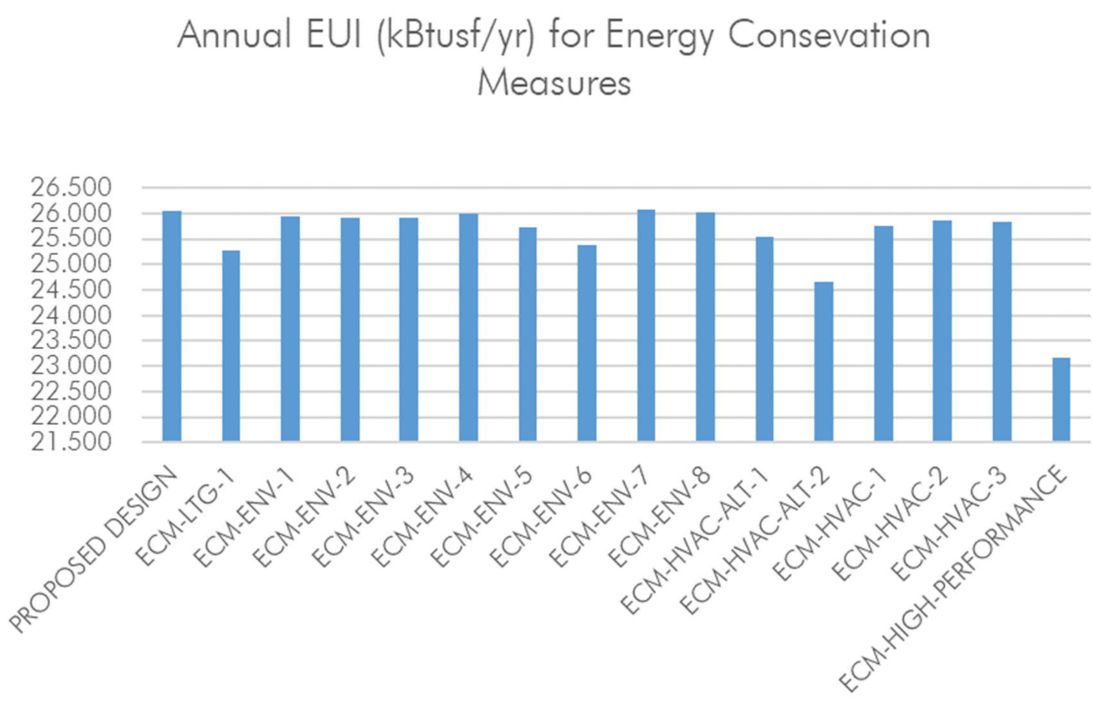
Energy Modeling Disclaimer

Building energy modeling is a comparative tool used for understanding the relative impact of alternate strategies and systems on annual energy use and cost. Energy modeling is not an absolute predictor of actual energy use or cost and shall not be relied on to predict actual building performance. Changes in construction, variable weather conditions, operational characteristics, end-user input, miscellaneous electrical and gas loads, controls alterations and other unpredictable metrics prevent energy models from predicting the actual annual energy consumption of any facility.

2. ENERGY MODEL RESULTS

The following figures show annual end-use breakdowns on an energy basis:





3. ENERGY MODEL INPUTS

Energy Model Methodology

Annual energy use for the project was analyzed using eQuest v3-64. eQuest/DOE-2 calculates building energy use on an hourly basis for 8,760 hours per year (full year) and utilizes typical meteorological year (TMY) weather data as published by the National Renewable Energy Laboratory. TMY weather data is average weather data based on approximately 30 years of weather data for a given location.

Project and Site Information

{The climate zone for Boston, MA is 5A}

Weather	Boston Logan International Airport – TMY3 Format
Orientation	Plan North
Electric Rate	EIA Average Electric Rate (MA) ▪ $0.1608 /kWh
Gas Rate	EIA Average Electric Rate (MA) ▪ $1.11 /therm

Schedule and Occupancy

The schedules of use are based on the school's annual operating calendar. These schedules include typical occupancy values for the typical school operation schedule. Occupancy is reduced in the summer and days off. Additional schedules are based on the hourly values listed in ASHRAE 90.1-2007 User's Manual.

Program Category	Weekdays	Weekends	Extended Day	Holidays / Summer
Lower Classrooms	7am - 4pm	Off	7am - 6pm	Off
Upper Classrooms	7am - 4pm	Off	7am - 5pm	Off
Kitchen/ Café	6am - 2pm	Off	6am - 2pm	Off
Gym	6am - 5pm	9am - 5pm Saturday, 9am - 9pm Sunday	6am - 9pm	Off
Preschool/ Afterschool Wing	6am - 5pm	6am - 5pm	6am - 5pm	6am - 5pm
Library	9am - 5pm	Off	9am - 6pm	Off
Band	9am - 5pm	Off	9am - 5pm	Off
Admin Offices	8am - 5pm	Off	8am - 5pm	8am - 5pm
Auditorium	8am - 2pm	Off	8am - 9pm	Off

The below information represents scheduled holidays in which the school building is assumed to be completed closed. Assumptions for holiday closings were taken from Tobin Public High School's "Important Dates" schedule. Airside ventilation systems and building occupancy/ internal loads are assumed to be off (or, in the case of lighting and plug loads, at minimum values), and space temperature setpoints are assumed to be set back for the entirety of the following scheduled days:

- 9/2 – Labor Day
- 10/9 – Yom Kippur
- 10/14 – Indigenous People's Day
- 11/11 – Veterans Day
- 11/28 & 11/29 – Thanksgiving
- 12/23 through 1/1 -- Christmas Break
- 1/20 – Dr. MLK, Jr. Day
- 2/17 through 2/21 – February Vacation
- 4/10 – Good Friday
- 5/25 – Memorial Day
- 6/16 through 9/3 – Summer Break

Geometry and Architecture

Zoning	Based on the Tobin DXF Model received 2020-02-19
Gross Area	▪ Basement Drop-Off -14,452 SF ▪ Basement Program -14,124 SF ▪ Basement District Storage – 12,326 SF ▪ First – 86,641 SF ▪ Second –75,741 SF ▪ Third – 86,996 SF ▪ Fourth – 38,771.71 SF ▪ Penthouse 1: 5,484 SF ▪ Penthouse 2: 8,096 SF ▪ Parking: 75,381 SF Totals: Excluding Parking Garage: 329,633 SF Excluding Parking Garage and Penthouse: 316,053 All Modeled Area: 40,5014
Whole-Building Program Area Summary (excluding parking garage & rooftop bulkhead)	School/Classrooms: 27% Corridor/Transition: 22% Back-Of-House: 18% Office/Conference: 8% Band/Music: 8% Gym: 6% Lobby: 5% Auditorium: 4% Dining: 2%
Floor to Floor Heights	▪ All floors 13' with 4' Plenum

Building Envelope Performance

The proposed design performance assumes the building and building systems are designed to meet or exceed the mandatory and prescriptive requirements of ASHRAE 90.1-2019. The baseline performances are based on the mandatory and prescripitive requirements as indicated in 90.1-2013 Appendix G. The performances for envelope, lighting, and HVAC are listed below.

Assembly Type	Baseline Performance (90.1-2013 Appendix G)	Proposed Description (per Feasibility Cost Study, unless otherwise noted)	Proposed Performance
Exterior Wall Type 1 (Above Grade Rain Screen Cladding)	0.055	- Cementitious panels, TAKTL or Oko Skin by Reider - Panel sizes, varying widths and heights approximately 3'-6" wide and 6" to 18" high. 1.25" panel thickness, face to support. - Panels to be custom colored, three colors, pattern by architect. - Insulation, (2) layers of 3" (6" total thickness) cavity grade mineral fiber insulation with offset joints between thermally broken girt system comprised of fiberglass structural sections..	U-Assembly: U-0.046 (ASHRAE 90.1-2016 Appendix A)
Exterior Wall Type 2 (Above Grade Masonry Wall)	0.055	- Regional stone, random coursed ashlar, 6" deep nominal dimension, stone and mortar color to match on-site wall selected by architect - Stone backs to be sawn, split or dressed to maintain cavity, as required by site conditions. - Stainless steel, 2-piece, thermally isolated masonry anchors - 2" cavity with 2" cavity drainage mat consisting of plastic mesh in dovetail form, above through wall flashing - Prefinished aluminum coping above stone at top of wall where required - Flexible through-wall flashing, preformed weep holes - Grout solid below flashing, continuous at base - Structural plastic setting course continuous at masonry shelf - (2) layers 2" extruded polystyrene insulation.	U-Assembly: U-0.056 (ASHRAE 90.1-2016 Appendix A)
Exterior Wall Type 3 (Below Grade Vertical Waterproofing)	C-1.119	- Geotextile on polyethylene egg-crate drainage mat - 3" extruded polystyrene foundation insulation - Sheet-applied waterproofing on foundation wall, with manufacturer's primer, and edge and joint sealer/mastic to create continuous air barrier. - Perimeter perforated pipe with free-draining gravel and geotextile wrap	C-Factor 0.082 (ASHRAE 90.1-2016 Appendix A)
Windows - Punched	U-Assembly: 0.42 (fixed) / 0.5 (operable) SHGC: 0.4	- Triple glazed thermal glass - Two low-e coatings, PPG Solarban 60 or equal - Argon filled cavities - Thermal edge	U-Center of Glass: 0.16 (Vitro Glazing Online) U-Assembly: 0.29 (ASHRAE Fundamentals 15.9 Table 4) SHGC: 0.25 (Perkins

			Eastman Recommended Target)
Windows - Curtainwall	U-Assembly: 0.42 (fixed) SHGC: 0.4	- Triple glazed thermal glass - Two low-e coatings, PPG Solarban 60 or equal - Argon filled cavities - Thermal edge	U-Center of Glass: 0.16 (Vitro Glazing Online) U-Assembly: 0.33 (ASHRAE Fundamentals 15.9 Table 4) SHGC: 0.25 (Perkins Eastman Recommended Target)
Underslab	F-0.52 (unheated)	- Location: Full Lower Level - Pressure-sensitive, single sided waterproofing - Protection board - 3” rigid insulation - 4” crushed stone base course and - 6” gravel base with 4” perforated underslab drain pipes, 10’-0” on center - under-slab drainage gravity fed to through-foundation piping connected to perimeter drain - Pump to stormwater treatment facility	F-Factor 0.57 (ASHRAE 90.1-2016 Appendix A)
Roof	U-0.032	- Thermoplastic, fully adhered roof membrane. - ½” overlayment as required by manufacturer - 8” thick (average) tapered polyisocyanurate insulation in 2 lifts with offset joints. - ½” thick roofing underlayment - Reinforced polyethylene vapor retarder on roof deck - 4” thick x 18” high prefabricated curbs for exhaust fans and heat recovery	U-Assembly 0.031 (ASHRAE 90.1-2016 Appendix A)
External Shades	None	- Type 1: At all windows on south façade 8” deep horizontal extruded aluminum solar shades, 2 per window, full width, custom color - Type 2: At west-facing curtainwall, 2’-0” deep vertical extruded perforated prefinished aluminum solar shades, 2’-6” on center. - Type 3: At south and east facing curtainwall, 1’-6” deep horizontal extruded prefinished aluminum solar shades, at levels 1 through 3, at multiple elevations. Custom color.	n/a
Infiltration	Same as Proposed	"Passive House" level infiltration, pending post-installation blower door test and verification	0.25 CFM per SF total conditioned wall area at 0.3-inch water pressure differential

Internal Electrical Loads

	Baseline Design	Proposed Design
Lighting	0.87 W/SF (school/university whole-building area method)	0.45 W/SF
Specialty Lighting	Same as Proposed	Auditorium: 5 kW lighting load, scheduled on during events
Daylighting	Same as Proposed	Yes – As required by Code
Lighting Controls	Occupancy sensors in employee lunch and breakrooms, conference/meeting rooms, and typical classrooms	As required by Code
Equipment Peak Power Densities	Same as Proposed	School/Classroom – 0.5 W/SF Offices – 0.75 W/SF Band/Music – 0.25 W/SF Gym – 0.25 W/SF Lobby – 0.25 W/SF Auditorium – 1 W/SF Dining – 0.5 W/SF Corridor – 0.15 W/SF BOH – 0.2 W/SF
Additional Internal Loads	Same as Proposed	Elevator Load – 10 kW peak (assumed), assumed diversity 30% during day, 0% at night (off fully during holidays) Kitchen Load – 122.5 kW peak, assumed diversity 55% during weekdays from 8am – 2 pm, 5% after hours, 0% during weekdays and holidays IT Load – 25 kW peak, assumed diversity 80% during day and 40% at night (year round)
General/Exhaust Fans	Same as Proposed	15 kW peak load (assumed), scheduled according to building program.

Occupants

The occupancy values are based on ASHRAE 90.1-2016 User's Manual and discussions with Perkins Eastman.

Space Type	Occupancy Densities (sf/person, unless otherwise noted)
School/Classroom	75
Offices	275
Band/Music	75
Gym	100
Lobby	250
Auditorium	625 peak occupants during events, 100 occupants during other regular program times
Dining	50
Corridor	750
BOH	1000

Baseline HVAC:

The following narratives and tables describe baseline systems based on ASHRAE 90.1-2013 Appendix G.

Airside Systems	Baseline Design
System Type	Floor-by-Floor Systems: VAV w/ Reheat (VAV) IT Space, Kitchen: Packaged Single Zone (PSZ-AC) Kitchen: VAV w/ Reheat (VAV) Parking Garage: H&V Unit
Ventilation	Total Ventilation Air: 83,000 CFM (assumed, derived from ASHRAE 62.1 ventilation calculations based on occupancy and areas listed above
Fan Power	PVAV: Avg. 0.0010 kW/CFM PSZ-AC: 0.0009 kW/CFM
System Efficiencies	Avg. 10.1 EER PSZ-AC: 11.2 EER
Supply Air Temperatures	55ºF supply air temperature, reset by 5ºF under warmest conditions
Airside Economizer	Temperature-based reset on Floor-by-Floor VAV system, 70 degree high-limit shutoff

Waterside Systems	Baseline Design
CHW Source	(2) Electric Centrifugal Water-Cooled Chillers. COP: 5.4
CHW Flow	(2) 22 W/gpm Pumps, Variable Speed
CHW Temperatures	44ºF supply at 80ºF OAT, 54ºF supply at 60ºF OAT, ramped linearly in between.
CW Source	Axial-Fan Open-Cell Cooling Towers
CW Flow	(2) 22 W/gpm Pumps, Constant Volume
CW Temperatures	Floating to maintain 70ºF leaving water temperature.
HW Source	(2) Gas-Fired Boilers, 80% efficient
HW Flow	(2) 19 W/gpm Pumps, Variable Speed
HW Temperatures	180ºF supply at 20ºF OAT, 150ºF supply at 50ºF OAT, ramped linearly in between.

HVAC Airside Performance Details

AHU Number	Area Served	Unit CFM / % OA	Remarks
AHU-1	Dining and Kitchen	12,000 CFM Supply, 30% OA	Variable air volume, mixed air, heat pump, airside economizer, interlock with kitchen hoods, 40 tons
AHU-2	Auditorium	14,000 CFM Supply, 30% OA	Single zone variable air volume, heat pump, airside economizer, carbon dioxide demand control ventilation, 40 tons
AHU-3	Large & Small Gym	10,000 CFM Supply, 30% OA	Single zone variable air volume, heat pump, airside economizer, carbon dioxide demand control ventilation, 25 tons
AHU-4	Learning Commons	12,000 CFM Supply, 30% OA	Variable air volume, heat pump, airside economizer, carbon dioxide demand control ventilation, 25 tons
ERU-1	Auditorium Support Areas	2,000 CFM Supply, 100% OA	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 5 tons
ERU-2	Visual Arts/Performing Arts	8,000 CFM Supply, 100% OA	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-3	Vassal School Ventilation	9,000 CFM Supply, 100% OA	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-4	Vassal School Ventilation	9,000 CFM Supply, 100% OA	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-5	Vassal School Ventilation	9,000 CFM Supply, 100% OA	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-6	Vassal School Ventilation	9,000 CFM Supply, 100% OA	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-7	Tobin School Ventilation	9,000 CFM Supply, 100% OA	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-8	Tobin School Ventilation	9,000 CFM Supply, 100% OA	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-9	Tobin School Ventilation	9,000 CFM Supply, 100% OA	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
ERU-10	Tobin School Ventilation	9,000 CFM Supply, 100% OA	Variable air volume, DOAS, energy recovery wheel, heat pump, airside economizer, 20 tons
Kitchen MUA	Makeup Air for Kitchen	9,000 CFM Supply, 100% OA	Variable air volume, energy recovery wheel, heat pump heating, 20 tons
Modular Water-to-Air Heat Pumps	Zonal space conditioning	Recirculating zonal units, autosized per thermal zone	Constant volume, heat pump heating and cooling, autosized per thermal zone

Efficiencies / Fan Powers	Fan Power	Cooling Efficiency (EER)	Heating Efficiency (COP)
Recirculating AHU's	5.5" supply 2.5" return	12.1	2.5
100% OA ERU's	7" supply 4" return	9.5	2.5
Modular Water-to-Air Heat Pumps	0.75" supply	18	4.3

HVAC Waterside Performance Details

Geothermal Loop	Pumping Energy: (2) pumps w/ variable speed drives @ 100 ft head (assumed)

Domestic Hot Water

General DHW Loads and Scheduling are based on values provided for School and Food Service per ASHRAE 90.1-2007 User's Manual. Water-to-water or air-to-water heat pumps will generate the domestic hot water. Low flow fixtures will be used throughout the building.

	Domestic Hot Water
Peak DHW Loads	General DHW – 78 kW Kitchen – 142 kW

Energy Conservation and Design Alternative Measure Summary

The building is currently in the feasibility design phase. Multiple Energy Conservation Measures (ECMs) are being analyzed through an eQuest energy model. Evaluating each ECM will provide design options for potentially reducing the building energy consumption. The investigated ECMs include a variety of different HVAC system types, adjusted temperature set points, lighting power reductions, and increased envelope performance components. The table below provides a short description of the modeled ECM and the respective baseline value.

<u>HVAC Alternates</u>

HVAC-ALT-1	Hybrid Air / Geothermal HVAC system	Geo-exchange water-to-air heat pumps	Hybrid of geo-exchange water –to-air heat pumps & air-to-air VRF heat pumps with heat recovery
HVAC-ALT-2	All-air HVAC system	Geo-exchange water-to-air heat pumps	Air-to-air VRF heat pumps with heat recovery

<u>ECM Name</u>	<u>ECM Description</u>	<u>Baseline Value</u>	<u>ECM Value</u>
ECM-LTG-1	LPD Reduction	0.45 w/sf whole building	0.4 w/sf whole building
ECM-HVAC-1	Reduced Fan Power	DOAS Fan Power: - 7.0” static supply - 4.4” static return	DOAS Fan Power: - 6.4” static supply - 4.0” static return
ECM-HVAC-2	Expanded temperature control band for all public spaces (dining, commons, corridors, gymnasium, auditorium)	Heating: 70°F Cooling: 75°F	Heating: 68°F Cooling: 76°F
ECM-HVAC-3	Expanded temperature control band for all classrooms and offices	Heating: 70°F Cooling: 75°F	Heating: 68°F Cooling: 76°F
ECM-ENV-1	Enhanced Infiltration	0.40 cfm/ft^2 of building envelope	0.36 cfm/ft^2 of building envelope

		area at 0.3-inch water pressure differential	area at 0.3-inch water pressure differential
ECM-ENV-2	Improved Roof Thermal Performance	U-Assembly 0.030	U-Assembly 0.024
ECM-ENV-3	Improved Above-grade Wall thermal performance	U-Assembly 0.045	U-Assembly 0.036
ECM-ENV-4	Improved Glazing Performance - SHGC	SHGC-0.38	SHGC-0.3
ECM-ENV-5	Improved Glazing Performance – U-Assembly	U-Assembly 0.36	U-Assembly 0.31
ECM-ENV-6	Reduced window-to-wall ratio	~30% whole-building WWR	22% whole-building WWR
ECM-ENV-7	Expanded Shading #1	Per Feasibility Design Report	Exterior window shading on windows facing within 45° of due south. (SE, S, SW)
ECM-ENV-8	Expanded Shading #2	Per Feasibility Design Report	Exterior window shading on windows facing within 135° of due south (NE, E, SE, S, SW, W, NW)

<u>Ultra High Performance ECM</u>

This ECM was developed as a "best-case" scenario, after verifying the performance of the other ECM's. It is a combination of the following ECMs/alternates:

- ECM-HVAC-ALT-1 Hybrid Air/Geothermal System
- ECM-LTG-1: LPD Reduction
- ECM-HVAC-1: Reduced Fan Power
- ECM-HVAC-2: Expanded temperature control band for all public spaces
- ECM-HVAC-3: Expanded temperature control band for all classrooms and offices
- ECM-ENV-1: Enhanced Infiltration
- ECM-ENV-2: Improved Roof Thermal Performance
- ECM-ENV-3: Improved Above-grade Wall thermal performance
- ECM-ENV-4: Improved Glazing Performance - SHGC
- ECM-ENV-5: Improved Glazing Performance – U-Assembly
- ECM-ENV-6: Reduced window-to-wall ratio
- ECM-ENV-7: Expanded Shading #1
- ECM-ENV-8: Expanded Shading #2

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