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ENVIRONMENTAL ANALYSIS

Sustainable and Resilient Buildings Questionnaire
LEED Compliance
Shadow Study
Pedestrian Level Wind Analysis
Solar Glare Analysis

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SUSTAINALBLE AND RESILIENT BUILDINGS QUESTIONNAIRE

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INTRODUCTION

This document outlines Development Review Application requirements in relation to the long-term environmental sustainability and climate resilience of buildings within Somerville. Development proposals that require Site Plan Approval by the Somerville Zoning Ordinance must include a completed Sustainable & Resilient Buildings Questionnaire (Questionnaire) with the required Development Review Application. A Development Review Application is considered incomplete unless a completed questionnaire is submitted with the application. It is strongly recommended that the development team meets with staff from the Office of Sustainability and Environment prior to submitting the Development Review Application.

The purpose of this Questionnaire is to minimize the adverse environmental impacts in the design, construction, and occupancy of buildings in Somerville and to ensure that the impacts of future climate conditions are carefully evaluated.

Please review the following documents before completing the Questionnaire:

- **Somerville Climate Change Vulnerability Assessment**
- **Carbon Neutrality Pathway Assessment**
- **Somerville Climate Forward**
- **High Resolution Flood Vulnerability Maps**

PROCEDURE:

A completed Sustainable & Resilient Buildings Questionnaire must be submitted with a Development Review Application for all development proposals that require Site Plan Approval. New construction or alterations to existing structures of 25,000 square feet or more must also submit an updated Questionnaire prior to the issuance of the first Building Permit and prior to the issuance of the first Certificate of Occupancy to identify any design changes made subsequent to Site Plan Approval or additional information determined as the development process unfolds.

BACKGROUND: CARBON NEUTRALITY

Understanding the global imperative to reduce greenhouse gas emissions in order to prevent extreme changes to the climate, Mayor Joseph A. Curtatone set a goal for Somerville to become carbon neutral by the year 2050. Carbon neutrality is defined as the net-zero release of carbon dioxide and other greenhouse gases (GHG) within Somerville's municipal boundary. Reducing greenhouse gas emissions is critical to avoiding the worst impacts of climate change and to protecting the health, safety, and welfare of current and future generations. In 2017, the Somerville Board of Aldermen passed a resolution reaffirming the city's carbon neutrality goal. And In 2018, Somerville released its first community-wide climate action plan, Somerville Climate Forward.

To achieve carbon neutrality by 2050 and to minimize adverse environmental impacts, Somerville will need to drastically reduce greenhouse gas emissions from electricity, buildings, transportation, and waste disposal. To meet these goals, all buildings within the city will need to pursue net zero emissions. New development should be designed to maximize envelope performance and energy efficiency, produce or procure renewable energy, and phase out fossil fuel use through electrification of building systems. The City of Somerville recognizes that as technology advances, incorporating design elements to mitigate carbon emissions and increase resilience may become more feasible. Applicants are asked to devise strategies that permit building systems to adapt and evolve over time to further reduce GHG emissions and to avoid path dependency that perpetuates reliance on fossil fuels.

BACKGROUND: CLIMATE CHANGE VULNERABILITY

Despite efforts to minimize greenhouse gas emissions, climate change is already impacting Somerville and changes to the climate will continue to intensify. The City of Somerville's Climate Change Vulnerability Assessment analyses vulnerabilities associated with Somerville's key climate stressors: increased precipitation, sea level rise and storm surge, and higher temperatures. The analysis recommends that new development consider these climate impacts and take appropriate measures to address the projected climatic conditions described in the assessment.

Several areas of Somerville are already prone to flooding from intense precipitation. With climate change, precipitation events will become more intense—meaning that a greater volume of rain will fall in a shorter period of time. Somerville is projected to experience more than a 30% increase in rainfall during a 100-year 24-hour event. This increase in precipitation will increase the risk of flooding in areas where the drainage system does not have sufficient capacity.

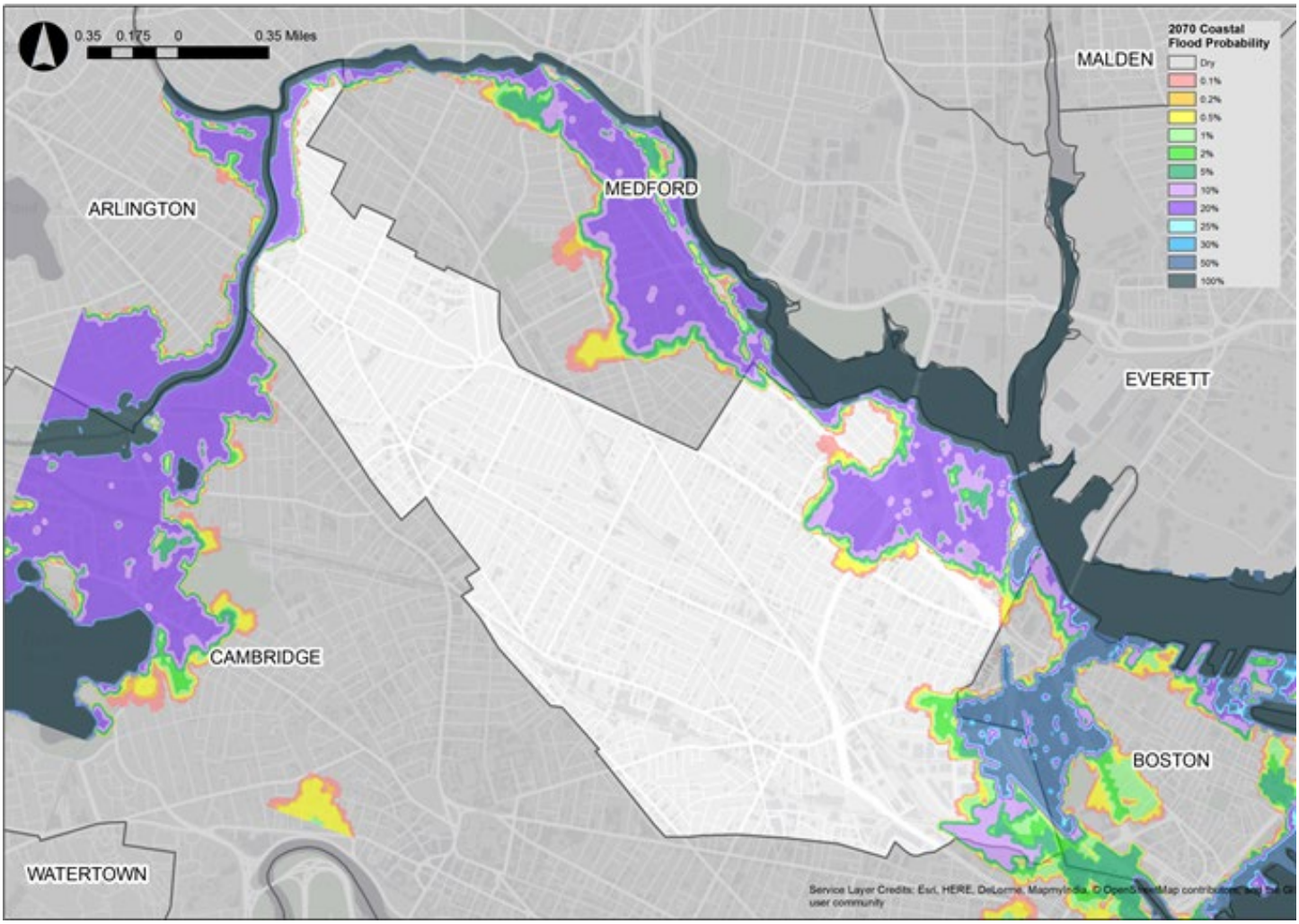
In addition to flooding from precipitation, sea level rise and storm surge are already potential concerns for areas of East Somerville and by 2035-2040 the Amelia Earhart Dam could be regularly flanked by storms, resulting in flooding for areas of Assembly Square, Ten Hills, and Winter Hill.

As the climate continues to change, average seasonal temperatures are also expected to increase and the number of days above 90 degrees Fahrenheit (historically about 10 a year) could rise to 40 days by 2030, a third of the summer, and 90 days by 2070, nearly the entire summer. In 2018 there were 23 days over 90 degrees.
As temperatures increase, Somerville will become more susceptible to the urban heat island effect which causes hotter temperatures due to paved surfaces and waste heat generated by energy use when compared to less developed areas. Increasing average temperatures can have wide-ranging impacts on human life, the built environment, and natural ecosystems. Rising temperatures and more intense heat waves present significant public health concerns and can contribute toward kidney, lung, and heart problems. Vulnerable populations are particularly susceptible to heat-induced illness and mortality. There will also be increasing demand for indoor cooling.

The following maps and figures provide an overview of projected climate exposure. Please review the Climate Change Vulnerability Assessment for more detailed analysis on Somerville's exposure, vulnerability, and risk

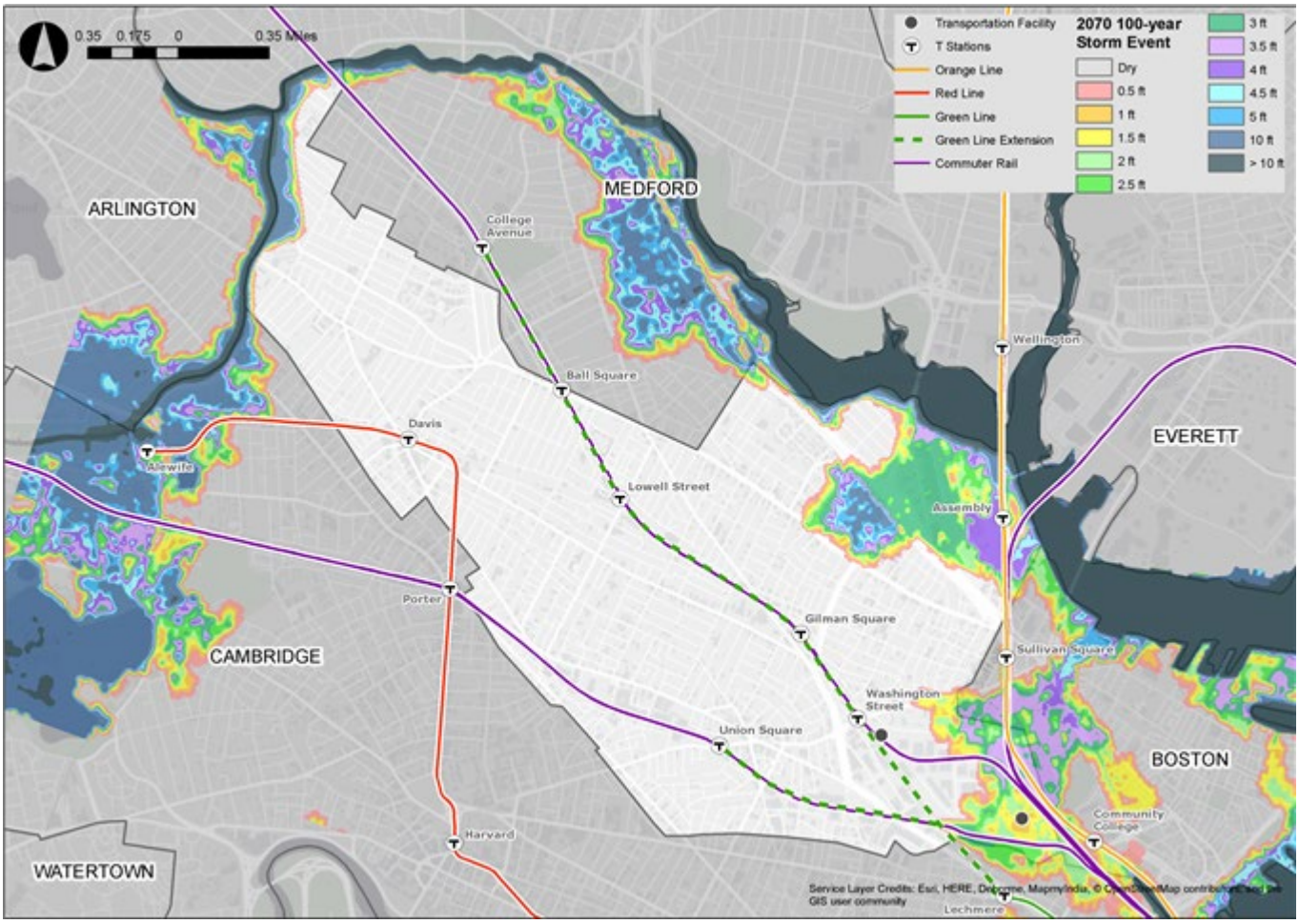
to climate change. **For higher resolution maps and GIS files, please click the link to visit www.somervillema.gov/floodready or contact the Office of Sustainability & Environmental staff at ose@somervillema.gov.**

2070 Coastal Flood Probability



This map shows the annual chance of flooding from coastal storm events and sea level rise in 2070. A 100% chance of flooding means that there is a nearly certain chance that the area will flood at least once in a given year, while a 50% chance means that there is an equal chance that it may or may not flood in a given year. A 1% chance of flooding corresponds with a 100-year event. A 0.1% chance corresponds with a 1000-year event. This map does not account for drainage (Somerville Climate Change Vulnerability Assessment, 2017)

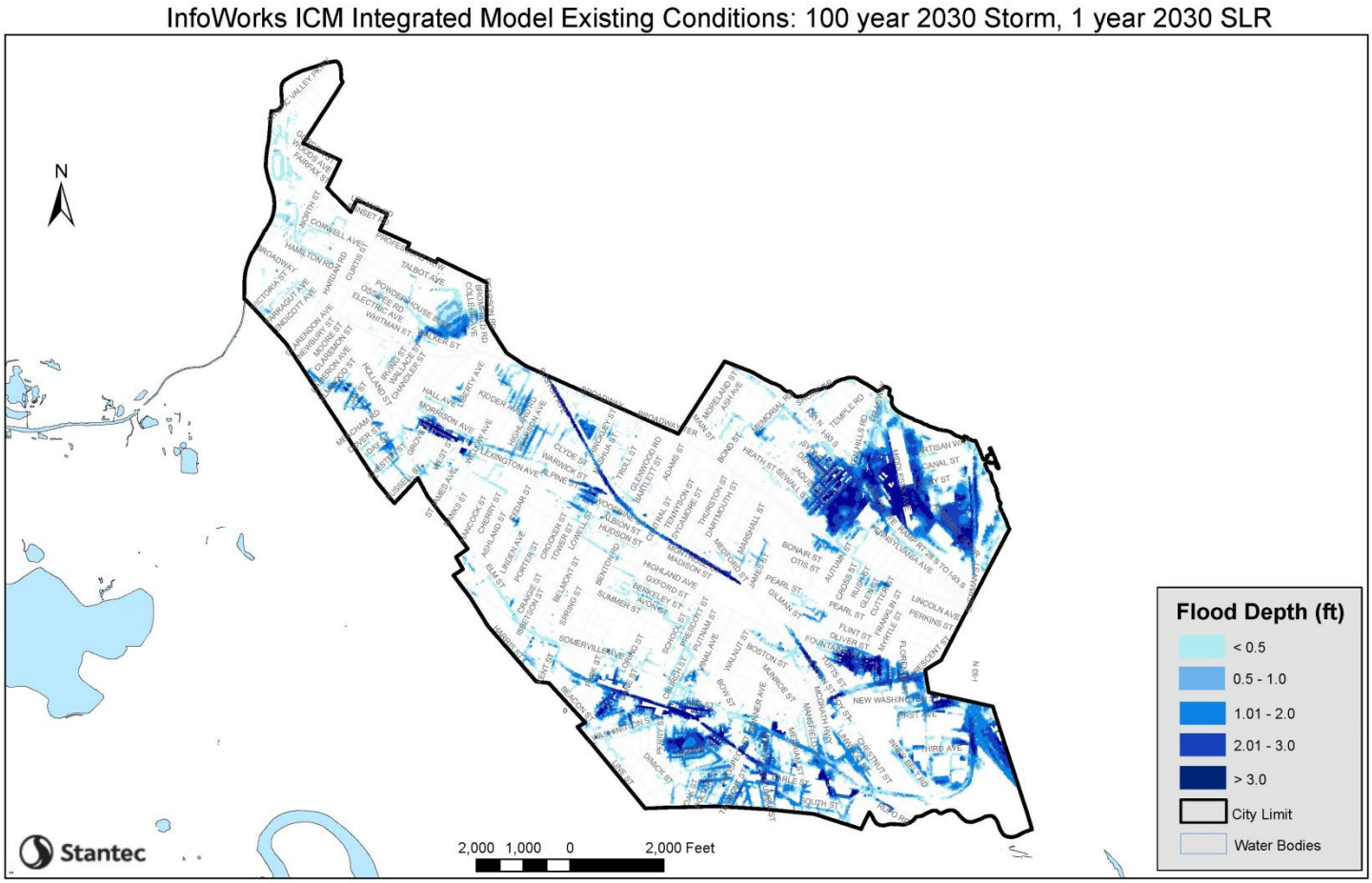
2070 Coastal Flood Depth from 2070 100-year Storm Event



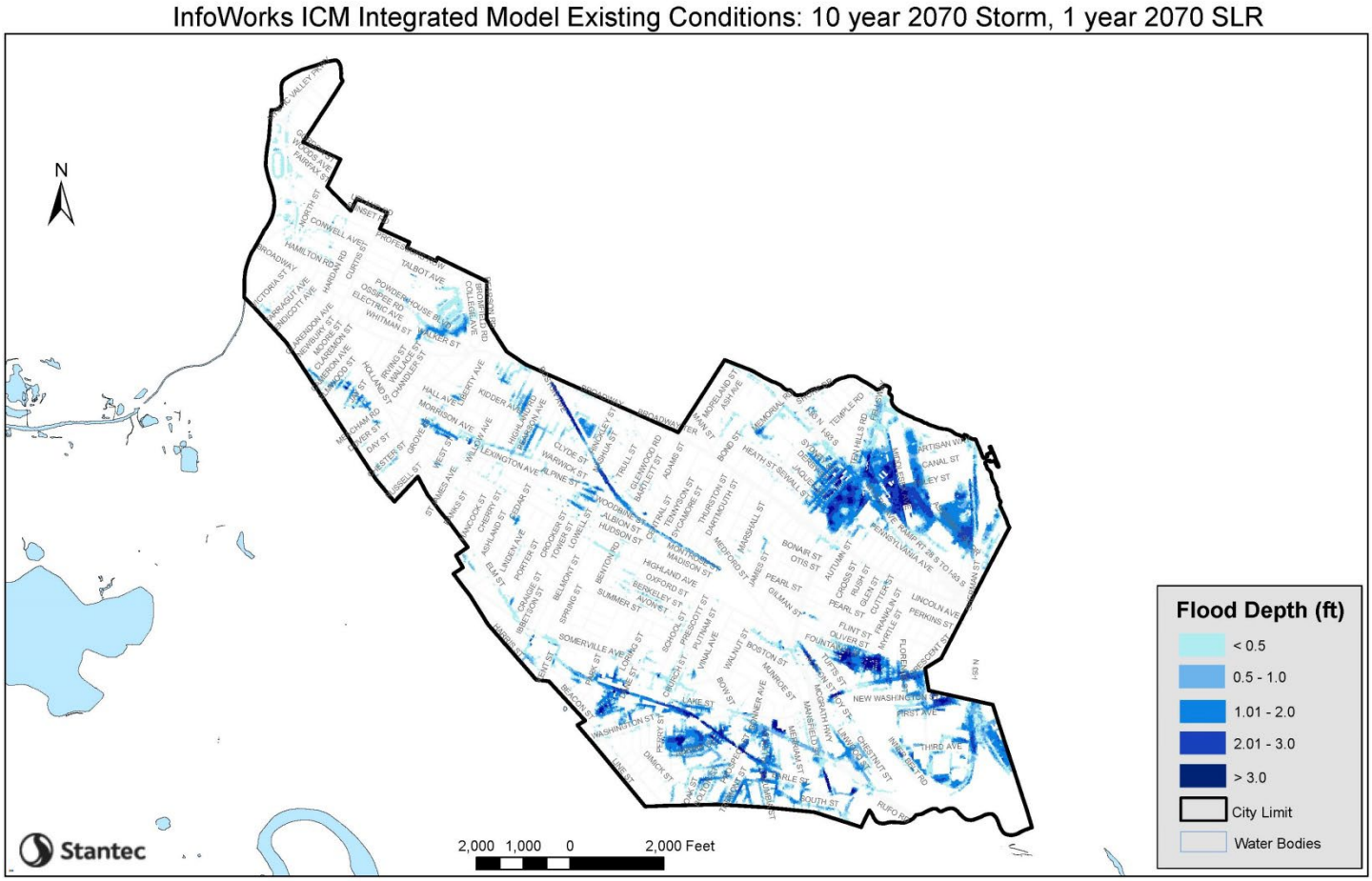
This map shows the projected flood depths of a 100-year coastal storm event in 2070 along with public transportation infrastructure assets. This map does not account for drainage (Somerville Climate Change Vulnerability Assessment, 2017).

Precipitation Projections
Precipitation-based flooding is projected to increase in Somerville and is currently more of an immediate and widespread threat than sea level rise and storm surge. The intensification of both the frequency and intensity of rainfall events is likely to cause increased risk of flooding during rain events.

Storm Type	Present-day Rainfall	2030 Rainfall	2070 Rainfall
10-year (10% annual chance), 24-hour	4.9 in	5.6 in	6.4 in
100-year (1% annual chance), 24-hour	8.9 in	10.2 in	11.7 in



This map shows the impact of both precipitation-based flooding and sea level rise and storm surge. This map shows the modeled flood depths of a 100-year, 24-hour Design Storm with 1-year storm surge and sea level rise projections in 2030. Unlike the maps above, this includes modeling of the drainage system, which takes into account how water will be conveyed out of the city. The model is based on how the system is designed to function, so actual areas of flooding and depth of flooding could vary (Stantec, 2019).



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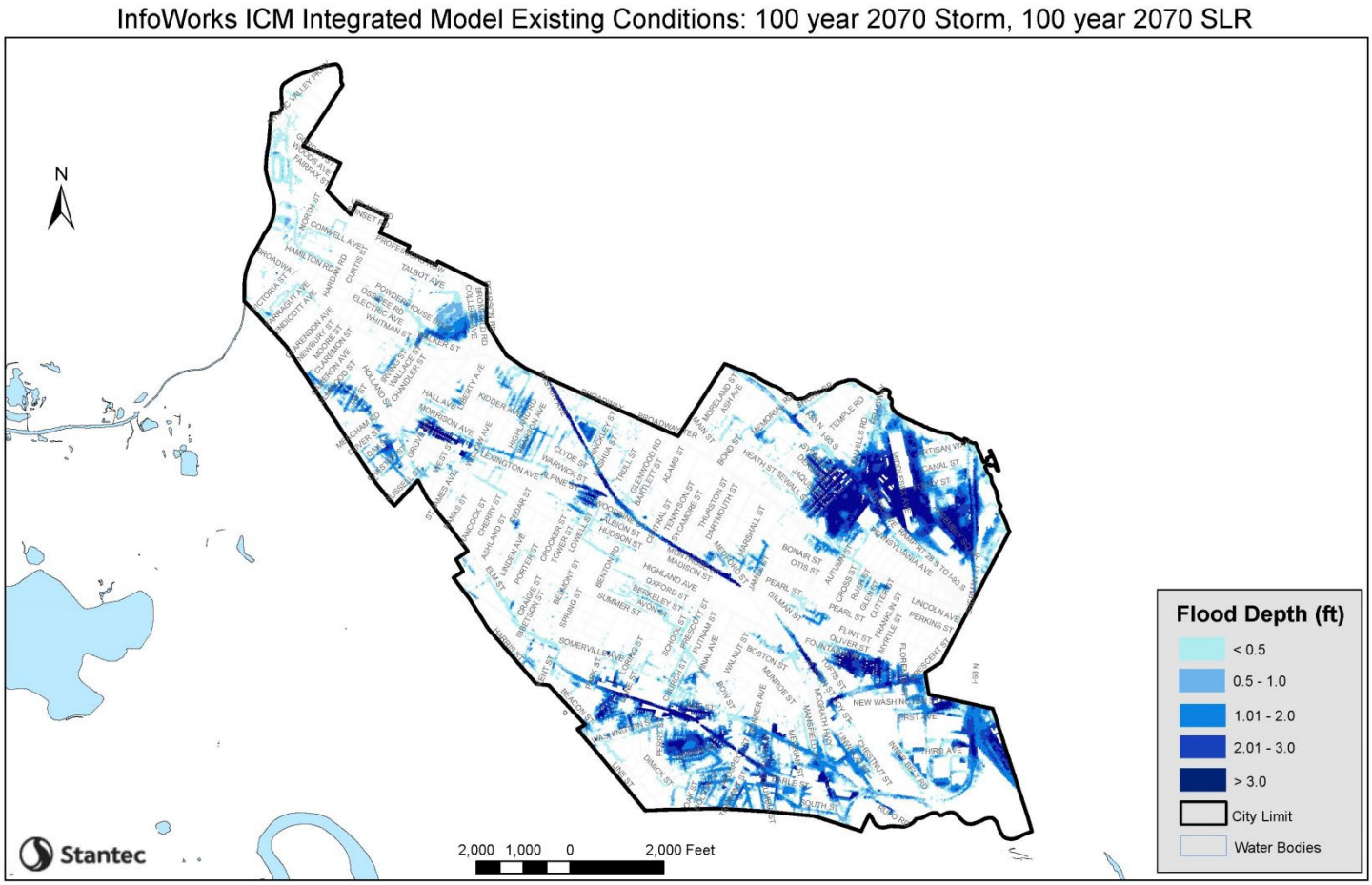

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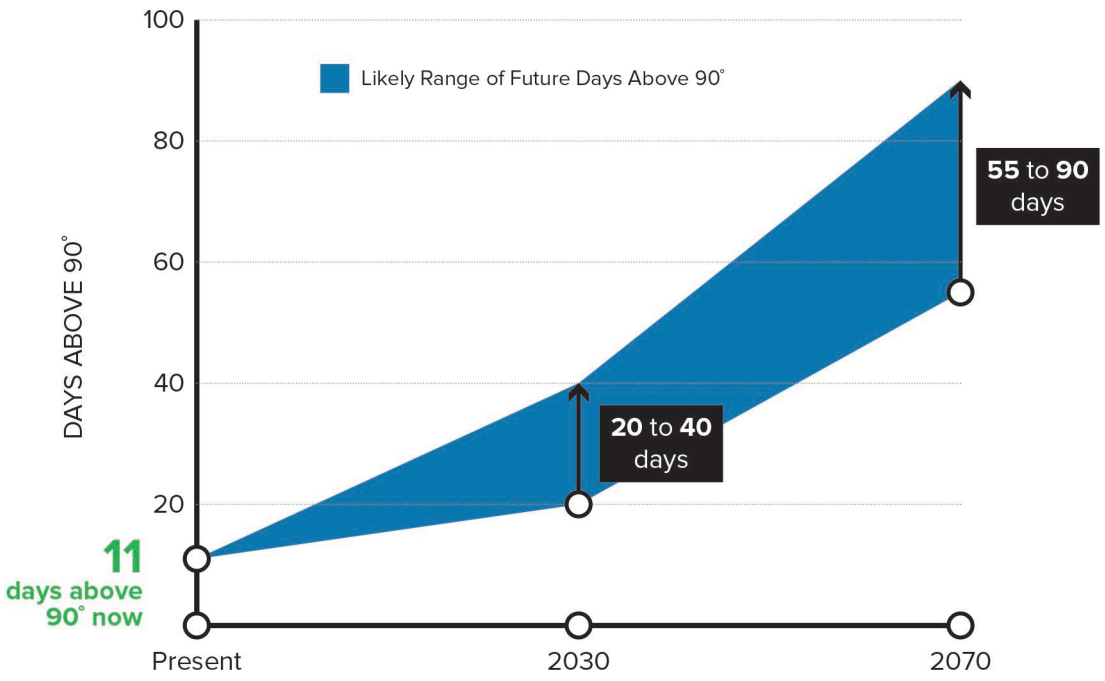
Temperature Projections



(Somerville Climate Change Vulnerability Assessment 2017)

Temperature	1971-2000 (average)	2030 (low)	2030 Avg.	2030 (high)	2070 (low)	2070 Avg.	2070 (high)
Annual	50.0º F	53.3º F		53.5º F	55.8º F		58.7º F
Summer	70.6º F	74.5º F		74.8º F	77.4º F		80.6º F
Winter	29.8º F	32.2º F		33.0º F	34.6º F		38.0º F

RESOURCES:

For information on net-zero and resilient building and site design, please review the following resources:

- Passive House Principles
- Architecture 2030 Palette (Net-zero design tools)
- Zero Energy Buildings in Massachusetts: Saving Money from the Start
- Building Resilience in Boston
- Enhancing Resilience in Boston
- A Better City's Resiliency Toolkit
- Ready to Respond: Strategies for Multifamily Building Resilience

For additional information visit www.somervillema.gov/sustainaville

SUSTAINABLE & RESILIENT BUILDINGS QUESTIONNAIRE

Section 1: Proposal Information

Proposal Name	50 Webster Avenue, P&Z 21-060
Address	50 Webster Avenue
Developer	US Union Square D3.1 Owner, LLC
Business Address	31 Union Square, Somerville, MA 02143
Designated Contact	Patrick Borzenski
Telephone Number	312.469.8021
Contact's Email Address	pborzenski@magellandevelopment.com
Date Submitted	04/15/2022
Filing Type (Development review application, Building Permit, or CoA)	Development Review Application
Is this a revised Questionnaire?	No
Is MEPA Approval Required?	Project already in receipt of MEPA Approval.

Section 2: Building & Site Details

2.1 Building Information

Building Uses	Core and shell lab/office building, retail
Gross Floor Area	280,000 SF
Expected Life of Building	60 years
Please describe the following	
Building heating plant and distribution System	High efficiency gas-fired hot water and exhaust energy recovery
Building cooling plant and distribution system	Chilled water provided by central water-cooled chillers and exhaust energy recovery
Ventilation system	100% OA System serving Office and Lab ventilation requirements.
Domestic hot water system	Combination electric hot water and air-source heat pump hot-water heaters

2.2. Green Building	
Green Building Professional(s): Name(s) and contact information	Jason Franken, jfranken@databasedplus.com, 312-847-1028
Professional Credentials: Green Building Program Certification(s)	LEED AP, WELL AP
Building LEED Rating	Gold
Building LEED Point Score	66
Will you pursue LEED certification through the USGBC?	The team may apply for certification
Are any other green building certifications being pursued? (Passive House, Enterprise Green Communities, etc.). Please describe.	No

2.3. Electric Vehicle Parking

The number of electric vehicles (EVs) in Somerville is expected to increase significantly over the next decade with more electric vehicles coming to market than ever before. Conservative estimates based on historical trends alone suggest 20% of personal vehicles in Somerville will be electric by 2040. Installing capacity for EV supply equipment (EVSE) has been shown to be more feasible and cost effective during construction than when retrofitting parking areas to support the installation of EVSE in the future[1]. Providing EVSE can increase the property value, become a future revenue source, and provide an amenity that more tenants and commuters will be looking for. It is recommended that parking facilities be designed to allow for the most flexibility to adapt to future needs of electric vehicles and changing mobility needs. **The City of Somerville recommends 25% of spaces have installed charging access and up to 100% of spaces be "EV Ready"** (everything but the station installed). Eversource currently has a program to pay the associated infrastructure costs of EV charging, including infrastructure needed to be "EV ready." Please consult with Eversource to determine if any installation costs could be covered through their Make Ready Program.

Total # of Parking Spaces	270

[1] http://evchargingpros.com/wp-content/uploads/2017/04/City-of-SF-PEV-Infrastructure-Cost-Effectiveness-Report-2016.pdf; https://www.richmond.ca/__shared/assets/Residential_EV_Charging_Local_Government_Guide51732.pdf

EVSE Plugs (number and voltage/ level of plugs)	15% of spaces with Level 2 Type EV Chargers
EV Ready Spaces (everything but station is installed)	Remaining 85% of available parking spaces
Please share any other information on your EV strategy. Have you spoken with Eversource? Are you talking with EVSE providers? Have you considered EVSE needs in conjunction with your parking and mobility management plans?	The team is currently developing an initial load letter that can be submitted to Eversource that is required in order to have a preliminary meeting with Eversource engineering team. The team has not spoken to any EVSE providers respecting this project, but is familiar with the EV Make-Ready program, funding for which is anticipated to provide for new incentives during the summer of 2022. The project is mindful to review the project early with EVSE providers as the parking and mobility management plans are developed.

2.4 Energy Input Form
Required for projects over 25,000 SF, optional for all other projects

Download a copy of the Somerville Low Load Building Energy Input Form and follow the instructions included in the spreadsheet.

Pre-Submittal Phase

- Complete the 'PRE-SUBMITTAL INFO' tab of the Energy Input Form and submit to the Office of Sustainability and Environment (ose@somervillema.gov) 1 week prior to your pre-submittal meeting with OSE.

Development Review Phase

- Complete the 'DEVELOPMENT REVIEW INFO' tab of the Energy Input Form and submit to the Office of Sustainability and Environment (ose@somervillema.gov) at least 3 weeks prior to your application submittal for Board review.
- Projects pursuing Passive House certification from PHIUS or PHI do not have to complete the Development Review Info tab.

Continue onto next page.

2.5 Net Zero Carbon Building Compliance
The City of Somerville encourages projects to eliminate the incorporation of fossil fuels in their building operations. Please explain the proposed building's electric heating system capacity and confirm it is consistent with Row 24 in 'Energy Input Form – Pre-submittal Dashboard Tab' or Row 28 if the project is a laboratory building. If the project intends to incorporate fossil fuels, please provide a rationale below and explain provisions that your project is taking to electrify base building systems in the future.

The building is planned to support a Life Science Laboratory program. The goal of the design is to maximize the heat recovery savings to minimize the overall load of the building. A high efficiency heat recovery loop will be used. Enhancements to this heat recovery system will be planned for to provide further load reductions in the future as technologies develop. Thesee enhancements include Day 1 installation of heat recovery coils that allow for operational efficiencies/control strategies to be implemented as well as space allocation for future water source heat pump technology to further reduce overall heating demand. In addition, the heat injection portion of the heat recovery loop will be designed to support future tie in of air source heat pumps that will be the primary heat source for the building in the future, with natural gas boilers acting as secondary and as backup.

2.6 Describe any and all incentives, rebates, grants provided by utilities, government organizations, and other organizations being pursued to maximize building efficiency and to reduce emissions. Description must include any incentives that were considered but are not being pursued, including reasoning for each decision.

In addition to monitoring the potential continuation of the EV-Make Ready program through Eversource, the team is investigating the MassSave program for Energy Use Intensity Reduction. More specifically 'Path 2: Whole Building Energy Use Intention (EUI) Reduction' provides for coordinated expertise in identifying energy conservation measures to reduce energy use. The project team recognizes a 10% reduction from the Mass Save baseline will be required to be eligible for the program.

2.7 Evaluate feasibility of on-site renewable generation. Please describe your analysis and findings. Analysis should consider incentives available. Will any renewable energy generation be incorporated into the project? If so, please describe (system type and capacity). If no, could it be added in the future? And will any off-site renewable energy be purchased?

The irregular site and its small area create challenges for on-site renewable energy generation. The Applicant supports the Idea of PV rooftop installations however the majority of the roof is to host the mechanical equipment required to support the lab program, making impractical a solar application at this site. In light of these constraints, the purchase of off-site renewable energy will be investigated. Additional monetary contributions to offsite infrastructure will support area-wide resiliency planning efforts. Please reference the LEED narrative for additional details on resiliency enhancements.

Section 4: Climate Change Risk and Vulnerability

4.1 Climate Vulnerability Exposure (check all that apply)	✓ **Sea Level Rise & Storm Surge** ✓ **Precipitation Induced Flooding** ✓ **Heat** ☐ Other(s):

4.2 How is your site vulnerable to projected climate change impacts?

The building is located at Union Square in the Ward 2 neighborhood. Per the Somerville Climate Change Vulnerability Assessment, this location is not at high-risk for flooding due to coastal storm events or sea-level rise. However, it is indicated as a high-priority risk location for flooding due to severe rain events, including the 100-year 24-hour precipitation event. In addition, the neighborhood is designated as a High Heat Exposure area, indicating that extreme heat events are more likely in this location, due to projected higher summer and impacts of the urban heat island effect.

The next two sections ask specific questions about how the project is designed to manage climate-related risks from heat, coastal and inland flooding.

Section 5: Managing Heat Risks

5.1 Describe all building features that will keep building occupants safe and comfortable during extreme heat, including mechanical systems and non-mechanical design elements to cool building (orientation, envelope, operable windows, etc.).

The building will have high efficiency envelope to retain comfortable temperatures in the building. Additionally, façade design of 50 Webster and the building's orientation on site have played a role in maximizing envelope performance. More specifically, north and northwest façades, provide for higher glazing ratios while the southern elevation introduced additional opacity. Beyond envelope facades, acting as the building's fifth façade, the high efficiency roof will be composed of high-albedo roofing materials as well as a vegetated green roof should additional space be available.

5.2 How has increased demand for indoor cooling been factored into the building design and energy management strategy?

The building façade features deep surrounds at the window openings in order to provide additional shading on the glass to reduce the solar heat gain to improve the overall occupant comfort within the building. Further, as described above, the façade design provides for additional glazing at northwest and north

oriented facades where direct sun is limited, and conversely prioritizes opacity in greater proportion on facades oriented so the south.

5.3 List any indoor spaces without cooling and their uses.

The building will feature a sub-grade parking garage that will not be conditioned at the parking areas.

5.4 What design features will be implemented on site to minimize the site's contribution to the urban heat island effect? Please describe any and all design elements. Strategies could include, but are not be limited to, the following:

- High albedo pavement or roof materials
- Passive cooling or increased ventilation capacity
- Green roofs or walls
- Heat resistant trees and plants
- Additional landscaped areas

The building will have a high efficiency roof with high-albedo roofing materials that will be specified as well as a vegetated green roof should additional space be available. Provided the existing site's condition as a single-story building and impermeable surface parking lot, he Project's approach to landscaping will introduce new opportunities for green infrastructure that will directly combat the urban heat island effect. With future frontages along the pedestrian-oriented streets of Prospect Street and Webster Avenue, a new, approximately 16,000 SF public plaza will serve as host to new landscaped areas. New, large trees will be planted strategically to address user comfort, and will be planted within soil volumes necessary to provide for their growth to full maturity. Located west of the building site, species selection will ensure that welcome shade is provided during summer months directly addressing the anticipated increase in number of high-heat days.

Section 6: Managing Flood Risks

6.1 Is the site susceptible to flooding from sea level rise and storm surge and/or rain events now or during the building's expected lifetime? Please refer to the Somerville Climate Change Vulnerability Assessment and the updated stormwater flooding maps provided in the Background section of this Questionnaire. Additional maps and data are available at www.somervillema.gov/floodready or by request (email ose@somervillema.gov).

Yes, although precipitation-based flooding represents a more immediate and widespread threat than sea level rise and storm surge.

If you answered YES to the previous question, please complete the remainder of Section 6. Otherwise, you have completed the Questionnaire. Thank you.

6.2 Flooding Design Considerations

Proposed Site Elevation - Low	13.6 (ft)	Proposed Site Elevation - High	32.2 (ft)
Lowest elevation of life-safety systems	(ft)	Proposed First Floor Elevation	24.5 and 26.0 (ft)
Nearest flood elevation for the 2070 10-year storm	9.4 ft existing. 2070 Requested	Nearest flood elevation for the 2070 100-year storm	10.2 ft

6.3 What are the first floor uses of the building? Are there any below ground stories of the building? If so, what uses are located below ground?

The ground floor will feature the main entry to the building lobby and retail fronting the adjacent civic space to encourage a vibrant condition at the streetscape. The ground level will also support the building's service areas, including access to bike parking, loading, utility entrance room, electrical vault and parking garage entrance to the sub-grade parking levels. The services will be located along the new thoroughfare to the west of the building with service access to the north side of the building. Below grade will facilitate parking to support the building, utility / mechanical rooms, long-term bike parking and shower facility.

6.4 Are there any flood-sensitive assets, utilities, mechanical equipment, or life-safety systems located in areas of the building that are at risk of flooding? What measures will protect building systems during a flood or severe storm? These might include, but may not be limited to, the following:

- Elevation of utilities and mechanical systems
- Water tight utility conduits
- Waste water back flow prevention

- Storm water back flow prevention
- Systems located above the ground floor
- Securing objects at risk of becoming dislodged

Water tight utility conduits, waste water back-flow and holding tank, and a storm water retention tank servicing the D3.1 parcel are part of project scope.

The property manager will create a flood/storm event plan to manage implementation of resiliency measures, including raising elevators, selectively turning off power, implementing temporary flood barrier system, etc.

6.5. Residential and commercial buildings should be designed to maintain regular operations during a 10-year storm in 2070. **Describe how the site and building have been designed to maintain regular operations--meaning all systems will remain operational and all occupied spaces are protected from flooding--during the 2070 10-year storm.** Please refer to both the 2070 coastal flood probability map and the 2070 10-year storm and 1-year sea level rise scenario (pages 3 and 6). Resilience measures might include, but may not be limited to, the following:

- Elevation of the site
- Structural elevation of the building
- Non-structural elevation of the ground floor
- Energy storage and backup generation
- Wet flood-proofing (allowing water to flow through building envelope)
- Dry flood-proofing (preventing water from entering building)

The first floor elevation of the building is designed above the 2070 10-year flood elevation and grades slope away from the building. Backwater valves will be installed on the sanitary sewer and storm drain line.

6.6 Residential buildings should be designed to allow occupants to shelter in place during a catastrophic storm (100-year event) today and in the future, this means all life-safety systems should be above the 2070 100-year flood elevation. **How will your site and building be impacted by the 2070 100-year, 24-hour storm and how will your site and building be designed to protect against those impacts?** Please evaluate impact based on both the 2070 coastal flood depth model for the 100-year storm and the 2070 100-year, 100-year sea level rise model (pages 4 and 7). Summarize anticipated pre- and post-event policies, strategies, and actions necessary to facilitate post-flood recovery.

N/A

6.7 Will hazardous or toxic material be stored on site? Where will it be stored? How will you protect hazardous or toxic material from flooding?

By code a Laboratory Use building is required to store chemicals at the ground level. Storage strategies for chemicals will address the top-shelf locating of these hazardous and toxic materials, locating them several feet above base flood elevation.

6.8 Will the site be accessible by a typical vehicle during a 10-year event (up to 6 inches of water) and by emergency vehicles (up to 12 inches of water) during a 100-year event?

The site will be accessible by a typical vehicle during a 10-year event (up to 6 inches of water) and by emergency vehicles (up to 12 inches of water) during a 100-year event based on the City's models for the 10-year, 24-hour storm event and 100-year, 24-hour storm event for existing conditions.

LEED COMPLIANCE

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Proposal Name: **50 Webster Avenue, P&Z 21-060**
Developer: **US Union Square D3.1 Owner, LLC**

Sustainability Affidavit

As the Sustainability Consultant overseeing the planning, design, and construction of the 50 Webster Avenue, I, Claudia Mattison, LEED AP BD+C, certify that I am knowledgeable of the project's green building strategies, designs, plans, and details, and to the best of my knowledge, this project has been planned and designed so as to meet the prerequisites and earn the credits necessary to achieve 66 points (minimum for Gold level of certification is 60 points) using the LEED for Core and Shell v4 Rating System. Assuming that the project follows through on the green strategies described in the LEED Checklist, the project will be able to earn LEED Gold level of certification.

Claudia Mattison
P.E., LEED AP BD+C, LEED for Homes Green Rater
Group Leader | High Performance Studio

Proposal Name: **50 Webster Avenue, P&Z 21-060**
Developer: **US Union Square D3.1 Owner, LLC**

Sustainable Design Narrative

As part of meeting the Union Square Redevelopment zoning requirements, the Somerville Parcel D3.1 project has set a minimum target of LEED v4 Gold certification. The descriptions below highlight strategies that will be pursued in order to achieve the level of sustainability desired for the project. The LEED Checklist is included at the end of the document. This document has been prepared by Claudia Mattison, LEED AP BD+C, LEED for Homes Green Rater.

Integrative Process

Integrative Process (Credit)
During SD and the early part of DD, the project team has used cross-discipline design and decision making to identify and use opportunities to achieve synergies across disciplines and building systems. As part of the commissioning process, an Owner's Project Requirements document has been put together to guide the design and construction team. As part of the MEPA and GHG processes and in early phase energy modeling, preliminary energy models were developed to test potential strategies associated with the following opportunities: Site condition, massing and orientation, basic envelope orientation, lighting levels, thermal comfort ranges, and plug and process load needs. A preliminary water budget analysis was completed for both indoor and outdoor water demand, and process water demand and supply sources were investigated. The results of these analysis were incorporated into the design of the project where practical and economical.

Location and Transportation

Sensitive Land Protection (Credit)
The project is a new building on a previously developed site; therefore, it meets the "Previously Developed" requirements.

High Priority Site (Credit)
The project team expects to earn Option 2 - Priority Designation. The site is located in a 2019 Difficult Development Area, which qualifies it for Option 2. Additionally, the site will be assessed for brownfield contamination per Option 3, and measures will be taken for remediation, abatement and removal in accordance with regulations, as needed.

Surrounding Density and Diverse Uses (Credit)
The area around the project will satisfy the surrounding density requirement. The project team will identify building sites and buildable land within required radius of the project site, collect information on density, and perform combined residential and non-residential density calculations. To fulfill the diverse uses requirements, the development is located within 0.5 miles of a dense residential area and a number of amenities including but not limited to: 1. J & A Used Auto Parts, 2. Taza Chocolate, 3. ONCE Somerville, 4. Royal Hospitality Services Inc, 5. Boynton Yards, 6. Gentle Giant Moving Company, 7. Union Square Donuts Production Kitchen, 8. Jagger's Surf City Classics, 9. Webster Auto Sales.

Access to Quality Transit (Credit – LEED v4.1 upgrade)
The project is located within 0.25 miles of the CT2, 91, 85, 86, and 87 MBTA bus lines. Additionally, the project will be directly adjacent to the Green Line Extension Union Square Station, which is expected to be complete in Spring 2022, within twenty-four months of the project's completion date.

Bicycle Facilities (Credit)
The project will meet the credit requirements by providing short-term bicycle storage for at least 2.5% of all peak visitors, and long-term bicycle storage for at least 5% of all regular building occupants. The current plans include a bike room with the required long-term bicycle storage spaces, exterior bike racks meeting the requirements, and the required number of showers, attached to the men's and women's locker rooms. The bicycle network through Union Square and the diverse destinations (noted above in the Surrounding Density and Diverse Uses credit) will be documented via a map.

Electric Vehicles (Credit– LEED v4.1 upgrade)
The project will designate at least 15% of all parking spaces for the installation of electric vehicle supply equipment and make the remaining parking spaces EVSE-ready, in all instances complying with the approved Mobility Management Plan for the project. This will meet the LEED requirements for 5% of all parking spaces to have electric vehicle supply equipment.

Sustainable Sites
Construction Activity Pollution Prevention (Prerequisite)
An erosion and sedimentation plan will enforce measures to protect adjacent areas from pollution from wind and water-borne soil and sedimentation. The civil design team prepared the erosion and sedimentation plan that meets the local codes and the EPA Construction General Permit of the National Pollution Discharge Elimination System (NPDES) program. The construction team will implement the erosion and sedimentation measures and will follow the requirements of the stormwater pollution prevention plan during the construction.

Site Assessment (Credit)
The project team will complete and document a site assessment that includes analysis of: topography, hydrology, climate, vegetation, soils, human use, and human health effects.

Site Development: Protect and Restore Habitat (Credit– LEED v4.1 upgrade)
The project will seek to restore at least 15% of previously developed land by restoring disturbed soils and planting a minimum of six native or adaptive species. Landscaping design will consider available space at both ground level and on rooftops.

Open Space (credit– LEED v4.1 upgrade)
The project will seek to provide outdoor space equal to 30% of the total site area and at least 25% of the outdoor space will be vegetated with a minimum of six native or adaptive species. The Design Team will consider whether accessible green roof space will contribute to this credit.

Heat Island Reduction (Credit)
The project will meet Option 2 by placing at least 75% of parking area under cover.

Light Pollution Reduction (Credit)
The project has designed the exterior lighting to meet the BUG rating requirements for Lighting Zone LZ3.

Tenant Design and Construction Guidelines (Credit)
The project will provide a Tenant Design and Construction Guidelines document to all tenants that includes a description of the sustainable design and construction features incorporated in the core and shell project; the project's sustainability goals and objectives (including those for tenant spaces); recommendations, including examples, for sustainable strategies, products, materials, and services; and information that enables the tenants to coordinate space design and construction with the building systems when pursuing the LEED v4 for Interior Design and Construction prerequisites and credits.

Water Efficiency
Outdoor Water Use Reduction (Prerequisite)
The project will reduce the project's landscape water requirement by at least 30% from the calculated baseline for the site's peak watering month. Reductions will be achieved through plant species selection and irrigation system efficiency (drip irrigation and smart controllers), as calculated by the Environmental Protection Agency (EPA) WaterSense Water Budget Tool. The project is currently planning on choosing native & adaptive species with lower water requirements, installing smart and water-efficient irrigation systems and discussing the possibility of removing irrigation altogether.

Indoor Water Use Reduction (Prerequisite)
The project will use low flush 1.1 GPF toilets, 0.125 GPF urinals, 0.35 GPM lavatory faucets, 1.5 GPM kitchen faucets, and 1.5 GPM showerheads, which are calculated to achieve a reduction in water usage of approximately 35% over the baseline. All fixtures except the kitchen and lavatory faucets will be WaterSense certified, and all appliances will be ENERGY STAR.

Building-Level Water Metering (Prerequisite)
The project will install permanent water meters that measure the total potable water use for the building and associated grounds.

Indoor Water Use Reduction (Credit)
The project will use low flush 1.1 GPF toilets, 0.125 GPF urinals, 0.35 GPM lavatory faucets, 1.5 GPM kitchen faucets, and 1.5 GPM showerheads, which are calculated to achieve a reduction in water usage of approximately 35% over the baseline. All fixtures except the kitchen and lavatory faucets will be WaterSense certified, and all appliances will be ENERGY STAR. Ownership will also consider whether signed lease agreements may be secured for the retail spaces specifying low-flow fixtures, which would increase the savings above the 40% threshold.

Water Metering (Credit)
The project will install permanent water meters to monitor water use for at least two water subsystems, likely irrigation and cooling tower water use. If permanent irrigation is eliminated, domestic hot water may be sub-metered.

Energy and Atmosphere
Fundamental Commissioning (Prerequisite)
Commissioning of mechanical, electrical, and plumbing, in accordance with ASHRAE Guideline 0-2005 and ASHRAE Guideline 1.1–2007 is under contract and will be performed. Owner's Project Requirements have been developed, and a Basis of Design will be developed as well.

Minimum Energy Performance (Prerequisite)
The energy code utilized for the Project will be the Massachusetts Energy Stretch Code and ASHRAE Standard 90.1-2010 for LEED purposes. The OSE Energy Input Form has been completed and suggests the building will show a 25.3% reduction in source energy and 48% reduction in site energy, resulting in a 48.4% decrease in 2035 Carbon Emissions Intensity. It is anticipated that the LEED energy model, which will be performed in-line with the LEED Alternative Energy Performance metric EApc95, will result in approximately ~20% greenhouse gas emissions reductions.

Building-Level Energy Metering (Prerequisite)
Building-level energy meters and submeters that can be aggregated to provide building-level data representing total building energy consumption (electricity and natural gas) will be installed. Energy consumption will be tracked and shared with the USGBC for a five-year period.

Fundamental Refrigerant Management (Prerequisite)
No CFC-based refrigerants will be utilized for the Project.

Enhanced Commissioning (Credit)
An independent commissioning authority has been contracted to perform on-board design reviews, verify operator training, and review building operations ten months after occupancy in accordance with ASHRAE Guideline 0–2005 and ASHRAE Guideline 1.1–2007. Additionally, the project will develop a monitoring-based commissioning plan that includes monitoring-based procedures and identifies points to be measured and evaluated to assess performance of energy- and water-consuming systems. An independent envelope commissioning authority will be hired to fulfill the requirements in EA Prerequisite Fundamental Commissioning and Verification as they apply to the building's thermal envelope. The BECxA will complete the commissioning process activities for the building's thermal envelope in accordance with ASHRAE Guideline 0–2005 and the National Institute of Building Sciences (NIBS) Guideline 3–2012, Exterior Enclosure Technical Requirements for the Commissioning Process, as they relate to energy, water, indoor environmental quality, and durability.

Optimize Energy Performance (Credit)
The OSE Energy Input Form has been completed and suggests the building will show a 25.3% reduction in source energy and 48% reduction in site energy, resulting in a 48.4% decrease in 2035 Carbon Emissions

Intensity. It is anticipated that the LEED energy model, which will be performed in-line with the LEED Alternative Energy Performance metric EApc95, will result in approximately ~20% greenhouse gas emissions reductions.

Materials and Resources

Storage and Collection of Recyclables (Prerequisite)
There will be a dedicated recycling storage area within the loading dock of the building. This area will store paper, corrugated cardboard, glass, plastics and metals for pick-up by local recycling haulers. This area will also include space for the storage and disposal of two of the following: batteries, mercury-containing lamps, and electronic waste.

Construction and Demolition Waste Management Planning (Prerequisite)
The project team will develop and implement a construction and demolition waste management plan establishing waste diversion goals and identifying at least five material streams targeted for diversion. The plan will specify materials that will be separated onsite, as well as commingled waste, and note the exclusion of Alternative Daily Cover from recycled materials. A final report detailing all major waste streams generated, including disposal and diversion rates, will be provided.

Building Life-Cycle Impact Reduction (Credit – LEED v4.1 upgrade)
The project team will complete a life-cycle assessment of the project building's structure and enclosure. Primary intent will be to quantify the embodied carbon footprint and the secondary goal will be to demonstrate a minimum of 5-10% reduction, compared with a baseline building, in at least three of the six impact categories (one of which must be global warming potential).

Building Product Disclosure & Optimization— Environmental Product Declarations (Credit – LEED v4.1 upgrade)
The project has specified at least 10 different products sourced from at least 3 manufacturers that either have industry-wide EPDs or product-specific EPDs available. The project is targeting 40 EPDs to earn the exemplary performance point for this credit. The design team will also seek to achieve the Option 2 Multi-Attribute Optimization criteria through careful specifications and product sourcing.

Building Product Disclosure & Optimization—Sourcing of Raw Materials (Credit – LEED v4.1 upgrade)
The project will use products that have recycled content and/or an extended producer responsibility program and wood that is FSC-certified for at least 15%, by cost, of the total value of permanently installed building products in the project.

Building Product Disclosure & Optimization— Material Ingredients (Credit – LEED v4.1 upgrade)
The project will use at least 10 different permanently installed products from at least five different manufacturers that have either a manufacturer inventory, a Health Product Declaration, or Cradle to Cradle certification. The design team will also seek to achieve the Option 2 Multi-Attribute Optimization criteria through careful specifications and product sourcing.

Construction and Demolition Waste Management (Credit)
The project team will develop and implement a construction and demolition waste management plan to maximize diversion and reuse of material and identify at least five materials targeted for diversion. The project will divert at least 50% of the total construction and demolition material, and the diverted materials will include at least three material streams or will be commingled material handled by a certified facility.

Indoor Environmental Quality

Minimum IAQ Performance (Prerequisite)
The ventilation code utilized for the Project will be ASHRAE Standard 62.1-2010, as required by the present Massachusetts Building Code and LEED. The mechanical systems are designed to provide the required ventilation throughout the building. Direct outdoor airflow measurement devices capable of measuring the minimum outdoor air intake flow will be provided for all OA systems.

Environmental Tobacco Smoke Control (Prerequisite)

Smoking is prohibited anywhere in the building and within 25 feet of main entries, operable windows, and air intakes. Signage will be posted at entrances to convey this prohibition.

Enhanced Indoor Air Quality Strategies (Credit)
Permanent entryway systems will be provided at least 10 feet long in the primary direction of travel at all regularly used exterior entrances. Spaces where hazardous gases or chemicals may be present will be exhausted at a minimum of 0.50 cfm per square foot to create negative pressure with respect to adjacent spaces when the doors to the room are closed. For each of these spaces, self-closing doors and deck-to-deck partitions will be provided. All ventilation systems will be provided with MERV 13 filters. Ownership will also evaluate the opportunity to install carbon dioxide monitors, integrated with the BAS, in all densely occupied spaces.

Low-Emitting Materials (Credit – LEED v4.1 upgrade)
Flooring, paints and coatings, and insulation will be in compliance with the CDPH Standard Method v1.2-2017 emissions testing, and the project will target adhesives and sealants and composite wood. All adhesives and sealants will be in compliance with the CDPH Standard Method v1.2-2017 emissions testing. All composite wood will be documented to have low formaldehyde emissions that meet the California Air Resources Board ATCM for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins or no added formaldehyde resins. Paints, coatings, adhesives, and sealants will be specified to meet the low-VOC content limits as prescribed by the respective applicable standards

Construction IAQ Management Plan (Credit)
An Indoor Air Quality Management plans will be implemented during the construction phase in accordance with the SMACNA Indoor Air Quality for Buildings under Construction Guideline. Absorptive materials will be protected from moisture damage. Permanently installed air handling units will most likely not be operated, but if they are, MERV 8 filters will be used and the filtration media changed prior to occupancy.

Quality Views (Credit)
At least 75% of all regularly occupied spaces will have a direct line of sight to the outdoors. View glazing in the contributing area will provide a clear image of the exterior, not obstructed by frits, fibers, patterned glazing, or added tints that distort color balance. Additionally, 75% of all regularly occupied floor area will have views with a view factor of 3 or greater and views that include at least two of the following: flora, fauna, or sky; movement; and objects at least 25 feet from the exterior of the glazing. This will be documented using typical floor plan layouts.

Innovation in Design
The team will be pursuing two exemplary performance points for Environmental Product Declaration and Material Ingredients. The team will also be pursuing the innovation credits for: Community Outreach and Development, Lamp Purchasing, and LEED O+M Starter Kit (Green Cleaning and Pest Management plans). The LEED AP credit criteria will be met via personnel on the Sustainability Consultant's team.

Regional Priority
The project expects to earn four regional priority points.

LEED Core and Shell v4 Summary: 66 LEED points

LEED CS v4 Scorecard

LEED v4 for CS: Core and Shell
Project Checklist

Project Name: 50 Webster Avenue, P&Z 21-060
Project Phase SD
Cert. Target: Gold
Date: 4/5/2022

C	S	G			
1			Credit	Integrative Process	1

17	1		Location and Transportation		20
			Credit	LEED for Neighborhood Development Location	20
2			Credit	Sensitive Land Protection	2
2			Credit	High Priority Site	3
6			Credit	Surrounding Density and Diverse Uses	6
6			Credit	Access to Quality Transit	6
	1		Credit	Bicycle Facilities	1
			Credit	Reduced Parking Footprint	1
1			Credit	Electric Vehicles	1

1	3	2	Sustainable Sites		11
Y			Prereq	Construction Activity Pollution Prevention	Required
	1		Credit	Site Assessment	1
		1	Credit	Site Development - Protect or Restore Habitat	2
		1	Credit	Open Space	1
			Credit	Rainwater Management	3
1			Credit	Heat Island Reduction	2
	1		Credit	Light Pollution Reduction	1
	1		Credit	Tenant Design Guidelines	1

	3	2	Water Efficiency		9
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
			Credit	Outdoor Water Use Reduction: 50% / 75% / 100%	3
	3	1	Credit	Indoor Water Use Reduction: 25% / 30% / 35% / 40% / 45% / 50%	6
			Credit	Cooling Tower Water Use	2
		1	Credit	Water Metering	1

8	2	3	Energy and Atmosphere		33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
		3	Credit	Enhanced Commissioning	6
8	2		Credit	Optimize Energy Performance	18
			Credit	Advanced Energy Metering	1
			Credit	Demand Response	2
			Credit	Enhanced Refrigerant Management	1
			Credit	Renewable Energy	5

4	1	2	Materials and Resources		12
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
1		1	Credit	Building Life-Cycle Impact Reduction	4
1			Credit	BPDO - Environmental Product Declarations	2
	1		Credit	BPDO - Sourcing of Raw Materials	2
1			Credit	BPDO - Material Ingredient Reporting	2
1		1	Credit	Construction and Demolition Waste Management	2

5		1	Indoor Environmental Quality		10
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
1			Credit	Enhanced Indoor Air Quality Strategies	2
3			Credit	Low-Emitting Materials	3
1			Credit	Construction Indoor Air Quality Management Plan	1
			Credit	Daylight	3
		1	Credit	Quality Views	1

5	1		Innovation			6
1			Credit	Innovation:	EP - EPD	1
	1		Credit	Innovation:	Innovation: Purchasing - lamps	1
1			Credit	Innovation:	Innovation: Community outreach and involvement	1
1			Credit	Innovation:	Innovation: LEED O+M Starter Kit	1
1			Credit	Innovation:	EP - HPD	1
1			Credit	LEED Accredited Professional		1

2		2	Regional Priority			4
		1	Credit	Regional Priority:	Indoor Water Use (4pts)	1
		1	Credit	Regional Priority:	Building Life-Cycle Impact Reduction (2pts)/	1
1			Credit	Regional Priority:	High Priority Site (2pts)	1
1			Credit	Regional Priority:	Optimize Energy (8pts)	1

C	S	G		
43	54	66	TOTALS	Possible Points: 106

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

SHADOW STUDY

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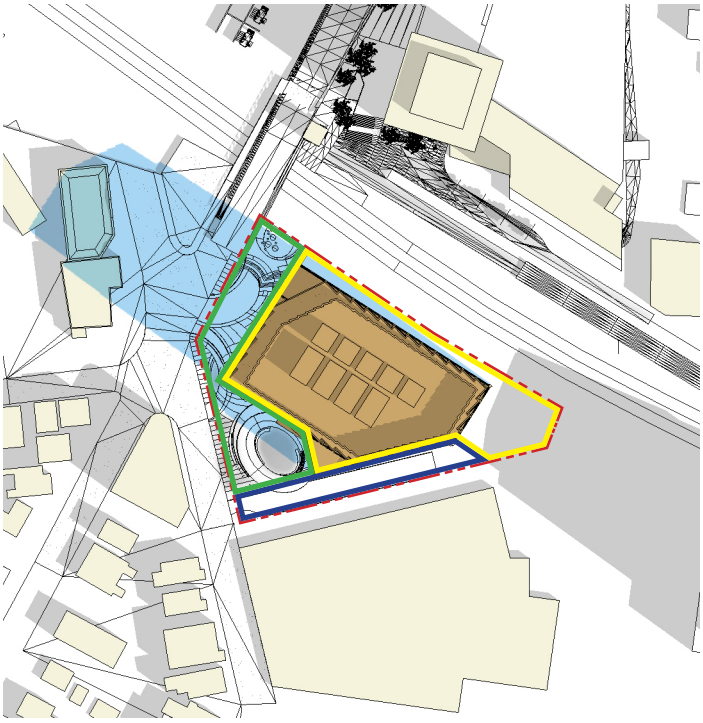
SHADOW STUDY

Existing and Net new shadows (March, 21)



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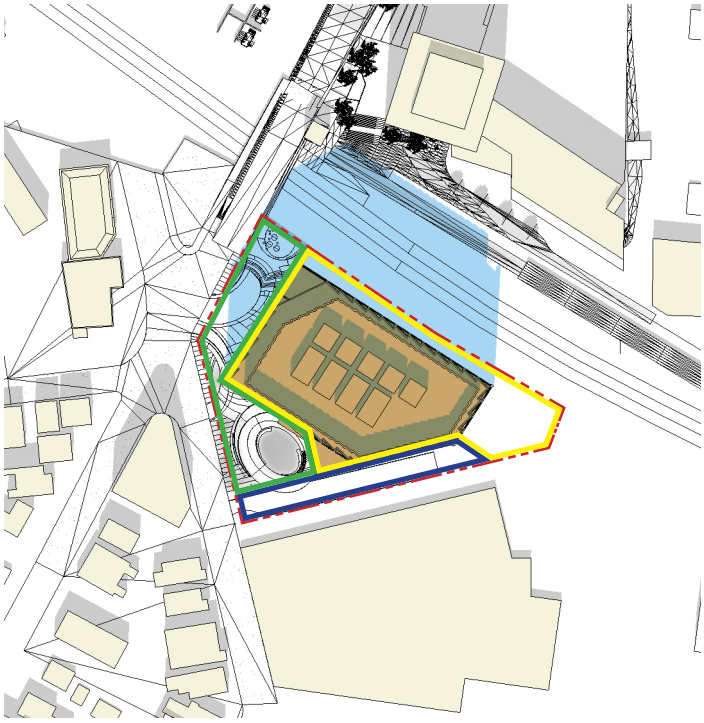

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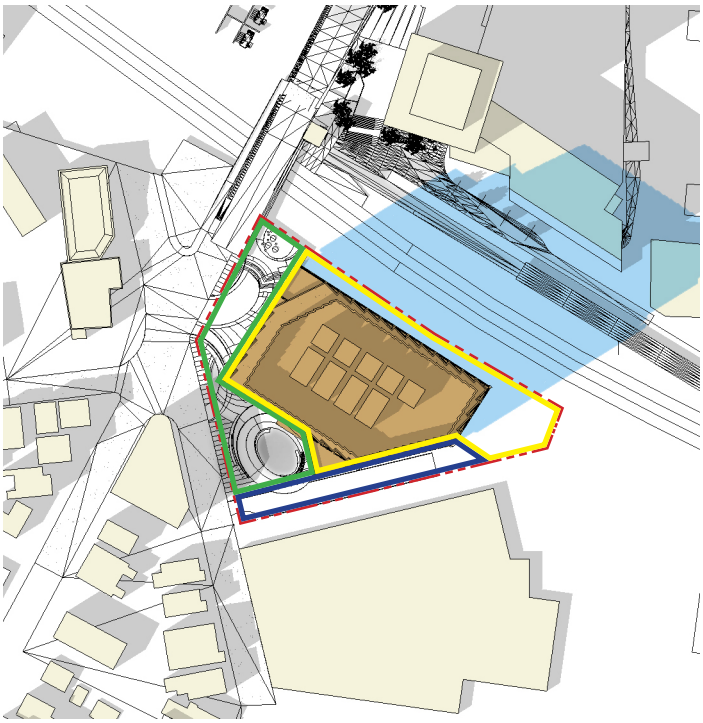

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PROPERTY LINE BUILDING LOT CIVIC SPACE LOT THOROUGHFARE LOT

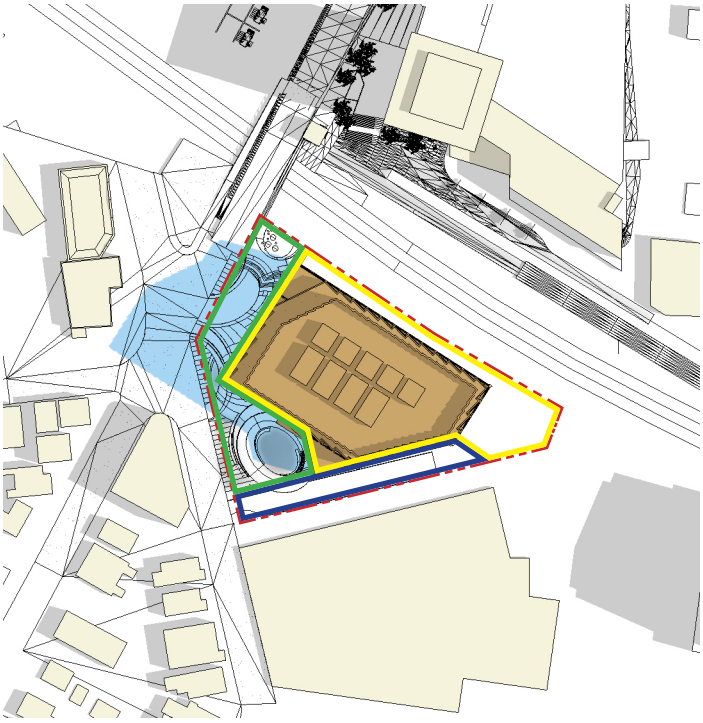
EXISTING SHADOWS NEW SHADOWS

N

SCALE 1”= 200’ - 0”

SHADOW STUDY

Existing and Net new shadows (June, 21)



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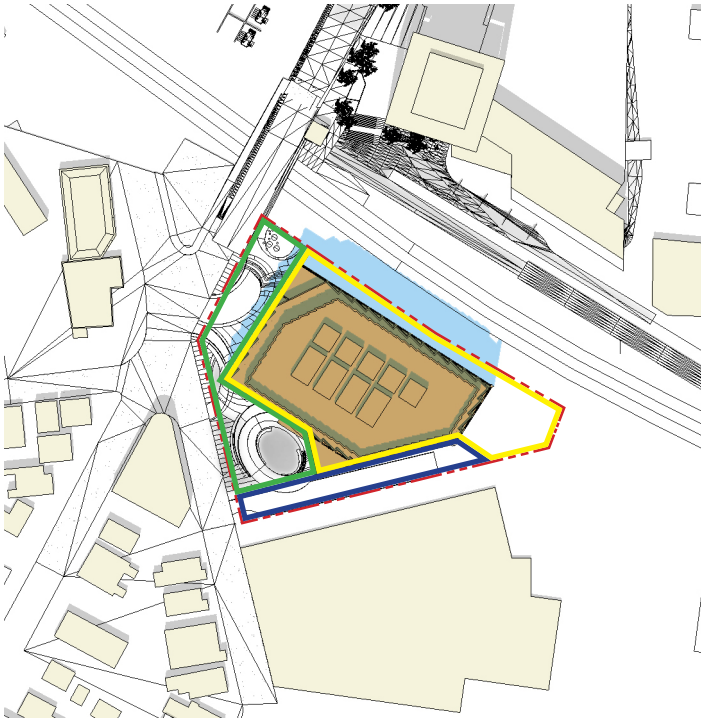

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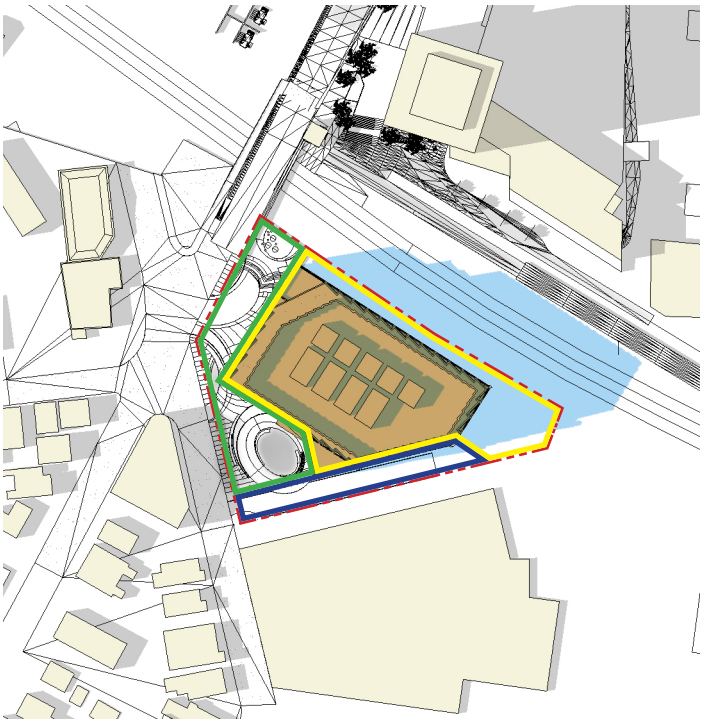

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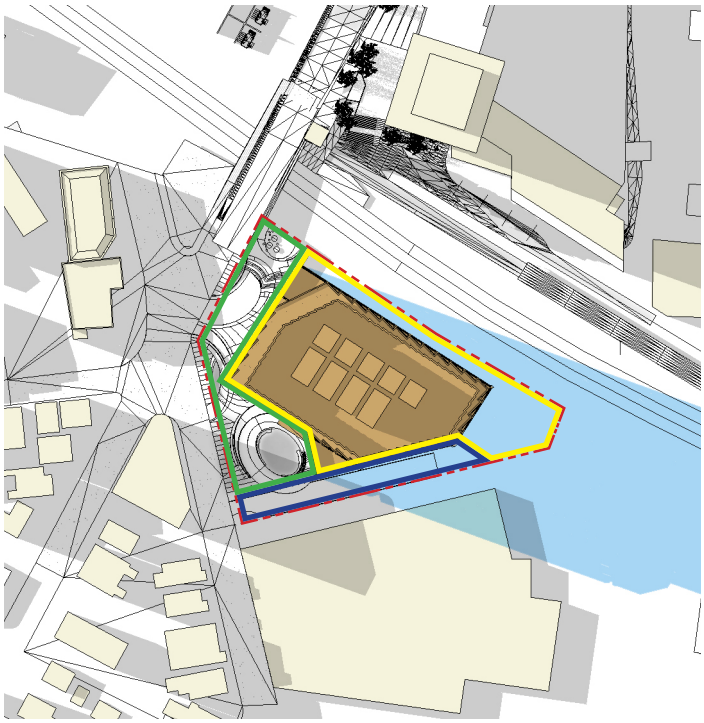

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PROPERTY LINE BUILDING LOT CIVIC SPACE LOT THOROUGHFARE LOT

EXISTING SHADOWS NEW SHADOWS

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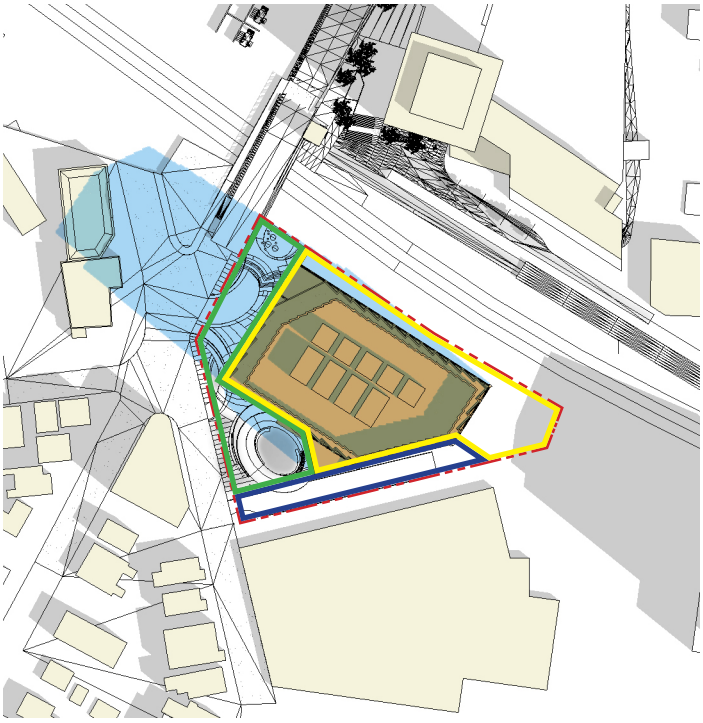
SCALE 1”= 200’ - 0”

SHADOW STUDY

Existing and Net new shadows (September, 21)



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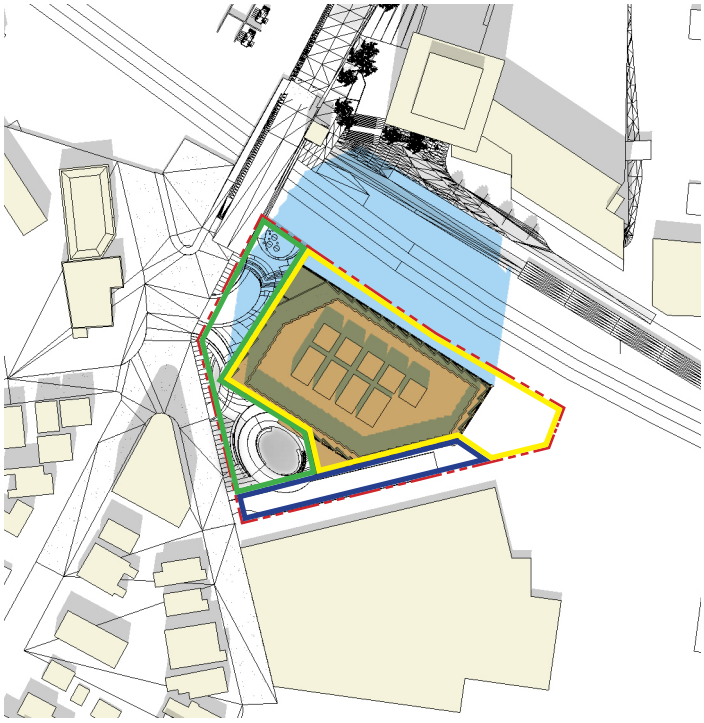

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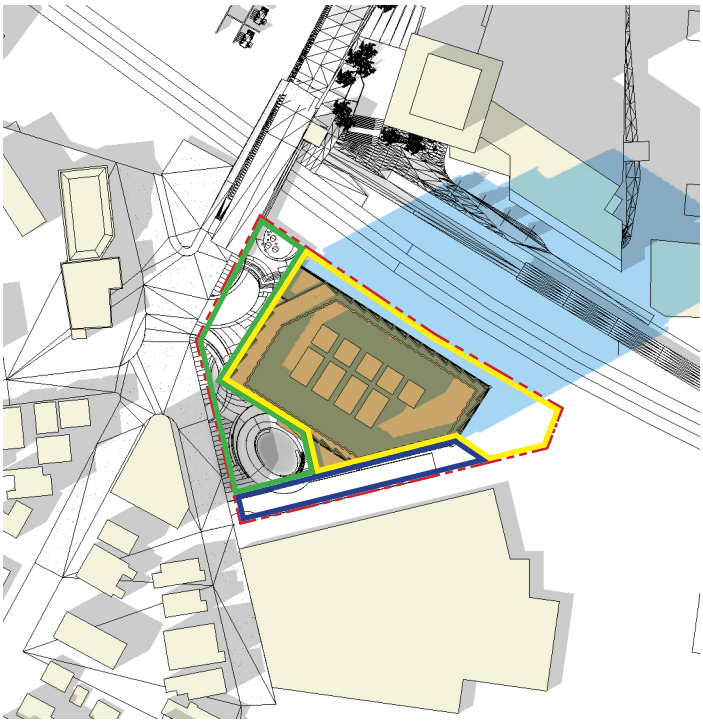

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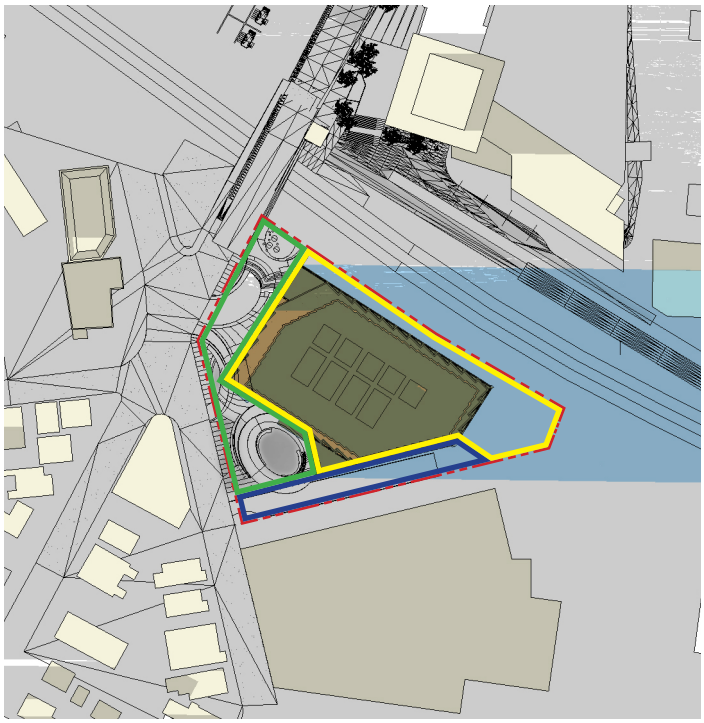

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PROPERTY LINE BUILDING LOT CIVIC SPACE LOT THOROUGHFARE LOT

EXISTING SHADOWS NEW SHADOWS

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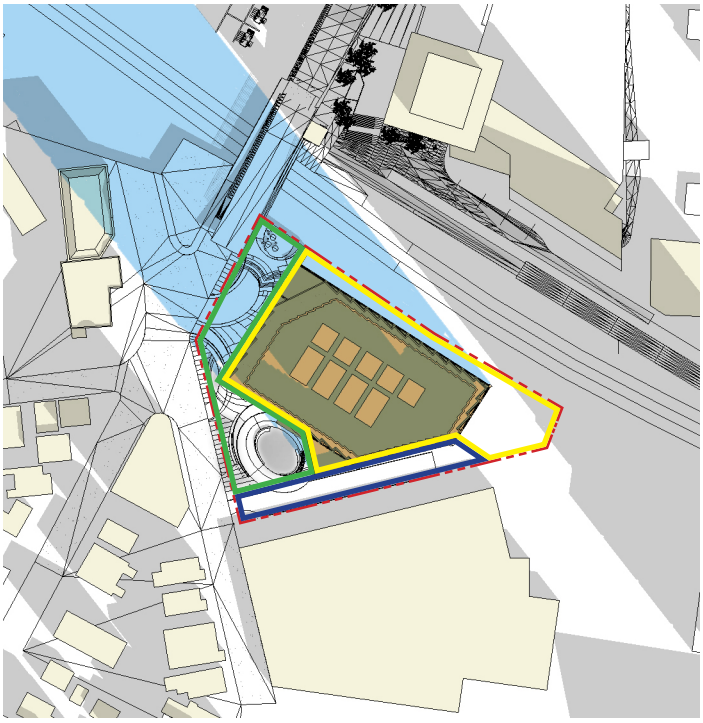
SCALE 1”= 200’ - 0”

SHADOW STUDY

Existing and Net new shadows (December, 21)



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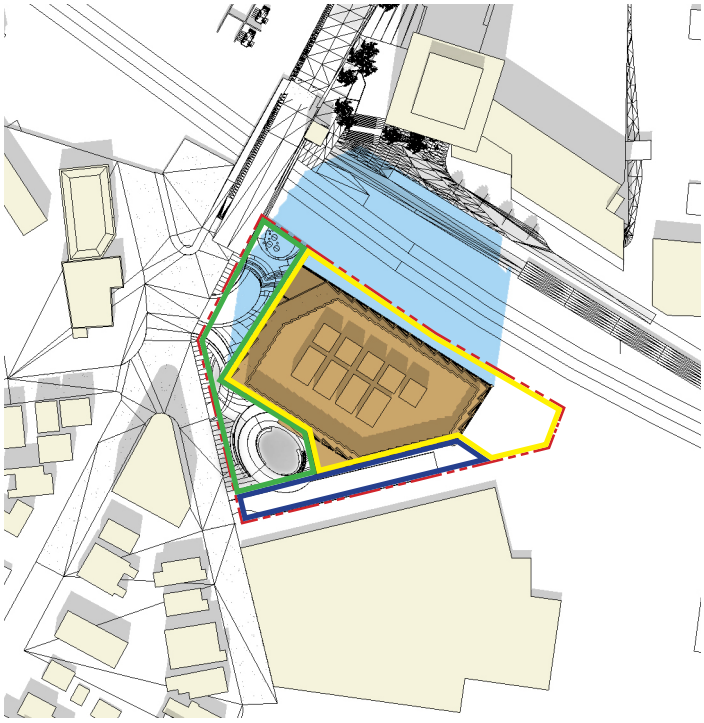

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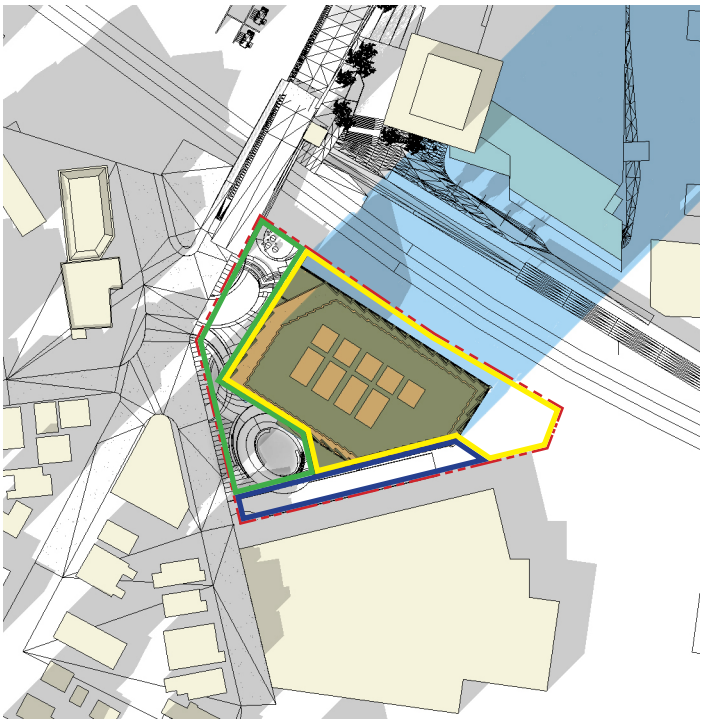

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PROPERTY LINE BUILDING LOT CIVIC SPACE LOT THOROUGHFARE LOT

EXISTING SHADOWS NEW SHADOWS

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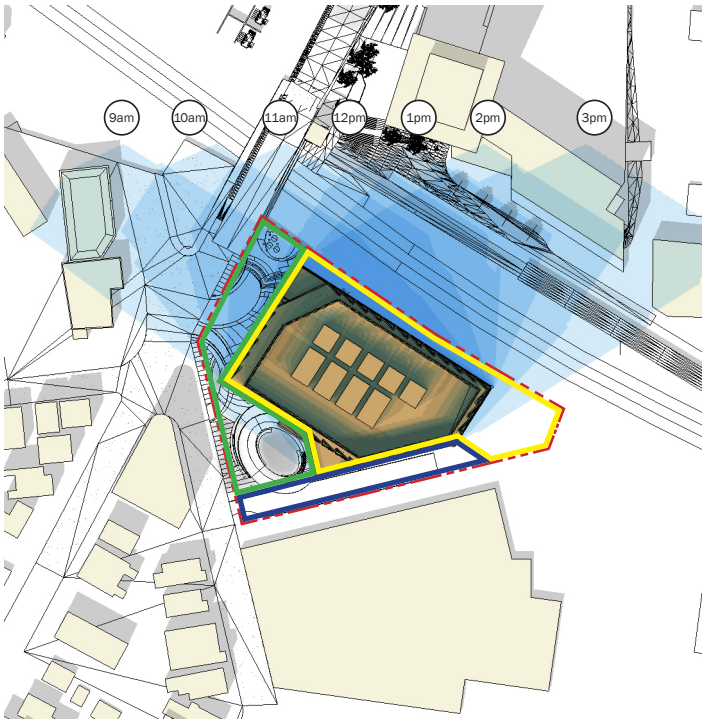
SCALE 1”= 200’ - 0”

SHADOW STUDY

Cumulative new shadows, March, 21



PROPERTY LINE BUILDING LOT CIVIC SPACE LOT THOROUGHFARE LOT

EXISTING SHADOWS CUMULATIVE NEW SHADOWS

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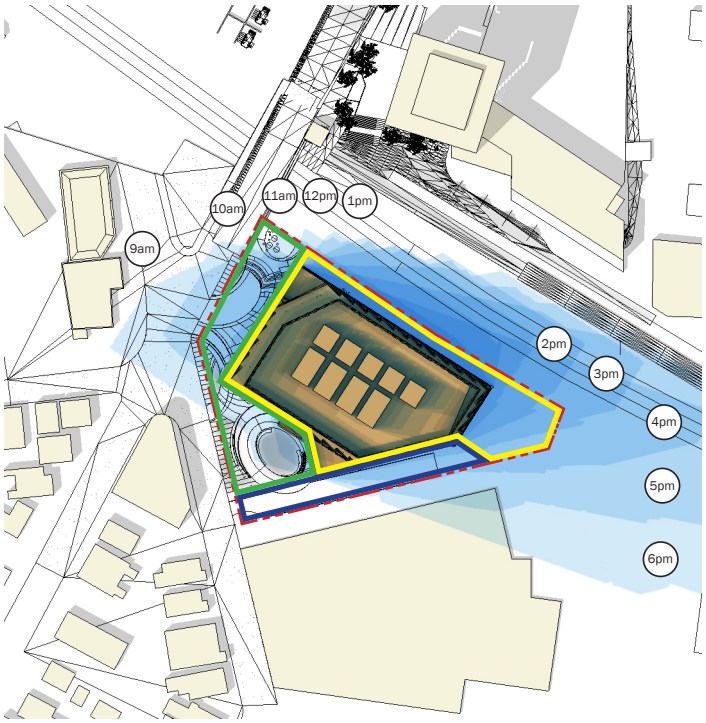
SHADOW STUDY

Cumulative new shadows, June, 21



PROPERTY LINE

BUILDING LOT

CIVIC SPACE LOT

THOROUGHFARE LOT

EXISTING SHADOWS

CUMULATIVE NEW SHADOWS

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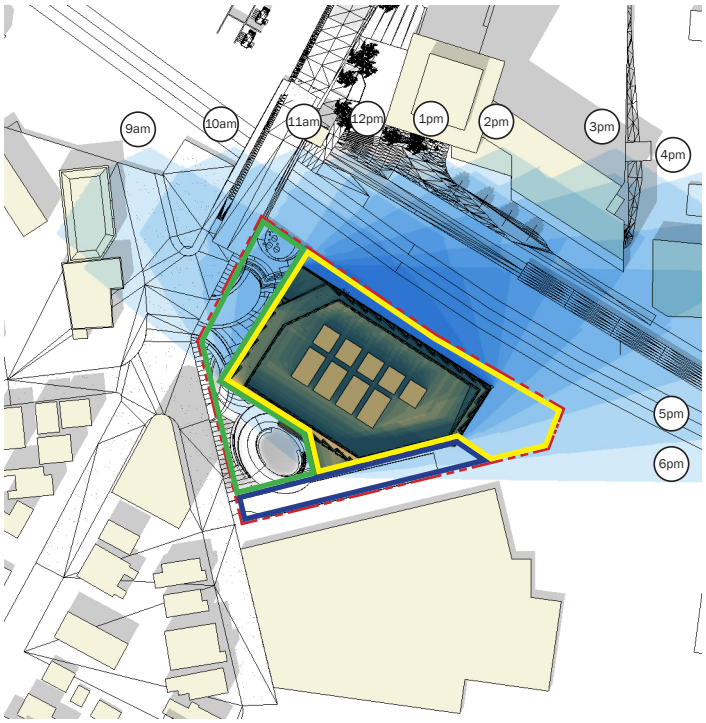
SCALE 1”= 200’ - 0”

SHADOW STUDY

Cumulative new shadows, September, 21



PROPERTY LINE BUILDING LOT CIVIC SPACE LOT THOROUGHFARE LOT

EXISTING SHADOWS CUMULATIVE NEW SHADOWS

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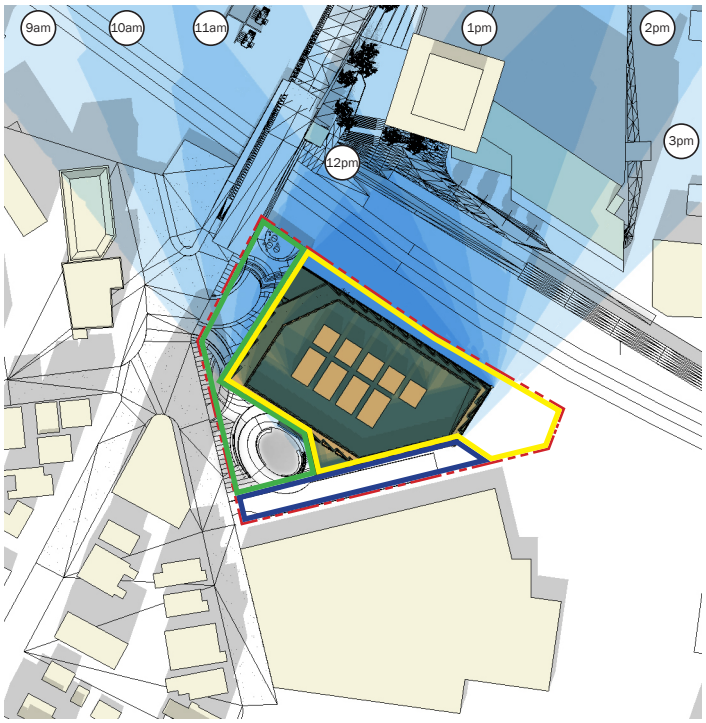
SHADOW STUDY

Cumulative new shadows, December, 21



PROPERTY LINE BUILDING LOT CIVIC SPACE LOT THOROUGHFARE LOT

EXISTING SHADOWS CUMULATIVE NEW SHADOWS

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PEDESTRIAN LEVEL WIND ANALYSIS

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Fax: +1.519.823.1316

April 5, 2022

Brian Slozak RA, LEED Green Associate
Principal
bslozak@sga-arch.com

SGA
200 High Street, 2nd Floor
Boston, MA 02110
T: 857.300.2642

Re: Pedestrian Wind Conditions - Letter of Opinion
Union Square Parcel D3.1 – Somerville (Boston), MA
RWDI Project #2202458

Dear Brian:

Rowan Williams Davies & Irwin Inc. (RWDI) has prepared this letter of opinion on the expected wind conditions around the proposed redevelopment at Union Square Parcel D3.1 in Somerville (Boston), Massachusetts. The approach is based on the local wind climate, the proposed building design information received by RWDI on March 2, 2022, the existing surroundings as well as our experience and professional judgment. Wind tunnel testing will be conducted as part of subsequent supplemental filings to confirm and quantify these predicted wind conditions and, if necessary, to further develop wind control solutions.

Site & Building Information

The project site is located at 50 Webster Avenue on the east side of the intersection between Webster Avenue and Prospect Street (see **Image 1**). It is currently occupied by a low-rise commercial building and is immediately surrounded by low-rise commercial buildings and/or residential buildings in all directions. Downtown Boston is approximately two miles to the southeast, while Logan International Airport is approximately three miles to the southeast.

The proposed project will be a nine-story mixed-use building with plans for office, life-science lab and retail uses (**Images 2 and 3)**.

Pedestrian areas of interest include major building entrances, retail entrances, public sidewalks and outdoor spaces.

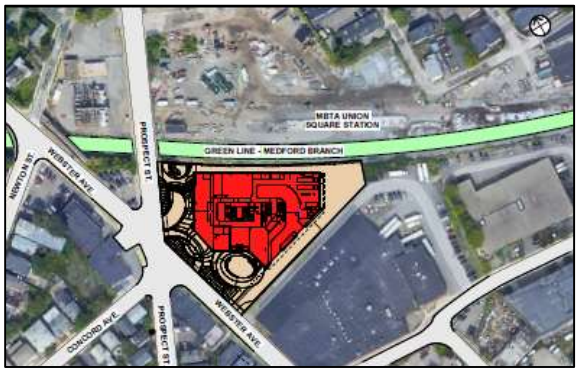


Image 1: Development Site and Existing Surroundings ***(courtesy of SGA Architecture)***

Image 2: Proposed Development – SW Corner from Webster Ave and Prospect St ***(courtesy of SGA Architecture)***

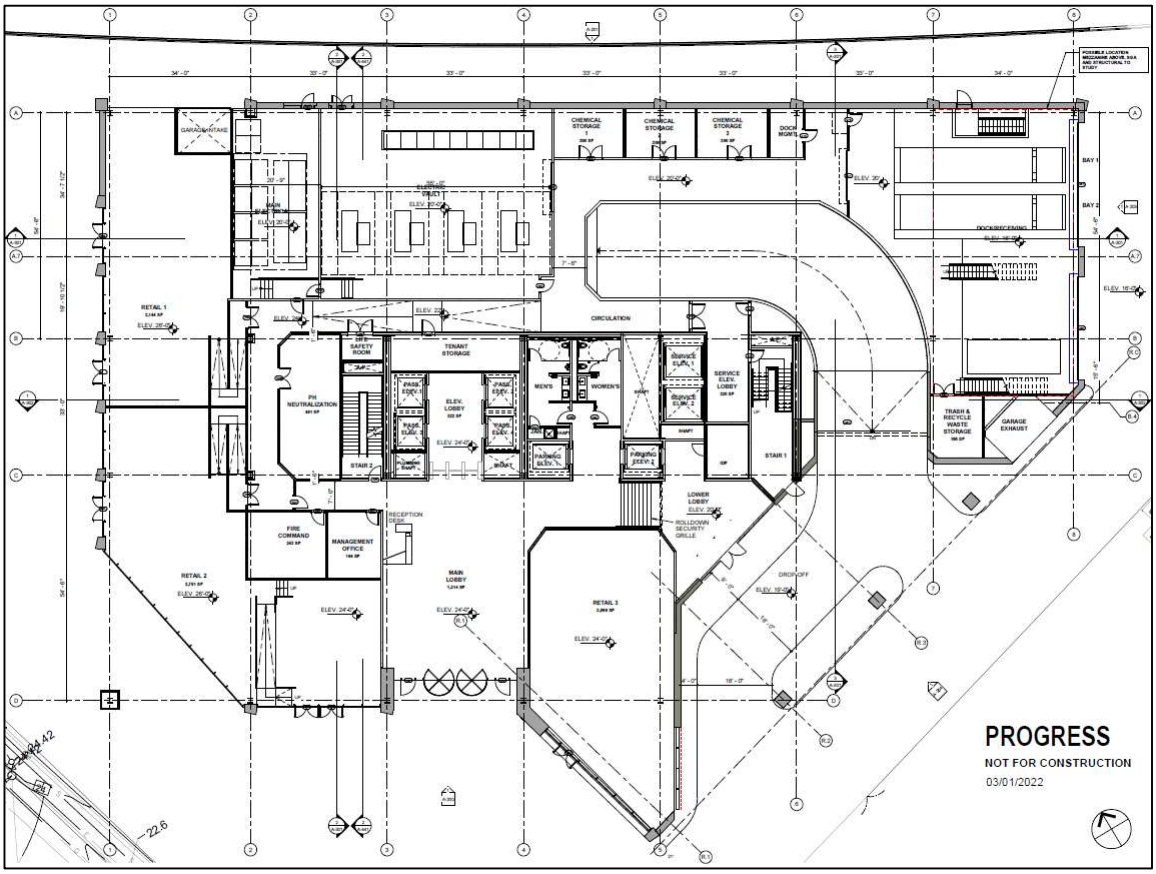
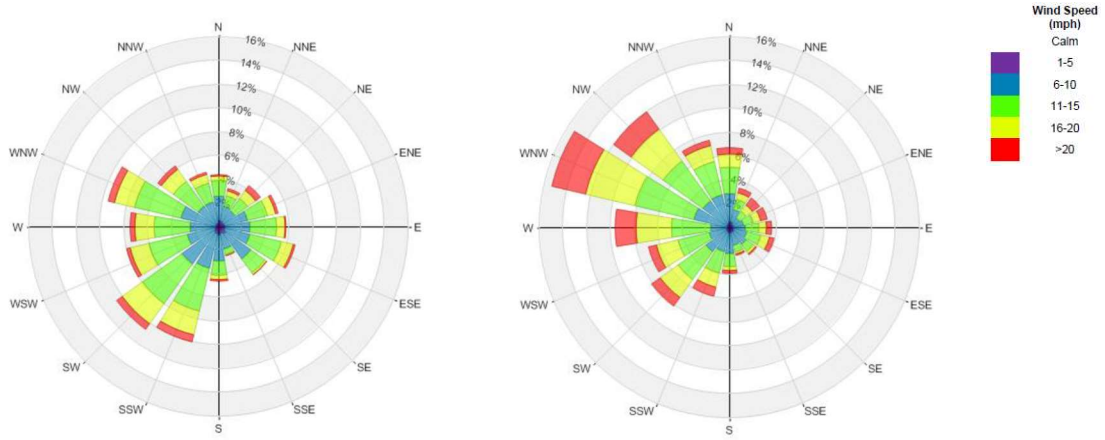


Image 3: Level 1 Plan ***(courtesy of SGA Architecture)***

Wind Data

Over 40 years of wind statistics recorded at Boston Logan International Airport were analyzed for the Summer (May through October) and Winter (November through April) seasons. **Image 4** graphically depicts the distribution of wind frequency and directionality for the two seasons. When all winds are considered, those blowing from the northwest and southwest quadrants are predominant.

Strong winds of a mean speed greater than 20 mph (indicated by the red bands in the wind roses) measured at the airport (at an anemometer height of 30 ft) occur more often in the winter than the summer. Strong northwest through south-southwest and northeast winds are prevalent in both seasons.



Summer (May – October) Winter (November – April)

Image 4: Directional Distribution of Winds Approaching Boston Logan International Airport

Criteria

The City of Somerville has adopted two standards for assessing the pedestrian wind comfort. First, the effective gust velocity of 31 mph should not be exceeded more than one percent of the time. This criterion is hereby referred to as the "effective gust criterion". The second is used to determine the relative level of wind comfort for activities such as sitting, standing or walking. Hourly mean wind speeds are associated with each of these activities. A particular comfort rating is given when conditions exceed the hourly mean wind speed for 1% of the year. These categories are described in **Image 5**.

Image 5: Sommerville Mean Wind Criteria

Comfort Category	Mean Wind Speed (mph)
Uncomfortable for Walking	> 19
Comfortable for Walking	> 15 and ≤ 19
Comfortable for Standing	> 12 and ≤ 15
Comfortable for Sitting	< 12

** Applicable to the hourly mean wind speed exceeded 1% of the time.*

Potential Wind Effects

The proposed development will be taller than its immediate surroundings, which is likely to lead to an increase of local wind speeds compared to the existing condition. Based on our experience and knowledge of the local climate, we expect the following pedestrian wind conditions around the proposed site:

- A wind tunnel study was carried out for the Union Square Parcels D2.1, D2.2 and D2.3 with results presented in a report dated February 8, 2019. The current assessment assumes that these three buildings are approved and present for the currently proposed Parcel D3.1. That wind tunnel study also considered a full build scenario with an additional nine building parcels from the overall master plan in place.

- Existing conditions are likely to be considered comfortable for sitting, standing or walking on an annual basis. No exceedances of the effective gust criterion are likely to exist.

- There is anticipated to be an increase in local wind speeds. However, we do not anticipate any dangerous winds, nor do we expect any exceedance of the effective gust criterion with the proposed project in place.

- The main lobby and the lower lobby entrances (locations A and B in **Image 6**, respectively) are well situated with respect to prevailing winds and are therefore predicted to have appropriate wind conditions (i.e., comfortable for standing on an annual basis).

- The retail entrances (locations C1, C2 and C3) will all be exposed to westerly winds flowing uninterrupted into the west building façades, which will be redirected toward grade level. The resulting conditions are expected to be comfortable for walking on an annual basis (see **Image 6**). These conditions are considered less than ideal for entrances. The proposed overhead canopies should therefore be preserved, in conjunction with the recessed entrances into the façade to protect them from stronger winds.

- With the introduction of the proposed project, the public sidewalks along Prospect Street and Webster Avenue are predicted to be appropriately comfortable for walking on an annual basis.

- As shown in Image 6, there are three areas where uncomfortable winds are possible. These include the northwest, southwest and south corners of the building where prevailing winds are likely to accelerate. The one near location C2 will be aggravated by the building overhang at this corner (above the uncomfortable location) under which winds will be channeled. These conditions could be improved by: 1) eliminating the overhang; 2) discouraging pedestrians from accessing this location; 3) introducing a porous wind screen on the northwest edge of the overhang; and/or 4) the addition of local landscaping. The other two corner locations would benefit from wrap-around canopies or the inclusion of winter trees near these corners. The need for and extent of the necessary mitigation measures will be determined from our upcoming wind tunnel tests.

- All other on-site pedestrian areas are expected to be comfortable for walking or better on an annual basis.

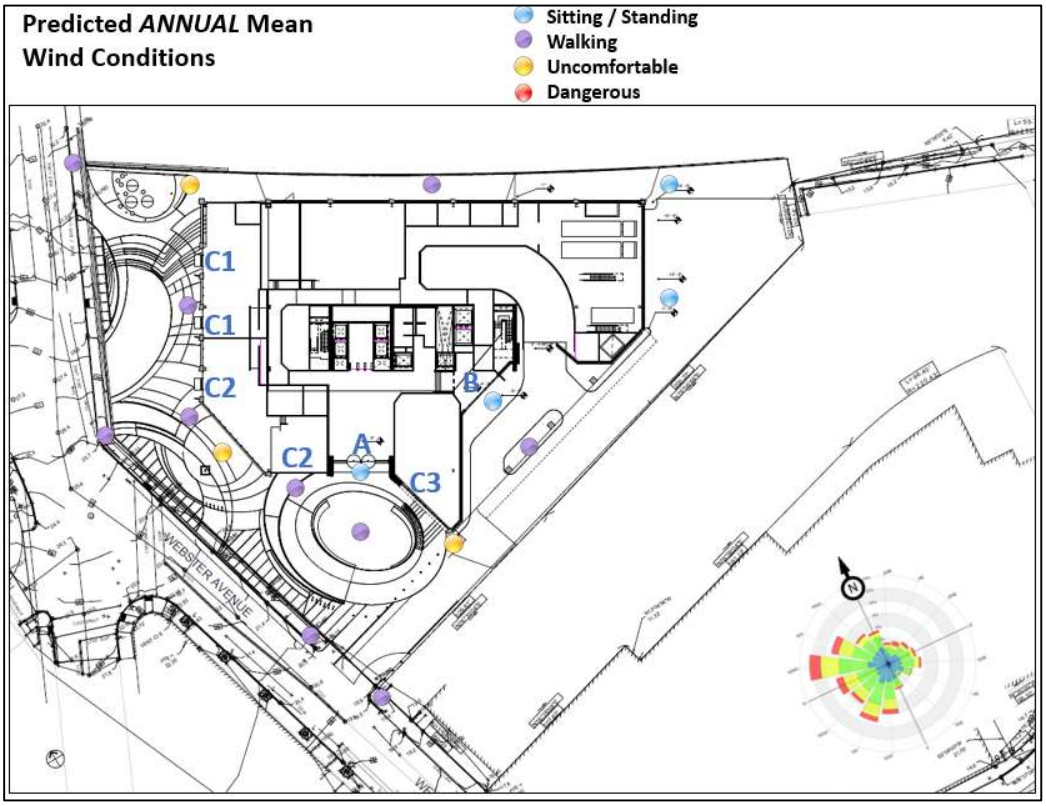


Image 6: Predicted Annual Mean Wind Conditions (at Level 1)

Conclusions

No dangerous winds are expected at this project, nor do we expect any exceedance of the effective gust criterion. The main lobby and lower lobby entrances are expected to have appropriate wind comfort conditions. The public sidewalks and most of the on-site walkways are predicted to be comfortable for walking. The retail entrances will be exposed to less than desirable winds where wind control strategies have been suggested. Uncomfortable winds are anticipated at a few building corners where conceptual wind control strategies have been suggested.

These predicted pedestrian wind conditions will be confirmed and quantified in an upcoming wind tunnel test. These results will be used to determine the need and extent of possible mitigation measures.

Closing

We trust this satisfies your requirements for the project. Should you have any questions or require additional information, please do not hesitate to contact us.

Yours very truly,

Rowan Williams Davies & Irwin Inc. (RWDI)

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Senior Project Manager / Principal

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Senior Consultant / Principal

FK/NSB/sep

FINAL REPORT

UNION SQUARE PARCEL D3.1

SOMERVILLE, MA

PEDESTRIAN WIND STUDY
RWDI # 2202458
May 2, 2022

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI was retained to conduct a pedestrian wind assessment for the proposed Union Square Parcel D3.1 development in Somerville, MA (Image 1). The key findings are summarized as follows:

Effective Gust

- The effective gust criterion is met at most areas in the No Build configuration, with the exception of two locations to the north of the existing site.
- With the proposed building in place, wind speeds are expected to continue satisfying the effective gust criterion at most areas; however, exceedances of this criterion are anticipated at the southwest building corner, as well as at four locations to the north of the proposed building.
- In the Full Build configuration, the effective gust criterion is expected to be met at all locations assessed.

Mean Speed

- Mean wind speeds are generally suitable for standing or sitting across the existing site; higher wind activity that leads to uncomfortable wind conditions is predicted on the north side of the railway.
- When the proposed building is introduced, wind conditions at most areas across the site are expected to remain appropriate for the intended pedestrian use. Exceptions include select building corners, a few isolated locations along Webster Avenue, and areas to the north where pre-existing high wind activity is present.
- Favorable wind conditions are expected at the two Green Rooms immediately near the building perimeter; however, the conditions are predicted to become less desired for passive activities further away from the building towards Prospect Street and Webster Avenue.
- During the summer, favorable wind conditions are predicted on the terraces at Levels 6 and 8 when these spaces will be used most frequently. Higher winds are anticipated during other seasons of the year, which might be acceptable due to the limited occupancy in the colder months.
- In the Full Build configuration, it is anticipated that the wind conditions will improve around the proposed building, with the number of uncomfortable locations predicted to be reduced.

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1 INTRODUCTION

RWDI was retained to conduct a pedestrian wind assessment for the proposed Union Square Parcel D3.1 development in Somerville, MA.

The project site is located at 50 Webster Avenue on the east side of the intersection between Webster Avenue and Prospect Street (see Image 1). It is currently occupied by a low-rise commercial building and is immediately surrounded by low to mid-rise commercial and/or residential buildings in all directions. The proposed project will be a nine-story mixed-use building with plans for office, life-science lab and retail uses. Downtown Boston is approximately two miles to the southeast, while Logan International Airport is approximately three miles to the southeast.

The objectives of the study were to assess the effect of the proposed development on local conditions in pedestrian areas on and around the study site and provide recommendations for minimizing adverse effects. The assessment focused on critical pedestrian areas, including sidewalks, building entrances and the upper terraces.

This report presents the project objectives, background, RWDI's approach, and a discussion of the results. It also provides conceptual wind control measures, where necessary.

Image 1: Aerial View of Site and Surroundings (Map Credit: Google™ Earth)

2 BACKGROUND AND APPROACH

2.1 Physical Modeling

To assess the wind environment around the proposed project, a 1:400 scale model of the project site and surroundings was constructed for the wind tunnel tests of the following configurations:

A – No Build:	Existing site with existing surroundings (Image 2A),
B – Build:	Proposed project with existing surroundings (Image 2B), and,
C – Future:	Proposed project with existing and future surroundings (Image 2C).

The wind tunnel model included all relevant surrounding buildings and topography within an approximately 1600 ft radius of the study site. The wind and turbulence profiles in the atmospheric boundary layer beyond the modelled area were also simulated in RWDI's wind tunnel. The wind tunnel model was instrumented with 91 wind speed sensors to measure mean and gust speeds at a full-scale height of approximately 5 ft above local grade in pedestrian areas throughout the study site. Wind speeds were measured for 36 directions in a 10-degree increment. The measurements at each sensor location were recorded in the form of ratios of local mean and gust speeds to the mean wind speed at a reference height above the model. The placement of wind measurement locations was based on our experience and understanding of the pedestrian usage for this site. The proposed layout was further provided to the team for review ahead of testing.

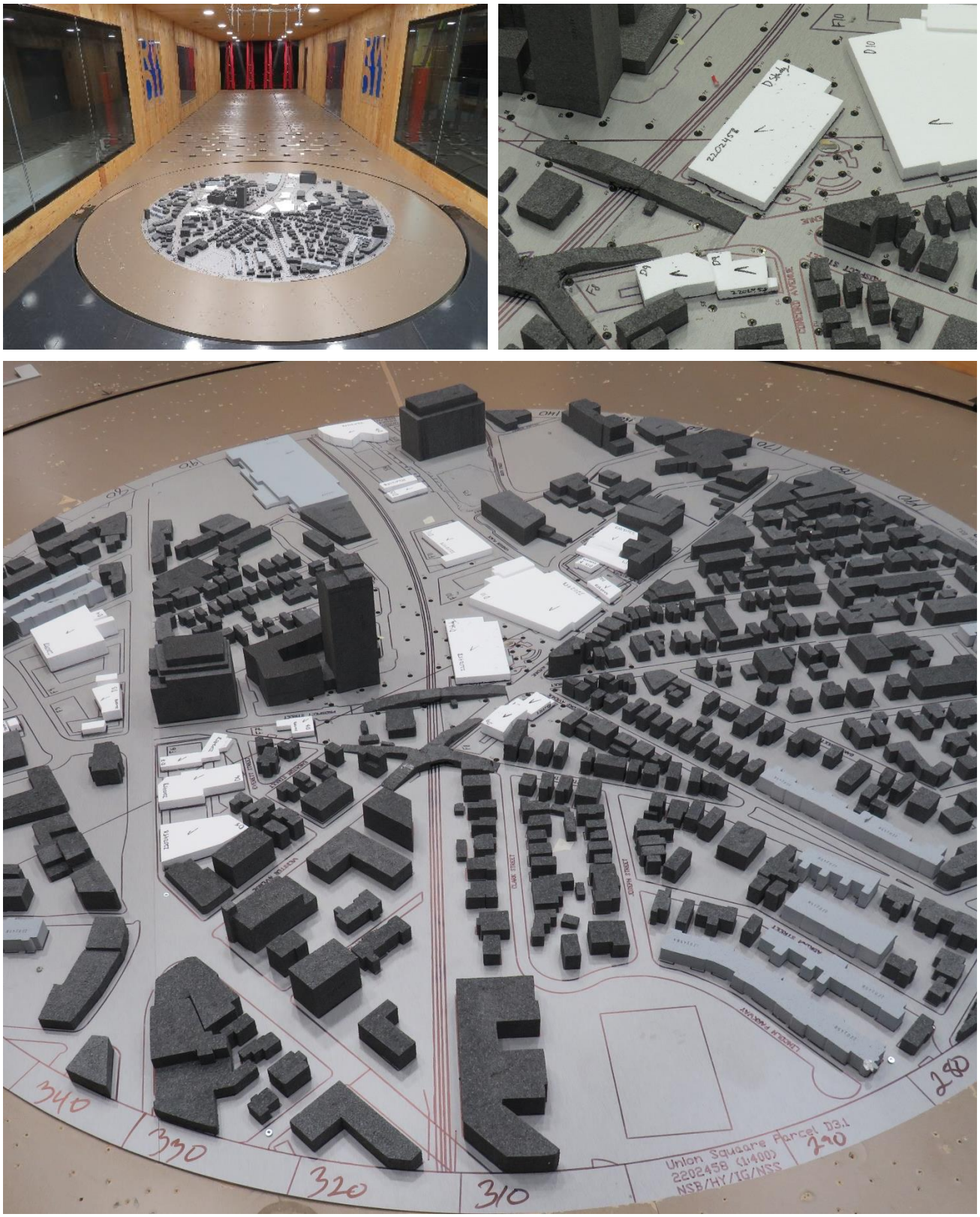


Image 2A: Wind Tunnel Study Model – No Build Configuration

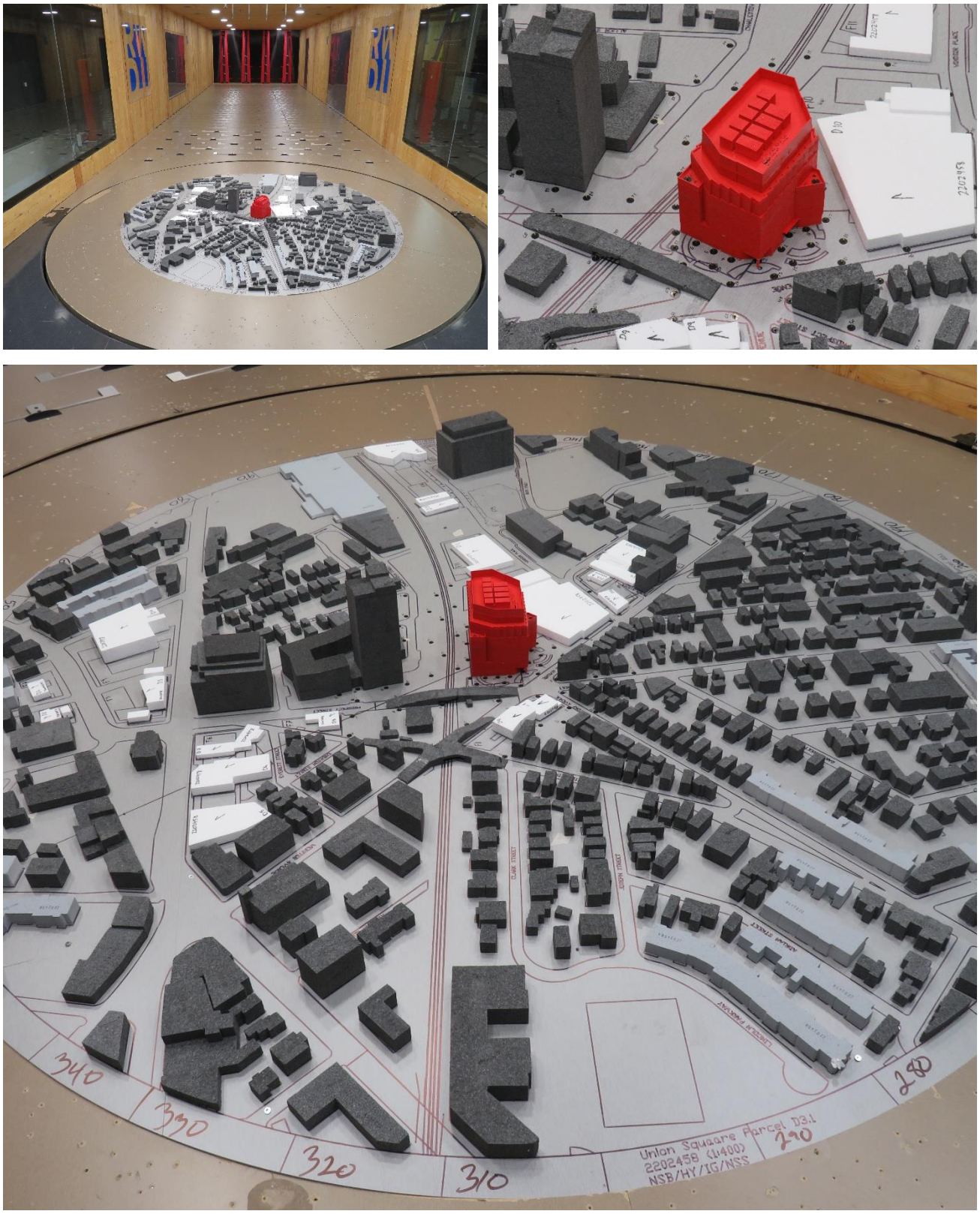


Image 2B: Wind Tunnel Study Model – Build Configuration

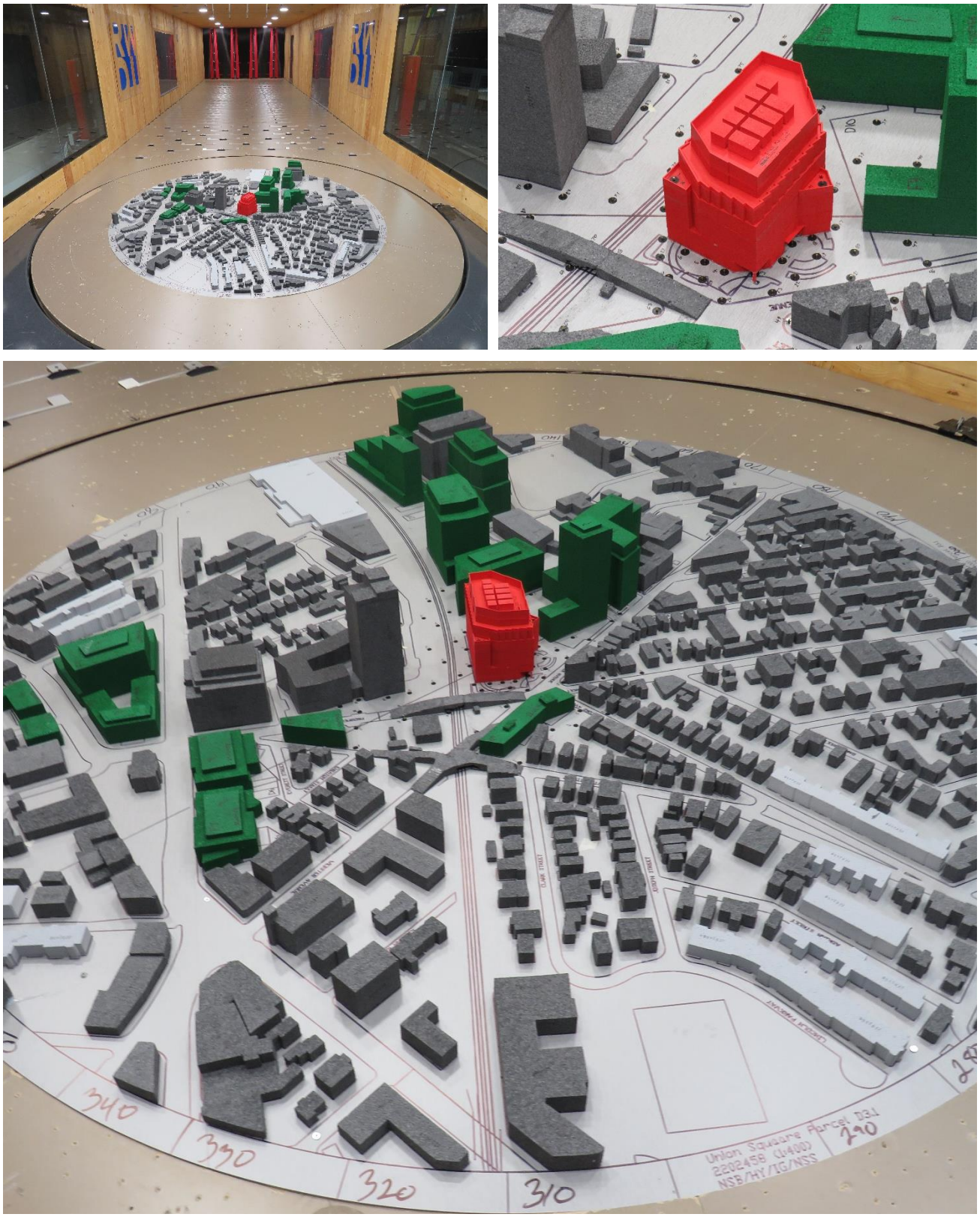
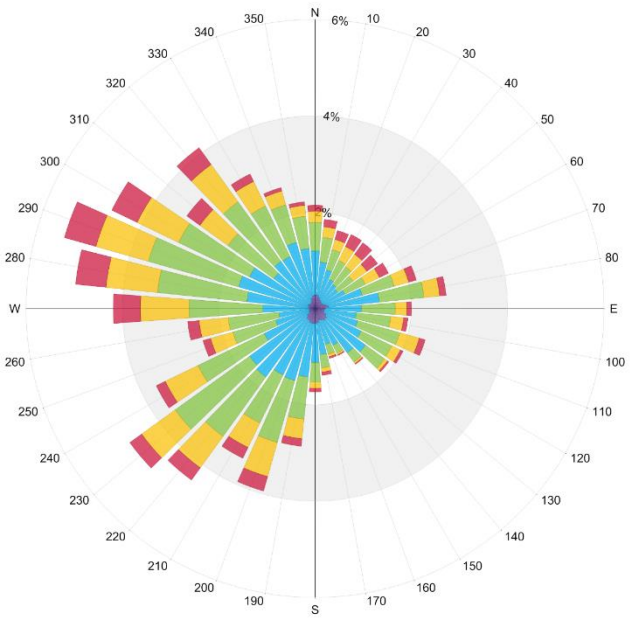


Image 2C: Wind Tunnel Study Model – Full Build Configuration

2.2 Meteorological Data

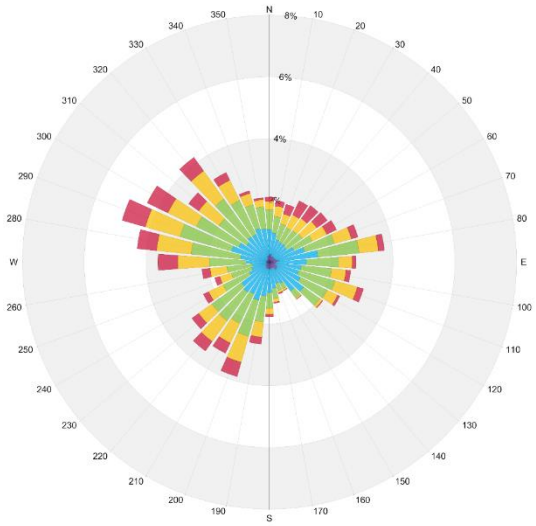
The data from the wind tunnel tests was combined with long-term meteorological data recorded during the years 1995 through 2020 at Boston Logan International Airport to predict full scale wind conditions. The analysis was performed separately for the entire year and for each of the four seasons. Images 3 and 4 present "wind roses", summarizing the annual and seasonal wind climates in the Boston area, respectively, based on the data from Logan Airport.

On an annual basis, the most common wind directions are those between north-northwest and south-southwest. Winds from the east-northeast to the east-southeast are also relatively common. In the case of strong winds, west-northwest, northwest, west and northeast are the dominant wind directions. A similar directional distribution is seen in the seasonal wind roses as well (Image 4).

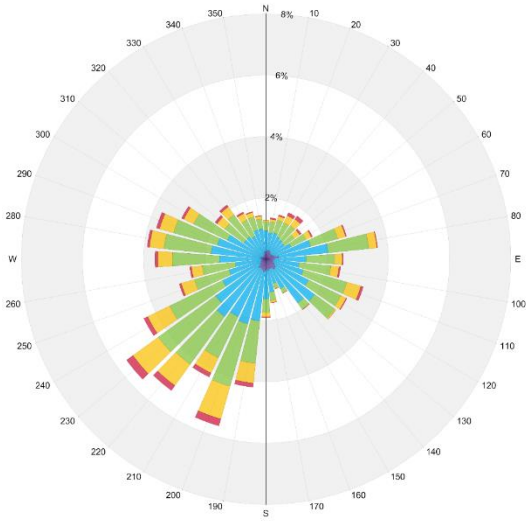


Wind Speed (mph)	Probability (%) Annual
Calm	3.0
1-5	7.9
6-10	32.5
11-15	35.3
16-20	14.5
>20	6.8

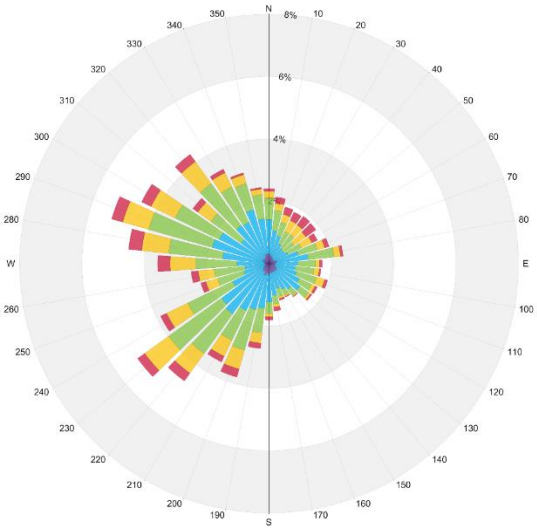
Image 3: Annual Directional Distribution of Winds Approaching Boston Logan International Airport from 1995 through 2020



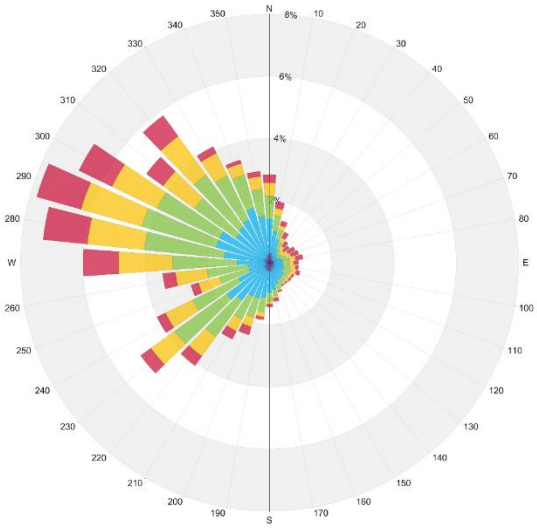
Spring (March – May)



Summer (June – August)



Fall (September – November)



Winter (December – February)

Wind Speed (mph)	Probability (%) Spring	Summer	Fall	Winter
Calm	2.7	3.1	3.4	2.6
1-5	6.8	9.5	8.7	6.6
6-10	28.6	38.9	34.5	28.2
11-15	35.9	36.7	34.6	34.2
16-20	17.2	9.9	13.0	17.7
>20	8.8	1.9	5.9	10.7

Image 4: Seasonal Directional Distribution of Winds Approaching Boston Logan International Airport from 1995 through 2020

2.3 Design Criteria

The City of Somerville has adopted two standards for assessing the relative wind comfort of pedestrians. First, the Somerville pedestrian wind design guidance criterion states that an effective gust velocity (hourly mean wind speed +1.5 times the root-mean-square wind speed) of 31 mph should not be exceeded more than 1% of the time.

Wind Acceptability	Effective Gust Velocity (mph)
Acceptable	≤ 31
Unacceptable	> 31
Comfort Category	Mean Wind Speed (mph)
Comfortable for Sitting	≤ 12
Comfortable for Standing	≤ 15
Comfortable for Walking	≤ 19
Uncomfortable	>19

Effective gust and mean wind speeds are based on a 1% exceedance or 99 percentile wind speeds.

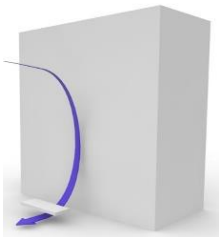
The second set of criteria is used to determine the relative level of pedestrian wind comfort for activities such as sitting, standing, or walking. The criteria are expressed in terms of benchmarks for the 1-hour mean wind speed exceeded 1% of the time (i.e., the 99-percentile mean wind speed). Note that wind speeds which do not meet the comfort criterion (i.e., wind speeds > 19 mph for more than 1% of the time) are identified as "Uncomfortable" in this assessment.

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

This study involved state-of-the-art measurement and analysis techniques to predict wind conditions. Nevertheless, some uncertainty remains in predicting wind comfort, and this must be kept in mind. For example, the sensation of comfort among individuals can be quite variable. Variations in age, individual health, clothing, and other human factors can change a particular response of an individual. The comfort limits used in this report represent an average for the total population. Also, unforeseen changes in the project area, such as the construction or removal of buildings, can affect the conditions experienced at the site. Finally, the prediction of wind speeds is necessarily a statistical procedure. The wind speeds reported are for the frequency of occurrence stated (1% of the time). Higher wind speeds will occur but on a less frequent basis.

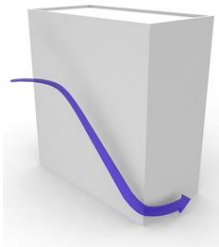
2.4 Generalized Wind Flows

In our discussion of wind conditions, reference may be made to the following generalized wind flows (Image 5):



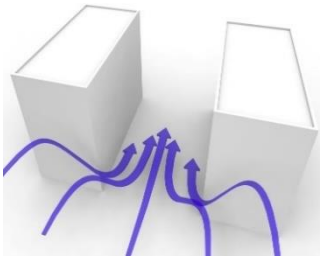
DOWNWASHING

Tall buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level. This is often the main cause for wind accelerations around large buildings at the pedestrian level.



CORNER ACCELERATION

When winds approach at an oblique angle to a tall façade and are deflected down, a localized increase in the wind activity or corner acceleration can be expected around the exposed building corners at pedestrian level.



CHANNELING EFFECT

When two buildings are situated side by side, wind flow tends to accelerate through the space between the buildings due to channeling effect caused by the narrow gap.

Image 5: Generalized Wind Flows

If these building/wind combinations occur for prevailing winds, there is a greater potential for increased wind activity. Design details such as; setting back a tall tower from the edges of a podium, deep canopies close to ground level, wind screens, tall trees with dense landscaping, etc. (Image 6) can help reduce wind speeds. The choice and effectiveness of these measures would depend on the exposure and orientation of the site with respect to the prevailing wind directions and the size and massing of the proposed buildings.

Podium/tower setback, canopy, landscaping and wind screens (left to right)

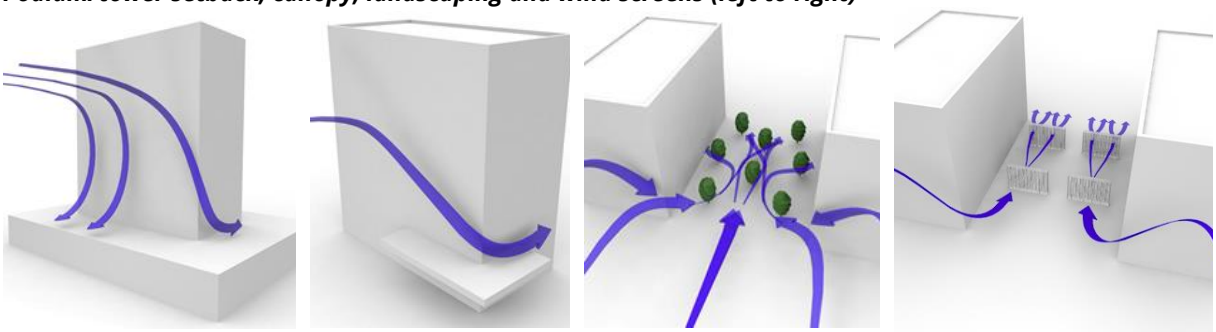


Image 6: Common Wind Control Measures

3 RESULTS AND DISCUSSION

The predicted mean and effective gust speeds pertaining to the assessed configurations are graphically depicted on site plans in Figures 1A through 2C located in the "Figures" section of this report. These conditions and the associated wind speeds are presented in Tables 1 and 2, located in the "Tables" section of this report. The following summary of pedestrian wind comfort is based on the annual winds for each configuration tested. Typically, the summer and fall winds tend to be more comfortable than the annual winds while the winter and spring winds are less comfortable than the annual winds.

Wind conditions comfortable for walking (indicated in green in the figures) are appropriate for sidewalks and walkways as pedestrians will be active and less likely to remain in one area for prolonged periods of time. Lower wind speeds conducive to standing (light blue) are preferred at main entrances where pedestrians are apt to linger. Wind speeds comfortable for sitting (darker blue) are ideal during the summer for areas intended for passive activities, such as the civic plaza and outdoor terraces.

3.1 No Build Configuration (Figures 1A and 2A)

The mean speed winds throughout the existing site are comfortable for sitting or standing in most areas on an annual basis (Figure 1A). This is due to the low-rise surrounding built environment where the bulk of winds flow freely over the site, relatively uninterrupted. These conditions are considered suitable for the current intended use of the area.

Higher wind activity is identified towards the north of the existing site near the D2.2 and D2.3 buildings, where conditions are comfortable for walking or categorized as uncomfortable (Figure 1A). High winds in this area also lead to exceedances of the effective gust criterion (Locations 71 and 73 in Figure 2A).

3.2 Build Configuration (Figures 1B and 2B)

3.2.1 Grade Level (Locations 1 through 89)

With the addition of the proposed development, wind conditions at most areas across the site are expected to remain appropriate for the intended pedestrian use (Figure 1B). Conditions at the main lobby entrance facing Webster Avenue (Location 1) and the lower lobby entrance near the drop-off area (Location 14) are predicted to be comfortable for sitting, which is suitable for the intended passive usage. The recessed entrances with overhead canopies are considered positive features from a wind control perspective and should be carried forward as the design progresses.

Wind conditions are predicted to be favorable at the two Green Rooms immediately near the building perimeter, with conditions suitable for sitting or standing. However, wind conditions are expected to become less ideal further away from the building (Figure 1B), being comfortable for strolling along Prospect Street (Locations 24-27) and uncomfortable along Webster Avenue (Locations 21 to 23). It may be noted that the proposed trees shown in the landscaping plan received on March 23, 2022 (see Image 7) are expected to improve the overall wind comfort level

within the Green Rooms when they are in full foliage. This will help enhance the wind comfort conditions around the outdoor seating areas during the summer when these areas will be used most frequently.

Image 7: Landscaping Plan Received on April 1, 2022

Wind speeds categorized as uncomfortable are predicted in two main areas around the development: to the south, near exposed building corners and isolated locations along Webster Avenue, and to the north of the site near the railway and the D2.2 and D2.3 buildings (see yellow locations in Figure 1B). Wind control strategies, as outlined in Section 3.2.2., may be considered to help reduce wind speeds in these areas.

The effective gust criterion is expected to be met at all locations except the southwest corner of the proposed building (Location 3 in Figure 2B), as well as between the proposed building and near the existing D2.2 and D2.3 buildings to the north (Locations 29 and 71-73 in Figure 2B). Note that high wind activity pre-exists to the north of the railway. The introduction of the D3.1 Building is not expected to have significant adverse impacts in that area (see Figures 1A and 1B, 2A and 2B for comparison).

3.2.2 Wind Control Strategies at Grade Level

The undesired high wind activity predicted at grade level is primarily driven by downwashing flows off the building façade, followed by localized corner accelerations (see Section 2.4). Wind control features such as large canopies or overhead trellises can be installed along building façades facing the plaza and wrap around the corners to help intercept downwashing flows. Vertical features such as windscreens and landscaping can be considered around building corners, throughout the plaza, as well as at open areas besides the railway, to breakup wind flows at grade level and improve comfort levels. Note that coniferous/marcescent species with large, dense crowns, need to be

used in order to extend the wind benefits of landscaping to the colder months. Photos examples of these mitigation strategies are presented in Images 8 and 9.

Image 8: Examples of Corner Wrapping Canopies

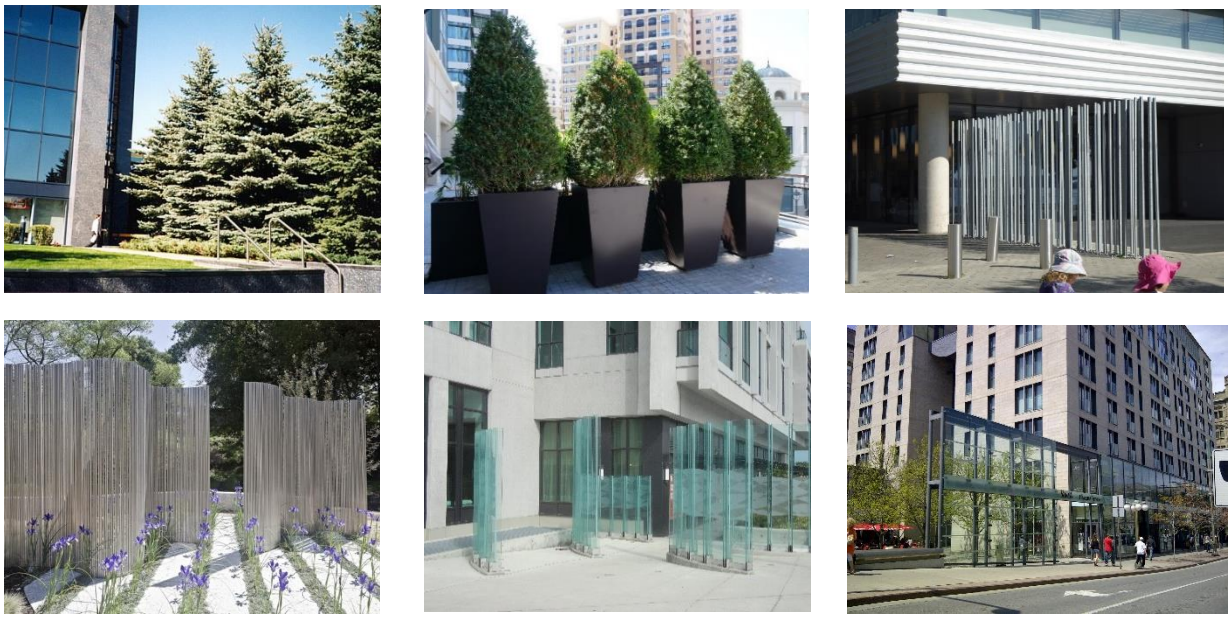


Image 9: Examples of Landscaping and Screens

3.2.3 Terrace Levels (Locations 90 and 91)

RWDI recommends that wind speeds comfortable for sitting or standing be targeted on amenity terraces during the seasons they will be in use. These calm wind speeds are considered appropriate for passive activities.

On an annual basis, wind conditions are predicted to be comfortable for standing on the Level 6 terrace and walking on the Level 8 terrace (see Figure 1B). During the summer season, calmer wind activity is anticipated, and the conditions are expected to be suitable for sitting and standing on the two terraces respectively (see seasonal results in Table 2), which satisfies the intended passive occupant activities. Although higher wind speeds on outdoor terraces are generally acceptable in the colder seasons, if desired, the design team may consider the use of screens, landscaping, or raised guardrails (minimum height of 6ft) on these terraces to improve their usability throughout the year. Examples of the mitigation measures are shown in Image 10.

Wind speeds on both terraces are predicted to satisfy the effect gust criterion (see Figure 2B).

Image 10: Examples of Wind Control Measures for Improved Comfort on Terraces

3.3 Full Build Configuration

The addition of tall buildings surrounding the proposed site will influence the wind flow patterns around the project due to sheltering and redirection of winds. Consequently, a decrease of wind speeds is expected, which will reduce the number of locations with uncomfortable wind conditions will be reduced (see Figure 1C). Undesirable wind speeds are still predicted to persist around select building corners and at open areas to the north. Increased wind activity, in comparison to the Build configuration, is predicted to the south of the site along Webster Ave and Columbia Street as a result of the tall future buildings (Figure 1C). The mitigation recommendations presented in Section 3.2.1 are expected to remain applicable for these areas.

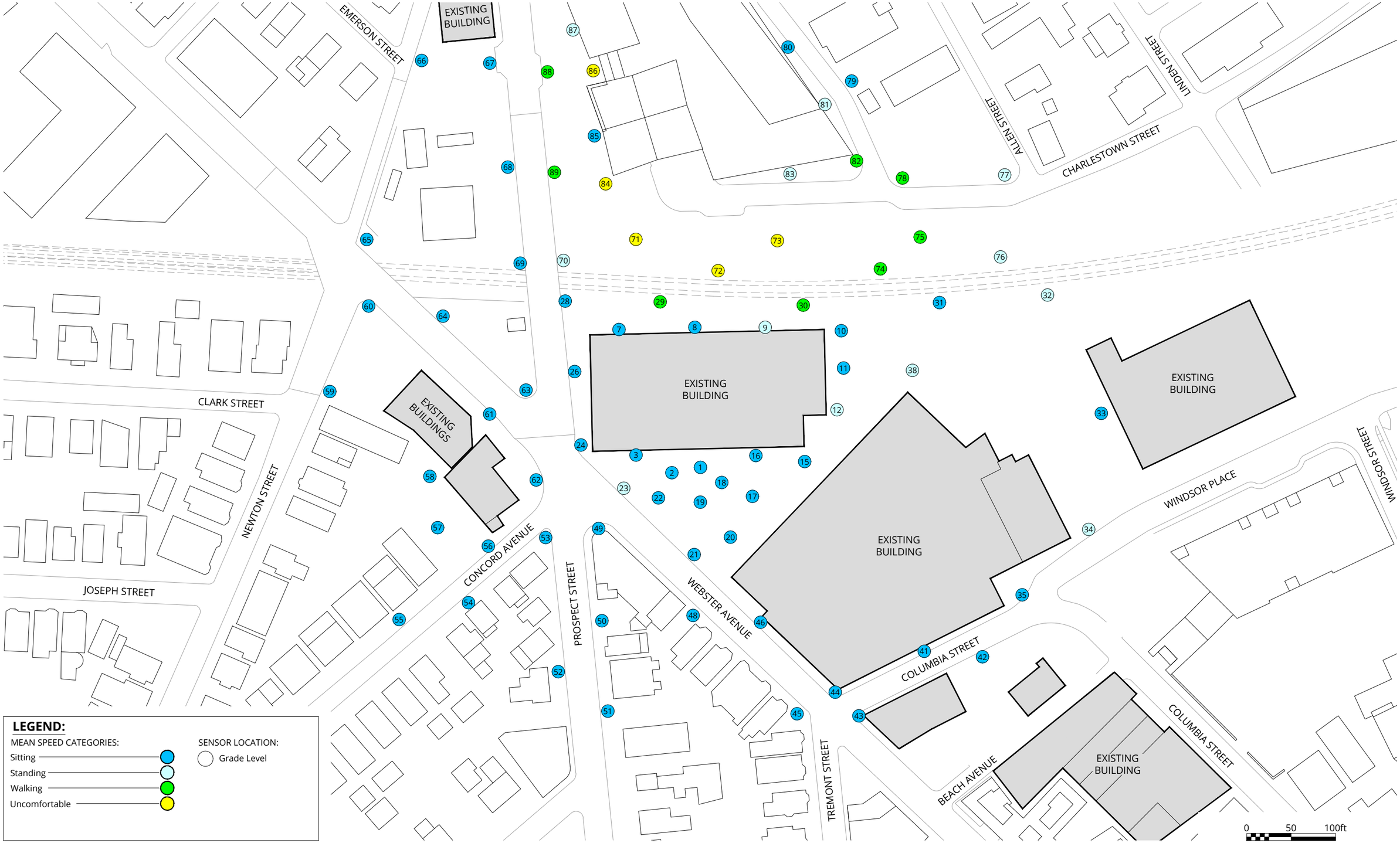
Positively, with the future developments in place, the effective gust criterion is predicted to be met at all locations assessed (see Figure 2C).

4 APPLICABILITY OF RESULTS

The wind conditions presented in this report pertain to the model of the Union Square Parcel D3.1 project was constructed using the drawings and information listed below. Should there be any design changes that deviate from this list of drawings, the wind condition predictions presented may change. Therefore, if changes in the design are made, it is recommended that RWDI be contacted and requested to review their potential effects on wind conditions.

File Name	File Type	Date Received (dd/mm/yyyy)
Marvel_Arch-5327-Union Square Parcel D3.1.rvt	Revit	07/02/2022
2022-02-28_50 Webster Civic Plaza - 100% Schematic Design	PDF	01/04/2022

FIGURES



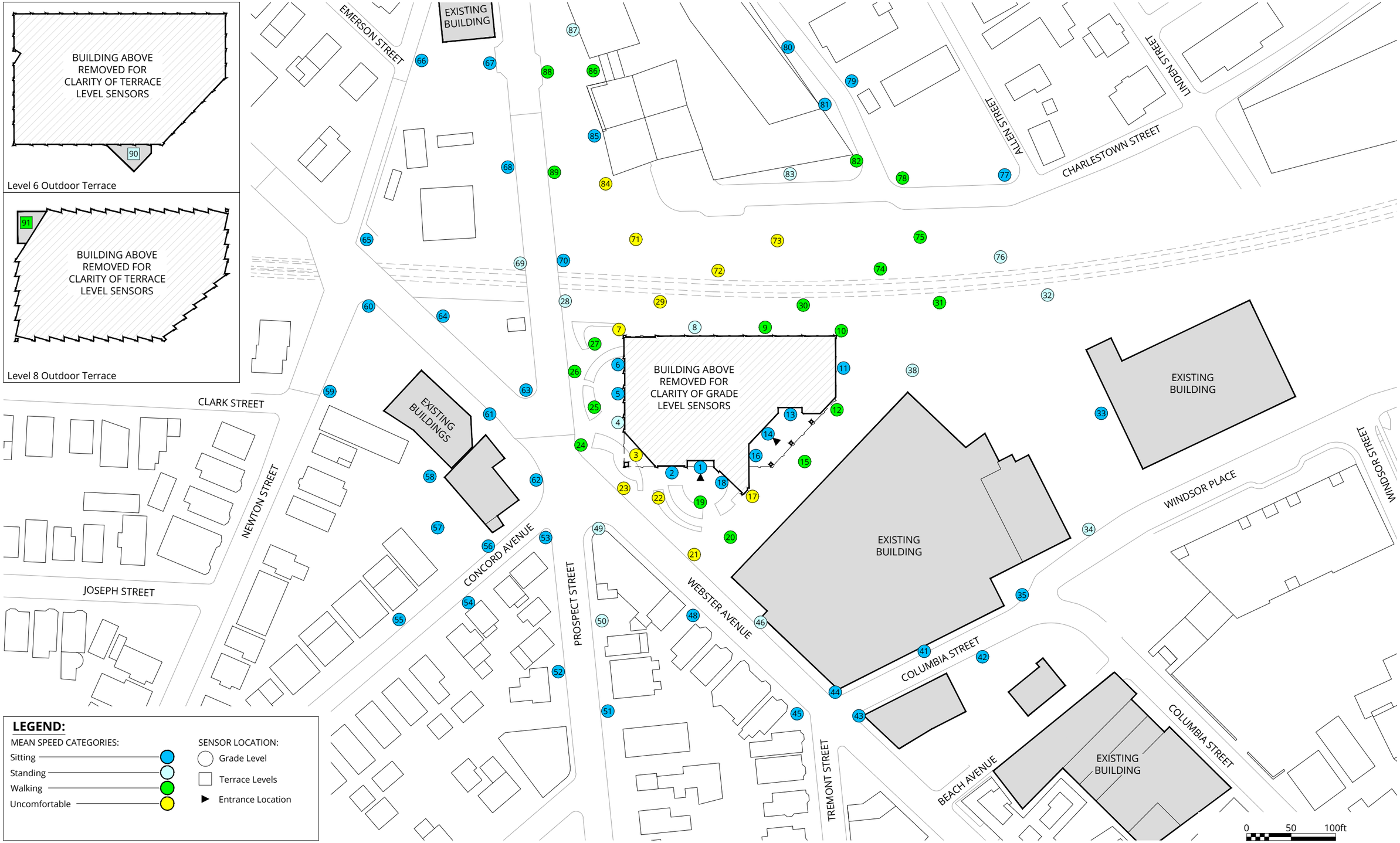
Pedestrian Wind Conditions - Mean Speed
No Build
Annual

Union Square Parcel D3.1 - Somerville, MA

True North

Project #2202458

Drawn by: GRE	Figure: 1A
Approx. Scale:	1"=100'
Date Revised:	Apr. 26, 2022



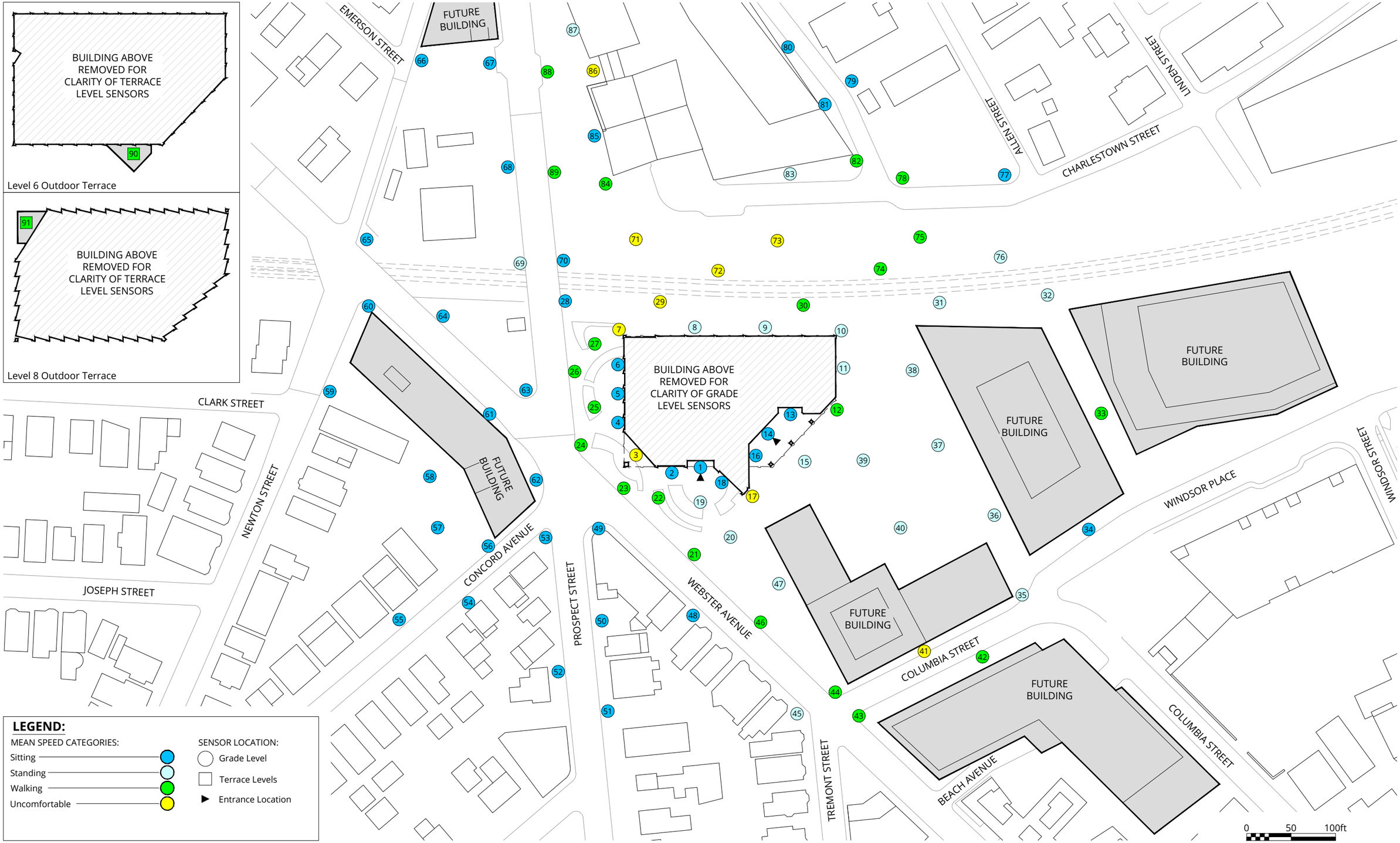
Pedestrian Wind Conditions - Mean Speed
Build
Annual

Union Square Parcel D3.1 - Somerville, MA

True North

Project #2202458

Drawn by: GRE	Figure: 1B
Approx. Scale:	1"=100'
Date Revised:	Apr. 26, 2022



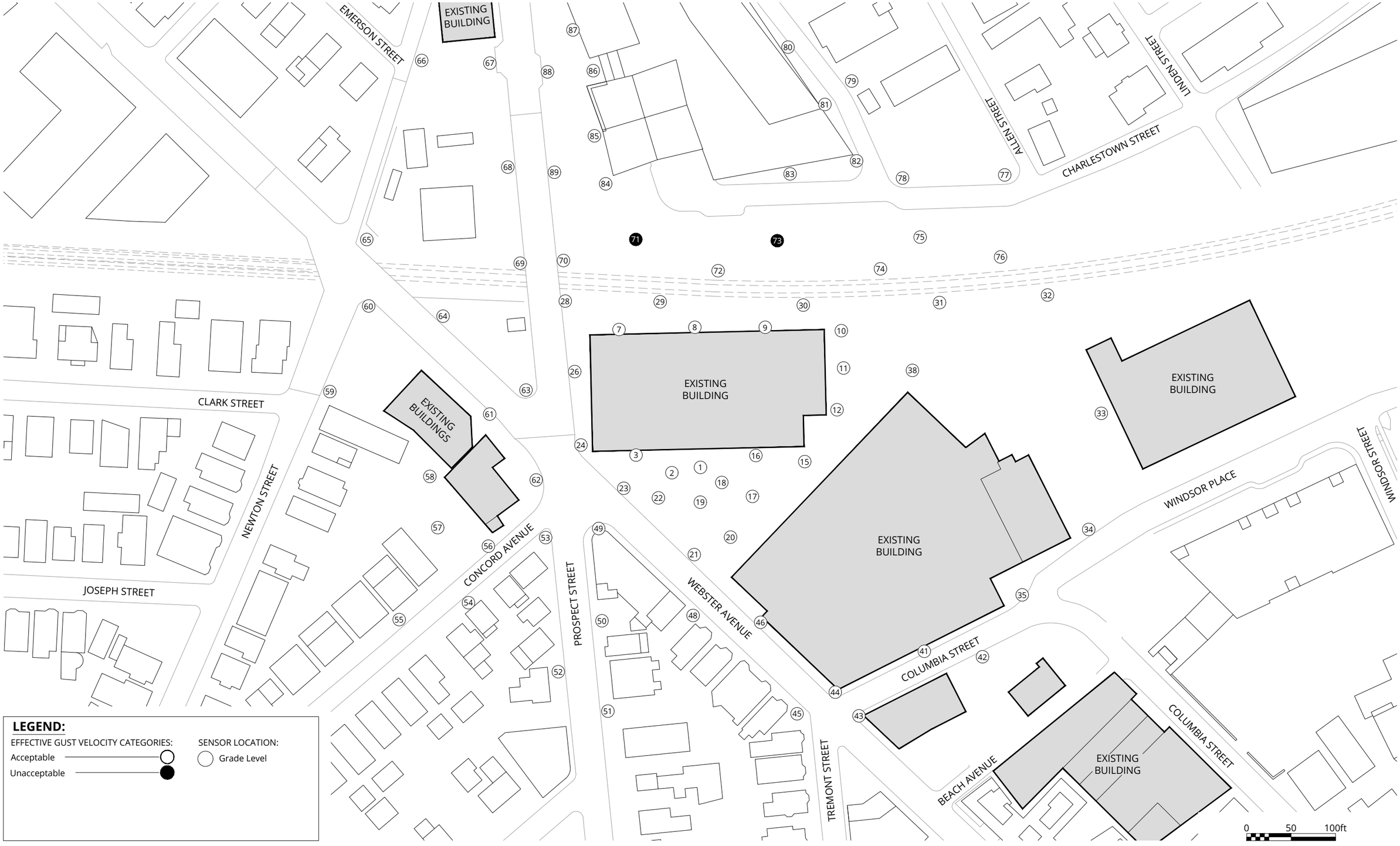
Pedestrian Wind Conditions - Mean Speed
Full Build
Annual

Union Square Parcel D3.1 - Somerville, MA

True North

Project #2202458

Drawn by: GRE	Figure: 1C
Approx. Scale:	1"=100'
Date Revised:	Apr. 26, 2022



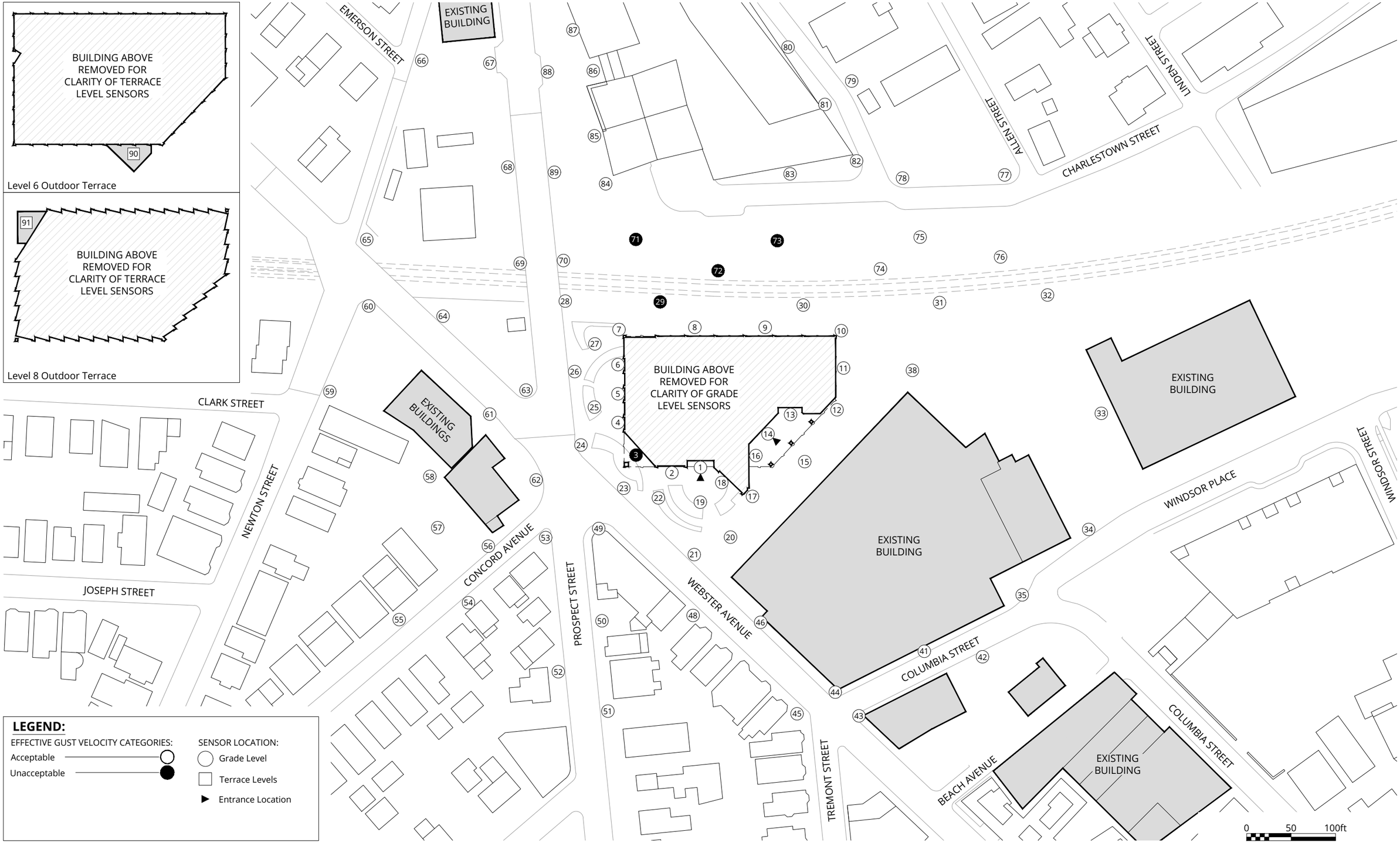
Pedestrian Wind Conditions - Effective Gust Velocity
No Build
Annual

Union Square Parcel D3.1 - Somerville, MA

True North

Project #2202458

Drawn by: GRE	Figure: 2A		
Approx. Scale: 1"=100'			
Date Revised: Apr. 26, 2022			



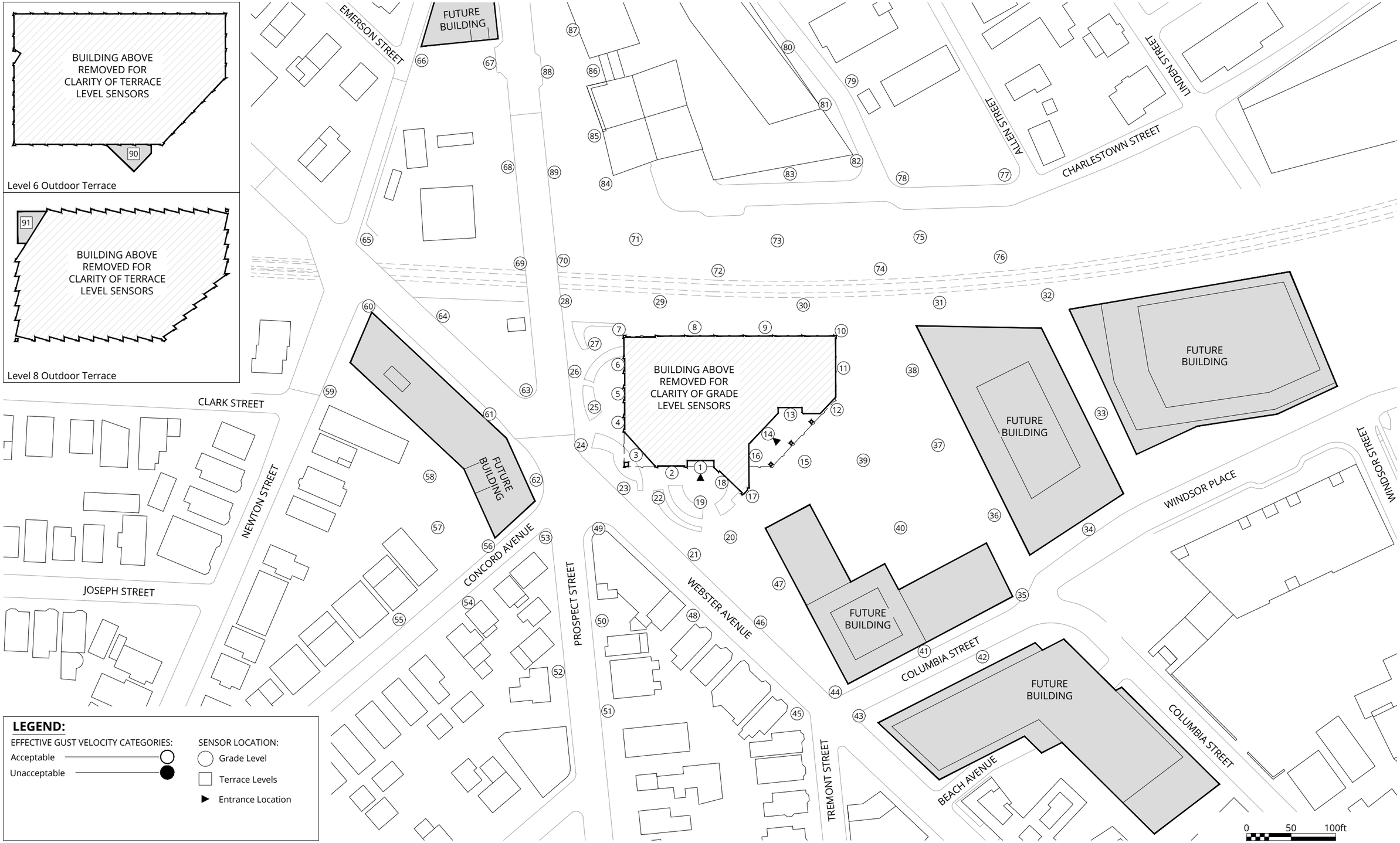
Pedestrian Wind Conditions - Effective Gust Velocity
Build
Annual

Union Square Parcel D3.1 - Somerville, MA

True North

Project #2202458

Drawn by: GRE	Figure: 2B		
Approx. Scale: 1"=100'			
Date Revised: Apr. 26, 2022			



LEGEND:

EFFECTIVE GUST VELOCITY CATEGORIES:
- Acceptable
- Unacceptable

SENSOR LOCATION:
- Grade Level
- Terrace Levels
- Entrance Location

Pedestrian Wind Conditions - Effective Gust Velocity
Full Build
Annual

Union Square Parcel D3.1 - Somerville, MA

True North

Project #2202458

Drawn by: GRE	Figure: 2C
Approx. Scale:	1"=100'
Date Revised:	Apr. 26, 2022

SOLAR GLARE ANALYSIS

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FINAL REPORT

UNION SQUARE PARCEL D3.1

SOMERVILLE, MA

SOLAR REFLECTION STUDY

RWDI # 2202458

April 29, 2022

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI was retained to investigate the impact of solar reflections emanating from the proposed Union Square Parcel D3.1 development in Somerville (Boston), MA. The key findings results and conclusions of the study can be summarized as follows:

Overall Impact of Reflections

The impact of the building on its surrounds are typical of any modern building of its size in an urban space. While the sculpture was predicted to have some potential to create reflections of higher irradiance levels, this can be mitigated through thoughtful material selection. Additional details on the potential times and dates of the reflections are presented in Appendix A.

Thermal Impacts on People

The planar facades of the proposed project were not predicted to focus sunlight. Therefore, RWDI does not expect any significant thermal impacts (i.e., risks to human safety or property damage) to occur offsite in the surrounding neighborhood. The simulations did indicate some potential for higher irradiance levels within the sculpture. This was predicted in only a small fraction of the year (0.2%) and occurred for less than 10 minutes at a time, but it may be noticeable should an individual happen to be exposed to it. RWDI would recommend that any glass used in such a configuration be rendered matte via frosting or acid-etching a design or pattern into the surfaces.

Thermal Impact on Property

At the majority of studied neighboring facades, reflections were predicted to be low intensity and short duration. Hence, RWDI would not expect these reflections to lead to a significant additional cooling load for a building. An individual exposed to the reflected energy may feel some temporary warmth which could be remedied by closing window treatments.

Visual Glare Impact on Drivers

For car and train drivers travelling in the vicinity of the proposed development, an increased level of visual glare was predicted. In particular, drivers along Webster Avenue, as well eastward travelling trains at and near Union Square station, were predicted to have the potential to experience reflections from the building which can cause a high level of impact. These reflections were predicted in less than 2% of the daytime annually, which is typical in a modern urban space like Boston. Further, many of the predicted impacts occur when the sun would also be within a driver's view which may lower the perceived impact of the reflection compared to the much brighter sunlight.

Visual Glare Impact on Pedestrians and Facades

Typical levels of visual glare were predicted for pedestrians and building occupants in the vicinity of the development. These types of reflections represent at worst a visual nuisance, as viewers can safely look away or close blinds. These potential impacts were predicted to be possible in only a fraction of the year for the surrounding buildings (less than approximately 12% of the daytime annually). Reflections may affect pedestrians more frequently, up to 25% of the daytime on an annual basis, specifically in areas south of the building such as on the greenspace south of the site and on the southern terrace. Reflections will also be frequent within the northwest glass sculpture, predicted to be approximately 21% of the daytime on an annual basis. None of these are expected to pose a risk to safety and in many cases a pedestrian would need to purposed turn and look towards the building to be affected.

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1 INTRODUCTION

RWDI was retained to investigate the impact that solar reflections emanating from the proposed Union Square Parcel D3.1 development will have on the surrounding urban terrain.

The project site is located at 50 Webster Avenue on the east side of the intersection between Webster Avenue and Prospect Street (see **Image 1**). It is currently occupied by a low-rise commercial building and is immediately surrounded by low to mid-rise commercial and/or residential buildings in all directions. The proposed project will be a nine-story mixed-use building with plans for office, life-science lab and retail uses.

The objective of this study was to determine the effect that solar reflections emanating from the proposed development will have on the surrounding neighborhood and to develop mitigative solutions, if needed.

This report presents the methodology used, the criteria applied, as well as the results and recommendations from RWDI's assessment.

Image 1: Aerial View of Site and Surroundings (Map Credit: Google™ Earth)

2 BACKGROUND AND APPROACH

2.1 Urban Reflections

While a common occurrence, solar reflections from buildings can lead to numerous visual and thermal issues.

Visual glare can:

- Impair the vision of motorists and others who cannot easily look away from the source;
- Cause nuisance to pedestrians or occupants of nearby buildings; and,
- Create undesirable patterns of light throughout the urban fabric.

Heat gain can:

- Affect human thermal comfort;
- Be a safety concern for people and materials, particularly if multiple reflections are focused in the same area; and
- Create increased cooling needs in conditioned spaces affected by the reflections.

The most significant safety concerns with solar reflections occur with concave facades (Image 2) which act to focus the reflected light in a single area. The current design does not feature concave elements. As such, RWDI does not expect this to be a concern given the form of the project.

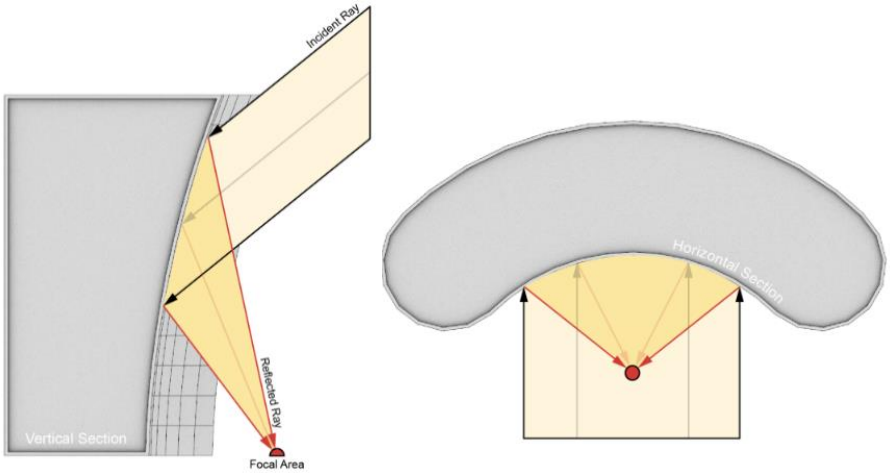

Image 2: Illustration of Reflection Focusing Due to a Concave Facade

2.2 Numerical Modeling

RWDI assessed the potential for reflection impacts using RWDI's in-house proprietary *Eclipse* software, in two phases as per the steps outlined below:

- The Phase 1 'screening' assessment began with the development of a 3D model of the area of interest (as shown in Image 3). This was then subdivided into many smaller triangular patches (see Image 4).
- For each hour in a year, the expected solar position was determined, and "virtual rays" were drawn from the sun to each triangular patch of the 3D model. Each ray that was considered to be "unobstructed" was reflected from the building surface and tracked through the surrounding area. The study domain included the entire pedestrian realm within 1,000 feet of the proposed buildings.
- The total reflected energy at that hour from all of the patches was computed and its potential for visual and thermal impacts assessed. Finally, a statistical analysis was performed to assess the frequency, and intensity of the glare events occurring throughout the year in the vicinity of the project. The criteria used to assess the level of impact is presented in Appendix B.
- Based on the findings of the screening analysis, multiple representative 'receptor points' were selected to undergo the Phase 2 'detailed' analysis. The points were chosen to understand in greater detail how reflections from the building will impact drivers, pedestrians and the rest of the built environment. The selected points are discussed further in Section 4.2.
- The detailed analysis process is similar to the screening analysis, except reflections are analyzed at one-minute increments for the entire year.
- In addition to the frequency and duration of reflection impacts, the detailed analysis allows for the prediction of when impacts can occur and the locations of problematic glare sources.

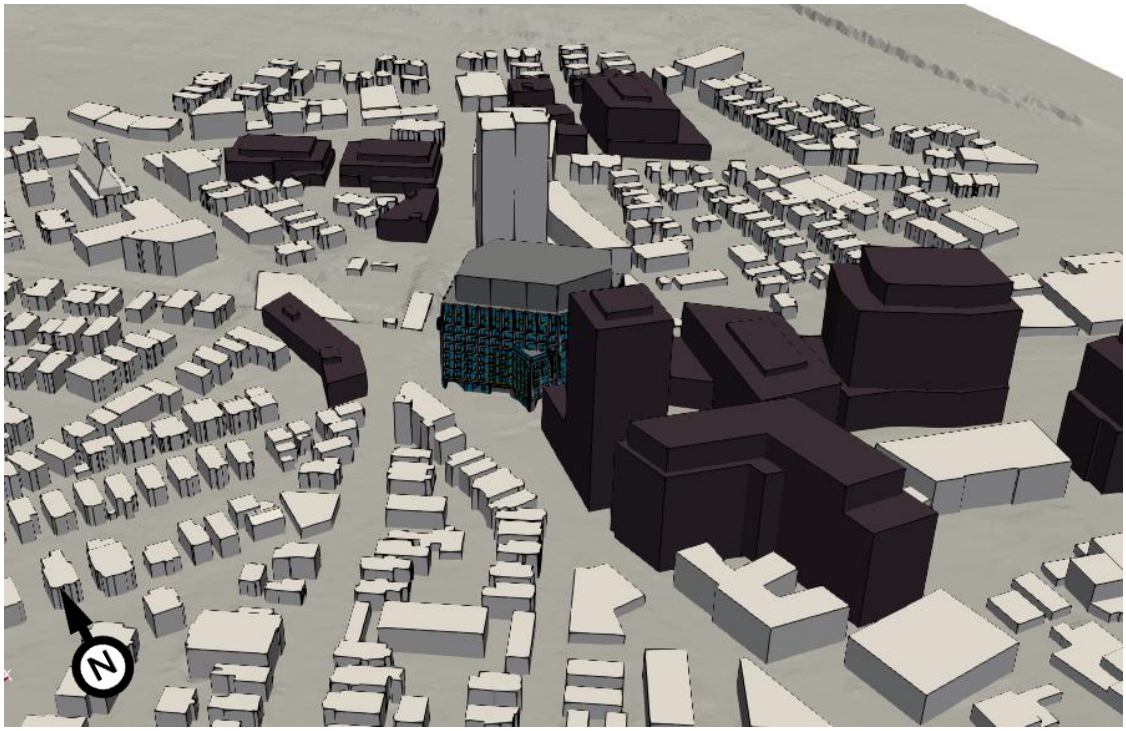

Image 3: 3D Computer Model of the Proposed Development and Surrounding Context

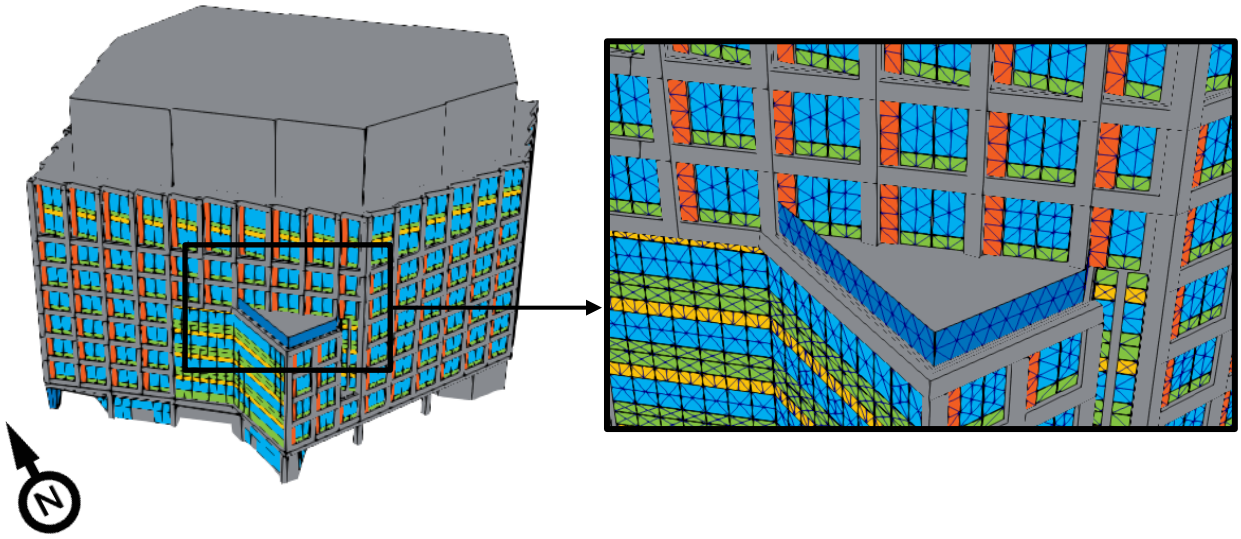

Image 4: Close-up View of the Model, Showing Surface Subdivisions

2.3 Design Criteria

The criteria with which RWDI assessed the impact of solar reflections in the Phase 2 'detailed' analysis are summarized below, with additional details provided in Appendix B.

2.3.1 Visual Impact Categories

- **Low:** Either no significant reflections occur, or the reflections will have a minimal effect on a viewer, even when looking directly at the source.
- **Moderate:** The reflections can cause some visual nuisance only to viewers looking directly at the source.
- **High:** The reflections can cause nuisance and emanate from within the critical field of view of vehicle operators or those performing other high-risk tasks who cannot safety look away from the source.
- **Damaging:** The brightest glare source is intense enough to permanently damage the eye for a viewer looking directly at the source.

2.3.2 Thermal Impact Categories for People

- **Low:** Either no significant reflections occur, or the reflection intensity is below the short-term exposure threshold of 1500 W/m^2.
- **Moderate:** The reflection intensity is above the short-term exposure threshold of 1500 W/m^2 but below the safety threshold of 2500 W/m^2. Such reflections would quickly cause thermal discomfort in people.
- **High:** The reflection intensity is above the safety threshold of 2500 W/m^2 but below 3500 W/m^2. This level of exposure to bare skin would lead to the onset of pain within 30 seconds.
- **Very High:** Reflection intensity exceeds 3500 W/m^2. This level of exposure leads to second degree burns on bare skin within 1 minute.

2.3.3 Thermal Impact Categories for Property

The impact of solar irradiance on different materials is primarily based on the temperature gains to the material which can cause softening, deformation, melting, or in extreme cases, combustion. These temperature gains are difficult to predict as they are highly dependent on the convective heat transfer from air movement around the object and long-wave radiative heat transfer to the surroundings. However, surfaces in the urban realm are routinely exposed to reflections from windows, metal panels and bodies of water without such impacts, therefore it is reasonable to use the intensity of a single (non-focused) reflection during a peak solar condition as a benchmark for potential impacts on property. Therefore, as this time, RWDI takes a conservative approach and uses a value of 1,000 W/m^2 (i.e., the typical peak intensity of natural sunlight), as a baseline threshold for reflected irradiance on stationary objects.

2.4 Assumptions and Limitations

2.4.1 Meteorological Data

This analysis used 'clear sky' solar data computed at the location of Boston Logan International Airport. This approach uses mathematical algorithms to derive solar intensity values for a given location, ignoring local effects such as cloud cover. This provides an assessment of a complete year showing the full extent of when and where glare could ever occur.

2.4.2 Radiation Model

RWDI's analysis is only applicable to the thermal and visual impacts of solar radiation (i.e., ultraviolet, visible and infrared wavelengths) on people and property in the vicinity of the development. It does not consider the impact of the building related to any other forms of radiation, such as cellular telephone signals, RADAR arrays, etc.

2.4.3 Study Building and Surrounds Models

The analysis was conducted based on a 3D model of the proposed development provided by Spagnolo & Gisness Associates (SGA) to RWDI on February 7, 2022.

The surroundings model was developed based on a combination of data provided by SGA, open-source GIS data from Sommerville, Cambridge, and MassGIS, OCM Partners LiDAR scan, all cross referenced with previous RWDI projects in the vicinity.

Potential reductions of solar reflections due to the presence of vegetation or other non-architectural obstructions was not included, nor are reflections from other buildings. Light that has reflected off several surfaces is assumed to have a negligible impact. As such, only a single reflection from the development was included in the analysis.

2.4.4 Facade Material Reflectance

Based on correspondence with SGA as well as information received up to April 1, 2022, the building will have four types of glazing units: GL-1, GL-2. GL-3, and GL-4. GL1 will use Vitro Starphire Ultra Clear lites, and a to-be-defined low-emissivity coating. For the purposes of this analysis RWDI assumed a coating which provided the highest reflectivity values. This material property was also used for GL 2 and GL4 as a conservatism. GL-3 is planned to be Okalux OKASOLAR Type – F Units. Information regarding how the refracting interlayer within the OKASOLAR products effects external reflectivity was not available from the manufacturer. As the presence of this layer likely acts to reduce external reflectance towards the pedestrian realm, it was ignored as a conservatism. Reflected light from the internal louvers is likely to be directed upwards away from the roads, however this is not captured in our current simulation.

In the model, the Vitro units have a visible and full spectrum reflectance of 33% and 59% respectively. The OKASOLAR units have a visible and full spectrum reflectance of 12% and 34% respectively.

Glazed balustrades and a glass sculpture in the northwest of the site were also noted. These are unlikely to be insulated glazing units, therefore we have assumed that they are a single lite with a visible and full spectrum reflectance of 8% and 7%, respectively.

Image 5 illustrates the location of the reflective materials on the facades.

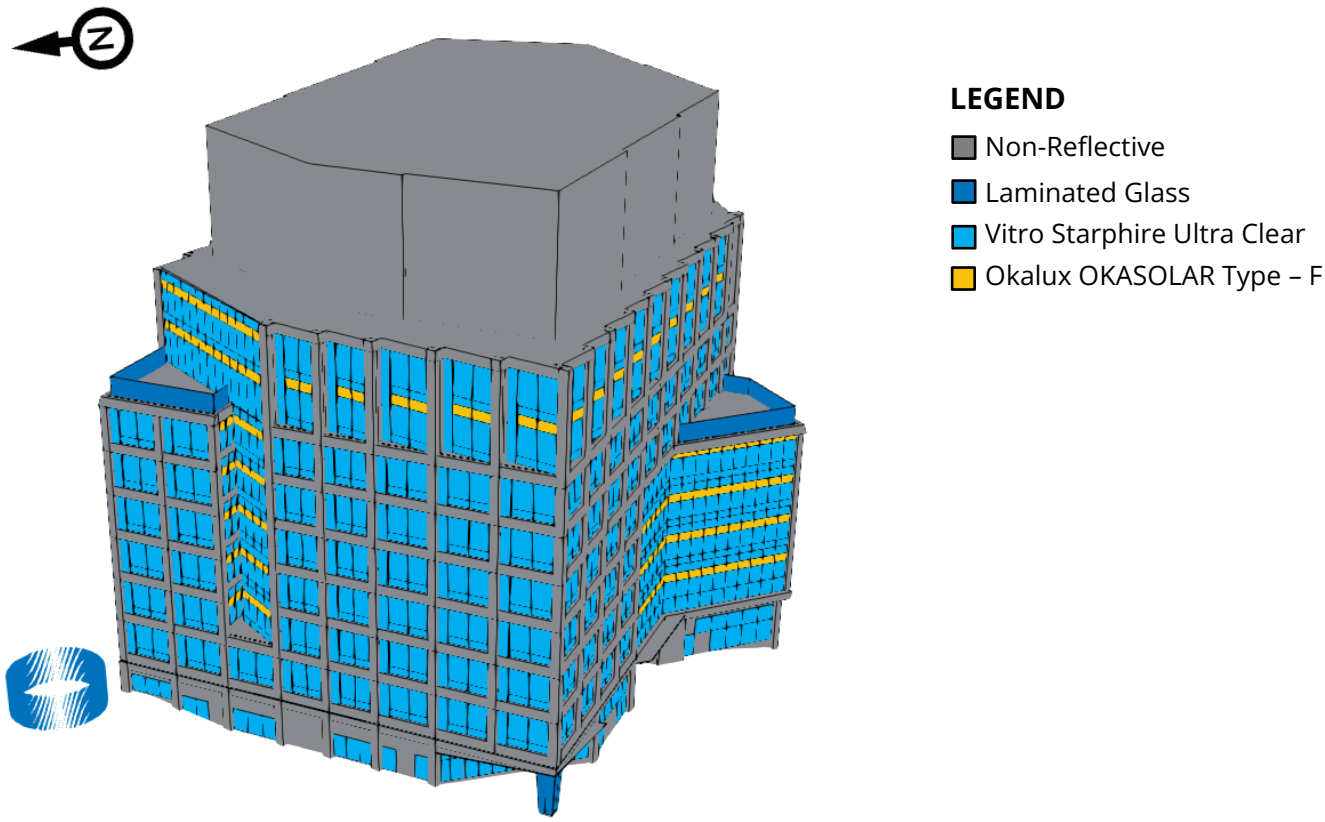

Image 5: Locations of Reflective Building Elements (Surrounding Context removed for Clarity)

3 RESULTS AND DISCUSSION

3.1 Screening-Level Analysis

3.1.1 Results

Peak Annual Reflected Irradiance

Images 6a and 6b display the annual peak intensity of all reflections emanating from the development at a typical pedestrian height (5 feet) above local grade.

The visible reflectance (Visual Glare), as shown in Image 6a, display the intensity of reflected visible light only. Depending on the ambient conditions, reflection intensities as low as 50 W/m^2 could be visible to people outdoors.

The full spectrum reflectance (Heat Gain), as shown in Image 6b, present the total intensity of a reflection, including both visible light and thermal energy which relates to the risk of excessive heat gain. For full spectrum reflectance, RWDI considers 1500 W/m^2 as a short-term thermal comfort threshold and reflections above 2500 W/m^2 as a human safety threshold (refer to Appendix B).

Frequency of Significant Visual Reflections

Image 6c identifies the locations of the most frequent significant reflections emanating from the facades. In this context a 'significant' reflection is one that is at least 50% as intense as one that would cause after imaging on a viewer (refer to Appendix B).

As this criterion is visually based, the visible reflectance of the facades was used.

Note that none of these images illustrate a specific moment in time, but rather an annualized assessment of the potential for reflections.

In order to develop a complete understanding of the impact that reflections may have on drivers, other factors must be considered, including the duration of the reflections and when they occur. The following plots serve to illustrate the general characteristics of reflections from the development and inform the locations of the receptor points used in the detailed phase of work which analyze these factors in greater detail.

PEAK ANNUAL REFLECTED IRRADIANCE - VISIBLE REFLECTANCE (PLAN VIEW)

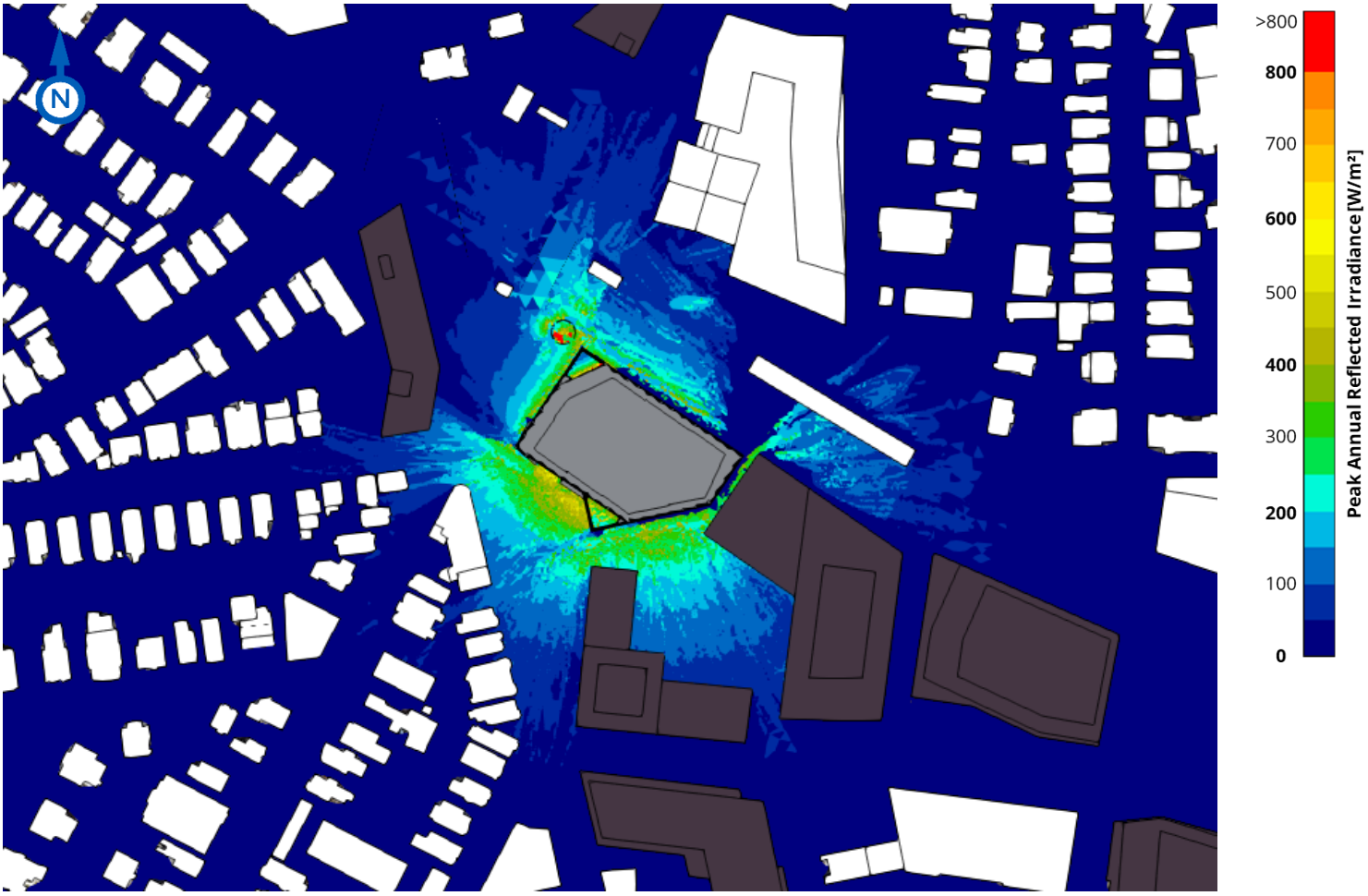

Image 6a: Maximum Annual Intensity of Visible Reflections at Pedestrian Height (Plan View)

PEAK ANNUAL REFLECTED IRRADIANCE - FULL SPECTRUM REFLECTANCE (PLAN VIEW)

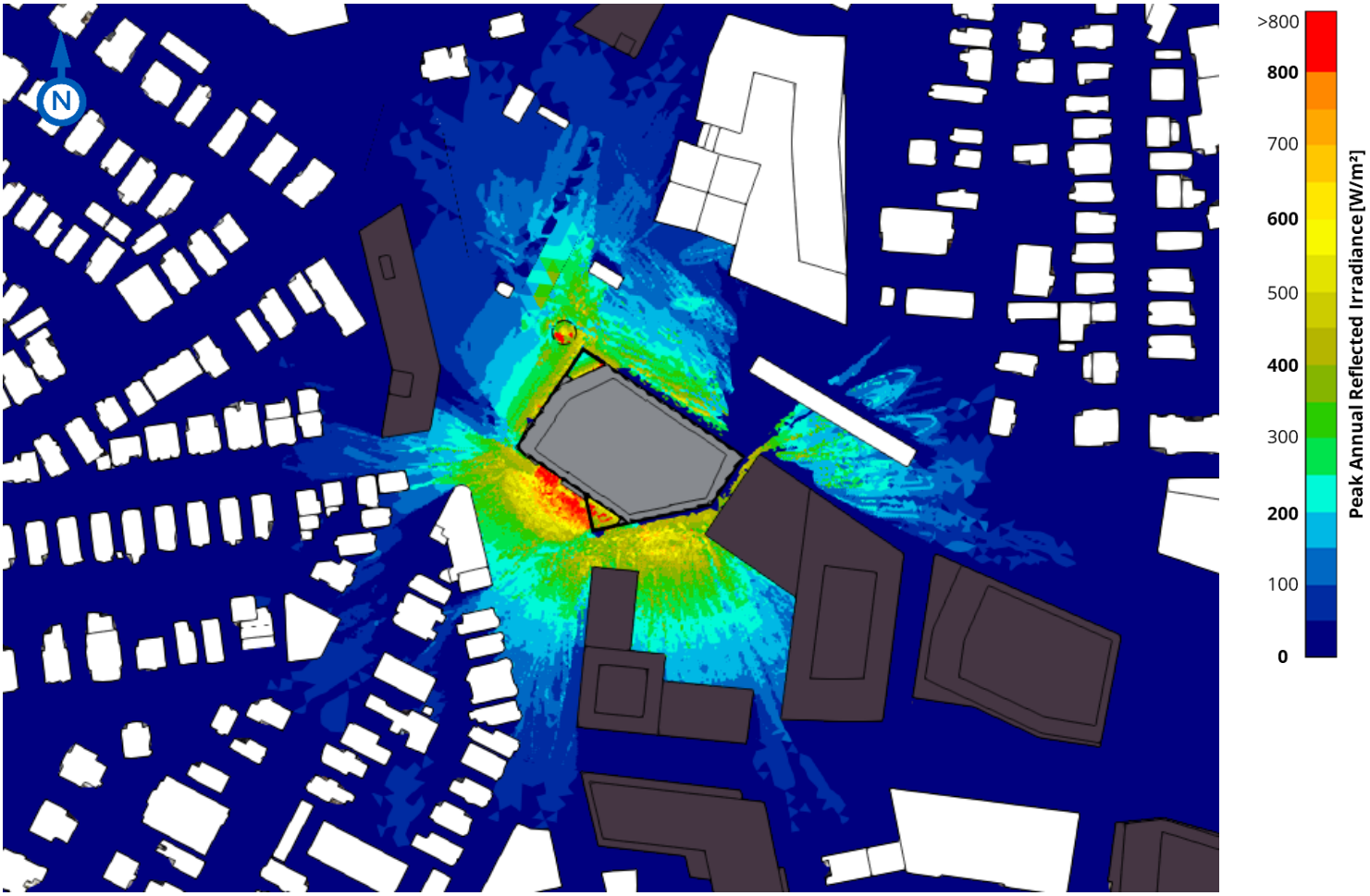

Image 6b: Maximum Annual Intensity of Full Spectrum Reflections at Pedestrian Height (Plan View)

FREQUENCY OF SIGNIFICANT VISIBLE REFLECTIONS (PLAN VIEW)

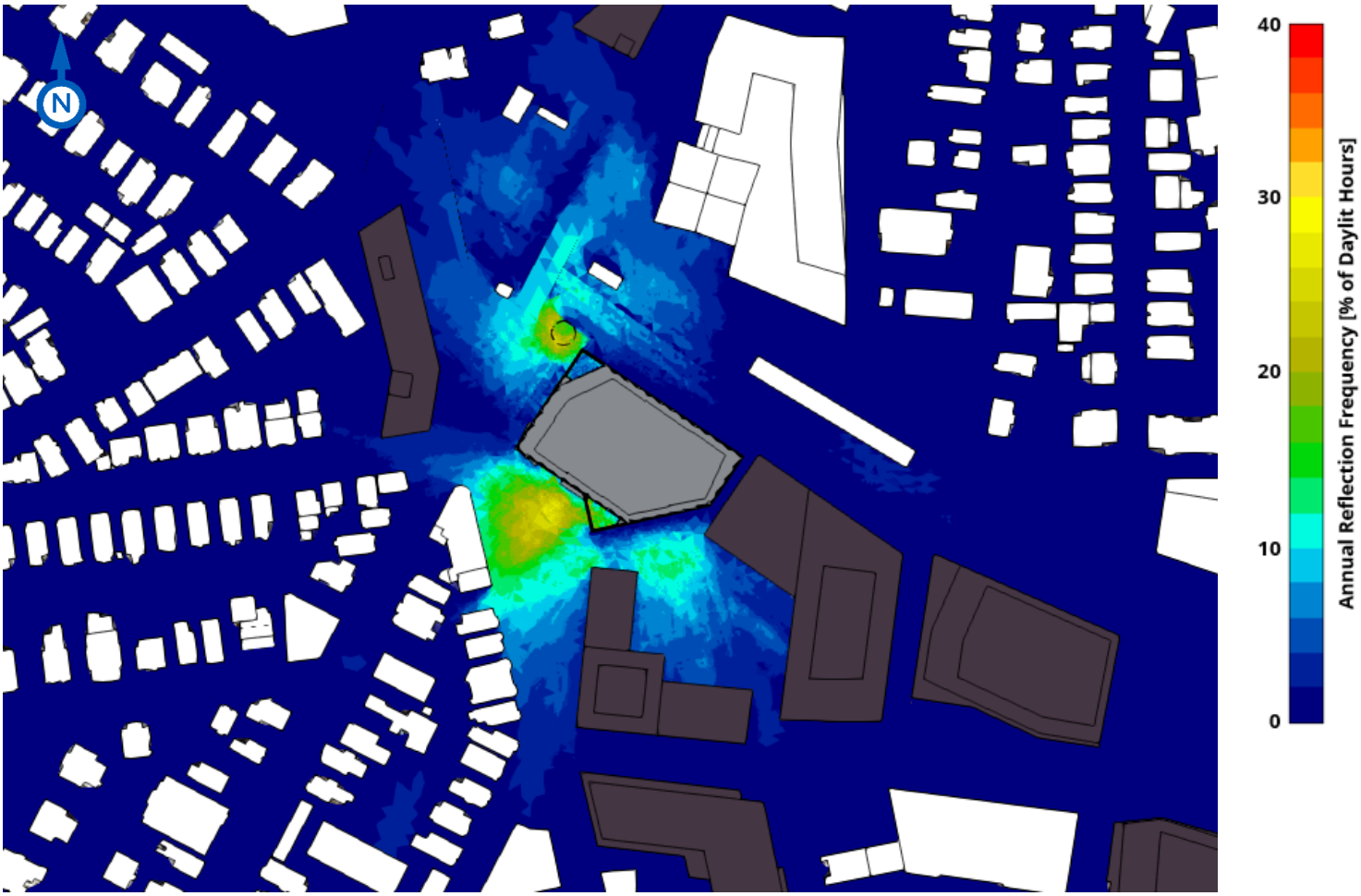

Image 6c: Frequency (% of Daylit Hours) Where Significant Visible Reflections Can Occur at Pedestrian Height (Plan View)

3.1.2 Screening Analysis Observations

1. Like any contemporary building, the reflective surfaces of the proposed development are naturally causing solar reflections in the surrounding areas.

2. The planar nature of the facades of the building prevents reflections from focusing (concentrating) in any particular area. Thus, RWDI does not anticipate any significant heat gain issues on offsite people or property due to the building. The simulations did indicate some potential for higher irradiance levels occurring within the sculpture approaching RWDI's thresholds. This location will be investigated further in the detailed analysis section.

3. At pedestrian level, reflections were predicted to fall most frequently onto the areas immediately south of the development, especially along the southwest face (Image 6c). The maximum frequency of glare occurrence found at pedestrian level was predicted to be approximately 27% of daytime hours.

4. Reflections from the development were predicted to be generally confined to within 500 feet of the development. These reflections may impact drivers on Prospect Street and Webster Avenue as well as trains servicing Union Square Station.

5. The occupants of the buildings located in the vicinity of the development were predicted to have the potential for reflections, though they not at an intensity that poses a risk to safety. The reflections are likely a nuisance at worst, as the occupants can look away or close blinds.

6. The exact nature of these impacts is explored further in the following detailed analysis section.

3.2 Detailed Analysis

Based on the findings of the Screening Analysis and the risk levels associated with reflections affecting specific areas, 21 representative points were selected for the Detailed Analysis. These points are described in Table 1 and illustrated in Image 7.

Table 1: Receptor Descriptions

Receptor Number	Receptor Description
D1 – D2	Northbound drivers on Webster Avenue
D3 – D4	Southbound drivers on Webster Avenue
D5 – D6	Southbound drivers on Prospect Street
D7	Northbound drivers on Prospect Street at the Intersection of Webster Avenue
D8 – D9	Eastbound train on the train tracks north of the development
D10	Westbound train on the train tracks north of the development
D11	Train exiting Union Square station
D12	Train entering Union Square station
F13	Northwest facade at approximately 2nd floor height of the building immediately southeast of Parcel D3.1
F14	Northwest facade at approximately 3rd floor height of the building immediately southeast of Parcel D3.1
F15	North facade at 2nd floor height of the building immediately south of Parcel D3.1
F16	East facade at 3rd floor height of the building immediately Southwest of Parcel D3.1
F17	South facade at 4th floor height of the building immediately Northeast of Parcel D3.1
P18	Pedestrian on the northern terrace of Parcel D3.1
P19	Pedestrian on the southern terrace of Parcel D3.1
P20 – P21	Pedestrians south of Parcel D3.1
P22	Pedestrian under the Northwest glass sculpture
P23	Pedestrian crossing Prospect Street at the intersection of Prospect St. and Webster Ave.
P24 – P25	Pedestrians waiting at Union Square station

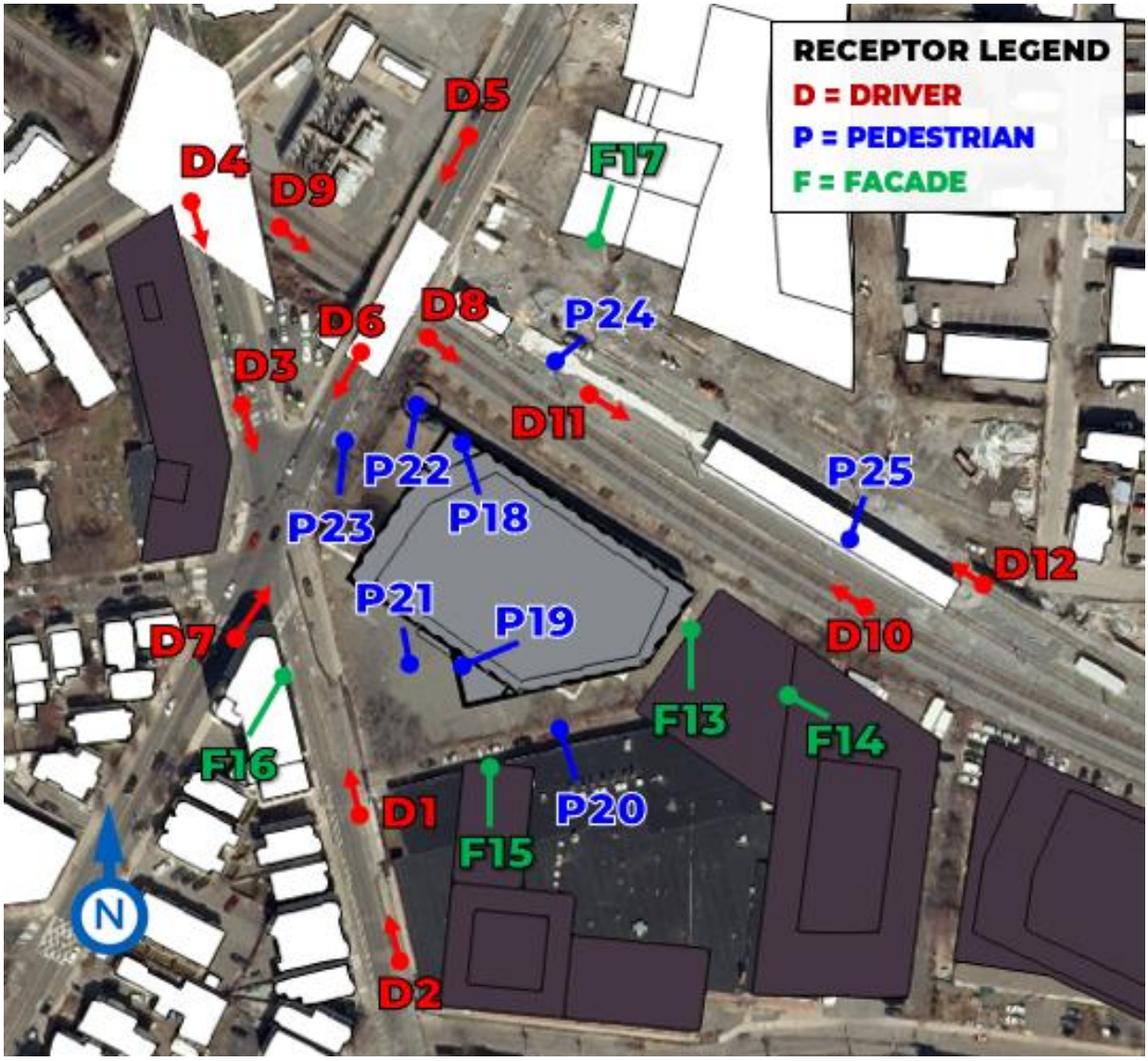

Image 7: Receptor Locations (Map Credit: Google Maps)

Table 2 summarizes the level of visual and thermal impact from the development's reflections at each of the studied locations.

The minute-by-minute results for each point are presented as 'Annual Reflection Impact Diagrams' which distill an entire year's worth of data into a single diagram. The diagrams for each of the receptor points, as well as an explanation on how to read the diagrams, are provided in Appendix A.

The level of mitigation required is determined based on a combination of factors including the predicted level of impact, the frequency and duration of the impacts, and the risk level associated with activities likely to be engaged in at the location. These factors are discussed in the Conclusions Section.

Table 2: Summary of Overall Predicted Impacts on Receptors

Receptor Number	Receptor Type	Assumed Activity Risk Level	Assumed Ability to Self-Mitigate	Peak Reflected Light Visual Impact	Duration / Number of Days with High Impact Reflection	% of High Impacts Where the Sun Is Also Visible	Peak Reflected Solar Thermal Impact on People	Peak Reflected Solar Thermal Impact on Facade
D1	Driver	High	Low	***High***	Longest Duration: **20 minutes** Average Duration: **10 minutes** No. of days: **52**	***0%***	***Low***	N/A
D2	Driver	High	Low	***High***	Longest Duration: **13 minutes** Average Duration: **6 minutes** No. of days: **45**	***0%***	***Low***	N/A
D3	Driver	High	Low	***High***	Longest Duration: **13 minutes** Average Duration: **5 minutes** No. of days: **14**	***0%***	***Low***	N/A
D4	Driver	High	Low	***High***	Longest Duration: **22 minutes** Average Duration: **5 minutes** No. of days: **49**	***0%***	***Low***	N/A
D5	Driver	High	Low	***High***	Longest Duration: **31 minutes** Average Duration: **8 minutes** No. of days: **107**	***0%***	***Low***	N/A
D6 – D7	Train Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A

Receptor Number	Receptor Type	Assumed Activity Risk Level	Assumed Ability to Self-Mitigate	Peak Reflected Light Visual Impact	Duration / Number of Days with High Impact Reflection	% of High Impacts Where the Sun Is Also Visible	Peak Reflected Solar Thermal Impact on People	Peak Reflected Solar Thermal Impact on Facade
D9	Train Driver	High	Low	***High***	Longest Duration: **28 minutes** Average Duration: **8 minutes** No. of days: **210**	***32%***	***Low***	N/A
D10	Train Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A
D11	Train Driver	High	Low	***High***	Longest Duration: **5 minutes** Average Duration: **3 minutes** No. of days: **11**	***64%***	***Low***	N/A
D12	Train Driver	High	Low	***Moderate***	N/A	N/A	***Low***	N/A
F13 – F17	Facade	Low	High	***Moderate***	N/A	N/A	N/A	***Low***
P22	Pedestrian	Low	High	***Moderate***	N/A	N/A	***Moderate***	N/A
P18-P21; P22-P25	Pedestrian	Low	High	***Moderate***	N/A	N/A	***Low***	N/A

3.3 Conclusions

3.3.1 Thermal Impacts on People

1. The planar facades of the proposed development ensure that reflected sunlight from the building will not focus (multiply) in any particular area in the surrounding neighborhood.
2. The simulations did indicate some potential for higher irradiance levels within the sculpture. This was predicted in only a small fraction of the year (0.2%) and occurred for less than 10 minutes at a time, but it may be noticeable should an individual happen to be exposed to it. RWDI would recommend that any glass used in such a configuration be rendered matte via frosting or acid-etching a design or pattern into the surfaces.
3. RWDI does not expect any other significant thermal impacts to occur for any pedestrians or drivers in the surrounding neighborhood.

3.3.2 Thermal Impacts on Property

4. The majority of reflected solar energy at most of the studied facade receptors were predicted to be low intensity (less than 300 W/m^2). RWDI would not expect these reflections to lead to a significant additional cooling load for a building. An individual exposed to the reflected energy may feel temporarily warm, which could be remedied by closing window treatments.

3.3.3 Visual Glare Impact on Drivers

5. As with the addition of glazed building, drivers traveling in the vicinity of the development are expected to experience an increased level of visual glare impact. Some of these may be considered high, which may alter a driver's experience. In particular, a driver's experience could be altered for:
   - Drivers traveling north or south on Webster Avenue (receptors D1-D4),
   - Drivers travelling south on Prospect Street (receptor D5); and
   - Train drivers travelling eastbound on the tracks north of the development (receptors D8-D9, D11).
6. Drivers travelling on Webster Avenue (receptors D1-D4) were predicted to have the potential to experience high impact reflections between 3:30 pm and 6:00 pm EST from mid-February to April, and from mid-August to late October. However, were predicted to be short in duration (lasting less than 10 minutes on average) and infrequent (predicted in less than 0.2% of the daytime annually).
7. High impact reflections were also predicted for drivers traveling south on Prospect Street (receptor D5) between 3:00 pm and 5:00 pm EST from January to March and September to November. These high impacts were also predicted to be infrequent (predicted in approximately 0.9% of the daytime annually) and of short duration (lasting 8 minutes on average).
8. High impact reflections were predicted for eastbound train drivers between 6:00 am and 8:00 am EST from mid-February to early April and September to October, as well as in the evening between 5:00 pm and 6:30 pm EST between mid-April to mid-August. The reflections were predicted to last an average of less than 8 minutes, and up to 28 minutes at most and were predicted to be possible in approximately 1.7% of the daytime. Further, many of the morning reflections were predicted when the sun would already be in view. This may act to reduce the perceived impact of the reflections due to glare already

being expected in these locations at that time and drivers preemptively self-mitigating (putting on sunglasses, lowering visors, etc.) because of it.

9. For the remainder of the driver receptors, visual glare impacts were predicted to be moderate at worst (i.e., emanate from outside a driver's critical field of view), and are therefore not expected to pose a significant safety concern. For further details refer to the visual impact diagrams for all driver receptors illustrated in Appendix A. RWDI notes that this assessment has assumed that drivers behave in a reasonable and safe fashion (i.e., that maintain forward eye contact in their direction of travel and are not purposely looking away from the road towards the building).

3.3.4 Visual Glare Impacts on Pedestrians and Facades

10. Moderate levels of visual impact were predicted to fall on all of the pedestrian and facade receptors studied in this analysis.
11. Reflections predicted on the studied neighboring facades are expected on average last less than approximately 15 minutes, but can last up to 61 minutes at maximum. This equates to glare being possible up to 12% of the daytime annually respectively.
12. The potential visual impacts noted above do not present a safety risk, but rather a temporary nuisance at worst which can be mitigated by closing blinds or looking away from the glare source.
13. It is also likely that a portion of these reflections reach the facades at angles that would limit how far that would penetrate into the buildings.

3.3.5 Overall Reflection Impact

14. In RWDI's experience, the reflections created by the building and their potential effects on people and property are not atypical for a contemporary building in an urban center.
15. The sculpture was predicted to have some potential to create reflections of higher irradiance levels, but this can be easily mitigated through thoughtful material selection.

4 GENERAL STATEMENT OF LIMITATIONS

This report entitled Union Square Parcel D3.1 – Solar Reflection Study dated April 29, 2022, was prepared by Rowan Williams Davies & Irwin Inc. ("RWDI") for Spagnolo & Gisness Associates ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared.

This report has endeavored to provide a robust and suitably conservative analysis of the potential effects of reflected sunlight, contextualized based on current industry and academic research, and common best practices. Regulation and enforcement of performance requirements is the responsibility of the relevant regional regulatory authority.

This analysis assumes reasonable and responsible behavior on the part of people in the vicinity of the project. A reasonable and responsible person would not purposely look towards a bright reflection, purposely prolong their exposure to reflected light or heat, or otherwise intentionally try to cause discomfort/harm to themselves or others and/or damage to property.

Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final stages of the project to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.