35 McGrath Highway

Address: 35 McGrath Highway, Somerville, MA 02143 Submitted by: 35 McGrath Highway Realty Trust



Owner:

35 McGrath Highway Realty Trust

Attorney:

McDermott Quilty & Miller LLP

Owners Representative:



Architecture:



MEP/FP Engineering:



Landscape/Civil:



Structural Engineering:



Traffic:



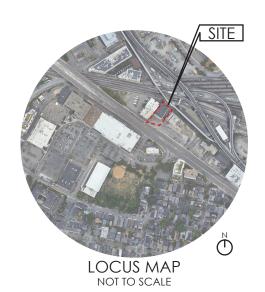


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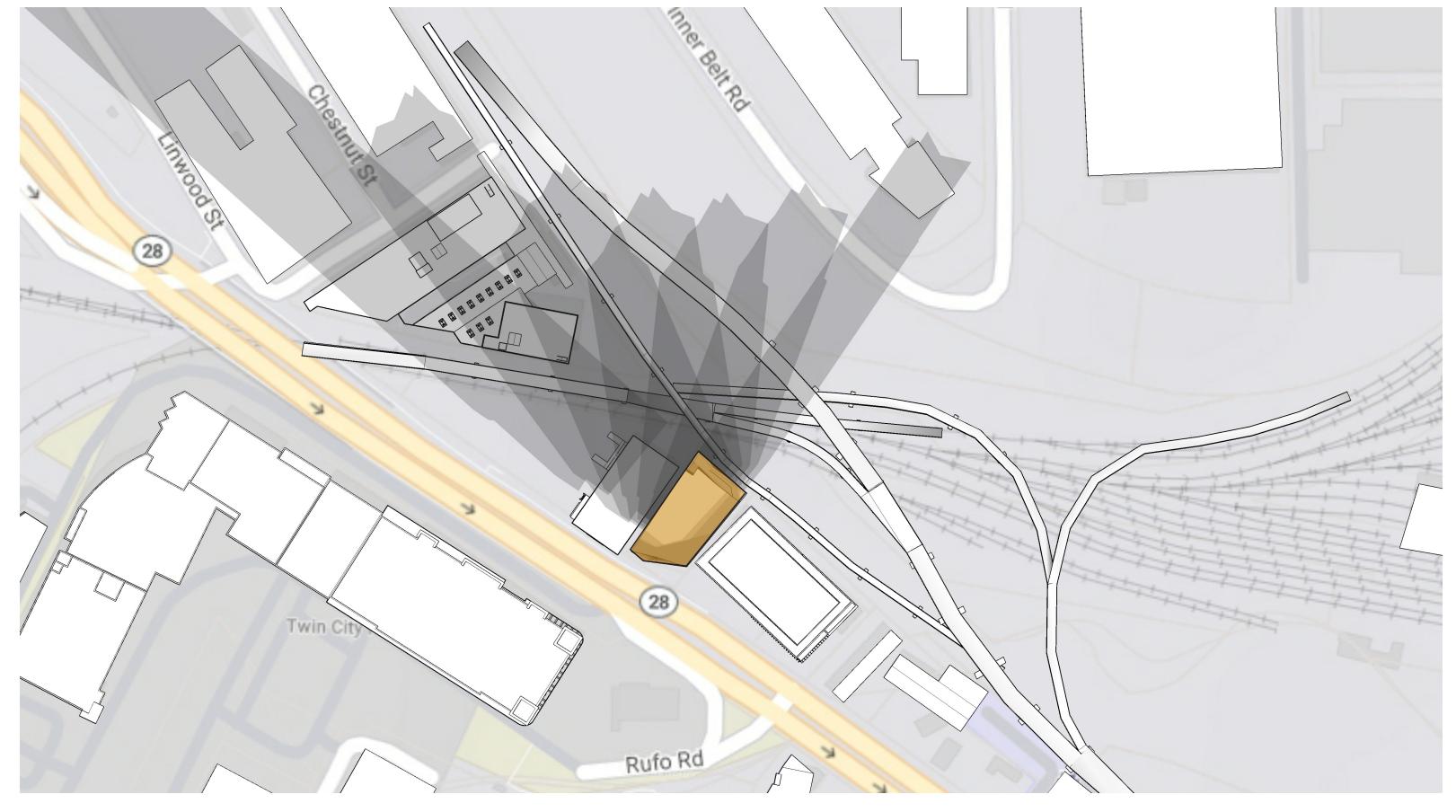
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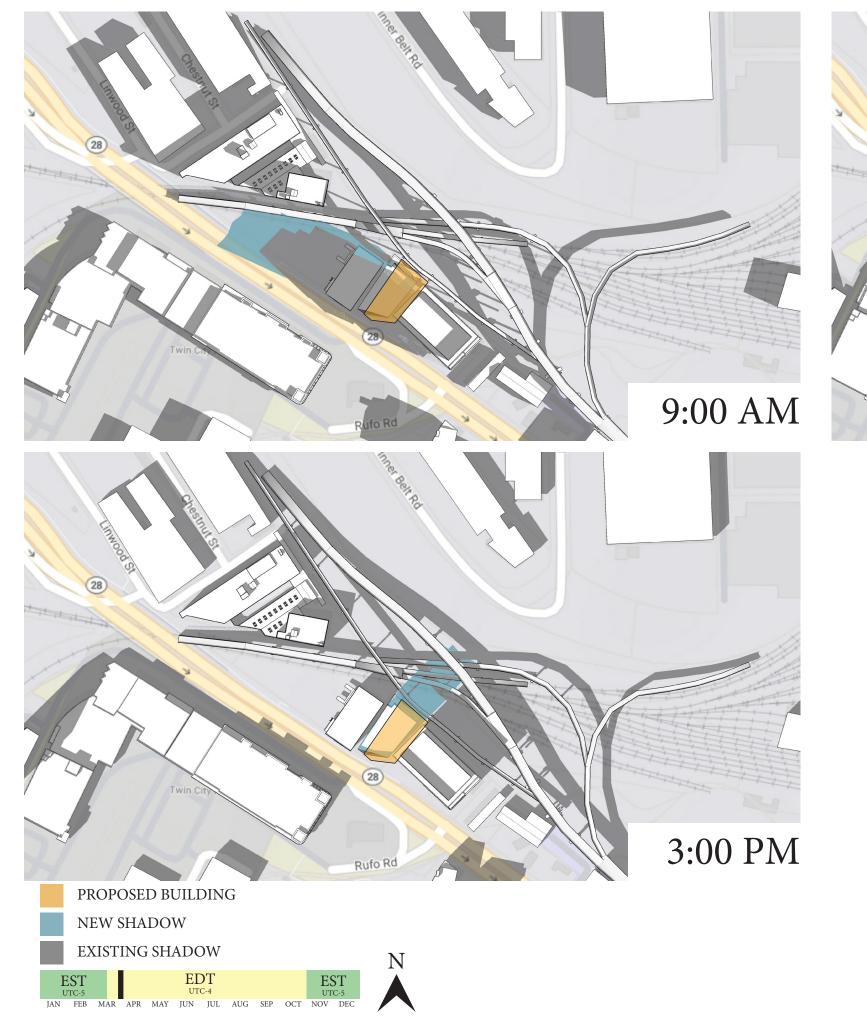
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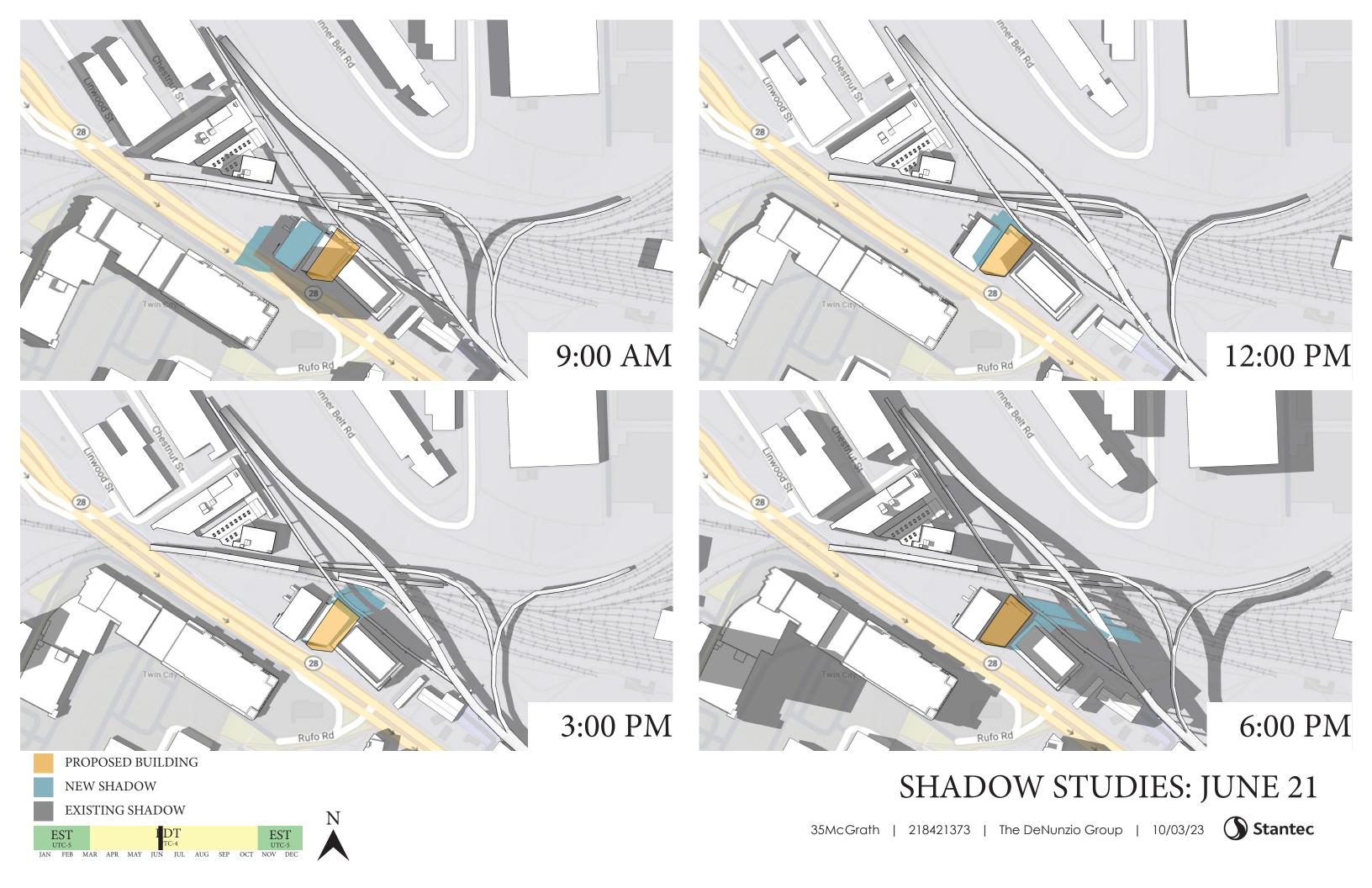
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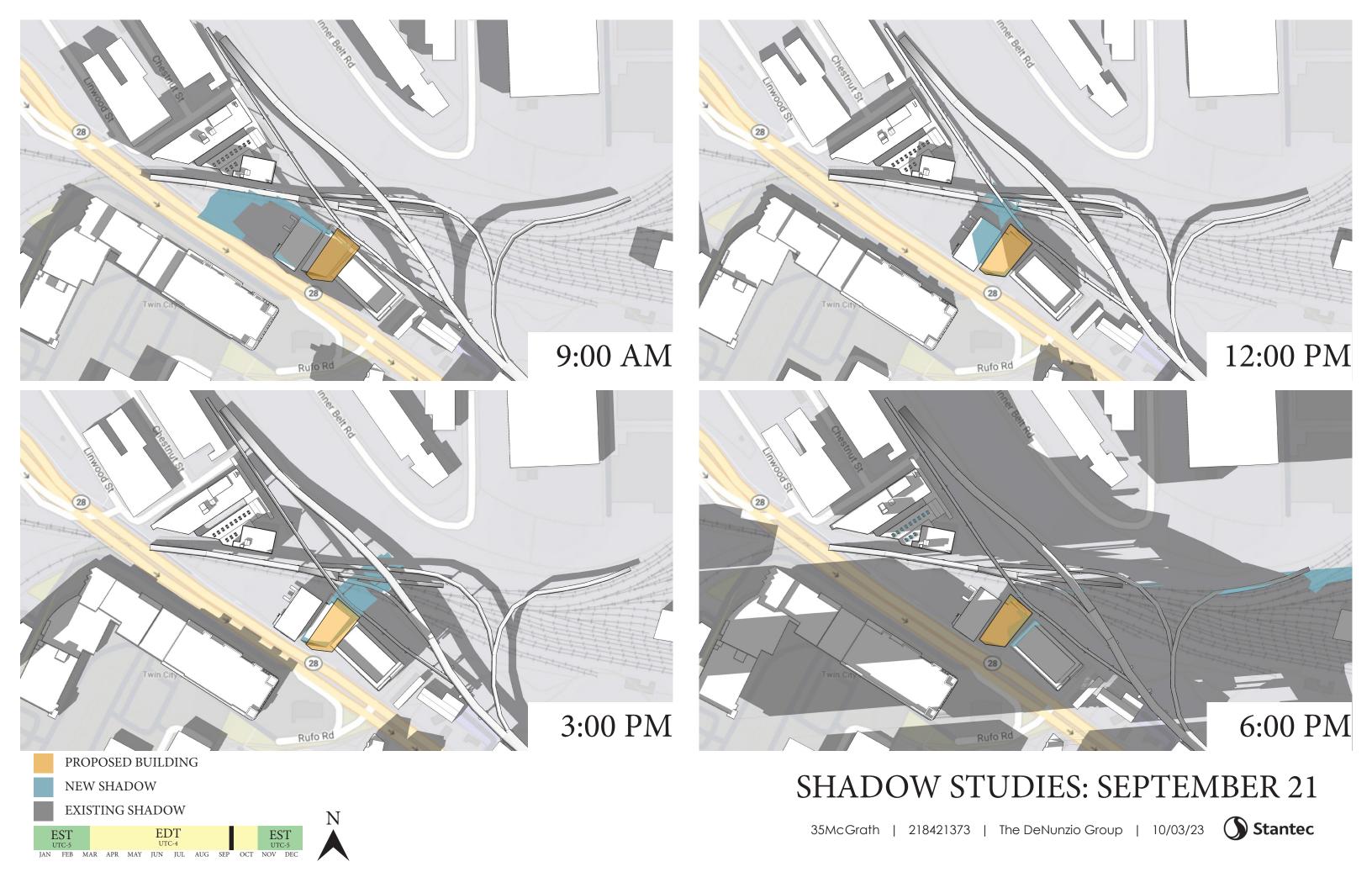






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CONTEXT ANALYSIS ENVIRONMENTAL IMPACT ANALYSIS

FINAL REPORT



35 MCGRATH HIGHWAY

SOMERVILLE. MA

SOLAR REFLECTION DETAILED ANALYSIS

RWDI # 2205912 June 26, 2023

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI was retained to investigate the impact that solar reflections emanating from the proposed 35 McGrath Highway redevelopment will have on the surrounding urban realm.

Thermal Impacts on People

The planar and convex nature of the facades of the proposed project ensure that reflected sunlight will not focus (multiply) in any particular area. Therefore, RWDI does not expect any significant thermal impacts (i.e. risks to human safety or property damage) to occur either on the site or in the surrounding neighborhood.

Visual Glare Impact on Drivers

As with the addition of any glazed building, drivers travelling in the vicinity of the new project were predicted to have the potential to experience visual glare. For the studied receptors, high reflections along McGrath Highway were predicted to last on average between 7 to 11 minutes and may occur less than 2% of the daytime annually. This is not unusual of other contemporary buildings studied by RWDI in the area. RWDI does not predict a significant impact to rail conductors to the north of the development.

Visual Glare Impact on Pedestrians and Facades

Typical levels of visual glare were predicted for pedestrians and building occupants in the vicinity of the proposed project. These types of reflections represent only a visual nuisance as viewers can safely look away or close blinds. These potential impacts were predicted to be possible in a very small fraction of the year (less than 1.2% of the daytime annually) for the proposed 15 McGrath Highway redevelopment, Brickbottom Condominium, and 262 Monsignor O'Brien Highway. Reflections may also affect pedestrians in Kenmore Square, Kenmore MBTA Station and other nearby green spaces more frequently. However, these results are not unusual for an urban space.

Thermal Impact on Facades

At all studied facade areas, 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 choosing to expose themselves to the reflected energy may feel warmth. However, this would be a temporary experience and one which would be remedied by closing window treatments or moving away from the window.

Overall Impact of Reflections

The predicted impacts of the proposed project on its surrounds are typical of any modern building of its size and glazed area. Additional details on when reflections were predicted to occur throughout the year, as well as predicted durations and intensities, can be found in Appendix A.



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1 INTRODUCTION

This report provides the computer modeling results of reflected sunlight from the proposed project at 35 McGrath Highway in Somerville, MA (as shown in Figure 1 - the "Project"). It is our understanding that the Project will be surrounded by typical urban spaces such as busy roadways, and other buildings.

RWDI was retained to investigate the impact that solar reflections emanating from the Project may have on the surrounding urban terrain.

A preliminary set of simulations was conducted to determine peak reflection intensities and the frequency of reflection occurrence for a broad area around the Project. This served to identify areas which may experience high intensity or very frequent reflections. This information informed the selection of 24 points for a more detailed analysis.

These receptor points represent drivers, pedestrians, and building facades. The detailed results allow us to quantify the frequency, intensity and duration of glare events at the receptors as well as the sources of those reflections.



Image 1: Aerial View of Site and Surroundings (Photo Courtesy of 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 would not expect this project to present a risk of causing significant heat gains to its surrounds.

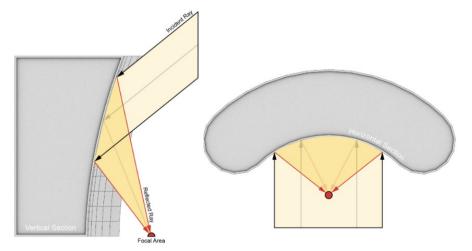


Image 2: Illustration of Reflection Focusing Due to a Concave Façade



3 METHODOLOGY

3.1 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 Figure 3). The model was subdivided into many smaller triangular patches (see Figure 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 1,500 feet of the Project.
- 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 can be found in Appendix B of this report.
- 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 Project will impact drivers, pedestrians and the rest of the built environment. The selected locations of the points are discussed further in the Detailed Analysis section this report.
- The Detailed analysis process is similar to the Screening analysis, except reflections are analyzed at oneminute increments for the entire year and the source of the reflections is stored for each receptor point.
- In addition to the frequency and duration of reflection impacts, the Detailed analysis allows to predict when impacts can occur, how long they can occur for and the locations of problematic glare sources.
- Note that the detailed analysis is not intended to be an exhaustive investigation of all locations where
 reflections are possible. It is instead intended to provide an understanding of the range of possible
 reflection characteristics from the proposed project.



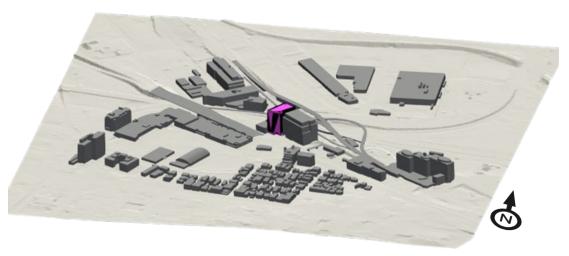


Image 3: 3D Computer Model of the Proposed Development and Surrounding Context

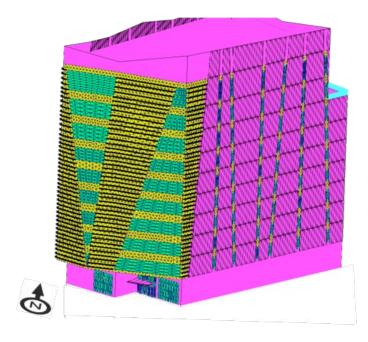


Image 4: Close-up View of the Model, Showing Surface Subdivisions



3.2 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.

3.2.1 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 reduce visual acuity for viewers operating vehicles or performing other high-risk tasks who are unable to look away from the source, posing a significant risk of distraction.
- **Damaging:** The brightest glare source is bright enough to permanently damage the eye for a viewer looking directly at the source.

3.2.2 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/m².
- **Moderate:** The reflection intensity is above the short-term exposure threshold of 1500 W/m² but below the safety threshold of 2500 W/m². Such reflections would quickly cause thermal discomfort in people.
- **High:** The reflection intensity is above the safety threshold of 2500 W/m² but below 3500 W/m². This level of exposure to bare skin would lead to the onset of pain within 30 seconds.
- **Very High:** Reflection intensity exceeds 3500 W/m². This level of exposure leads to second degree burns on bare skin within 1 minute.

3.2.3 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/m², as a baseline threshold for reflected irradiance on stationary objects.



3.3 Assumptions and Limitations

3.3.1 Meteorological Data

This analysis used 'clear sky' solar data computed at the location of Logan International Airport using the methodology promulgated by the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE). 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 can occur.

3.3.2 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.

3.3.3 Study Building and Surrounds Models

The analysis was conducted based on a 3D model of the Project provided by The Denunzio Group, LLC to RWDI on May 23, 2023.

The surroundings model was developed based on data made available by National Oceanic and Atmospheric Administration (NOAA). The surrounds model includes all buildings which currently exist or are approved for construction by the BPDA.

The ground surface and the surrounding buildings were topographically corrected based on a high-resolution LiDAR survey conducted by NOAA in 2021-2022. NOAA states that the horizontal accuracy of this data set is 6.3-7.9 inches at a 95% confidence level. Its vertical accuracy is stated as 2.9 inches at a 95% confidence level.

Potential reductions of solar reflections due to the presence of vegetation or other non-architectural obstructions were 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.

This analysis assumed that all reflective elements are in their as-designed condition, (i.e. clean, free from damage, degradation, distortion, etc.) and that the building envelopes of all buildings are complete and uncompromised (i.e. any elements of the walls/roofs that are not designed to be exposed to sun, are shielded).

3.3.4 Facade Material Reflectance

Based on information received from Stantec on May 4, 2023, several insulated glazing units (IGUs) are currently under consideration for the vision glass of this project. Upon review of their reflectance characteristics, the nominal visible reflectance of Viracon VRE1-59 (GL-1) and Viracon VE1-2M (GL-2) were approximately 33% and 15%, respectively. The properties of GL-3 (spandrel) were assumed to be similar to those of GL-2. The full spectrum



reflectance (which relates to heat gain related issues) for each of the glazing units were 39% and 32% for GL-1 and GL-2, respectively. Once more, the spectrum reflectance of GL-3 was assumed similar to those of GL-2.

Glass balustrades were also noted in the 3D model. These are unlikely to be IGUs; therefore we have assumed that they are typical laminated safety glass with a visible reflectance of 8% and full spectrum reflectance of 7%.

It is RWDI's understanding that all other facade materials have negligible specular reflectance.

The reflectance properties of the reflective elements are summarized in Table 1. Figure 5 illustrates the location of the reflective materials on the facades.

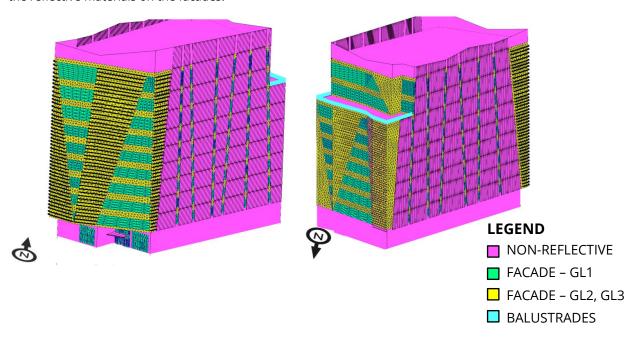


Image 5: Locations of Reflective Building Elements (Surrounding Context removed for Clarity)

Table 1: Nominal Visible and Full Spectrum Reflectance Values of the Reflective Building Elements

Location	Material	Visible Reflectance	Full Spectrum Reflectance	
Facade - GL1	Viracon VRE1-59 Triple Pane – Low E	33%	39%	
Facade - GL2, GL3	Viracon VRE1-2M Triple Pane – Low E – High Iron	15%	32%	
Balustrades	Clear 6mm laminated glass	8%	7%	



3.3.5 Applicability of Results

The results presented in this report are highly dependent on both the form and materiality of the Project's facades. Should there be any changes to the design, RWDI should be contacted and requested to review their potential effects on the findings of this report.

This analysis also 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.

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 others.

4 RESULTS AND DISCUSSION

4.1 Screening-Level Analysis

4.1.1 Results

This section presents the screening results pertaining to the solar impacts of the development on the surrounding urban area. The following plots are presented:

Peak Annual Reflected Irradiance

This plot displays the annual peak intensity of all reflections emanating from the development at a typical pedestrian height (5 feet) above local grade.

Two versions of this plot are included:

- **Visible Reflectance (Visual Glare):** This plot (Figure 6a) displays the intensity of reflected visible light only. Depending on the ambient conditions, reflection intensities as low as 50 W/m² could be visible to people outdoors.
- **Full Spectrum Reflectance (Heat Gain):** This plot (Figure 6b) presents 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/m² as a short-term thermal comfort threshold and reflections above 2500 W/m² as a human safety threshold (refer to Appendix B).



Frequency of Significant Visual Reflections

This plot (Figure 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 the figures do not show a specific moment in time, but rather present aggregated reflection predictions for an entire year.

In order to attain 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 will analyze these factors in greater detail.

PEAK ANNUAL REFLECTED IRRADIANCE - VISIBLE REFLECTANCE (VISUAL GLARE)

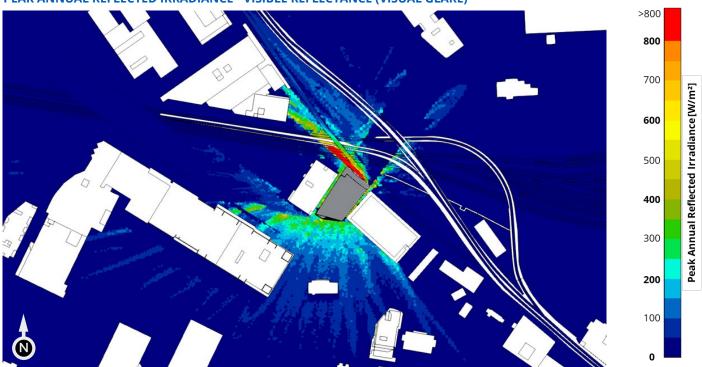


Image 6a: Maximum Annual Intensity of Visible Reflections at Pedestrian Height (Plan View)



PEAK ANNUAL REFLECTED IRRADIANCE - FULL SPECTRUM REFLECTANCE (HEAT GAIN)

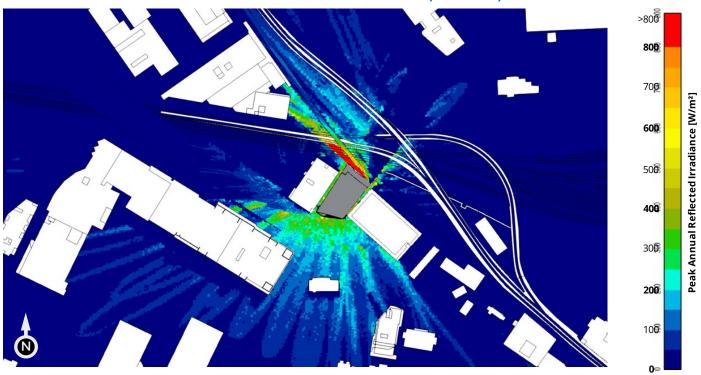


Image 6b: Maximum Annual Intensity of Full Spectrum Reflections at Pedestrian Height (Plan View)

FREQUENCY OF SIGNIFICANT VISIBLE REFLECTIONS

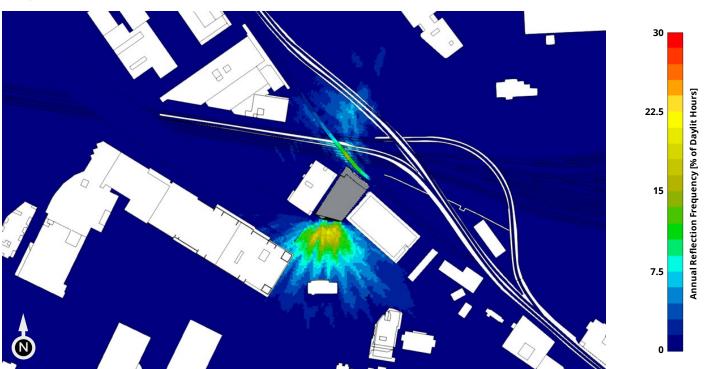


Image 6c: Frequency (% of Daylit Hours) Where Significant Visible Reflections Can Occur at Pedestrian Height (Plan View)



4.1.2 Screening Analysis Observations

- 1. Like any contemporary building, the reflective surfaces of the Project are naturally causing solar reflections in the surrounding neighborhood.
- 2. The planar nature of the facades of the Project prevents reflections from focusing (concentrating) in any particular area. Thus, RWDI does not anticipate any heat gain issues on people or property.
- 3. At pedestrian level, reflections were predicted to fall most frequently onto the area immediately north and south of the project. The maximum frequency of glare occurrence found at pedestrian level is approximately 20% of daytime hours.
- 4. Reflections from the Project were predicted to be generally confined to within 550 feet of the building and may impact eastbound and westbound drivers on McGrath Highway. Light rail drivers to the north of the project may also be affected.
- 5. Areas of higher reflection intensity are predicted to the north of the project close to the pedestrian bridge. These reflections are likely due to brief instances where sunlight strikes the glass at glancing angles and are expected to occur when the sun is also within the field of view. This is not atypical for contemporary buildings.
- 6. The occupants of the buildings located close to the development were predicted to experience visible reflections from the development. The reflections are unlikely to pose a risk to safety and can be mitigated by temporary closing blinds or moving away from the window.
- 7. Pedestrians within the vicinity of the project may also experience intermittent reflections. This condition is common in many urban centers and is unlikely to present a significant safety risk.
- 8. The exact nature of these impacts is explored further in the following detailed analysis section.

4.2 Detailed Analysis

SOLAR REFLECTION DETAILED ANALYSIS 35 MCGRATH HIGHWAY

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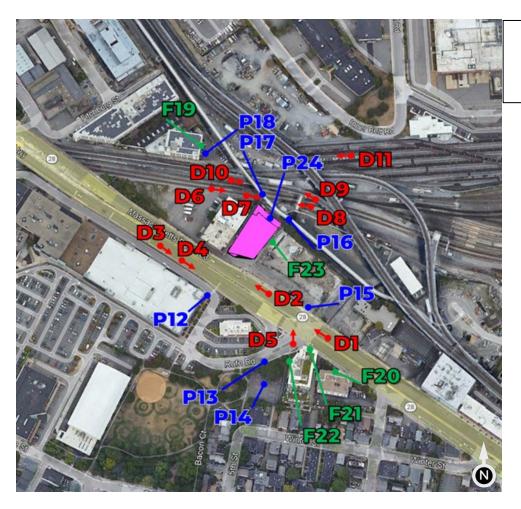


Based on the findings of the Screening Analysis and the risk levels associated with reflections effecting specific areas, 24 representative points were selected for the Detailed Analysis. These points are described in Table 2 and illustrated in Figure 7. Unless otherwise noted all driver/pedestrian receptors are located at 5 feet above local grade.

Table 2: Receptor Descriptions

Receptor Number	Receptor Description
D1-D2	Westbound drivers on McGrath Hwy
D3-D4	Eastbound drivers on McGrath Hwy
D5	Driver at the intersection of Rufo Rd. and McGrath Hwy
D6-D7, D10	Eastbound light rail conductors
D8-D9, D11	Westbound light rail conductors
P12-P13	Pedestrians on Rufo Rd.
P14	Pedestrian on Gold Star Mothers Park Basketball court
P15	Pedestrian on McGrath Hwy
P16-P17	Pedestrians on pedestrian bridge
P18	Pedestrians at Brickbottom Condominium Parking lot
F19	Facades at approximately 4 th floor height of Brickbottom Condominium
F20	Facades at approximately 1 st floor height of the Holiday Inn express (250 Monsignor O'Brien Highway)
F21 - F22	Facades at approximately 1st and 6 th floor of 262 Monsignor O'Brien Highway
F23	Facades at approximately 6 th floor height of the proposed 15 McGrath Highway building
P24	Pedestrians on the 9 th floor terrace at 35 McGrath Highway





RECEPTOR LEGEND

D = DRIVER

P = PEDESTRIAN

F = FACADE

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

Table 3 summarizes the level of visual and thermal impact from the development's reflections predicted 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 for how to read the diagrams are provided in Appendix A.

For further detail on RWDI's criteria refer to Appendix B.

The level of mitigation required (discussed further in the Overall Observations and Conclusions section), 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.



Table 3: 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: 14 minutes Average Duration: 8 minutes No. of days: 33	N/A	Low	N/A
D2	Driver	High	Low	High	Longest Duration: 41 minutes Average Duration: 11 minutes No. of days: 260	N/A	Low	N/A
D3-D11	Driver	High	Low	Moderate	N/A	N/A	Low	N/A
P12 - P18	Pedestrian	Low	High	Moderate	N/A	N/A	Low	N/A
F19, F21- F23	Facade	Low	High	Moderate	N/A	N/A	N/A	Low
F20	Facade	Low	High	Low	N/A	N/A	N/A	Low
P24	Pedestrian	Low	High	Moderate	N/A	N/A	Low	N/A



4.3 Conclusions

4.3.1 Thermal Impacts on People

1. The planar facades of the Project ensure that reflected sunlight will not focus (multiply) in any particular area. Therefore, RWDI does not expect any significant thermal impacts (i.e. risks to human safety or property damage) to occur either on the site of the development or in the surrounding neighborhood.

4.3.2 Thermal Impacts on Facades

2. The majority of reflected solar energy at the studied facade areas was predicted to be low intensity (less than 300 W/m²) and short duration. Hence, RWDI would not expect these reflections to lead to a significant additional cooling load for a building. An individual exposing themselves to the reflected energy may temporarily feel warm, which would easily be remedied by closing window treatments.

4.3.3 Visual Glare Impact on Drivers

- 3. As with the addition of any glazed building, drivers travelling in the vicinity of the Project are expected to have the potential to experience visible reflections from it. Some reflections with a high visual impact potential were predicted. Some of these impacts may alter a driver's experience since the glare was predicted at times when the sun would not be within a driver's field-of-view. In particular, a driver's experience could be altered when travelling west on McGrath Highway (receptors D1 and D2). The high impact reflections predicted at these locations can last up to 41 minutes, but on average lasted 7 to 11 minutes. The impacts were predicted between 3:00 pm EST and 4:30 pm EST between January and mid-March and again between mid-September and December. High impacts were also predicted between mid-May to late July at around 6pm. This equates to the potential for high impact glare being predicted up to 1.8% of the daytime for receptors D1 and D2, respectively.
- 4. For the remainder of the driver receptors, visual glare impacts were predicted to be moderate, and therefore pose a limited risk of glare. For further details refer to the visual impact diagrams for all driver receptors (D1-D11) illustrated in Appendix A.

4.3.4 Visual Glare Impacts on Pedestrians and Facades

- 5. Moderate levels of visual impact were predicted to fall on most of the pedestrian and façade receptors studied in this analysis. The exception to this was the receptor representing the façade of the Holiday Inn express (F20 250 Monsignor O'Brien Highway) where essentially no impact was predicted.
- 6. The potential impacts predicted on the facades of the surrounding buildings (F19, F21-F23) can last between 8 to 14 minutes at most, but on average lasted between 6 and 9 minutes.

SOLAR REFLECTION DETAILED ANALYSIS 35 MCGRATH HIGHWAY

RWDI #2205912 June 26, 2023



- 7. Reflections were predicted at Receptor F19 (Brickbottom Condominium) mainly in the morning hours between 7:00 am EST and 9:00 am EST October to March, and between noon and 2:00pm year-round for Receptor F23 (the proposed 15 McGrath Highway building). This equates to glare being possible up to 1.2% of the daytime annually for F19 and F23, respectively.
- 8. Reflections were predicted at Receptors (F21 at 250 Monsignor O'Brien Highway, F22 at 262 Monsignor O'Brien Highway) briefly around 3:00pm in Early February and later October, this equates to glare being possible less than 1% of the daytime annually for both receptors.
- 9. Moderate reflections were predicted at pedestrian receptors (P12 on Rufo Rd, P17 on the pedestrian bridge to the north of the project, and P24 on the 9th floor terrace of the project). These reflections not unusual for an urban environment.
- 10. The potential visual impacts noted above do not present a safety risk which can be mitigated by briefly closing blinds or looking away from the glare source.



5 GENERAL STATEMENT OF LIMITATIONS

This report entitled 35 McGrath Highway Solar Reflection Detailed Analysis was prepared by Rowan Williams Davies & Irwin Inc. ("RWDI") for The Denunzio Group, LLC ("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.

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.



APPENDIX A

ANNUAL REFLECTION IMPACT DIAGRAMS

ANNUAL REFLECTION IMPACT DIAGRAMS



Presentation of Results

The frequency, duration, and intensity of glare events throughout the year is illustrated using "annual impact diagrams" (see Figure A1 below for the general layout of these plots). The color of the plot for a given combination of date and time indicates the relative impact of any glare sources found. The horizontal axis of the diagram indicates the day of the year, and the vertical axis indicates the hour of the day.

We note that the referenced times are in local standard time, so in jurisdictions where Daylight Savings Time is used, the time should be shifted by an hour when appropriate.

The following pages present the impact categories for three types of Annual Impact Diagrams: Visual Impact, Thermal Impact on People, and Thermal Impact on Property. More information on RWDI's criteria is available in Appendix B.

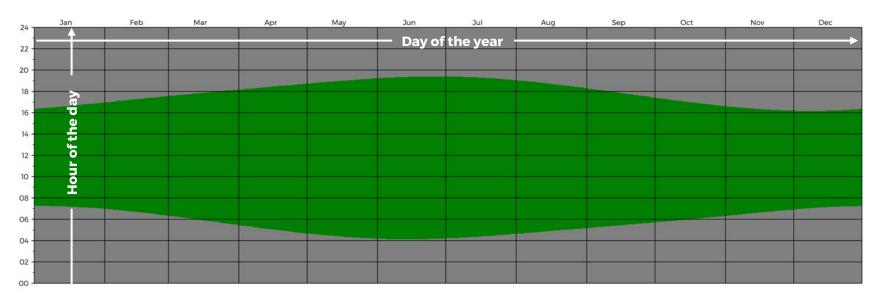


Figure A1: Layout of Annual Reflection Impact Diagram

ANNUAL REFLECTION IMPACT DIAGRAMS



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 reduce visual acuity for viewers operating vehicles or performing other high-risk tasks who are unable to look away from the source, posing a significant risk of distraction.

Damaging: The brightest glare source is bright enough to permanently damage the eye for a viewer looking directly at the source.

Hatched areas indicate times and dates when the sun would also be in a driver's field of view.

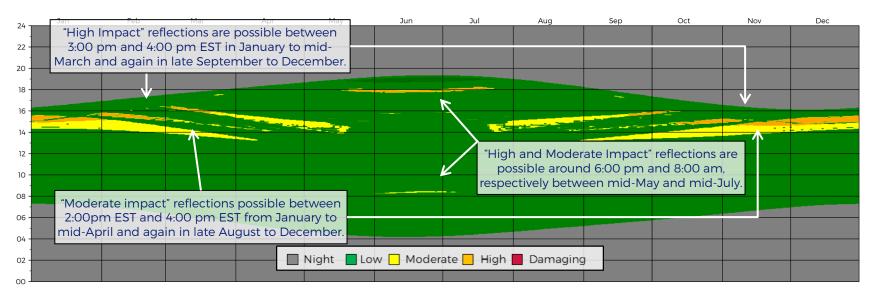


Figure A2: Example of Annual Visual Glare Impact Diagram – Receptor D2

ANNUAL REFLECTION IMPACT DIAGRAMS



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/m².

Moderate: The reflection intensity is above the short-term exposure threshold of 1500 W/m² but below the safety threshold of 2500 W/m². Such reflections would quickly cause thermal discomfort in people.

High: The reflection intensity is above the safety threshold of 2500 W/m² but below 3500 W/m². This level of exposure to bare skin would lead to the onset of pain within 30 seconds.

Very High: Reflection intensity exceeds 3500 W/m². This level of exposure leads to second degree burns on bare skin within 1 minute.

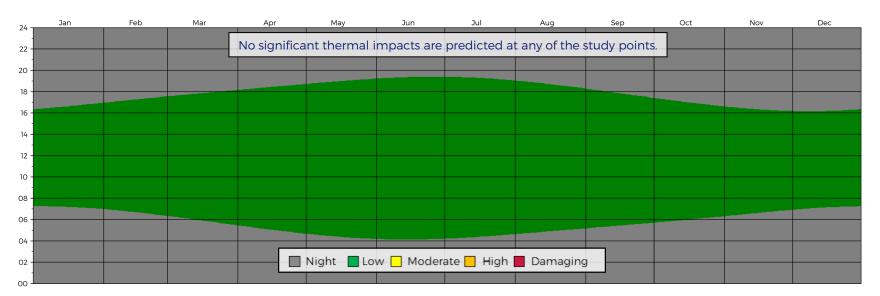


Figure A3: Example of Annual Pedestrian Thermal Impact Diagram – All Receptors

ANNUAL REFLECTION IMPACT DIAGRAMS



Thermal Impact Categories for Property

A different scale is used to illustrate the reflected thermal energy on facades in order to provide further clarity on the potential for heat gain issues. The diagrams illustrate the irradiance levels of all predicted reflection events along with their frequency and duration.

The format of the diagram is similar to the diagrams described in the previous pages. The color of the plot for a given combination of date and time indicates the intensity of the reflected light at that point in time.

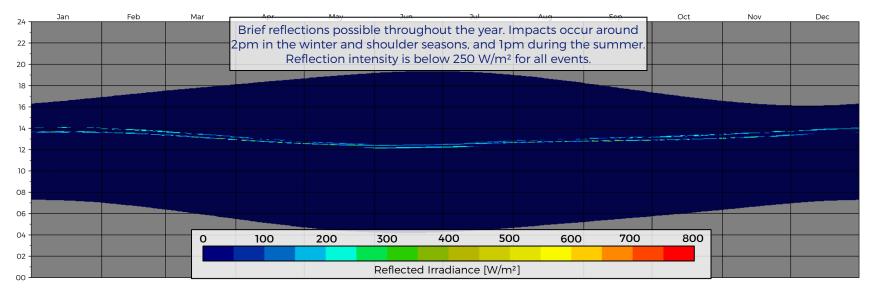
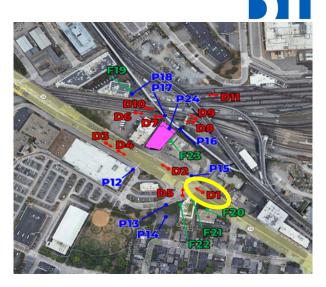
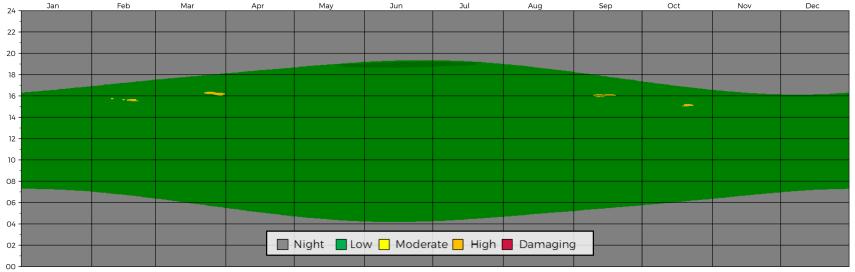


Figure A4: Example of Annual Property Thermal Impact Diagram – Receptor F23

Driver Receptor D1

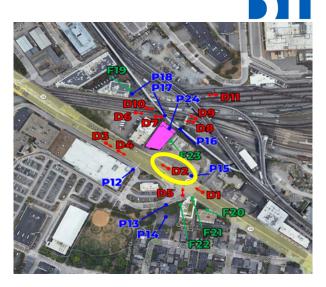
Receptor D1 was chosen to assess the visual impact associated with solar reflections affecting westbound drivers on McGrath Hwy.

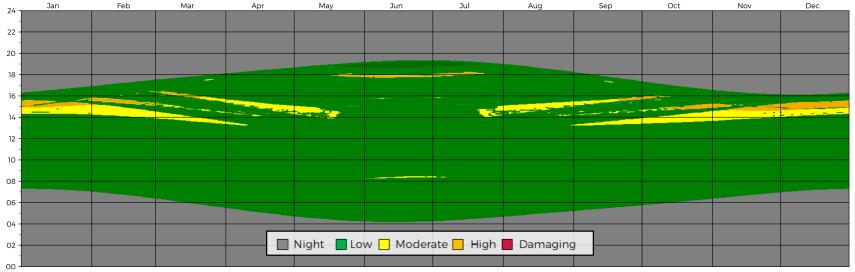




Driver Receptor D2

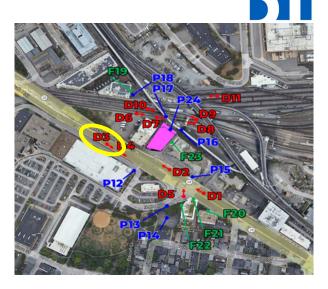
Receptor D2 was chosen to assess the visual impact associated with solar reflections affecting westbound drivers on McGrath Hwy.





Driver Receptor D3

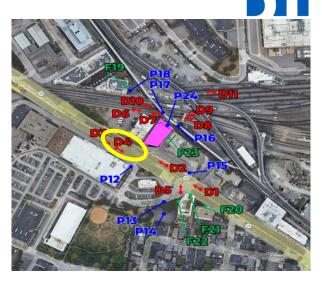
Receptor D3 was chosen to assess the visual impact associated with solar reflections affecting eastbound drivers on McGrath Hwy.

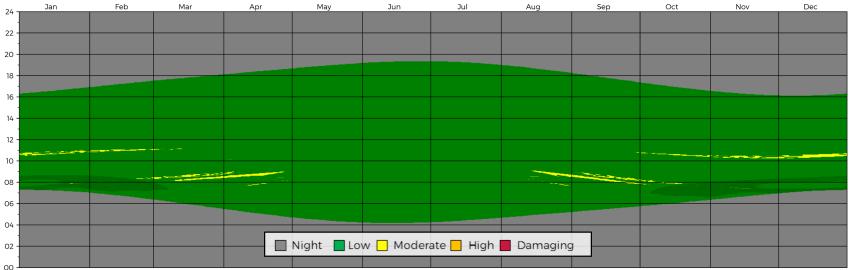




Driver Receptor D4

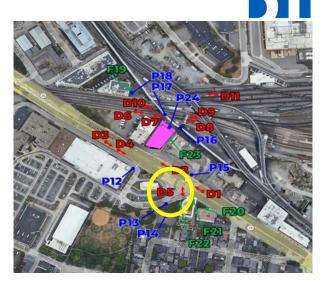
Receptor D4 was chosen to assess the visual impact associated with solar reflections affecting eastbound drivers on McGrath Hwy.

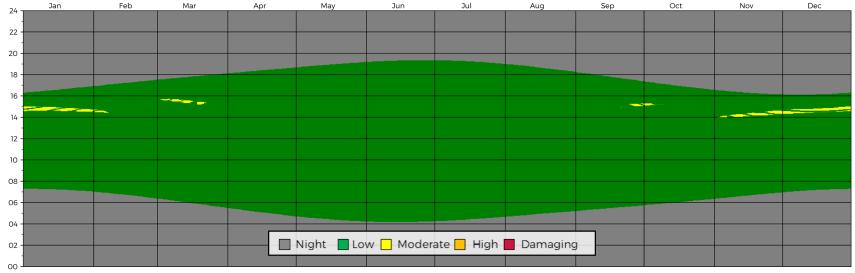




Driver Receptor D5

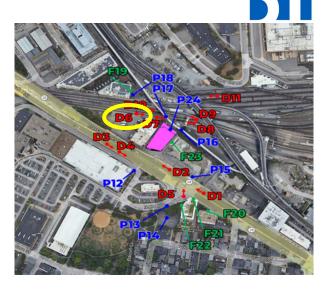
Receptor D5 was chosen to assess the visual impact associated with solar reflections affecting driver at the intersection of Rufo Rd and McGrath Hwy.

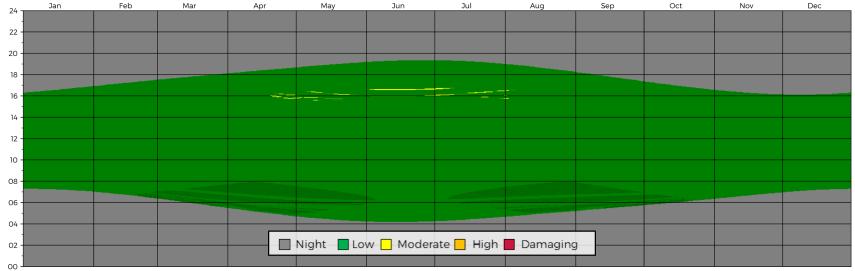




Driver Receptor D6

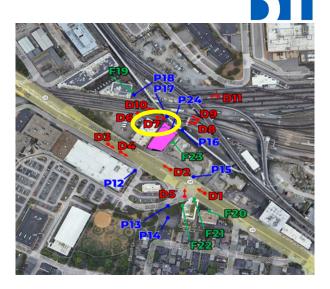
Receptor D6 was chosen to assess the visual impact associated with solar reflections affecting eastbound light rail conductors.

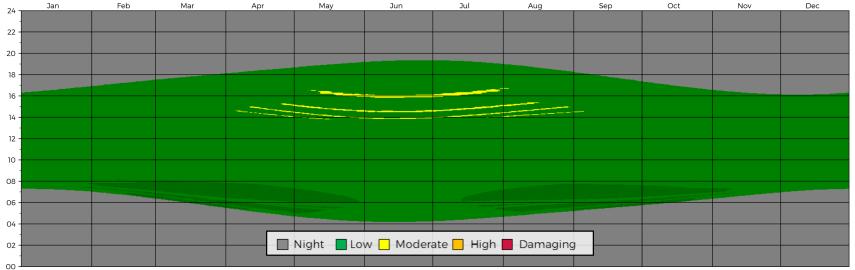




Driver Receptor D7

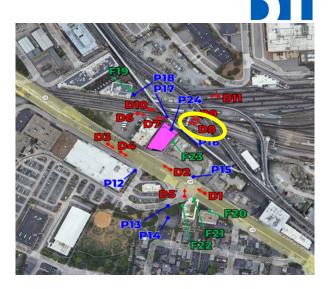
Receptor D7 was chosen to assess the visual impact associated with solar reflections affecting eastbound light rail conductors.

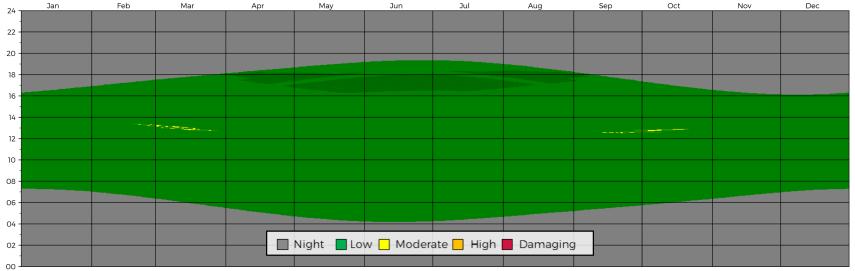




Driver Receptor D8

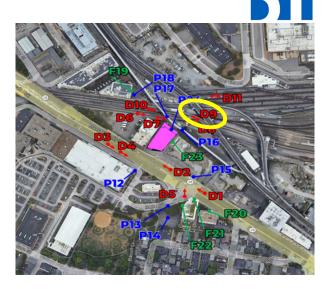
Receptor D8 was chosen to assess the visual impact associated with solar reflections affecting westbound light rail conductors.

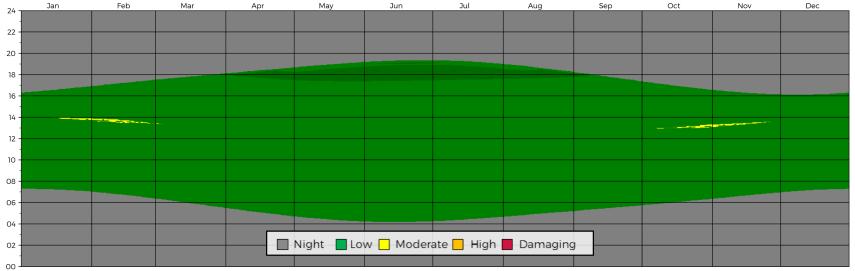




Driver Receptor D9

Receptor D9 was chosen to assess the visual impact associated with solar reflections affecting westbound light rail conductors.

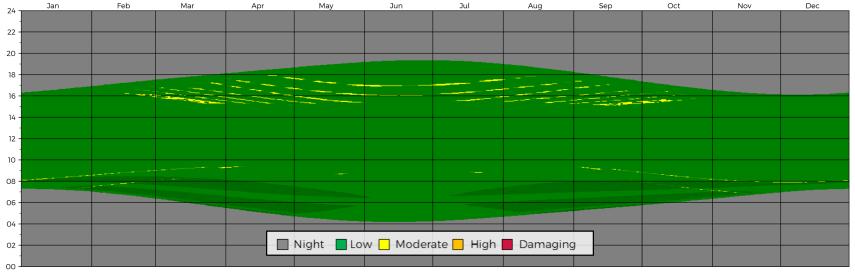




Driver Receptor D10

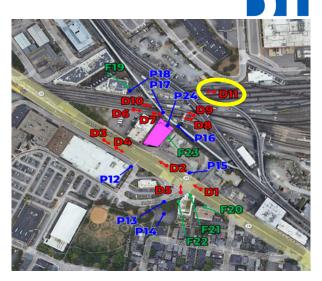
Receptor D10 was chosen to assess the visual impact associated with solar reflections affecting eastbound light rail conductors.

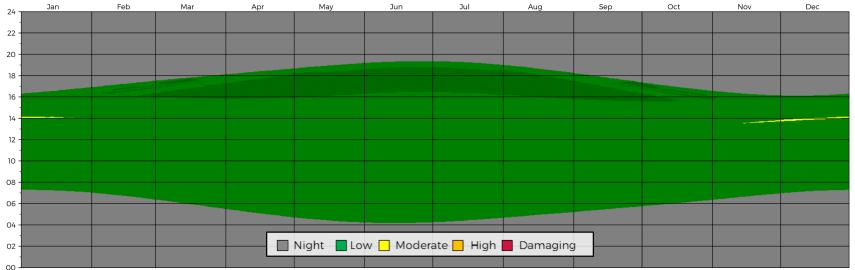




Driver Receptor D11

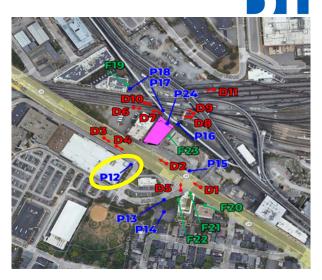
Receptor D11 was chosen to assess the visual impact associated with solar reflections affecting westbound light rail conductors.

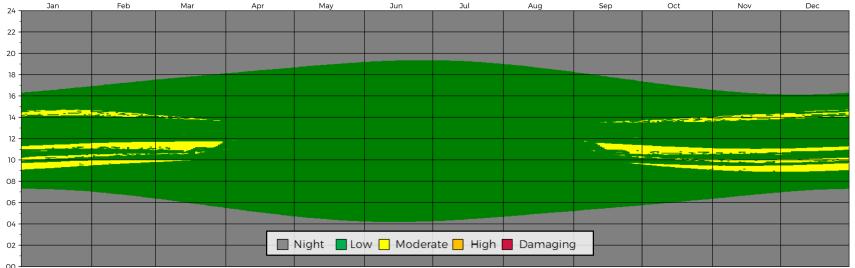




Pedestrian Receptor P12

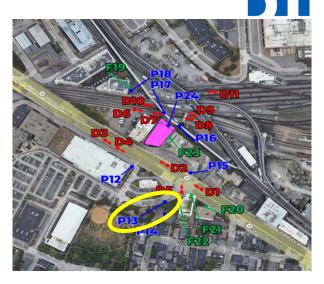
Receptor P12 was chosen to assess the visual impact associated with solar reflections affecting pedestrians on Rufo Rd.

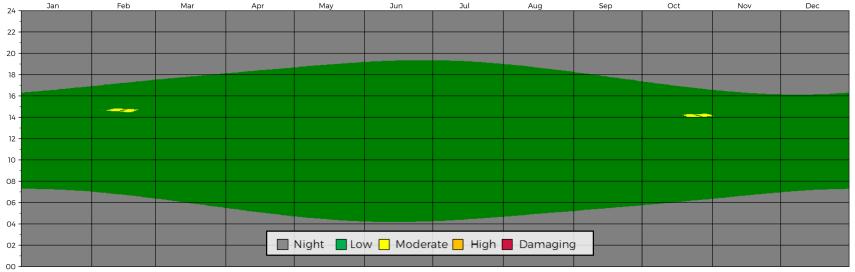




Pedestrian Receptor P13

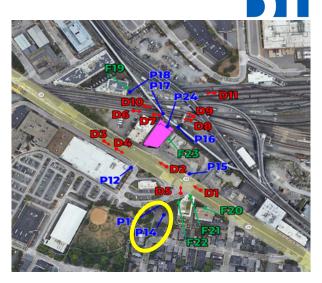
Receptor P13 was chosen to assess the visual impact associated with solar reflections affecting pedestrians on Rufo Rd.





Pedestrian Receptor P14

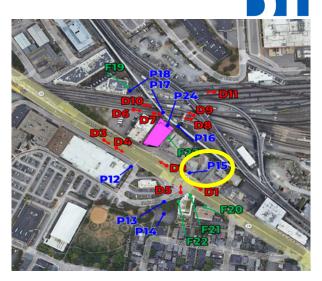
Receptor P14 was chosen to assess the visual impact associated with solar reflections affecting pedestrian on Gold Star Mothers Park Basketball court.

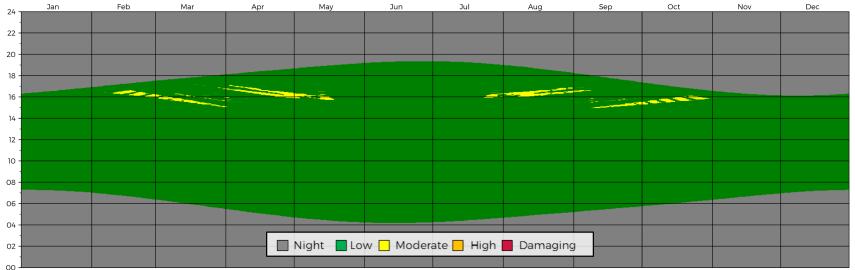




Pedestrian Receptor P15

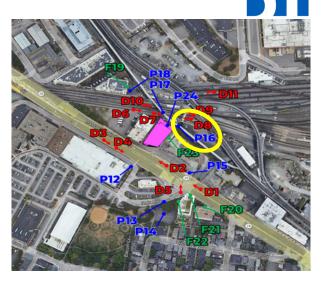
Receptor P15 was chosen to assess the visual impact associated with solar reflections affecting pedestrians on McGrath Hwy.

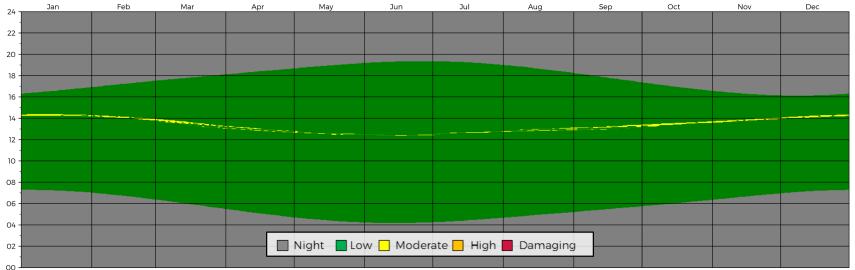




Pedestrian Receptor P16

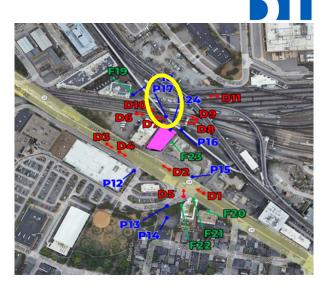
Receptor P16 was chosen to assess the visual impact associated with solar reflections affecting pedestrians on pedestrian bridge.

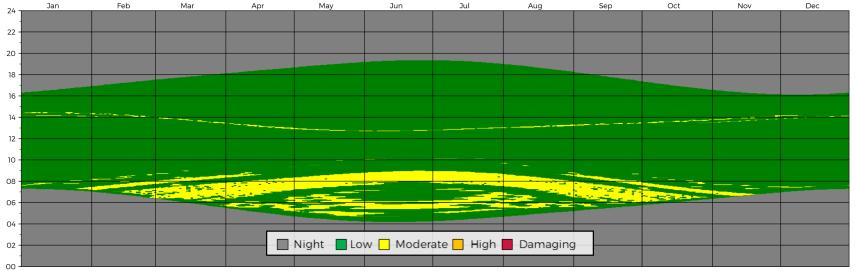




Pedestrian Receptor P17

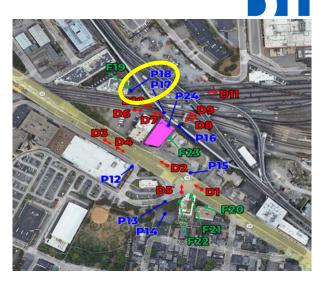
Receptor P17 was chosen to assess the visual impact associated with solar reflections affecting pedestrians on pedestrian bridge.

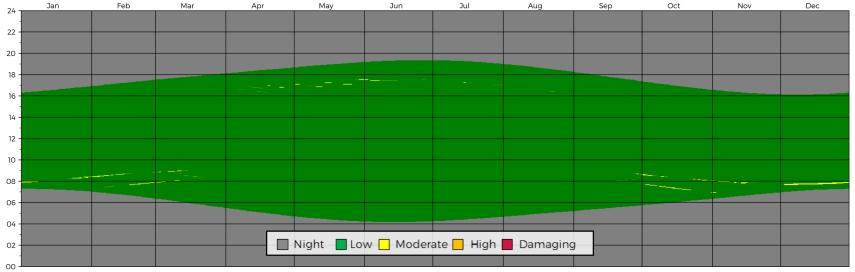




Pedestrian Receptor P18

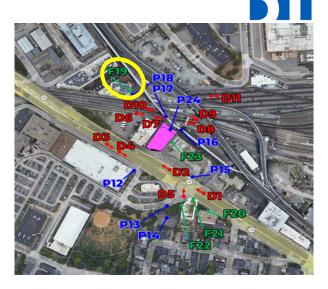
Receptor P18 was chosen to assess the visual impact associated with solar reflections affecting pedestrians at Brickbottom Condominium Parking lot.

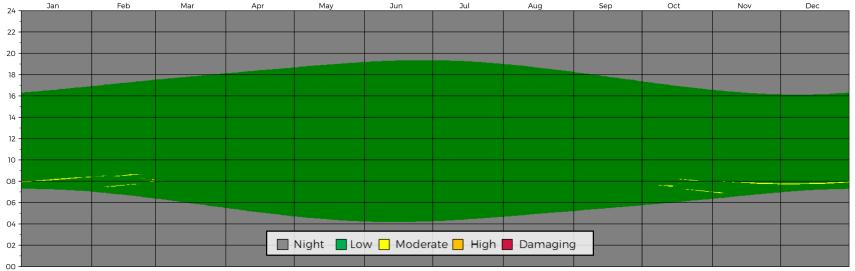




Facade Receptor F19

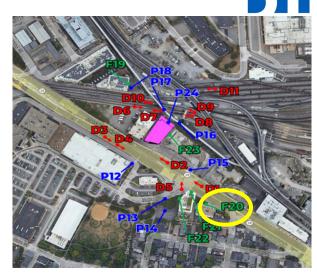
Receptor F19 was chosen to assess the visual impact associated with solar reflections affecting facades at approximately 4th floor height of Brickbottom Condominium .

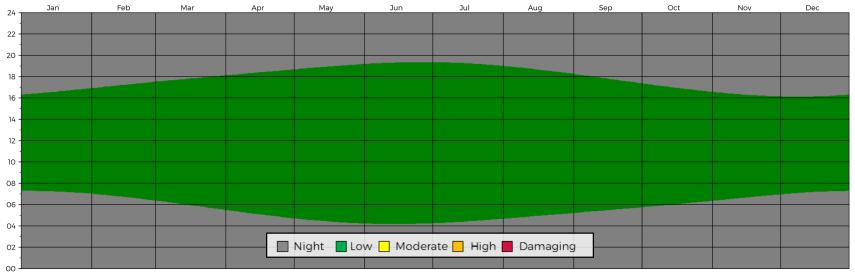




Facade Receptor F20

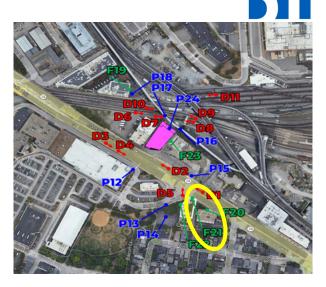
Receptor F20 was chosen to assess the visual impact associated with solar reflections affecting facades at approximately 1st floor height of the Holiday Inn express (250 McGrath Highway).

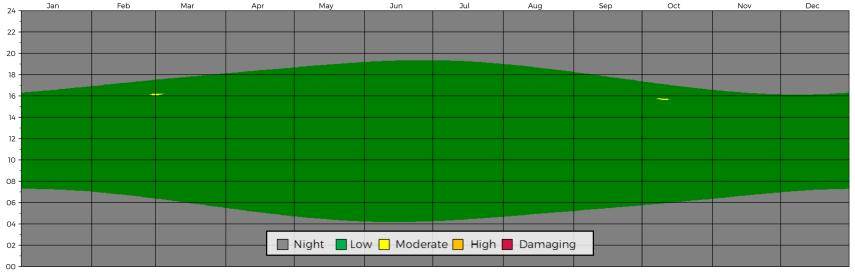




Facade Receptor F21

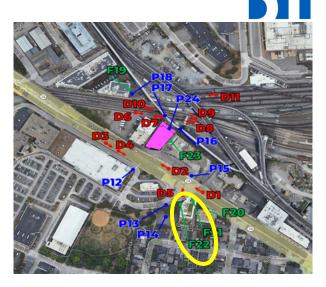
Receptor F21 was chosen to assess the visual impact associated with solar reflections affecting facades at approximately 6th floor of 262 McGrath Highway.

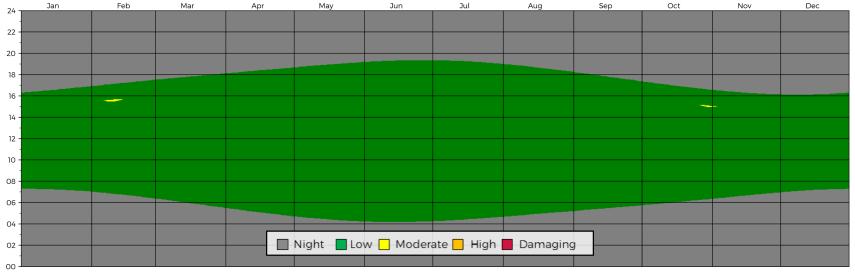




Facade Receptor F22

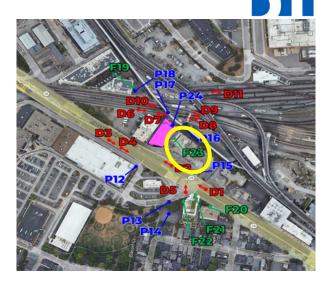
Receptor F22 was chosen to assess the visual impact associated with solar reflections affecting facades at approximately 6th floor of 262 McGrath Highway.

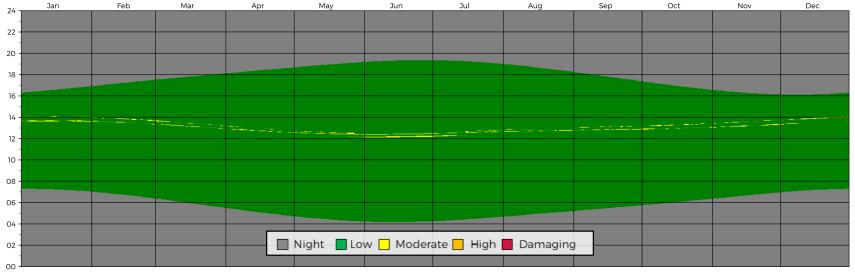




Facade Receptor F23

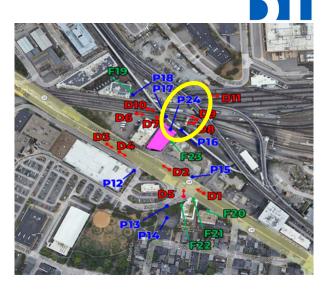
Receptor F23 was chosen to assess the visual impact associated with solar reflections affecting facades at approximately 6th floor height of the proposed 15 McGrath Highway.

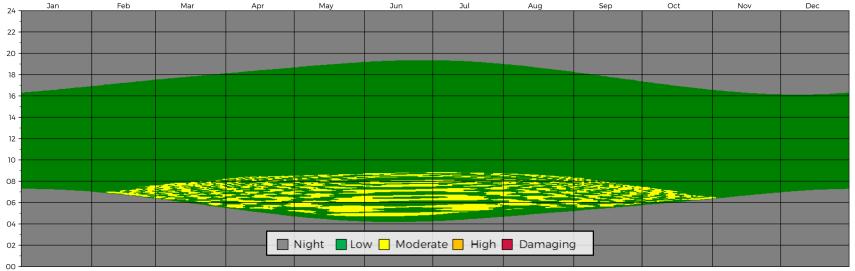




Pedestrian Receptor P24

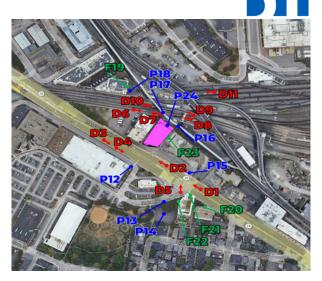
Receptor P24 was chosen to assess the visual impact associated with solar reflections affecting pedestrians on the 9th floor terrace at 35 McGrath Highway.

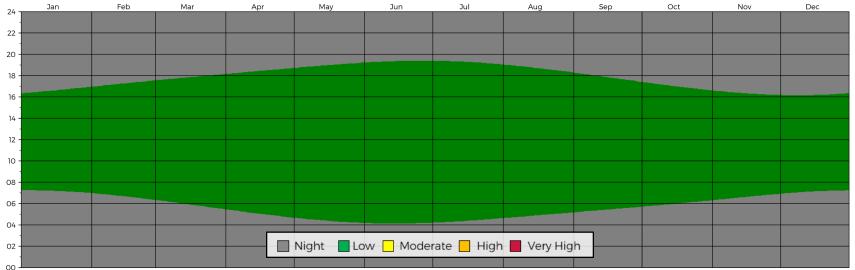




All Receptors

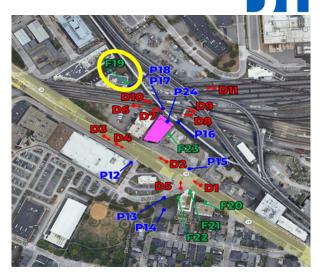
All reflection impacts at all receptors were found to have intensities below RWDI's short-term and human safety threshold values.

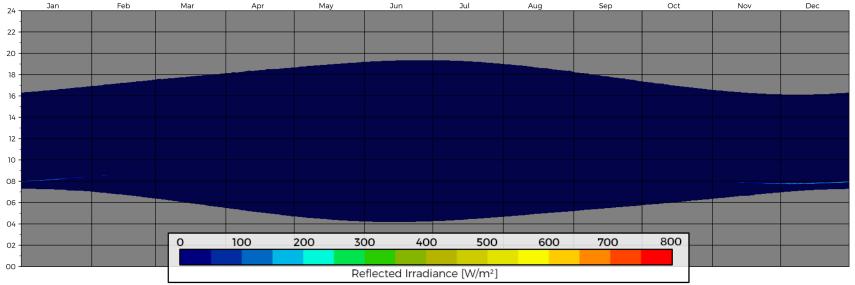




Facade Receptor F19

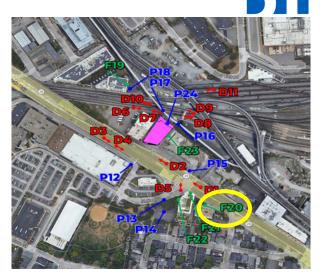
Receptor F19 was chosen to assess the thermal impact associated with solar reflections affecting facades at approximately 4th floor height of Brickbottom Condominium .

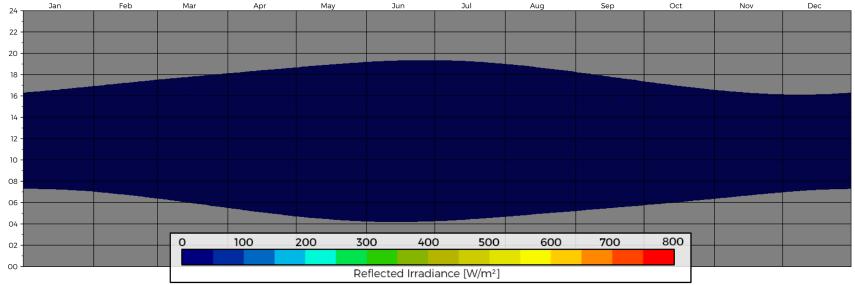




Facade Receptor F20

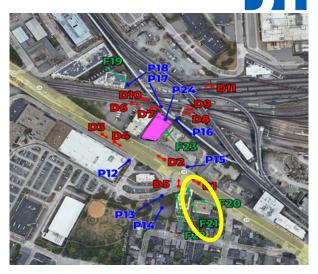
Receptor F20 was chosen to assess the thermal impact associated with solar reflections affecting facades at approximately 1st floor height of the Holiday Inn express (250 McGrath Highway).

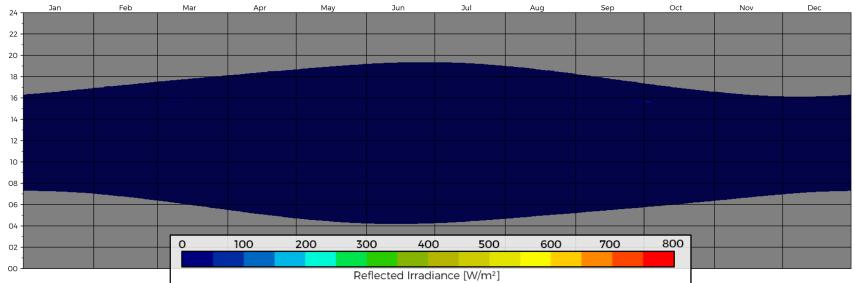




Facade Receptor F21

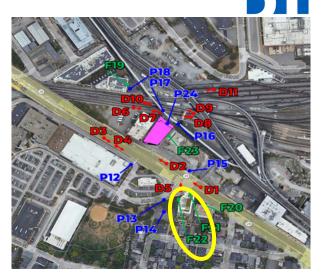
Receptor F21 was chosen to assess the thermal impact associated with solar reflections affecting facades at approximately 6th floor of 262 McGrath Highway.

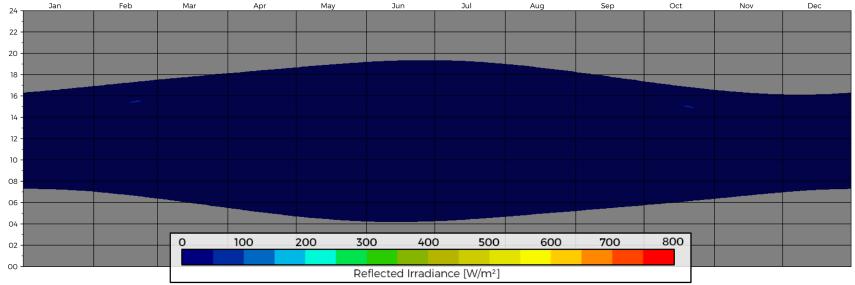




Facade Receptor F22

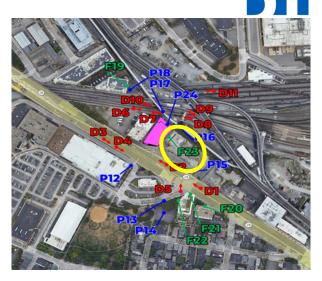
Receptor F22 was chosen to assess the thermal impact associated with solar reflections affecting facades at approximately 6th floor of 262 McGrath Highway.

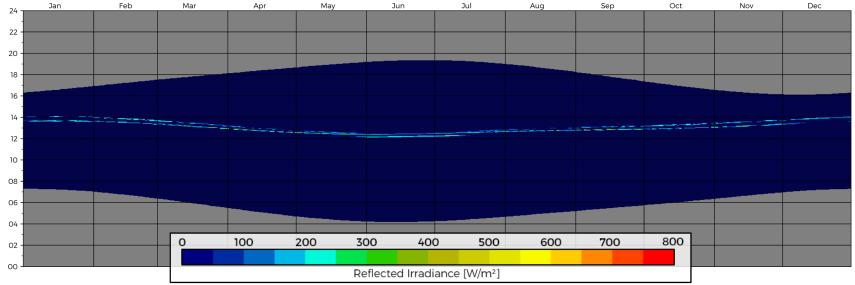




Facade Receptor F23

Receptor F23 was chosen to assess the thermal impact associated with solar reflections affecting facades at approximately 6th floor height of the proposed 15 McGrath Highway.







APPENDIX B

RWDI REFLECTION CRITERIA



Visual Glare

There are currently no criteria or standards that define an "acceptable" level of reflected solar radiation from buildings. RWDI has conducted a literature review of available scientific sources¹ to determine levels of solar radiation that could be considered acceptable to individuals from a visual standpoint.

Many glare metrics are designed for interior use and have been found to not correlate well with the glare impact humans perceive from direct sun or in outdoor environments. RWDI uses the methodology of Ho et al², which defines glare impact based on a physical reaction rather than on a preference-based correlation.

Based on the intensity of the glare source and the size of the source in the field of view (Figure B1), the risk of that source causing temporary flash blindness (i.e. the after images visible after one is exposed to a camera flash in a dark room) faster than a person can reflexively close their eyes can be determined.

If this 'after-imaging' can occur faster than the human blink reflex, it presents an unavoidable effect on a person based on physiology rather than preference. This forms the basis of how we determine if a reflection is 'significant'.

This methodology was previously required by the United States Federal Aviation Administration (FAA) to determine the risk of glare to pilots and other airport staff under FAA Interim Policy 78 FR 63276. While the need to use this exact metric has since been relaxed under FAA Policy 86 FR25801, RWDI still feels that it is appropriate for this work.

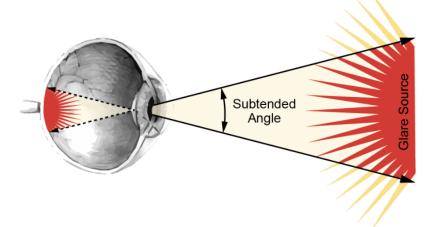


Figure B1: Schematic Illustrating the Subtended Angle of a Glare Source



Visual Glare (cont'd)

At the screening level, we conservatively take any reflections at least 50% of the intensity required to cause after-images as a "significant" reflection to be counted in the frequency analysis. In the detailed phase of work, we use the typical threshold level.

As a reference, point 1 on Figure B2 illustrates where looking directly at the sun falls in terms of irradiance on the retina (the back of the eye) and the size of the angle that the sun subtends in the sky. This puts it just at the border of causing serious damage before the blink reflex can close the eye.

The other points in Figure B2 correspond to the following:

- 2. Direct viewing of high-intensity car headlamp from 50 feet / 15 m
- 3. Direct viewing of typical camera flash from 7 feet / 2 m
- 4. Direct viewing of high-intensity car headlamp from 5 feet / 1.5 m
- 5. Direct viewing of frosted 60W light bulb from 5 feet / 1.5 m
- 6. Direct viewing of average computer monitor from 2 feet / 0.6 m

Note that the retinal irradiances described on this page are significantly higher than the irradiance levels discussed elsewhere in this report. This is because the human eye focuses the energy on to the retina. The magnitude of the increase is dependent on the geometry of the human eye and the source of the glare, both of which are computed per the Ho et al methodology.

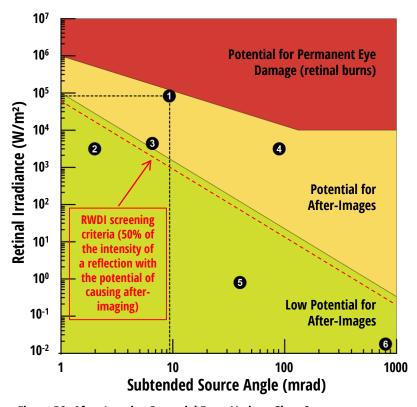


Figure B2: After-Imaging Potential From Various Glare Sources



Visual Glare (cont'd)

Significant glare impacts on the operators of vehicles or heavy equipment pose a particular risk to public safety due to operator distraction or reduction in their visual acuity. Thus, in the detailed analysis, RWDI assigns an assumed view direction to those engaged in "high-risk" activities (e.g. driving a car or flying a plane) as well as an assumed field of view.

The assigned directions and fields of view acknowledge that an operator is particularly sensitive to reflections emanating from the direction in which they are travelling (and therefore cannot safely look away from) and that the opaque elements of the vehicle will act to obstruct reflections beyond a given angle.

For drivers, the critical angle is taken to be 20° away from the direction of view³. Thus, any reflections emanating from within this 20° field of view are considered 'high' impacts, whereas reflections emanating from outside this cone are classified as 'moderate' impacts. This angle is adjusted as needed for impacts on other vehicles such as aircraft⁴, trains⁵, and other heavy equipment⁶.

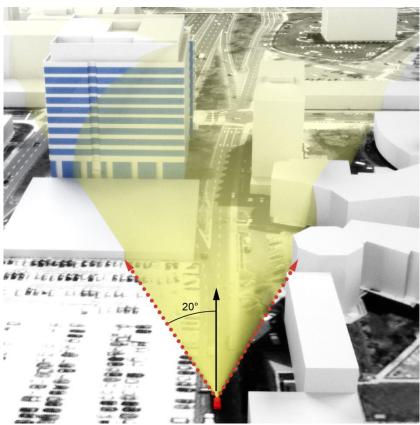


Figure B3: Illustration of a Driver's 20° Field of View



Thermal Impact (Heat Gain) on People

The primary sources for exposure limits to thermal radiation come from fire protection literature. However, there is currently inconsistency between different bodies regarding what level of exposure can be reasonably tolerated by people.

The U.S. National Fire Protection Association (NFPA) defines 1,700 W/m² as an upper limit for a tenable egress environment⁷; i.e. an individual could escape through such an environment successfully, though they would not necessarily emerge unscathed. The British Standards Institution⁸ sets their limit at 2,000 W/m², which "...is tolerable for ~ 5 min[utes]...". Other researchers⁹ have found that higher irradiance levels (3,500 – 5,000 W/m²) can be tolerated in outdoor environments for several minutes without issue.

The only current quantitative guideline specific to reflections comes from the City of London's Planning Note on 'Solar Convergence'¹⁰. Produced in conjunction with the UK Building Research Establishment (BRE), this document indicates that no areas should receive 10,000 W/m² or more for any duration, exposures above 2,500 W/m² should be limited to less than 30 seconds; and that "...areas with reflected irradiances above 1,500 W/m², and preferably those above 1000 W/m², should be minimized."

It should be noted that all these thresholds are guideline values only, and that in reality many factors (skin color, age, clothing choice, etc.) influence how a person reacts to thermal radiation.

Clearly, there are currently no definitive guidelines or criteria with respect to the issue of thresholds for exposure to thermal irradiance in an urban setting. We know this criterion should be lower than the thresholds set in the context of an individual escaping from a fire and greater than typical peak solar noon levels of 1,000 W/m² which people commonly experience.

Therefore, RWDI's opinion at this time, is that reasonable criteria is to establish 2,500 W/m² as a ceiling exposure limit, which reflection intensity should not exceed for any length of time; and 1,500 W/m² as a short term (10 minutes or less) exposure limit.

RWDI REFLECTION CRITERIA



Thermal Impact (Heat Gain) on 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.

Generally, irradiance levels at or above 10,000 W/m² for more than 10 minutes are required to ignite common building and automotive materials in the presence of a pilot flame. That value increases to 25,000 W/m² when no pilot flame is present¹¹¹,¹²,¹³. However, some materials like plastics and even some asphalts may begin to soften and deform at lower temperatures. For example, some plastics can deform at a temperature of 140°F (60°C), or lower if force is applied. The applied force typically comes from the thermal expansion of the material, the force of gravity acting on the material or an external mechanical force (i.e. someone or something pushing or pulling on it).

Aside from the risk of damage to the material itself, a hot surface poses a safety risk to any person who may come into contact with it. This is particularly important in an urban context as the individual may not expect the object to be heated. NASA¹⁴ defines an upper limit of 111°F (44°C) for surfaces that require extended contact time with bare skin. Surface temperatures below this limit can be handled for any length of time without causing pain.

That said, surfaces within the urban realm are routinely exposed to reflections from windows, metal panels and bodies of water without causing material damage or excessive heating.

Therefore, as this time, RWDI takes a conservative approach and uses a value of 1,000 W/m², consistent with a single (i.e. non-focused) reflection of the sun's peak intensity, as a baseline threshold for reflected irradiance on stationary objects.

However, this is simply a starting point. As noted, depending on the environmental conditions and material properties of the object/assembly other values may be used instead.

We note that this also assumes any materials exposed to direct/reflected light were appropriately designed for the exposure to direct sun and/or reflections typically expected in the project's location. More sensitive materials (i.e. internal components of walls and roofs exposed during construction/maintenance), or materials intended for other climates may not be as robust.

RWDI REFLECTION CRITERIA



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- V. Babrauskas 'Ignition Handbook' Fire Science Publishers + SFP, 2003
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PRELIMINARY RESULTS



35 MCGRATH HIGHWAY

SOMERVILLE, MA

PEDESTRIAN WIND STUDY RWDI # 2205912 June 19, 2023

SUBMITTED TO

35 McGrath Highway Realty Trust c/o The DeNunzio Group 3060 US-19 ALT Pal Harbor, FL 34683

SUBMITTED BY

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RWDI





EXECUTIVE SUMMARY

RWDI was retained to conduct a pedestrian wind assessment for the proposed project at 35 McGrath Highway in Somerville, MA (Image 1). The potential wind conditions have been assessed based on wind-tunnel testing of the project under the No Build, Build and Full Build configurations (Images 2A through 2C), and the local wind records (Image 3) and compared to the Mean Speed and Effective Gust criteria adopted by the City of Somerville. The results of the assessment are shown on site plans in Figures 1A through 2C, and the associated wind speeds are listed in Tables 1 and 2. The key findings are summarized as follows:

Effective Gust

- The Effective Gust criterion is met at almost all assessed locations on an annual basis for all configurations considered in this study. One annual exceedance predicted at the northwest corner of the proposed building in the Build and Full Build configurations.
- A few seasonal exceedances are predicted in the winter and spring in all configurations.

Mean Speed

- In the No Build configuration, mean wind speeds at most locations around the project site are appropriate for pedestrian use on an annual basis. Uncomfortable speeds occur at some locations on the east side of the site and around the intersection of McGrath Highway and Rufo Road.
- In the Build configuration, mean wind speeds are expected to remain appropriate for pedestrian use in most areas on an annual basis. Uncomfortable speeds are anticipated at additional locations around the western concerns of the proposed building and in the narrow gaps formed with the adjacent buildings to the west and east. These areas will not be frequently accessed by pedestrians.
- In the Full Build configuration, mean wind speeds around the proposed building are expected to be similar to the Build configuration, with lower speeds occurring further to the east and west on the sidewalks of McGrath Highway. Uncomfortable speeds are still expected at some locations on the west and east sides of the proposed building and at a localized area at the intersection of McGrath Highway and Rufo Steet.
- Wind conditions on the Level 10 terrace are anticipated to be comfortable for standing or sitting during the summer, when the area is expected to be used the most. Higher wind speeds, not suitable for passive activities, are expected on an annual basis and in the colder months of the year.

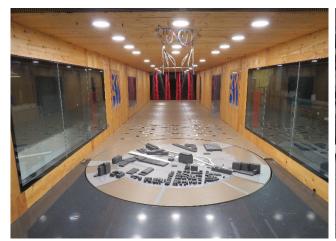
While referring to the Pedestrian Wind Criteria description that follows, we encourage the design team to review the results and assess them against the intended pedestrian usage at specific locations. If there are locations where improved conditions are desired, the RWDI team is prepared to discuss and suggest conceptual wind control strategies. Additional commentary regarding background on wind flow patterns, wind comfort levels, and any further recommendations for wind control measures to help moderate wind activity in areas of high wind activity will be presented within the final report. Prior to issuing the report, we suggest that we have a teleconference to go over the results and discuss the types/locations/feasibilities of possible wind control measures





Image 1: Aerial View of Site and Surroundings (Photo Courtesy of Google™ Earth)







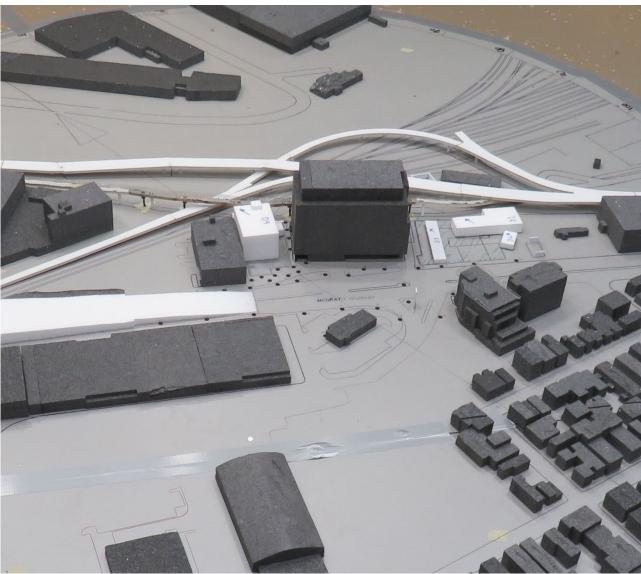
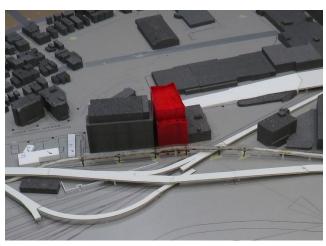


Image 2A: Wind Tunnel Study Model – Existing Configuration







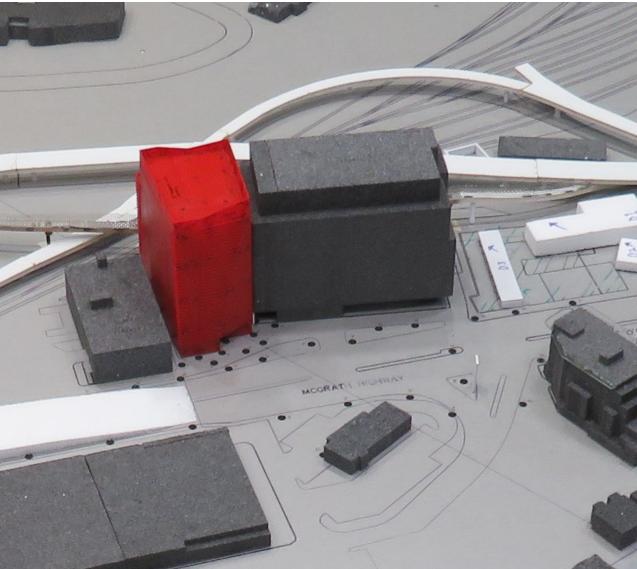


Image 2B: Wind Tunnel Study Model - Proposed Configuration







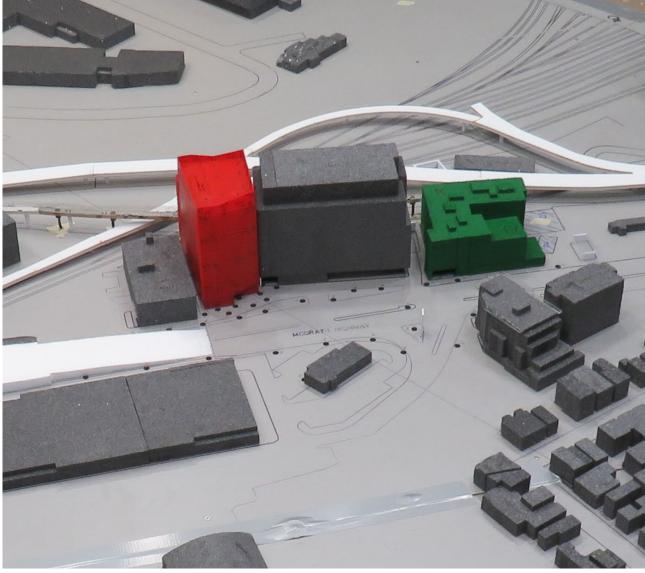


Image 2C: Wind Tunnel Study Model - Future Configuration



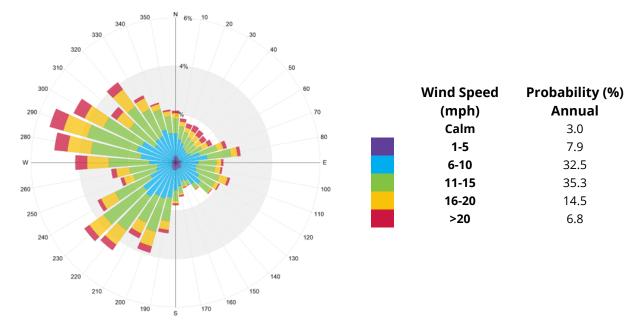


Image 5: Annual Directional distribution of winds approaching Boston Logan International Airport from 1995 through 2020



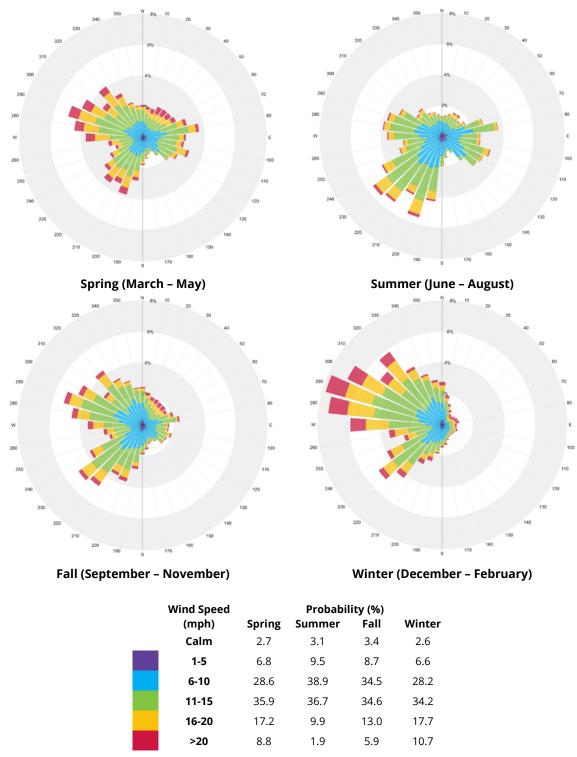


Image 6: Seasonal Directional Distribution of Winds Approaching Boston Logan International Airport from 1995 through 2020



1.1 Pedestrian Wind 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.

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). Wind speeds that do not

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

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

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.



Statement of Limitations

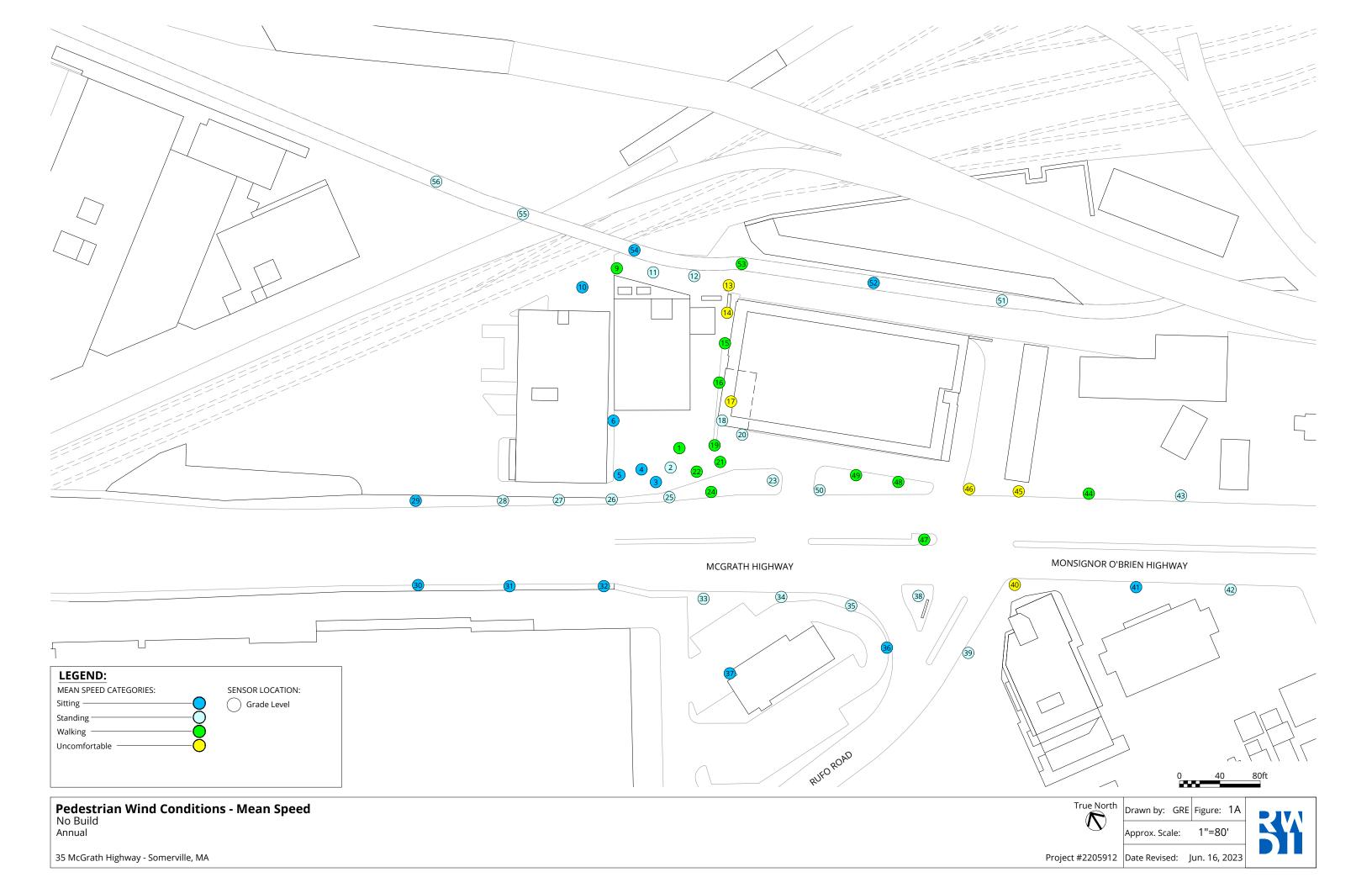
This report entitled was prepared by Rowan Williams Davies & Irwin Inc. ("RWDI") for 35 McGrath Highway Realty Trust ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. 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.

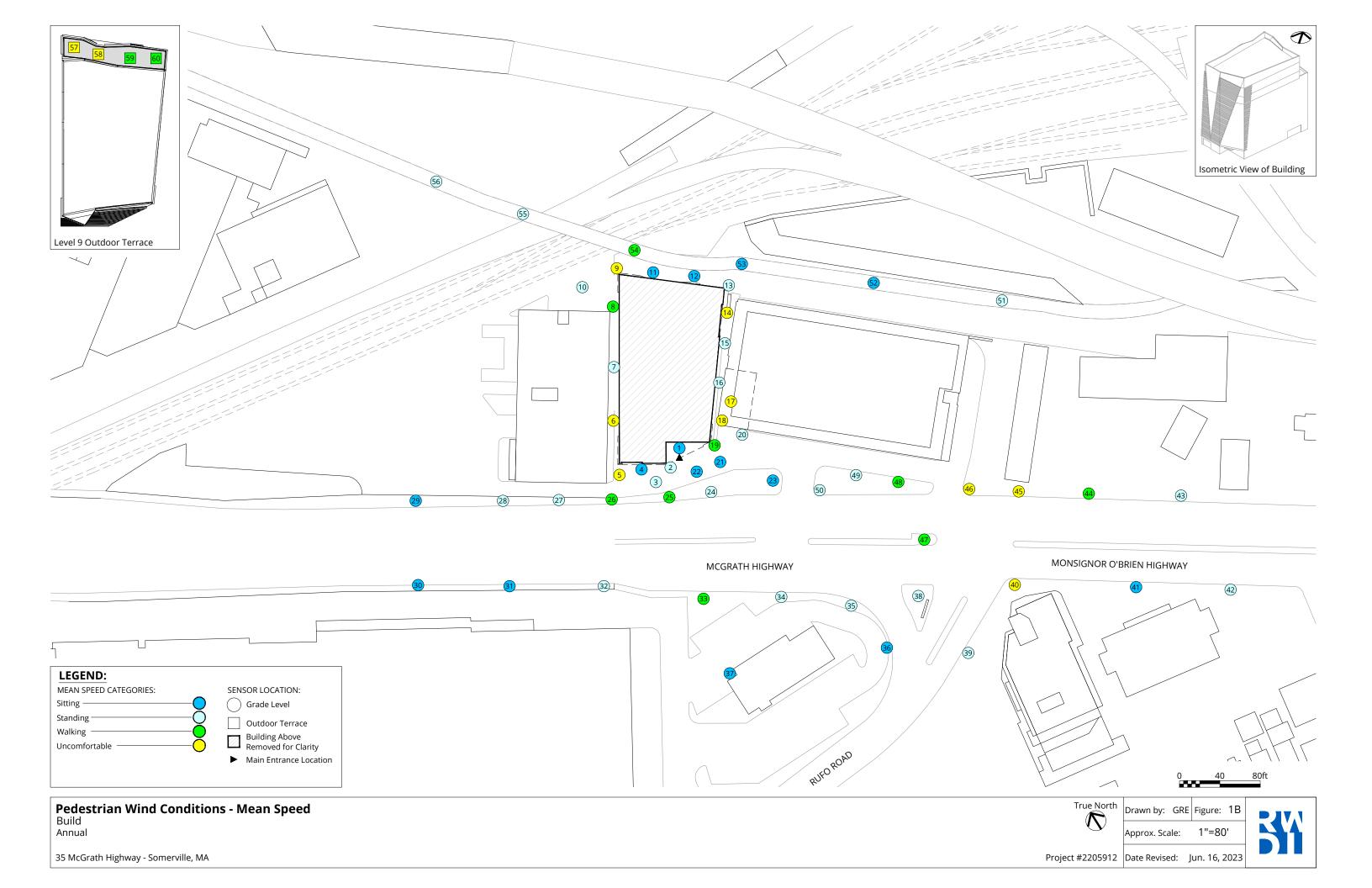
The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the 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.

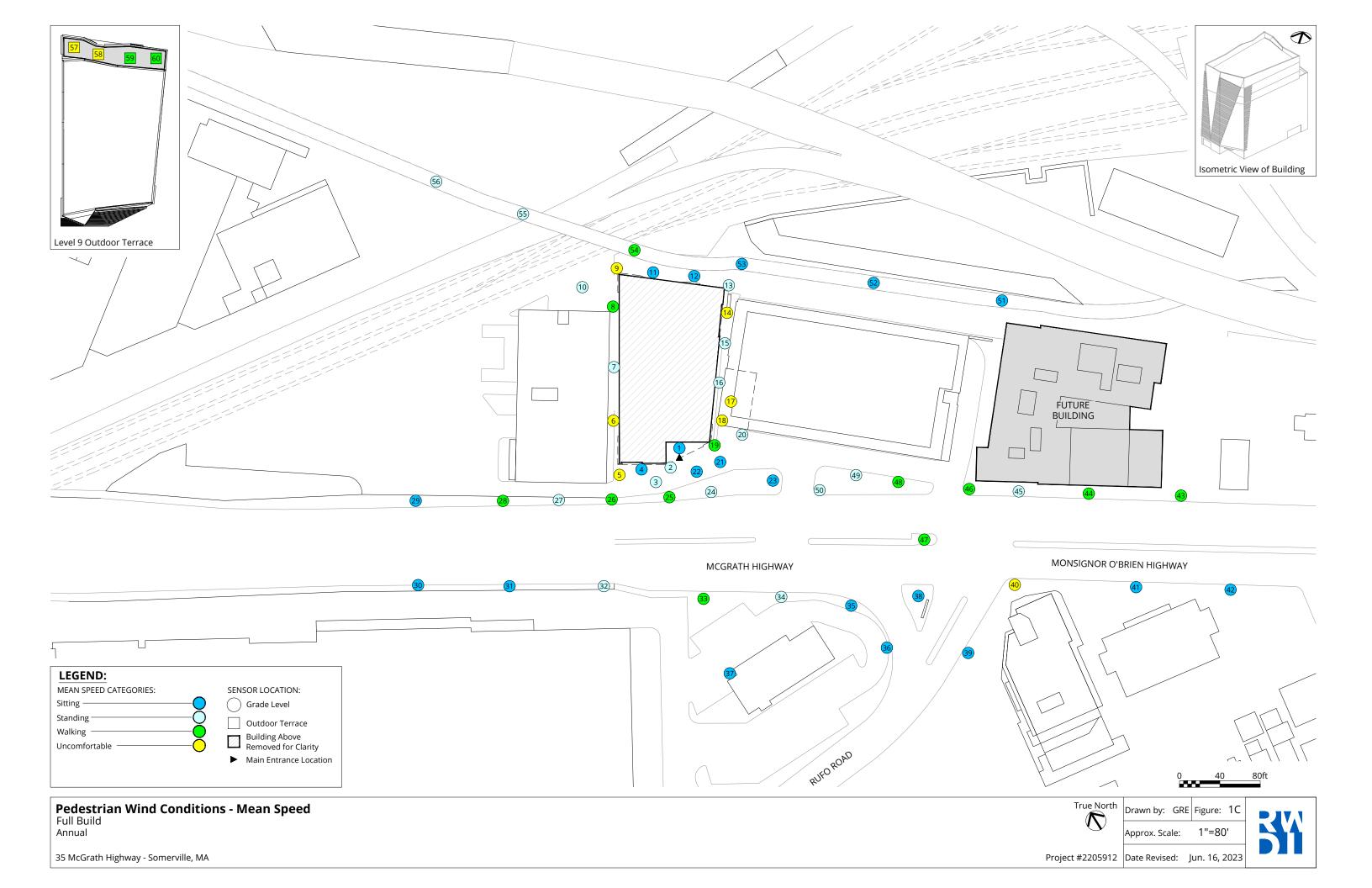
Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.

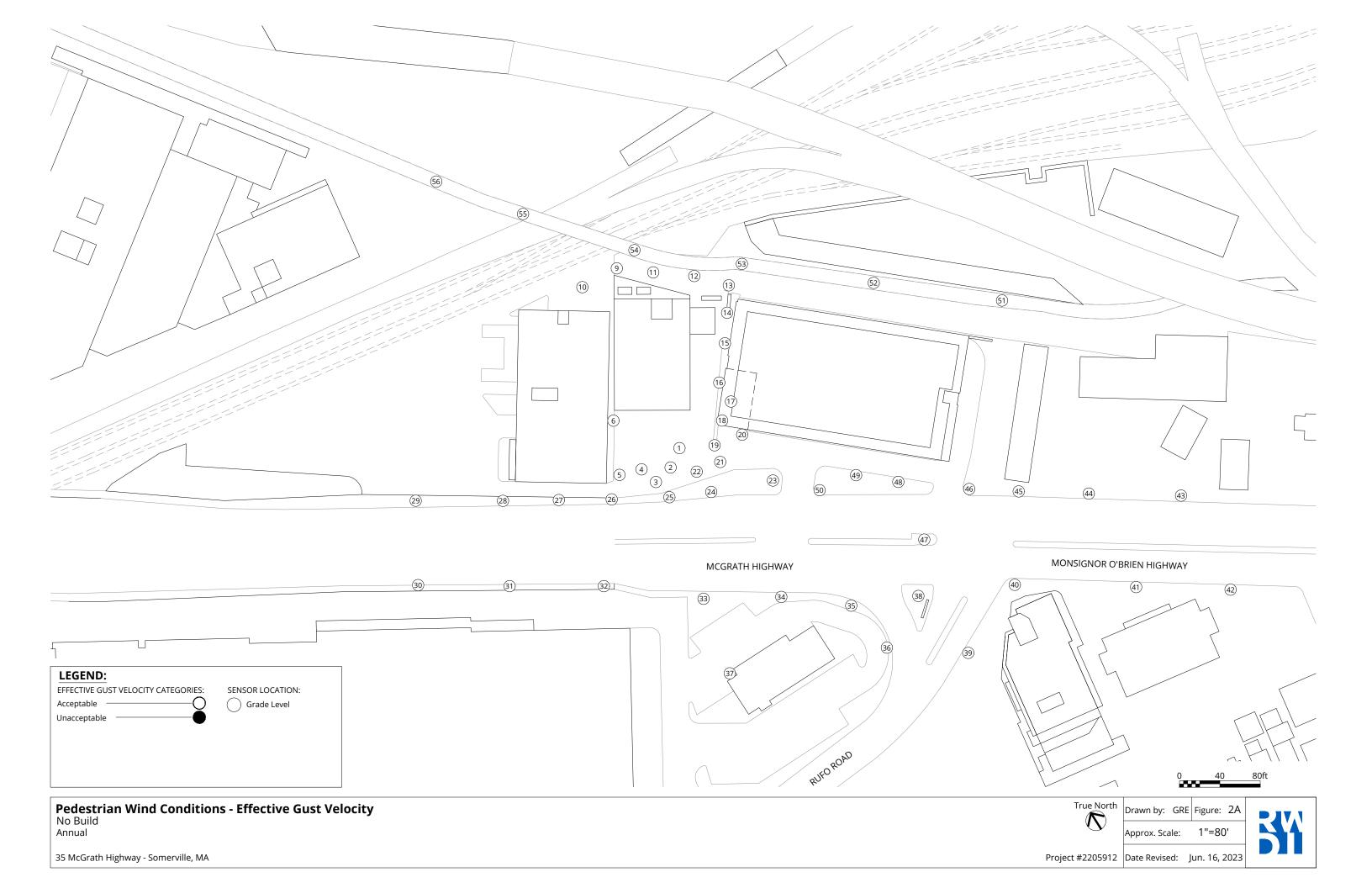


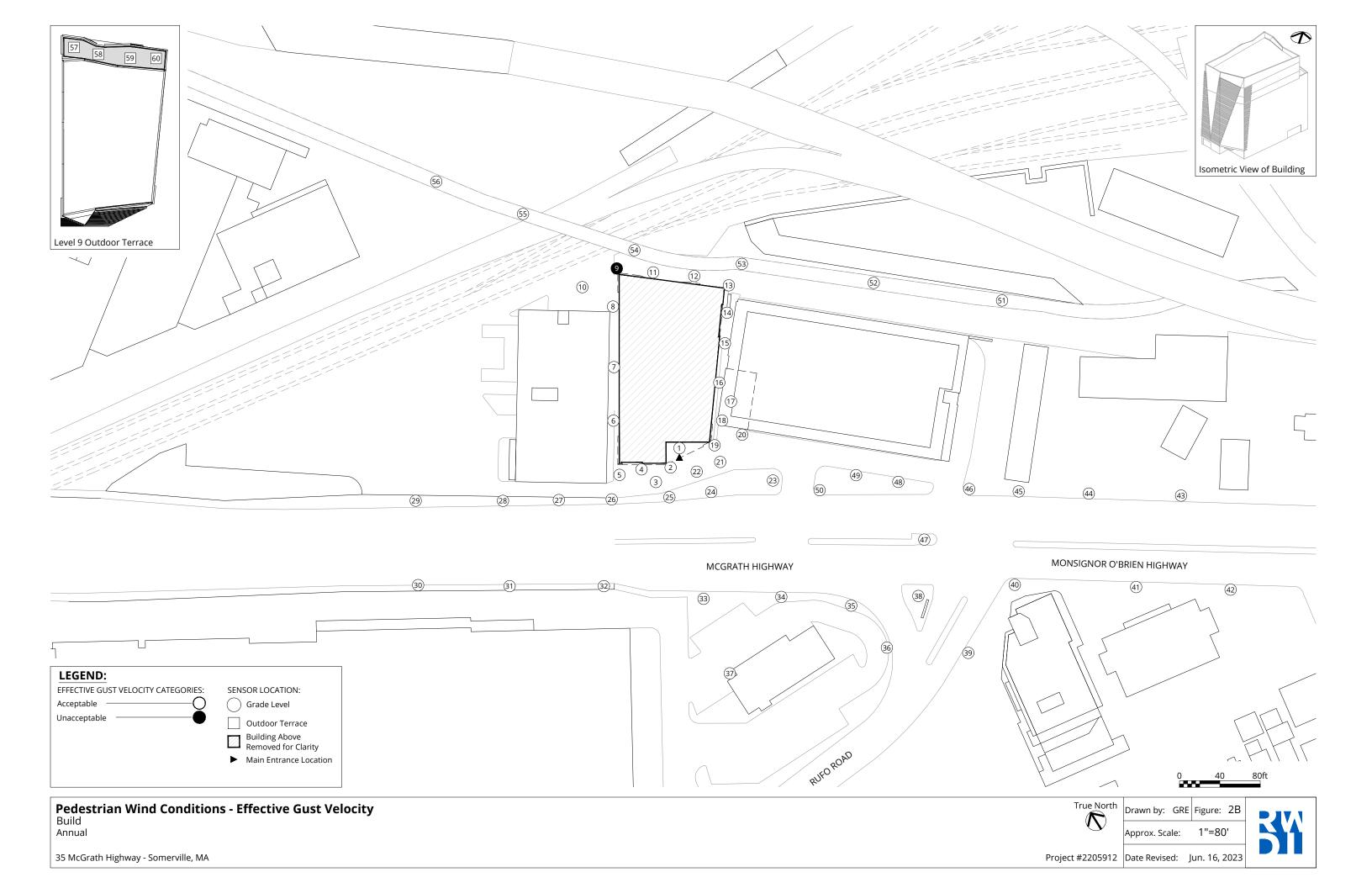
FIGURES

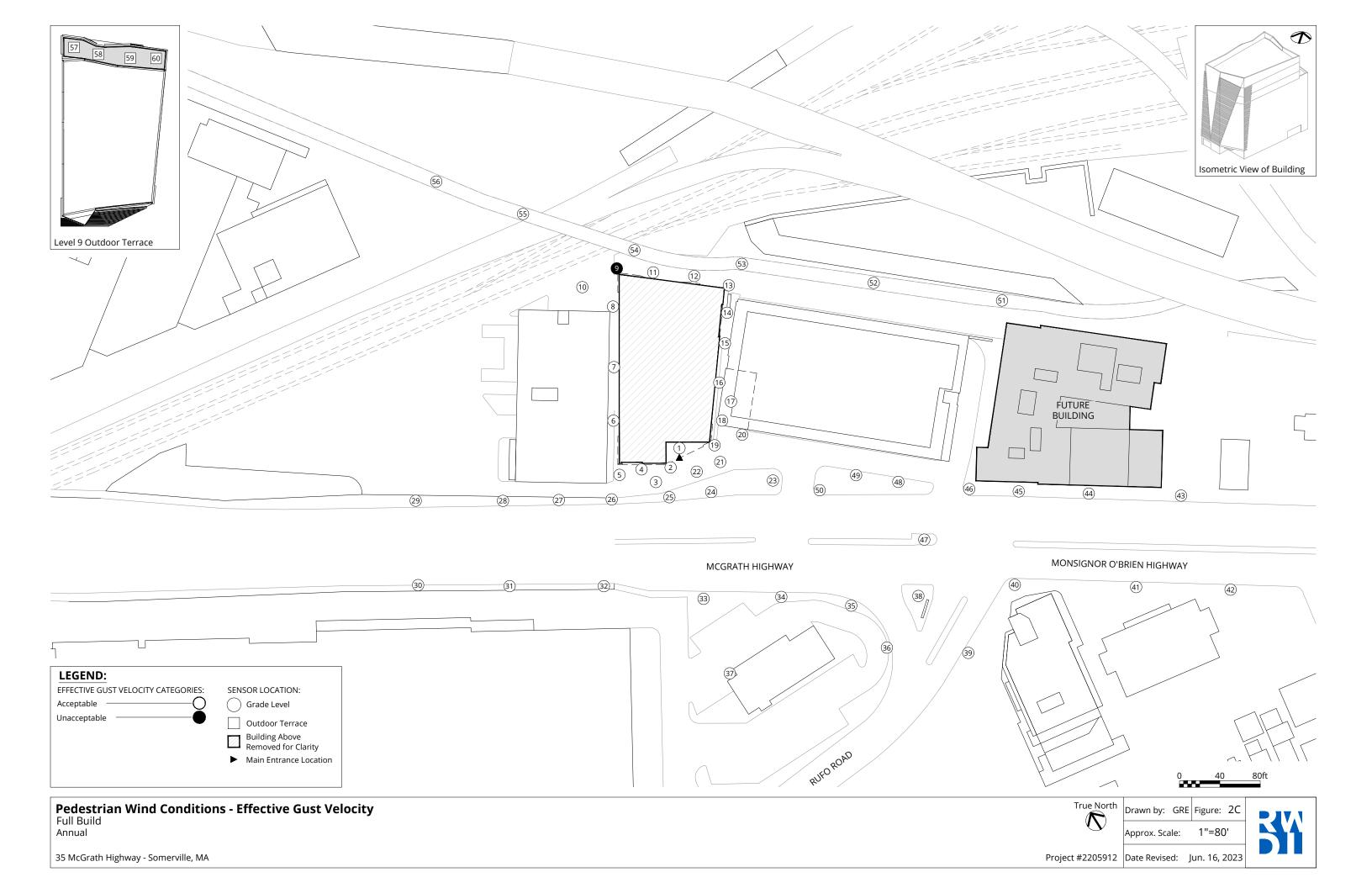














TABLES



Table 1: Mean Speed and Effective Gust Categories - Annual

				Mean W	/ind Speed	Effe	ctive Gus	st Wind Speed
Location	Configuration	Season	Speed	%		Speed	%	Basting .
			(mph)	Change	Rating	(mph)	Change	Rating
1	Α	Annual	16		Walking	25		Acceptable
	В	Annual	9	-44%	Sitting	12	-52%	Acceptable
	С	Annual	9	-44%	Sitting	13	-48%	Acceptable
2	A	Annual	14		Standing	23		Acceptable
	В	Annual	13		Standing	21		Acceptable
	С	Annual	13		Standing	21		Acceptable
3	A	Annual	12		Sitting	19	440/	Acceptable
	В	Annual	13		Standing	21	11%	Acceptable
	С	Annual	13		Standing	22	16%	Acceptable
4	Α	Annual	10		Sitting	17		Acceptable
	В	Annual	10		Sitting	17		Acceptable
	С	Annual	10		Sitting	18		Acceptable
5	Α	Annual	10		Sitting	16		Acceptable
	В	Annual	22	120%	Uncomfortable	29	81%	Acceptable
	С	Annual	23	130%	Uncomfortable	31	94%	Acceptable
6	A	Annual	11		Sitting	16		Acceptable
	В	Annual	20	82%	Uncomfortable	27	69%	Acceptable
	С	Annual	20	82%	Uncomfortable	28	75%	Acceptable
7	A	Annual	-		-	-		-
	В	Annual	13		Standing	19		Acceptable
		Annual	13		Standing	19		Acceptable
8	Α	Annual	-		-	ļ		-
	В	Annual	19		Walking	26		Acceptable
	С	Annual	19		Walking	27		Acceptable
9	A	Annual	16		Walking	22	4=0/	Acceptable
	В	Annual	24	50%	Uncomfortable	32	45%	Unacceptable
	С	Annual	24	50%	Uncomfortable	32	45%	Unacceptable
10	A	Annual	11		Sitting	16		Acceptable
	В	Annual	15	36%	Standing	22	38%	Acceptable
	С	Annual	15	36%	Standing	22	38%	Acceptable
11	A	Annual	13		Standing	19		Acceptable
	В	Annual	11	-15%	Sitting	16	-16%	Acceptable
	С	Annual	10	-23%	Sitting	16	-16%	Acceptable
12	A	Annual	15	2221	Standing	22	070	Acceptable
	В	Annual	10	-33%	Sitting	16	-27%	Acceptable
	С	Annual	10	-33%	Sitting	16	-27%	Acceptable
13	Α	Annual	20		Uncomfortable	27		Acceptable
	В	Annual	14	-30%	Standing	20	-26%	Acceptable
	С	Annual	15	-25%	Standing	21	-22%	Acceptable

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Table 1: Mean Speed and Effective Gust Categories - Annual

				Mean V	Vind Speed	Effe	ctive Gu	st Wind Speed
Location	Configuration	Season	Speed	%	Battan	Speed	%	Bart's a
			(mph)	Change	Rating	(mph)	Change	Rating
14	Α	Annual	22		Uncomfortable	31		Acceptable
	В	Annual	20		Uncomfortable	26	-16%	Acceptable
	С	Annual	21		Uncomfortable	27	-13%	Acceptable
15	A	Annual	18		Walking	25		Acceptable
	В	Annual	14	-22%	Standing	19	-24%	Acceptable
	С	Annual	13	-28%	Standing	18	-28%	Acceptable
16	A	Annual	16		Walking	23		Acceptable
	В	Annual	13	-19%	Standing	15	-35%	Acceptable
	С	Annual	13	-19%	Standing	15	-35%	Acceptable
17	A	Annual	22		Uncomfortable	29		Acceptable
	В	Annual	23		Uncomfortable	30		Acceptable
	С	Annual	23		Uncomfortable	29		Acceptable
18	Α	Annual	15		Standing	21		Acceptable
	В	Annual	22	47%	Uncomfortable	29	38%	Acceptable
	С	Annual	21	40%	Uncomfortable	28	33%	Acceptable
19	A	Annual	19		Walking	26		Acceptable
	В	Annual	16	-16%	Walking	21	-19%	Acceptable
	С	Annual	16	-16%	Walking	21	-19%	Acceptable
20	A	Annual	13		Standing	19		Acceptable
	В	Annual	15	15%	Standing	21	11%	Acceptable
	С	Annual	14		Standing	20		Acceptable
21	A	Annual	18		Walking	25		Acceptable
	В	Annual	12	-33%	Sitting	18	-28%	Acceptable
	С	Annual	12	-33%	Sitting	18	-28%	Acceptable
22	A	Annual	17		Walking	25		Acceptable
	В	Annual	11	-35%	Sitting	20	-20%	Acceptable
	С	Annual	12	-29%	Sitting	21	-16%	Acceptable
23	A	Annual	15		Standing	23		Acceptable
	В	Annual	12	-20%	Sitting	19	-17%	Acceptable
	С	Annual	12	-20%	Sitting	19	-17%	Acceptable
24	A	Annual	17		Walking	25		Acceptable
	В	Annual	14	-18%	Standing	23		Acceptable
	С	Annual	15	-12%	Standing	23		Acceptable
25	A	Annual	13		Standing	21		Acceptable
	В	Annual	17	31%	Walking	27	29%	Acceptable
	С	Annual	18	38%	Walking	28	33%	Acceptable
26	A	Annual	13		Standing	21		Acceptable
	В	Annual	17	31%	Walking	26	24%	Acceptable
	С	Annual	18	38%	Walking	27	29%	Acceptable

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Table 1: Mean Speed and Effective Gust Categories - Annual

				Mean W	/ind Speed	Effe	ective Gus	st Wind Speed
Location	Configuration	Season	Speed	%		Speed		
			(mph)	Change	Rating	(mph)	Change	Rating
27	Α	Annual	14		Standing	20		Acceptable
	В	Annual	15		Standing	22		Acceptable
	С	Annual	15		Standing	22		Acceptable
28	A	Annual	14		Standing	20	4.50/	Acceptable
	В	Annual	15 16	1.40/	Standing	23	15%	Acceptable
	С	Annual	16	14%	Walking	23	15%	Acceptable
29	A	Annual	7	1.40/	Sitting	11	1.00/	Acceptable
	B C	Annual	8 8	14% 14%	Sitting	13 14	18% 27%	Acceptable
		Annual	0	1470	Sitting	14	2/90	Acceptable
30	A	Annual	7		Sitting	11		Acceptable
	В	Annual	7		Sitting	12		Acceptable
	С	Annual	8	14%	Sitting	12		Acceptable
31	A	Annual	9		Sitting	14		Acceptable
	В	Annual	10	11%	Sitting	15		Acceptable
	С	Annual	10	11%	Sitting	16	14%	Acceptable
32	A	Annual	11		Sitting	16		Acceptable
	В	Annual	13	18%	Standing	19	19%	Acceptable
	С	Annual	13	18%	Standing	19	19%	Acceptable
33	A	Annual	13		Standing	19		Acceptable
	В	Annual	17	31%	Walking	22	16%	Acceptable
	С	Annual	18	38%	Walking	24	26%	Acceptable
34	A	Annual	14		Standing	20		Acceptable
	В	Annual	15 15		Standing	21		Acceptable
	С	Annual	15		Standing	21		Acceptable
35	A	Annual	14		Standing	20		Acceptable
	В	Annual	13	210/	Standing	19	1 = 0/	Acceptable
	С	Annual	11	-21%	Sitting	17	-15%	Acceptable
36	Α	Annual	11		Sitting	17		Acceptable
	В	Annual	11		Sitting	17		Acceptable
	С	Annual	11		Sitting	16		Acceptable
37	A	Annual	7		Sitting	12		Acceptable
	В	Annual	8	14%	Sitting	12		Acceptable
	С	Annual	8	14%	Sitting	13		Acceptable
38	A	Annual	15		Standing	21		Acceptable
	В	Annual	15 12	200/	Standing	21	1.00/	Acceptable
	С	Annual	12	-20%	Sitting	17	-19%	Acceptable
39	A	Annual	13		Standing	20		Acceptable
	В	Annual	13		Standing	20		Acceptable
	С	Annual	12		Sitting	19		Acceptable

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Table 1: Mean Speed and Effective Gust Categories - Annual

				Mean V	Vind Speed	Effe	ctive Gu	st Wind Speed
Location	Configuration	Season	Speed	%	Bartan	Speed	%	Bart's a
			(mph)	Change	Rating	(mph)	Change	Rating
40	Α	Annual	22		Uncomfortable	29		Acceptable
	В	Annual	22		Uncomfortable	29		Acceptable
	С	Annual	22		Uncomfortable	29		Acceptable
41	A	Annual	12		Sitting	18		Acceptable
	В	Annual	12		Sitting	18		Acceptable
	С	Annual	12		Sitting	19		Acceptable
42	A	Annual	13		Standing	19		Acceptable
	В	Annual	13		Standing	19		Acceptable
	С	Annual	11	-15%	Sitting	18		Acceptable
43	A	Annual	14		Standing	22		Acceptable
	В	Annual	13		Standing	21		Acceptable
	С	Annual	17	21%	Walking	25	14%	Acceptable
44	A	Annual	19		Walking	26		Acceptable
	В	Annual	18		Walking	26		Acceptable
	С	Annual	17	-11%	Walking	24		Acceptable
45	A	Annual	21		Uncomfortable	30		Acceptable
	В	Annual	21	220/	Uncomfortable	30	200/	Acceptable
	С	Annual	14	-33%	Standing	21	-30%	Acceptable
46	A	Annual	23		Uncomfortable	31		Acceptable
	В	Annual	23	470/	Uncomfortable	31	420/	Acceptable
	С	Annual	19	-17%	Walking	27	-13%	Acceptable
47	A	Annual	18		Walking	26		Acceptable
	В	Annual	19		Walking	27		Acceptable
	С	Annual	16	-11%	Walking	25		Acceptable
48	A	Annual	19		Walking	26		Acceptable
	В	Annual	17	-11%	Walking	25		Acceptable
	С	Annual	17	-11%	Walking	24		Acceptable
49	A	Annual	17		Walking	24		Acceptable
	В	Annual	14	-18%	Standing	22		Acceptable
	С	Annual	15	-12%	Standing	23		Acceptable
50	A	Annual	15		Standing	23		Acceptable
	В	Annual	14		Standing	22		Acceptable
	С	Annual	14		Standing	22		Acceptable
51	A	Annual	14		Standing	19		Acceptable
	В	Annual	13	240/	Standing	19	4.604	Acceptable
	С	Annual	11	-21%	Sitting	16	-16%	Acceptable
52	Α	Annual	10		Sitting	16		Acceptable
	В	Annual	10		Sitting	15		Acceptable
	С	Annual	10		Sitting	15		Acceptable

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Table 1: Mean Speed and Effective Gust Categories - Annual

				Mean W	/ind Speed	Effe	ctive Gus	st Wind Speed
Location	Configuration	Season	Speed	%	Rating	Speed	%	Rating
			(mph)	Change		(mph)	Change	
53	Α	Annual	17		Walking	23		Acceptable
	В	Annual	10	-41%	Sitting	16	-30%	Acceptable
	С	Annual	11	-35%	Sitting	16	-30%	Acceptable
54	A	Annual	12		Sitting	17		Acceptable
	В	Annual	19	58%	Walking	25	47%	Acceptable
	С	Annual	19	58%	Walking	25	47%	Acceptable
55	Α	Annual	15		Standing	20		Acceptable
	В	Annual	15		Standing	21		Acceptable
	С	Annual	15		Standing	21		Acceptable
56	Α	Annual	15		Standing	21		Acceptable
	В	Annual	14		Standing	21		Acceptable
	С	Annual	15		Standing	21		Acceptable
57	Α	Annual	-		-	-		-
	В	Annual	21		Uncomfortable	29		Acceptable
	С	Annual	20		Uncomfortable	28		Acceptable
58	Α	Annual	-		-	-		-
	В	Annual	20		Uncomfortable	28		Acceptable
	С	Annual	20		Uncomfortable	27		Acceptable
59	A	Annual	-		-	-		-
	В	Annual	17		Walking	24		Acceptable
	С	Annual	17		Walking	24		Acceptable
60	A	Annual	-		-	-		-
	В	Annual	18		Walking	25		Acceptable
	С	Annual	18		Walking	25		Acceptable

Configurations	Mean Wind Criter	ia Speed (mph)	Effective Gust Criteria (mph)
A) No Build	≤ 12 Comfortable fo	or Sitting	≤31 Acceptable
	13 - 15 Comfortable fo	or Standing	> 31 Unacceptable
B) Build	16 - 19 Comfortable fo	r Walking	
	>19 Uncomfortable	for Walking	
C) Full Build			

Notes

1) Wind Speeds are for a 1% probability of exceedance

2) % Change is based on comparison with Configuration A

3) % changes less than 10% are excluded

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Table 2: Mean Speed and Effective Gust Categories - Seasonal

		N	lean Wind	Speed (m	ph)	Effect	ive Gust Wi	ive Gust Wind Speed (mph)				
Location	Configuration	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter			
1	A	17	14	16	17	26	21	24	27			
	B	9	7	9	9	13	10	12	13			
	C	10	7	9	10	13	10	12	14			
2	A	15	13	14	15	24	20	22	24			
	B	13	12	13	13	22	19	21	21			
	C	14	12	13	13	23	19	21	22			
3	A	12	10	11	12	19	16	18	20			
	B	13	10	12	14	22	17	20	24			
	C	14	11	13	15	23	18	21	25			
4	A	11	9	10	11	18	15	16	18			
	B	10	7	9	11	18	13	16	20			
	C	11	8	10	12	19	13	17	21			
5	A	11	9	10	10	17	15	16	17			
	B	22	17	20	24	30	22	27	32			
	C	23	18	21	25	31	24	29	33			
6	A	11	9	11	12	17	13	15	18			
	B	21	18	19	20	28	24	27	28			
	C	21	18	20	21	29	25	27	29			
7	A B C	- 13 13	- 11 11	- 13 13	- 13 14	20 20	- 17 17	- 19 19	- 20 20			
8	A	-	-	-	-	-	-	-	-			
	B	20	14	18	21	27	19	24	29			
	C	20	14	18	22	27	20	25	30			
9	A	17	13	15	17	23	18	21	24			
	B	24	17	22	27	32	23	29	35			
	C	25	18	23	27	33	24	30	36			
10	A	12	9	11	12	17	13	16	17			
	B	16	12	15	16	23	18	21	24			
	C	16	12	14	16	23	17	21	24			
11	A	13	11	12	14	20	16	18	20			
	B	12	9	10	12	17	13	16	17			
	C	11	8	10	11	17	13	15	17			
12	A	16	12	15	16	24	17	22	23			
	B	10	8	9	11	17	13	15	17			
	C	10	8	9	11	17	13	15	17			
13	A	21	15	19	22	28	20	26	30			
	B	14	11	14	15	21	16	19	21			
	C	16	12	14	16	22	16	20	23			

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Table 2: Mean Speed and Effective Gust Categories - Seasonal

		N	lean Wind	Speed (m	ph)	Effect	ive Gust W	ind Speed	(mph)
Location	Configuration	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
14	A	24	18	22	23	33	24	30	32
	B	21	17	20	21	27	22	26	28
	C	21	18	20	22	28	23	26	28
15	A	20	14	18	18	28	20	26	26
	B	15	11	14	15	20	15	19	20
	C	14	10	13	14	20	14	18	19
16	A	17	13	15	16	25	19	23	24
	B	13	11	12	14	15	13	14	16
	C	13	11	12	14	15	13	14	16
17	A	22	21	22	23	29	27	28	31
	B	24	21	23	25	30	27	29	31
	C	24	21	23	25	30	26	29	31
18	A	15	14	15	16	21	19	20	22
	B	22	20	22	23	29	26	28	30
	C	22	19	21	23	29	25	28	30
19	A	20	16	18	20	27	22	25	28
	B	17	12	16	16	22	17	21	22
	C	17	12	16	17	22	16	20	22
20	A	13	10	12	13	20	16	19	20
	B	16	12	15	16	22	17	21	22
	C	16	11	14	15	22	16	20	21
21	A	18	15	17	19	25	22	24	26
	B	13	10	12	13	19	14	18	19
	C	13	10	12	13	19	14	18	20
22	A	18	14	17	18	27	21	24	27
	B	12	9	11	13	20	15	19	22
	C	12	9	11	13	21	16	19	23
23	A	16	12	14	16	23	19	22	25
	B	12	11	12	13	20	17	19	21
	C	13	11	12	13	20	17	19	21
24	A	18	14	17	19	26	22	25	27
	B	15	12	14	15	24	19	22	24
	C	16	12	15	16	24	19	22	25
25	A	14	11	13	14	22	18	20	22
	B	17	13	16	19	27	20	25	30
	C	18	14	16	20	29	21	26	31
26	A	13	11	13	13	22	19	21	21
	B	18	15	17	18	27	22	25	29
	C	19	15	17	19	28	23	26	30

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Table 2: Mean Speed and Effective Gust Categories - Seasonal

		N	Mean Wind	Speed (m	ph)	Effect	ive Gust Wi	nd Speed	d (mph)
Location	Configuration	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
27	Α	14	10	13	15	21	15	19	22
	В	15	12	14	16	23	18	21	23
	С	16	13	15	17	23	19	22	24
28	Α	14	12	14	15	21	18	20	22
	В	16	14	15	16	24	20	22	24
	С	17	14	16	17	24	21	23	24
29	Α	7	5	6	7	12	9	11	12
	В	8 8	6	8 8	8 9	14	12	13	14
	С	δ	7	ŏ	9	14	12	14	14
30	Α	7	5	7	7	11	9	11	12
	B C	8 8	6	7	8	13	11	12	13
	C	8	7	8	8	13	11	12	13
31	Α	9	8	9	9	14	12	14	14
	В	10	9	10	10	16 16	14	16 16	16
	С	11	9	10	11	16	14	16	17
32	Α	11	9	10	11	17	13	16	17
	В	14 14	11	13	14	20	16 16	19	20
	С	14	11	13	14	20	16	19	20
33	Α	14	10	13	15	20	15	18	20
	В	17	13	16	18	23	18	22	24
	С	18	14	17	19	24	18	22	26
34	Α	14	11	13	15	20	16	19	21
	В	15	12	14	16	21	17	20	22
	С	15	11	14	16	21	16	20	23
35	Α	14	11	13	15	20	16	19	22
	В	13	10	12	14	20	15	18	20
	С	11	9	10	12	17	14	16	19
36	Α	12	9	11	12	18	14	17	19
	В	11	9	10	12	18	13	16	18
	С	11	9	11	11	17	13	16	18
37	Α	8	6	7	8	12	9	11	13
	В	8	6	7	8	13	10	12	13
	С	9	6	8	9	14	10	13	14
38	A	16	13	15	16	23	17	21	23
	В	16	13	15	16	23	17	21	22
	С	12	9	11	12	18	14	17	19
39	Α	13	10	12	14	21	16	20	22
	В	13	10	12	14	21	16	19	21
	С	13	10	12	13	20	15	18	21

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Table 2: Mean Speed and Effective Gust Categories - Seasonal

Location		Mean Wind Speed (mph) Effective Gust Wind S						ila speci	a (mpn)
	Configuration	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
40	A	22	17	21	24	29	22	27	32
	B C	22 22	17 17	21 21	25 24	29 30	23 23	27 27	32 32
41	A	13	10	12	12	20	15	18	19
	B C	12 14	10 11	11 13	12 12	19 21	15 16	18 19	19 19
42	A	14	10	13	13	21	15	19	20
	B C	14 12	10 9	13 11	13 12	21 19	15 14	19 17	20 19
43	A	14	10	13	16	22	16	20	24
	B C	13 17	10 15	12 17	15 19	21 25	16 21	19 24	23 27
44	A	19	15 15	18	21	27	21	25	28
	B C	19 17	15 15	18 17	20 19	27 25	22 22	25 24	28 26
45	A	22	18	21	23	30	25	28	32
	B C	22 14	19 12	21 13	23 15	30 21	27 18	29 20	32 22
46	A	24	20	22	25	31	26	30	33
	B C	23 19	20 17	23 18	25 20	31 28	27 24	30 27	33 30
47	A	19	15	18	20	27	23	26	28
	B C	19 16	16 15	18 16	20 17	28 26	25 23	27 25	29 27
48	A	19	15	18	21	26	20	24	29
	B C	18 17	15 14	17 16	19 18	25 25	21 21	24 23	27 26
49	A	17	12	15	18	24	18	22	26
	B C	15 15	12 12	14 14	16 16	22 23	18 19	21 22	24 25
50	A	16	12	15	17	24	19	22	25
	B C	14 14	12 12	14 14	15 15	22 22	19 19	21 21	23 23
51	A	15	11	14	14	20	16	19	20
	B C	15 12	11 8	14 11	14 12	20 17	16 13	19 16	20 17
52	A	11	8	10	11	17	13	15	18
	B C	11 11	8 8	10 10	11 11	16 16	12 12	15 15	16 16

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Table 2: Mean Speed and Effective Gust Categories - Seasonal

		N	lean Wind	Speed (m	ph)	Effect	ive Gust W	ind Speed	(mph)
Location	Configuration	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
53	Α	17	12	16	18	23	17	21	25
	В	11	8	10	11	16	13	15	17
	С	11	8	10	11	17	12	15	17
54	Α	12	9	11	13	17	13	16	19
	В	19	14	17	21	25	18	23	28
	С	19	13	17	21	25	18	23	28
55	A	15	12	14	16	21	17	20	22
	В	15	13	15	16	21	18	20	22
	С	15	13	15	17	21	17	20	22
56	A	16	11	15	15	22	16	21	22
	В	16	11	15	15	23	16	21	22
	С	16	11	15	15	22	17	21	22
57	Α	-	-	-	-	-		-	-
	В	24	16	21	20	33	22	30	29
	С	23	16	21	20	32	21	29	29
58	A	-	-	-	-	-	-	-	-
	В	22	15	20	20	31	21	28	28
	С	22	15	20	20	30	21	28	28
59	A	-	-	-	-	-	-	-	-
	В	18	13	17	18	25	18	23	25
	С	18	13	17	19	26	18	24	26
60	Α	-	-	-	-	-	-	-	-
	В	19	14	18	19	27	19	24	26
	С	19	14	18	20	27	19	25	27

Seasons	Months	Mean W	/ind Criteria Speed (mph)	Effective Gust Criteria (mph)
Spring	March - May	<u>≤</u> 12	Comfortable for Sitting	≤31 Acceptable
Summer	June - August	13 - 15	Comfortable for Standing	> 31 Unacceptable
Fall	September - November	16 - 19	Comfortable for Walking	
Winter	December - February	>19	Uncomfortable for Walking	
Annual	January - December			
Configurat	ions			
A) No Build				
B) Build				
C) Full Build				
Notes				

1) Wind Speeds are for a 1% probability of exceedance

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