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Date: June 28, 2021

To: Ms. Jennifer Michi
Coordinator, Development
Choice Properties Limited Partnership
22 St. Clair Ave. E., Suite 700
Toronto, ON M4T 2S5

Re: **Pedestrian Wind Assessment**
683-685 Warden Avenue
Toronto, Ontario
SLR Project #241.30167.00000

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Microclimate Engineer

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1.0 INTRODUCTION

SLR Consulting (SLR) was retained by Choice Properties Limited Partnership to conduct a pedestrian wind assessment for the proposed 685 Warden Avenue development in Toronto, Ontario. This report is in support of the Zoning Bylaw Amendment (ZBA) application for the development.

1.1 Existing Development

The proposed development is located at 685 Warden Avenue in the City of Toronto (Scarborough). Currently, the site is an open field. Figure 1 provides an aerial view of the immediate study area. A virtual site visit was conducted by SLR using Google Earth images dated November 2020; some of these images are included in Figures 2a through 2d.

Immediately surrounding the site are Warden Woods and Taylor Massey Creek to the southwest through northwest, a low-rise commercial development and Warden Transformer Station to the north, low-rise residential buildings to the northeast through southeast, and low-rise commercial and residential developments to the south. Immediately southwest of the site is an existing high-rise residential building. Lake Ontario is located approximately 2.6km to the southeast.

Typically, developments with Site Plan Control approval and/or those currently under construction within a 500 radius are included as existing surroundings. For this study only the future development of 80 Bell Estate Road was included.

Figure 1: Aerial view of existing site & surroundings
Credit: Google Earth Pro, dated 06/22/2019

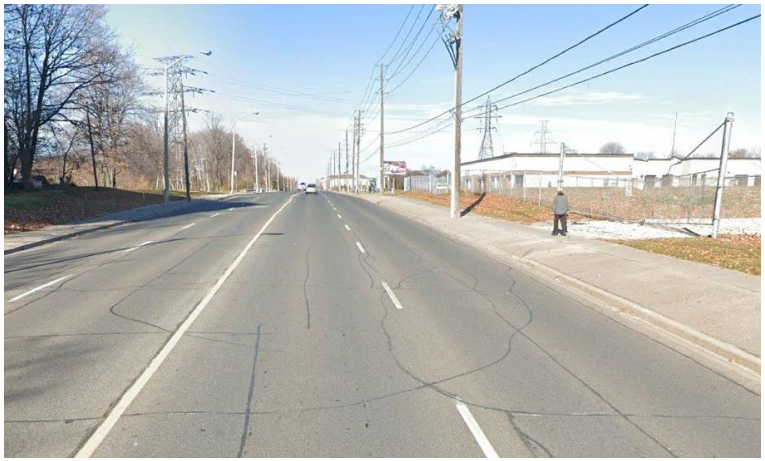


Figure 2a: Warden Avenue – Looking North (Site to the Right)

Figure 2b: Warden Avenue – Looking South (Site to the Left)

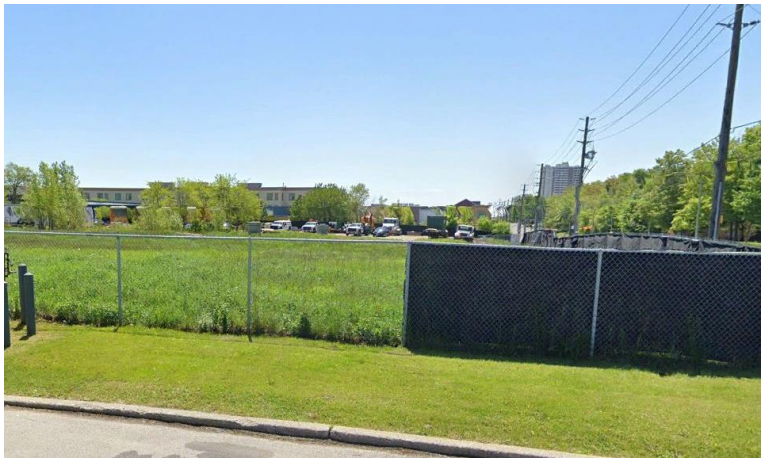


Figure 2c: Neighbourhood Property Looking at Site to the South

Figure 2d: Pilkington Road Looking at Site to the West

1.2 Proposed Development

The proposed development includes two new buildings. The westerly building consists four towers (Towers C through F) that range in height between 19 and 36 storeys and are atop a common single storey podium. The easterly building consists two mid rise towers (Buildings A and B) that are both 13-storeys in height with a common single storey podium. Figure 3 shows rendering of the proposed development.

1.3 Areas of Interest

Areas of interest for pedestrian wind conditions include those areas which pedestrians are expected to use on a frequent basis. Typically, these include sidewalks, main entrances, transit stops, plazas and parks.

There are three transit stops along Warden Avenue in the vicinity of the development. The main entrance to the east building is located in the middle of the west facade of the building. The main entrances to the west building are located on the north and south facades of the building . These entrances are shown in Figure 4a.

Amenity spaces associated with the new development are located on the podium roof (Level 2). There is an outdoor bridge connecting the east building and west building at Level 2. There are also grade level amenity areas that slope upwards towards the central amenity space from the east and west edges of the site. A proposed park is planned at the east edge of the site. These areas are shown in Figures 4b.

Figure 3: Rendering of proposed development
Credit: Turner Fleischer Architects Inc.

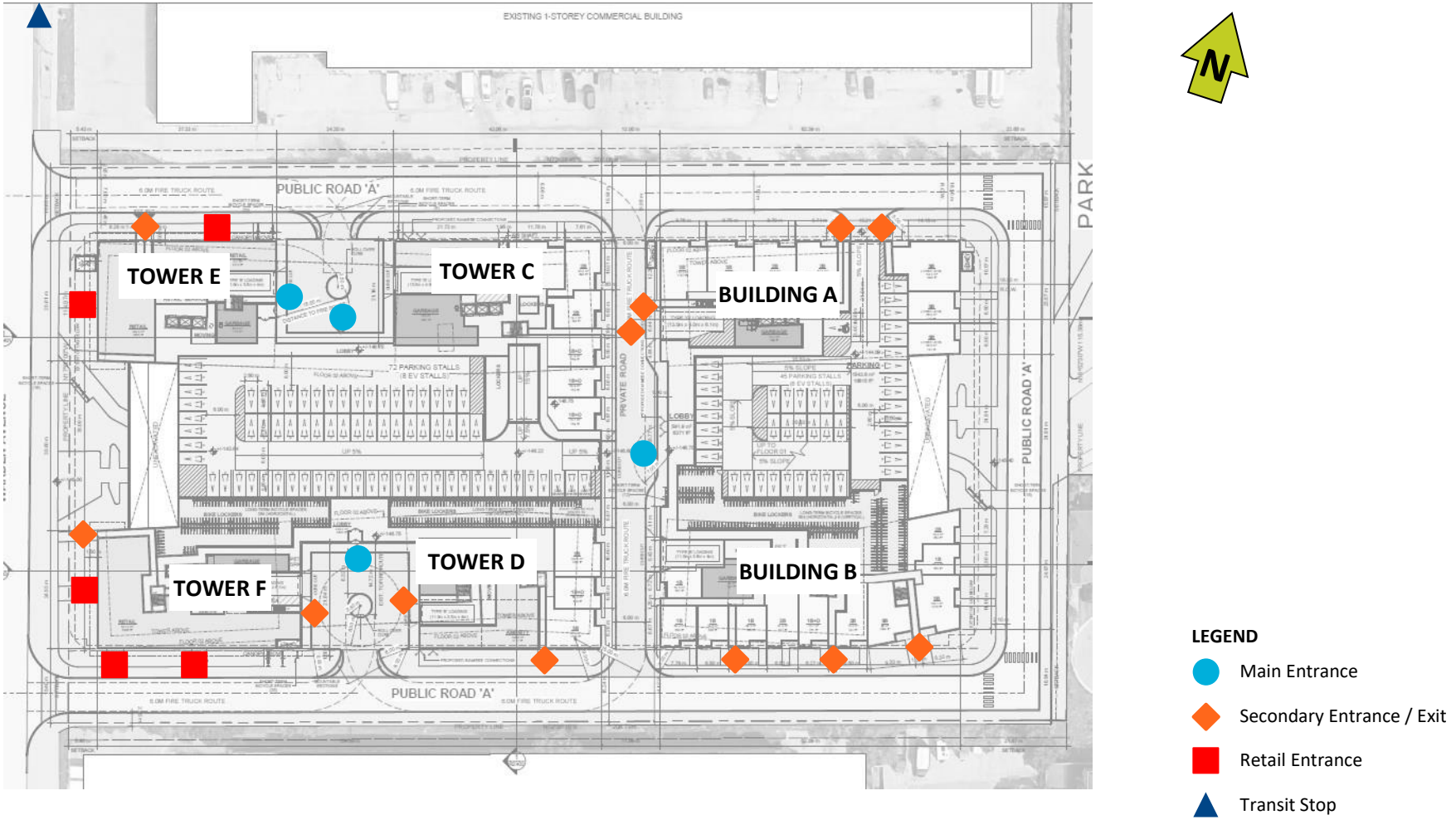


Figure 4a: Areas of Interest – Buildings Entrances and Walkways at Grade (Floor Plan Received June 22, 2021)

Figure 4b: Areas of Interest – Outdoor Amenity Areas (on Level 2)

2.0 APPROACH

A screening-level assessment was conducted using computational fluid dynamics (CFD). As with any simulation, there are some limitations with this modeling technique, specifically in the ability to simulate the turbulence, or gustiness, of the wind. Nonetheless, CFD analysis remains a useful tool to identify potential wind issues, especially when assessing mean wind speeds. This CFD-based mean wind speed assessment employs a comparable analysis methodology to that used in wind tunnel testing. The results of CFD modeling are also an excellent means of readily identifying relative changes in wind conditions associated with different site configurations or with alternative built forms.

2.1 Methodology

Wind comfort conditions for areas of interest were predicted on and around the development site to identify potentially problematic windy areas. A 3D model of the proposed development as well as floor plans and elevations were provided by Turner Fleischer Architects Inc. on June 10, 2021. A view of the 3D model used in the computer wind comfort analysis is shown in **Figure 5**. This model included surrounding buildings within 500 m from the study site centre. The simulations were performed using CFD software by Meteodyn Inc.

The entire 3D space throughout the modeled area is filled with a three-dimensional grid. The CFD virtual wind tunnel calculates wind speed at each one of the 3D grid points. The upstream "roughness" for each test direction is adjusted to reflect the various upwind conditions and wind characteristics encountered around the actual site. Wind flows for a total of 16 compass directions were simulated. Although wind speeds are calculated throughout the entire modeled area, wind comfort conditions were only plotted for a smaller area immediately surrounding the proposed development.

Wind flows were predicted for both the existing site, as well as with the proposed development for comparison purposes. The CFD-predicted wind speeds for all test directions and grid points were then combined with historical wind climate data for the region to predict the occurrence of wind speeds in the pedestrian realm, and to compare against wind criteria for comfort and safety; these results are shown in the various wind flow images. The analysis of wind conditions is undertaken for four seasons: Winter (January to March), Spring (April to June), Summer (July to September), and Autumn (October to December). However, only the seasonal extremes of summer and winter are discussed within the report. The results of the analysis for spring and autumn can be found in **Appendix A**.

Results are presented through discussion of the wind conditions along major streets and the areas of interest. The comfort criteria are based on predictions of localized wind forces combined with frequency of occurrence. Climate issues that influence a person's overall "thermal" comfort, (e.g., temperature, humidity, wind chill, exposure to sun or shade, etc.) are not considered in the comfort rating.

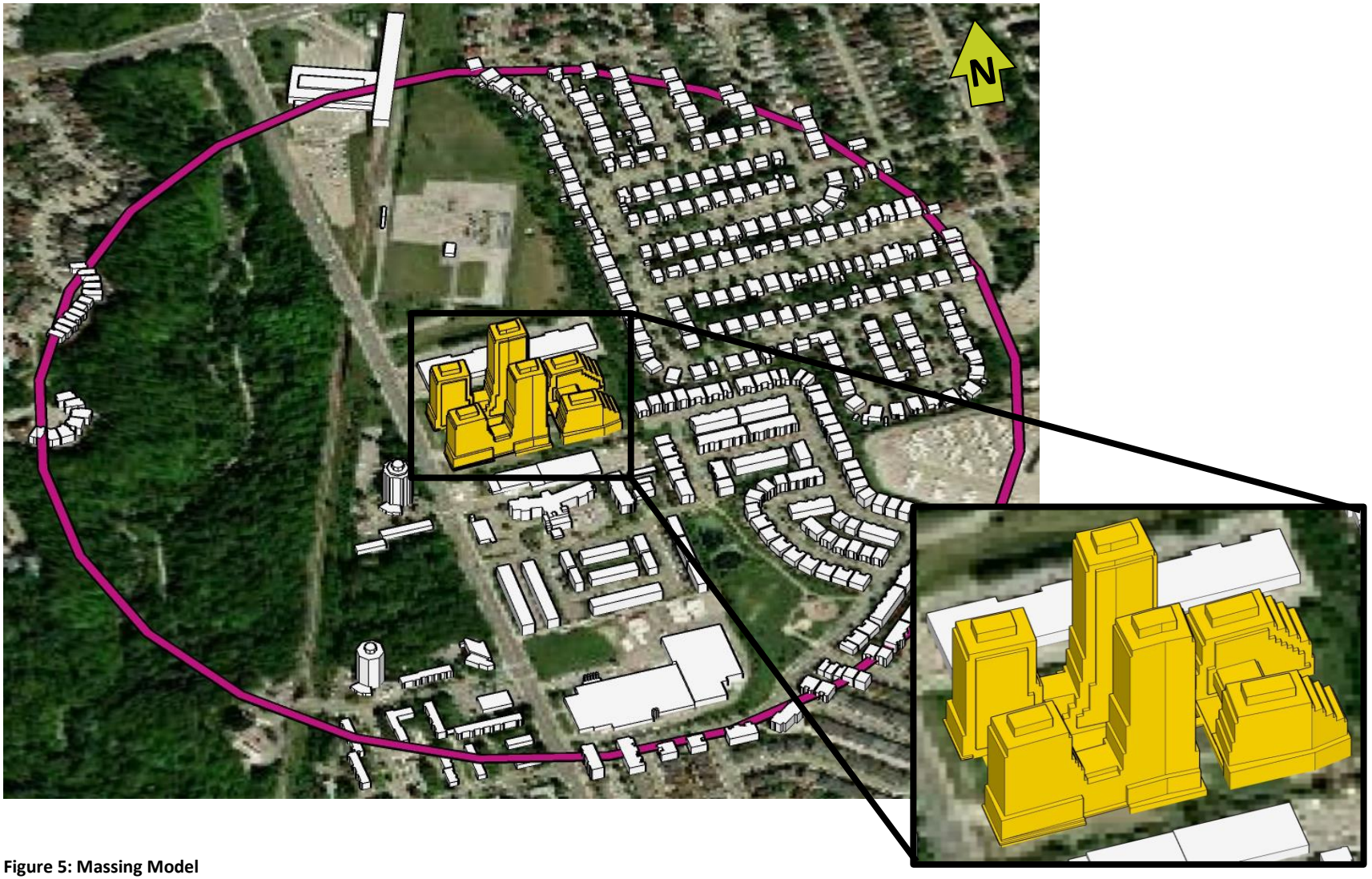


Figure 5: Massing Model

2.2 Wind Climate

Wind data recorded at the Toronto Island Billy Bishop Airport for the period of 1986 to 2015 were obtained and analysed to create a wind climate model for the region. Annual and seasonal wind distribution diagrams ("wind roses") are shown in Figure 6. These diagrams illustrate the percentage of time wind blows from the 16 main compass directions. Of main interest are the longest peaks that identify the most frequently occurring wind directions. The annual wind rose indicates that wind approaching from the northeasterly and west through southwesterly directions are most prevalent. The seasonal wind roses readily show how the prevalent winds shift throughout the year.

The directions from which stronger winds (e.g., > 30 km/h) approach are also of interest as they have the highest potential of creating problematic wind conditions, depending upon site exposure and the building configurations. The wind roses in Figure 6 also identify the directional frequency of these stronger winds, as indicated in the figure's legend colour key. On an annual basis, strong winds occur from the northeast and west through southwest directions. All wind speeds and directions were included in the wind climate model.

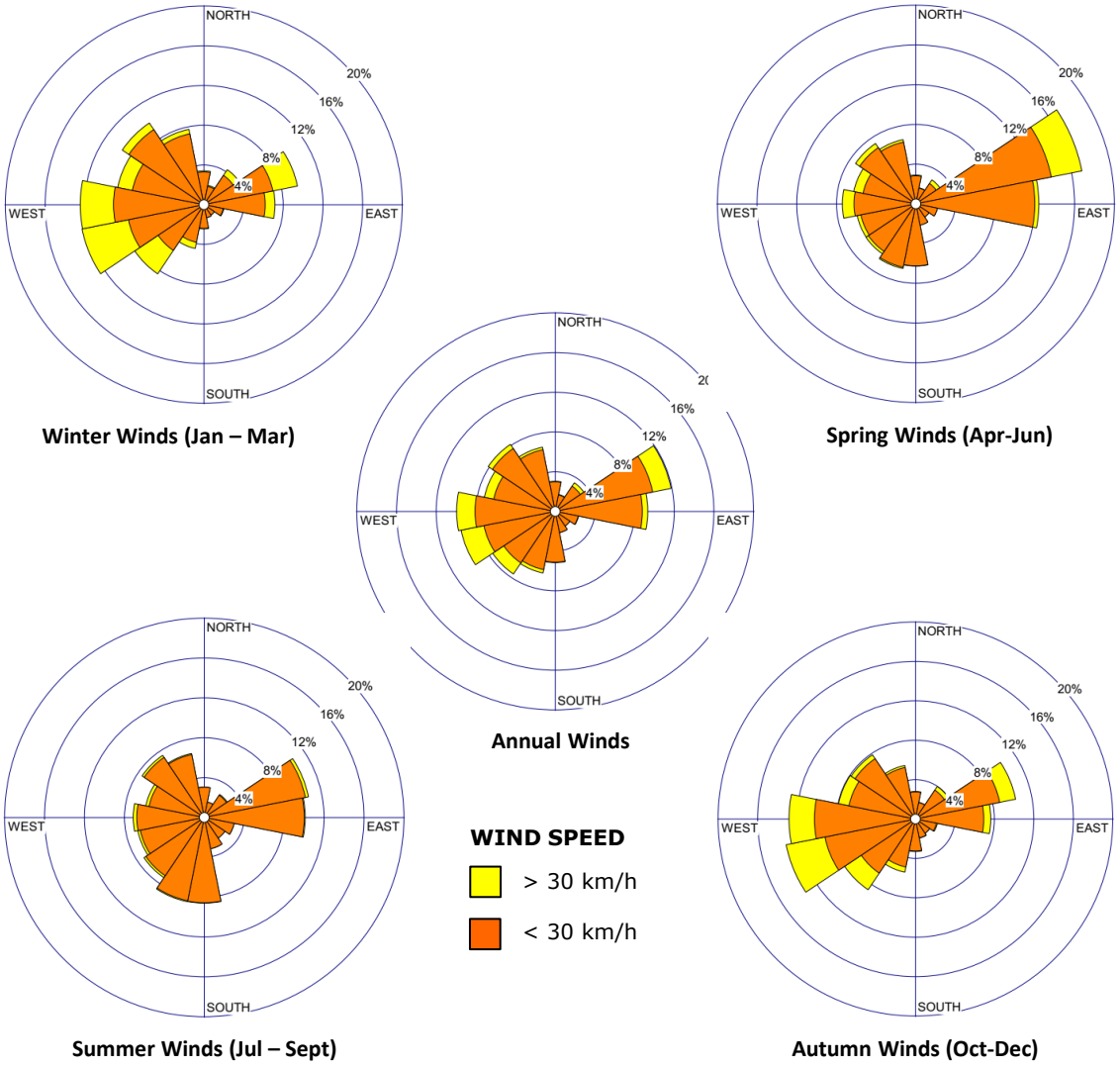


Figure 6: Wind Roses for Toronto Island Billy Bishop Airport (1986-2015)

3.0 PEDESTRIAN WIND CRITERIA

Wind comfort conditions are discussed in terms of being acceptable for certain pedestrian activities and are based on predicted wind force and the expected frequency of occurrence. Wind chill, clothing, humidity and exposure to direct sun, for example, all affect a person's thermal comfort; however, these influences are not considered in the wind comfort criteria.

The comfort criteria, which are based on certain predicted hourly mean wind speeds being exceeded 5% of the time, are summarized in Table 1. Generally, this is equivalent to a wind event of several hours duration occurring about once per week.

The criterion for wind safety in the table is based on hourly mean wind speeds that are exceeded once per year (approximately 0.01% of the time). When more than one event is predicted annually, wind mitigation measures are then advised. The wind safety criterion is shown in Table 2.

The criteria for wind comfort and safety used in this assessment are similar to those developed at the Boundary Layer Wind Tunnel Lab of the University of Western Ontario, together with building officials in London, England. They are broadly based on the Beaufort Scale and on previous criteria that were originally developed by Davenport. Similar criteria are used by the Alan G. Davenport Wind Engineering Group Boundary-Layer Wind Tunnel Laboratory for pedestrian wind study projects located around the globe. For a list of references, describing the criteria and history of its development see Section 7.0.

Table 1: Wind Comfort Criteria

Activity	Comfort Ranges for Mean Wind Speed Exceeded 5% of the Time		Description of Wind Comfort
Sitting	0 to 14 km/h	0 to 4 m/s	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper comfortably.
Standing	0 to 22 km/h	0 to 6 m/s	Gentle breezes suitable for main building entrances and transit stops.
Leisurely Walking	0 to 29 km/h	0 to 8 m/s	Moderate breezes suitable for walking along pedestrian thorough fares.
Fast Walking	0 to 36 km/h	0 to 10 m/s	Strong breezes that can be tolerated if one's objective is to walk, run or cycle without lingering.
Uncomfortable	> 36 km/h	> 10 m/s	Strong winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended.

Table 2: Wind Safety Criterion

Activity	Safety Criterion Mean Wind Speed Exceeded Once Per Year (0.01%)		Description of Wind Effects
Any	72 km/h	20 m/s	Excessive gust speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is typically required.

4.0 RESULTS

Figures 7a through 10b present graphical images of the wind comfort conditions for the summer and winter months around the proposed development. These represent the seasonal extremes of best and worst case. Appendix A presents the wind comfort conditions for spring and autumn. The "comfort zones" shown are based on an integration of wind speed and frequency for all 16 wind directions tested with the seasonal wind climate model. The assessment does not account for the presence of mature trees, thus wind comfort conditions for months when foliage is present could be better than those predicted. Appendix B presents the wind safety conditions on an annual basis.

There are generally accepted wind comfort levels that are desired for various pedestrian uses. For example, for public sidewalks, wind comfort suitable for leisurely walking would be desirable year-round. For main entrances and transit stops, wind conditions conducive to standing would be preferred throughout the year but can be difficult to achieve in regions where winter winds are inherently harsh. For amenity spaces, wind conditions suitable for sitting and/or standing are generally desirable during the summer months. The most stringent category of sitting is considered appropriate for cafes and dedicated seating areas, while for parks sitting and/or standing would be appropriate in the summer.

4.1 Building Entrances & Walkways

Existing wind conditions are expected to be comfortable for sitting or standing in the summer (Figure 7a). During the winter, wind conditions are expected to be comfortable for leisurely walking or better on the site (Figure 8a).

With the addition of the proposed development in the Proposed Configuration, wind conditions are generally predicted to be suitable for the intended usage year-round. In the summer, wind conditions are anticipated to be comfortable for sitting or standing on the walkways (Figure 7b) and in the winter, wind conditions conducive to leisurely walking or better are predicted in most of the areas (Figure 8b). The exceptions are at the northwest corner of Tower E, the southwest corner of Tower F, and the area between Towers A and C, where wind conditions are expected to be conducive to fast walking or uncomfortable in the winter (Figure 8b). To improve wind conditions in at the corners of Towers E and F, we recommend the design team consider the inclusion of large wrap-around canopies, with a minimum protrusion of 3 m from the building facade. We also recommend keeping entrances and exits at least 5 m away from these corners, to keep the doors away from the stronger wind flows. In addition, vertical wind screens and/or dense marcescent landscaping should be planted in these areas to improve wind conditions. Such features should be a minimum 2.2 m tall to be effective.

Wind conditions at the main entrances and all other secondary entrances are expected to be comfortable for sitting or standing throughout the year, which is considered suitable for the intended use (Figures 9a and 9b).

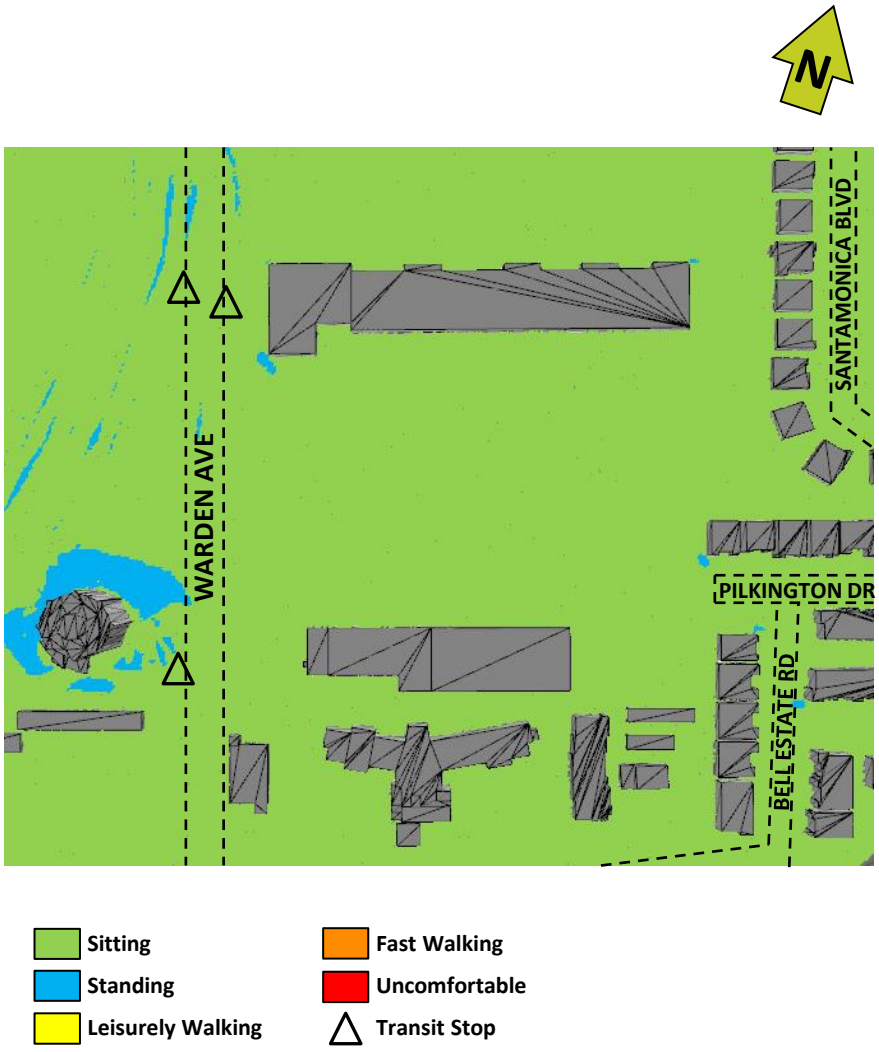


Figure 7a: Existing Configuration – Pedestrian Wind Comfort – Summer – Grade

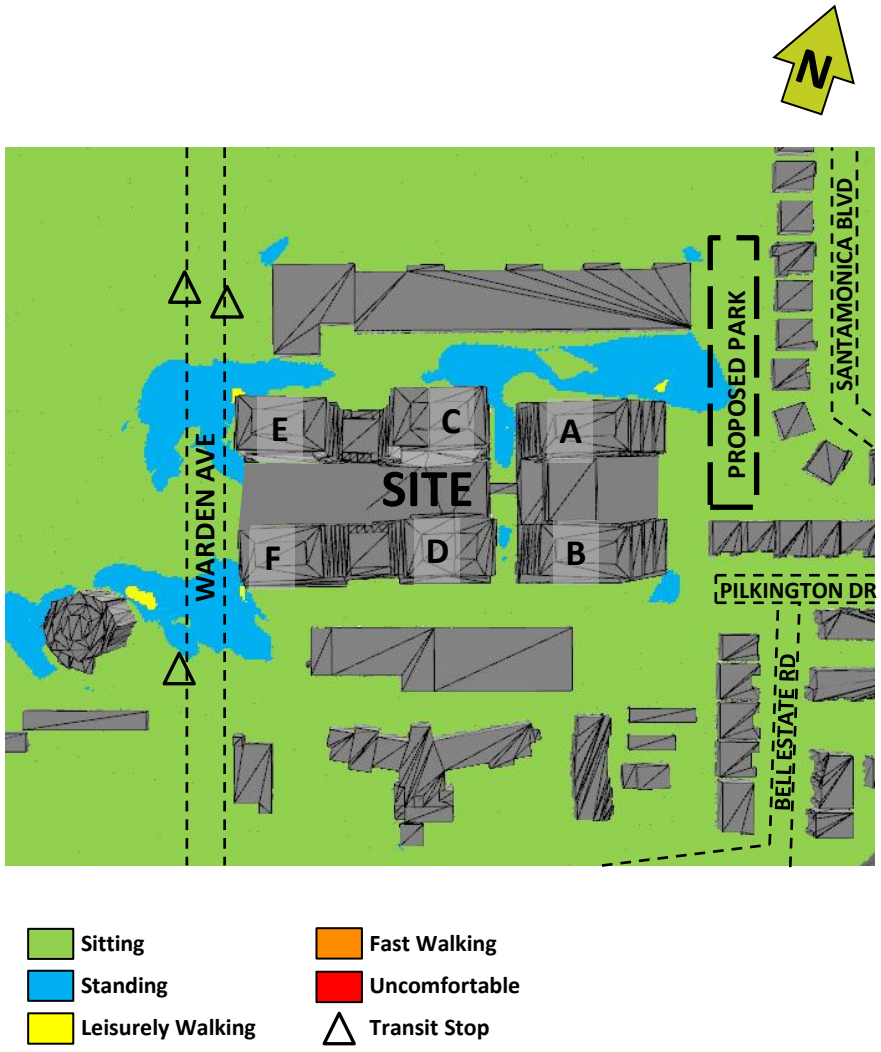


Figure 7b: Proposed Configuration – Pedestrian Wind Comfort – Summer – Grade

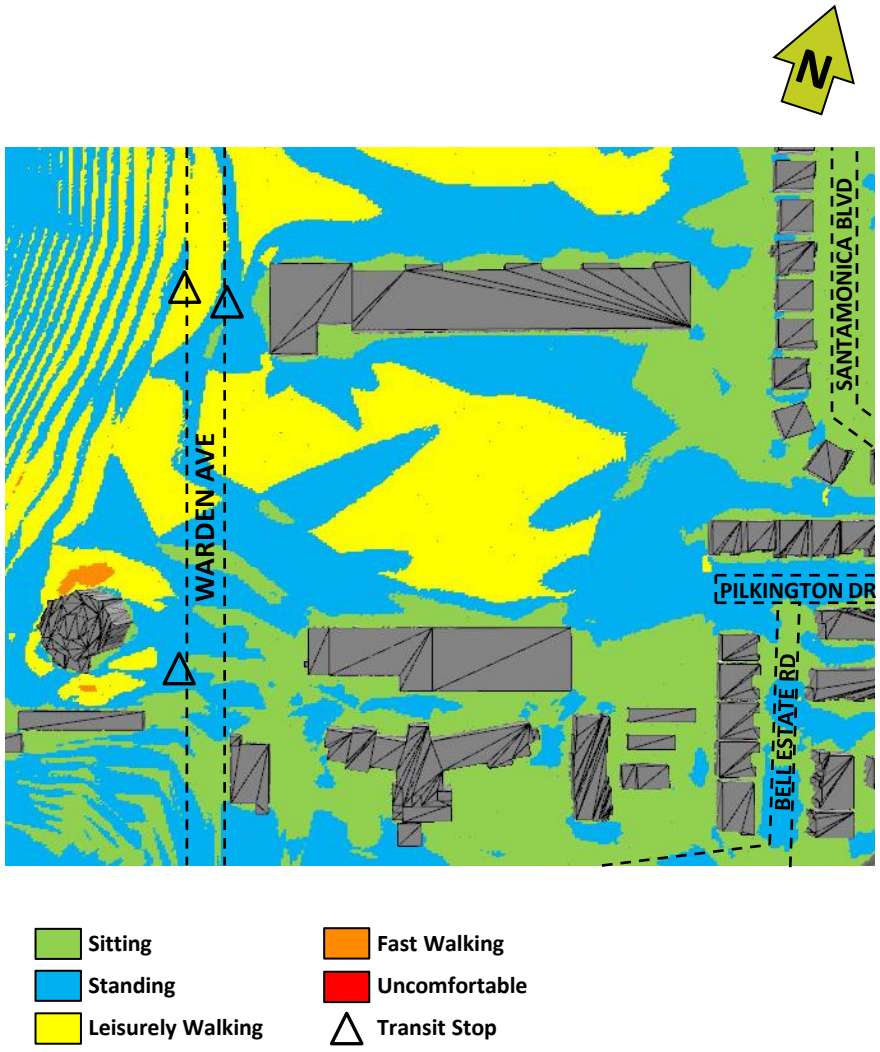


Figure 8a: Existing Configuration – Pedestrian Wind Comfort – Winter – Grade

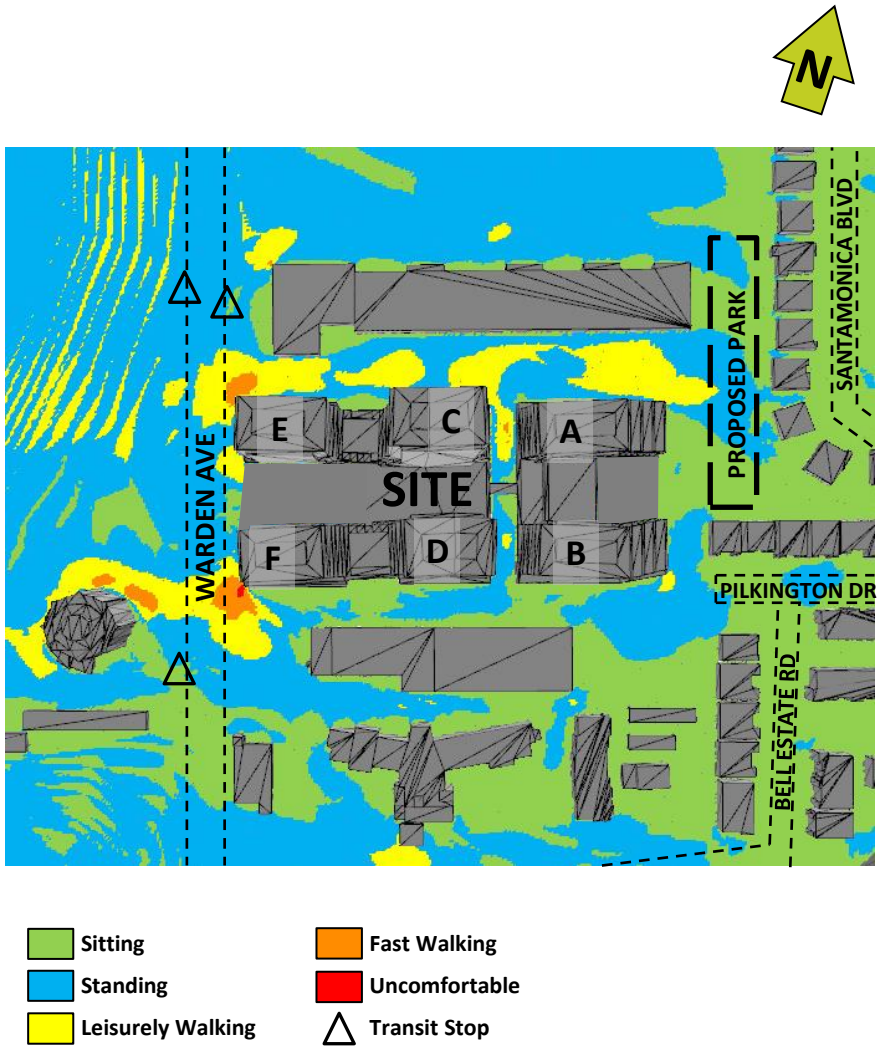


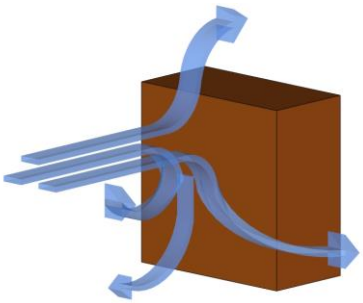
Figure 8b: Proposed Configuration – Pedestrian Wind Comfort – Winter – Grade

4.2 Amenity Areas

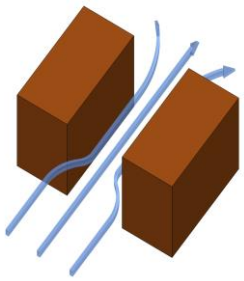
Wind conditions in the proposed park at the east edge of the site are anticipated to be comfortable for sitting or standing throughout the year (Figures 7b and 8b). These wind conditions are considered satisfactory.

Wind conditions on the central amenity area are anticipated to be comfortable for sitting or standing during the summer (Figure 10a). These wind conditions are considered suitable for the intended use. During the winter, wind conditions conducive to fast walking or better are generally expected on this amenity area (Figure 10b). However, uncomfortable wind conditions are anticipated in the winter season in the central portion of the space, between Towers C and D (Figure 10b). These strong wind flows are due to the downwashing and channeling of the prevailing winds between, and around the towers.

To improve wind conditions in the central amenity space during the winter season we recommend the design team consider including mitigation measures (e.g., wind screens, dense landscaping, trellises, etc.) throughout the space to provide local wind shelter from the strong easterly and westerly wind flows.



Downwashing Flow



Channeling Flow

4.3 Surrounding Sidewalks

Existing wind conditions along the adjacent sidewalks are expected to be comfortable for leisurely walking or better throughout the year. Wind conditions at the transit stops on Warden Avenue are also anticipated to be comfortable for leisurely walking or better throughout the year (Figures 7a and 8a).

In the Proposed Configuration, wind conditions on the surrounding sidewalks are generally predicted to be comfortable for leisurely walking or better throughout the year. The exceptions are near the northwest corner of Tower E and the southwest corner of Tower F, where wind conditions are anticipated to be suitable for fast walking in the winter. The wind conditions at the transit stops are expected to be comfortable for sitting or standing throughout the year, which is better than the existing wind conditions (Figures 7b and 8b).

4.4 Wind Safety

The wind safety criterion is expected to be met in all areas on an annual basis for both Existing and Proposed Configurations (Appendix B).

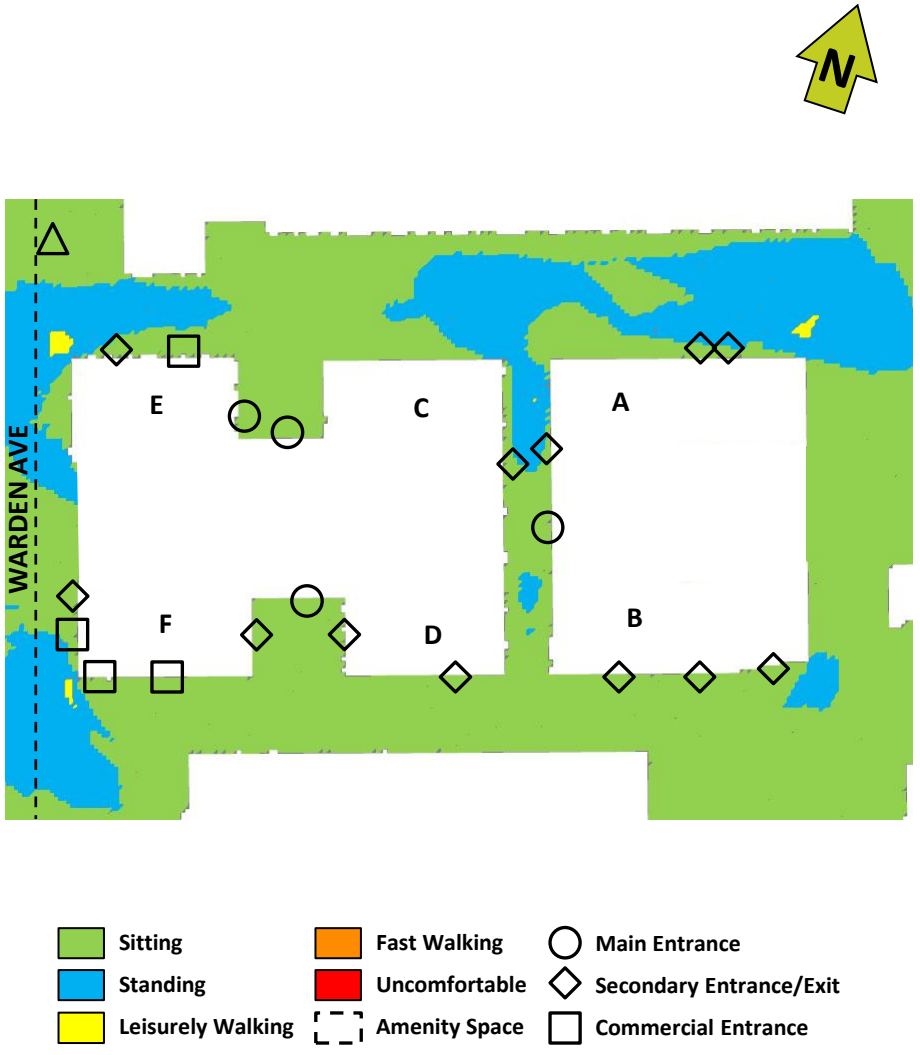


Figure 9a: Proposed Configuration – Pedestrian Wind Comfort – Summer – At Grade

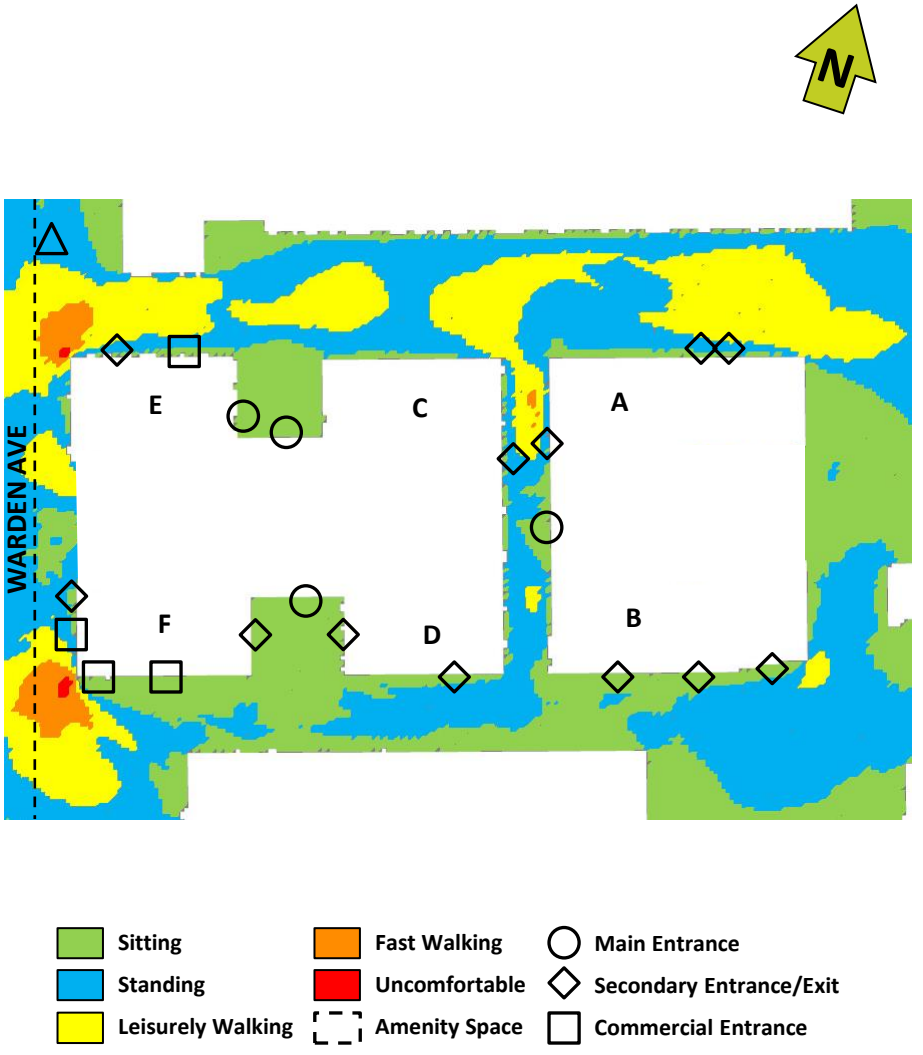


Figure 9b: Proposed Configuration – Pedestrian Wind Comfort – Winter – At Grade

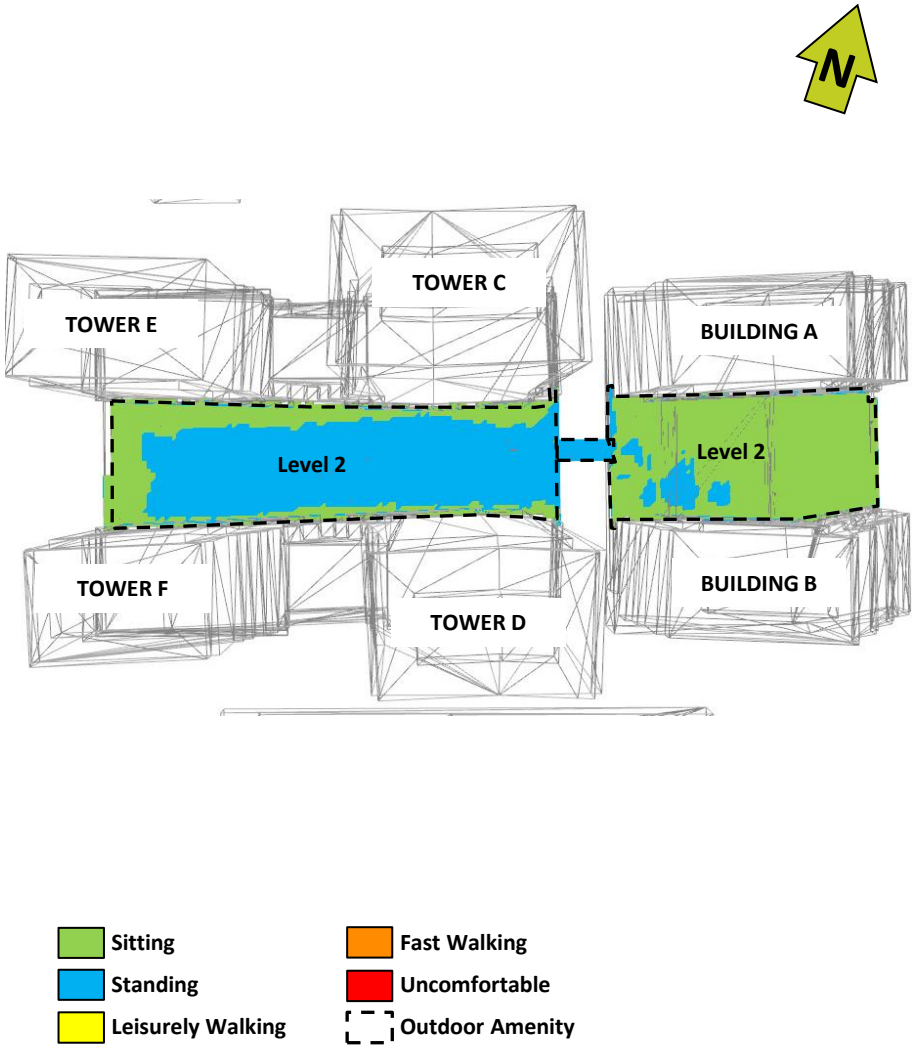


Figure 10a: Proposed Configuration – Pedestrian Wind Comfort – Summer Amenity Terraces

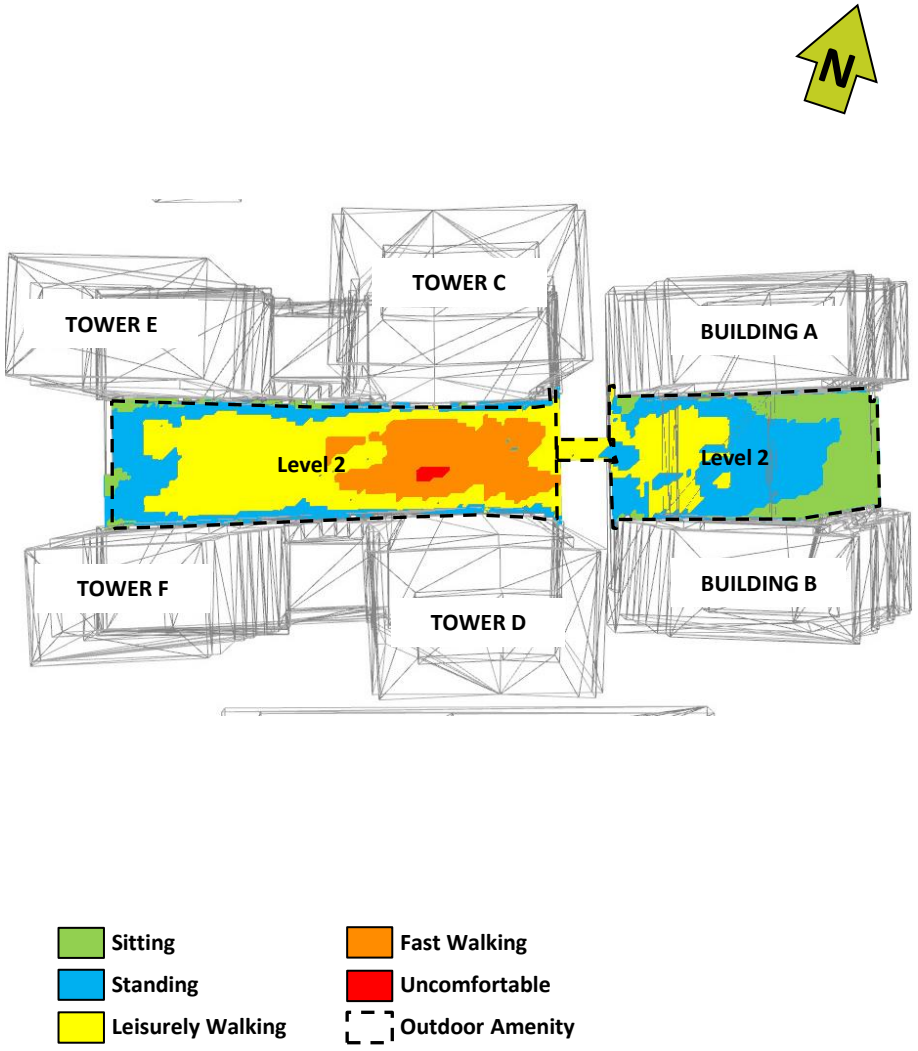


Figure 10b: Proposed Configuration – Pedestrian Wind Comfort – Winter Amenity Terraces

5.0 CONCLUSIONS & RECOMMENDATIONS

The pedestrian wind conditions predicted for the proposed development at 685 Warden Avenue in Toronto, Ontario have been assessed through computational fluid dynamics modeling techniques. Based on the results of our assessment, the following conclusions have been reached:

- The wind safety criterion is expected to be met at all areas on and surrounding the project in both the Existing and Proposed Configurations.
- Wind conditions at the numerous entrances and exits to the proposed development are expected to be suitable for the intended usage year-round.
- In the Proposed Configuration, wind conditions at the northwest corner of Tower E and at the southwest corner of Tower F are predicted to be uncomfortable in the winter. Wind mitigation measures are recommended for these corners.
- At the park and on the outdoor amenity space on Level 2, wind conditions are expected to be suitable for sitting or standing during the summer season. Windier conditions are anticipated in the winter on the Level 2 space; mitigation measures are recommended.
- On the sidewalks surrounding the project, wind conditions are generally expected to be suitable for the intended usage in both the Existing and Proposed Configurations.

6.0 ASSESSMENT APPLICABILITY

This assessment is based on computer modeling techniques and provides a qualitative overview of the pedestrian wind comfort conditions on and surrounding the proposed development site. Any subsequent alterations to the design may influence these findings, possibly requiring further review by SLR.

Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Sincerely,

SLR Consulting (Canada) Ltd.

Nishat Nourin, M.Eng., P. Eng.
Microclimate Engineer

Tahrana Lovlin, MAES, P.Eng.
Specialist – Microclimate

7.0 REFERENCES

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Appendix A

Pedestrian Wind Comfort Analysis

Spring (April – June) and Autumn (October – December)

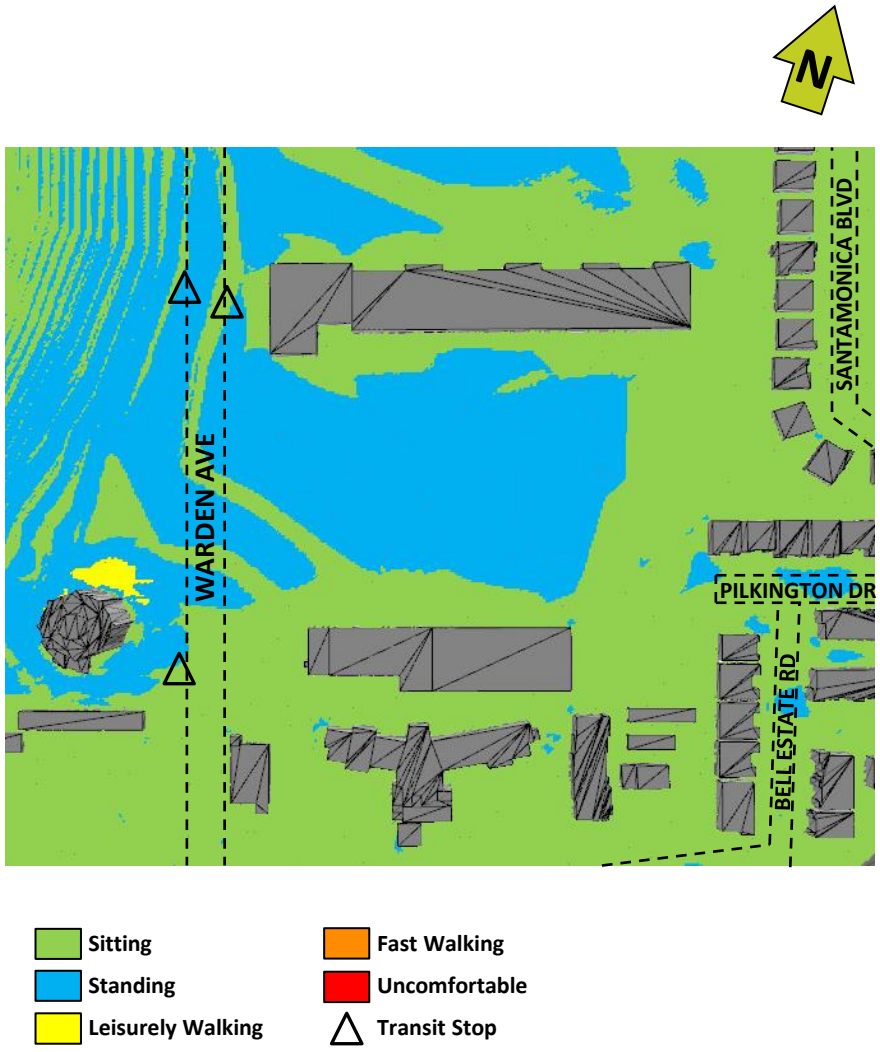

Figure A1a: Existing Configuration – Pedestrian Wind Comfort – Spring – Grade

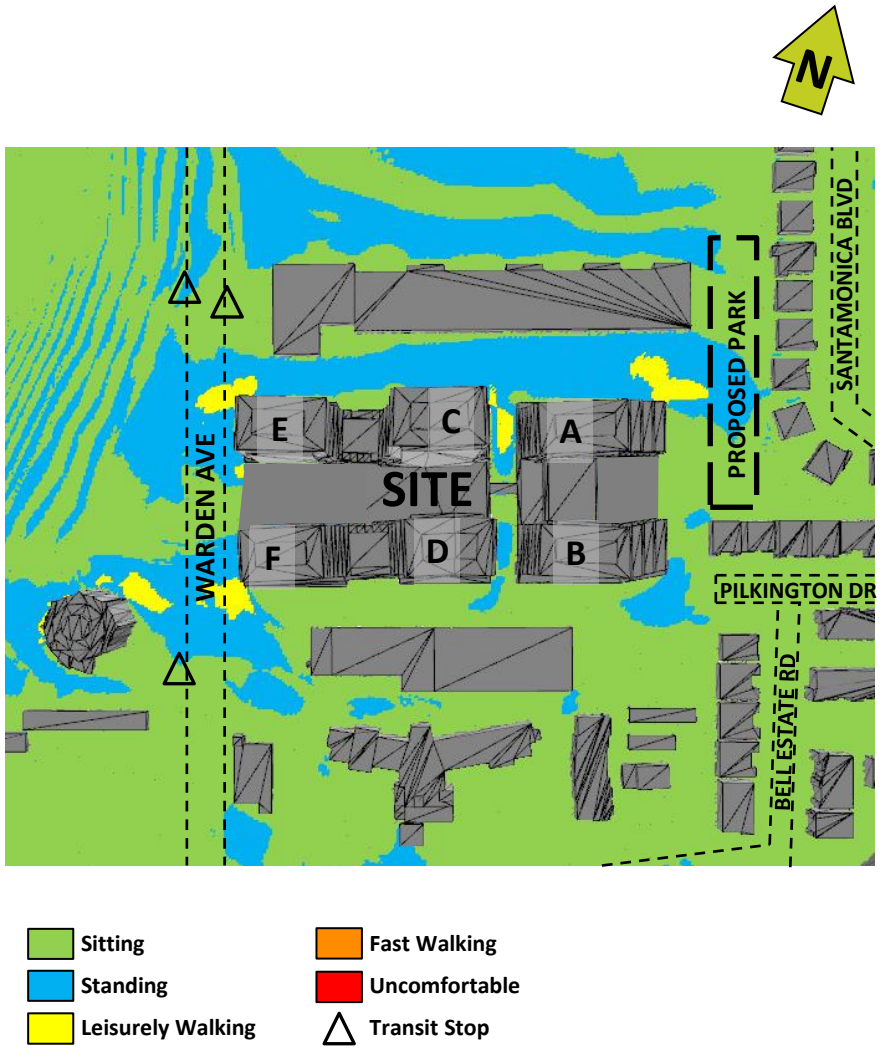

Figure A1b: Proposed Configuration – Pedestrian Wind Comfort – Spring – Grade

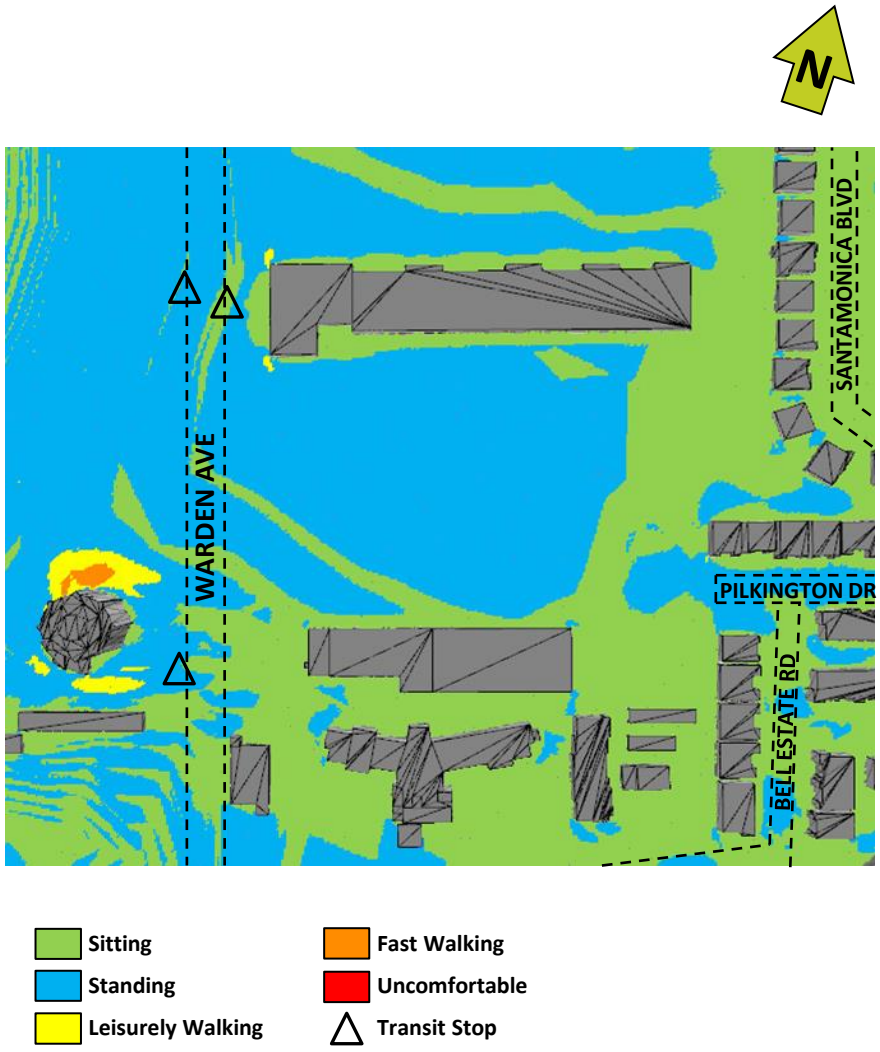

Figure A2a: Existing Configuration – Pedestrian Wind Comfort – Autumn – Grade

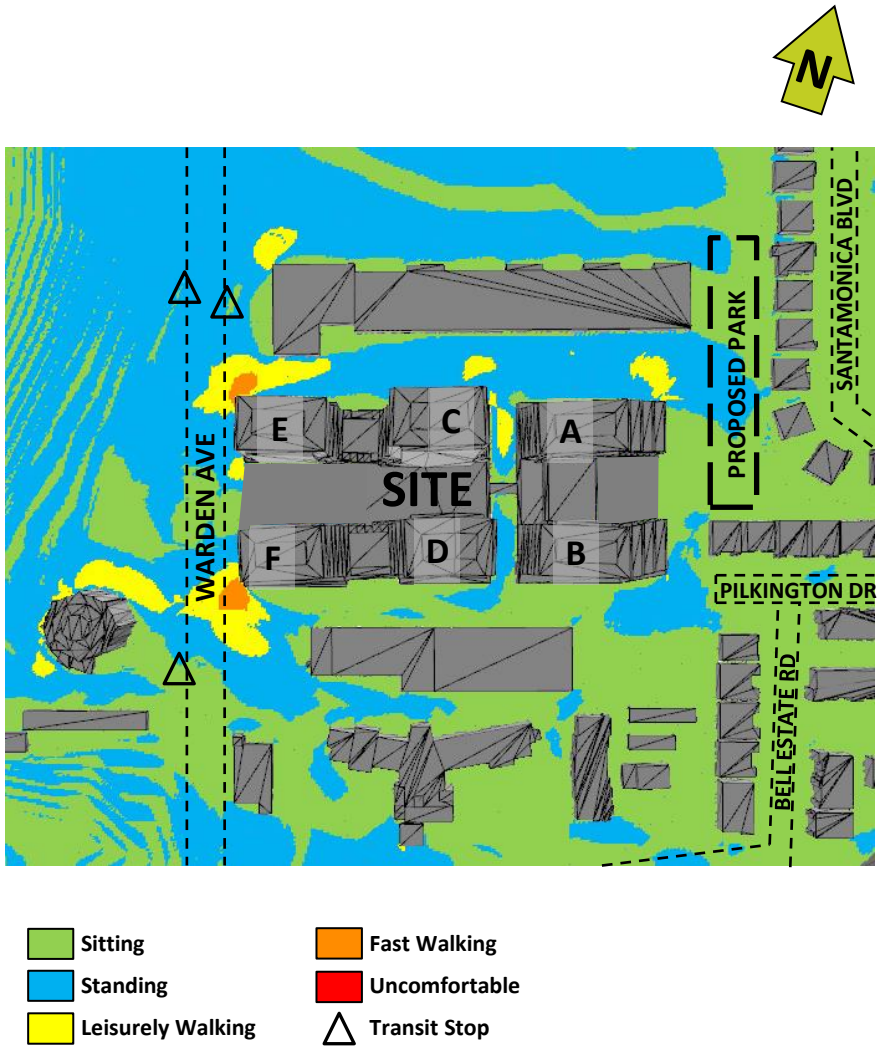

Figure A2b: Proposed Configuration – Pedestrian Wind Comfort – Autumn – Grade

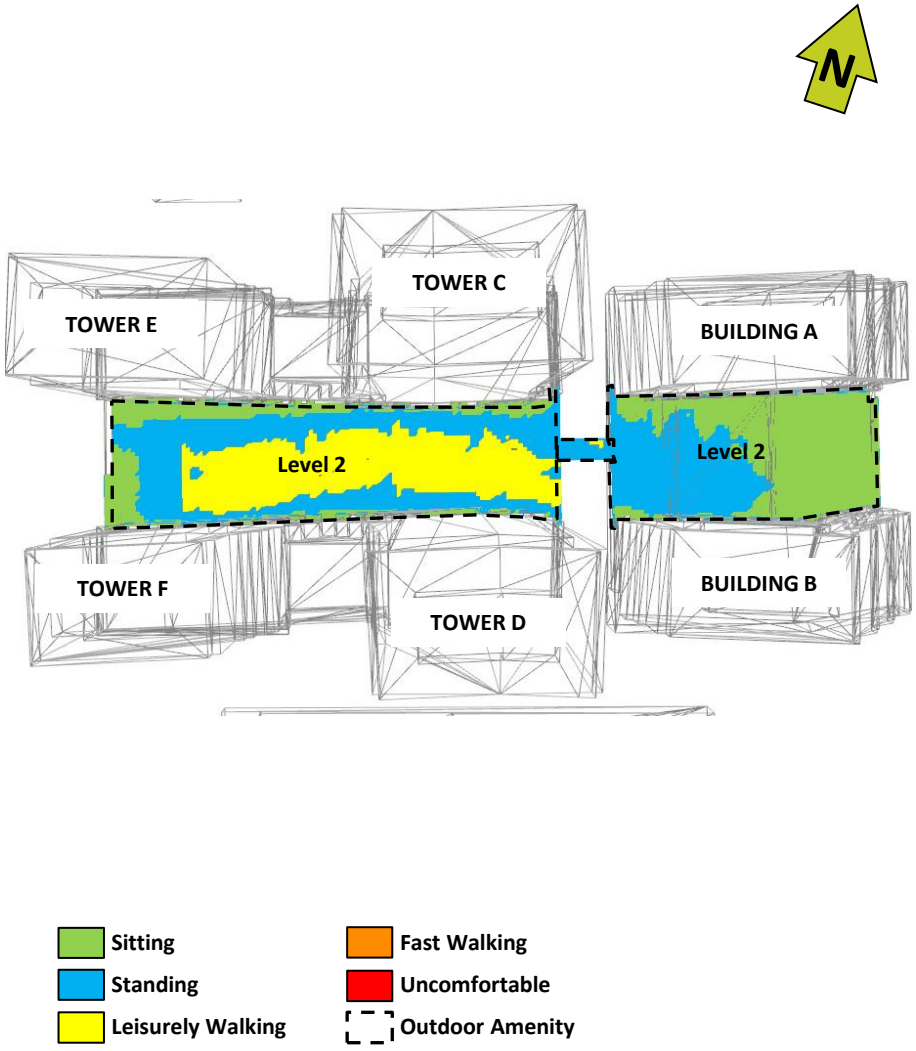

Figure A3a: Proposed Configuration – Pedestrian Wind Comfort – Spring Amenity Terraces

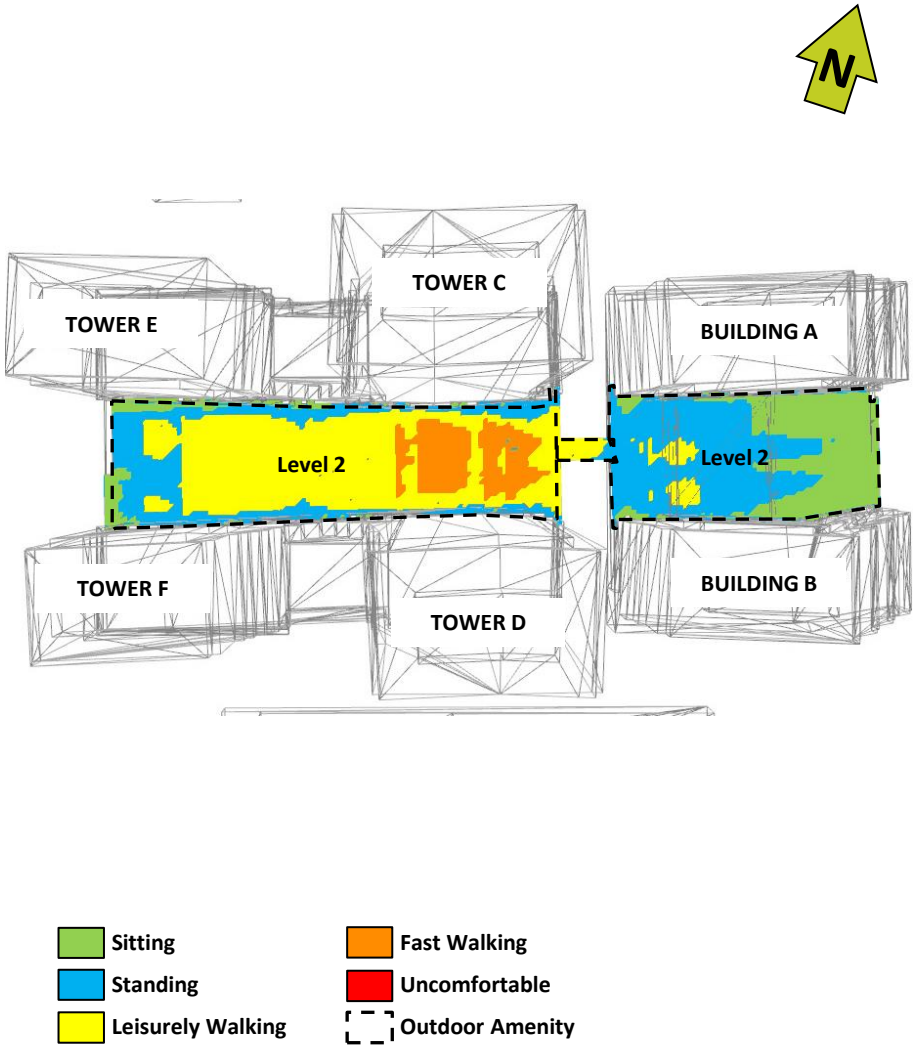

Figure A3b: Proposed Configuration – Pedestrian Wind Comfort – Autumn Amenity Terraces

Appendix B

Pedestrian Wind Safety Analysis

Annual

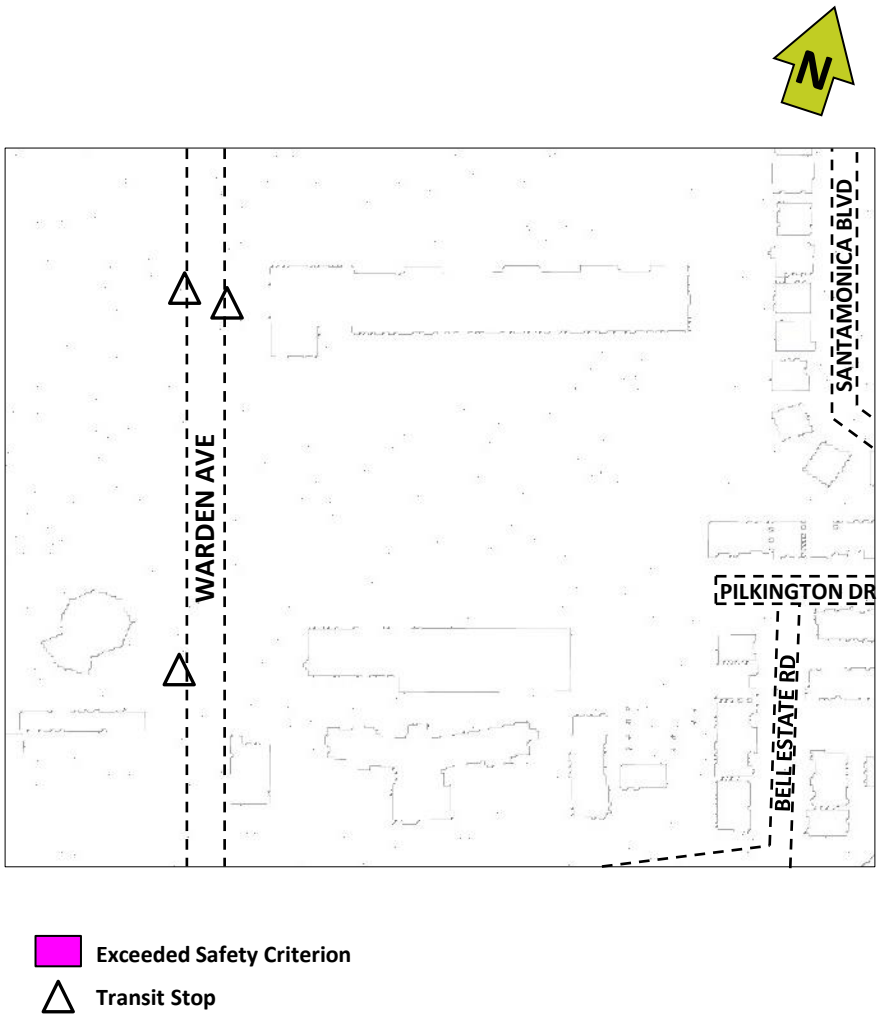

Figure B1a: Existing Configuration – Wind Safety – Annual – Grade

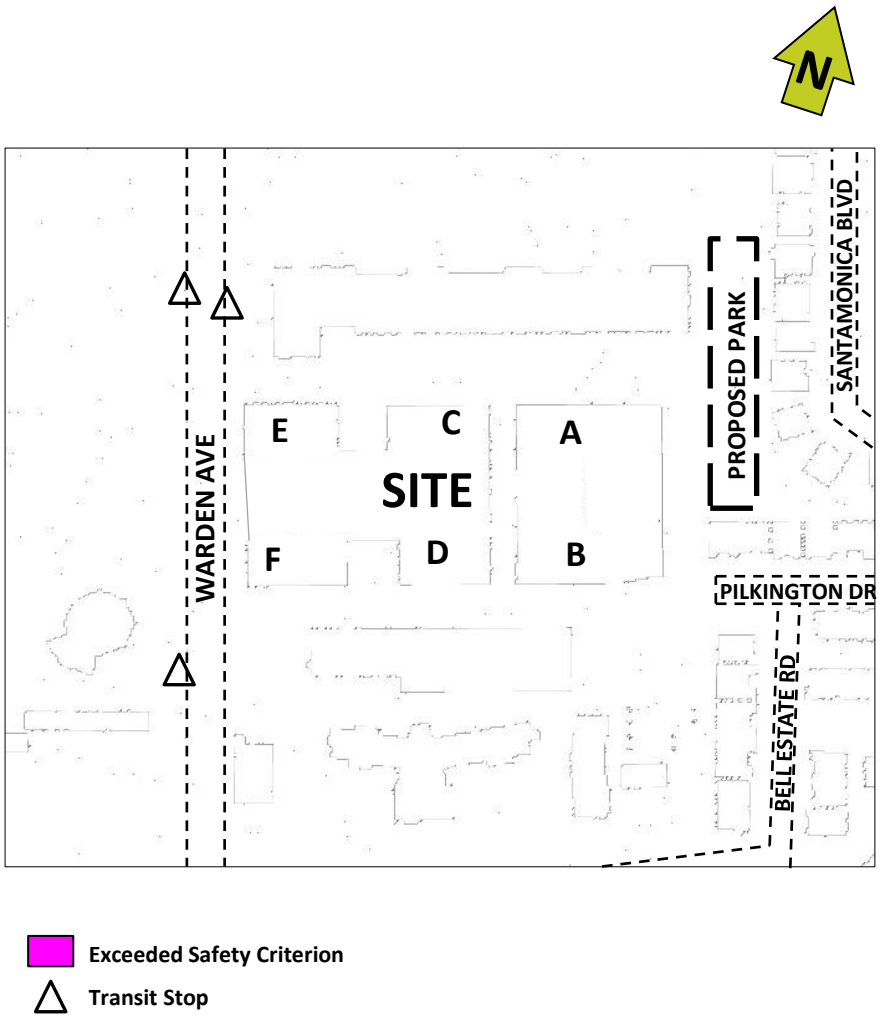

Figure B1b: Proposed Configuration – Wind Safety – Annual – Grade

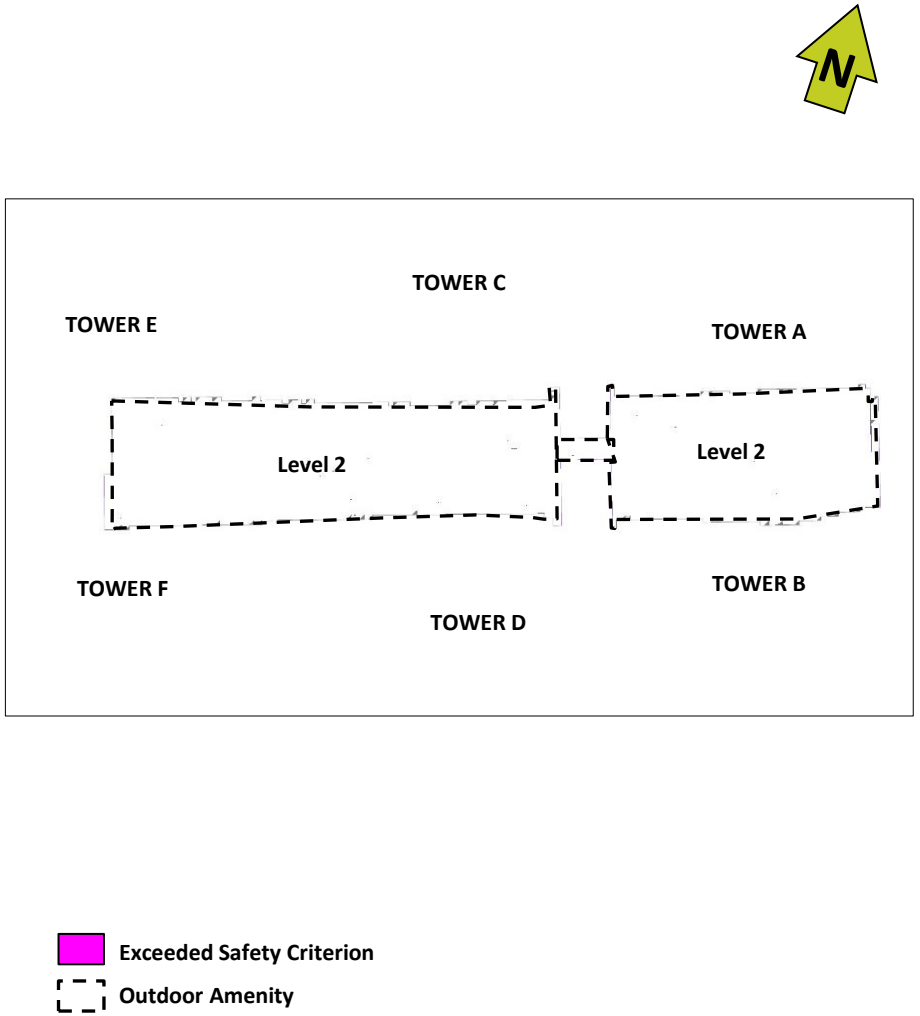

Figure B2a: Proposed Configuration – Wind Safety – Annual – Amenity Terraces