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Date: December 10, 2014

To: Deltera
4800 Dufferin Street
Toronto, ON M3H 5S9

Re: **Pedestrian Wind Assessment**
On the Park
Toronto, ON
Novus Project # 14-0262

Novus Team:
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Credit: Graziani & Corazza Architects Inc.

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Credit: Graziani & Corazza Architects Inc.

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1.0 INTRODUCTION

Novus Environmental Inc. (Novus) was retained by Deltera to conduct a pedestrian wind assessment for the proposed On the Park development in Toronto, Ontario. This report is in support of the Zoning By-law Amendment (ZBA) application to the City of Toronto.

1.1 Existing Development

The proposed development is located on the east side of Leslie Street, just north of Eglinton Avenue, in Toronto. The site is currently occupied by two low-rise commercial buildings, as well as a 21-storey commercial tower. **Figure 1** provides an aerial view of the immediate study area. A site visit was conducted by Novus on November 28, 2014 (**Figures 2a** through **2d**).

Immediately surrounding the proposed development is Serena Gundy Park and Wilket Creek Park to the southwest through northwest, mid-rise residential buildings to the north, railway tracks to the northwest through southwest, and low-rise commercial buildings to the south. Beyond the immediate surroundings are low-rise residential and commercial buildings in all directions, with high-rise buildings along Elginton Avenue East to the southwest and northeast.

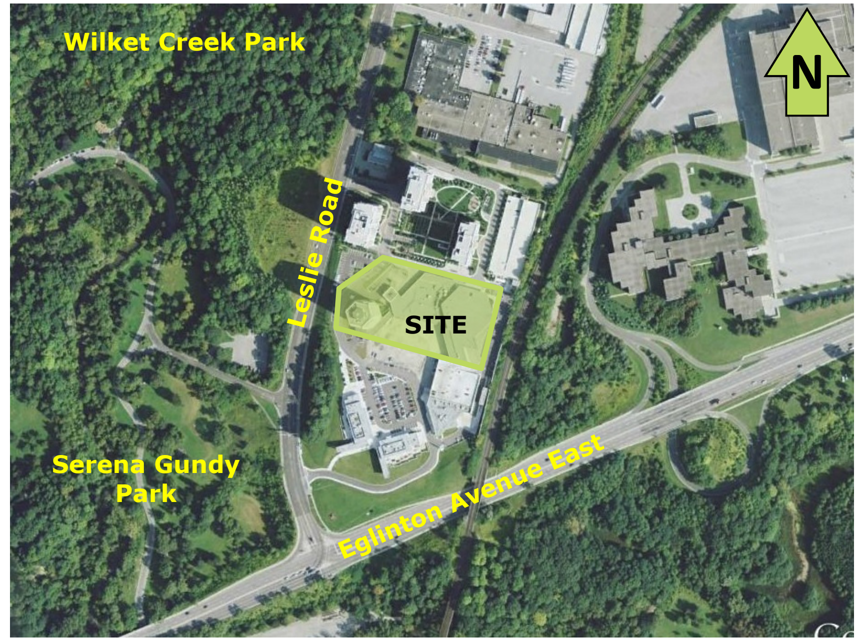

Figure 1: Context Plan
Credit: Google Earth™, Dated August 31, 2009

Figure 2a: Looking south at existing site

Figure 2c: Looking north along Leslie Street

Figure 2b: Looking north at nearby car dealerships

Figure 2d: Looking south along Leslie Street

1.2 Proposed Development

The proposed development consists of two blocks: Block 1, on the west half of the site includes 20 three-storey townhouses in two buildings; an L-shaped three-storey podium with Tower C (34-storeys) at the southeast corner; and, Tower D (28-storeys) at the northwest corner. This podium also includes 27 townhouses around the perimeter. The main entrance to Towers C and D is in the interior corner of the podium, and there are retail entrances along the south facade of the podium. Block 2, on the east half of the site, includes two towers atop a three-storey podium. The podium incorporates 17 three-storey townhouses, while on top of the podium is Tower A (north half) at 29-storeys in height, while Tower B (south half) is 39-storeys tall.

Both podiums include outdoor amenity spaces in addition to the grade level amenity spaces between Blocks 1 and 2.

1.3 Areas of Interest

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

There are numerous sidewalks and pedestrian areas throughout the site, in addition to the numerous townhouse and retail entrances. There are also three amenity spaces atop the podiums. Also, there are two transit stops located nearby on Leslie Street. These areas of interest are illustrated in **Figure 4**.

Figure 3: Rendering of On the Park
Credit: Graziani & Corazza Architects Inc.

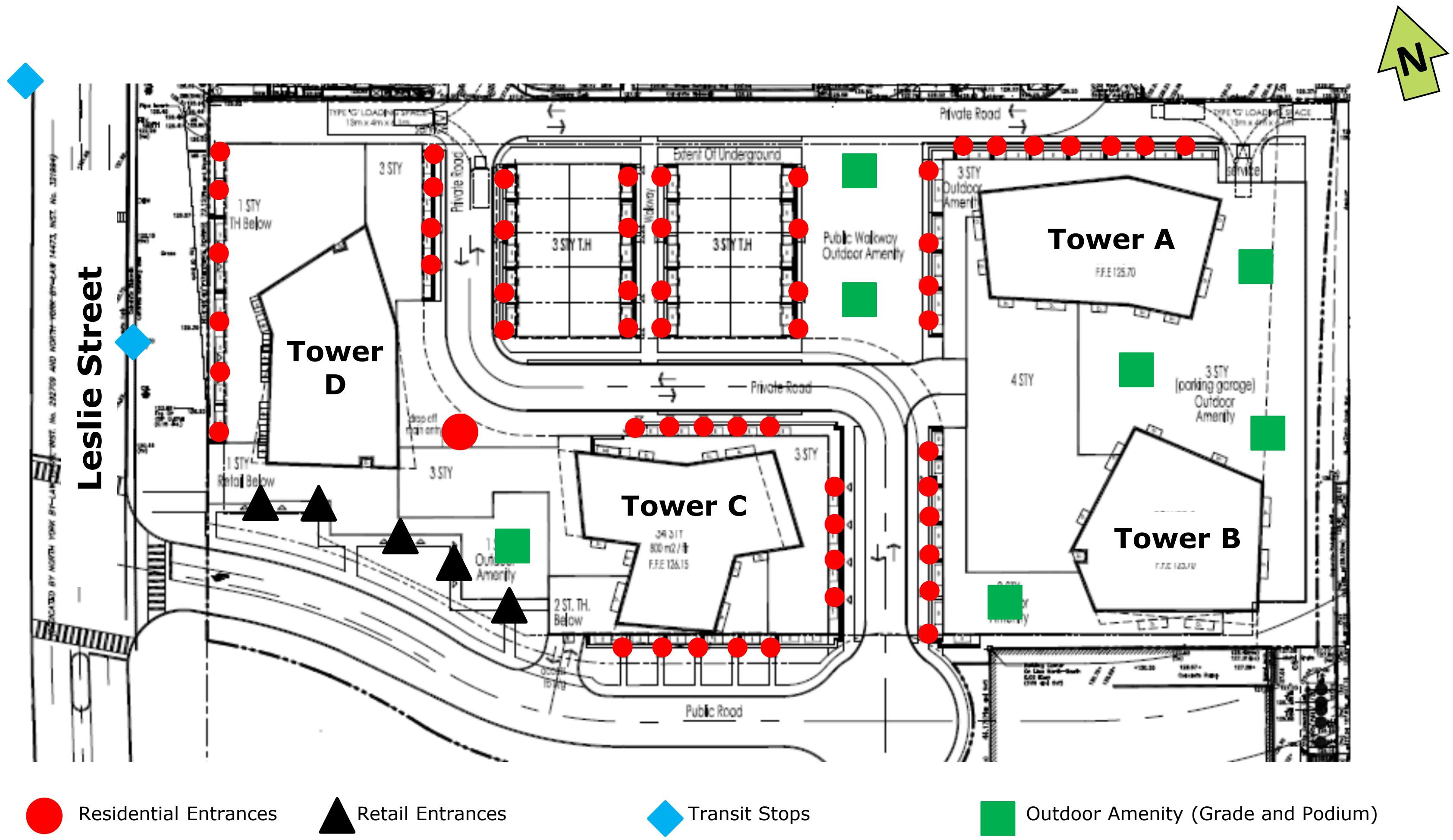

Figure 4: Areas of Interest

2.0 PEDESTRIAN WIND 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 modelling are 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 Graziani & Corazza Architects Inc. on December 4, 2014. This 3D model was refined and simplified for the computer wind comfort analysis, and is shown in **Figure 5**. This model included surrounding buildings within approximately 450 m from the study site. 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 speeds for a total of 16 compass directions were assessed.

Although wind speeds are calculated throughout the entire modeled area, wind comfort conditions were plotted for a smaller area within approximately one block of the development site to reduce computational run time.

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 was undertaken for the seasonal extremes of summer and winter.

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.

Also note that landscaping is not included in the 3D computer model. This provides a conservative estimate of the wind conditions. However, it is our experience that the significant number of trees surrounding the site, and their density, will create slightly calmer wind conditions than those illustrated here.

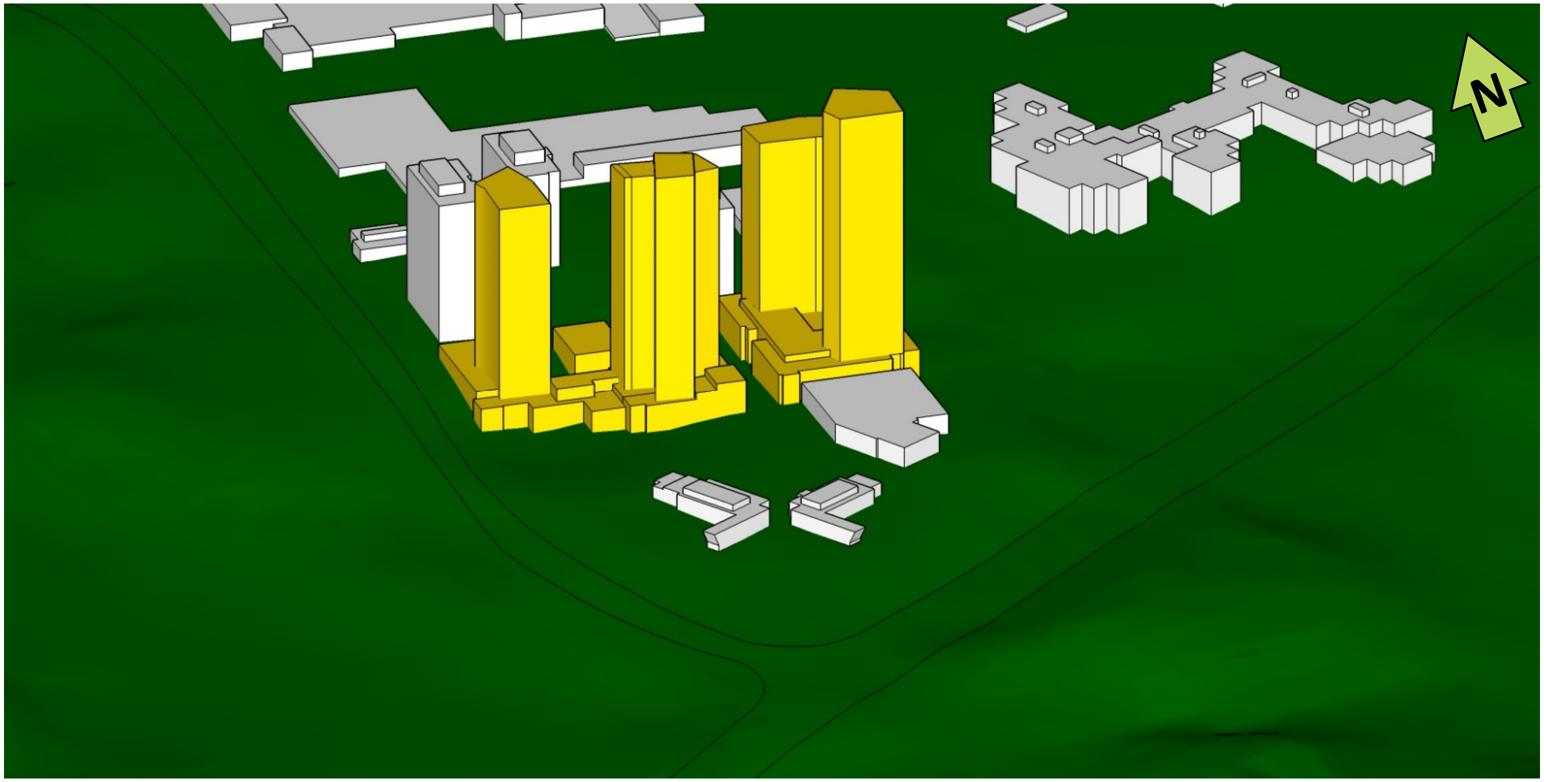

Figure 5: 3D Massing Model

2.2 Wind Climate

Wind data recorded at Pearson International Airport in Toronto for the period of 1982 to 2011 were obtained and analysed to create a wind climate model for the seasonal extremes. 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 westerly through northerly 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 northwesterly and westerly sectors. All wind speeds and directions were included in the wind climate model.

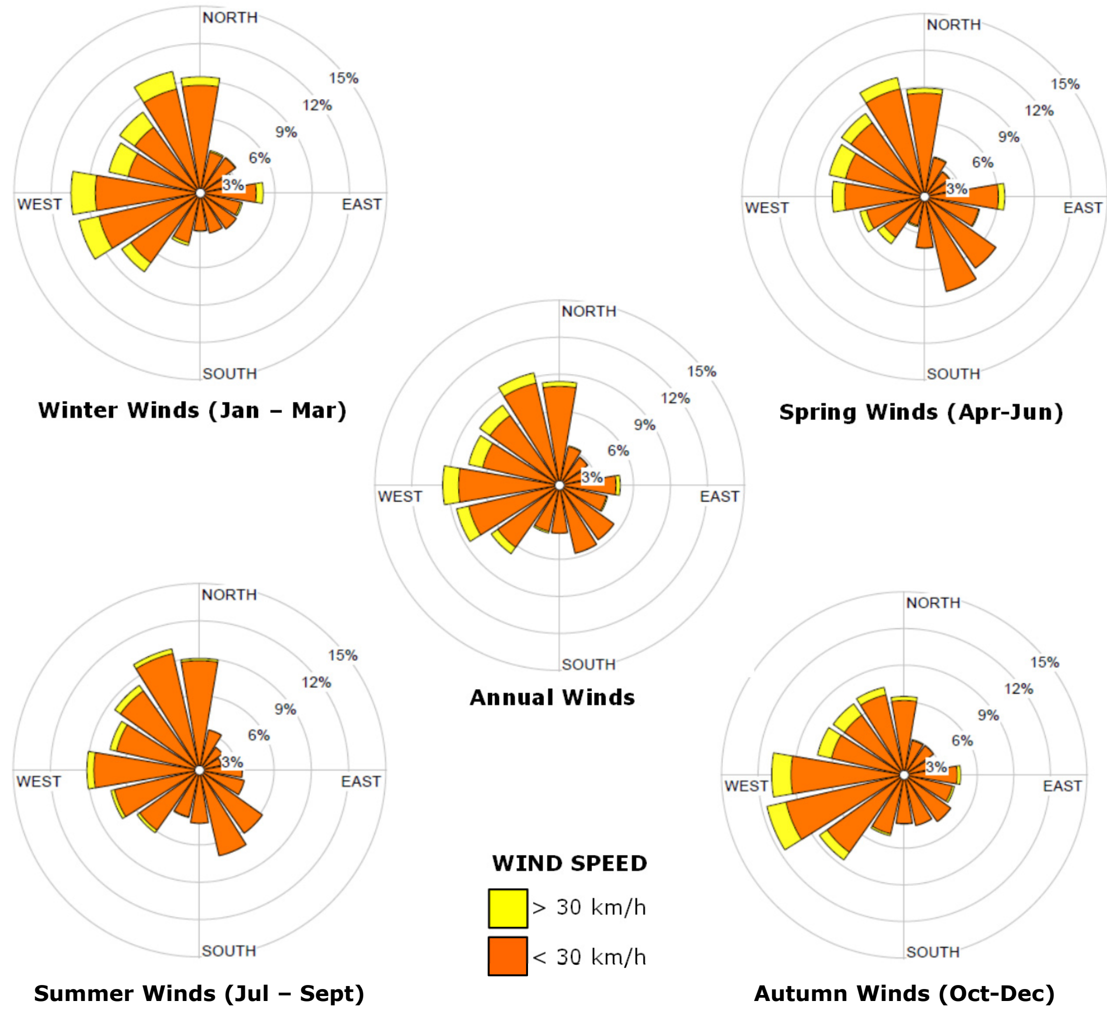

Figure 6: Wind Roses for Pearson International Airport (1982-2011)

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**. Very roughly, 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 0.1% of the time (approximately nine hours per year). When more than three, 3-hour events (nine hours a year) are predicted to exceed the Fair-Weather Area criterion on an annual basis, wind mitigation measures are then advised, especially for frequently accessed areas. The wind safety criterion is shown in **Table 2**.

The criteria for wind comfort and safety used in this assessment are based on those developed at the Boundary Layer Wind Tunnel Lab of the University of Western Ontario, together with building officials in London England. They are based broadly on the Beaufort Scale and on previous criteria that were originally developed by Davenport. The 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.

Table 1: Wind Comfort Criteria

Activity	Comfort Ranges for Mean Wind Speed Exceeded 5% of the Time		Description of Wind Effects
Sitting	0 to 14 km/h	0 to 4 m/s	• Light wind felt on face • Leaves rustle
Standing	0 to 22 km/h	0 to 6 m/s	• Hair is disturbed, clothing flaps • Light leaves and twigs in motion • Wind extends lightweight flag
Leisurely Walking	0 to 29 km/h	0 to 8 m/s	• Moderate, raises dust, loose paper • Hair disarranged • Small branches move
Fast Walking	0 to 36 km/h	0 to 10 m/s	• Force of wind felt on body • Trees in leaf begin to move • Limit of agreeable wind on land
Uncomfortable	> 36 km/h	> 10 m/s	• Small trees sway • Umbrella use becomes difficult

Table 2: Wind Safety Criterion

Activity	Safety Criterion Mean Wind Speed Exceeded 3 Times per Year (3x3hr)		Description of Wind Effects
Any [1]	72 km/h	20 m/s	• Difficult to walk straight • Wind noise on ears unpleasant

[1] Equivalent to the "Fair Weather Location" criterion of UWO's Criteria, which applies to frequently accessed areas.

4.0 PEDESTRIAN WIND RESULTS

Figures 7a through **10b** present graphical images of the wind comfort conditions for the summer and winter months around the site for the existing and proposed development conditions. 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.

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 public parks **sitting** and/or **standing** would be appropriate in the summer.

Wind conditions during the spring and autumn seasons are included in **Appendix A**.

4.1 Building Walkways & Entrances

In the Existing Configuration, wind conditions on the site were suitable for leisurely walking or better in the summer (**Figure 7a**). In the winter, wind conditions were rated for fast walking near the corners of buildings, but generally wind conditions were suitable for leisurely walking or better (**Figure 8a**).

In the Proposed Configuration, wind conditions were suitable for standing or sitting in the summer (**Figure 7b**). This includes the numerous entrances to the individual townhouses throughout the site (**Figure 4**), the retail entrances at the southwest corner of the site, and the numerous sidewalks throughout the development. At the main entrance to Towers C and D, wind conditions were conducive to sitting throughout the year.

During the winter, wind conditions throughout the development were generally suitable for leisurely walking or better (**Figure 8b**). The exception was along the street to the north of Tower D, where wind conditions were rated as suitable for fast walking in the winter. Wind conditions in this area of the site should be improved as the conceptual development design evolves.

To improve wind conditions at the northwest corner of the site (orange color in **Figure 8b**) consider including dense landscaping as part of the streetscape in this area, in order to disrupt the downwashing flows from the existing tower to the north. Also, the significant setback of Tower D from the north edge of the podium is a positive design influence on the wind conditions along this same street. We suggest maintaining this setback through the design process.

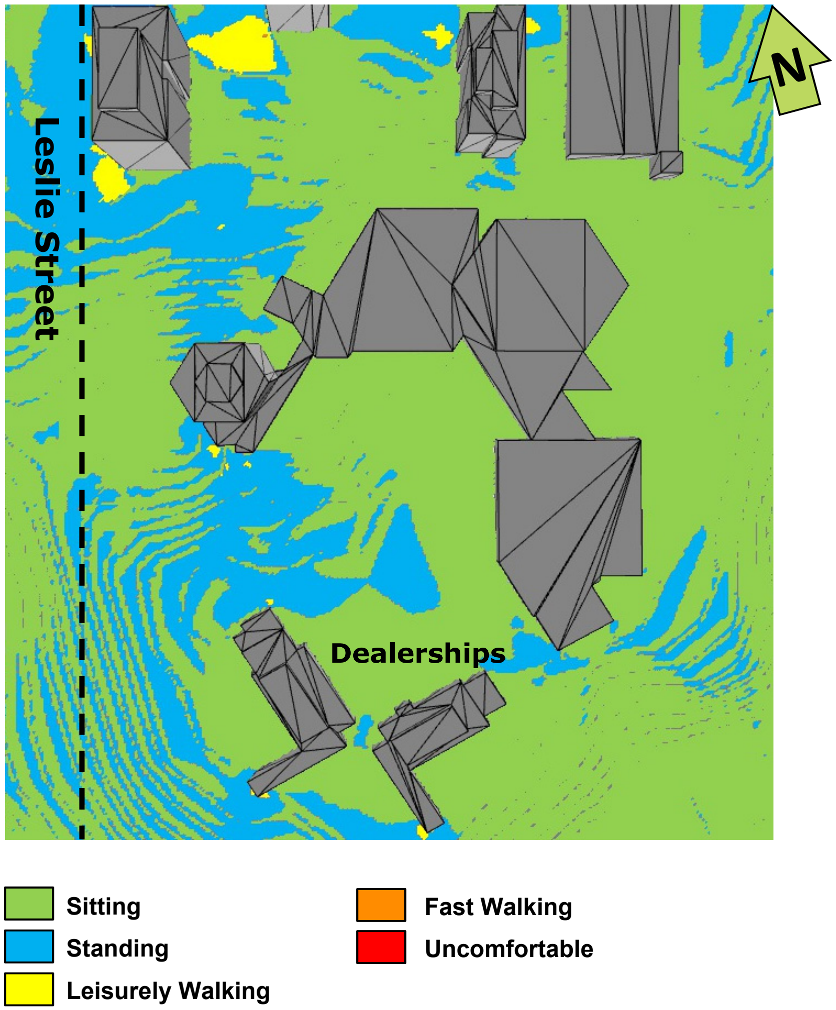

Figure 7a: Existing Configuration – Summer, Grade

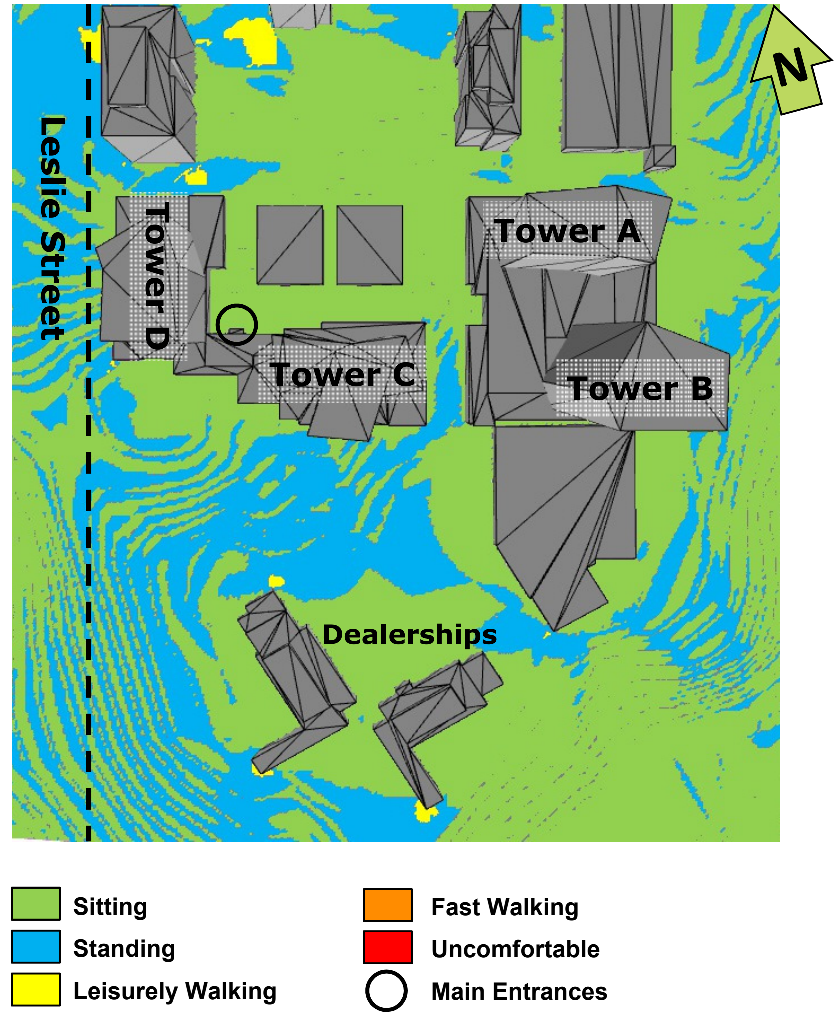

Figure 7b: Proposed Configuration – Summer, Grade

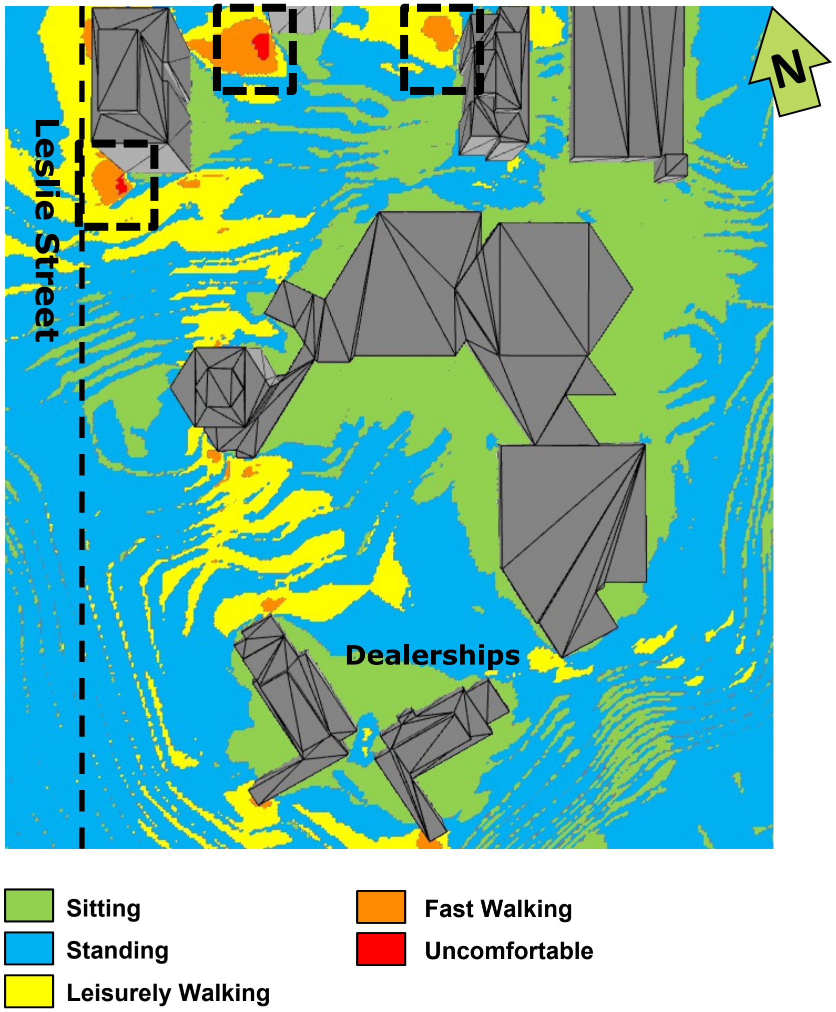

Figure 8a: Existing Configuration – Winter, Grade

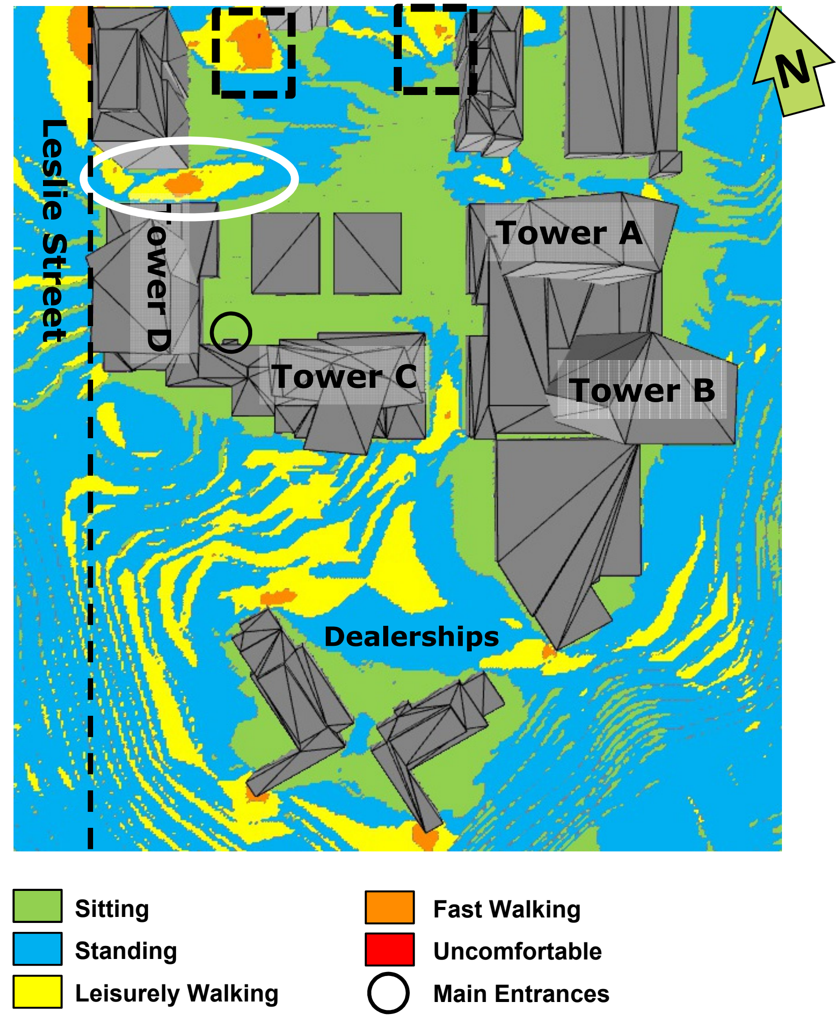

Figure 8b: Proposed Configuration – Winter, Grade

4.2 Leslie Street & Surroundings

Wind conditions along Leslie Street were generally suitable for leisurely walking or better throughout the year in the Existing Configuration (**Figures 7a** and **8a**). The exception was along the west side of the existing development to the north, where existing winds were rated as suitable for fast walking and/or uncomfortable in the winter. At the nearby transit stops (**Figure 4**) wind conditions were comfortable for leisurely walking or better in both the summer and winter seasons. Around the dealerships to the south, existing wind conditions were generally comfortable for leisurely walking throughout the year, with winds rated for fast walking occurred near the corners during the winter months (**Figure 8a**).

In the Proposed Configuration, wind conditions along Leslie Street were generally suitable for leisurely walking or better throughout the year (**Figures 7b** and **8b**). Wind conditions along the west side of the existing development to the north were rated suitable for fast walking in the winter, an improvement in comparison to the existing wind conditions. Additionally, wind conditions in some areas of the existing development to the north improved with the construction of the proposed development, as illustrated by the reduction in areas rated uncomfortable and/or suitable for fast walking (see boxes in **Figures 8a** and **8b**). At the nearby transit stops wind conditions remained suitable for leisurely walking or better in both the summer and winter months. Wind conditions around the dealerships were similar to those observed in the Existing Configuration.

As the wind conditions are similar between the Existing and Proposed Configurations, they are considered appropriate for the intended usage.

4.3 Outdoor Amenity Spaces

Wind conditions suitable for standing or sitting are typically desired for amenity spaces. Between the townhouses and the Block 2 podium is an outdoor amenity space at grade (**Figure 4**). Wind conditions in this area were rated as suitable for sitting throughout the year (**Figures 7b** and **8b**), which is considered ideal.

On the 2nd floor outdoor amenity space of Block 1 (immediately west of Tower C) wind conditions were comfortable for sitting or standing throughout the year (**Figures 9a** and **10a**), which suits the intended usage.

On the 3rd floor amenity space of Block 1, west of Tower B, wind conditions were conducive to sitting throughout the year (**Figures 9b** and **10b**), which is considered ideal.

On the 4th floor amenity space of Block 1, between Towers A and B (**Figure 9b**) wind conditions were suitable for leisurely walking or better in the summer. In the winter, wind conditions were generally suitable for leisurely walking or better, with the exception of the central portion where wind conditions were rated as uncomfortable and/or fast walking (**Figure 10b**). Summer winds in the amenity space can be enhanced through strategic placement of landscape elements during the future evolution of the project's landscape plan. Improved wind conditions in this area could be achieved through the inclusion of hard and soft architectural features such as trellises, canopies, dense landscaping, etc. and/or strategic layout of activities on the podium that take into account the wind conditions. These approaches should be considered prior to the Site Plan Application process.

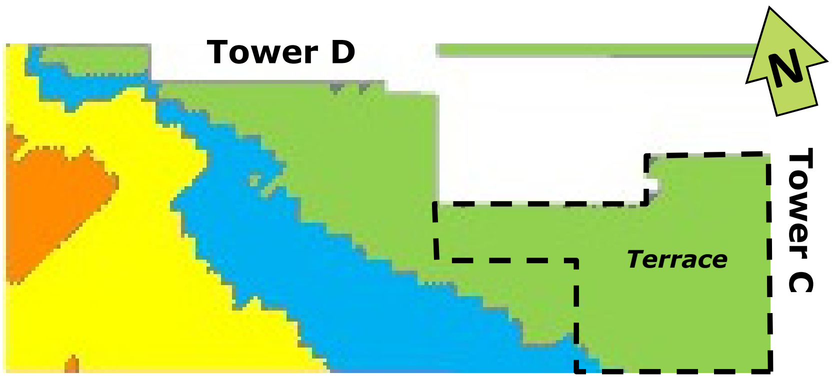

Figure 9a: Proposed Configuration – 2nd Floor, Summer

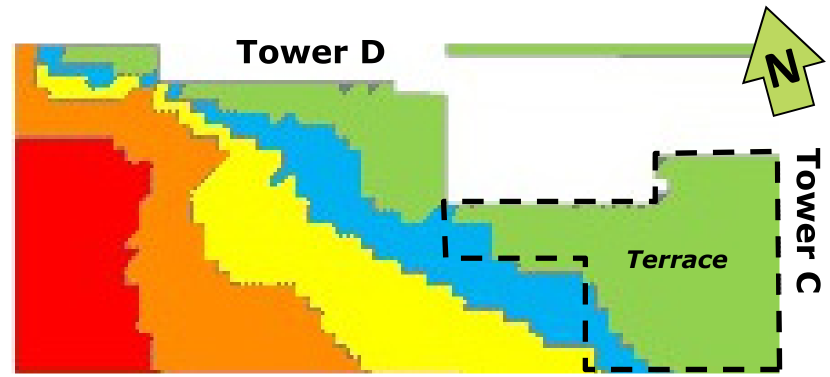

Figure 10a: Proposed Configuration – 2nd Floor, Winter

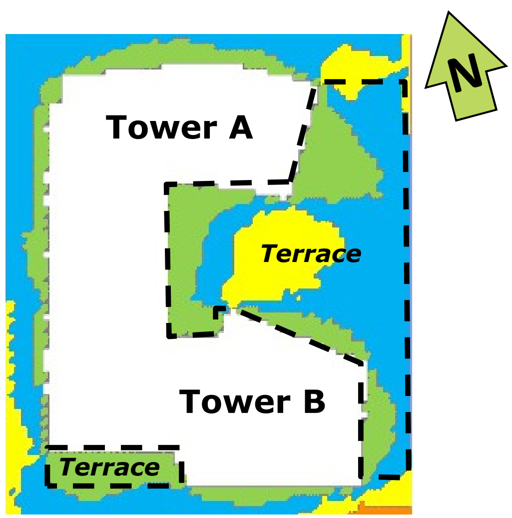

Figure 9b: Proposed Configuration – 4th Floor, Summer

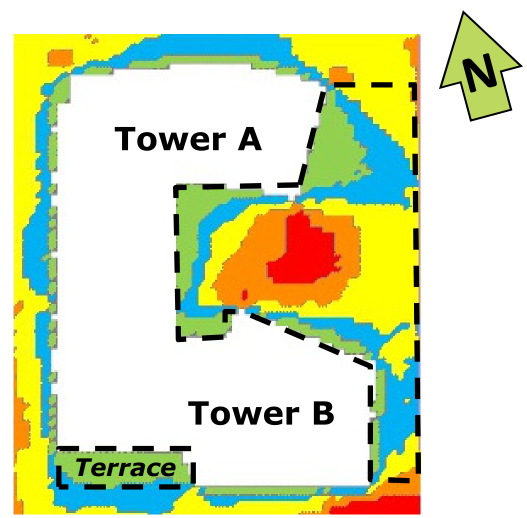

Figure 10b: Proposed Configuration – 4th Floor, Winter

4.4 Wind Safety

In the Existing Configuration, there were no wind safety issues predicted on the site at grade (**Appendix B**). In the Proposed Configuration, the wind safety criterion was met in all areas at grade on the proposed site.

The wind safety criterion was not met on the 4th floor amenity space of the Block 2 podium on an annual basis (**Figure 11**). We recommend the design team consider the wind control strategies previously described for this space.

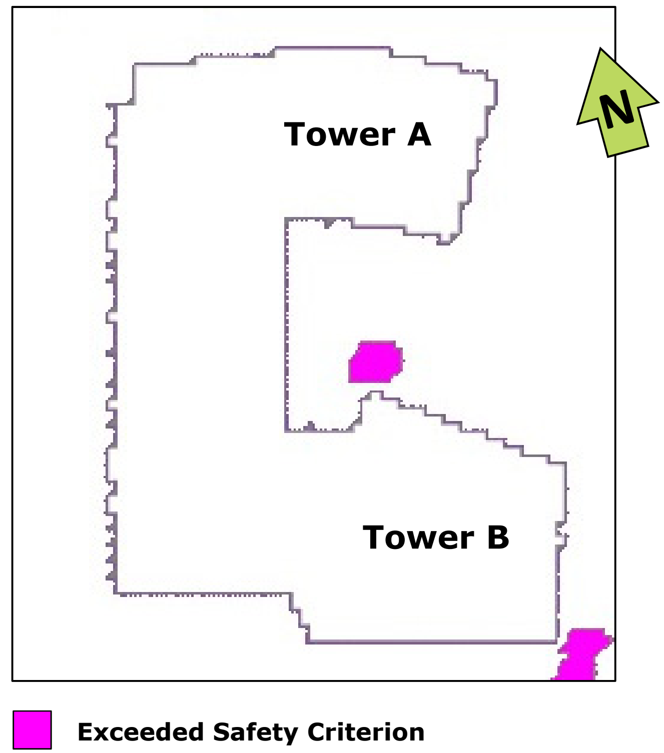

Figure 11: Proposed Configuration – Annual

5.0 CONCLUSIONS & RECOMMENDATIONS

The pedestrian wind conditions predicted for the Zoning By-law Amendment application of the proposed On the Park development in Toronto have been assessed through numerical modelling techniques. Based on the results of our assessment, the following conclusions and recommendations are presented:

- Wind conditions at the numerous entrances (main, retail, townhouse) were suitable for the intended usage throughout the year.
- Wind conditions around the proposed development were generally suitable for the intended usage at grade. For an area at the northwest corner of the site with increased wind activity, wind control measures have been suggested.
- All areas at grade, on the proposed development, passed the criterion for wind safety in both the Existing and Proposed Configurations.
- Wind safety issues occurred on the 4th floor amenity space of the Block 2 podium (between Towers A and B). Wind control features have been described for future consideration as the design evolves.
- For areas where concept guidance has been provided to address wind comfort or wind safety conditions, we recommend they be assessed through wind tunnel testing in the future during preparation for the site plan application process.

6.0 ASSESSMENT APPLICABILITY

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

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

Sincerely,
Novus Environmental Inc.

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

Bill Waechter, C.E.T.
Sr Specialist - Microclimate

7.0 REFERENCES

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Appendix A

Pedestrian Wind Comfort Analysis
Spring (April – June) and Autumn (October – December)

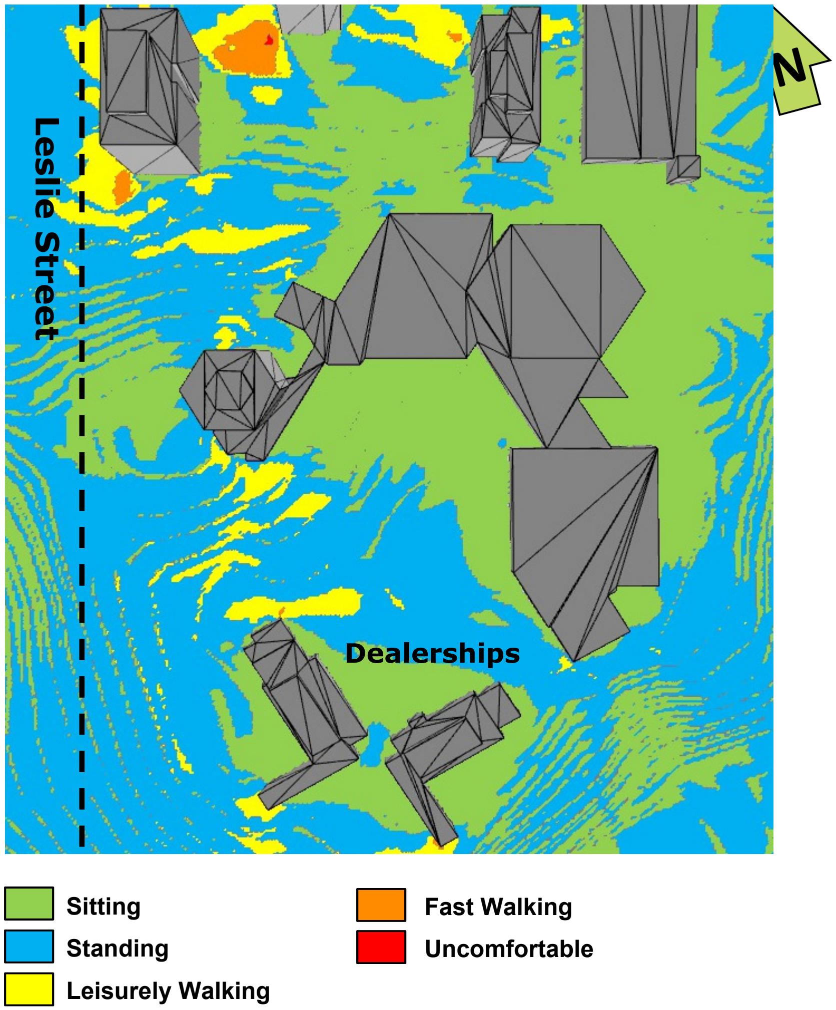

Figure A1a: Existing Configuration – Spring, Grade

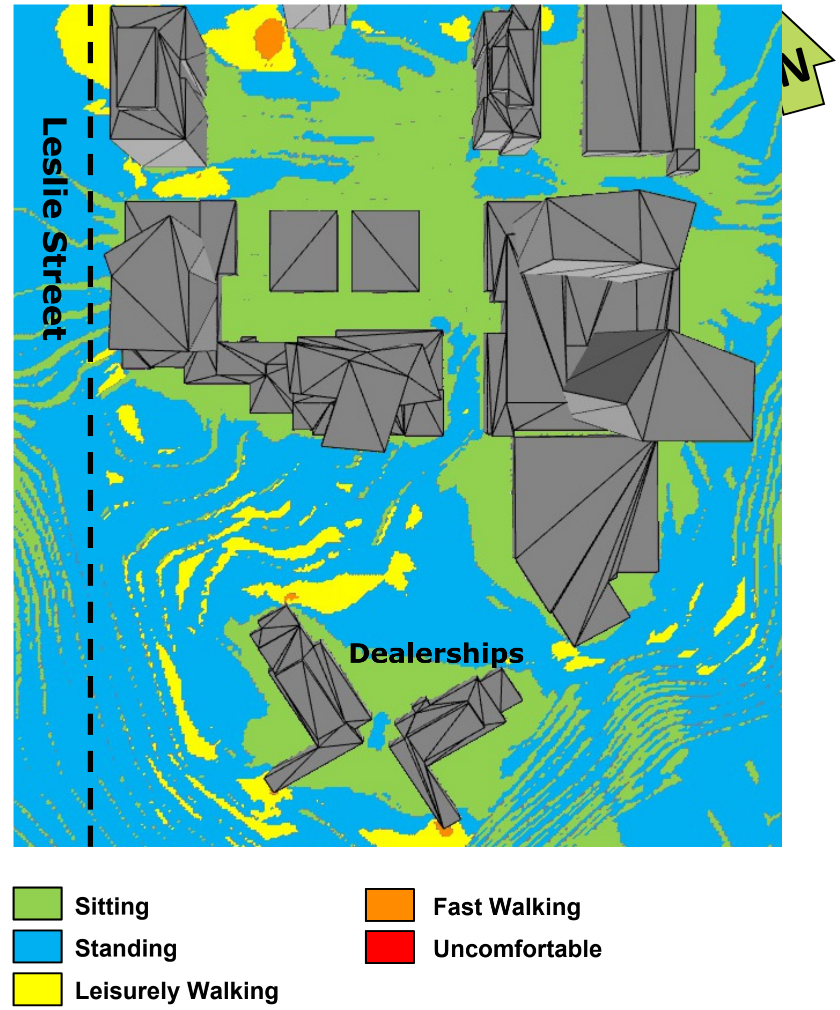

Figure A1b: Proposed Configuration – Spring, Grade

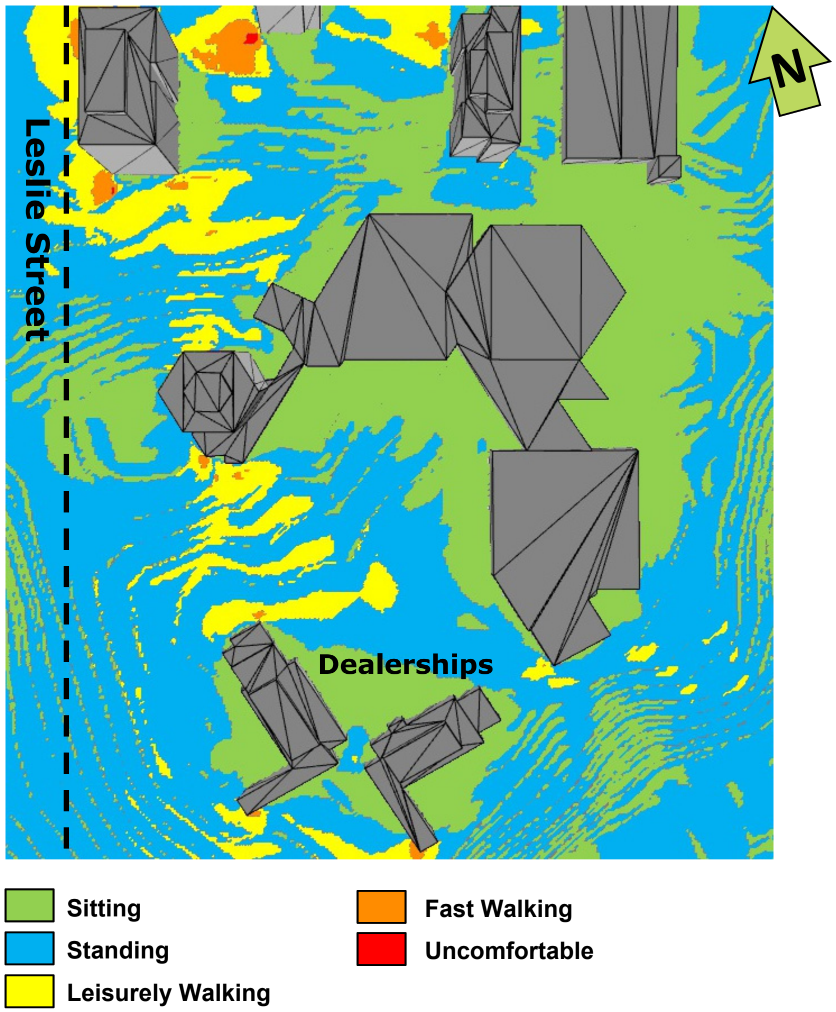

Figure A2a: Existing Configuration – Autumn, Grade

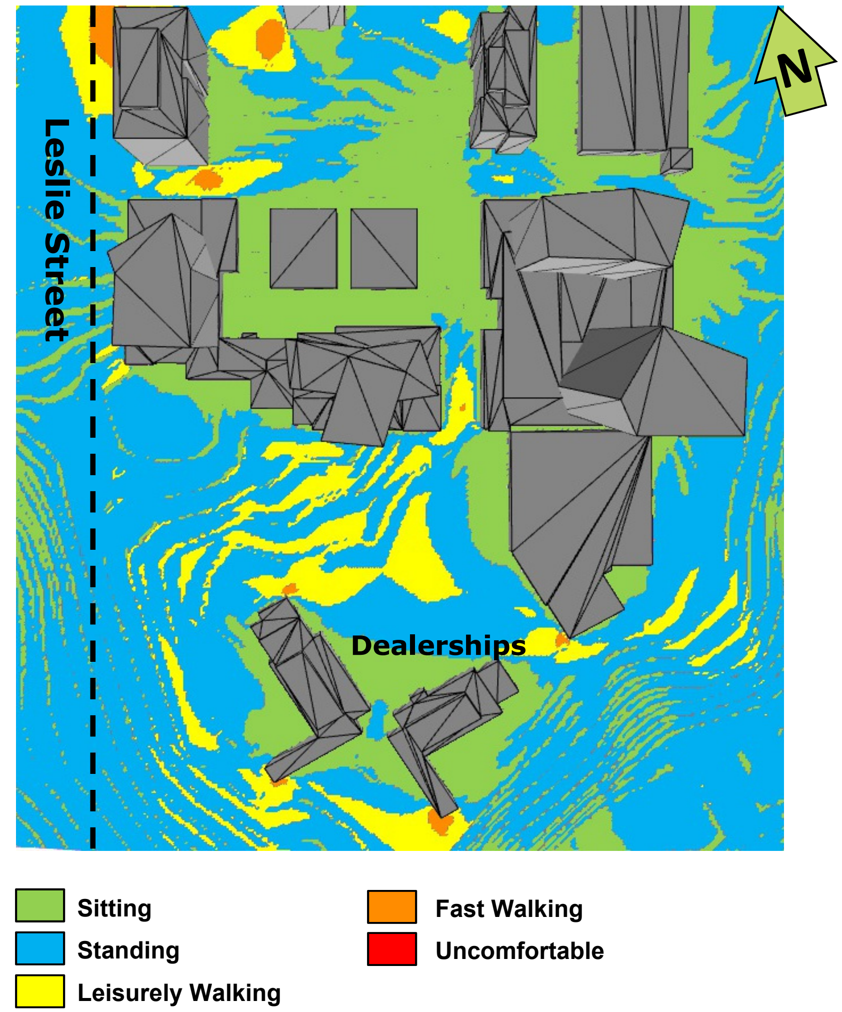

Figure A2b: Proposed Configuration – Autumn, Grade

Appendix B

Pedestrian Wind Safety Analysis
Annual

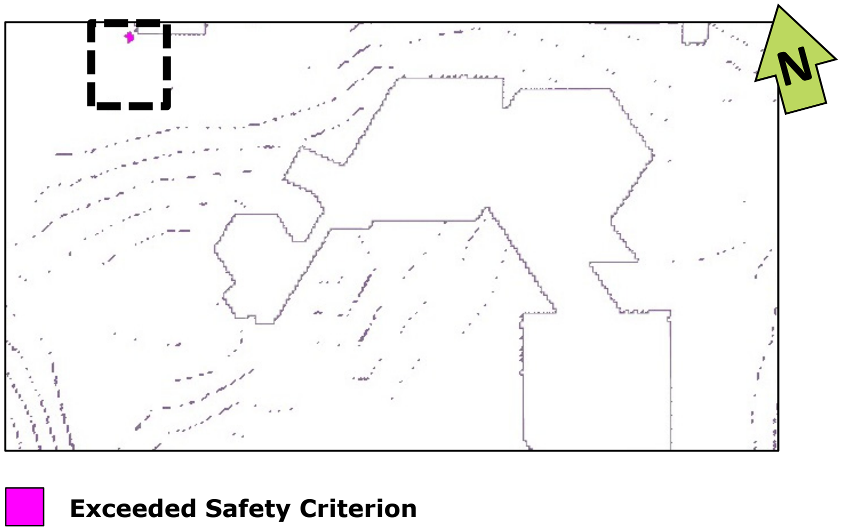

Figure B1a: Existing Configuration – Annual

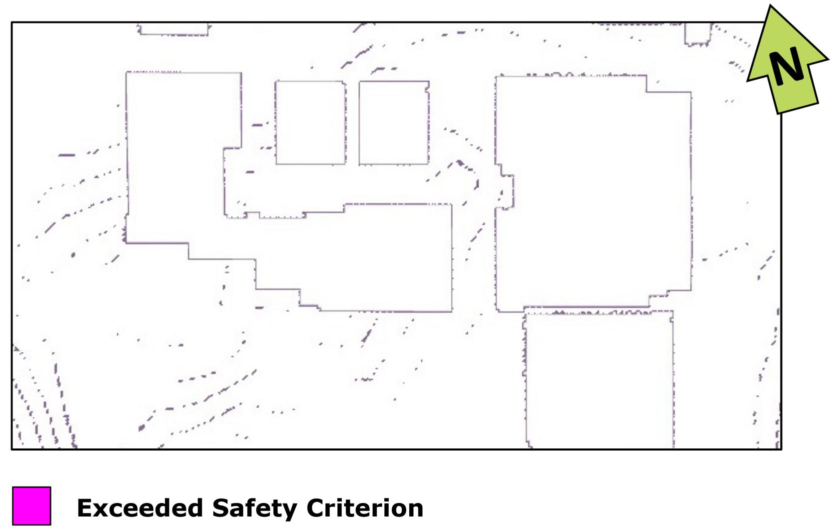

Figure B1b: Proposed Configuration – Annual