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07/03/19
PROVINCE OF ONTARIO

Date: March 7, 2019

To: 300 Bloor Street West LP
20 Eglinton Avenue West, Suite 1700
Toronto, Ontario

Re: **Pedestrian Wind Assessment**
300 Bloor Street West
Toronto, Ontario
Novus Project #17-0272

Novus Team:

Jenny Vesely, P.Eng. — Senior Engineer
Tahrana Lovlin, MAES, P.Eng. — Specialist

KPMB Architects

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Credit: KPMB Architects

1.0 INTRODUCTION

Novus Environmental Inc. (Novus) was retained by 300 Bloor Street West LP to conduct a pedestrian wind assessment for the proposed 300 Bloor Street West development in Toronto, Ontario. This report is in support of the Zoning Bylaw Amendment (ZBA) and Site Plan Control Application for the development.

1.1 Existing Development

The proposed development is located at 300 Bloor Street West, just west of Huron Street. The site is currently occupied by a parking lot and the Bloor Street United Church. **Figure 1** provides an aerial view of the immediate study area. A virtual site visit was conducted by Novus using Google Earth images dated July 2018; these images are included in **Figures 2a** through **2d**.

Immediately surrounding the site there are high rise buildings to the west and southeast, low and mid-rise residential to the northwest through northeast, and low-rise institutional buildings to the east, south and southwest. Beyond the immediate surroundings there is low-rise residential to the southwest through northwest to northeast, with a mixture of mid and high-rise commercial and residential buildings to the east through south.

Approved developments and developments under construction in the surrounding area were also included as existing surroundings for the analysis. For this assessment approved developments included:

- 316 Bloor Street West
- 56 Spadina Road
- 130 St George Street
- 368 Huron Street
- 9 Madison Avenue

Figure 1: Aerial view of existing site
Credit: GoogleEarth Pro™, dated May 7, 2018

Figure 2a: Looking northwest at existing site

Figure 2b: Looking west along Bloor Street West at site

Figure 2c: Looking south along Huron Street at site

Figure 2d: Looking east along Bloor Street West

1.2 Proposed Development

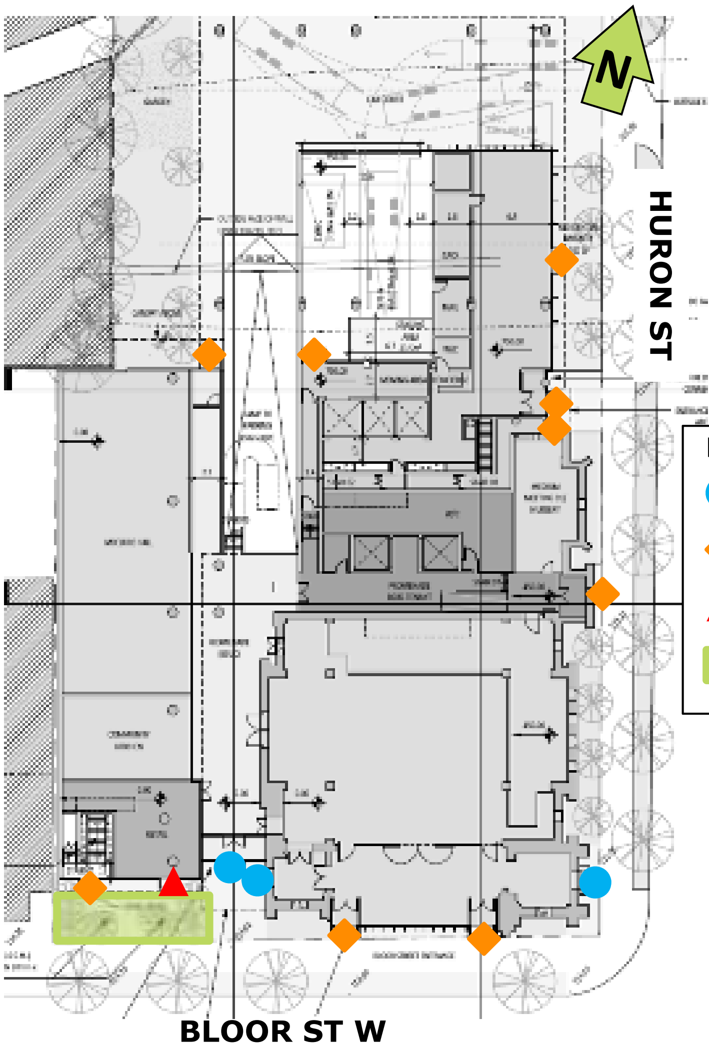
The proposed development is 30-storeys tall, plus a mechanical penthouse, for a total height of approximately 105m. The development will maintain the existing church, and add retail/office space to the west of the church (retail space on Level 1 and office space on Levels 1-4). The tower portion north of the church will include office space on Levels 1 through 3, with residential space above. There is an outdoor patio at grade, outside of the retail space, and an outdoor amenity space associated with the residential portion of the development on Levels 5 and 6. A rendering of the proposed development is shown in **Figure 3**.

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 no nearby transit stops for this particular development.

There are several main and secondary entrances to the building associated with the various uses (church, retail, office and residential). All entrances to the building are identified on **Figure 4a**. The grade level patio and Levels 5 and 6 outdoor amenity spaces are shown on **Figures 4a** and **4b**.

Figure 3: Rendering of Proposed Development
Credit: KPMB Architects



LEGEND

- Main Entrance
- Secondary Entrance/Exit
- Retail Entrance
- Outdoor Amenity Space

Figure 4a: Areas of Interest – Grade Level

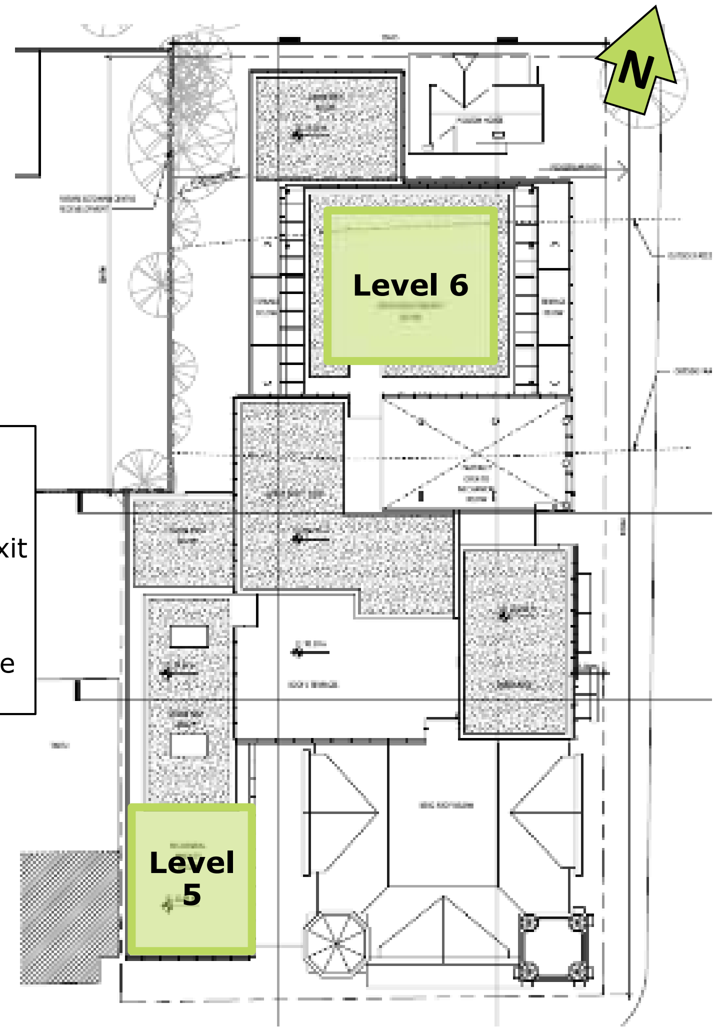


Figure 4b: Areas of Interest – Above-Grade

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 KPBM Architects on October 26, 2018. A view of the 3D model used in the computer wind comfort analysis is shown in **Figure 5**. Updated drawings were received November 9, 2018; these drawings show minor differences in overall massing, therefore, the results of this study remain applicable to the updated drawing set. The 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 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

2.3 Wind Climate

Wind data recorded at Pearson International Airport in Toronto 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 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.

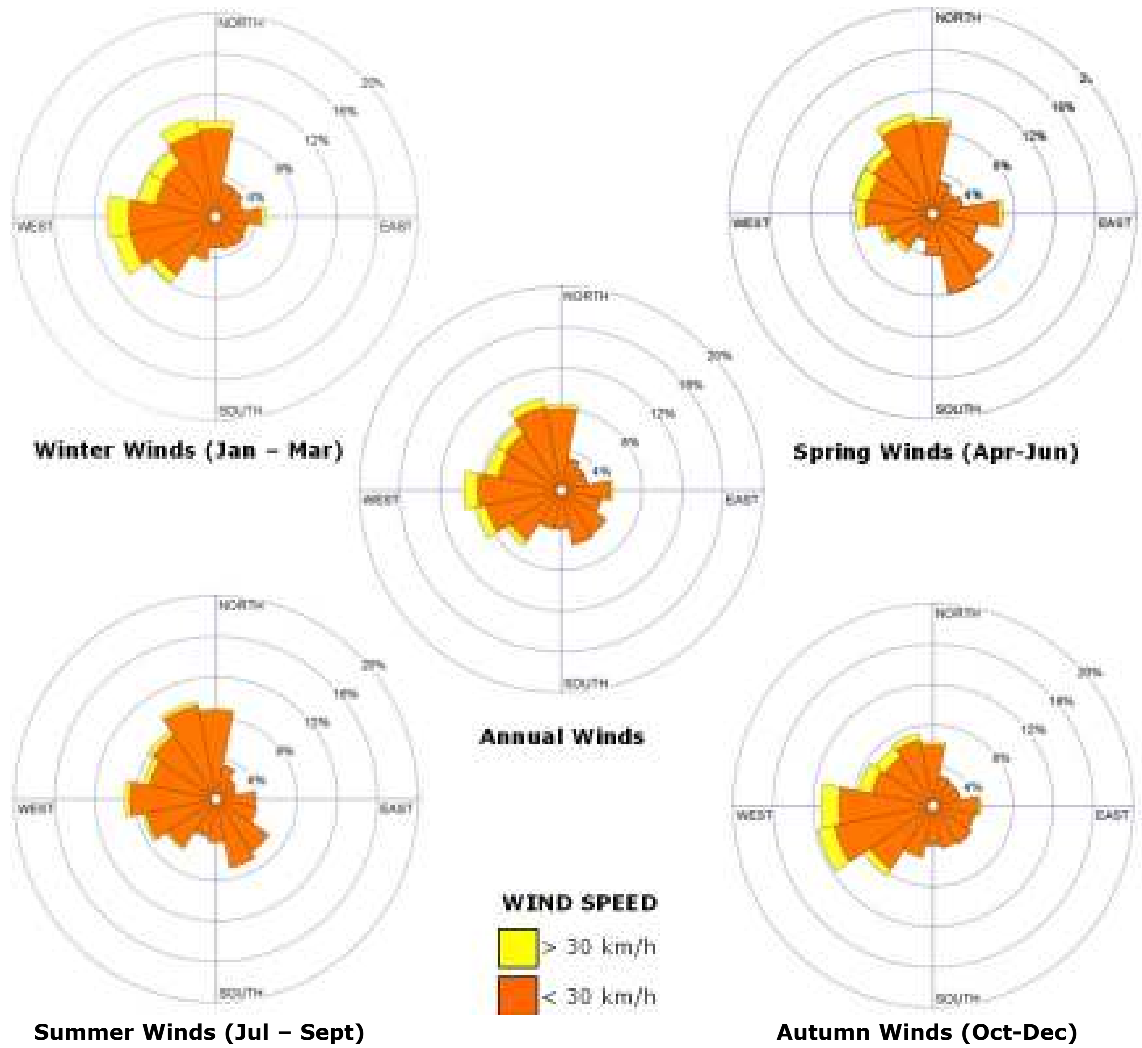


Figure 6: Wind Roses for Pearson International Airport (1986-2015)

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**. 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 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. 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 Once Per Year (0.01%)		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 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.

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.

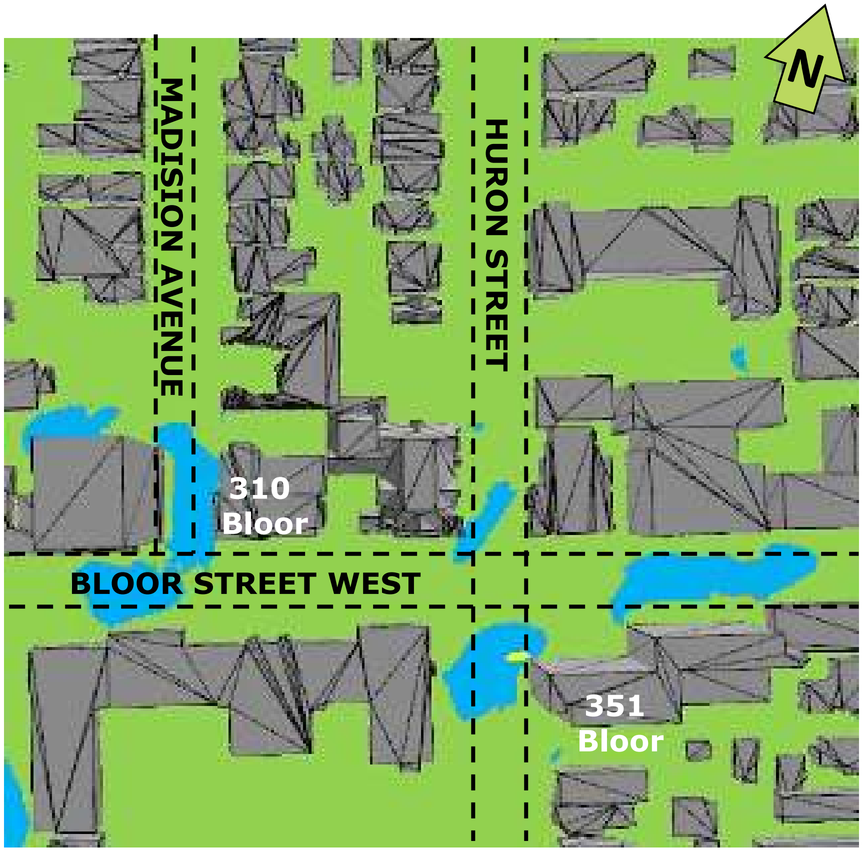
4.1 Existing Wind Conditions

In the Existing Configuration, wind conditions on the proposed site are generally comfortable for sitting or standing throughout the year (**Figures 7a** and **8a**). The exception is at the southeast corner of the existing church, where wind conditions are comfortable for leisurely walking during the winter (**Figure 8a**). On the sidewalks surrounding the proposed site, including Bloor Street West, Huron Street and Madison Avenue, wind conditions are generally comfortable for leisurely walking or better (**Figures 7a** and **8a**). The exception is on Huron Street, at the northwest corner of 351 Bloor Street West where wind conditions are conducive to fast walking during the winter.

4.2 Building Entrances & Walkways

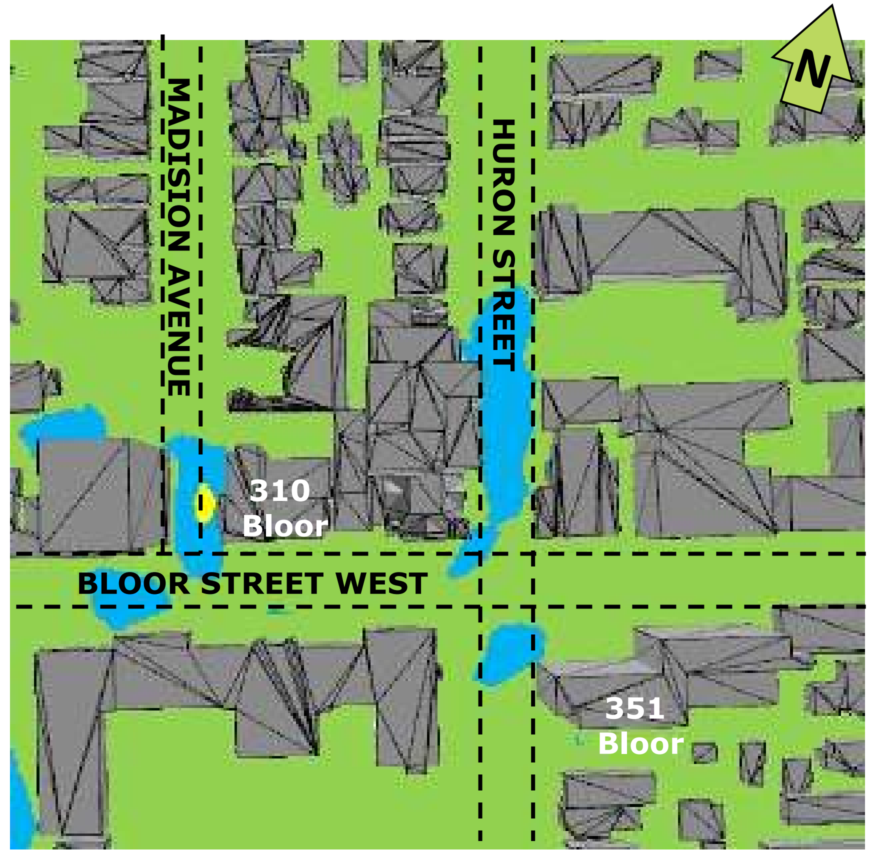
At all main entrances to the church, commercial and residential spaces, as well as the retail entrance and numerous secondary entrances, wind conditions are comfortable for sitting or standing throughout the year (**Figures 9a** and **9b**). These wind conditions are considered ideal for entrances. At the retail patio on Bloor Street West, wind conditions are comfortable for sitting throughout the year, which is considered ideal (**Figures 9a** and **9b**).

On the walkways surrounding the proposed building, wind conditions are generally comfortable for leisurely walking or better throughout the year (**Figures 9a and 9b**). The exception is at the northeast corner of the proposed development, where wind conditions are conducive to fast walking in a small area during the winter. These accelerated wind flows are due to the downwashing of northwesterly winds around the tower, towards grade-level.



Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

Figure 7a: Existing Conditions – Grade Level – Summer



Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

Figure 7b: Proposed Conditions – Grade Level – Summer

Figure 8a: Existing Conditions – Grade Level – Winter

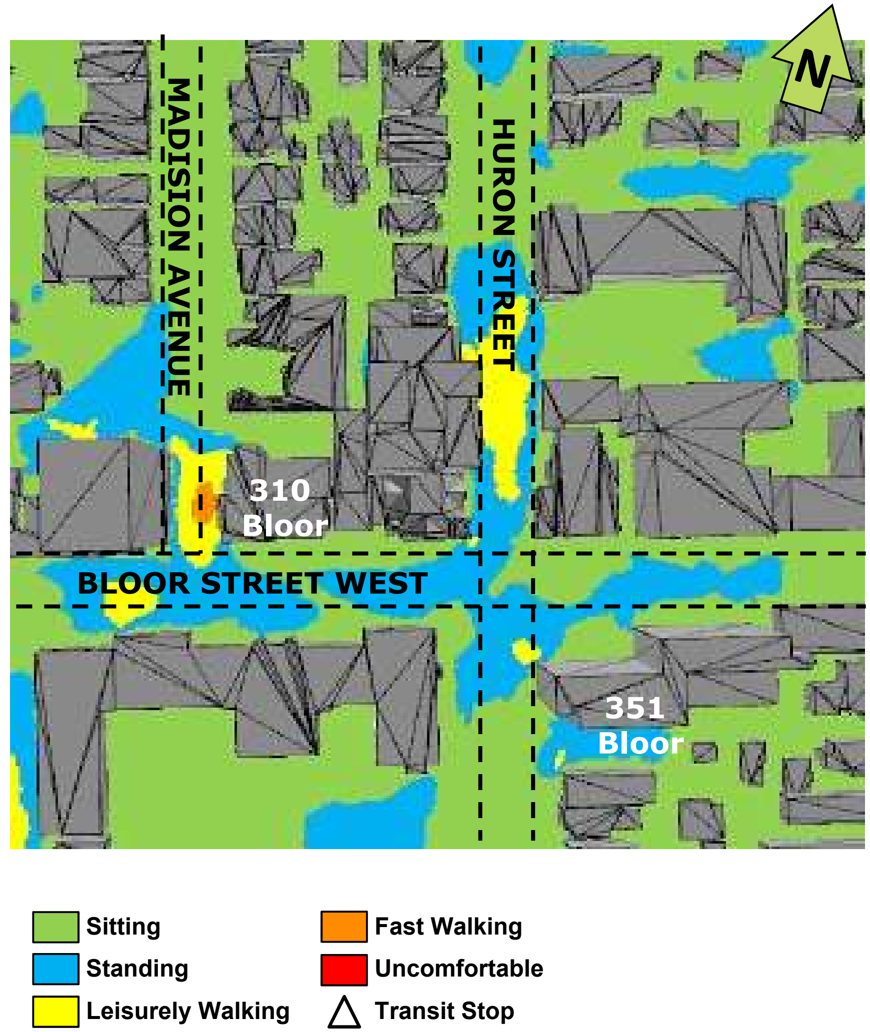


Figure 8b: Proposed Conditions – Grade Level – Winter

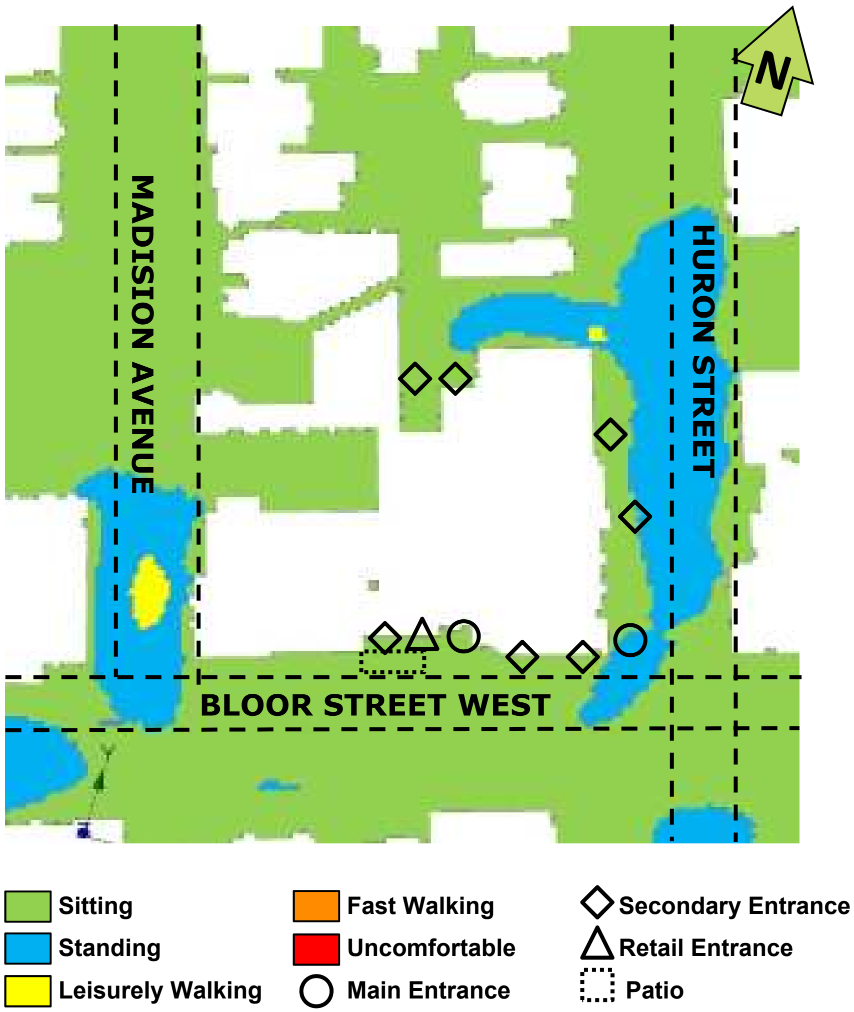


Figure 9a: Proposed Conditions – Grade Level – Summer

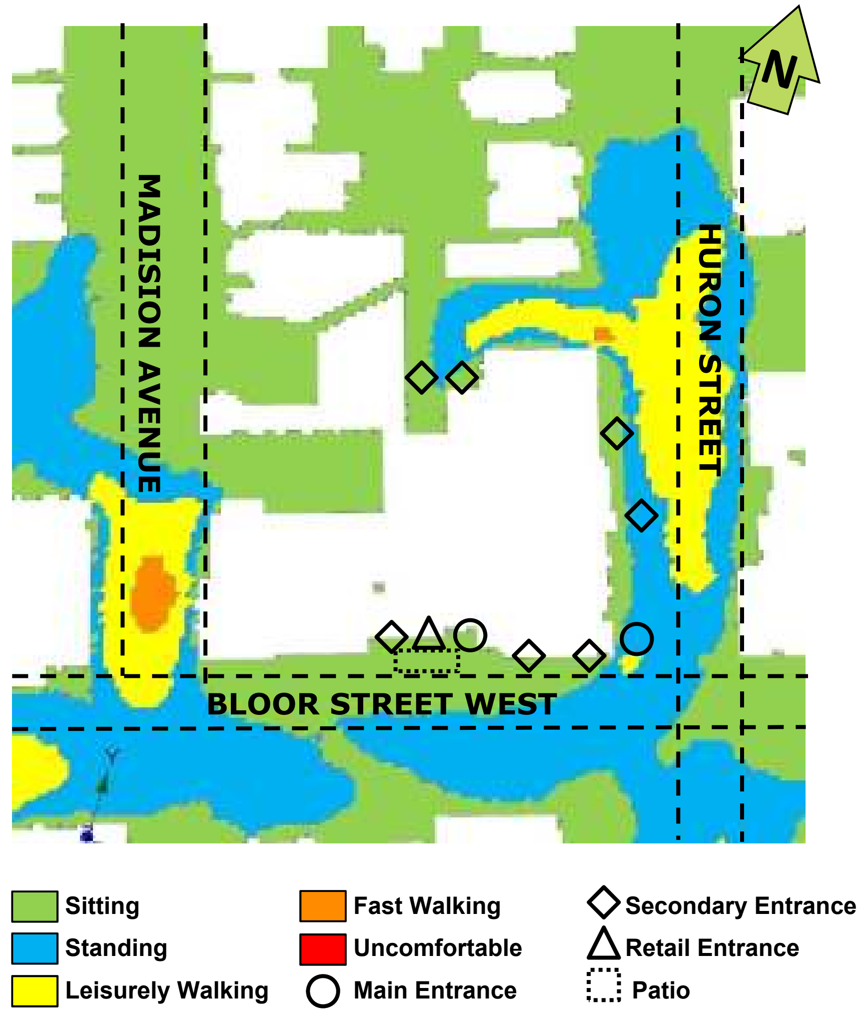


Figure 9b: Proposed Conditions – Grade Level – Winter

Although these strong wind flows are common in downtown Toronto, particularly at the corners of tall buildings, we still recommend including mitigation to disrupt these wind flows. We recommend marcescent trees be added to the landscaping plan at the northeast corner of the building to provide a disruption to the northwesterly wind flows during the winter season. We will work with the landscape architect as the design progresses to incorporate appropriate landscaping into the design.

4.3 Amenity Terraces

The Level 5 amenity terrace is located at the southeast corner of the building. Here, wind conditions are generally comfortable for sitting or standing throughout the year (**Figures 10a** and **10b**). The exception is at the northwest corner of the space, where wind conditions are conducive to leisurely walking in the summer, and considered uncomfortable or suited for leisurely and/or fast walking in the winter. These strong wind flows are due to the downwashing of the prevailing northwesterly winds off the nearby 310 Bloor Street West building. To improve wind conditions, we recommend including a vertical wind screen along the north and west edges of the spaces, at this corner, as well as a horizontal trellis over the corner area to provide local protection. We recommend the trellis and vertical screen connect.

On the Level 6 amenity space north of the tower, wind conditions during the summer are generally comfortable standing or leisurely walking (**Figure 10a**). At the east edge of the space, wind conditions are comfortable for fast walking. During the winter, wind conditions are generally comfortable for leisurely and/or fast walking (**Figure 10b**). Uncomfortable wind conditions also occur along the east edge of the terrace. Accelerated wind flows on this

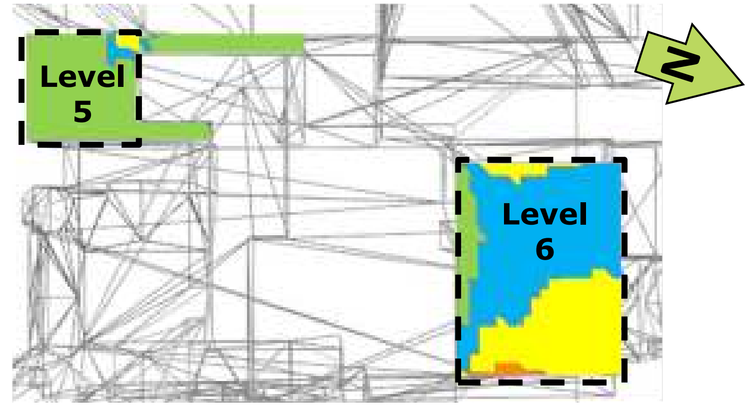


Figure 10a: Wind Conditions on Level 5 and 6 Terraces Proposed – Summer

Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable

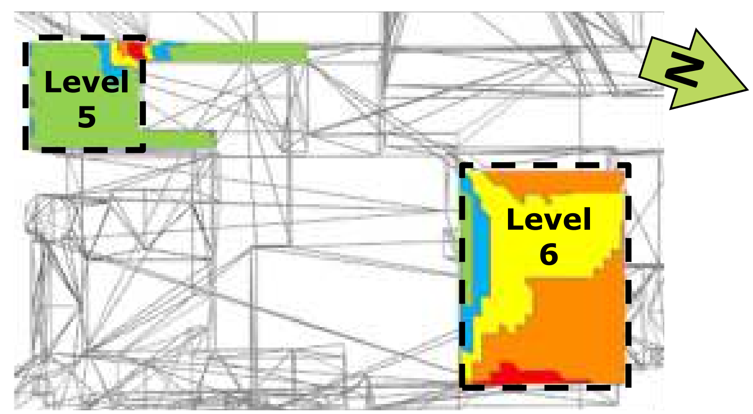


Figure 10b: Wind Conditions on Level 5 and 6 Terraces Proposed – Winter

terrace are due to downwashing of north and northwesterly winds as well as overall exposure of the terrace to the strong wind flows found at higher elevations. To improve wind conditions on the Level 6 terrace, we recommend including a semi-porous wind screen around the perimeter of the terrace, to disrupt horizontal wind flows from the prevailing winds. In addition, we recommend including a canopy along the north facade of the tower, as well as trellises above seating areas, to disrupt the vertical wind flows.

4.4 Surrounding Sidewalks

On the sidewalks surrounding the proposed development, including Bloor Street West, Huron Street and Madison Avenue, wind conditions are generally conducive to leisurely walking or better throughout the year (**Figures 7b** and **8b**). The exception is on Madison Avenue, in front of the 310 Bloor Street Building, where wind conditions are comfortable for fast walking in the winter. These wind conditions occur mainly on the road, not the sidewalk (**Figure 9b**). Wind conditions suitable for fast walking are common in downtown Toronto during the winter season.

4.5 Wind Safety

The wind safety criterion is met at grade-level in both the Existing and Proposed Configurations (**Appendix B**).

However, on the Level 6 amenity terrace, the safety criterion is not met at the east edge of the terrace (**Figure 11**). The wind mitigation previously described for the terrace will aid in addressing the safety concern. Management could also consider limiting access to the terrace during the winter season, when wind flows are typically stronger.

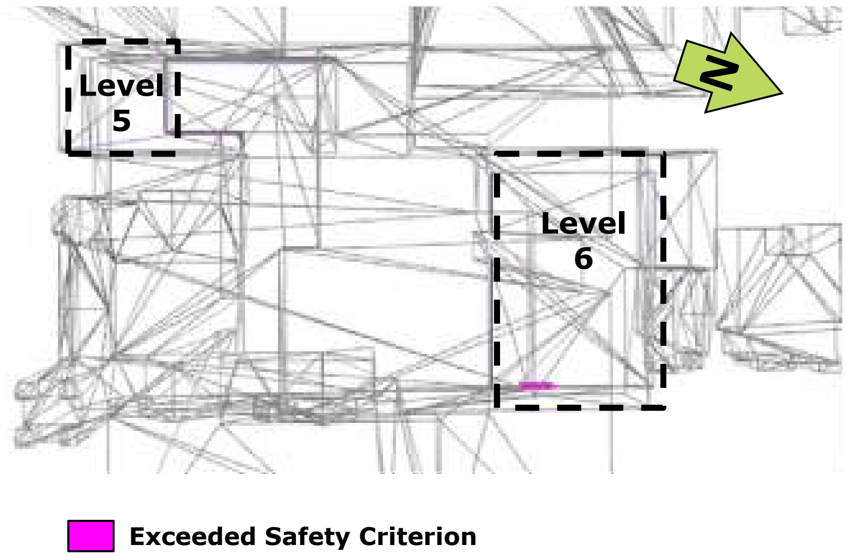


Figure 11: Wind Safety – Proposed Configuration – Level 9 Terrace – Annual

5.0 UPDATED ARCHITECTURAL INFORMATION

Updated architectural and landscape drawings were received on February 25, 2019. The following differences were noted between this information and the information used to construct the 3D computer model in November 2018:

- The overall height of the development has been decreased. Previously, the development was 30 storeys tall, with a height (top of mechanical penthouse) of approximately 105m. The latest drawings show the development is 29 storeys tall, with a height (top of mechanical penthouse) of approximately 104m.
- The floor plates for on all levels have been adjusted slightly, within less than a few metres.
- The east facade of the tower now has a roughness to it, rather than the previous smooth facade.
- The tower now cantilevers outwards along the east facade at Level 7, rather than Level 8 as previously.

From a wind perspective, none of these changes are significant enough to influence the wind conditions around the building. Therefore, the pedestrian wind comfort analysis presented in this report remains applicable.

6.0 CONCLUSIONS & RECOMMENDATIONS

The pedestrian wind conditions predicted for the proposed development at 300 Bloor Street West in Toronto have been assessed through numerical modeling techniques. Based on the results of our assessment, the following conclusions have been reached:

- The wind safety criterion is met in all areas at grade.
- The wind safety criterion is not met on the Level 6 terrace. Mitigation measures have been recommended. We will work with the design team prior to SPA to ensure appropriate features have been incorporated.
- Wind conditions at all entrances to the proposed building are suitable for the intended usage throughout the year.
- Wind conditions on the sidewalks surrounding the proposed development are suitable for the intended usage.
- Wind conditions on the Levels 5 and 6 terraces are generally suitable for the intended usage; mitigation measures are described.
- To determine the efficacy of the mitigation described herein, additional testing would be required.

7.0 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 Novus.

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

Sincerely,
Novus Environmental Inc.

Jenny Vesely, P. Eng. Senior Engineer – Microclimate	Tahrana Lovlin, MAES, P.Eng. Specialist - Microclimate

8.0 REFERENCES

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Appendix A

Pedestrian Wind Comfort Analysis

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

Figure A1a: Existing Configuration – Grade – Spring

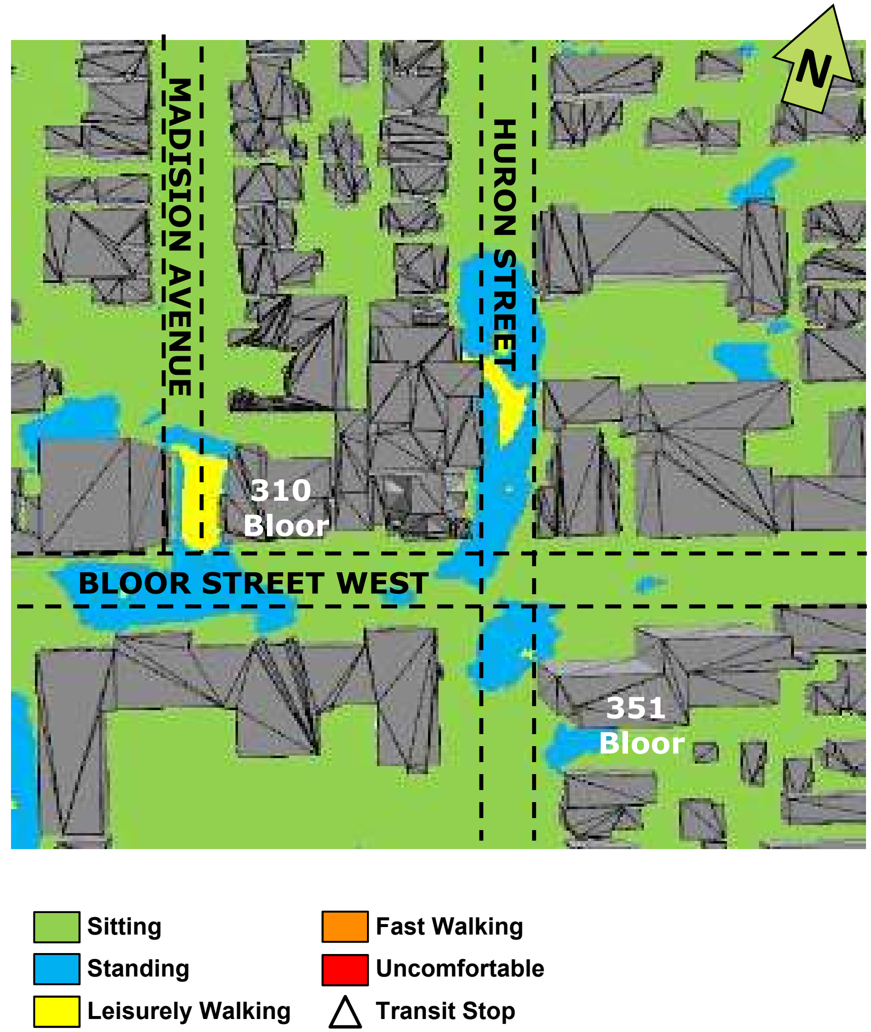
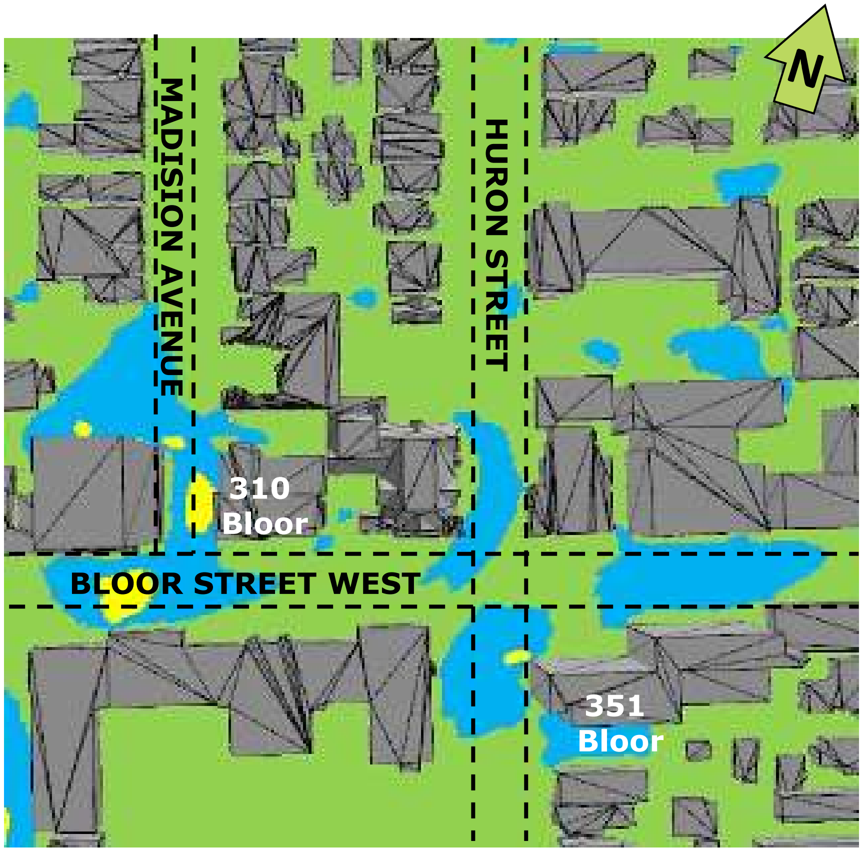
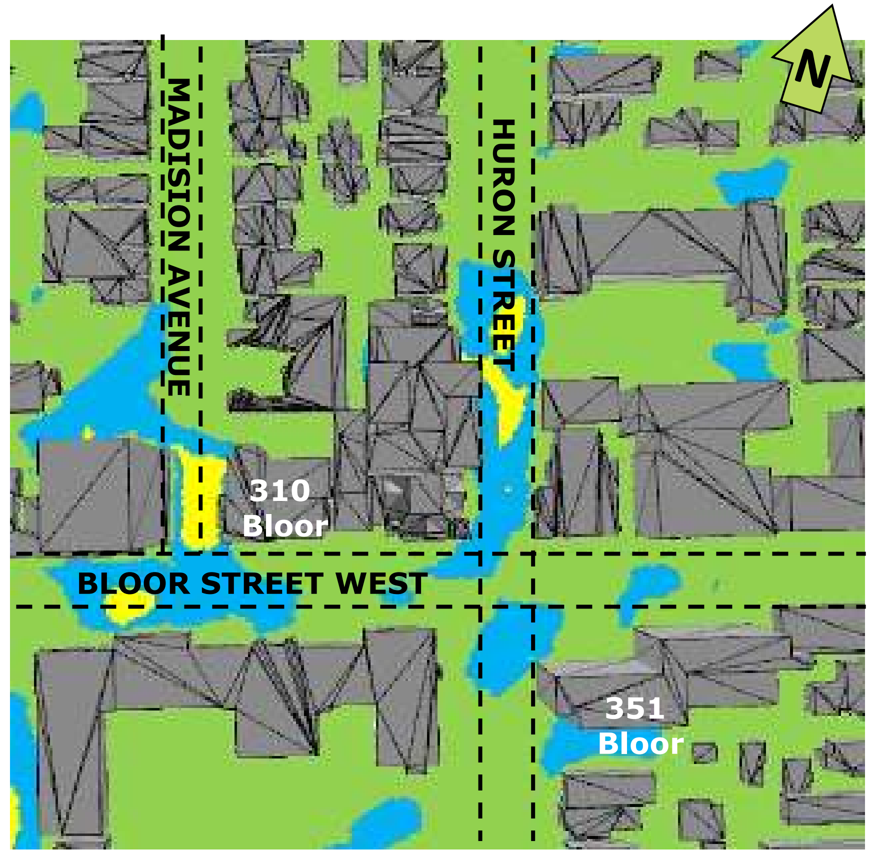


Figure A1b: Proposed Configuration – Grade – Spring



- Sitting
- Standing
- Leisurely Walking
- Fast Walking
- Uncomfortable
- △ Transit Stop

Figure A2a: Existing Configuration – Grade – Autumn



- Sitting
- Standing
- Leisurely Walking
- Fast Walking
- Uncomfortable
- △ Transit Stop

Figure A2b: Proposed Configuration – Grade – Autumn

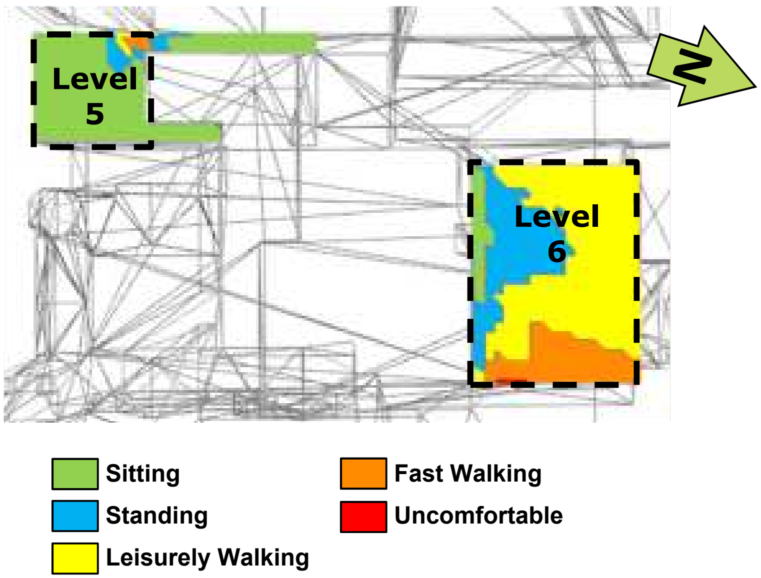


Figure A3a: Wind Conditions on Level 5 and 6 Terraces Proposed – Spring

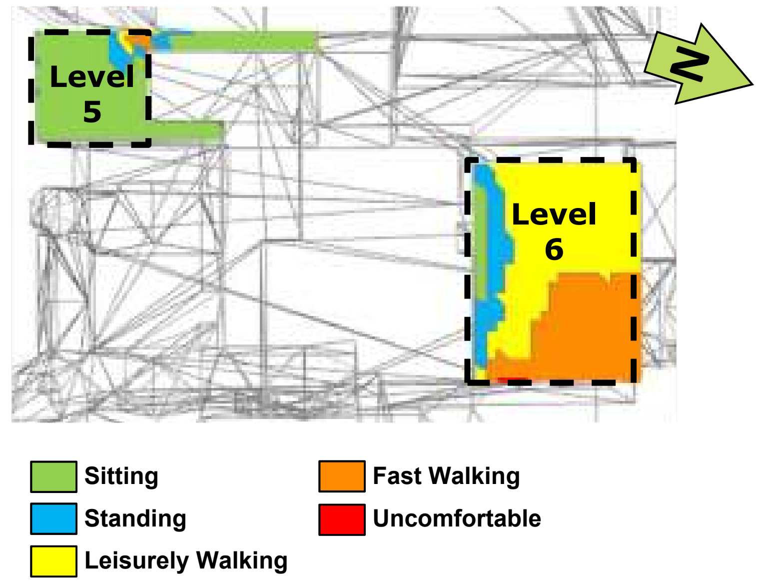


Figure A3b: Wind Conditions on Level 5 and 6 Terraces Proposed – Autumn

Appendix B

Pedestrian Wind Safety Analysis

Grade Level

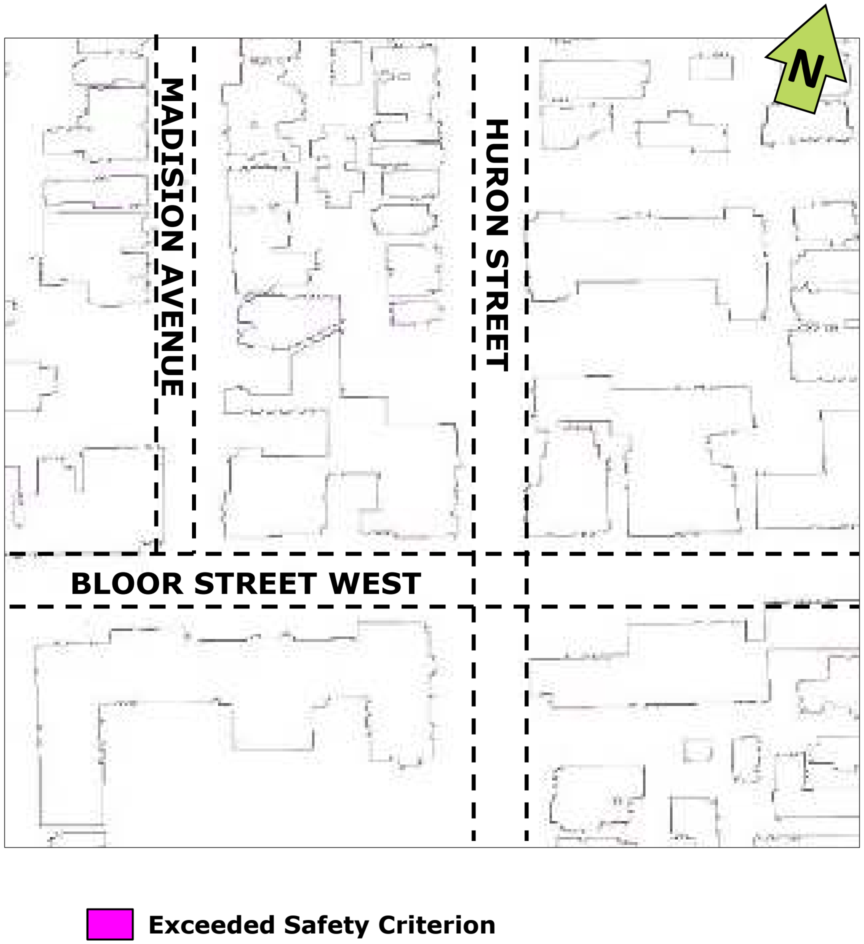


Figure B1a: Wind Safety – Existing Configuration – Grade Level– Annual

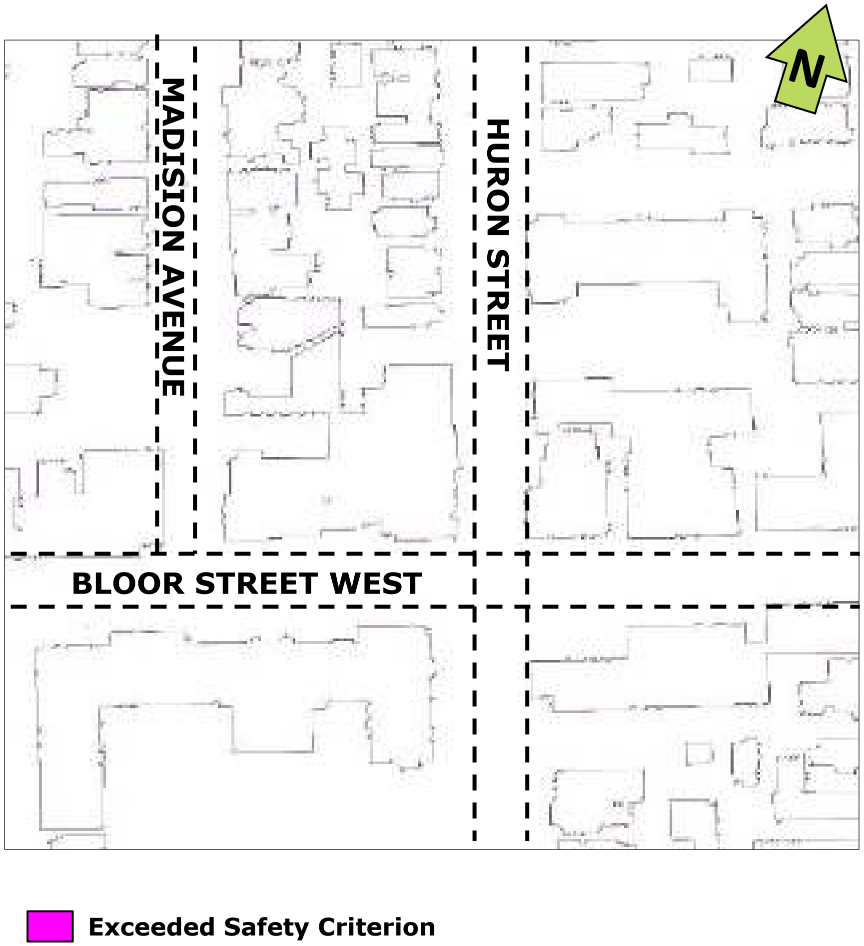


Figure B1b: Wind Safety – Proposed Configuration – Grade Level – Annual