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LICENSED PROFESSIONAL ENGINEER
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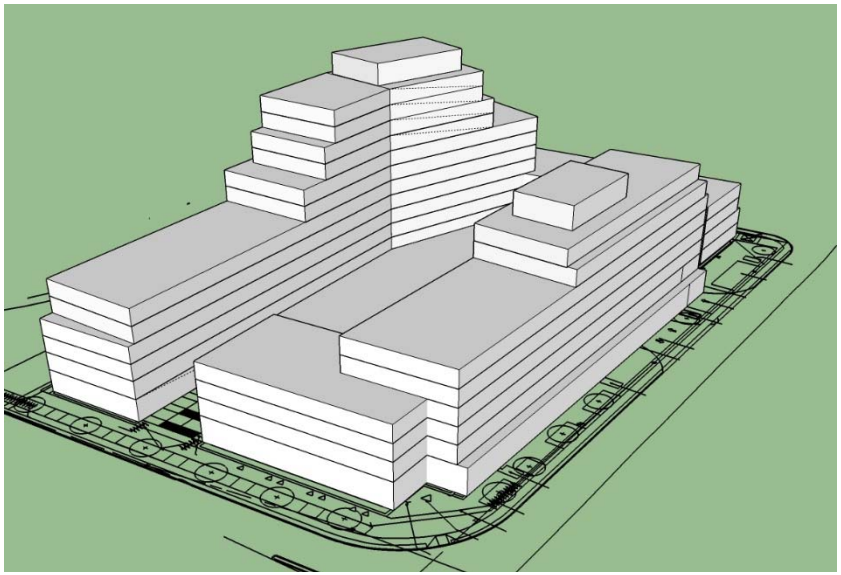
03/05/18
PROVINCE OF ONTARIO

Date: May 3, 2018

To: Vandyk Group of Companies
1944 Fowler Drive
Mississauga, ON L5K 0A1

Re: **Pedestrian Wind Assessment**
1345 Lakeshore Road East
Mississauga, Ontario
Novus Project #17-0355



Kohn Partnership Architects Inc.

Novus Team:

Sr. Engineer:	Jenny Vesely, P.Eng.
Specialist:	Tahrana Lovlin, MAES, P.Eng.

TABLE OF CONTENTS

1.0 INTRODUCTION

Novus Environmental Inc. (Novus) was retained by the Vandyk Group of Companies to conduct a pedestrian wind assessment for the proposed development at 1345 Lakeshore Road East in Mississauga, Ontario. This report is in support the Official Plan Amendment (OPA) and Zoning By-law Amendment (ZBA) applications for the development.

1.1 Existing Development

The proposed development is located at 1345 Lakeshore Road East, just west of Dixie Road. The site is currently occupied by a low-rise commercial building. **Figure 1** provides an aerial view of the immediate study area. A virtual site visit was conducted by Novus using Google Earth Pro™ images dated June 2014 and May 2017; these images are included in **Figures 2a** through **2d**.

Immediately surrounding the site are low-rise residential buildings to the west through north, low-rise commercial building to the northeast and southeast, an empty lot to the east, a park to the south, and a mid-rise residential building to the southwest. Beyond the immediate surroundings there is the Toronto Golf Course with low-rise residential beyond to the northwest; low-rise residential buildings to the west, north and northeast; parkland and Lake Ontario to the east and southeast; and, low-rise industrial and commercial to the south and southwest, with Lake Ontario beyond.

Approved developments and developments under construction in the surrounding area were also included as existing surroundings for the analysis. For this assessment no approved developments or developments under construction were found in a 500m radius.

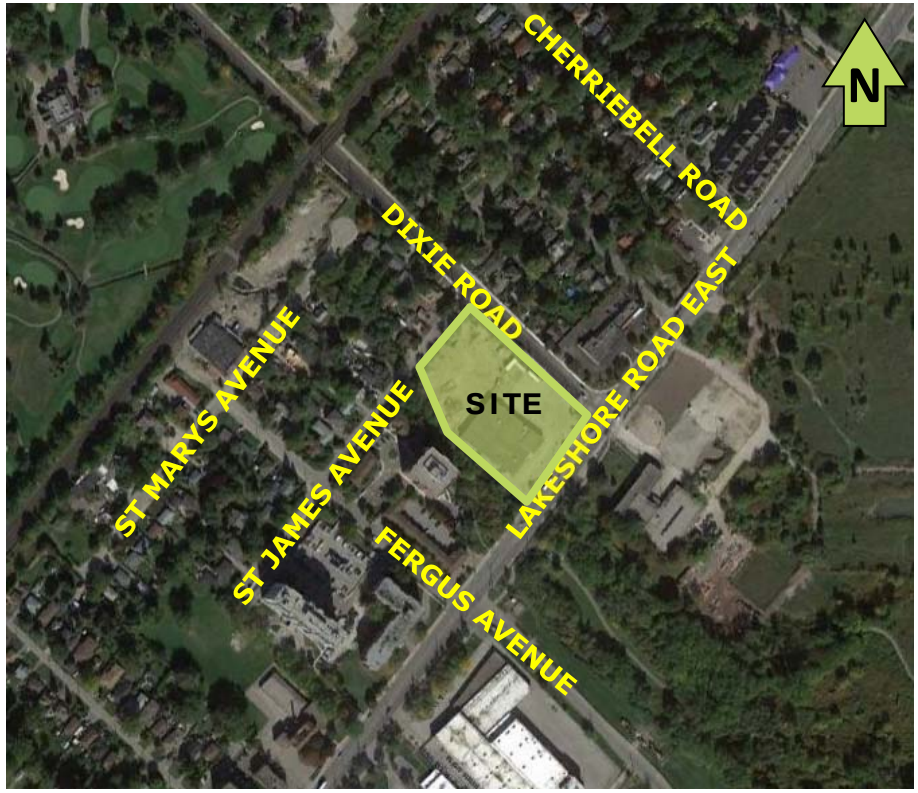


Figure 1: Aerial view of existing site and surroundings
Credit: Google Earth Pro™, dated October 9, 2016

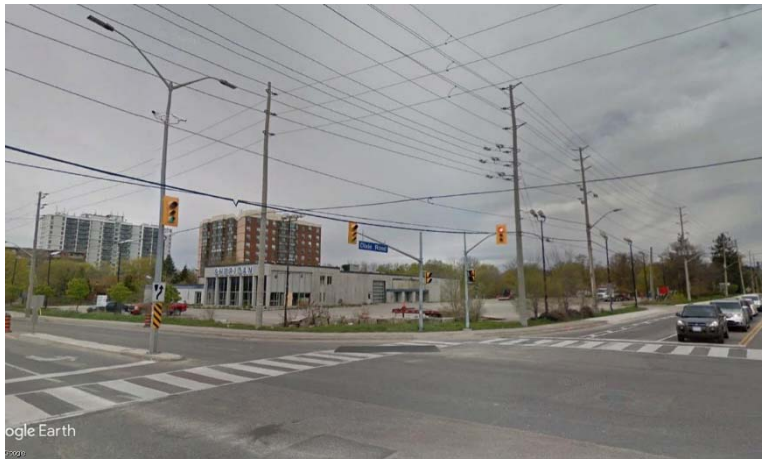


Figure 2a: Looking west at site

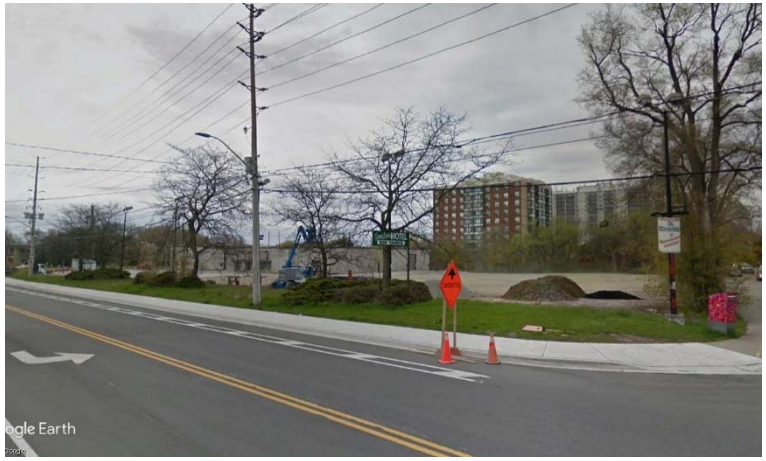


Figure 2b: Looking south at site

Figure 2c: Looking southwest along St James Avenue

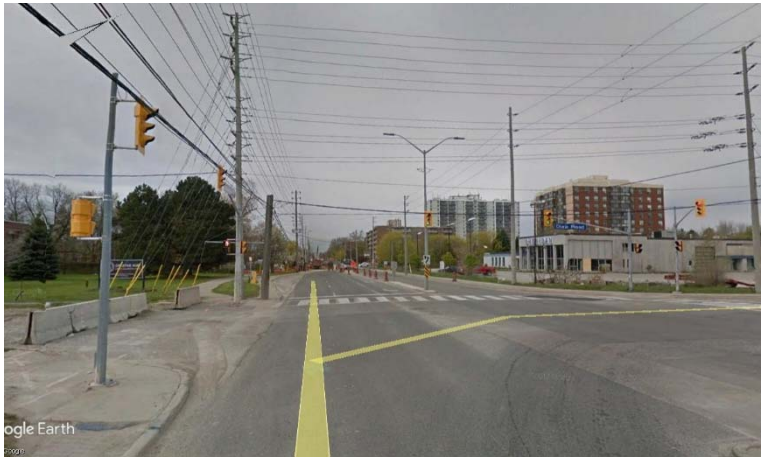


Figure 2d: Looking southwest along Lakeshore Road East

1.2 Proposed Development

The proposed development includes: a one-storey parking podium with commercial and residential spaces around the perimeter; an eight-storey residential building (Building A) along the north edge; a four-storey residential building along the north edge; a 12-storey residential building along the west edge (Building B); and, a four-storey commercial building at the southwest corner of Building A. In the centre of the development, atop the podium, there is outdoor amenity space (Level 2).

An early rendering of the development is shown in **Figure 3**.

Figure 3: Preliminary rendering of proposed development
Credit: Kohn Partnership Architects Inc., dated March 6, 2018

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 two transit stops nearby, along Lakeshore Road East.

These features, as well as the outdoor amenity space on Level 2, are shown in **Figure 4**.

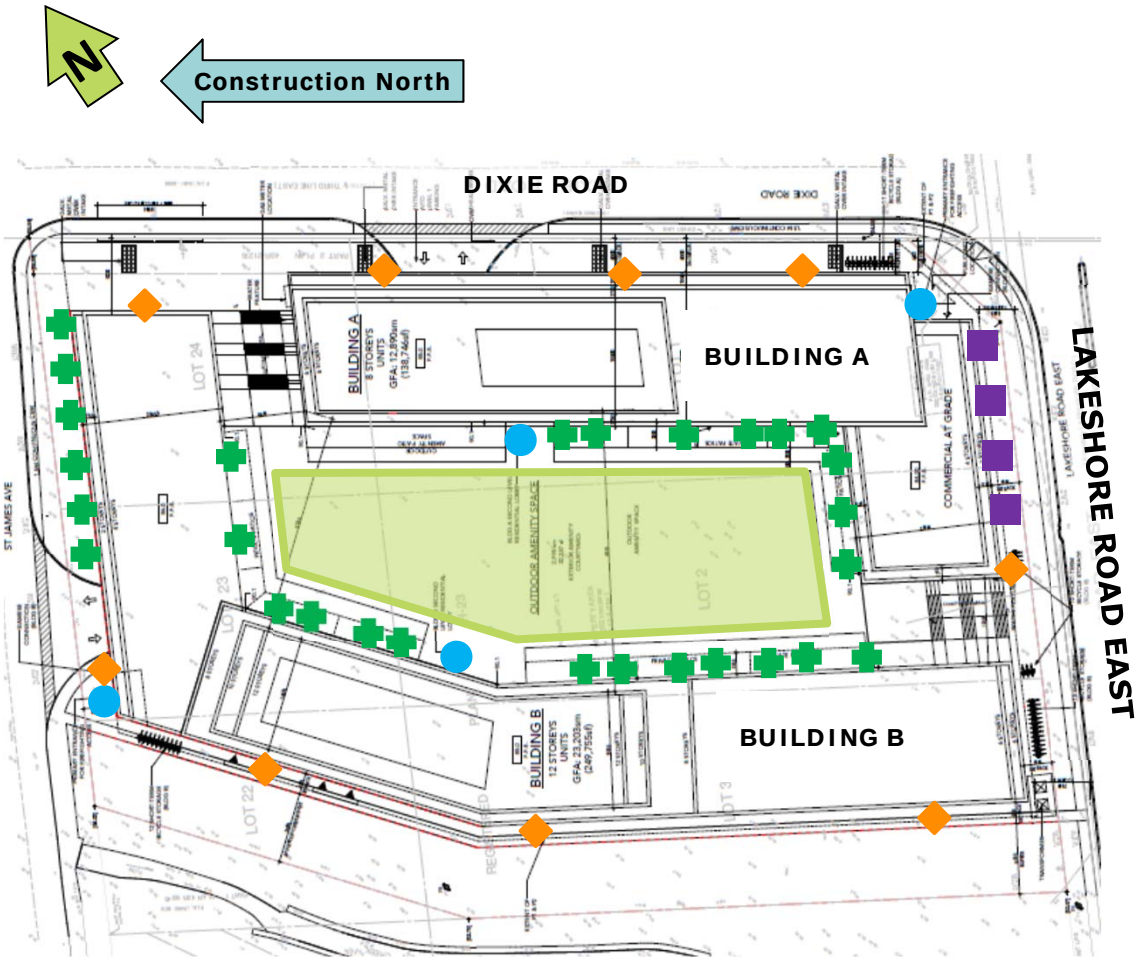


Figure 4: Areas of interest (*Site Plan, April 17, 2018***)**

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.

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 Kohn Partnership Architects Inc. on April 17th, 2018. A view of the 3D model used in the computer wind comfort analysis 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 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 two seasons: Winter (November to April) and Summer (May to October).

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 Billy Bishop Toronto City Airport for the period of 1986-2015 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 and easterly 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 westerly and east-northeasterly directions. All wind speeds and directions were included in the wind climate model.

The seasonal wind roses show daytime hours only from 6:00am to 11:00pm, while the annual wind rose shows all hours.

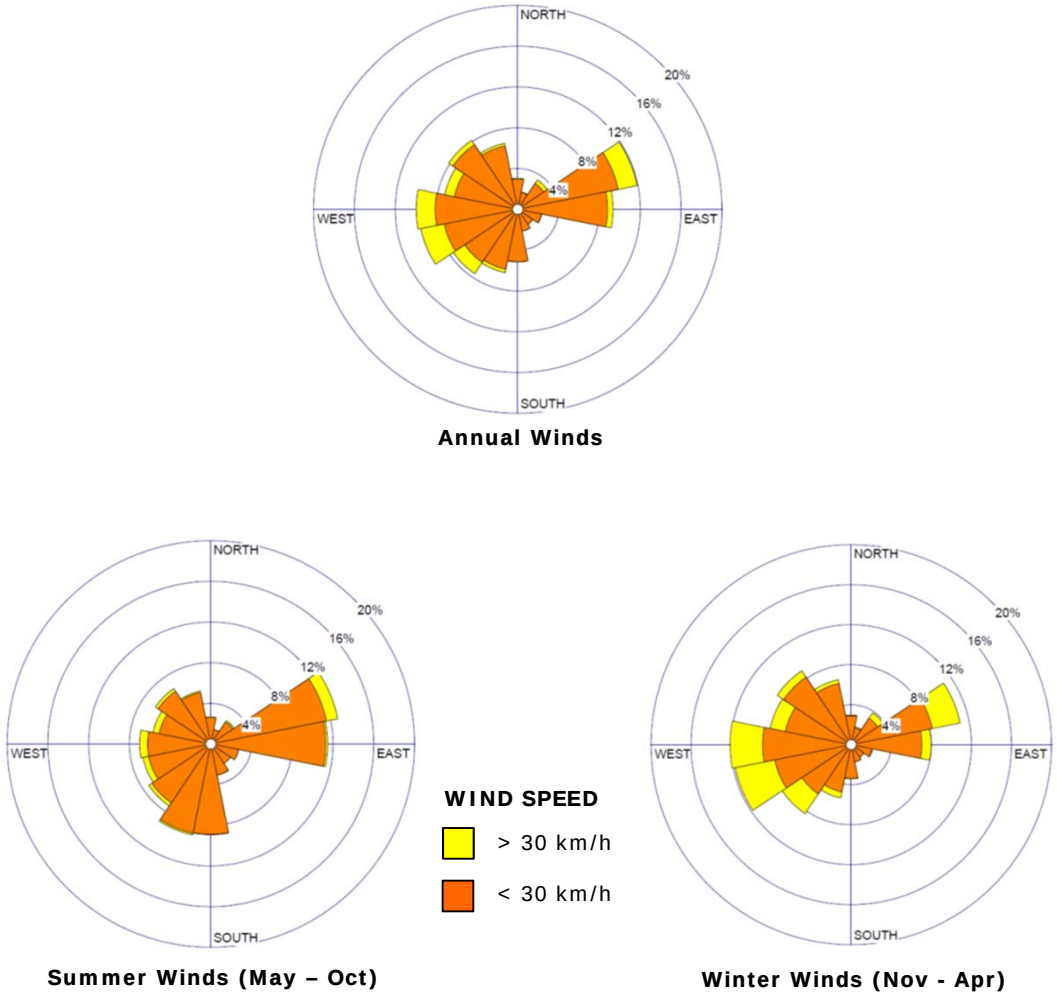


Figure 6: Wind Roses for Billy Bishop Toronto City Airport (1986-2015)

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 criteria utilized for this analysis is provided by the City of Mississauga, in the document *Urban Design Terms of Reference – Pedestrian Wind Comfort and Safety Studies* (June 2014). The comfort criteria, which is based on certain predicted hourly gust-equivalent mean (GEM) wind speeds being exceeded 20% of the time, are summarized in **Table 1**. By allowing for a 20% exceedance, it assumes wind speeds will be comfortable for the corresponding activity at least four out of five days. The comfort criteria consider only daytime hours, between 6:00am and 11:00pm. GEM is defined as the maximum mean wind speed or the gust wind speed divided by 1.85.

The criterion for wind safety in the table is based on hourly gust wind speeds that are exceeded nine hours per year (approximately 0.1% of the time) assuming a 24 hour day. When more than one event is predicted annually, wind mitigation measures are then advised. The wind safety criterion is shown in **Table 2**.

Table 1: Wind Comfort Criteria

Activity	Comfort Ranges for GEM Wind Speed Exceeded 20% of the Time		Description of Wind Effects
Sitting	0 to 10 km/h	0 to 2.8 m/s	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away.
Standing	0 to 15 km/h	0 to 4.2 m/s	Gentle breezes suitable for main building entrances and bus stops.
Walking	0 to 20 km/h	0 to 5.6 m/s	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.
Uncomfortable	> 20 km/h	> 5.6 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 Gust Wind Speed Exceeded Once Per Year (0.1%)		Description of Wind Effects
Any	90 km/h	25 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. 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 A includes graphical images of the annual wind safety for the Existing and Proposed Configurations. **Appendix B** includes vertical slices of the wind flows around the building.

There are generally accepted wind comfort levels that are desired for various pedestrian uses. For example, for public sidewalks, wind comfort suitable for **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.

When describing the building, reference will be made to construction north (**Figure 4**). When describing winds, reference is to true north. True north is 55° clockwise from construction north.

4.1 Existing Wind Conditions

In the summer, wind conditions on the site are comfortable for walking or better on the existing site (**Figure 7a**). Along the nearby sidewalks, wind conditions are also suitable for walking or better in the summer. At the two transit stops along Lakeshore Road East, wind conditions are conducive to walking in the summer.

In the winter, wind conditions are generally uncomfortable along the sidewalks of Lakeshore Road East and Dixie Road as well as on the north portion of the site (**Figure 8a**). This area of uncomfortable wind conditions includes the two nearby transit stops. These uncomfortable wind conditions are due to the overall climate near the lake, as well as the exposure of the existing site to the prevailing winds.

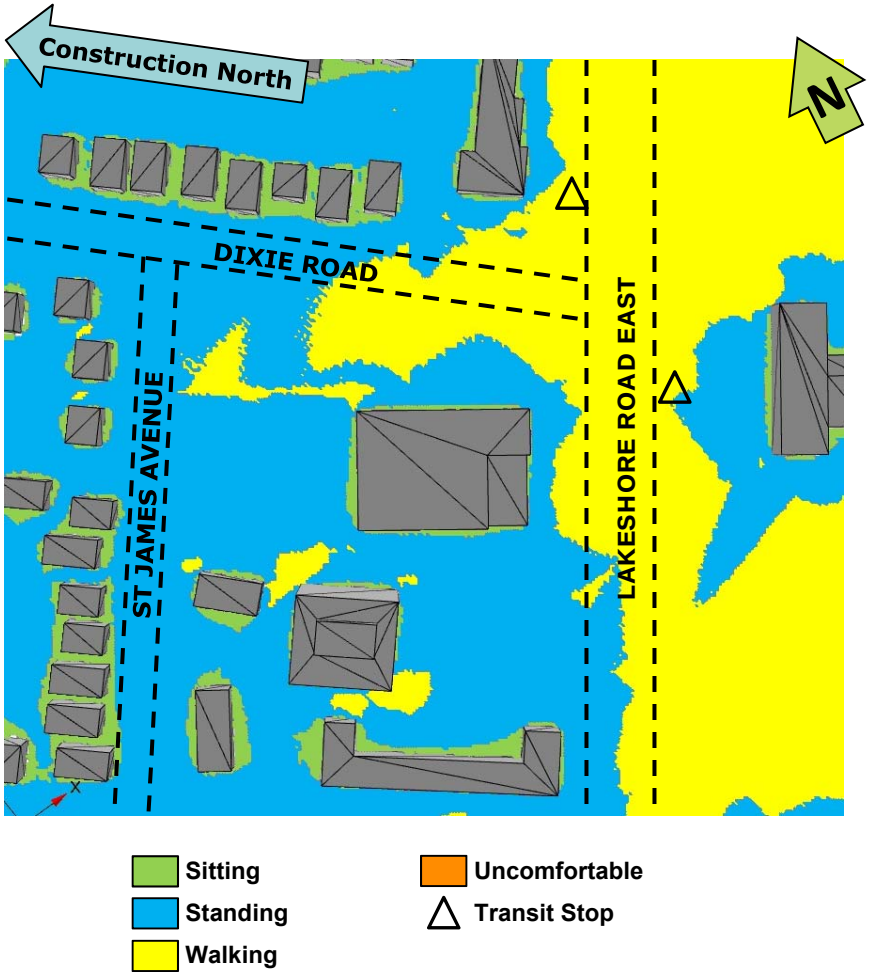


Figure 7a: Existing Conditions – Grade Level – Summer

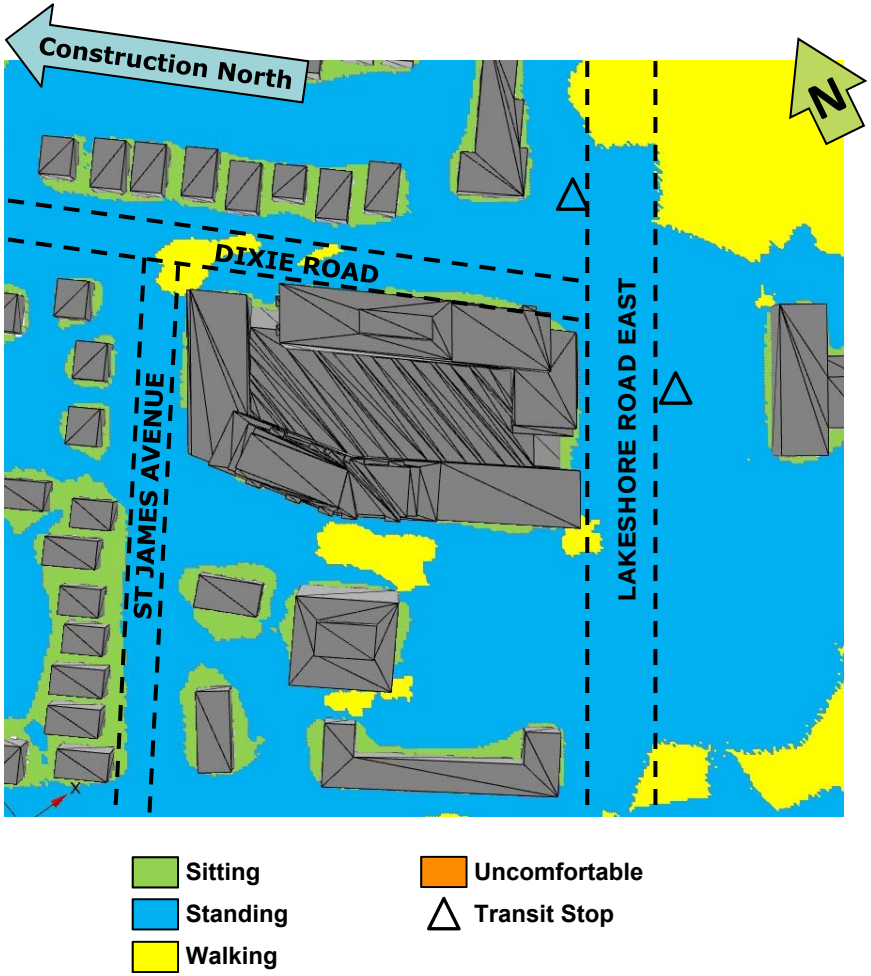


Figure 7b: Proposed Conditions – Grade Level – Summer

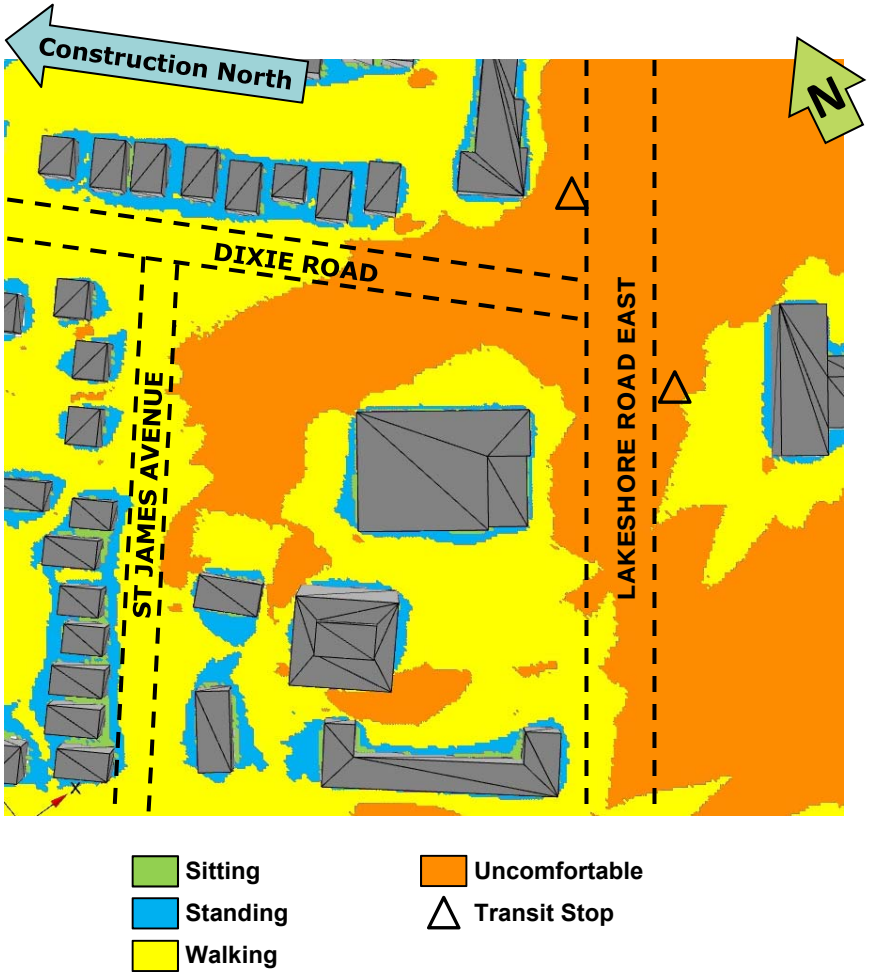


Figure 8a: Existing Conditions – Grade Level – Winter

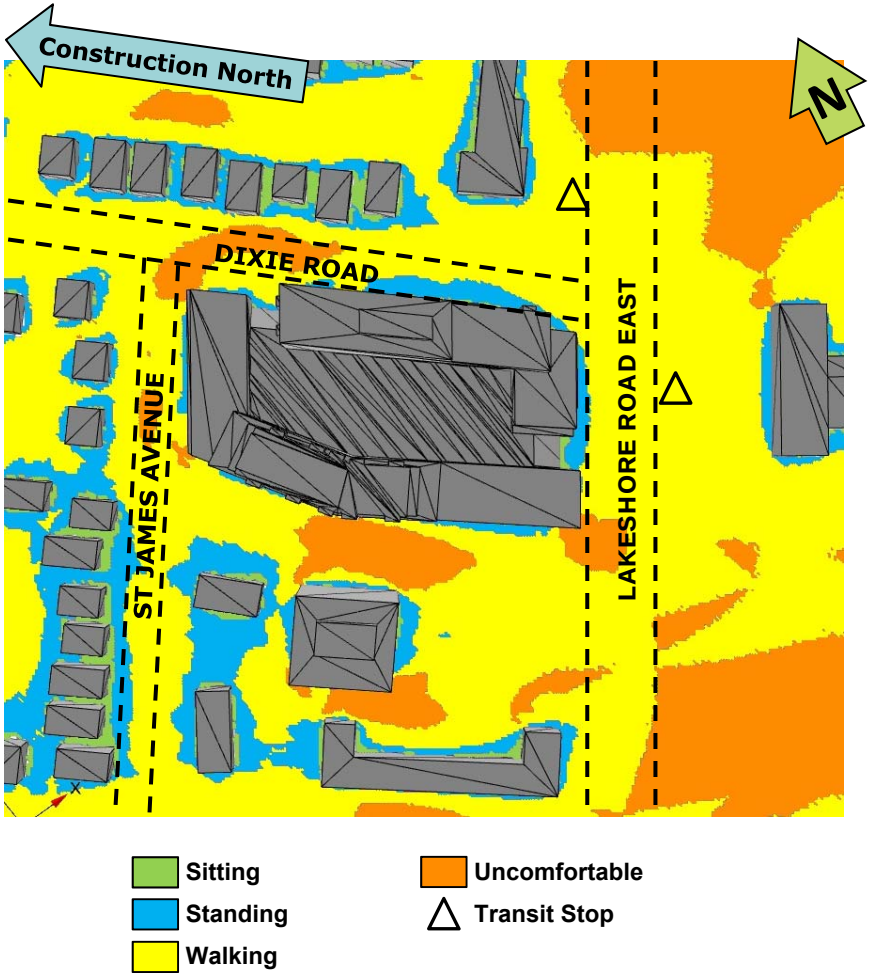


Figure 8b: Proposed Conditions – Grade Level – Winter

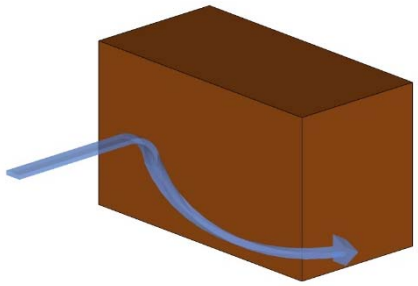
4.2 Building Entrances & Walkways

Wind conditions at the main entrances to the development, located at the northwest and southeast corners, are comfortable for sitting or standing throughout the year (**Figures 9a** and **9b**). At the numerous individual residential entrances along the north facade (**Figure 4**) wind conditions are suitable for sitting or standing in both the summer and winter seasons. At the retail entrances along the south facade, wind conditions are also conducive to sitting or standing throughout the year. In addition, at the numerous exits and secondary entrances at grade, wind conditions are comfortable for sitting or standing year-round (**Figures 9a** and **9b**).

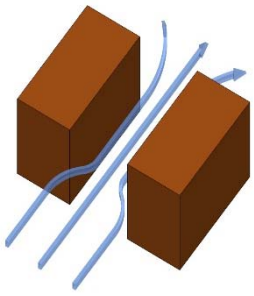
These wind conditions are considered appropriate for the intended usage.

On the sidewalks immediately surrounding the development, wind conditions are generally suitable for walking or better throughout the year (**Figures 7b a**nd **8b**). The exceptions are at the southwest corner of the development, where wind conditions are uncomfortable in the winter season (**Figures 8b** and **9b**). Wind conditions are also uncomfortable in the winter near the northwest and northeast corners of the development, as well as along the middle of the west facade. These strong wind flows are due to the mass of the building redirecting the prevailing easterly and westerly winds to the corners of the development. In the middle of the west facade, the strong wind flows are due to the downwashing of winds off the existing adjacent mid-rise, which are then channeled along the facade of the proposed building (see images on right).

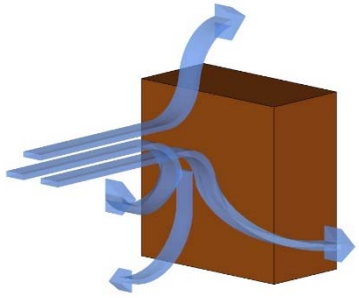
To improve wind conditions at the southwest corner of Building B, we recommend the design team consider including canopies along the west and/or south edges of the building. To improve wind conditions at the northwest corner of the site, we recommend including canopies along the north and west facades. At the northeast corner of the site, we recommend including a canopy along the east side of the building. Novus will work with the design team in prior to SPA to determine the efficacy and practicality of the recommendations described.



Wind flows directed to corner



Channeling flow



Downwashing flow

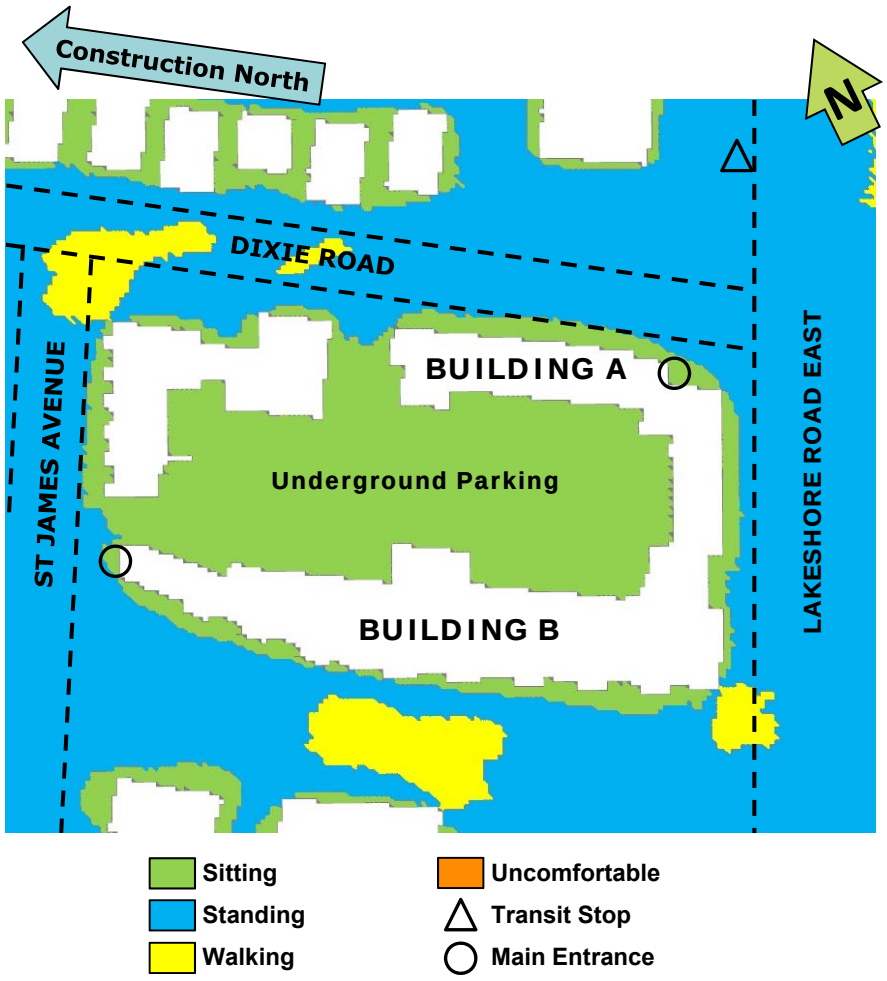


Figure 9a: Proposed Configuration – Grade – Summer

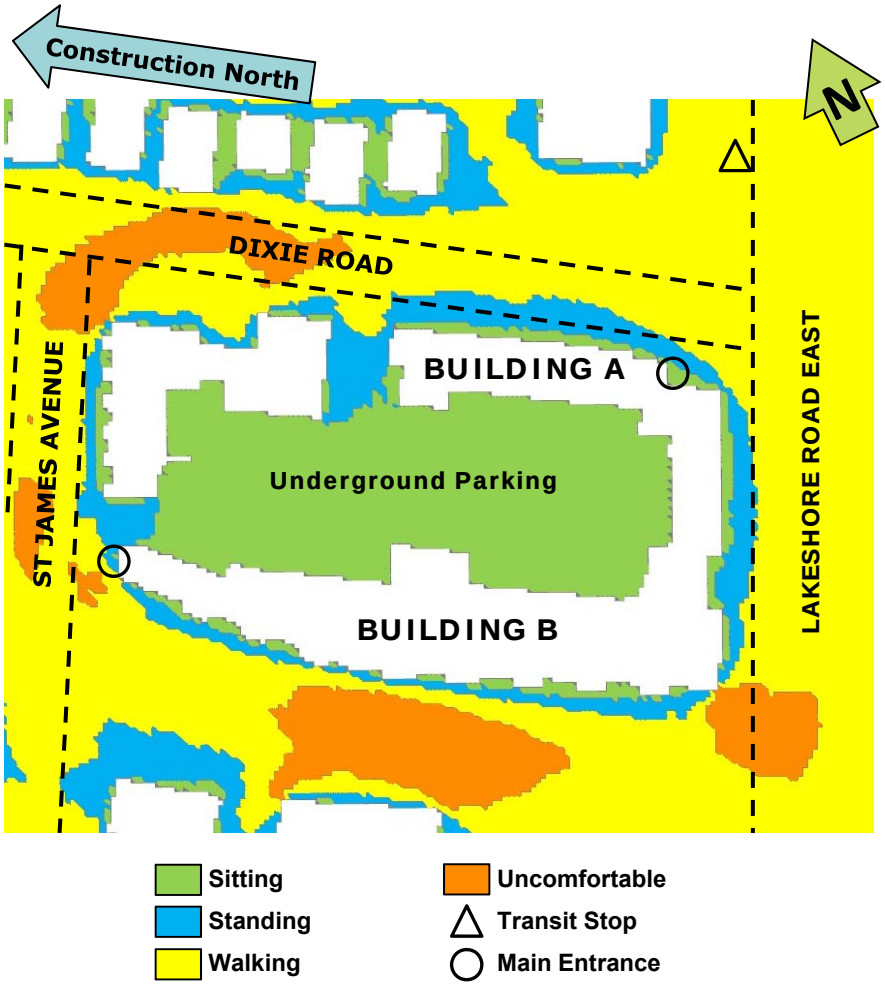


Figure 9b: Proposed Configuration – Grade – Winter

4.3 Outdoor Amenity Space

In the middle of the development, on Level 2, there is a large outdoor amenity space (**Figure 4**). In the summer, wind conditions within the amenity space are generally comfortable for sitting or standing (**Figure 10a**). However, there areas are slightly windier and hence suitable for walking, such as at the northwest corner of Building A, as well as on the north portion of the amenity space. At the main entrances on Level 2, wind conditions are conducive to sitting or standing in the summer. On the stairs leading to Dixie Road wind conditions are comfortable for standing, as are the wind conditions on the stairs leading to Lakeshore Road East (**Figure 10a**).

In the winter season, wind conditions within the amenity space are generally comfortable for walking or better (**Figure 10b**). The exception is on the north portion of the space, where wind conditions are uncomfortable. Wind conditions are also uncomfortable at the northwest corner of Building A, as well as on the stairs leading to Dixie Road, during the winter season. On the stairs leading to Lakeshore Road East, wind conditions are suitable for walking in the winter. At the main entrances on Level 2, wind conditions are comfortable for sitting or standing in the winter season (**Figure 10b**).

To improve wind conditions at the northwest corner of Building A, within the Level 2 outdoor amenity space, we recommend including dense landscaping on the north portion of the outdoor amenity space, to improve wind conditions throughout the year. Novus will work with the design team in prior to SPA to determine the efficacy and practicality of the recommendations described.

4.4 Surrounding Sidewalks

In the Proposed Configuration, wind conditions are comfortable for walking or better in the summer season (**Figure 7b**). This includes the nearby sidewalks along St James Avenue, Lakeshore Road East, and Dixie Road. At the two nearby transit stops on Lakeshore Road East, wind conditions are suitable for standing in the summer.

In the winter season, wind conditions on the surrounding sidewalks are generally comfortable for walking or better (**Figure 8b**). The exceptions are along portions of St James Avenue, Dixie Road, and Lakeshore Road East where wind conditions are uncomfortable. At the two transit stops, wind conditions are conducive to walking in the winter.

Note, the wind conditions on the surrounding sidewalks, as well as at the transit stops, improve with the construction of the proposed development. The proposed development blocks and diverts the prevailing easterly and westerly winds, and hence shelters portions of the surrounding area.

4.5 Wind Safety

In the Existing Configuration, the wind safety criterion is met in all areas surrounding the existing site.

In the Proposed Configuration, the wind safety criterion is met in all areas on and surrounding the site, including the Level 2 amenity space.

Images can be found in **Appendix A**.

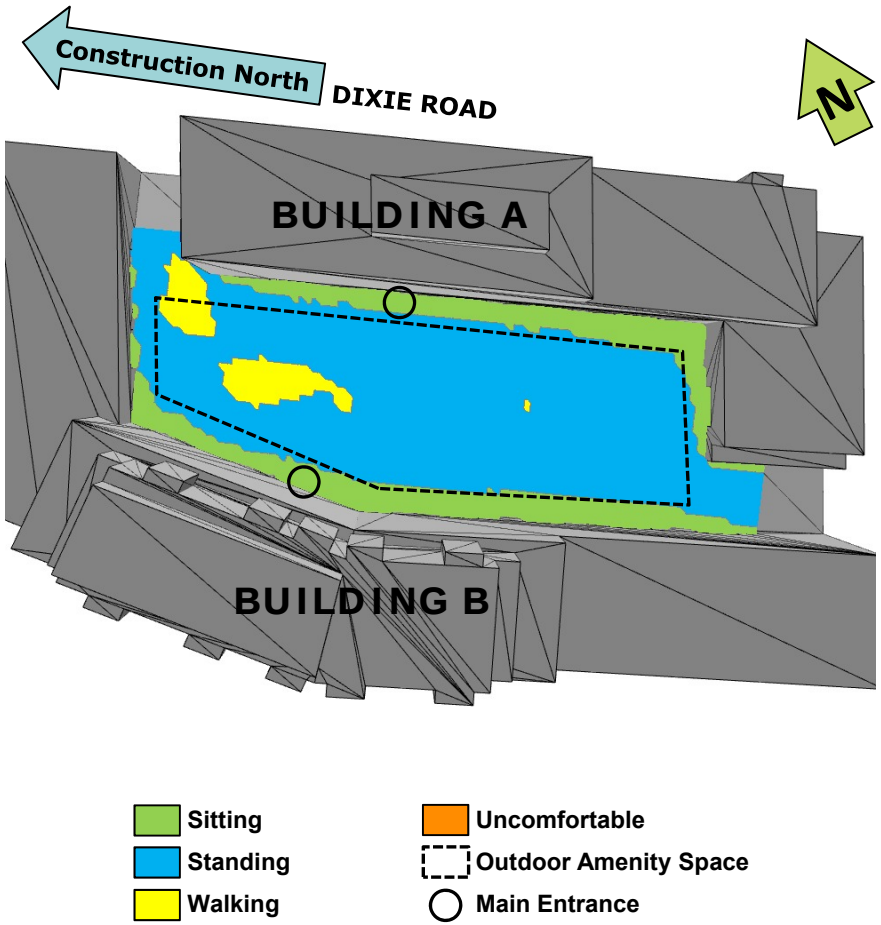


Figure 10a: Proposed Configuration – Level 2 – Summer

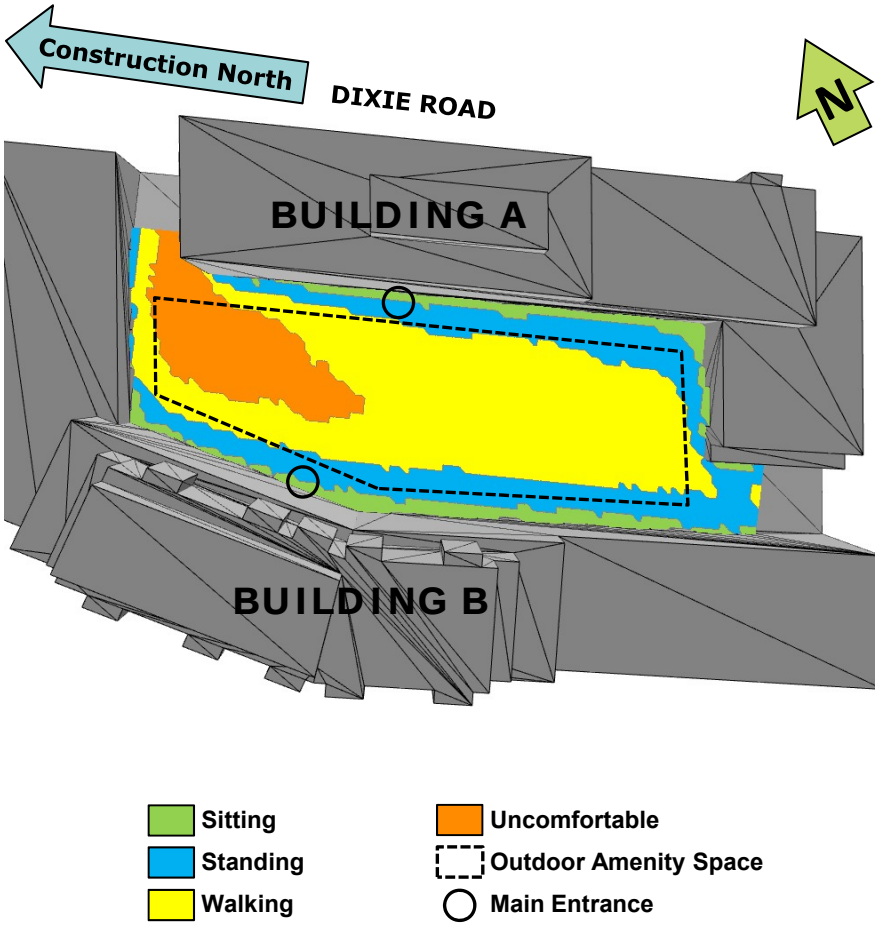


Figure 10b: Proposed Configuration – Level 2 – Winter

5.0 CONCLUSIONS & RECOMMENDATIONS

The pedestrian wind conditions predicted for the proposed development at 1345 Lakeshore Road East in Mississauga 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 on and surrounding the development in both the Existing and Proposed Configuration.
- Wind conditions at the numerous residential and retail entrances are comfortable for the intended usage throughout the year.
- Wind conditions on the sidewalks immediately surrounding the development are generally comfortable for walking or better throughout the year. Recommendations are provided where applicable.
- In the outdoor amenity space on Level 2, wind conditions are generally suitable for the intended usage. Recommendations are provided where applicable.
- As the proposed development provides a blockage for the prevailing easterly and westerly winds, wind conditions in the Proposed Configuration are generally comfortable for walking or better throughout the year on the surrounding sidewalks. This is an improvement from the Existing Configuration, particularly along Lakeshore Road.
- As per the City of Mississauga *Terms of Reference for Pedestrian Wind Comfort and Safety*, Novus will conduct wind tunnel testing prior to SPA to confirm the wind conditions and efficacy of mitigation features incorporated into the design.

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 Novus.

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

Sincerely,
Novus Environmental Inc.

Jenny Vesely, P. Eng.
Sr. Engineer – Microclimate

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

7.0 REFERENCES

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Appendix A

Pedestrian Wind Safety Results
Annual

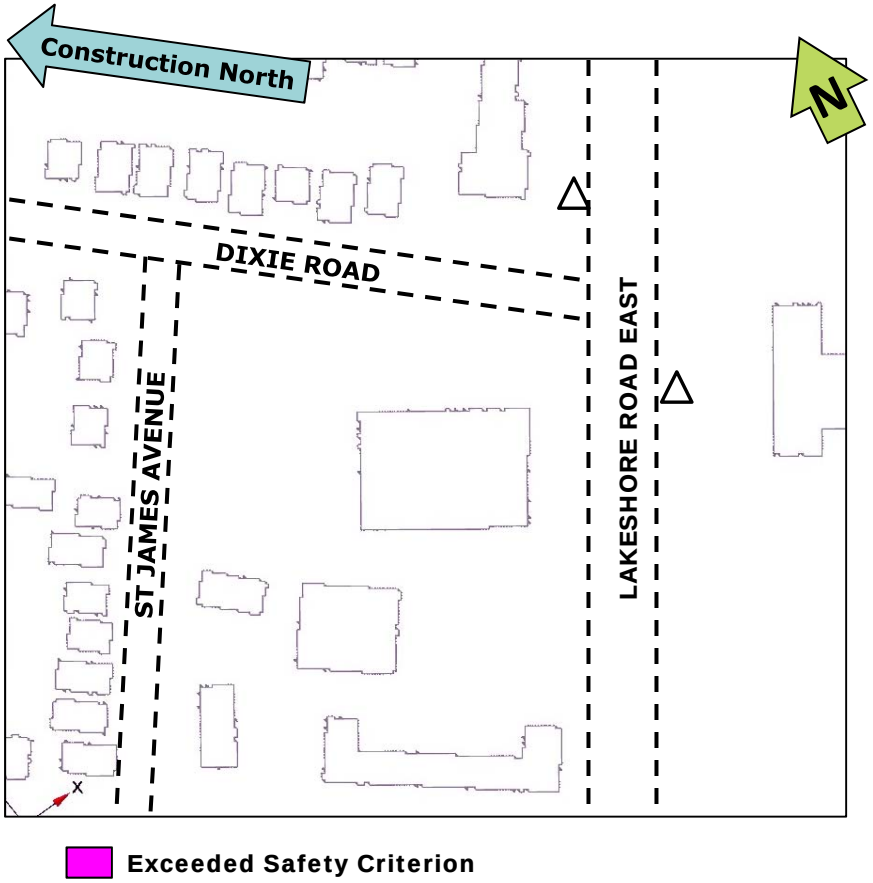

Figure A1a: Wind Safety – Existing Configuration – Grade Annual

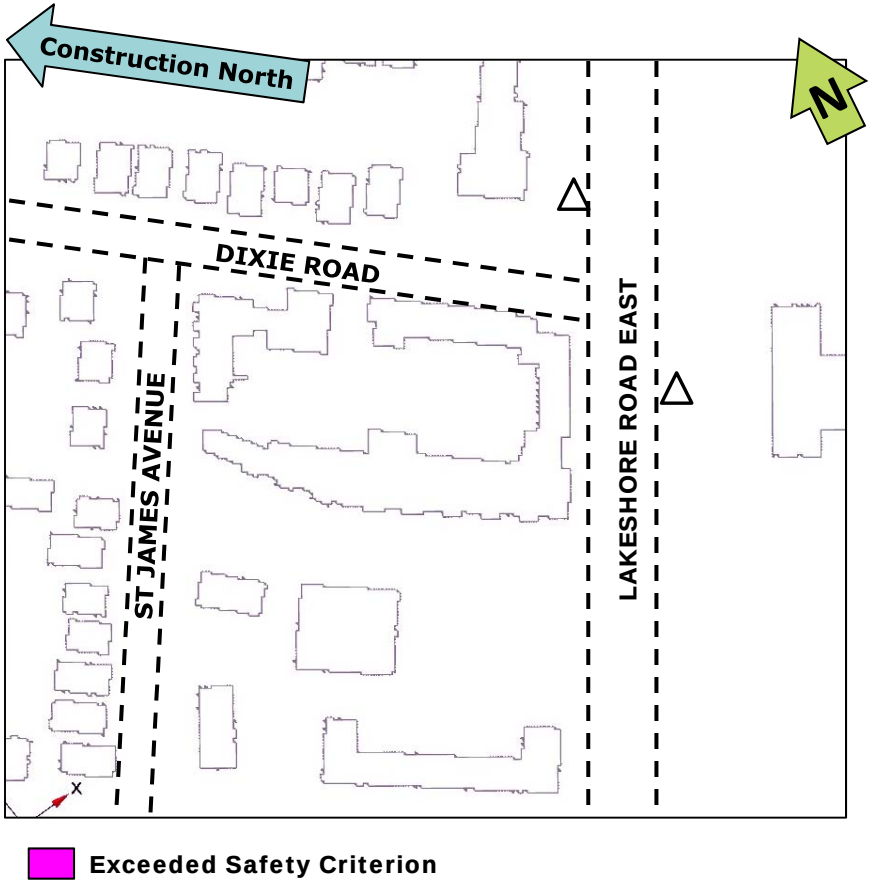

Figure A1b: Wind Safety – Proposed Configuration – Grade Annual

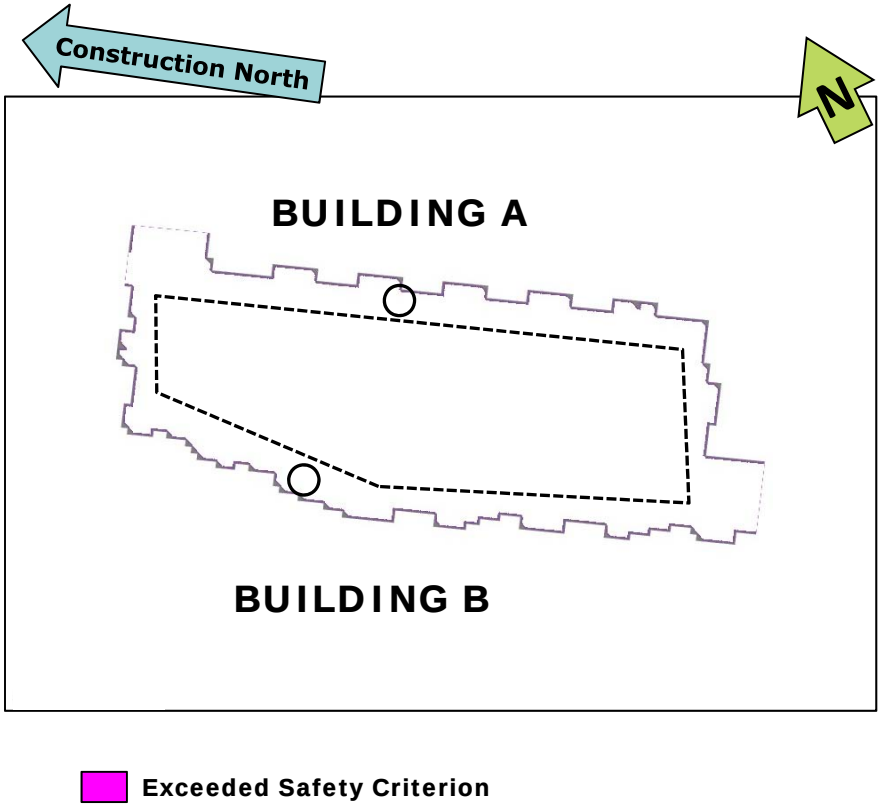

Figure A2: Wind Safety – Existing Configuration – Level 2 Annual

Appendix B

Wind Flow Vectors – Proposed Configuration
Vertical Slices

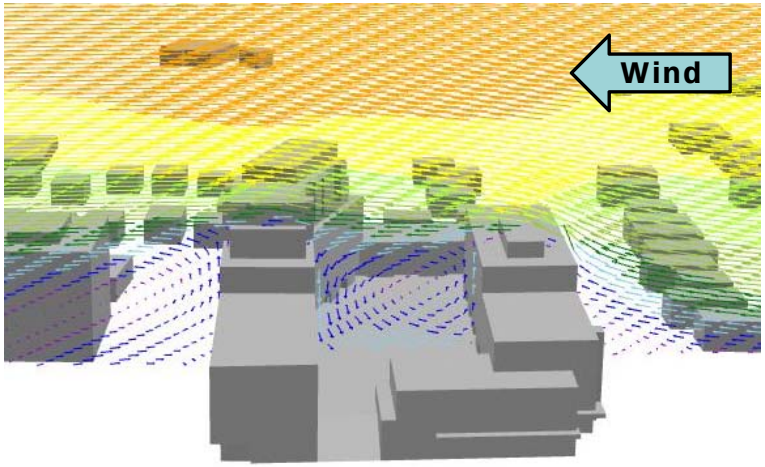

Figure B1: Wind Flow Vectors – Vertical Slice (SW / NE)
Wind from northeast

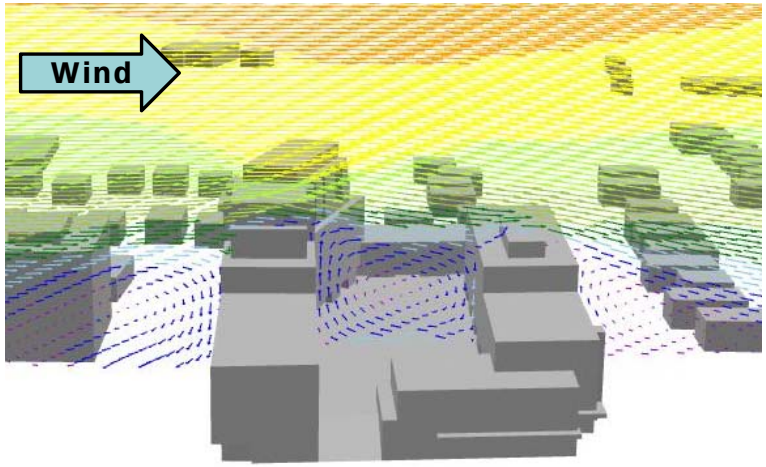

Figure B2: Wind Flow Vectors – Vertical Slice (SW / NE)
Wind from southwest

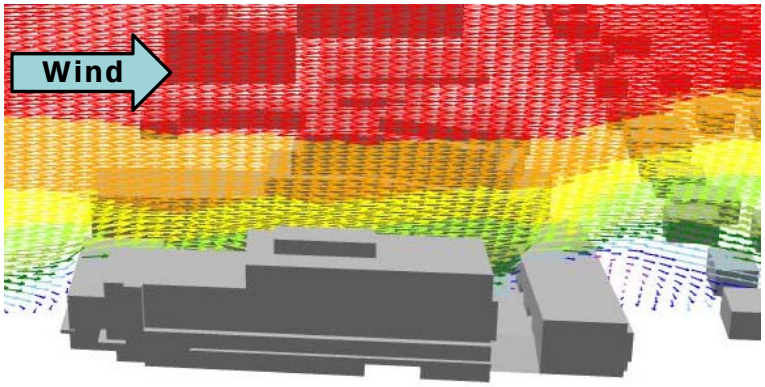

Figure B3: Wind Flow Vectors – Vertical Slice (SE / NW)
Wind from southeast

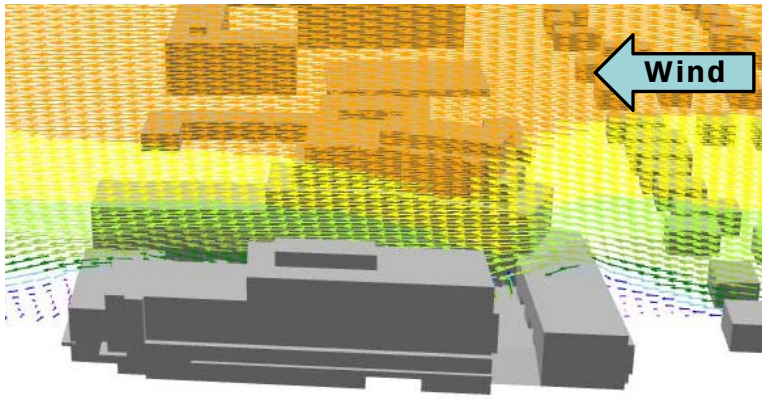

Figure B4: Wind Flow Vectors – Vertical Slice (SE / NW)
Wind from northwest