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Date: February 24, 2021

To: 2683421 Ontario Limited
2300 Yonge Street, Suite 904
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Re: **Pedestrian Wind Assessment**
7449 Montrose Road
Niagara Falls, ON
SLR Project #241.30010.00000

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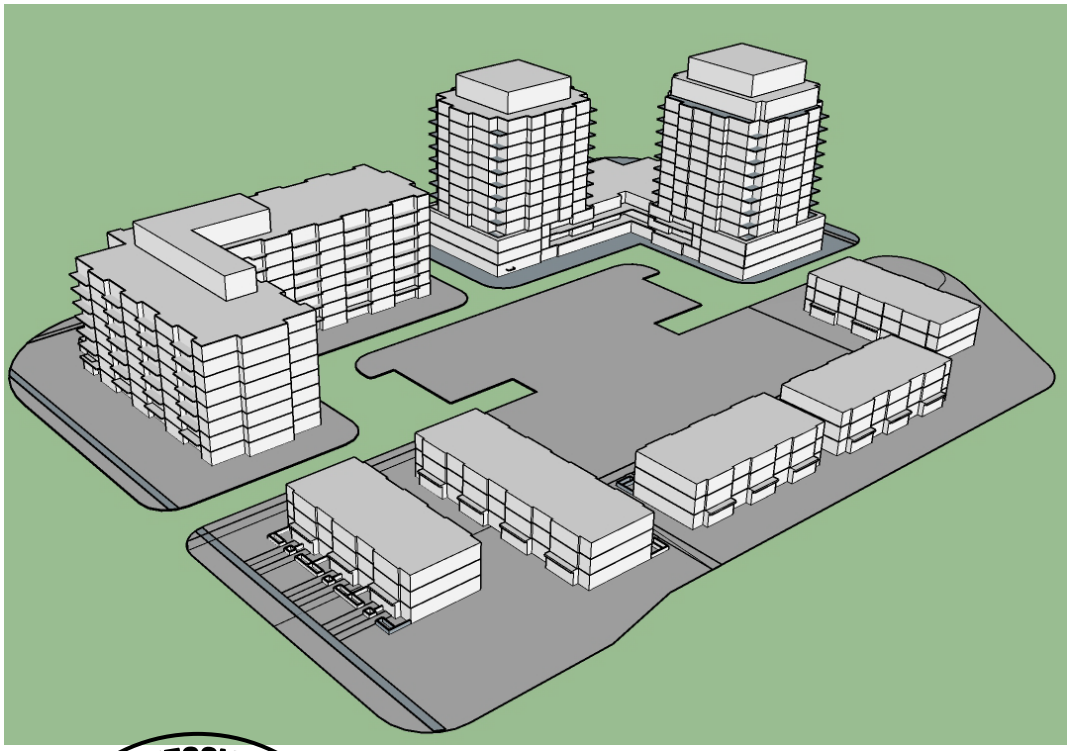

Credit: LLA Architecture

LICENSED PROFESSIONAL ENGINEER
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PROVINCE OF ONTARIO

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1.0 INTRODUCTION

SLR Consulting (SLR) was retained by 2683421 Ontario Limited to conduct a pedestrian wind assessment for the proposed development at 7449 Montrose Road in Niagara Falls, Ontario. This report is in support of 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 7449 Montrose Road, on the west side of the street. The site is encompassed by Pine Oak Drive to the west, McLeod Road to the north, Montrose Road to the east, and a parking lot to the south. The site is currently an empty lot with vegetation. Figure 1 provides an aerial view of the immediate study area. A virtual site visit was conducted by SLR using Google Earth images dated July 2017 and July 2019; some of these images are included in Figures 2a through 2d.

Immediately surrounding the site are low-rise commercial developments to the southwest and west, parking lots and low-rise commercial buildings to the north and northeast, an empty lot to the east, and the decommissioned Niagara Square Mall to the southeast and south. Beyond the immediate surroundings there are low-rise residential buildings to the northwest through northeast to southeast, with farmland, woodlots and scattered low-rise residential buildings to the south through west.

We typically include developments with Site Plan Approval (SPA) and those currently under construction in the surrounding 500 m radius as part of the existing surroundings. For this this assessment SPA-approved developments included the nearby 8056 McLeod Road development and the recently constructed Costco building to the south.

Figure 1: Aerial view of existing site & surroundings
Credit: Google Earth Pro, dated June 15, 2018

Figure 2a: Looking southwest at existing site

Figure 2b: Looking southeast at existing site

Figure 2c: Looking north along Pine Oak Drive (site on right)

Figure 2d: Looking north along Montrose Road (site on left)

1.2 Proposed Development

The proposed development includes a high-rise residential building (Building A), a mid-rise residential building (Building B) and five low-rise townhouse buildings (Buildings C1 through C5).

- The L-shaped Building A is located at the northeast corner of the site, and includes two 13-storey towers, with mechanical penthouses, atop a three storey podium. The total height is approximately 45 m.
- The L-shaped Building B is located at the northwest corner of the site and is eight storeys tall, plus a mechanical penthouse, for a total height of approximately 29 m.
- The five townhouse buildings (Buildings C1 through C5) are located on the south half of the site and are each three storeys in height (approximately 9 m).

There is also a parkette centrally located on the site at grade, and an outdoor amenity space on Level 4 of Building A, between the towers. A rendering of the overall site is shown in Figure 3.

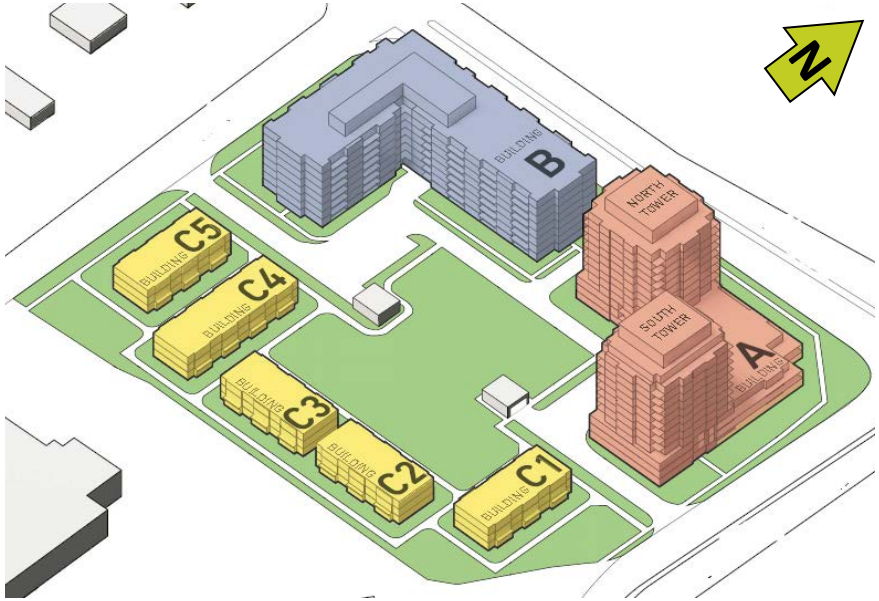


Figure 3: Rendering of proposed development
Credit: LLA Architecture

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.

In addition to the areas on site, there are transit stops along McLeod Road and Pine Oak Drive. These areas of interest are shown in Figure 4.

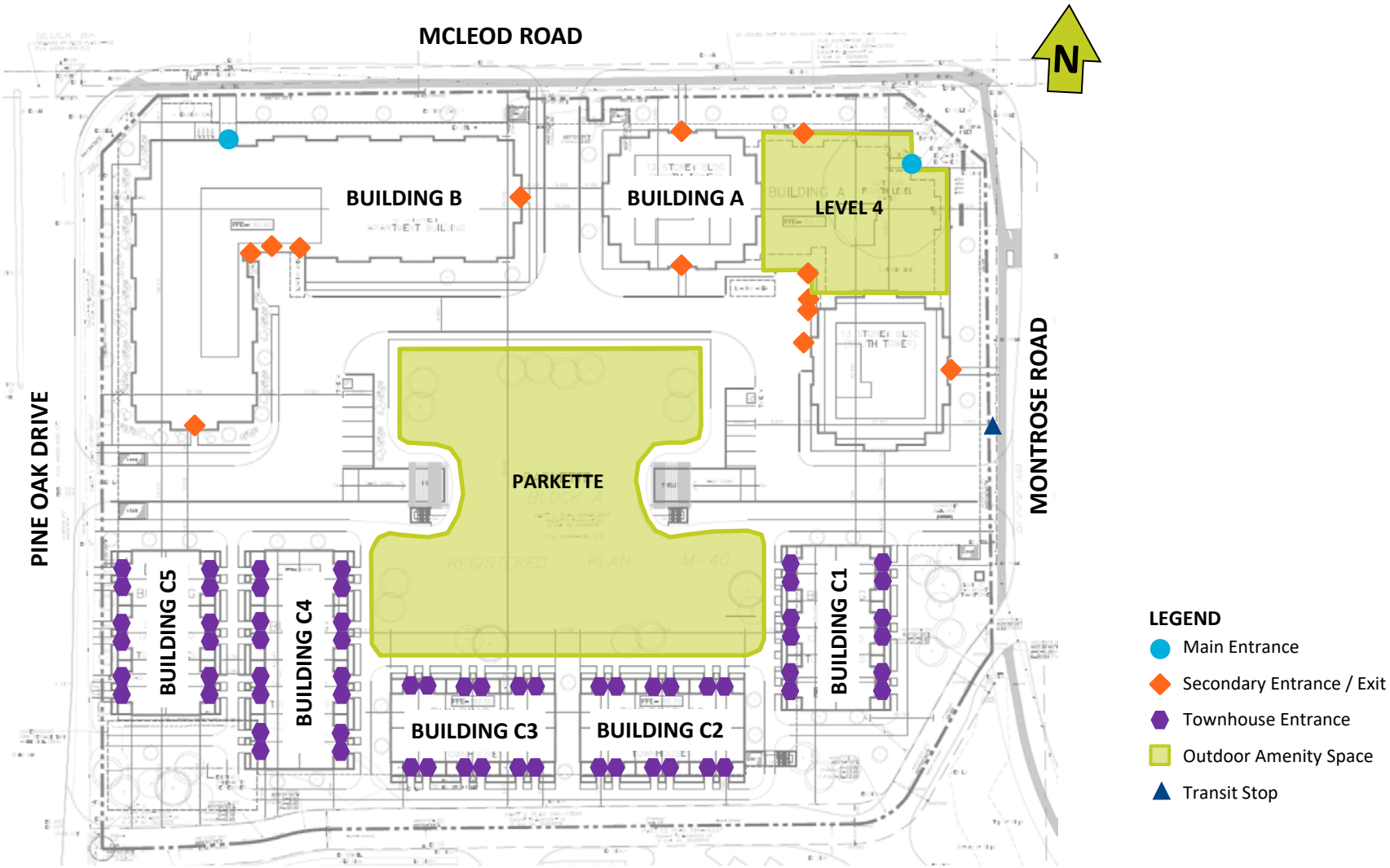


Figure 4: Areas of interest

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 were provided by LLA Architecture on November 19th and 20th, 2020. 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.

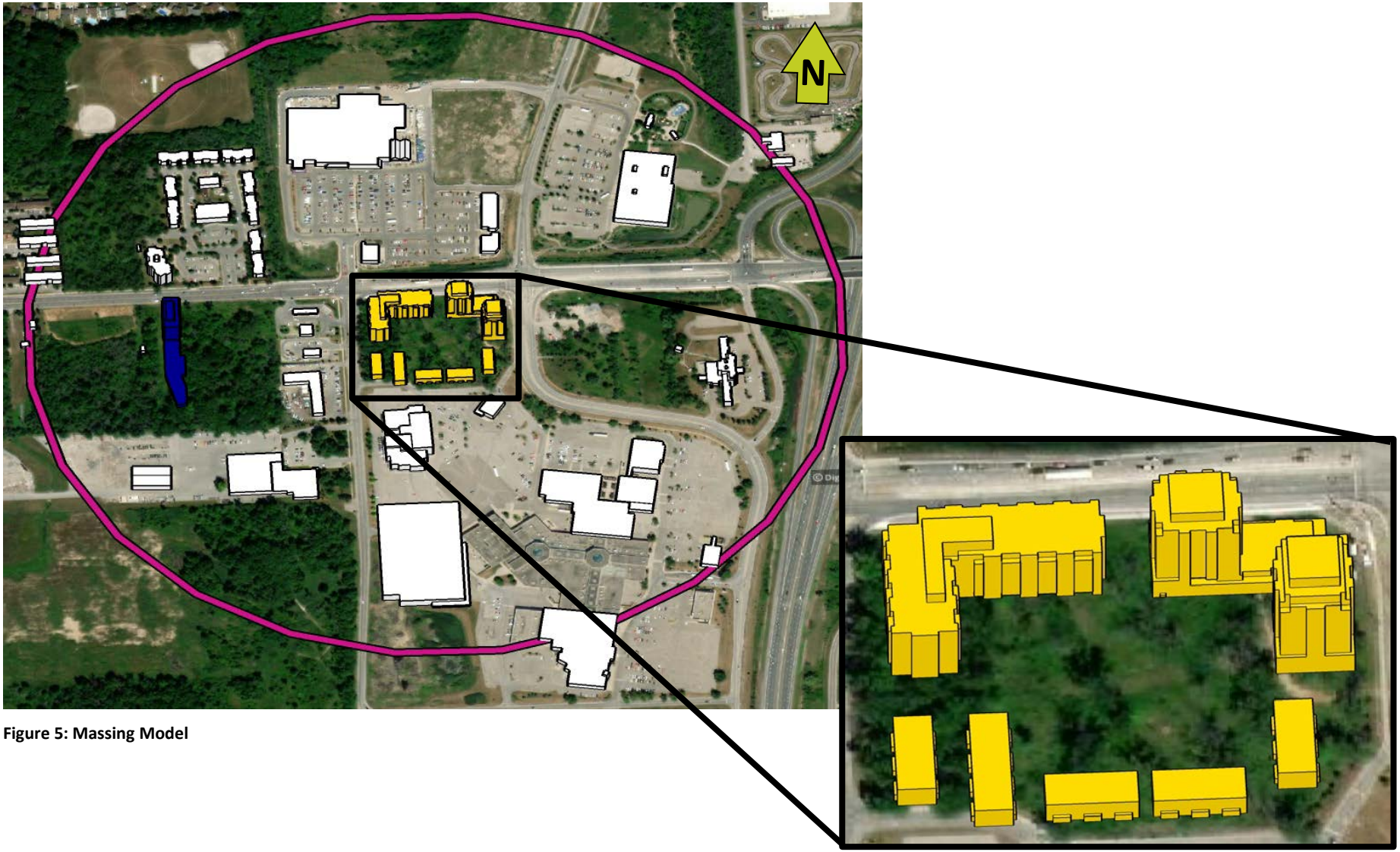


Figure 5: Massing Model

2.2 Wind Climate

Wind data recorded at Niagara Falls International Airport in Niagara Falls, New York (approximately 15 km to the east-northeast) for the period of 1989 to 2019 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 south-southwest through west 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 southwest sector. All wind speeds and directions were included in the wind climate model.

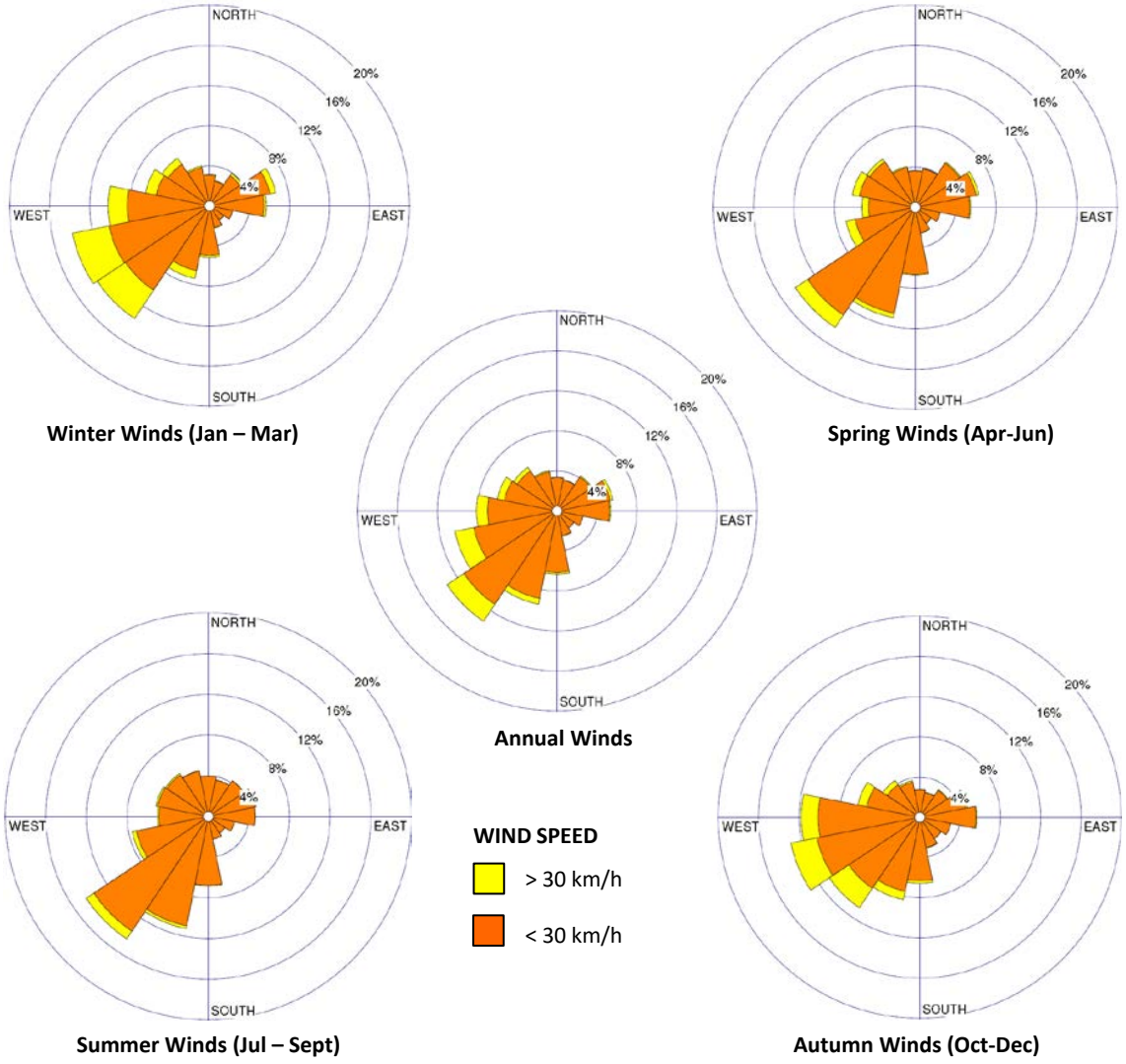


Figure 6: Wind Roses for Niagara Falls International Airport (1989 – 2019)

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 Western University, 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

In the Existing Configuration wind conditions on the site are predicted to be comfortable for sitting throughout the year (Figures 7a and 8a).

Wind conditions in the Proposed Configuration are predicted to be generally comfortable for leisurely walking or better throughout the site's walkways (Figures 7b and 8b). The exception is on the sidewalk at the northwest corner of Building B, where wind conditions are expected to be conducive to fast walking in the winter. These strong wind flows are due to the downwashing of the prevailing southwesterly winds around the corner of Building B. To disrupt these strong wind flows we suggest including marcescent trees along the west side of Building B, to provide a disruption to these horizontal and vertical wind flows.

Wind conditions at the main entrance to Building A are expected to be comfortable for sitting in both the summer and winter seasons in the Proposed Configuration as the building provides shelter from the prevailing southwesterly winds (Figures 9a and 9b). Similar calm wind conditions are predicted for the numerous secondary entrances and exits around the base of Building A.

At the main entrance to Building B wind conditions are anticipated to be suitable for sitting year-round (Figures 9a and 9b). At the secondary entrances and exits around Building B wind conditions are generally predicted to be comfortable for sitting or standing throughout the year. The exception is the exit on the east side of the building, where wind conditions are predicted to be conducive to leisurely walking in the winter, due to the channeling of southwesterly winds between Buildings A and B. We suggest recessing this exit from the main facade to provide local wind protection at the door.

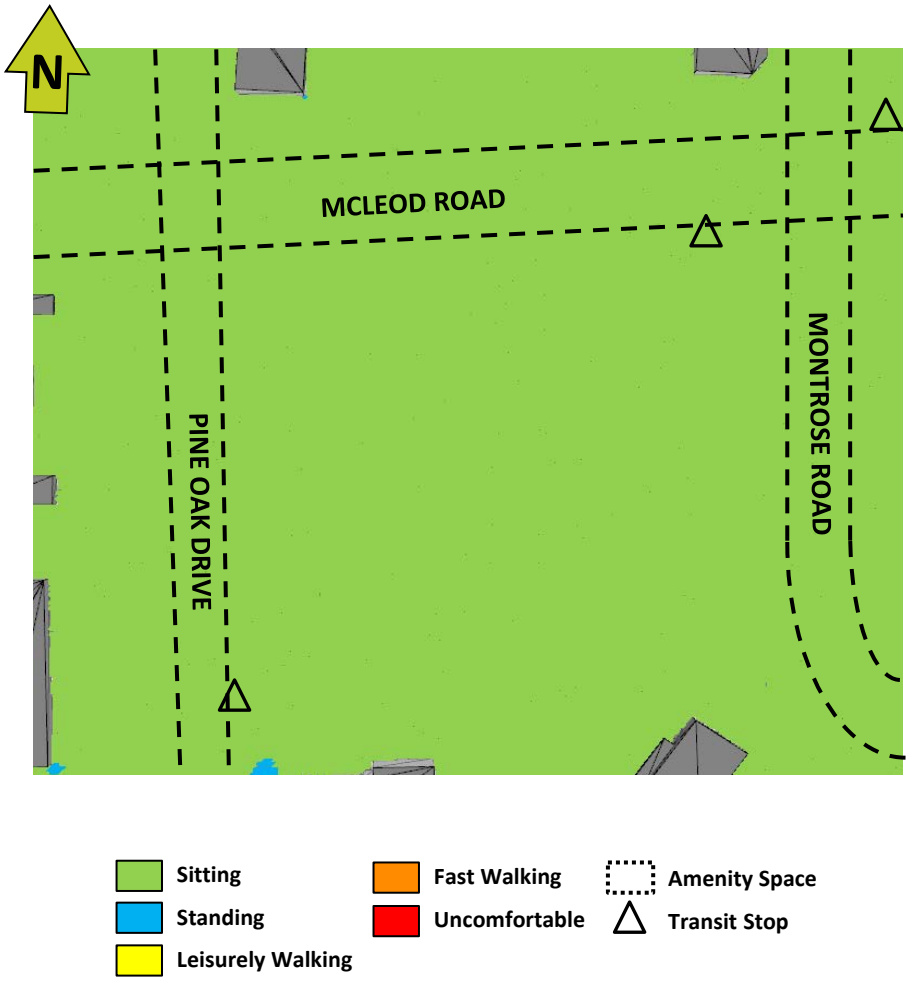


Figure 7a: Existing Configuration – Pedestrian Wind Comfort – Summer – Grade

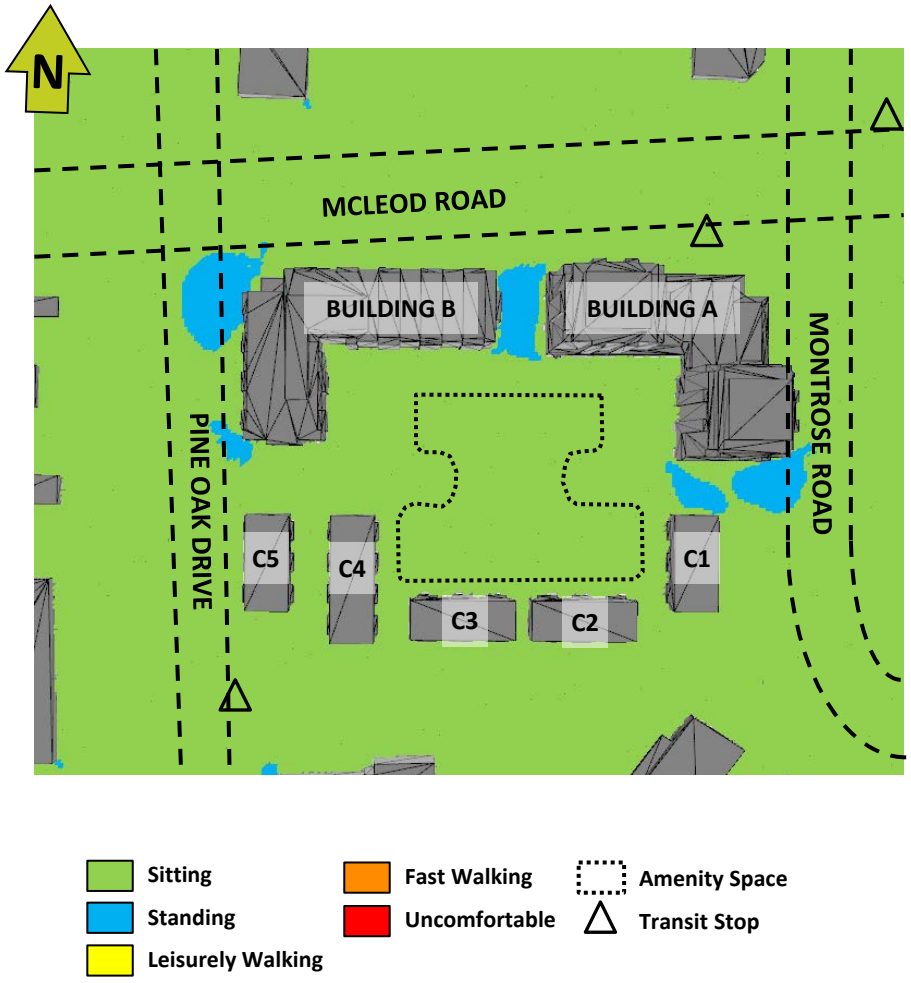


Figure 7b: Proposed Configuration – Pedestrian Wind Comfort – Summer – Grade

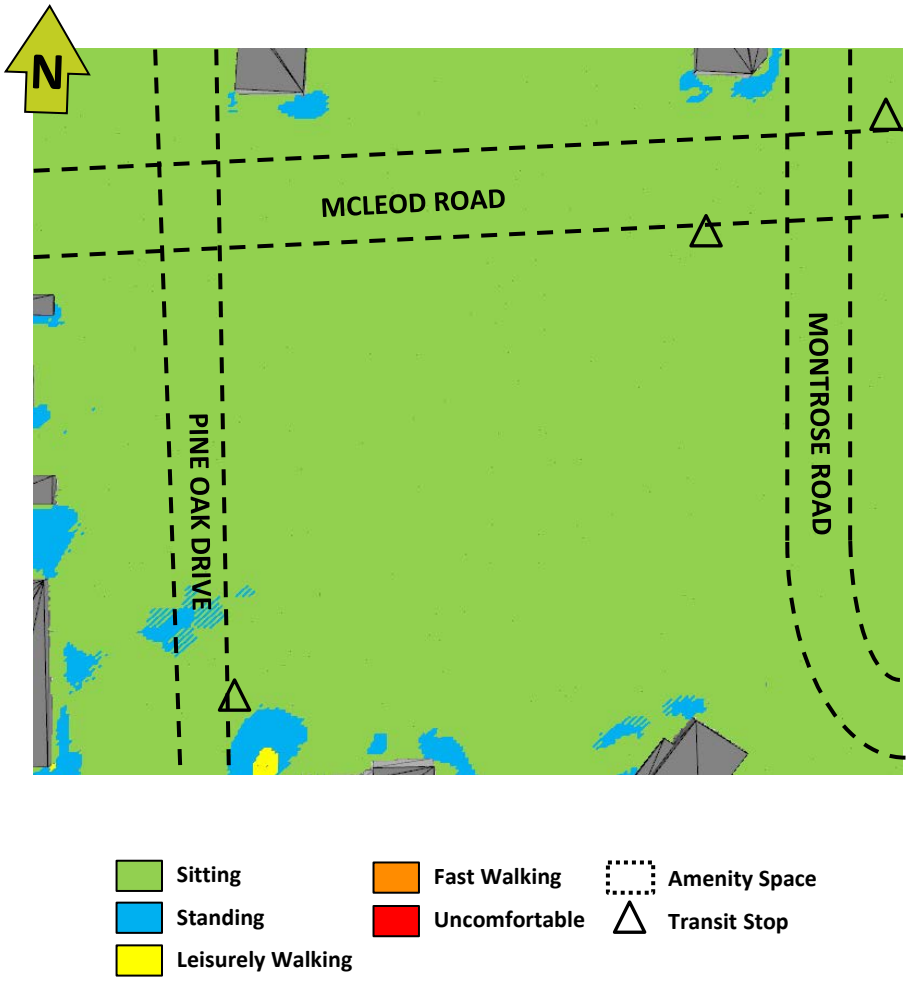


Figure 8a: Existing Configuration – Pedestrian Wind Comfort – Winter – Grade

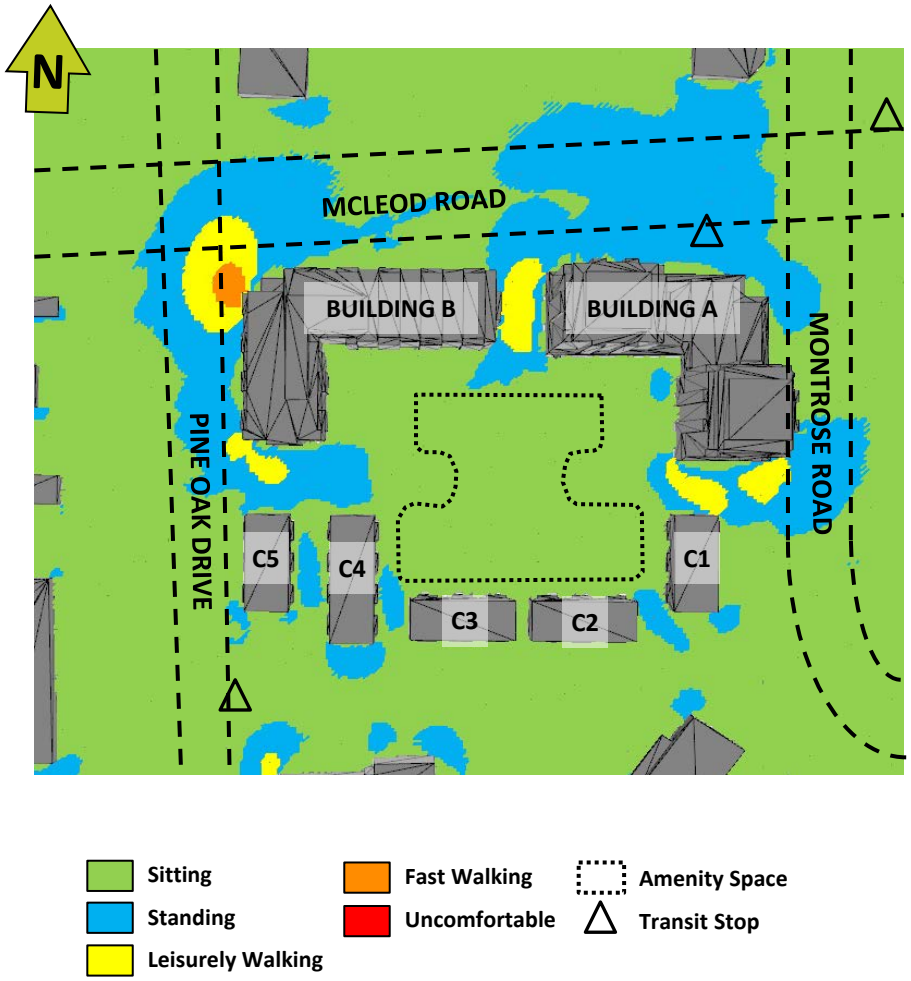


Figure 8b: Proposed Configuration – Pedestrian Wind Comfort – Winter – Grade

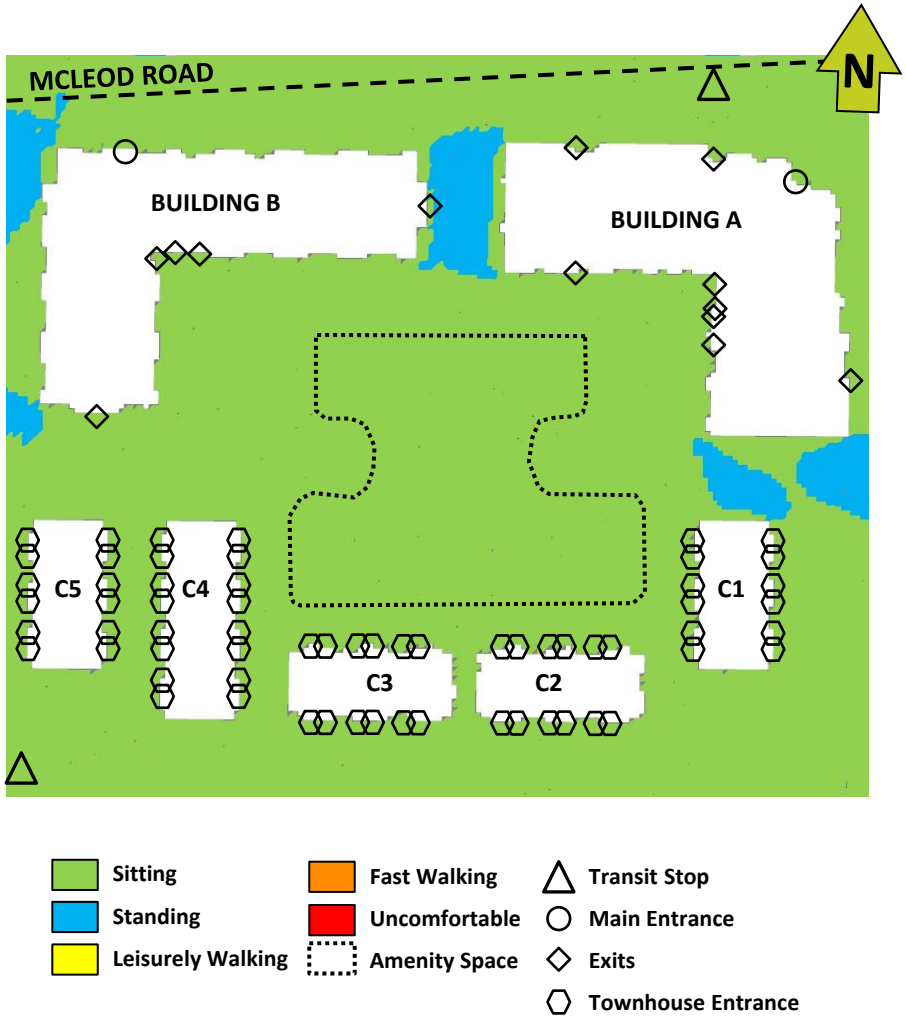


Figure 9a: Proposed Configuration – Pedestrian Wind Comfort – Summer – On Site

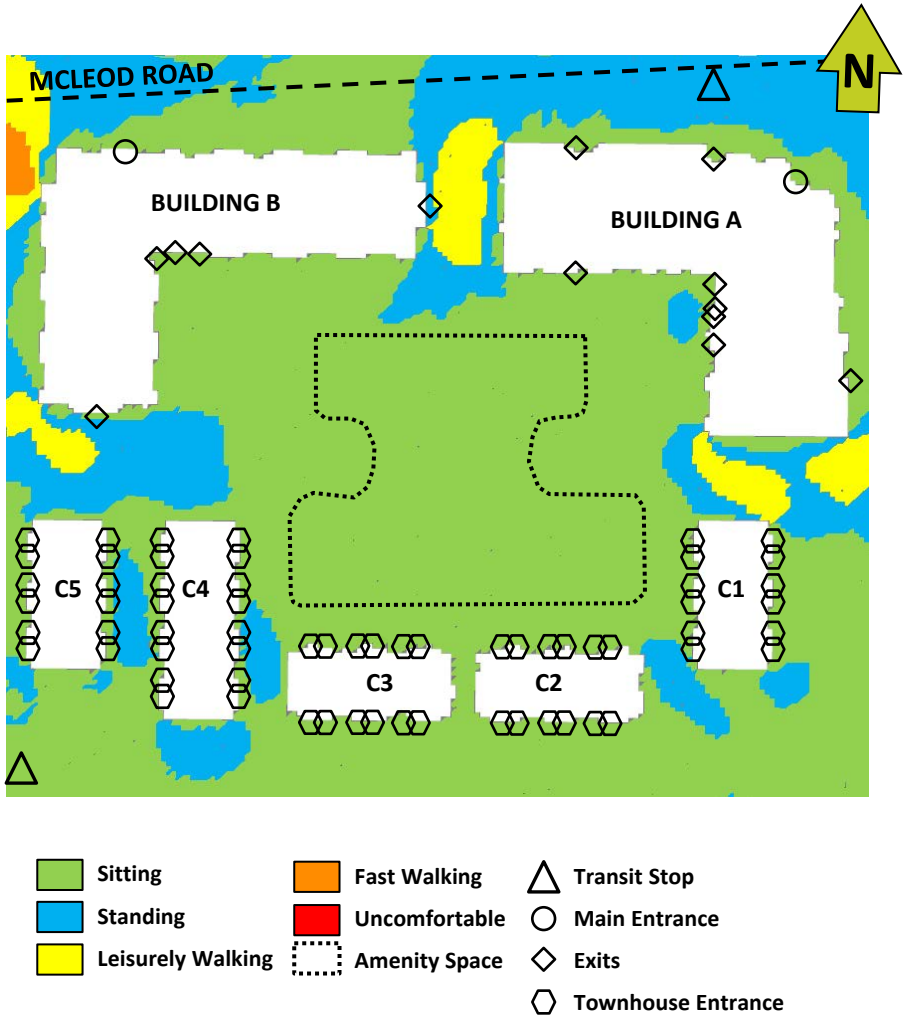


Figure 9b: Proposed Configuration – Pedestrian Wind Comfort – Winter – On Site

Wind conditions around the five townhouse buildings are anticipated to be conducive to leisurely walking or better year-round in the Proposed Configuration (Figures 9a and 9b). At the individual entrances, wind conditions are predicted to be comfortable for sitting or standing throughout the year.

4.2 Amenity Spaces

In the parkette in the centre of the development wind conditions are predicted to be comfortable for sitting in both the summer and winter seasons (Figures 9a and 9b).

On the Level 4 amenity of Building A wind conditions on the terrace are generally expected to be suitable for sitting or standing throughout the year (Figures 10a and 10b). The exception is along the southwest edge of the space where wind conditions are predicted to be comfortable for leisurely walking in the summer and fast walking in the winter. These strong wind flows are due to the downwashing of southwesterly winds off the two towers; these flows are then channeled between the towers. If calmer wind conditions are desired in the area, we recommend the design team include local wind mitigation features along the southwest edge of the space (i.e., tall vertical wind screen, trellises, etc.).

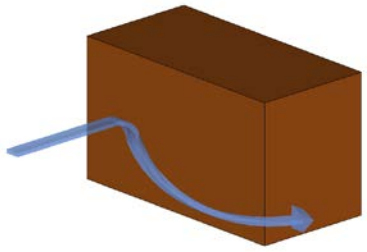
4.3 Surrounding Sidewalks

In the Existing Configuration wind conditions on the surrounding sidewalks of McLeod Road, Montrose Road and Pine Oak Drive are predicted to be suitable for leisurely walking or better year-round (Figures 7a and 8a). At the nearby transit stops wind conditions are predicted to be comfortable for sitting year-round.

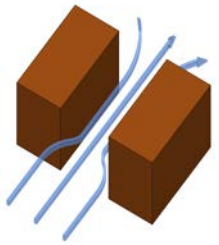
With the proposed development in place wind conditions on the surrounding sidewalks are generally expected to remain comfortable for leisurely walking or better throughout the year (Figures 7b and 8b). The exception is at the northwest corner of Building B, where wind conditions are predicted to be suitable for fast walking in the winter. Recommendations are provided are in Section 4.1. At the nearby transit stops wind conditions are predicted to be conducive to sitting or standing year-round.

4.4 Wind Safety

In both the Existing and Proposed Configurations, the wind safety criterion is expected to be met on an annual basis both at grade and above grade (Appendix B).



Downwashing Flow



Channeling Flow

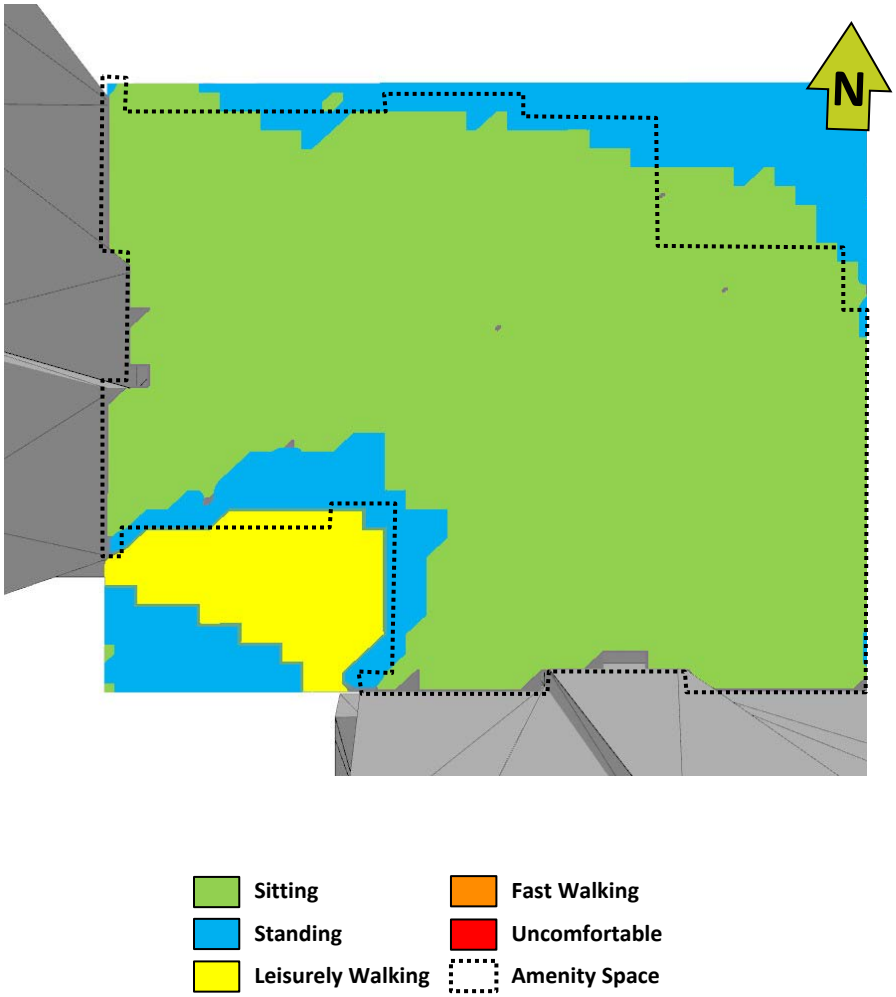


Figure 10a: Proposed Configuration – Pedestrian Wind Comfort – Summer – Level 4

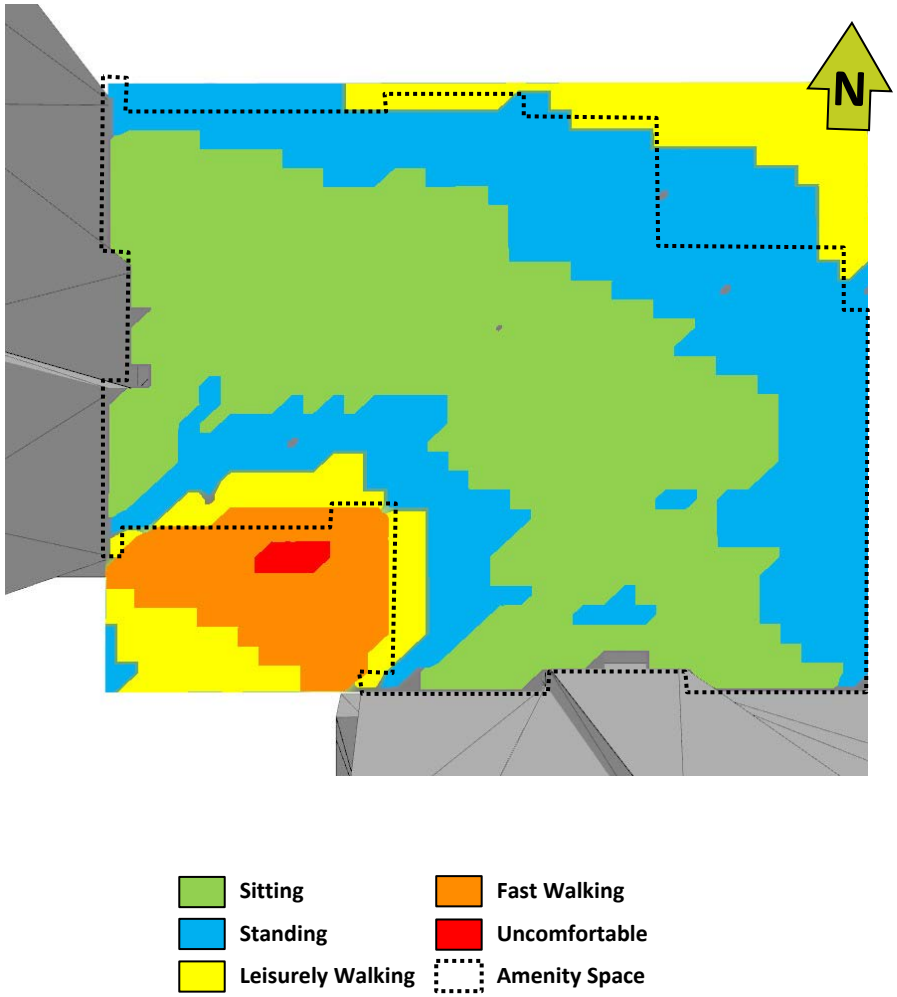


Figure 10b: Proposed Configuration – Pedestrian Wind Comfort – Winter – Level 4

5.0 CONCLUSIONS & RECOMMENDATIONS

The pedestrian wind conditions predicted for the proposed development at 7449 Montrose Road 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 development in both the Existing and Proposed Configurations.
- Wind conditions on the site are generally expected to be suitable for the intended usage year-round. Suggestions for wind mitigation features are provided for specific areas around Building B to improve local wind conditions.
- Wind conditions on the Level 4 amenity terrace of Building A are generally expected to be suitable for the intended usage year-round. Mitigation measures are recommended to improve local wind conditions at the southwest corner of the space.
- Wind conditions on the surrounding sidewalks and at nearby transit stops are generally expected to be comfortable for the intended usage year-round. Suggestions are provided for the sidewalks at the northwest corner of Building B.

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.

Jenny Graham, P. Eng.
Senior Engineer

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

7.0 REFERENCES

Blocken, B., and J. Carmeliet (2004) “Pedestrian Wind Environment around Buildings: Literature Review and Practical Examples” *Journal of Thermal Environment and Building Science*, 28(2).

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Appendix A

Pedestrian Wind Comfort Analysis

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

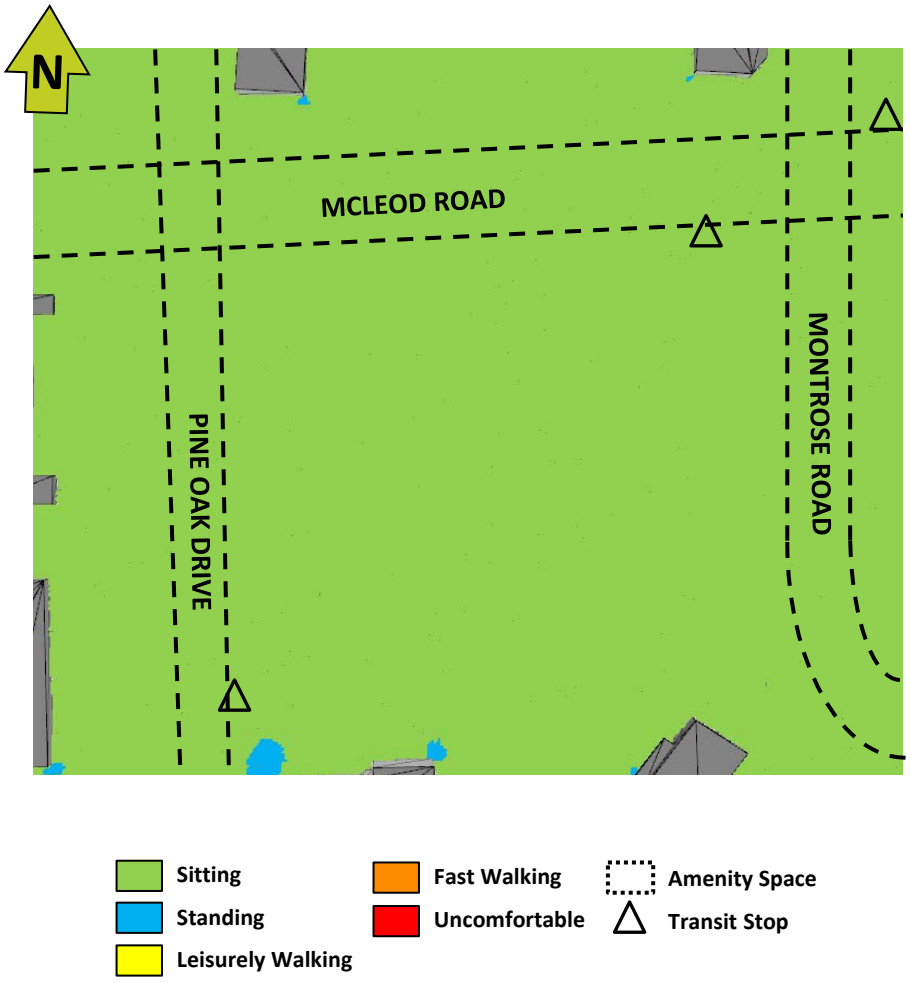

Figure A1a: Existing Configuration – Pedestrian Wind Comfort – Spring – Grade

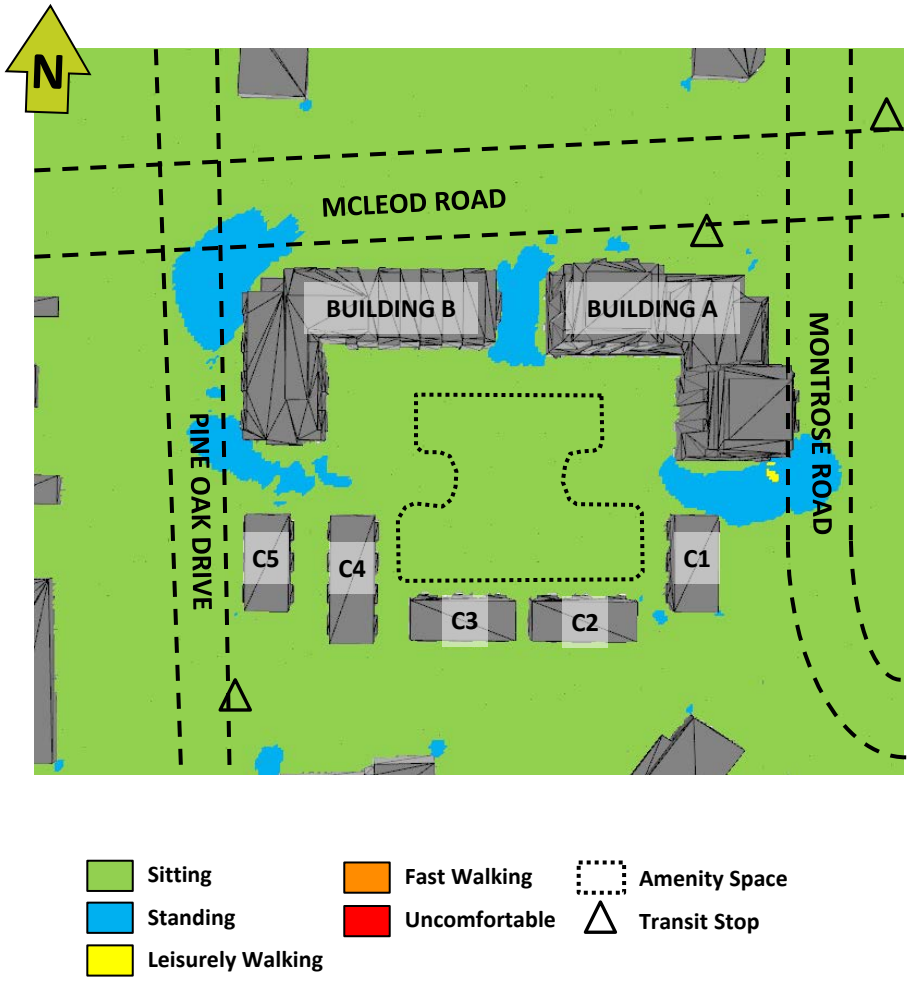

Figure A1b: Proposed Configuration – Pedestrian Wind Comfort – Spring – Grade

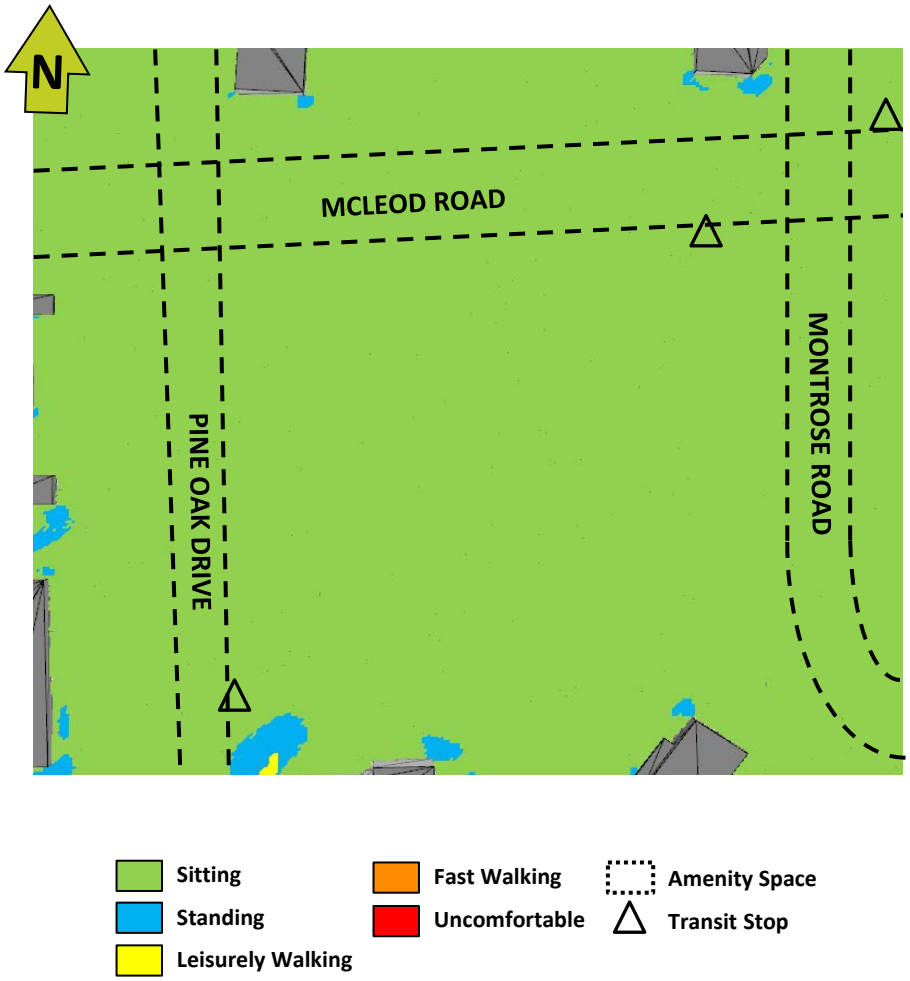

Figure A2a: Existing Configuration – Pedestrian Wind Comfort – Autumn – Grade

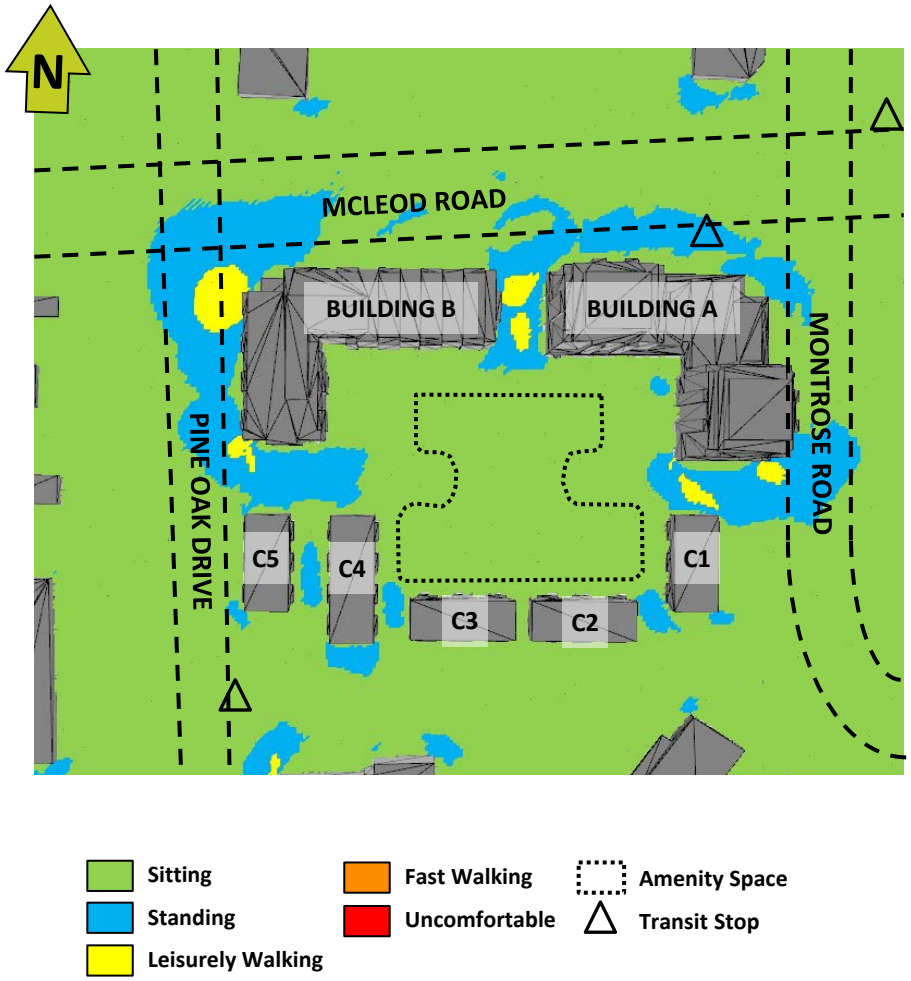

Figure A2b: Proposed Configuration – Pedestrian Wind Comfort – Autumn – Grade

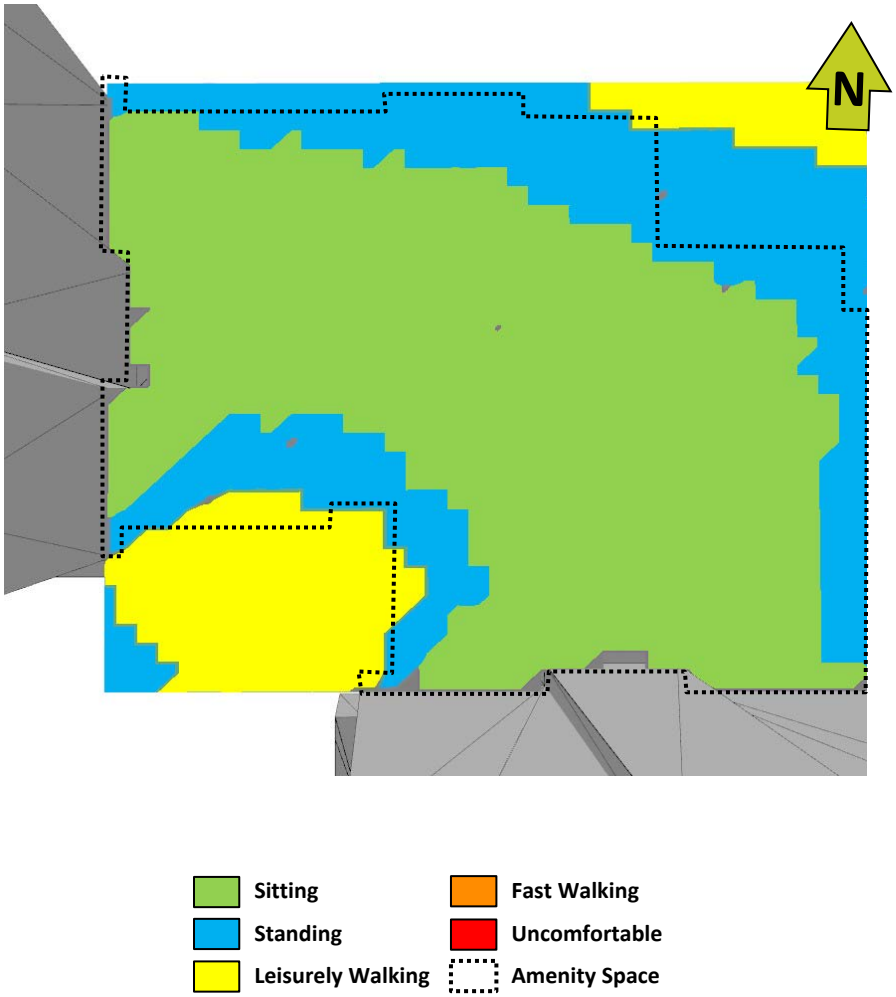

Figure A3a: Proposed Configuration – Pedestrian Wind Comfort – Spring – Level 4

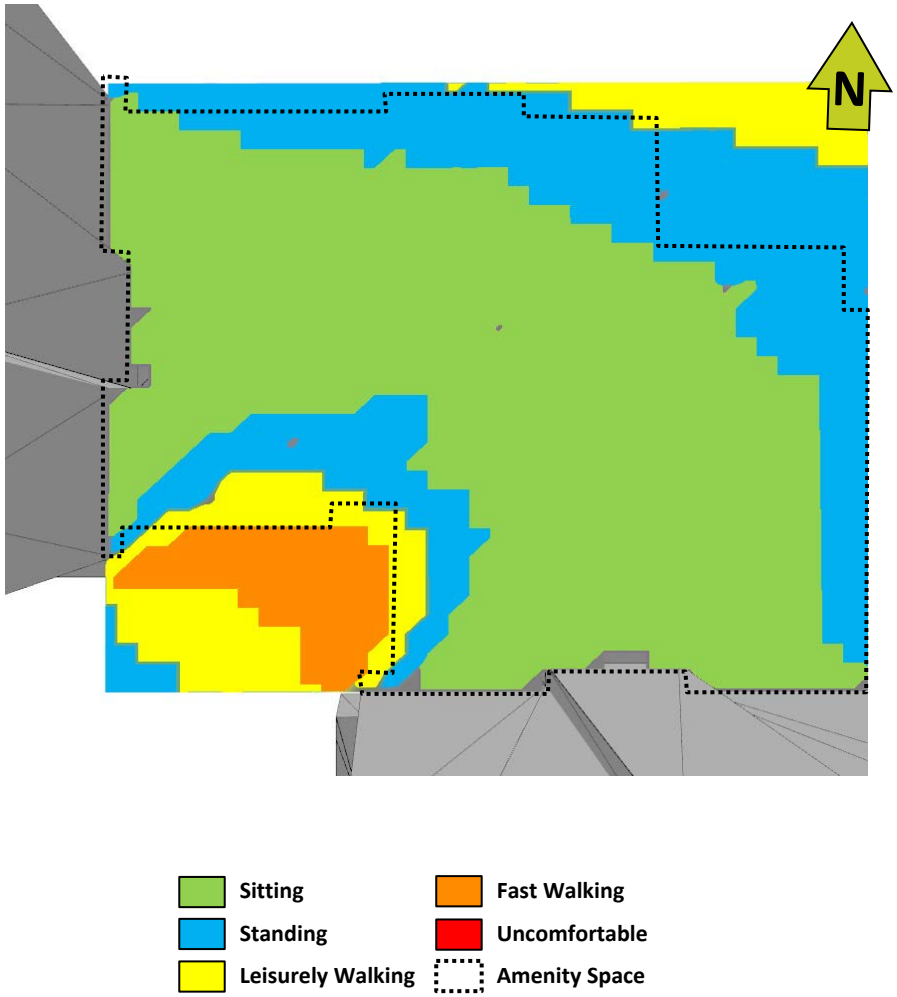

Figure A3b: Proposed Configuration – Pedestrian Wind Comfort – Autumn – Level 4

Appendix B

Pedestrian Wind Safety Analysis

Annual

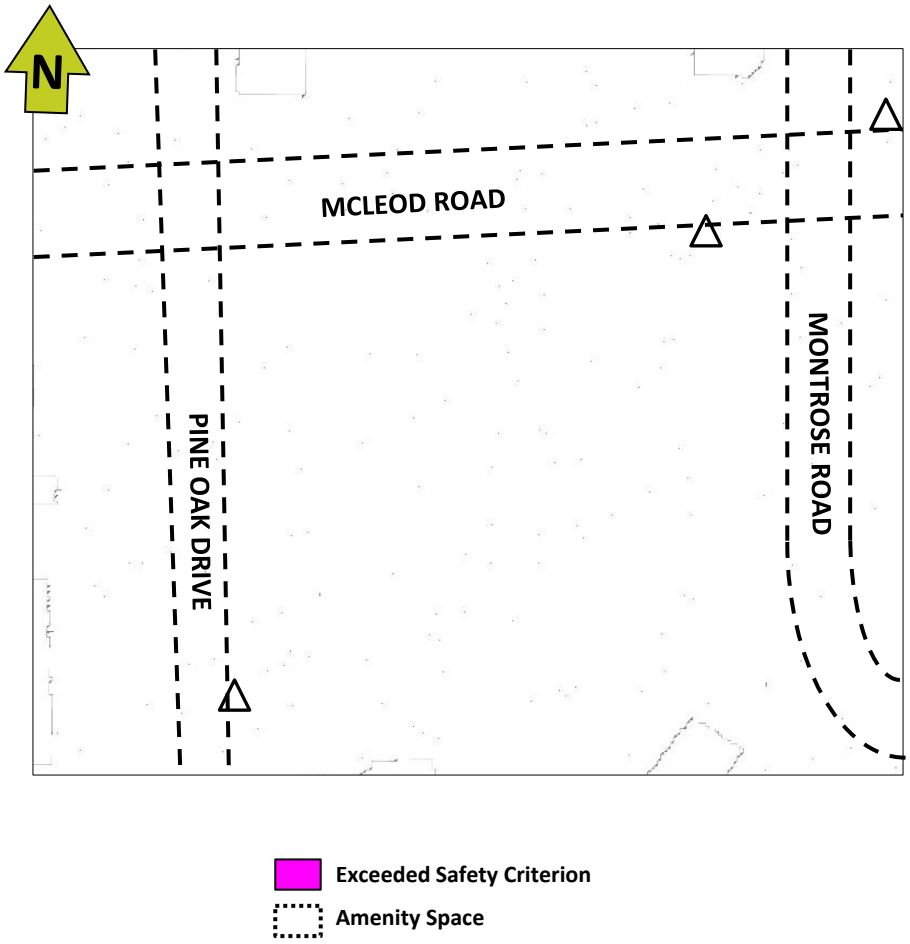

Figure B1a: Existing Configuration – Wind Safety – Annual – Grade

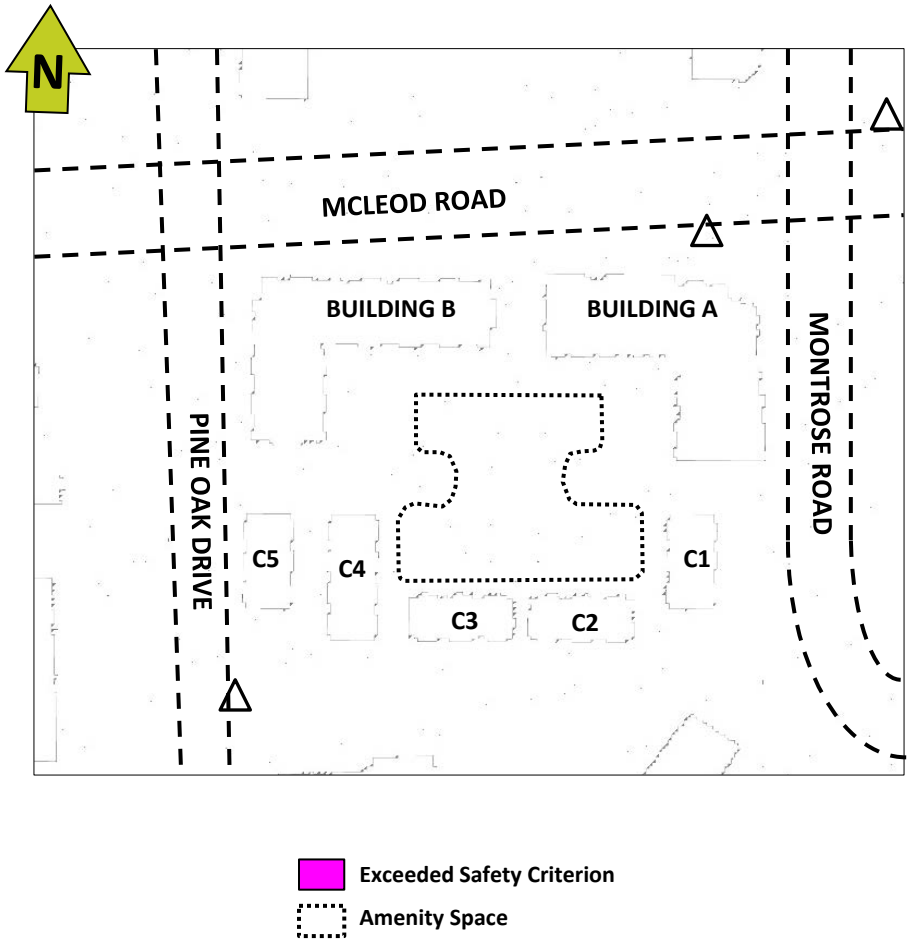

Figure B1b: Proposed Configuration – Wind Safety – Annual – Grade

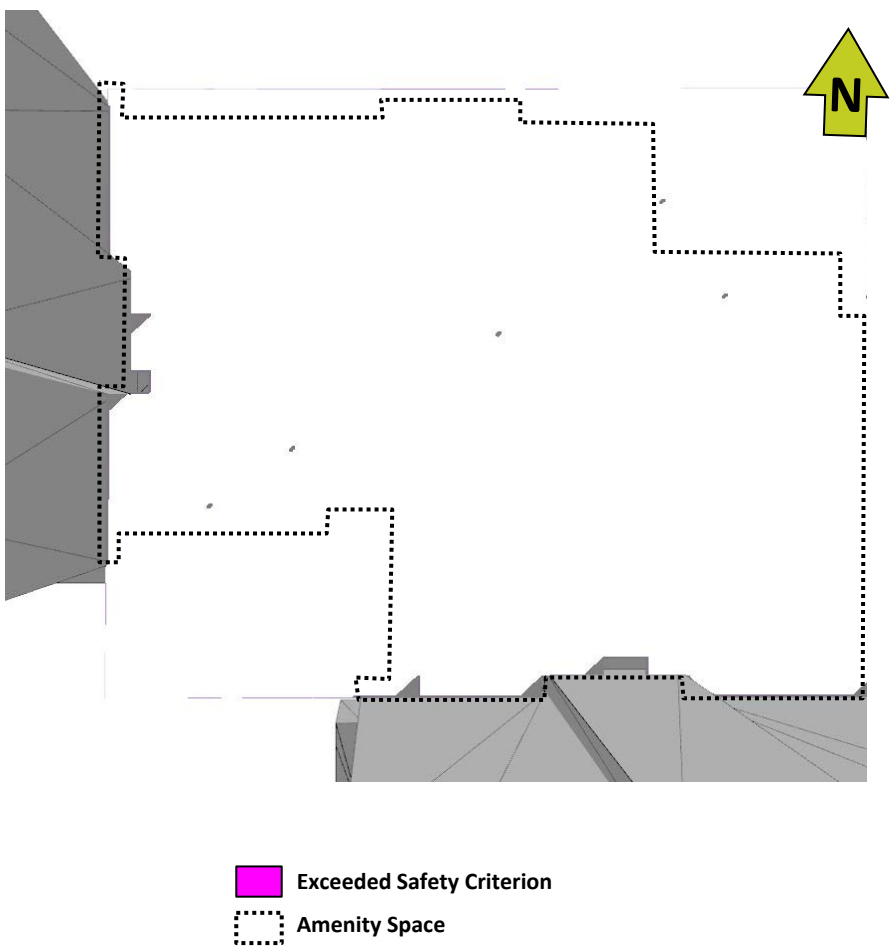

Figure B2: Proposed Configuration – Wind Safety – Annual – Level 4