100 Stone Road West, Suite 201
Guelph, Ontario, N1G 5L3
226.706.8080 | www.slrconsulting.com

Date: May 19, 2022

To: Hygate Development Corp.
1700 Langstaff Road, Suite 2001
Vaughan, ON L4K 3S3

Re: **Pedestrian Wind Assessment**
215 Lexington Phase 2
Waterloo, Ontario
SLR Project #241.30381.00000

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

Tahrana Lovlin, MAES, P.Eng.
Principal, Microclimate

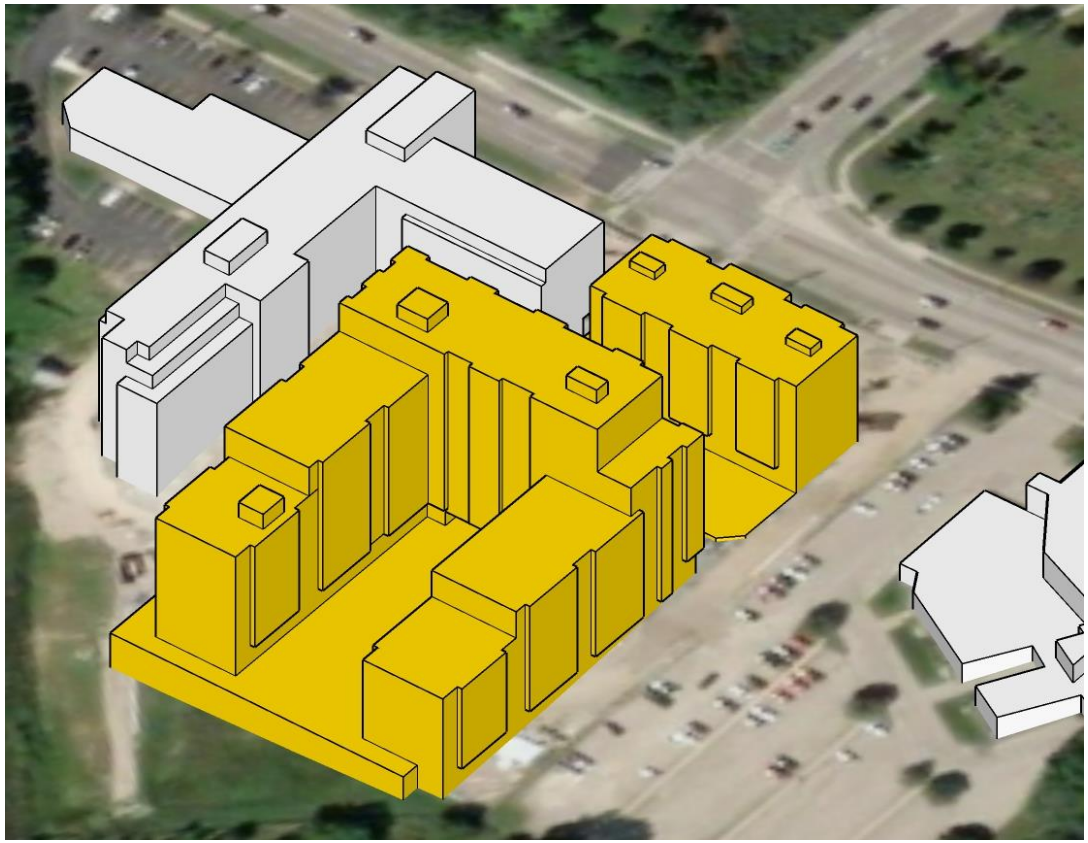




TABLE OF CONTENTS

1.0 Introduction 2

1.1 Existing Site 2

1.2 Proposed Development 4

1.3 Areas of Interest 4

2.0 Approach 6

2.1 Methodology 6

2.2 Wind Climate 9

3.0 Pedestrian Wind Criteria 10

4.0 Results 11

4.1 Building Entrances & Walkways 11

4.2 Amenity Terrace 11

4.3 Surrounding Sidewalks 16

4.4 Wind Safety 16

5.0 Updated Architectural Information 17

6.0 Conclusions & Recommendations 18

7.0 Assessment Applicability 18

8.0 References 19

Appendix A 20

Appendix B 24

1.0 INTRODUCTION

SLR Consulting (Canada) Ltd. (SLR) was retained by Hygate Development Corp. to conduct a pedestrian wind assessment for Phase 2 of the proposed development at 215 Lexington Road in Waterloo, Ontario. This report is in support of the Official Plan Amendment (OPA) and Zoning Bylaw Amendment (ZBA) applications. SLR, previously Novus Environmental Inc., provided a pedestrian wind assessment for Phase 1 of the property in March 2019.

1.1 Existing Site

The proposed development is located at 215 Lexington Road, to the east of Conestoga Parkway. The site is currently occupied by a low-rise institutional building. **Figure 1** provides an aerial view of the immediate study area. A site visit was conducted by SLR dated December 22, 2021; some of these images are included in **Figures 2a** through **2d**.

Immediately surrounding the site there are churches to the north through east, with residential buildings to the southeast and northwest. To the west is the mid-rise Phase 1 building, while the Conestoga Parkway is to the south. Beyond the immediate surroundings there are low-rise residential buildings in all directions, with commercial buildings to the west, along Lexington Road.

Typically, developments with Site Plan Control approval and/or those currently under construction within a 500 radius are included as existing surroundings. For this assessment, no such developments were found within the radius.



Figure 1: Aerial view of existing site & surroundings
Credit: Google Earth Pro, dated 8/9/2018



Figure 2a: Looking southwest along Lexington Road (site to the left)



Figure 2b: Looking northeast at the site from Lexington Road



Figure 2c: Looking west towards Davenport Road from Lexington Road



Figure 2d: Looking east from Davenport Road

1.2 Proposed Development

The proposed Phase 2 development includes a seven-storeys tall institutional building (approximately 19 m in height) along the north edge of the site, fronting Lexington Road (Building A). Building B of Phase 2 is 11 storeys tall (approximately 31 m), with stepped facade on the south side, located on the south edge of the site. There is a 4 m elevation change, approximately, from north edge to the south edge of the site. Figure 3 provides a rendering of the proposed development, including Phase 1.

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 along Lexington Road within the project's vicinity. The main residential entrance to Building A is located on the north facade along Lexington Road. The main entrance to Building B is on the west side of the central pass-thru, beneath the building. In addition, an amenity terrace is planned on the west side of Building B at Level 1. On-site areas of interest are shown in Figure 4.

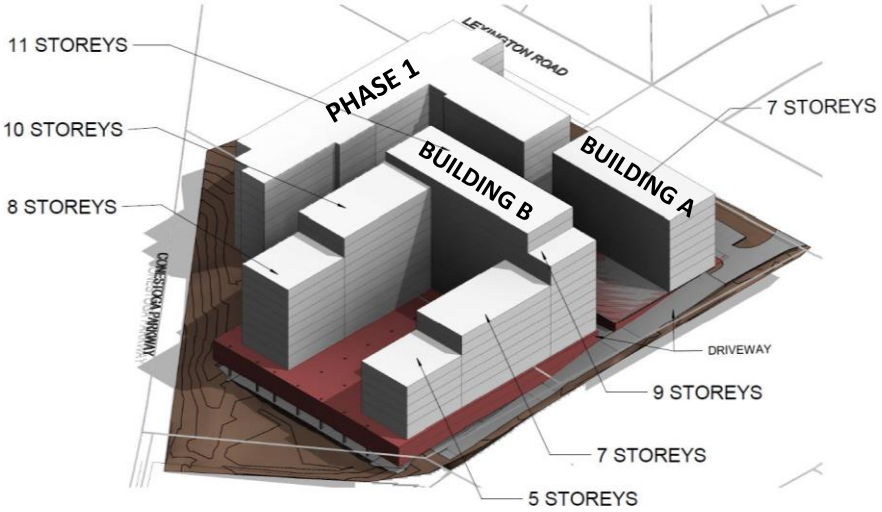


Figure 3: Rendering of proposed development
Credit: IBI Group

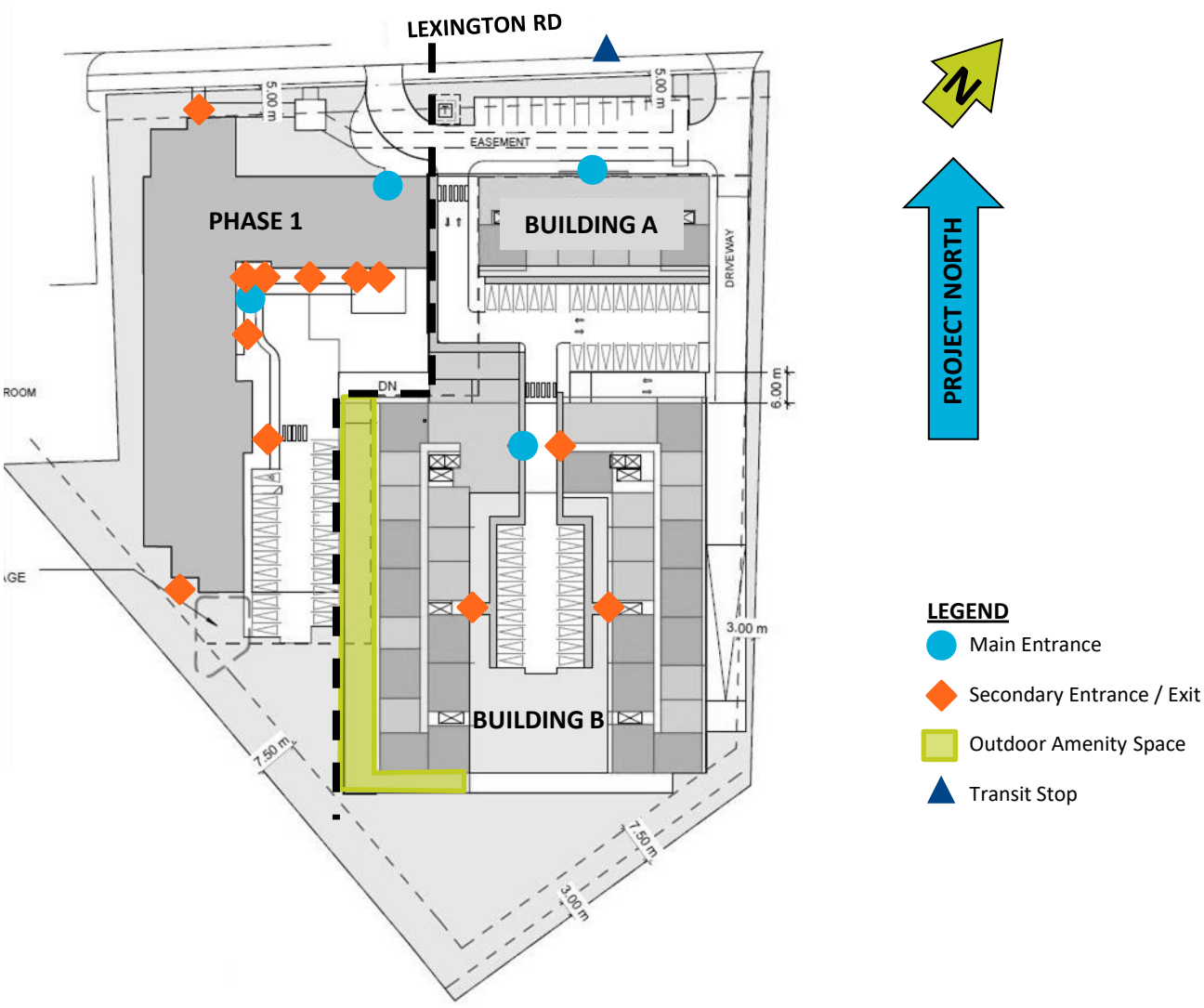


Figure 4: Areas of Interest

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 and elevations, were provided IBI Group on November 17 and December 8, 2021. A view of the 3D model used in the computer wind comfort analysis is shown in **Figure 5**. This model included surrounding buildings within 500 m from the study site centre. The simulations were performed using CFD software by Meteodyn Inc. The entire 3D space throughout the modeled area is filled with a three-dimensional grid. The CFD virtual wind tunnel calculates wind speed at each one of the 3D grid points. The upstream "roughness" for each test direction is adjusted to reflect the various upwind conditions and wind characteristics encountered around the actual site. Wind flows for a total of 16 compass directions were simulated. Although wind speeds are calculated throughout the entire modeled area, wind comfort conditions were only plotted for a smaller area immediately surrounding the proposed development.

SLR assessed two configurations for comparison purposes. The descriptions are as follows:

- **Existing Configuration:** Existing site and surroundings
- **Proposed Configuration:** Proposed development with existing surroundings

A view of two configurations are shown in **Figures 5a** and **5b**.

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.

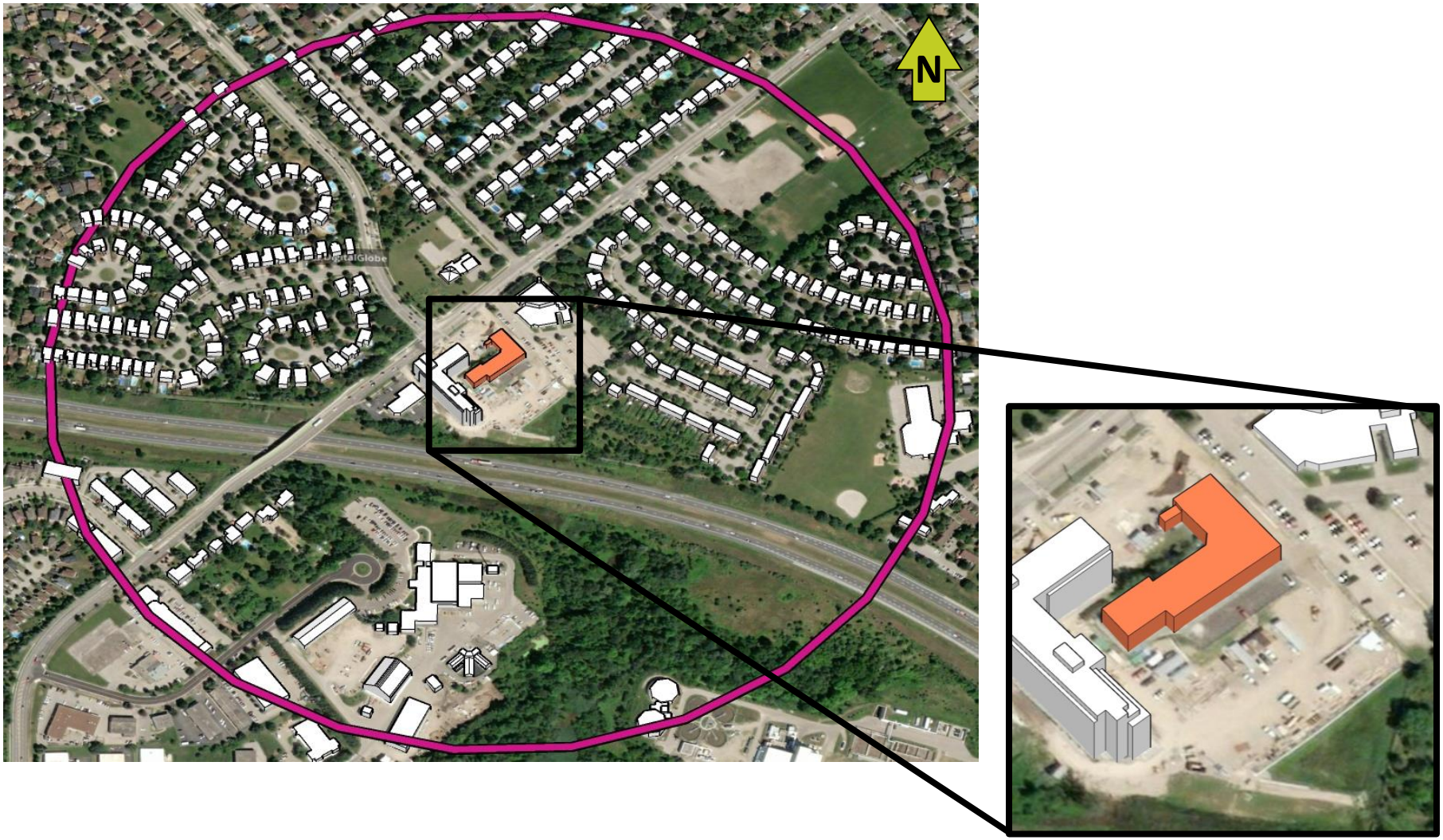


Figure 5a: Massing Model – Existing Configuration

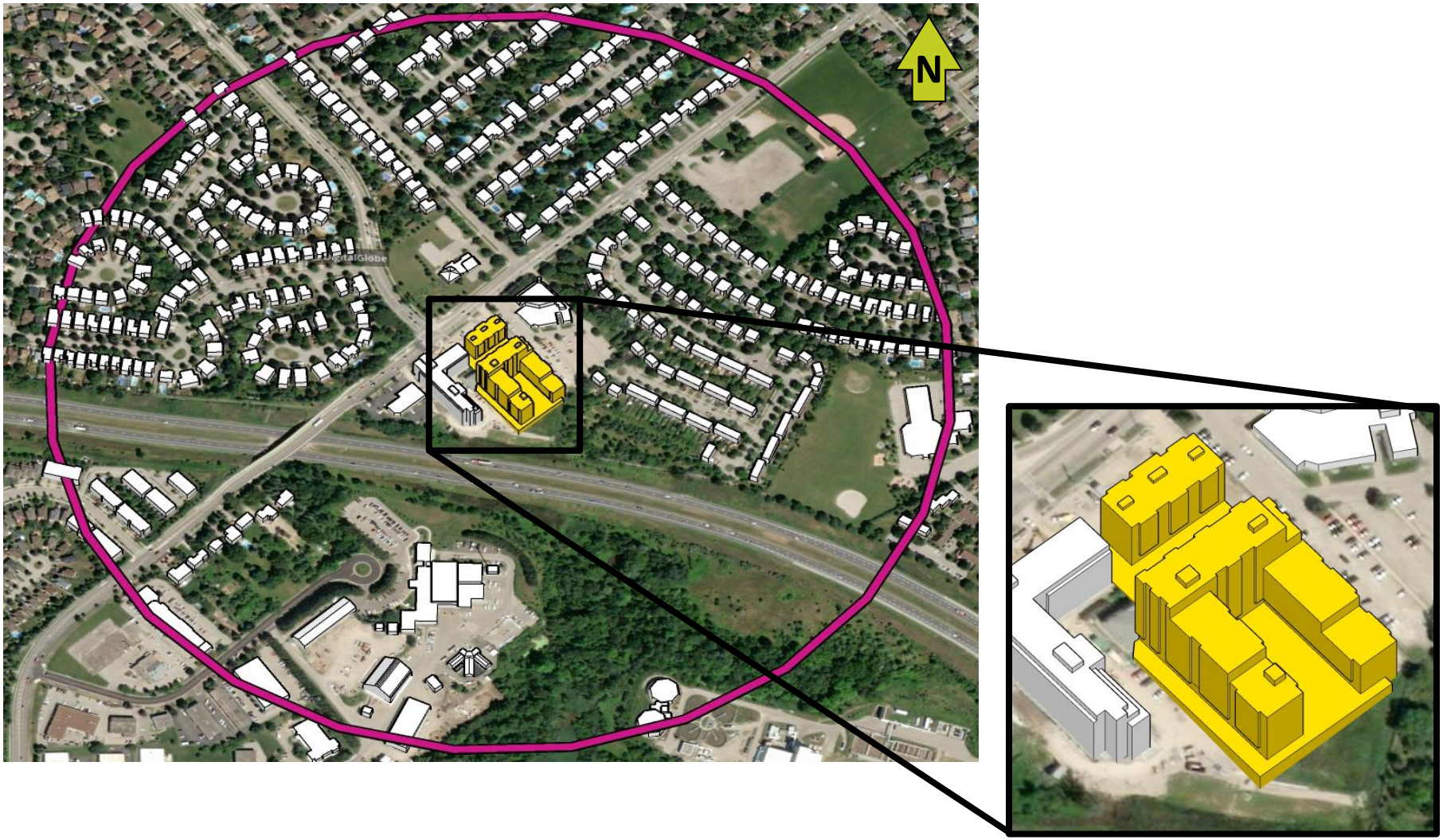


Figure 5b: Massing Model – Proposed Configuration

2.2 Wind Climate

Wind data recorded at Waterloo Regional Airport in Toronto for the period of 1993 to 2020 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 southwest through northwest and east 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, southwesterly sectors and from the east. All wind speeds and directions were included in the wind climate model.

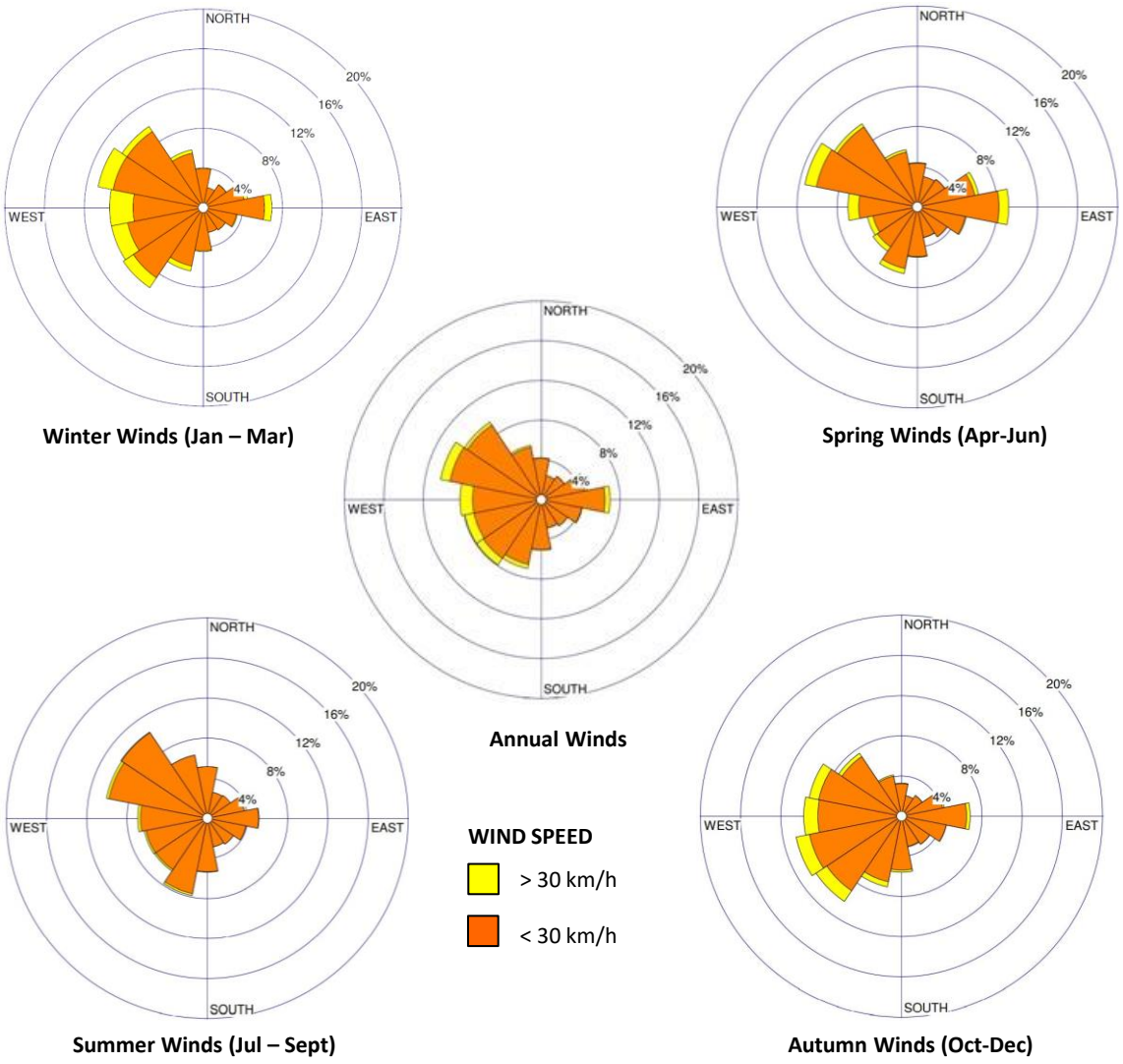


Figure 6: Wind Roses for Waterloo Regional Airport (1993 - 2020)

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 presence of mature trees can lead to wind comfort levels that are marginally more comfortable than shown, during seasons when foliage is present. 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. However, in some climates these may be difficult to achieve in the winter due to the overall climate. For sidewalks, walkways and pathways, wind comfort suitable for leisurely walking are desirable year-round but may not be feasible in the winter. The presence of benches on a sidewalk, which are an optional use, does not change the overall wind comfort requirement for sidewalk. Wind conditions of fast walking are satisfactory for loading areas, laneways, and a limited portion of a sidewalk, considering exposure is brief for pedestrians. For main entrances, transit stops, and public amenity spaces such as parks and playgrounds, wind conditions conducive to standing are preferred throughout the year. For on-site amenity areas, wind conditions suitable for sitting or standing are desirable during the summer, with stronger wind flows, conducive to leisurely walking, tolerated in the winter. The most stringent category of sitting is desirable during the summer for dedicated seating areas, such as patios, where calmer wind is expected for the comfort of patrons.

4.1 Building Entrances & Walkways

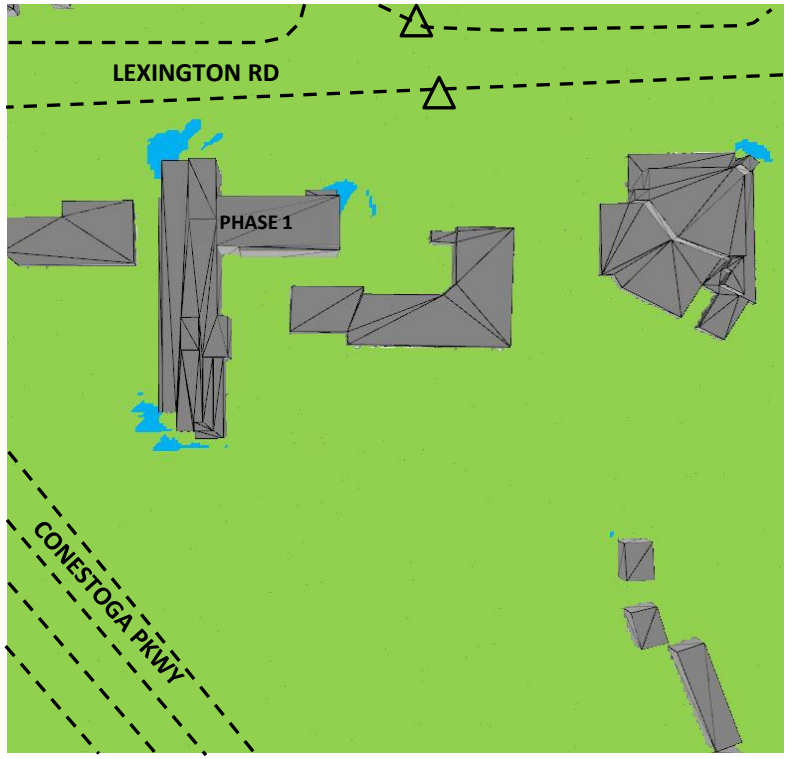
Existing wind condition on-site are expected to be comfortable for leisurely walking or better throughout the year (Figures 7a and 8a).

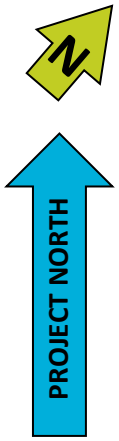
In the Proposed Configuration, wind conditions on the site are predicted to remain comfortable for leisurely walking or better year-round (Figures 7b and 8b). Wind conditions at the main entrances and all secondary entrances as well as exits are anticipated to be comfortable for sitting or standing throughout the year, which is considered suitable for the intended use (Figures 7b, 8b, 9a, and 9b). Wind conditions on the rest of Level 1, which includes the parking lot, are predicted to be comfortable for sitting or standing in the summer (Figure 10a). During the winter, wind conditions are generally expected to be comfortable for leisurely walking or better (Figure 10b).

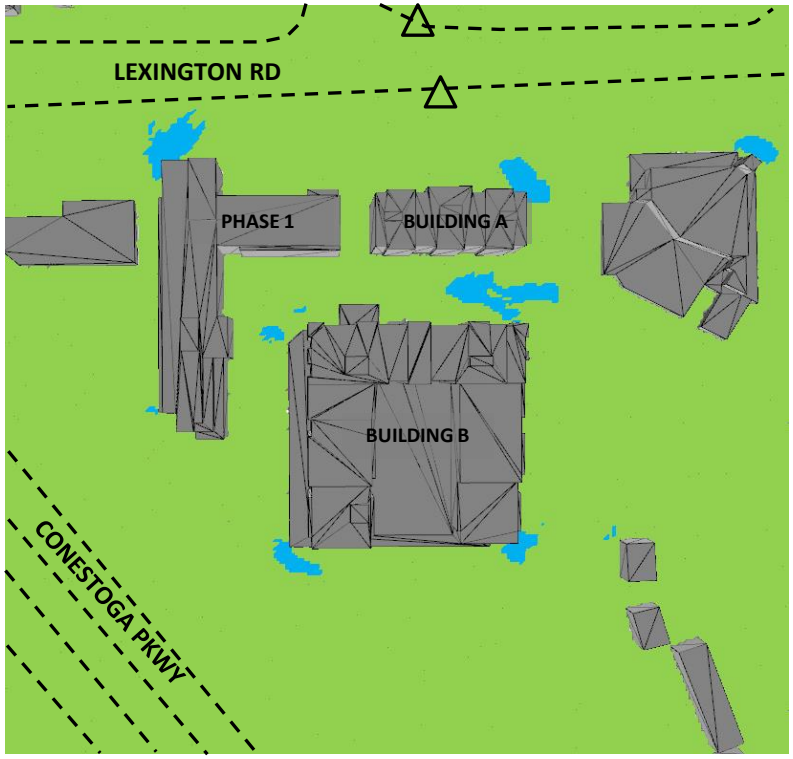
These conditions are considered suitable for the intended use.

4.2 Amenity Terrace

At the amenity terrace on the west side of Building B, wind conditions are generally predicted to be suitable sitting or standing throughout the year (Figures 10a and 10b). One exception is near the southwest corner of Building B, where wind conditions conducive to fast walking are predicted in the winter (Figure 10b). We recommend not planning passive activities near this corner. Alternatively, if calmer wind conditions are desired near this corner, the design team could consider wind control measures in the form of vertical wind screens or a canopy wrapping around the southwest corner of the building.





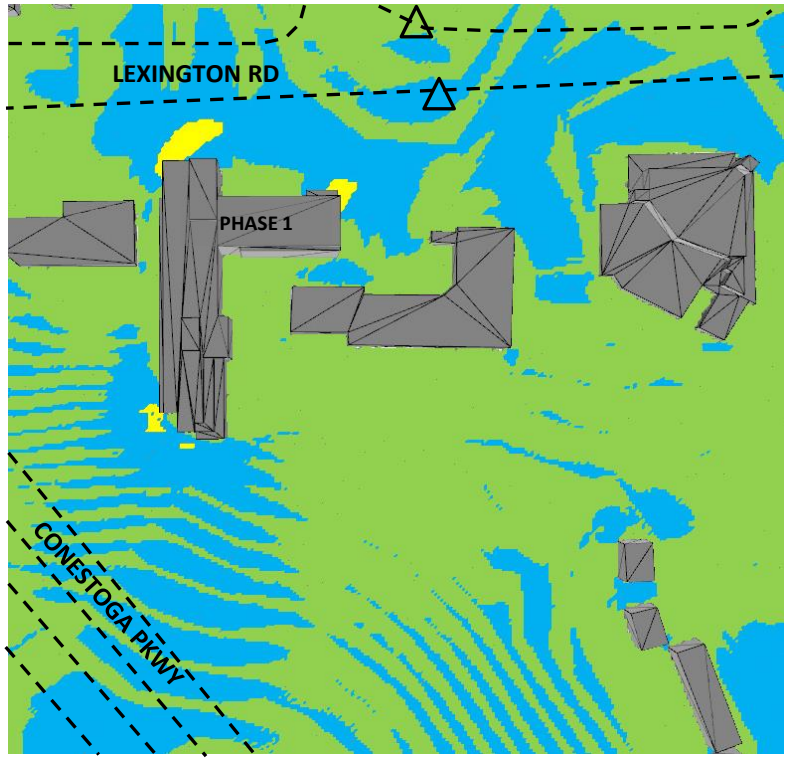


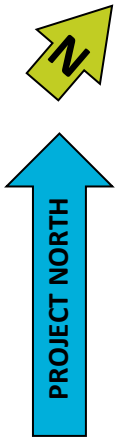
Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

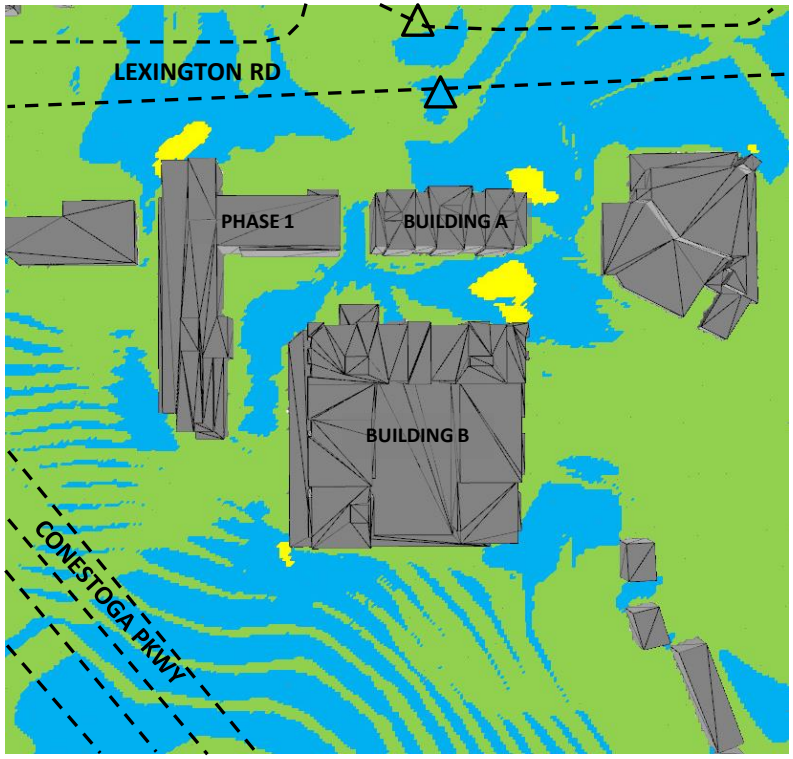
Figure 7a: Existing Configuration – Pedestrian Wind Comfort Summer – On-site & Surrounding Areas

Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

Figure 7b: Proposed Configuration – Pedestrian Wind Comfort Summer – On-site & Surrounding Areas







Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

Figure 8a: Existing Configuration – Pedestrian Wind Comfort Winter – On-site & Surrounding Areas

Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

Figure 8b: Proposed Configuration – Pedestrian Wind Comfort Winter – On-site & Surrounding Areas

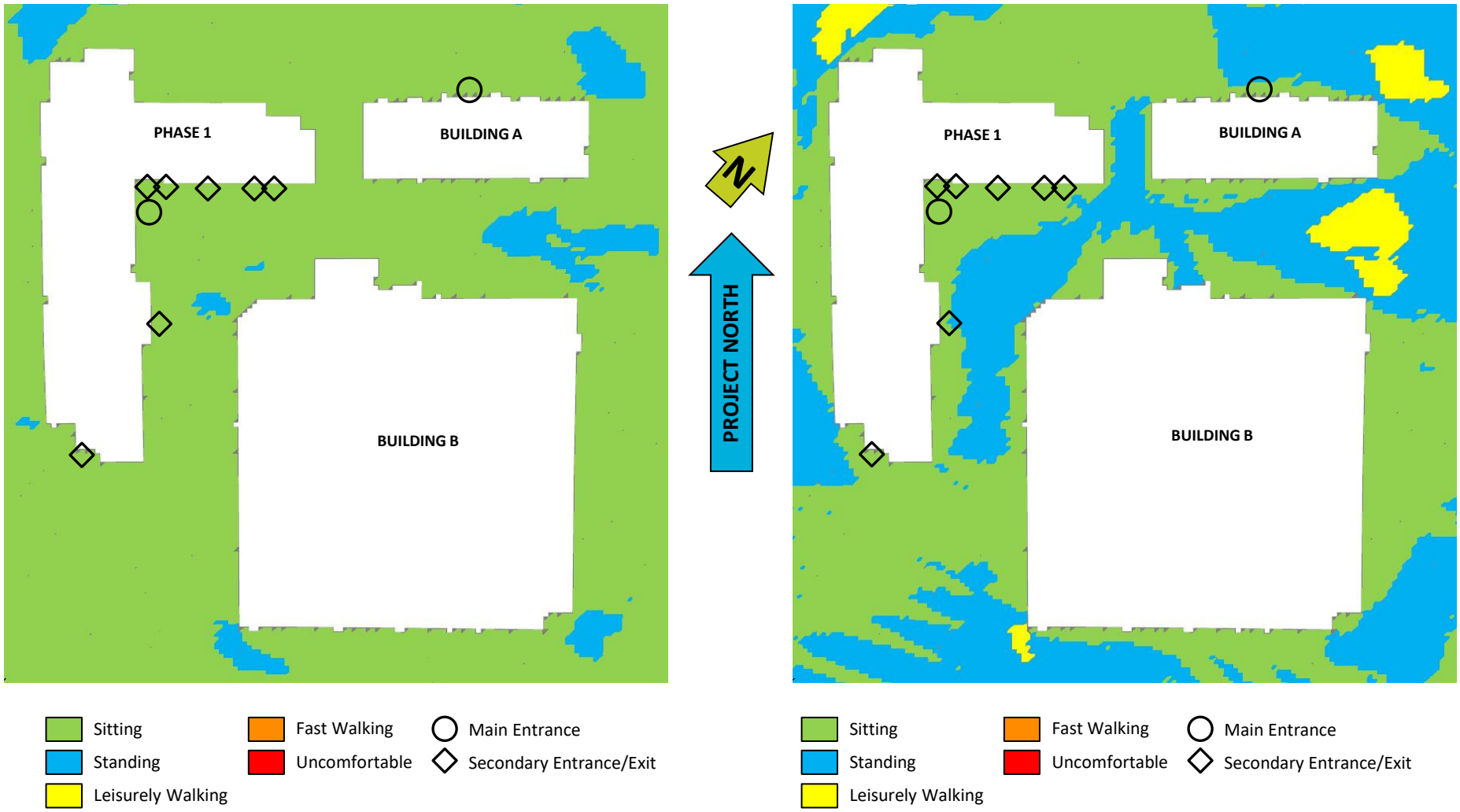
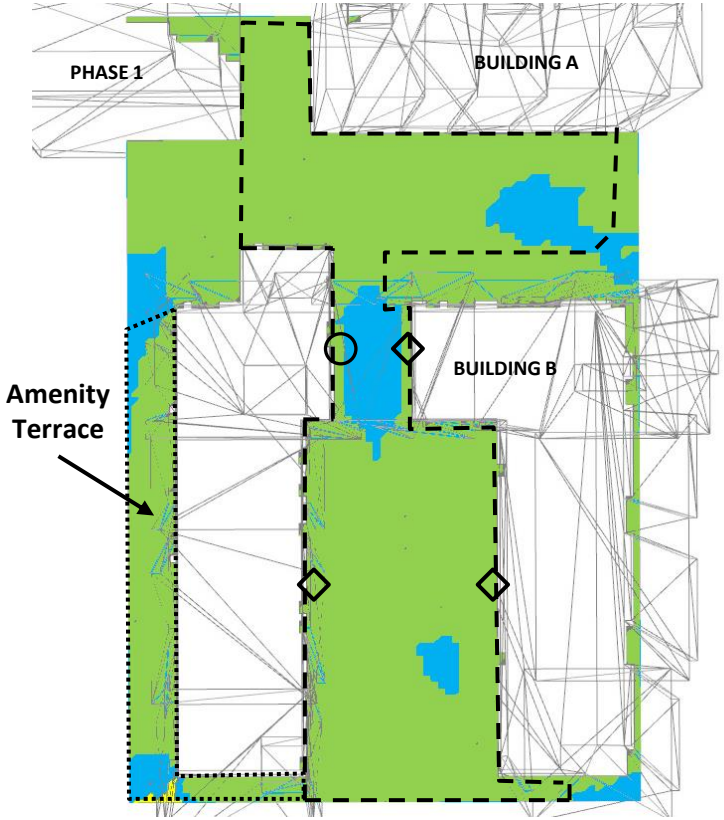
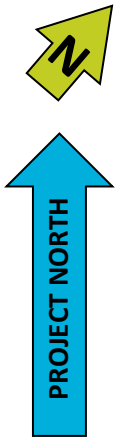
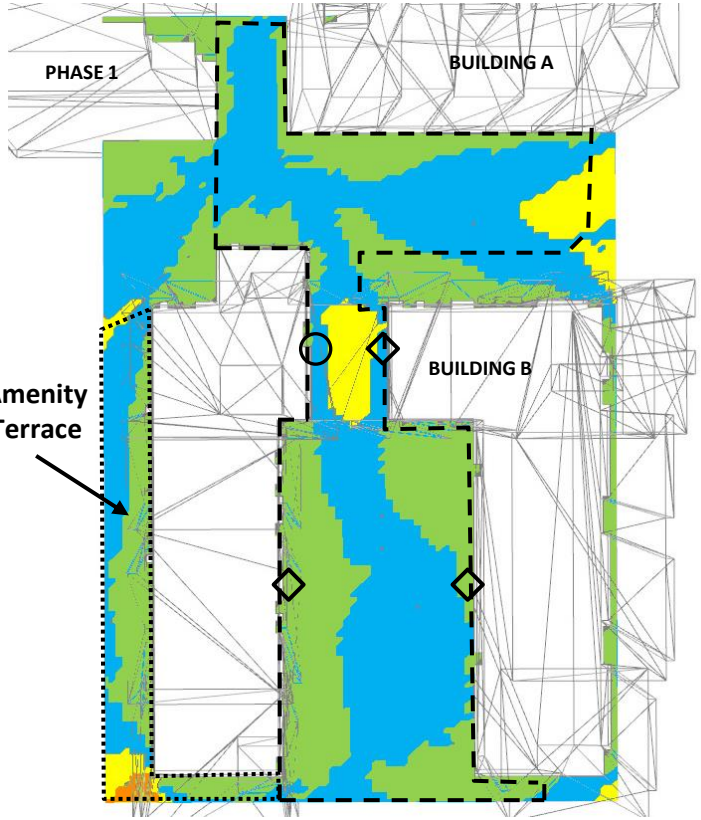


Figure 9a: **Proposed Configuration – Pedestrian Wind Comfort Summer – Building Entrances & Walkways**

Figure 9b: **Proposed Configuration – Pedestrian Wind Comfort Winter – Building Entrances & Walkways**







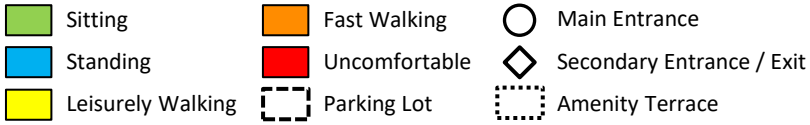


Figure 10a: Proposed Configuration – Pedestrian Wind Comfort Summer – Level 1

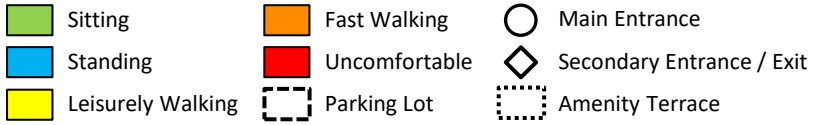


Figure 10b: Proposed Configuration – Pedestrian Wind Comfort Winter – Level 1

4.3 Surrounding Sidewalks

Existing wind conditions along the sidewalks of Lexington Road are expected to be comfortable for leisurely walking or better year-round (Figures 7a and 8a). At the nearby transit stops, wind conditions are predicted to be suitable for sitting or standing throughout the year.

With the addition of the proposed development, wind conditions along the surrounding sidewalks and at the nearby transit stops are predicted to remain similar to the existing conditions throughout the year (Figures 7b and 8b).

These wind conditions are satisfactory for the anticipated use.

4.4 Wind Safety

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

5.0 UPDATED ARCHITECTURAL INFORMATION

SLR received updated architectural drawings of the proposed development on May 9, 2022. The following differences were noted between the latest architectural information and the information used to construct the 3D model:

- Building B is now 10-storeys tall on the north end, with a five-storey and eight-storey elements on the east side, as well as 10-storey and 12-storey elements on the west side. Previously, Building B was 11 storeys on the north end, and five and seven storey elements on the east side, as well as eight and ten storey elements on the west side.
- An amenity courtyard has been added between the east and west elements of Building B and a new amenity terrace is now included along the east side of the building, as shown in **Figure 11**.

The massing changes of Building B are considered to have minimal influence on the anticipated wind conditions previously discussed. The wind conditions on-site are expected to remain similar those described in **Sections 4.1** through **4.4**. In the new courtyard and on the amenity terrace to the east of Building B, the wind conditions are predicted to be comfortable for sitting or standing throughout the year, which is considered suitable for the intended use.

Overall, the wind conditions on and surrounding the site are expected to remain similar to the results presented herein.

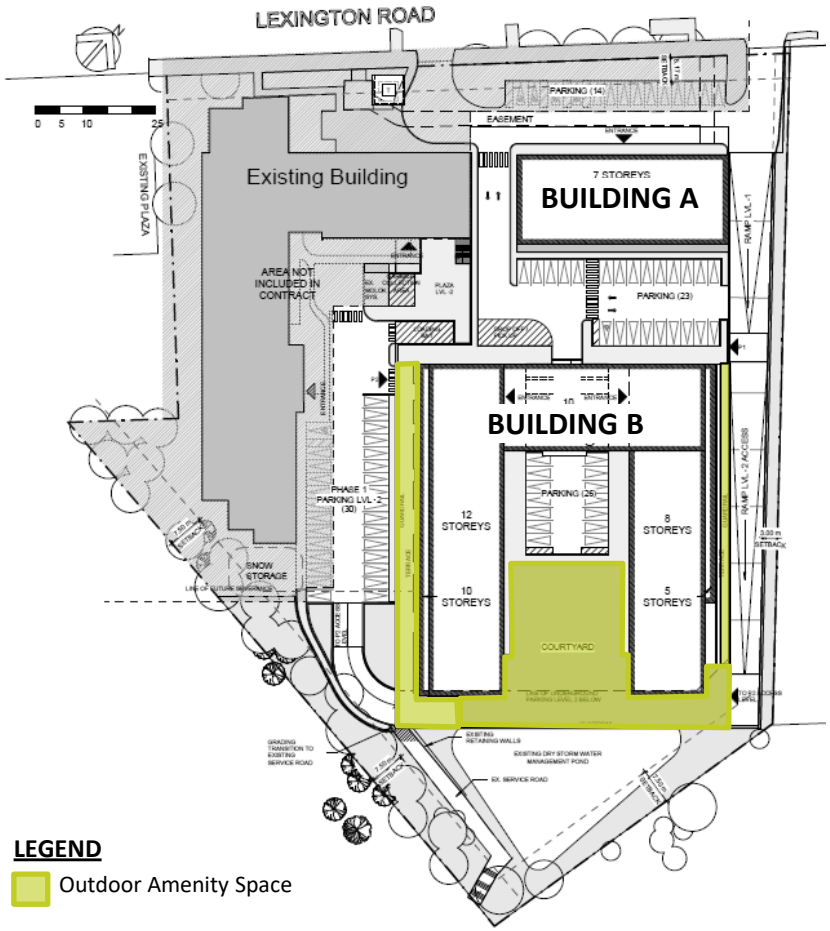


Figure 11: Updated site plan of the proposed development
Credit: IBI Group, received May 9, 2022

6.0 CONCLUSIONS & RECOMMENDATIONS

The pedestrian wind conditions predicted for the proposed development at 215 Lexington Road Phase 2 in Waterloo 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 met at all areas on-site and surrounding the development in both the Existing and Proposed Configurations.
- Wind conditions on the site, including entrances are generally expected to be suitable for the intended use year-round.
- On the sidewalks surrounding the proposed development, wind conditions are suitable for the intended use throughout the year.

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

Sincerely,

SLR Consulting (Canada) Ltd.



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



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

8.0 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).

Cochran, L. (2004) “Design Features to Change and/or Ameliorate Pedestrian Wind Conditions” ASCE Structures Conference 2004.

Davenport, A.G. (1972) "An Approach to Human Comfort Criteria for Environmental Wind Conditions", *Colloquium on Building Climatology*, Stockholm, September 1972.

Durgin, F.H. (1997) “Pedestrian level wind criteria using the equivalent average” *Journal of Wind Engineering and Industrial Aerodynamics* 66.

Isyumov, N. and Davenport, A.G., (1977) “The Ground Level Wind Environment in Built-up Areas”, Proc. of 4th Int. Conf. on Wind Effects on Buildings and Structures, London, England, Sept. 1975, Cambridge University Press, 1977.

Isyumov, N., (1978) “Studies of the Pedestrian Level Wind Environment at the Boundary Layer Wind Tunnel Laboratory of the University of Western Ontario”, *Jrnl. Industrial Aerodynamics*, Vol. 3, 187-200, 1978.

Irwin, P.A. (2004) “Overview of ASCE Report on Outdoor Comfort Around Buildings: Assessment and Methods of Control” ASCE Structures Conference 2004.

Kapoor, V., Page, C., Stefanowicz, P., Livesey, F., Isyumov, N., (1990) “Pedestrian Level Wind Studies to Aid in the Planning of a Major Development”, *Structures Congress Abstracts*, American Society of Civil Engineers, 1990.

Koss, H.H. (2006) “On differences and similarities of applied wind criteria” *Journal of Wind Engineering and Industrial Aerodynamics* 94.

Soligo, M.J., P.A., Irwin, C.J. Williams, G.D. Schuyler (1998) “A Comprehensive Assessment of Pedestrian Comfort Including Thermal Effects” *Journal of Wind Engineering and Industrial Aerodynamics* 77/78.

Stathopoulos, T., H. Wu and C. Bedard (1992) “Wind Environment Around Buildings: A Knowledge-Based Approach” *Journal of Wind Engineering and Industrial Aerodynamics* 41/44.

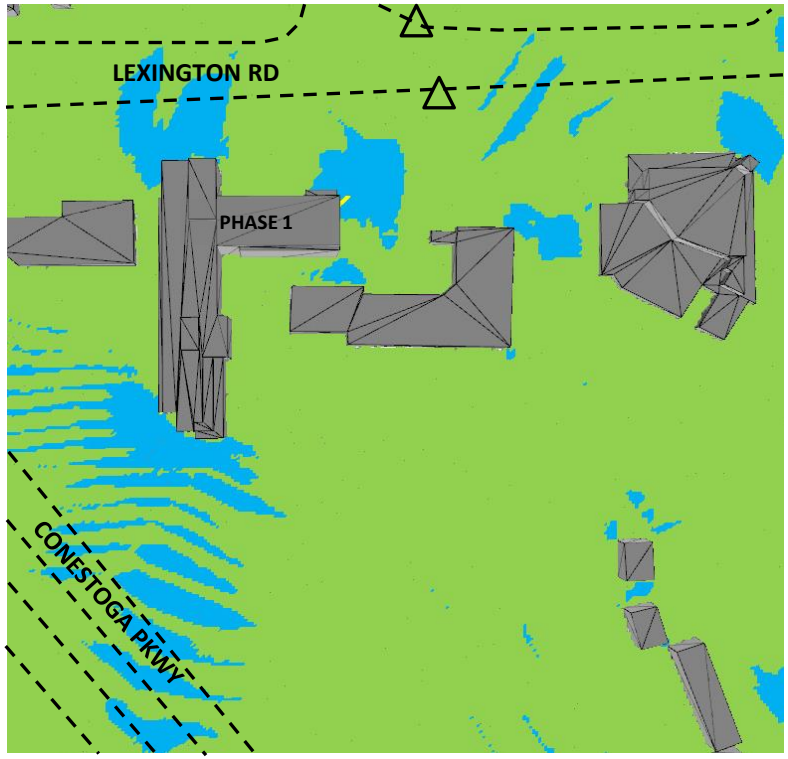
Stathopoulos, T., and H. Wu (1995) “Generic models for pedestrian-level winds in built-up regions” *Journal of Wind Engineering and Industrial Aerodynamics* 54/55.

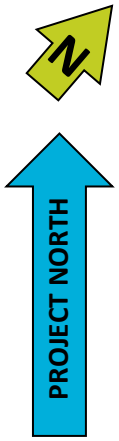
Wu, H., C.J. Williams, H.A. Baker and W.F. Waechter (2004) “Knowledge-based Desk-top Analysis of Pedestrian Wind Conditions”, ASCE Structures Conference 2004.

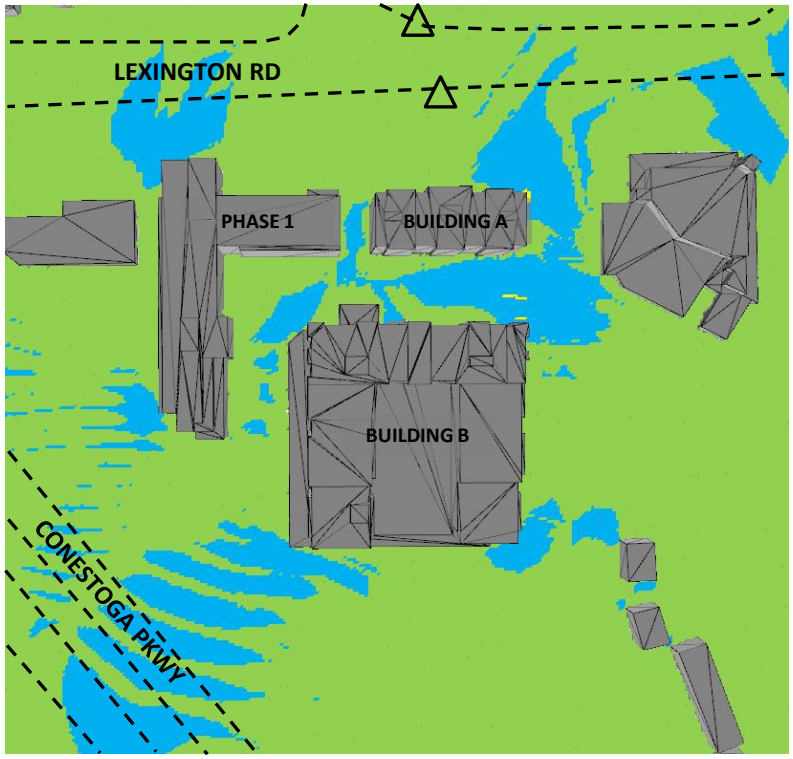
Appendix A

Pedestrian Wind Comfort Analysis

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





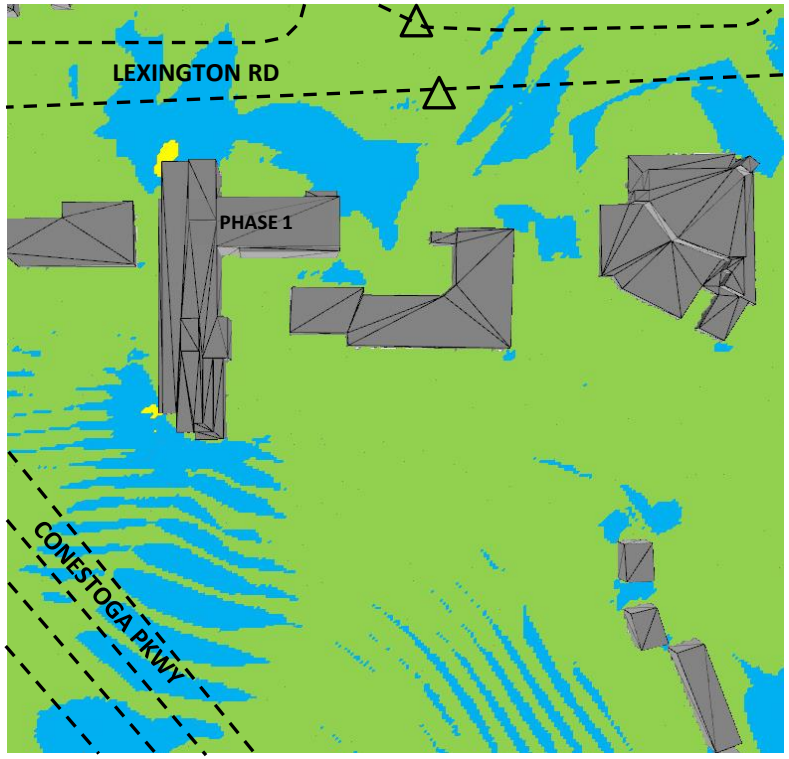


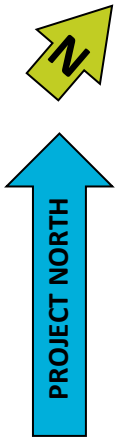
Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

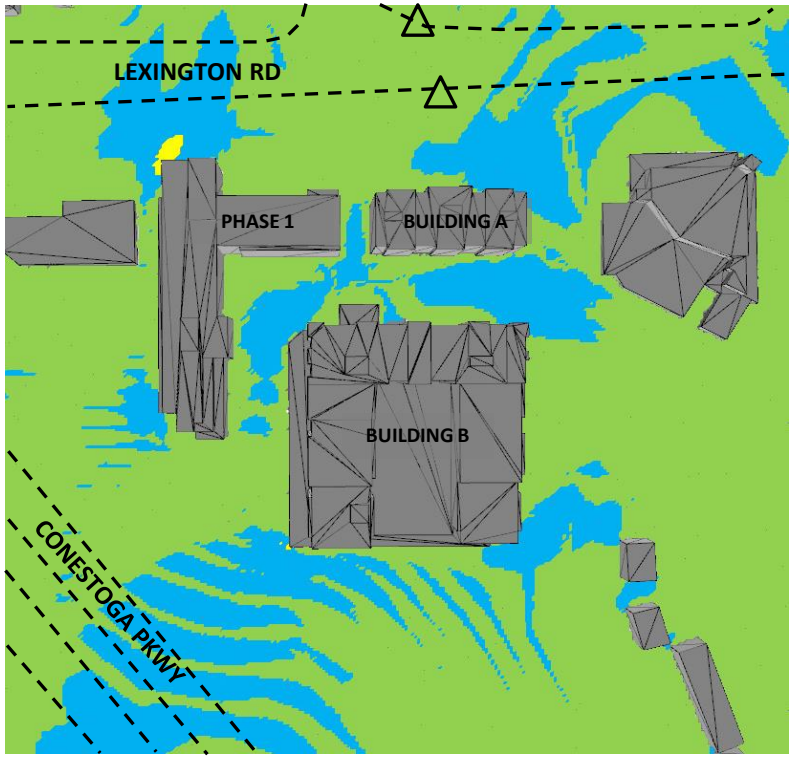
Figure A1a: Existing Configuration – Pedestrian Wind Comfort Spring – On-site & Surrounding Areas

Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

Figure A1b: Proposed Configuration – Pedestrian Wind Comfort Spring – On-site & Surrounding Areas





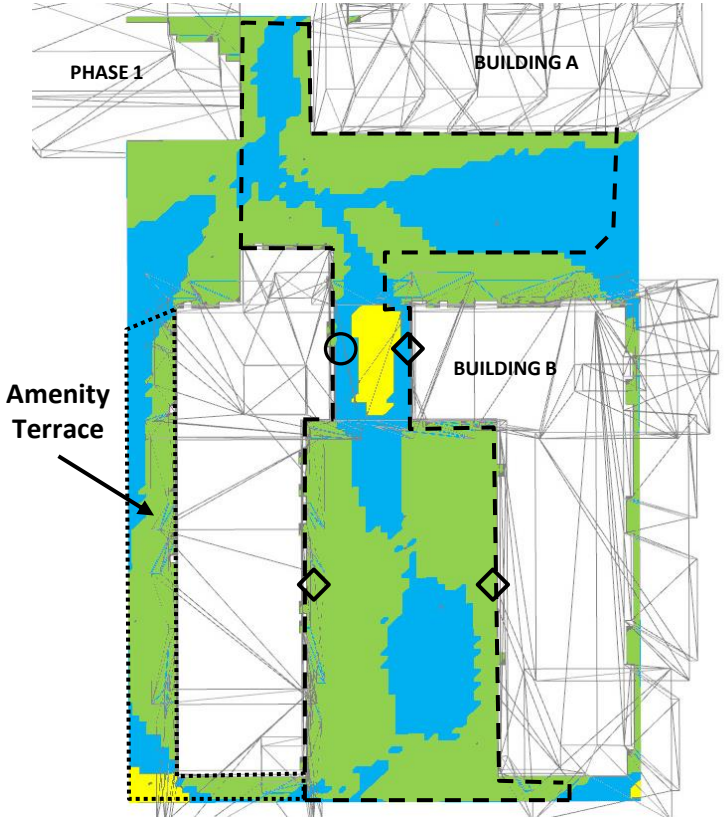


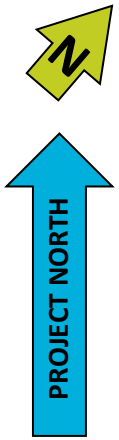
Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

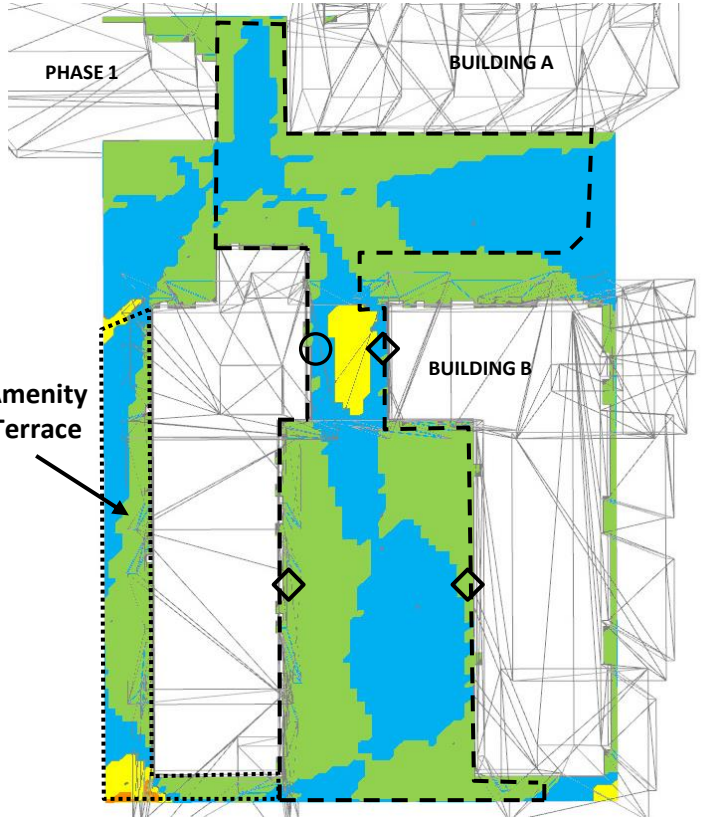
Figure A2a: Existing Configuration – Pedestrian Wind Comfort Autumn – On-site & Surrounding Areas

Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

Figure A2b: Proposed Configuration – Pedestrian Wind Comfort Autumn – On-site & Surrounding Areas







Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Parking Lot
Main Entrance
Secondary Entrance / Exit
Amenity Terrace

Figure A3a: Proposed Configuration – Pedestrian Wind Comfort Spring – Level 1

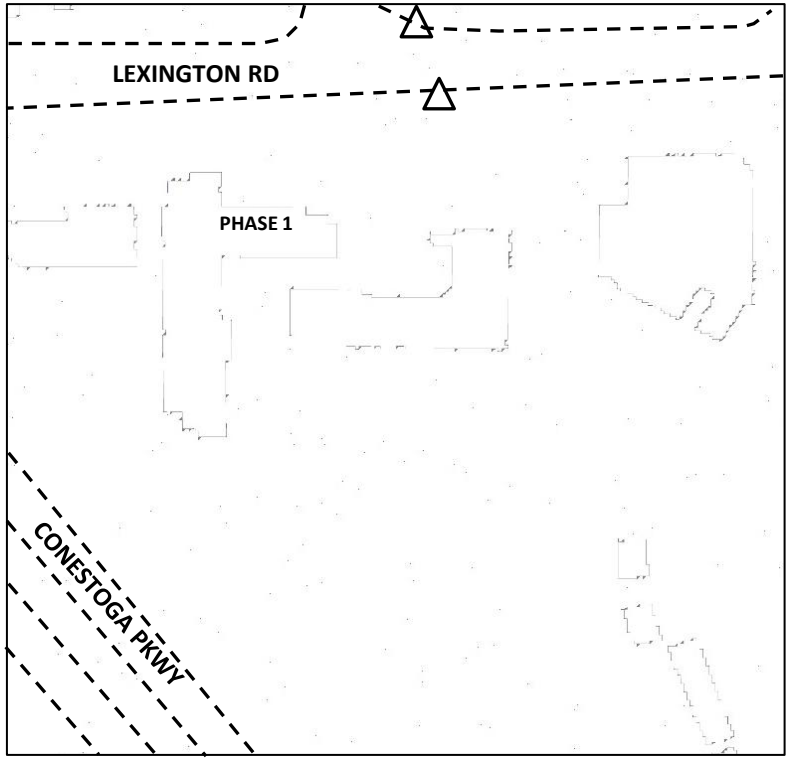
Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Parking Lot
Main Entrance
Secondary Entrance / Exit
Amenity Terrace

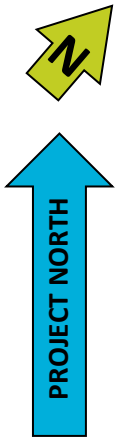
Figure A3b: Proposed Configuration – Pedestrian Wind Comfort Autumn – Level 1

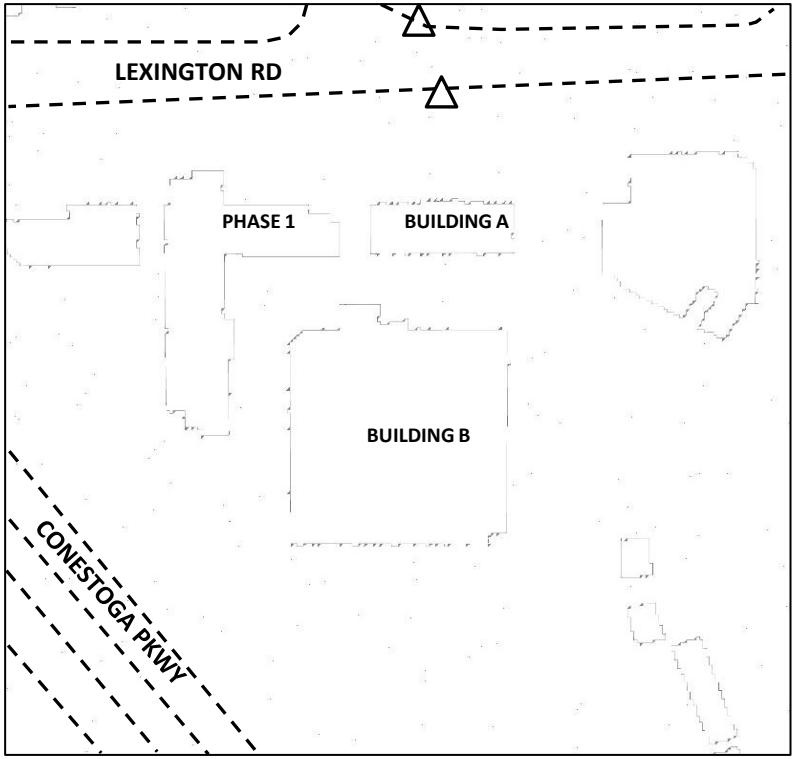
Appendix B

Pedestrian Wind Safety Analysis

Annual







Exceeded Safety Criterion
Transit Stop

Figure B1a: Existing Configuration – Wind Safety Annual – On-site & Surrounding Areas

Exceeded Safety Criterion
Transit Stop

Figure B1b: Proposed Configuration – Wind Safety Annual – On-site & Surrounding Areas

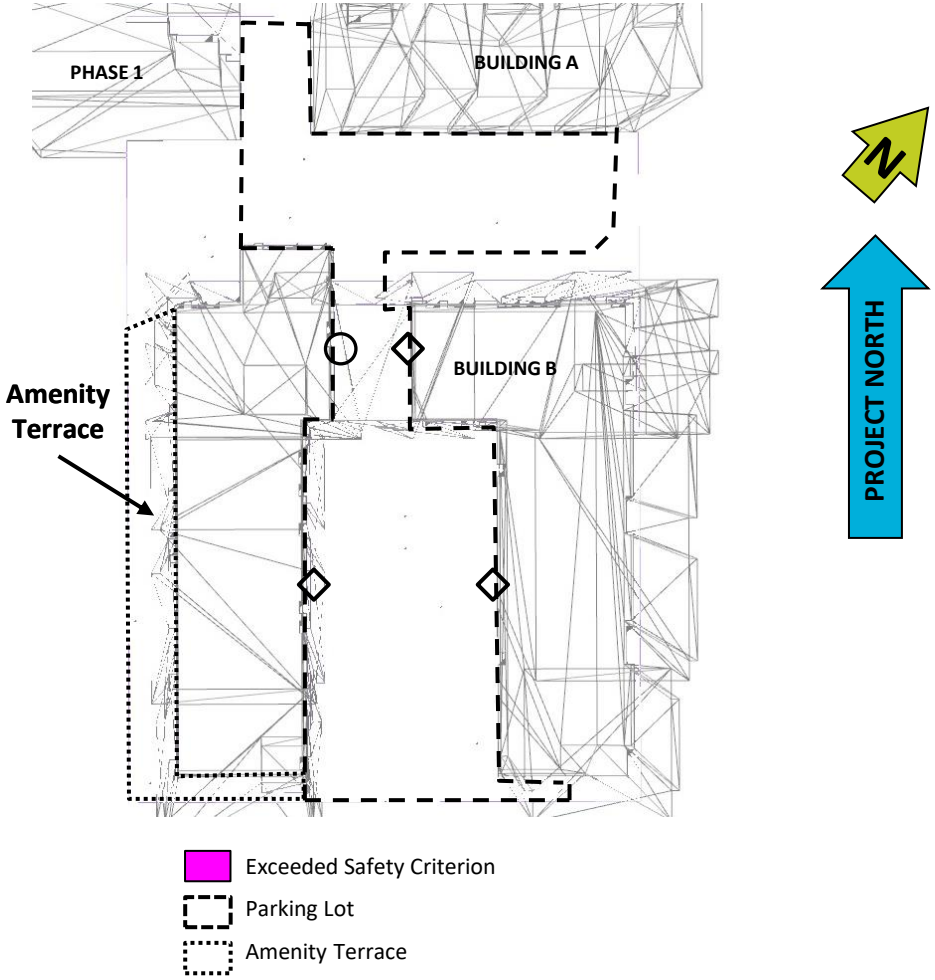


Figure B2a: Proposed Configuration – Wind Safety Annual – Level 1