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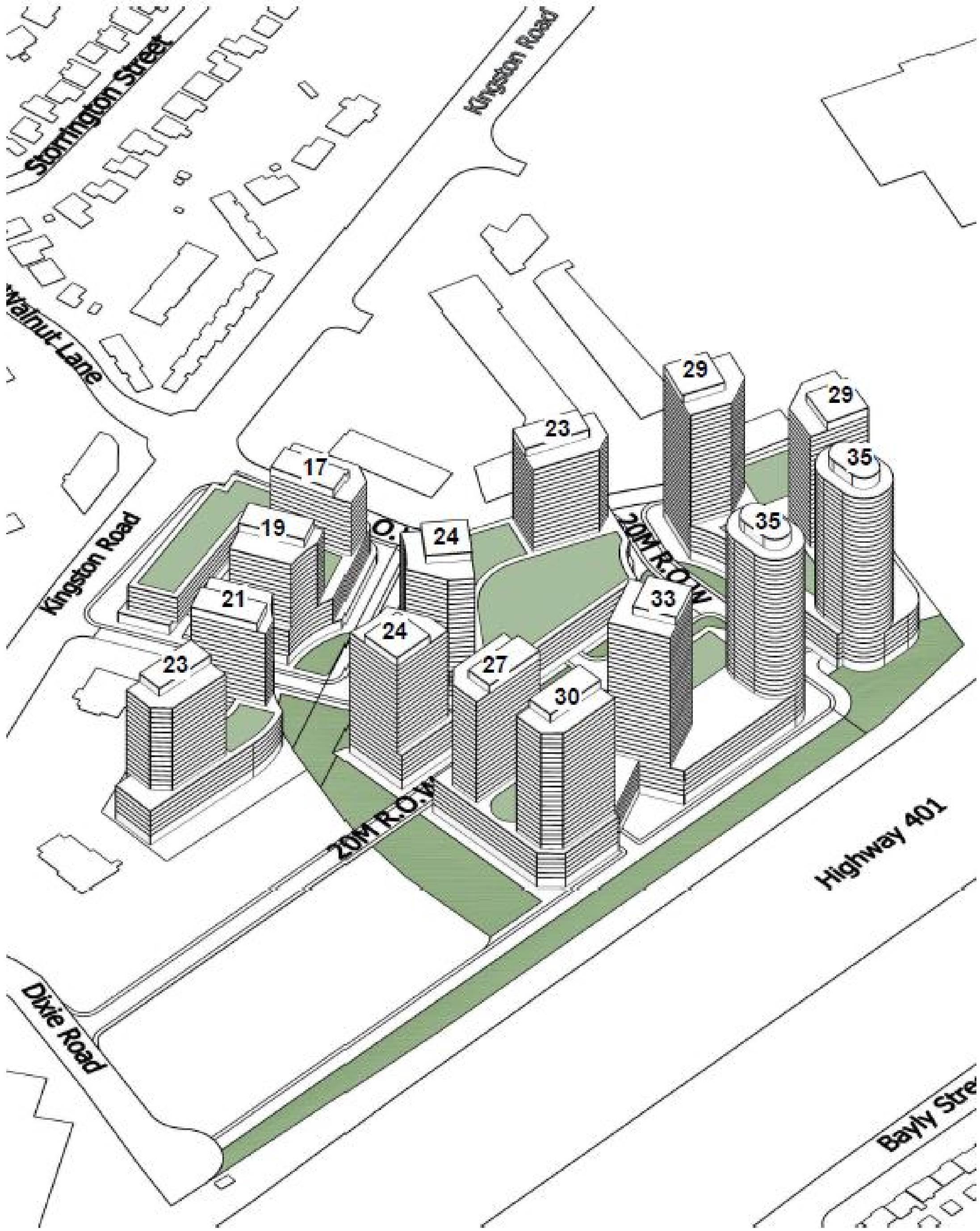
Date: October 17, 2023

Re: Pedestrian Wind Assessment

1101, 1105, & 1163 Kingston Road
Pickering, Ontario

SLR Project #241.013026.00001



Credit: Turner Fleischer Architects Inc.

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For
Tribute (Brookdale) Ltd.
1815 Ironstone Manor, Unit 1
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Version	Date
0.1 Draft	June 22, 2023
0.2 Draft Updated	October 4, 2023
0.3 Final	October 17, 2023

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1.0 INTRODUCTION

SLR Consulting (Canada) Ltd. (SLR) was retained by Tribute (Brookdale) Ltd. to conduct a pedestrian wind assessment for the proposed development at 1101, 1105, & 1163 Kingston Road in Pickering, Ontario. This report is in support of the combined Official Plan Amendment (OPA) and Zoning By-Law Amendment (ZBA) application for the development.

1.1 Existing Development

The proposed development is located between Kingston Road and Highway 401, just east of Dixie Road. The site is currently occupied by parking lots and low-rise commercial buildings. **Figure 1** provides an aerial view of the immediate study area. A virtual site visit was conducted by SLR using Google Earth images dated October 4, 2022. Several images of the site and surroundings are included in **Figures 2a** through **2d**.

Immediately surrounding the site there are lightly forested fields to the east; Highway 401 to the southeast through south; low-rise commercial buildings to the southwest and northeast; and low-rise residential developments to the west through north. Beyond the immediate surroundings, Frenchman's Bay lies to the south and there are low-rise residential and commercial buildings in all other directions.

Typically, developments with Site Plan Control (SPA) approval within a 500 m radius are included as existing surroundings. For this assessment, the in-construction Walnut Lane development (blue in **Figure 5**) to the east was included.

Figure 1: Aerial view of existing site & surroundings
Credit: Google Earth Pro, dated 10/4/2022

Figure 2a: Looking northeast along Kingston Road (site at right)

Figure 2b: Looking south along Kingston Road (site at left)

Figure 2c: Looking southwest along Walnut Lane (site at left)

Figure 2d: Looking north along Highway 401 (site at left)

1.2 Proposed Development

The proposed master plan development (**Figure 3**) consists of Blocks A1, A2, B, C1, C2, and D, including multiple towers ranging from 17 to 35 storeys in height, with multiple shared six-storey podiums. The site is located between Kingston Road and Highway 401, just east of Dixie Road.

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. On-site areas of interest are shown in **Figure 4**.

The main entrances are situated at various locations along the podiums of the individual blocks. Multiple park spaces and POPS are also designated at grade level.

In addition, there are transit stops located at the west and south intersections of Kingston Road and Walnut Lane.

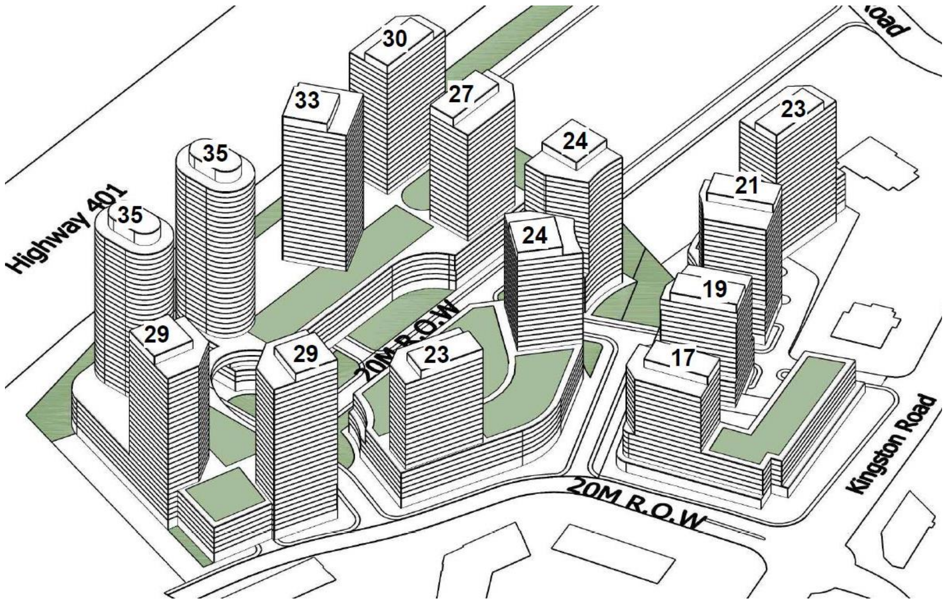


Figure 3: Rendering of proposed development

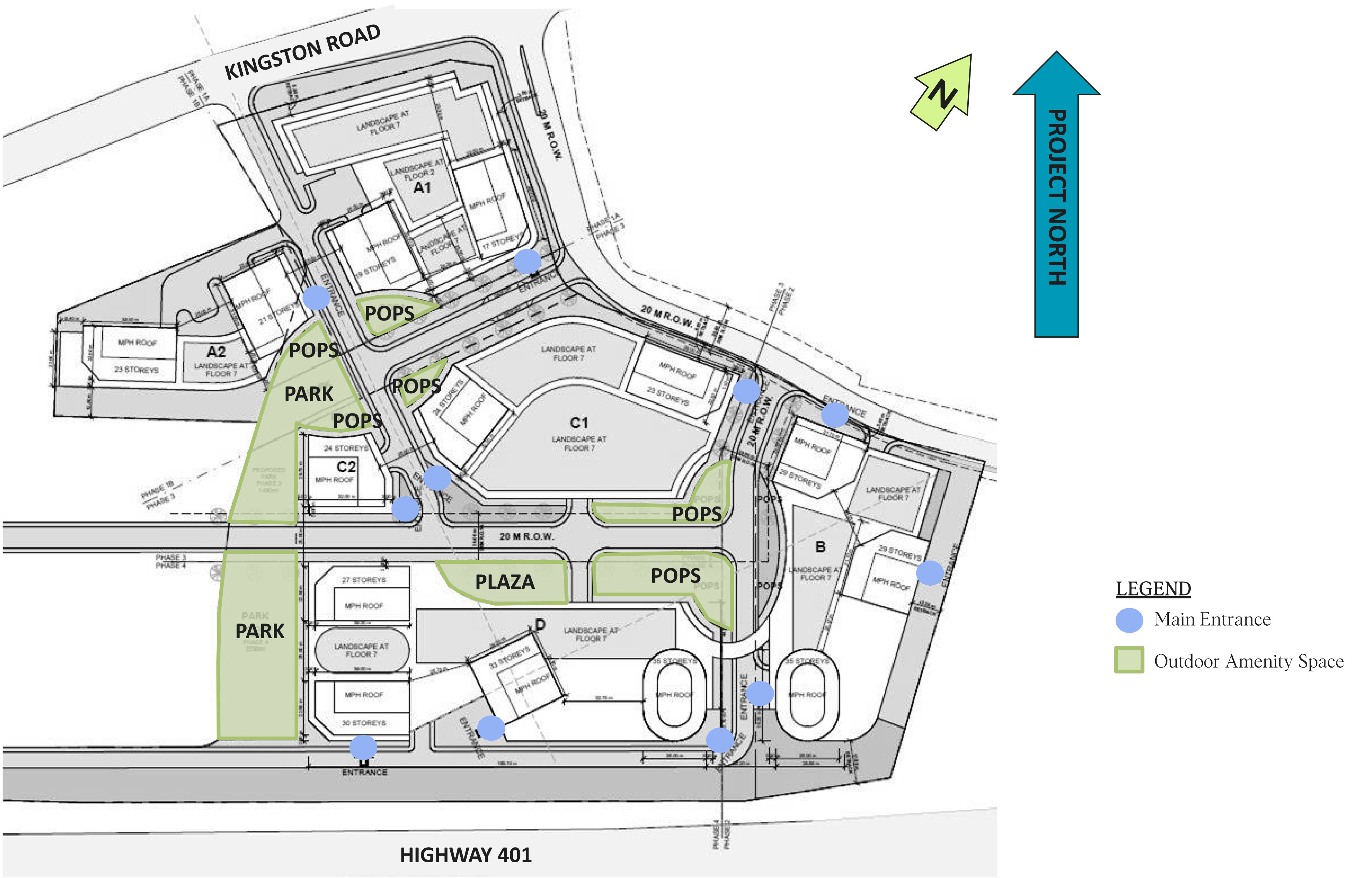


Figure 4: Areas of Interest

(Site plan dated May 4, 2023)

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. This CFD-based 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 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 Turner Fleischer Architects Inc. on May 23, 2023. 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 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 upwind conditions encountered around the site. Wind flows for 16 compass directions were simulated. Although wind speeds are calculated throughout the modeled area, wind comfort conditions were only plotted for a smaller area immediately surrounding the proposed development.

SLR assessed two configurations, for comparison, as follows:

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

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

The CFD-predicted wind speeds for all test directions and grid points were 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. 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) are not considered in the comfort rating.

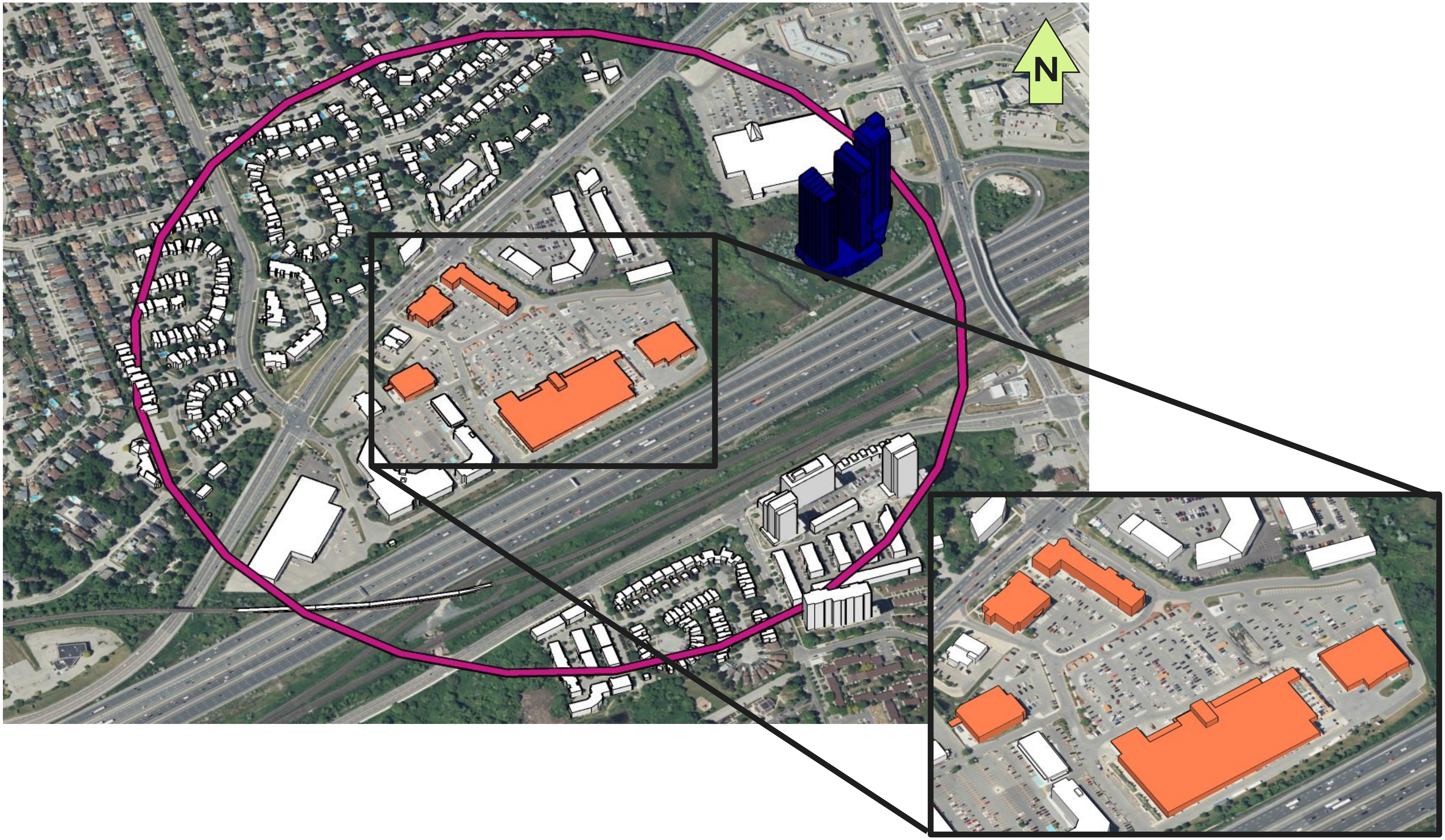


Figure 5a: Massing Model – Existing Configuration

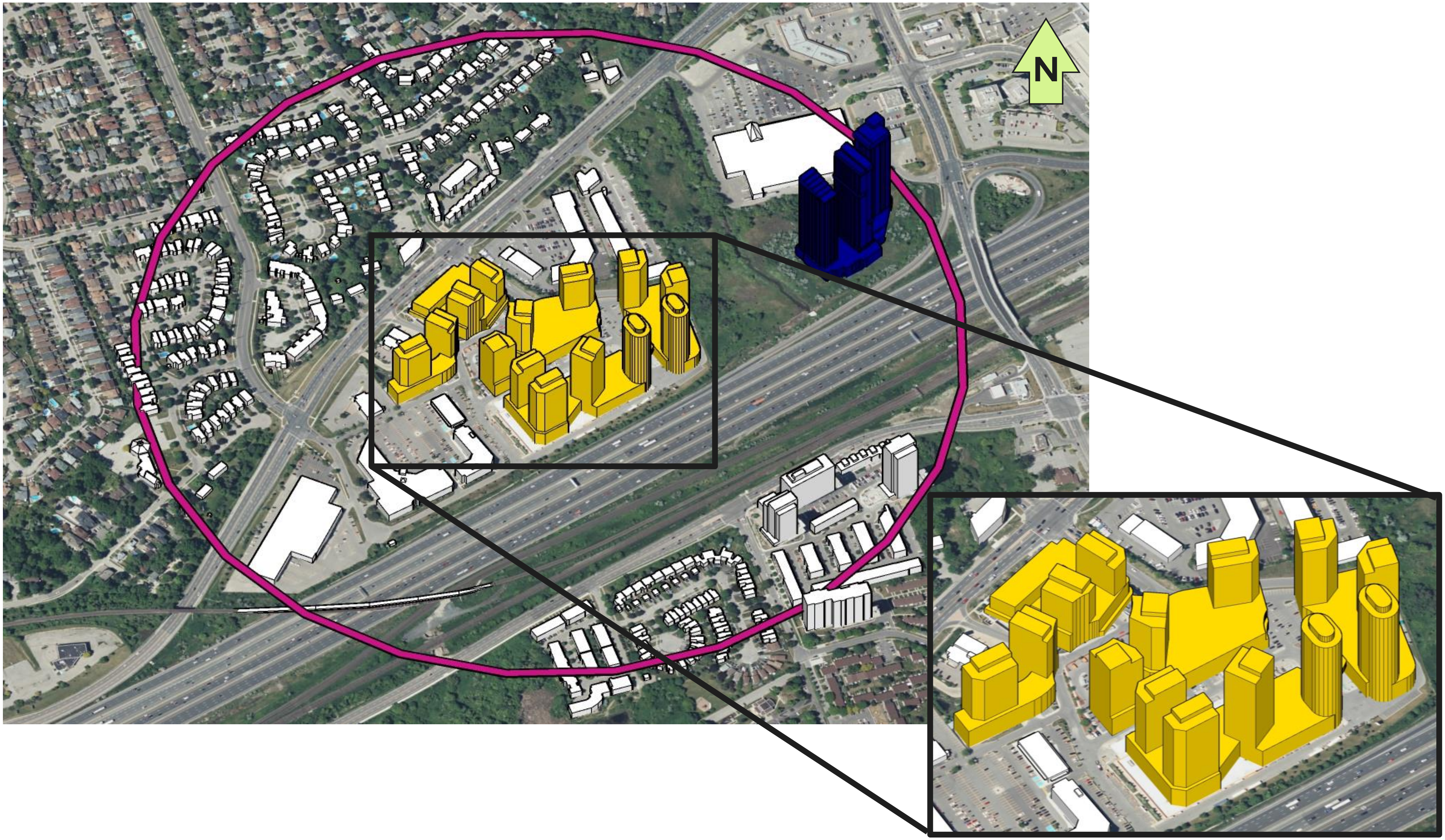


Figure 5b: Massing Model – Proposed Configuration

2.2 Wind Climate

Wind data recorded at Pearson International Airport in Toronto for the period of 1991 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 northerly through westerly 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.

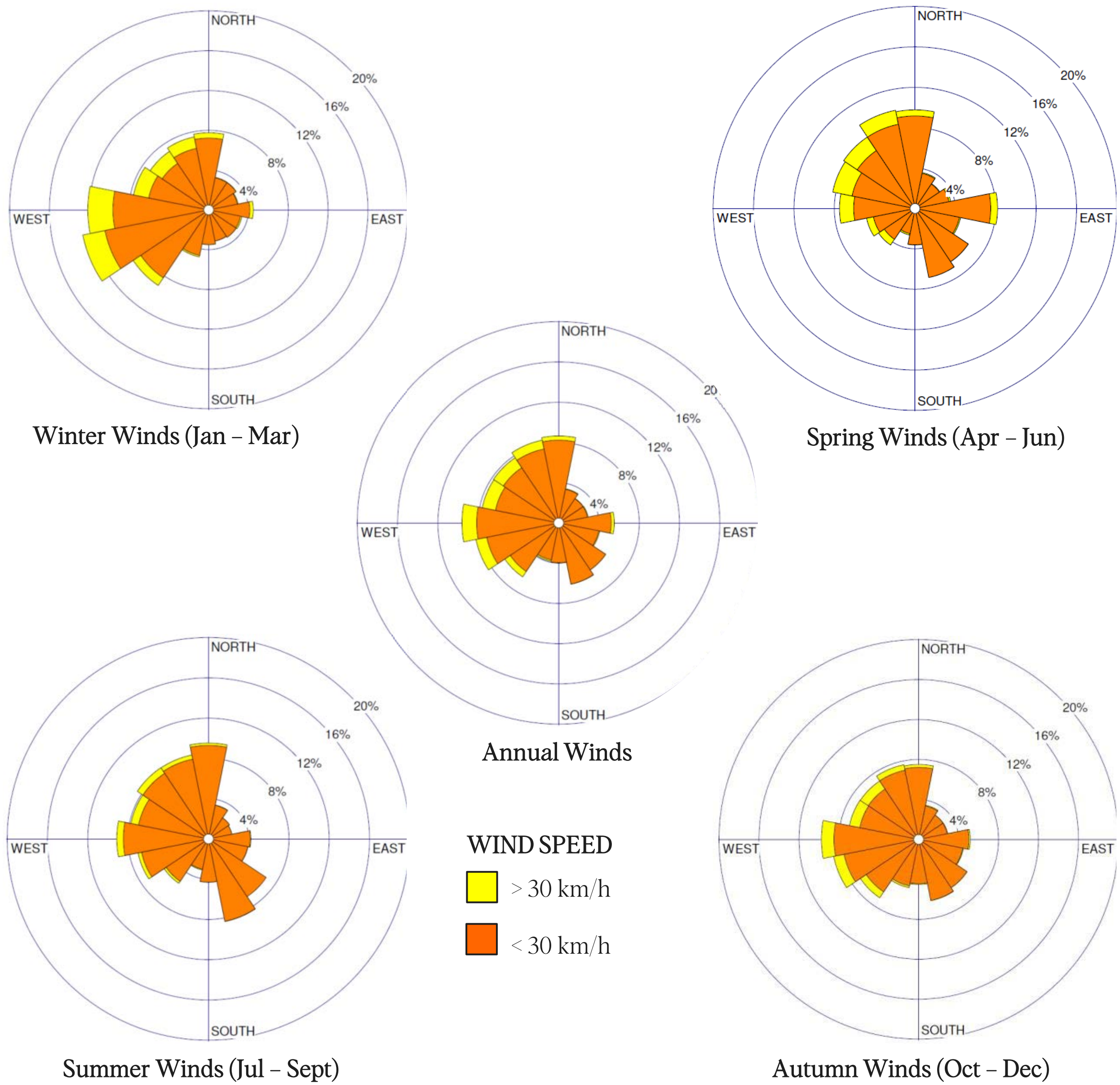


Figure 6: Wind Roses for Toronto Pearson International Airport (1991 to 2020)

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 typically 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

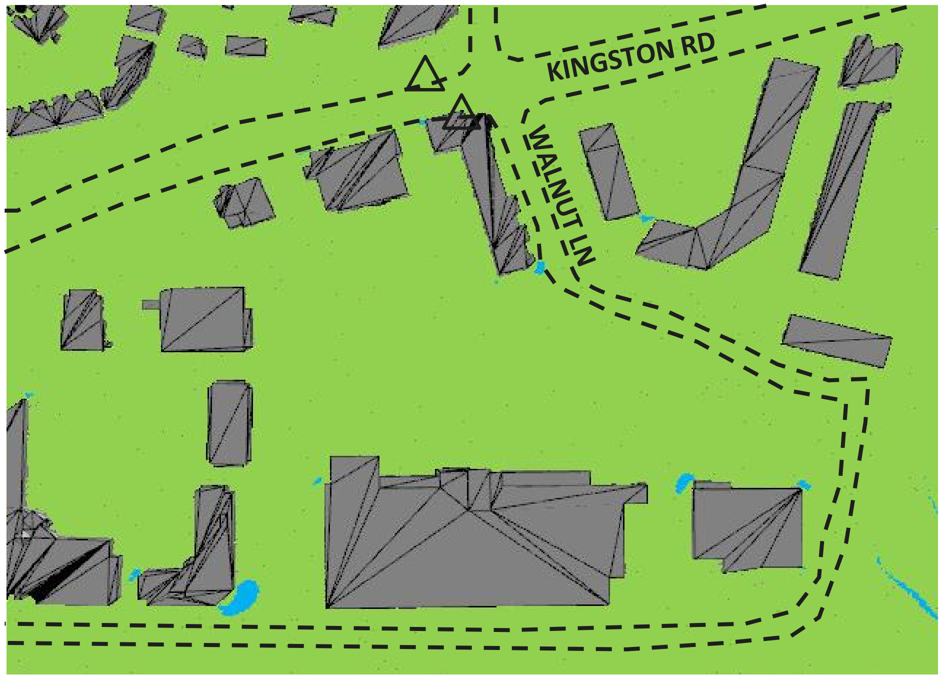
Existing wind conditions on-site are expected to be comfortable for sitting or standing year-round (**Figures 7a** and **8a**).

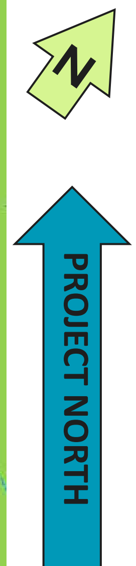
In the Proposed Configuration, wind conditions are predicted to remain comfortable for sitting or standing in the summer (**Figure 7b**). During the winter season, similar wind conditions are generally anticipated, with stronger wind flows conducive to leisurely walking or fast walking at a few building corners and in some areas between buildings (**Figure 8b**). These wind conditions are considered suitable for transient movement.

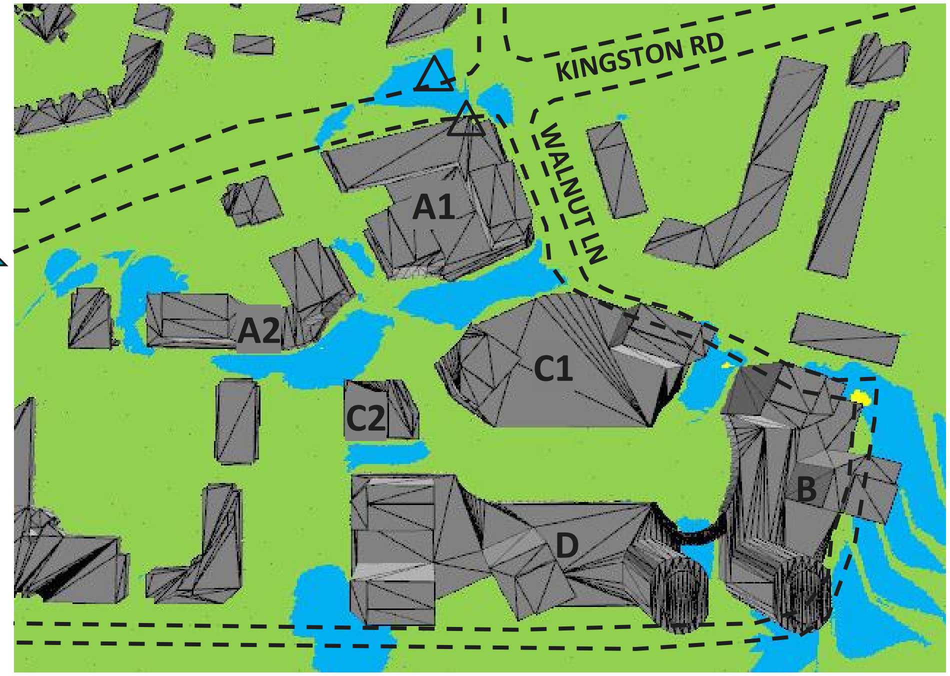
Wind conditions at the main entrances of the proposed development are generally expected to be suitable for sitting or standing year-round, which is considered suitable for the intended use (**Figures 9a** and **9b**). The only exception is the west entrance of Building B, where slightly stronger wind flows, conducive to leisurely walking are anticipated in the winter months (**Figure 9b**). To improve wind conditions, the design team may consider recessing the entrances into the building facade for localized wind protection. Alternatively, vertical screens, minimum 2.2 m in height can be considered on both sides of the entrance, to reduce wind flows near the entrance.

4.2 Outdoor Amenity Spaces

In the proposed park and POPS at grade on-site, wind conditions are predicted to be comfortable for sitting or standing in the summer, which is considered suitable for the intended use (**Figure 9a**).





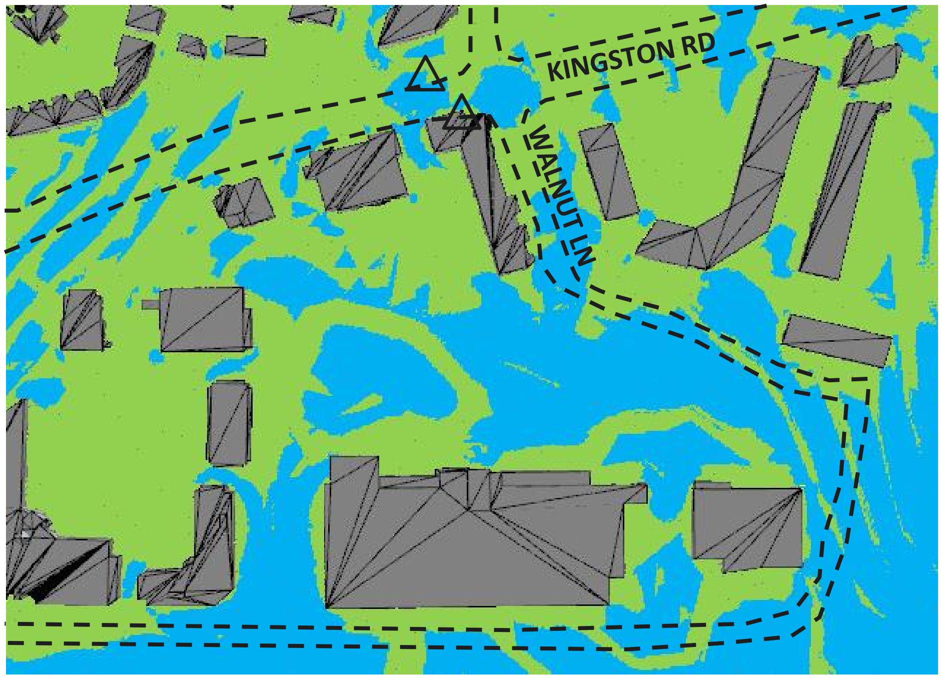


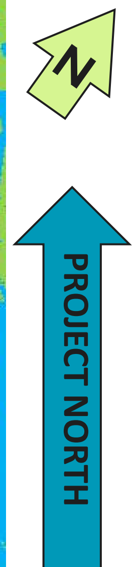
Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

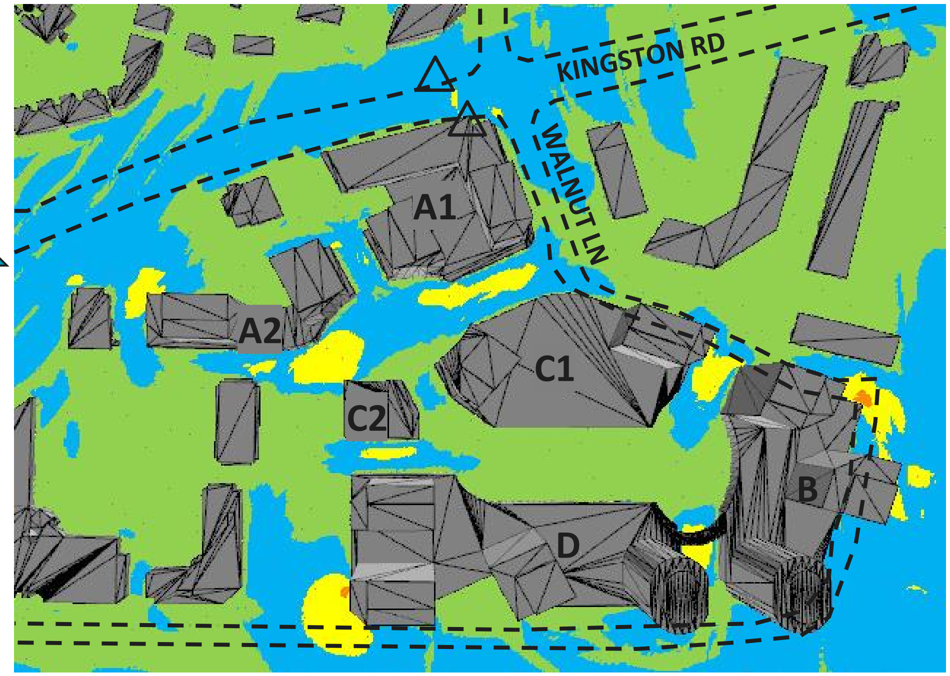
Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

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

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







Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Transit Stop

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

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

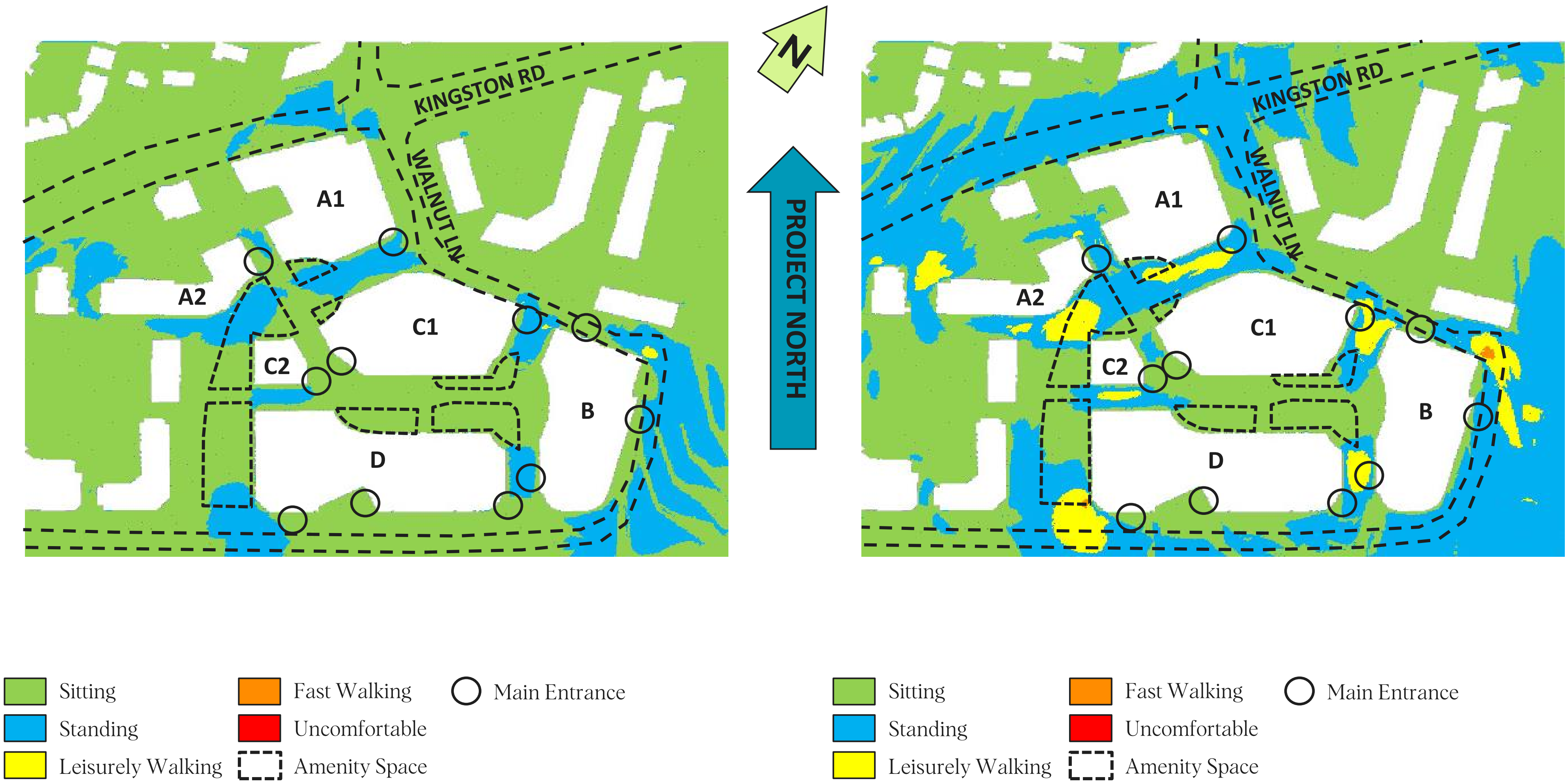


Figure 9a: Proposed Configuration – Pedestrian Wind Comfort Summer – Building Entrances & Walkways

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

During the winter, wind conditions in the parks and POPS are generally predicted to be suitable for sitting or standing, with a few areas conducive to leisurely walking (**Figure 9b**). Since these areas are not expected to be used frequently during the winter months, stronger wind flows in some localized area may not be a concern. An improvement in wind conditions on the amenity terraces, should it be desired by the design team, could be achieved through the use of landscaping such as planters or trees with dense underplanting.

The proposed development includes numerous amenity terraces on the podium roofs of all buildings. During the summer, wind conditions at the amenity terraces are generally predicted to be comfortable for sitting or standing (**Figure 10a**). During the winter, similar wind conditions are generally expected, with the exceptions at a few localized areas close to building corners, or on more exposed corners of the terrace. In these areas, wind conditions conducive to leisurely walking or fast walking are predicted (**Figure 10b)**. However, uncomfortable wind conditions are expected along the north edge of the terrace of Building A2 in the winter (**Figure 10b**).

The strong wind flows on the terraces are due to the overall exposure of the development to the prevailing northwesterly and westerly winds. These strong wind flows are directed downwards by the mass of the buildings, resulting in wind accelerations on the terraces. In other areas, the prevailing winds are channeled between the towers, resulting in accelerated wind flows across the terraces.

To take advantage of the calmer wind conditions, we recommend planning passive activities where wind conditions are predicted to be conducive to sitting or standing (green and blue regions in **Figures 10a** and **10b**). In addition, we recommend the design team consider adding tall wind screens (minimum 2.2 m in height) along the perimeter of each terrace.

4.3 Surrounding Sidewalks

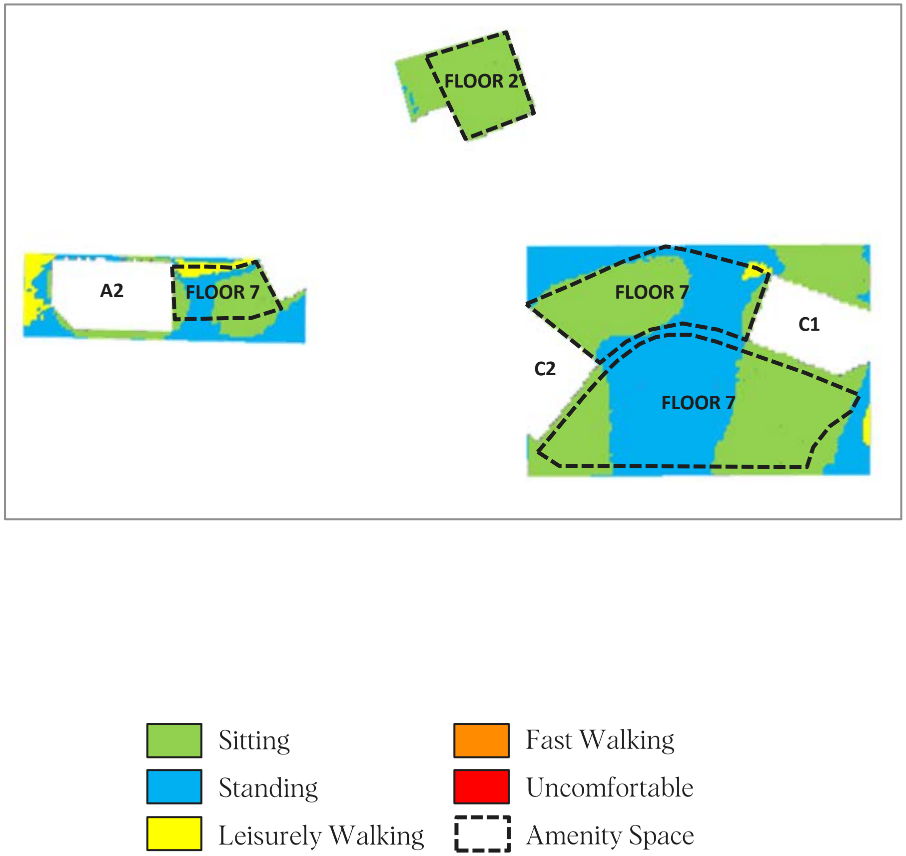
Existing wind conditions along the sidewalks of Kingston Road and Walnut Lane, including the nearby transit stops along Kingston Road, are expected to be comfortable for sitting or standing year-round (**Figures 7a** and **8a**).

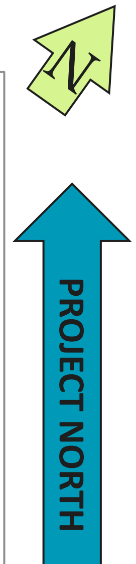
In the Proposed Configuration, wind conditions are generally predicted to be suitable for leisurely walking or better throughout the year on the surrounding sidewalks. At the nearby transit stops along Kingston Road, wind conditions are expected to be comfortable for sitting is standing throughout the year (**Figures 7b** and **8b**).

These wind conditions are satisfactory for the anticipated use.

4.4 Wind Safety

The wind safety criterion is expected to be met on an annual basis in all areas for both the Existing Configuration and Proposed Configuration (**Appendix B**), including at all entrances, surrounding sidewalks, and park spaces, POPS, and amenity terraces.





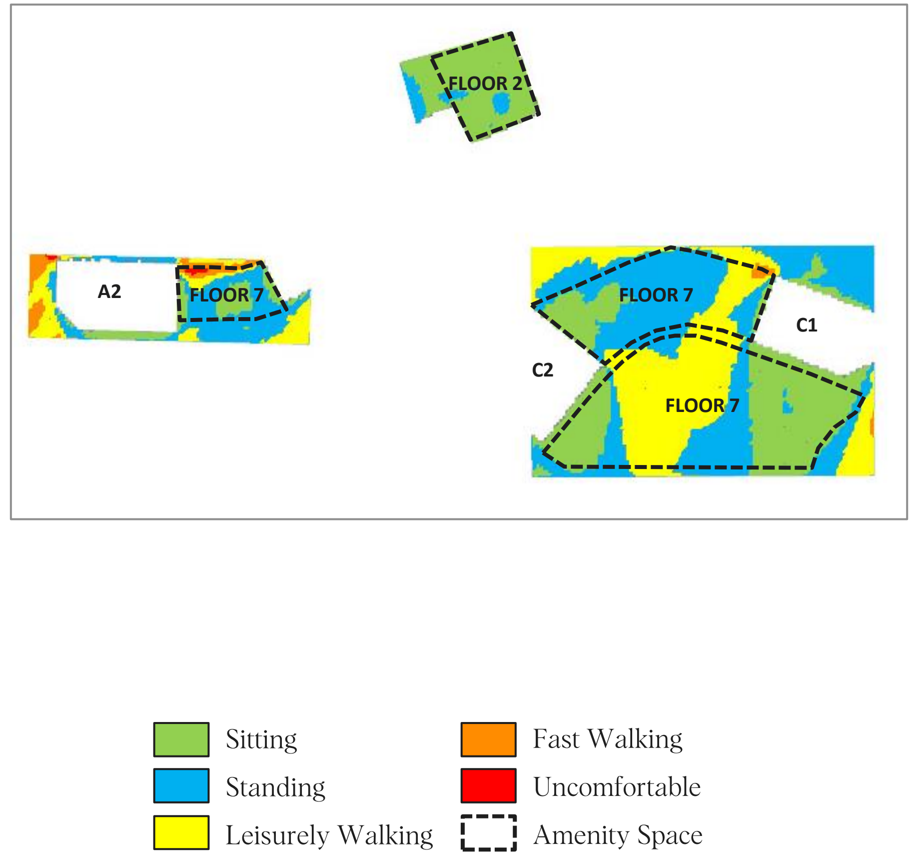


Figure 10a: Proposed Configuration – Pedestrian Wind Comfort Summer – Amenity Terraces

Figure 10b: Proposed Configuration – Pedestrian Wind Comfort Winter – Amenity Terraces

5.0 UPDATED ARCHITECTURAL INFORMATION

Updated architectural information was received from Turner Fleischer Architects Inc. on September 27, 2023, after the CFD simulations for this assessment were conducted.

The updated site plan (**Figure 11**) illustrates the following changes to the massing of the development:

- For Block B, the northwest and northeast towers both increased in height by one storey (from 29 to 30-storeys).
- For Block C1, the heights of both the west and east towers increased by three storeys (from 24 to 27-storeys and from 23 to 26-storeys, respectively).
- For Block C2, the tower increased in height by three storeys (from 24 to 27-storeys).
- For Block D, the northwest tower increased in height by three storeys (from 27 to 30 storeys).

The building height increases are generally considered minor compared with the overall heights of the towers. While there is increased exposure to the stronger wind flows that occur at higher elevations, the overall impact on wind comfort conditions on the site will be negligible. To confirm our opinion, a quantitative wind-tunnel study could be conducted later in the planning process.

As such, the wind conditions are expected to remain similar overall to those discussed in **Section 4.0** and our corresponding recommendations retain their validity.

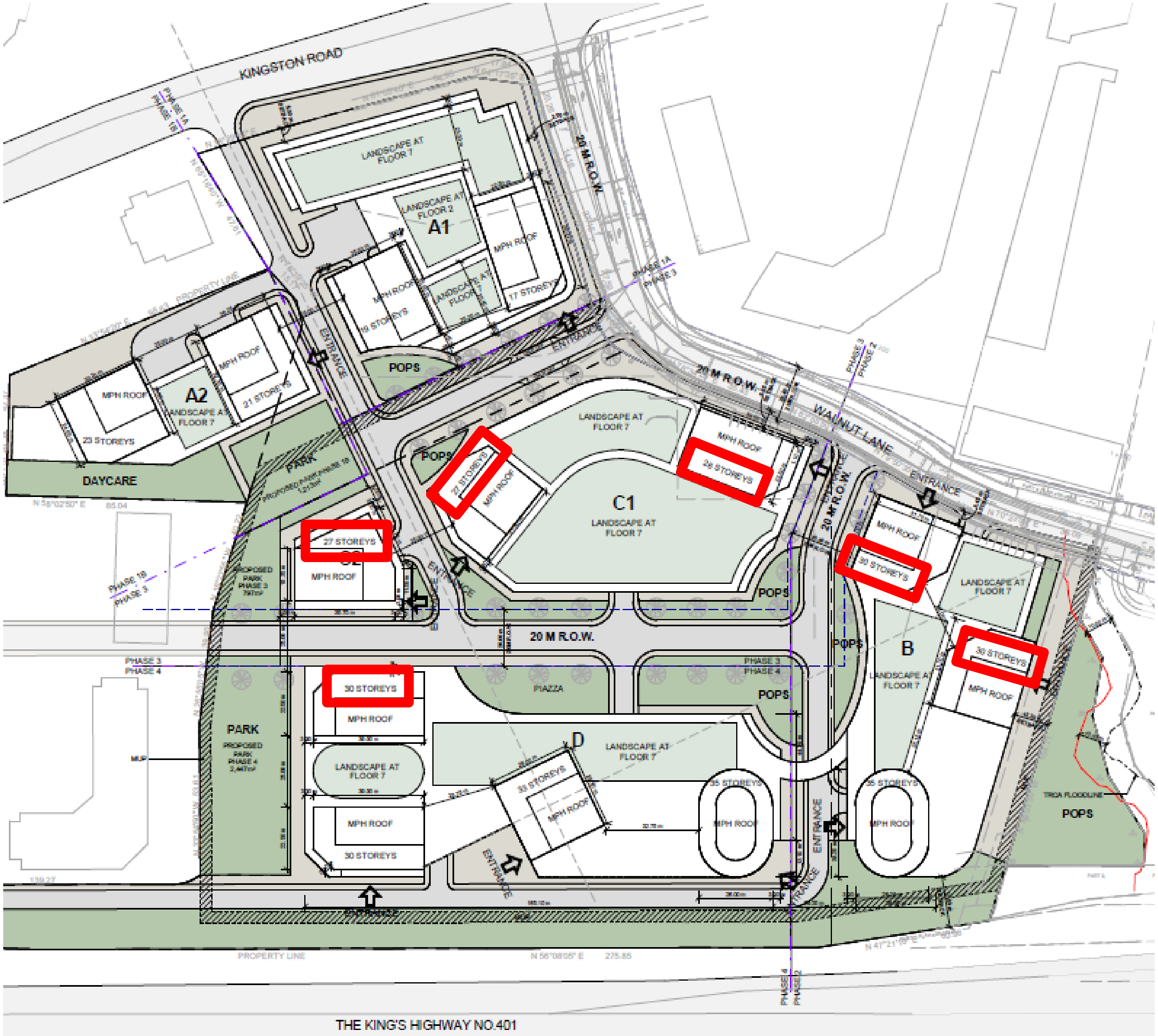


Figure 11: Updated Ste Plan with Increased Heights Highlighted
(Site Plan dated September 27, 2023)

6.0 CONCLUSIONS & RECOMMENDATIONS

The pedestrian wind conditions predicted for the proposed 1101, 1105, & 1163 Kingston Road development in Pickering, Ontario, 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 Configuration and Proposed Configuration.
- Wind conditions on the site, including entrances and amenity spaces, are generally expected to be suitable for the intended use year-round. Wind control measures are recommended for the west main entrance of Building B.
- Wind conditions on the proposed terraces are generally predicted to be suitable for the intended use in the summer. Wind mitigation measures are recommended for a few localized areas.
- On the sidewalks surrounding the proposed development, wind conditions are suitable for the intended use.
- Updated architectural information showing increased heights for towers on Blocks B, C2, C2, and D was received after the CFD simulations were conducted. The resulting changes to overall wind comfort conditions is expected to be negligible due to these changes to massing.

7.0 LIMITATIONS OF LIABILITY

This report has been prepared and the work referred to in this report has been undertaken by SLR Consulting (Canada) Ltd. (SLR) for Tribute (Brookdale) Ltd., hereafter referred to as the "Client". It is intended for the sole and exclusive use of the Client. The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. Other than by the Client and by the City of Pickering in their role as land use planning approval authorities, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted unless payment for the work has been made in full and express written permission has been obtained from SLR.

This report has been prepared in a manner generally accepted by professional consulting principles and practices for the same locality and under similar conditions. No other representations or warranties, expressed or implied, are made.

Opinions and recommendations contained in this report are based on conditions that existed at the time the services were performed and are intended only for the client, purposes, locations, time frames and project parameters as outlined in the Scope or Work and agreement between SLR and the Client. The data reported, findings, observations and conclusions expressed are limited by the Scope of Work. SLR is not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. SLR does not warranty the accuracy of information provided by third party sources.

8.0 REFERENCES

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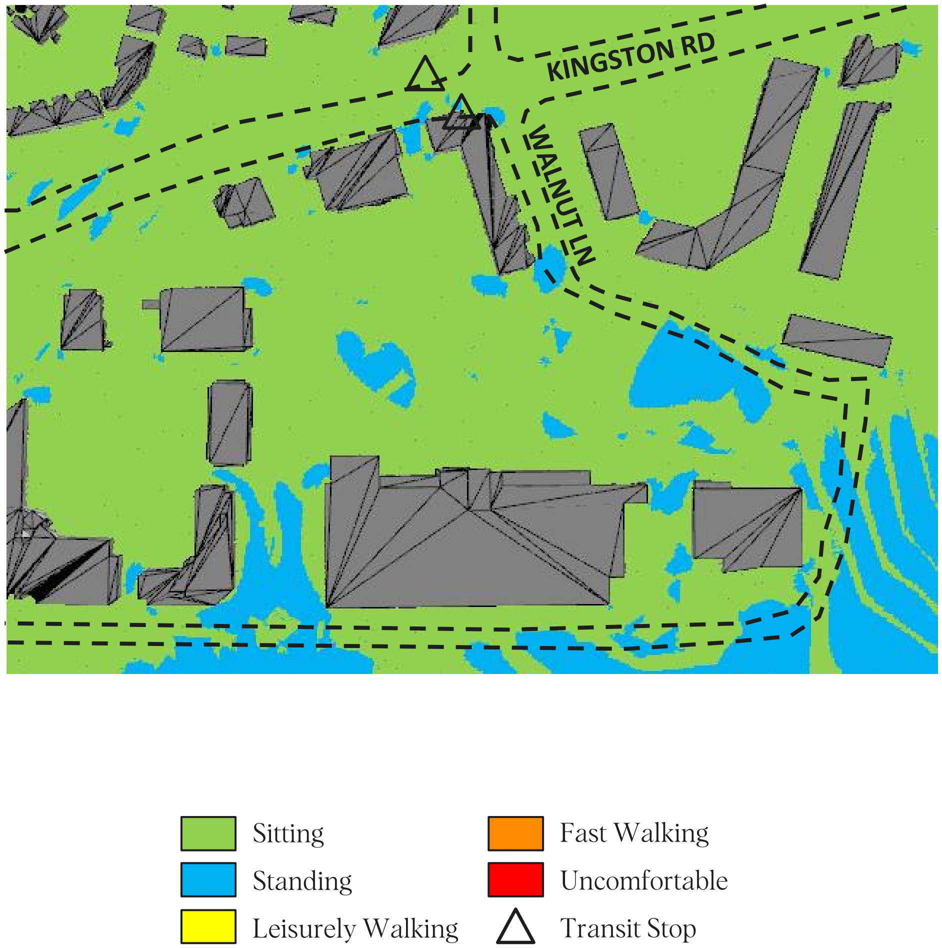
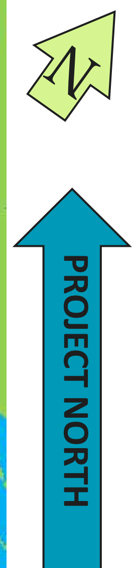
Appendix A

Pedestrian Wind Comfort Analysis

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





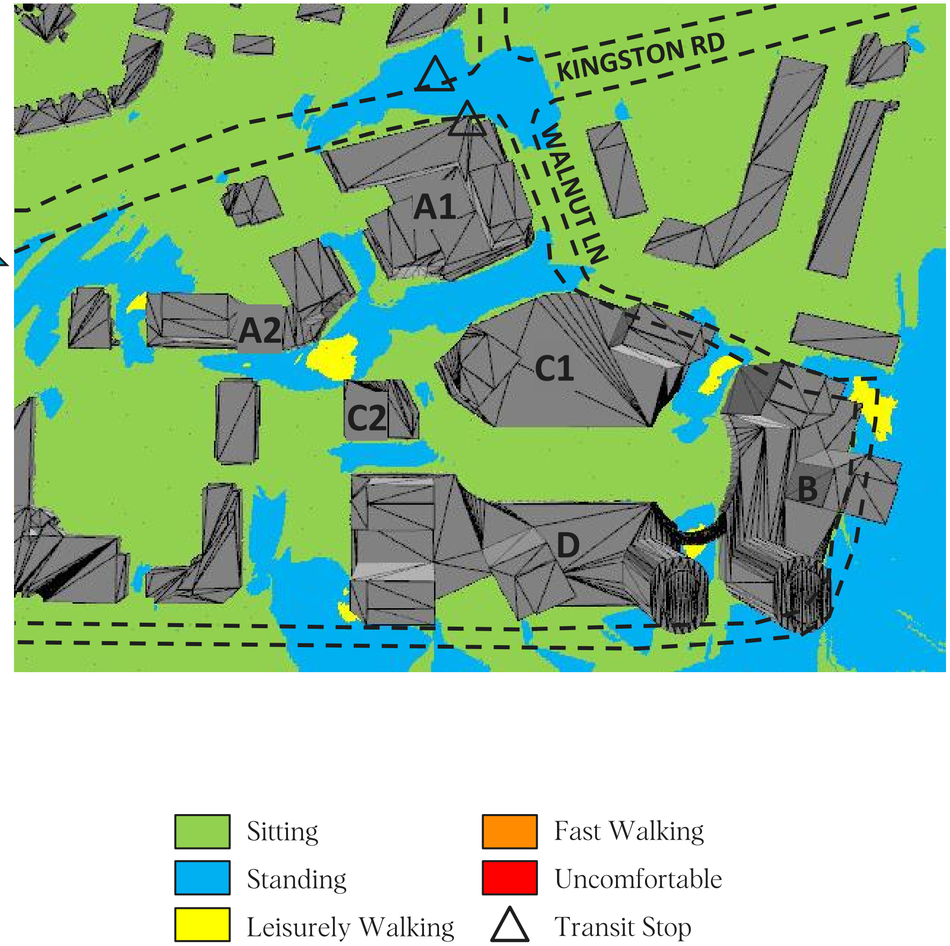
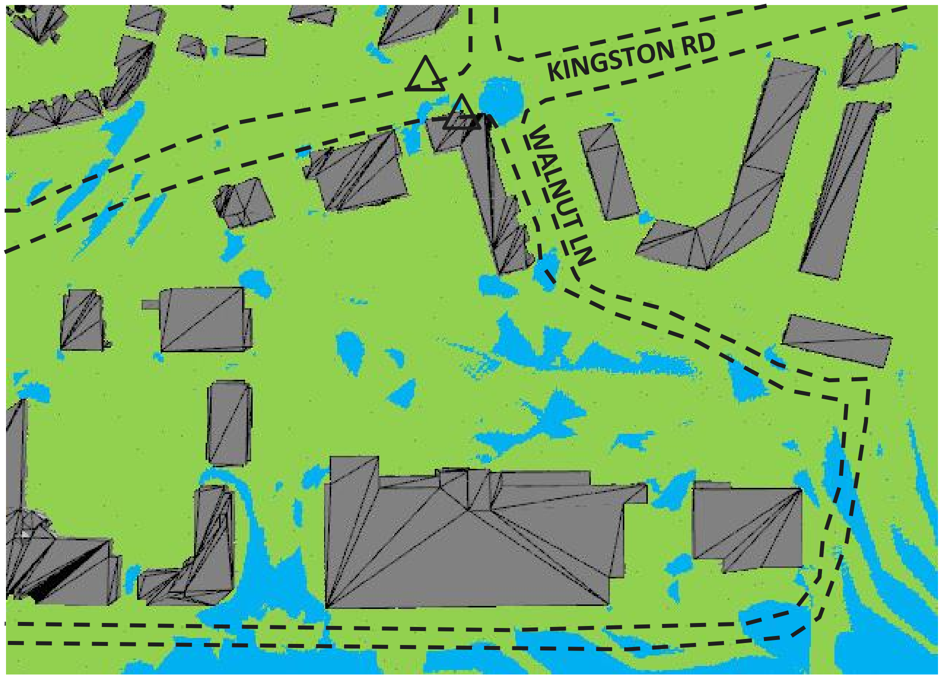
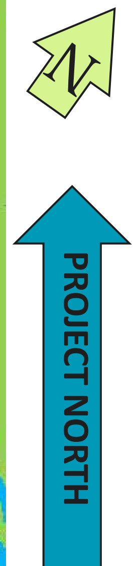
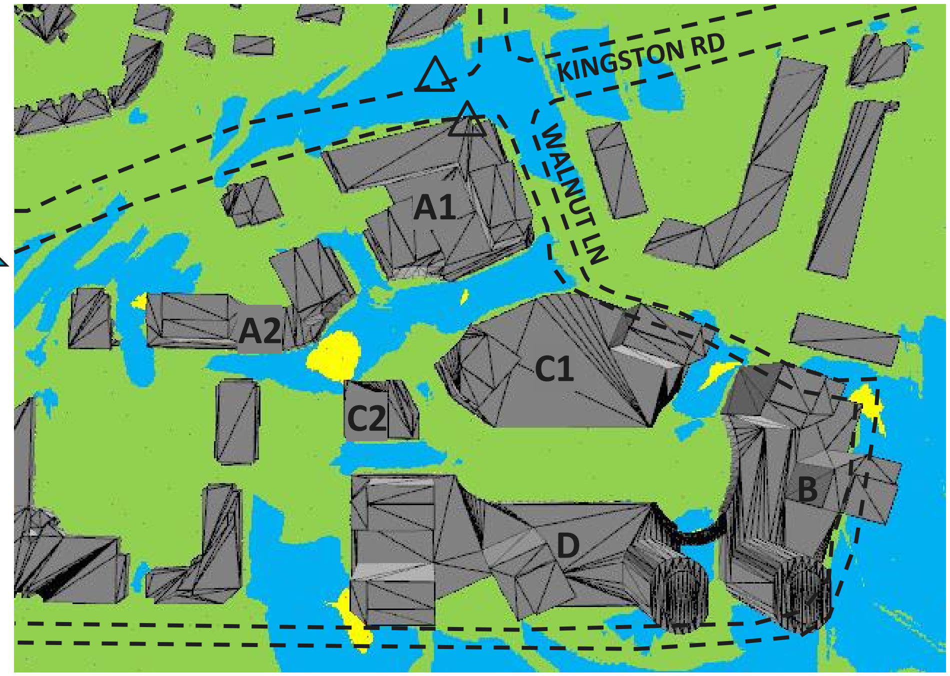


Figure A1a: Existing Configuration – Pedestrian Wind Comfort
Spring – On-site & Surrounding Areas

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





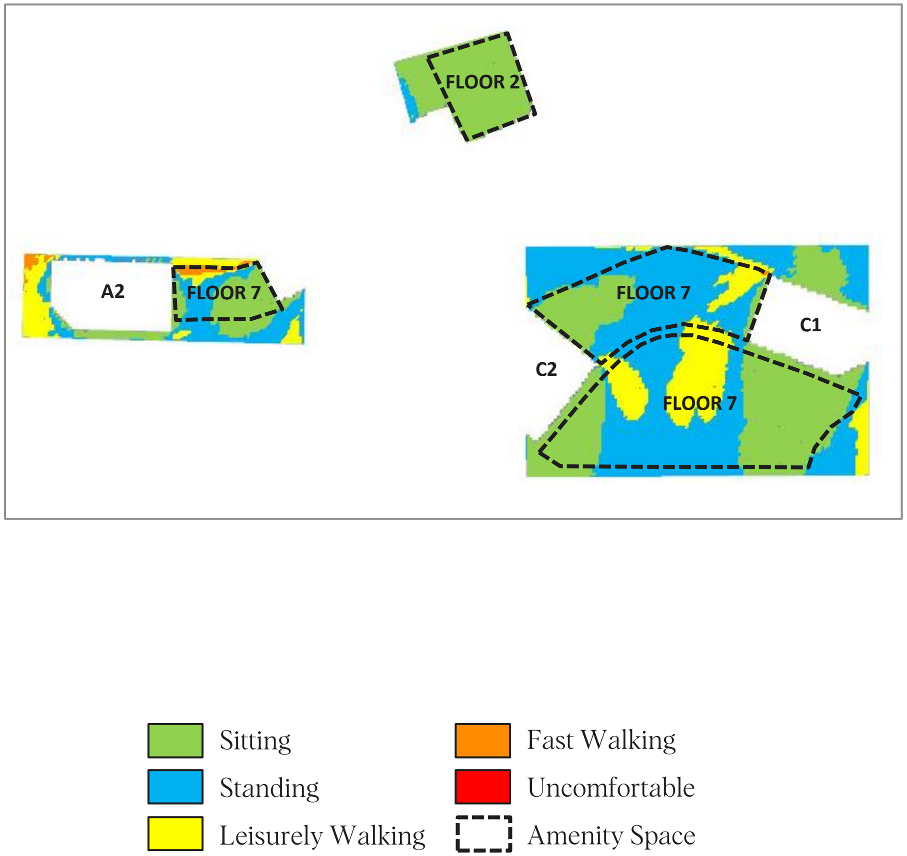


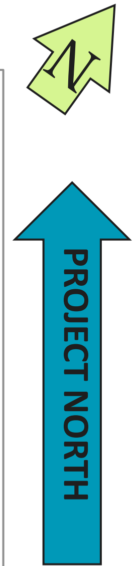
- Sitting
- Standing
- Leisurely Walking
- Fast Walking
- Uncomfortable
- △ Transit Stop

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

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

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





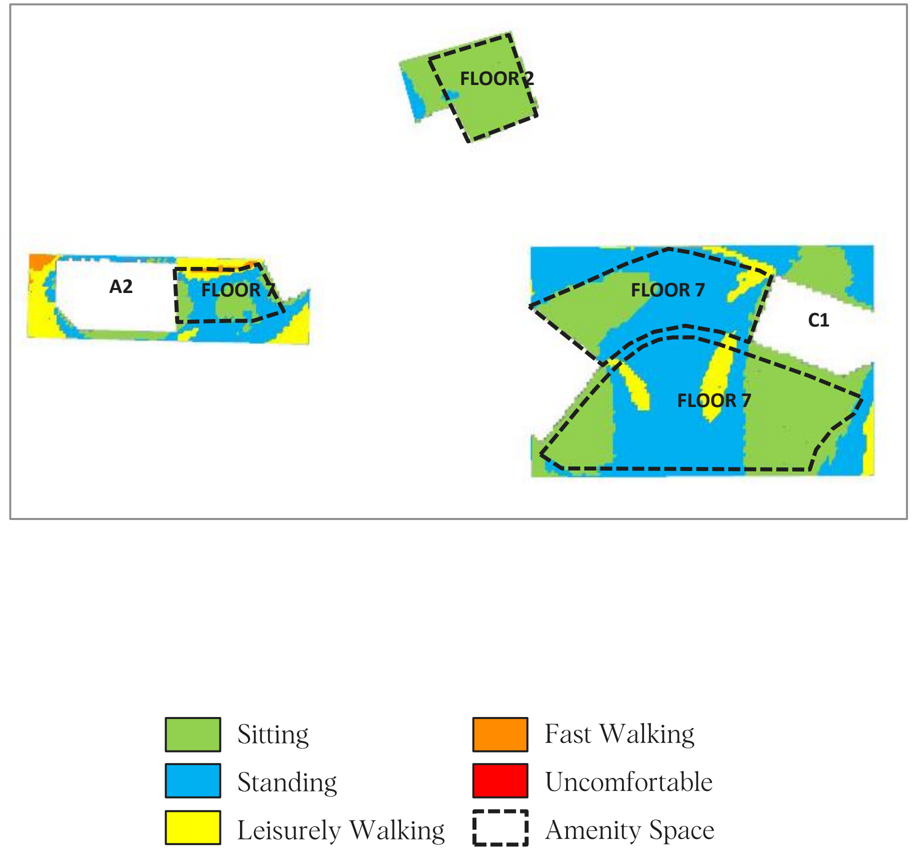


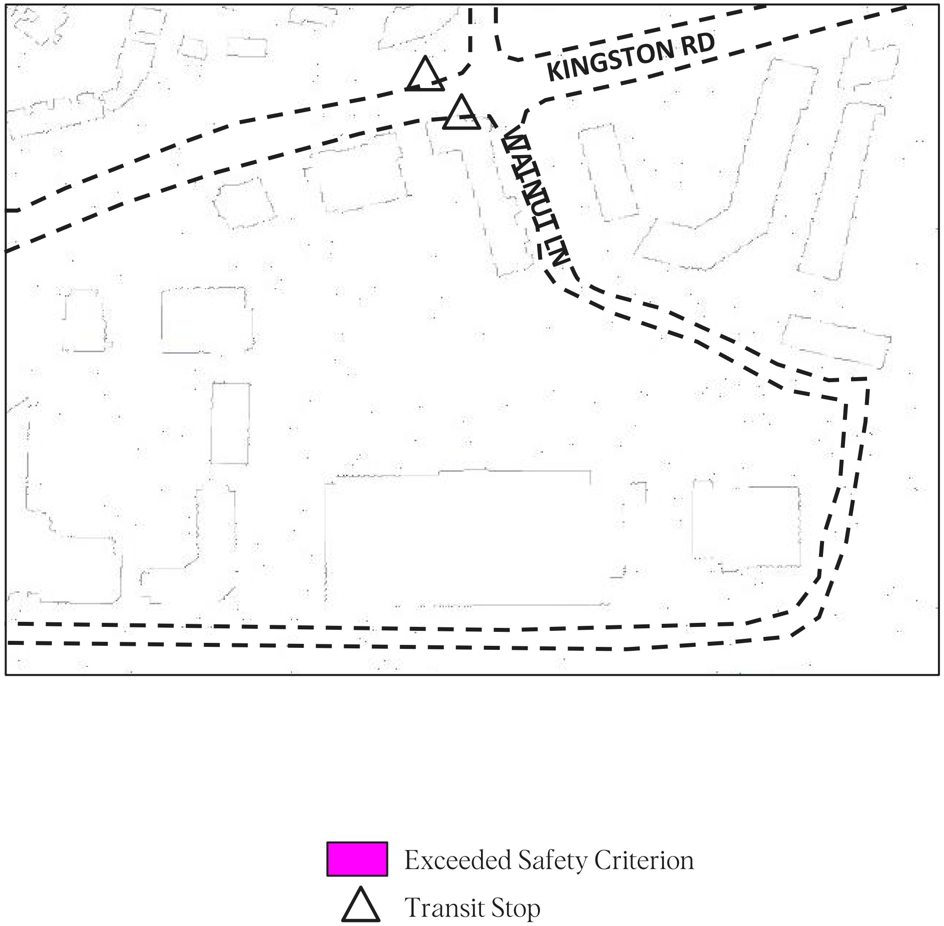
Figure 10a: Proposed Configuration – Pedestrian Wind Comfort
Spring – Amenity Terraces

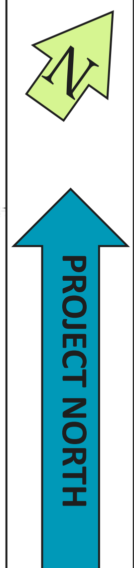
Figure 10b: Proposed Configuration – Pedestrian Wind Comfort
Autumn – Amenity Terraces

Appendix B

Pedestrian Wind Safety Analysis

Annual





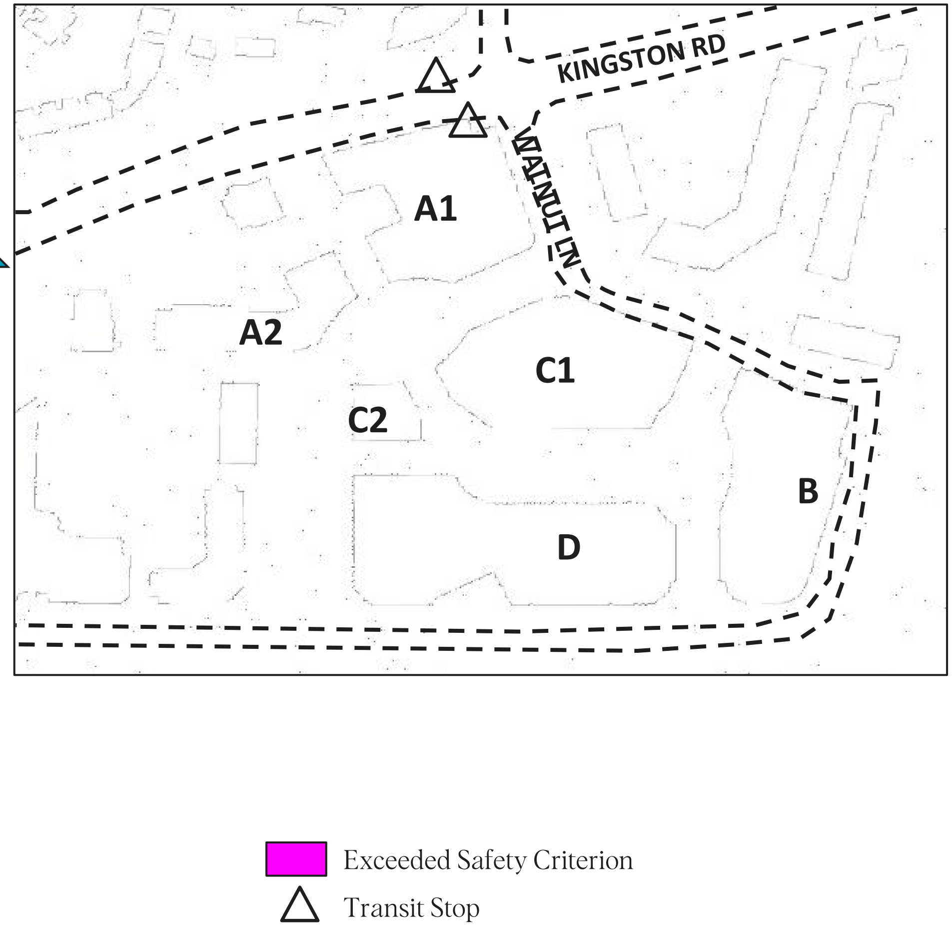


Figure B1a: Existing Configuration – Wind Safety
Annual – On-site & Surrounding Areas

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

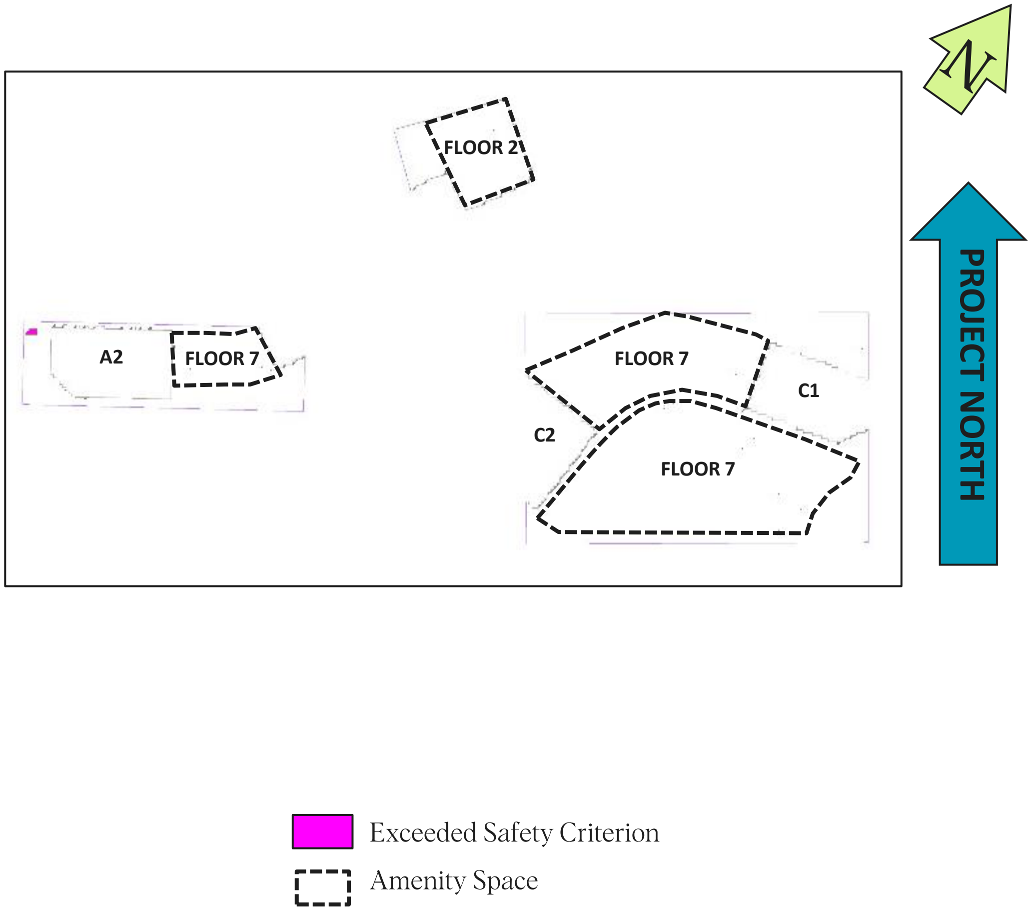


Figure B2: Proposed Configuration – Wind Safety
Annual – Amenity Terraces