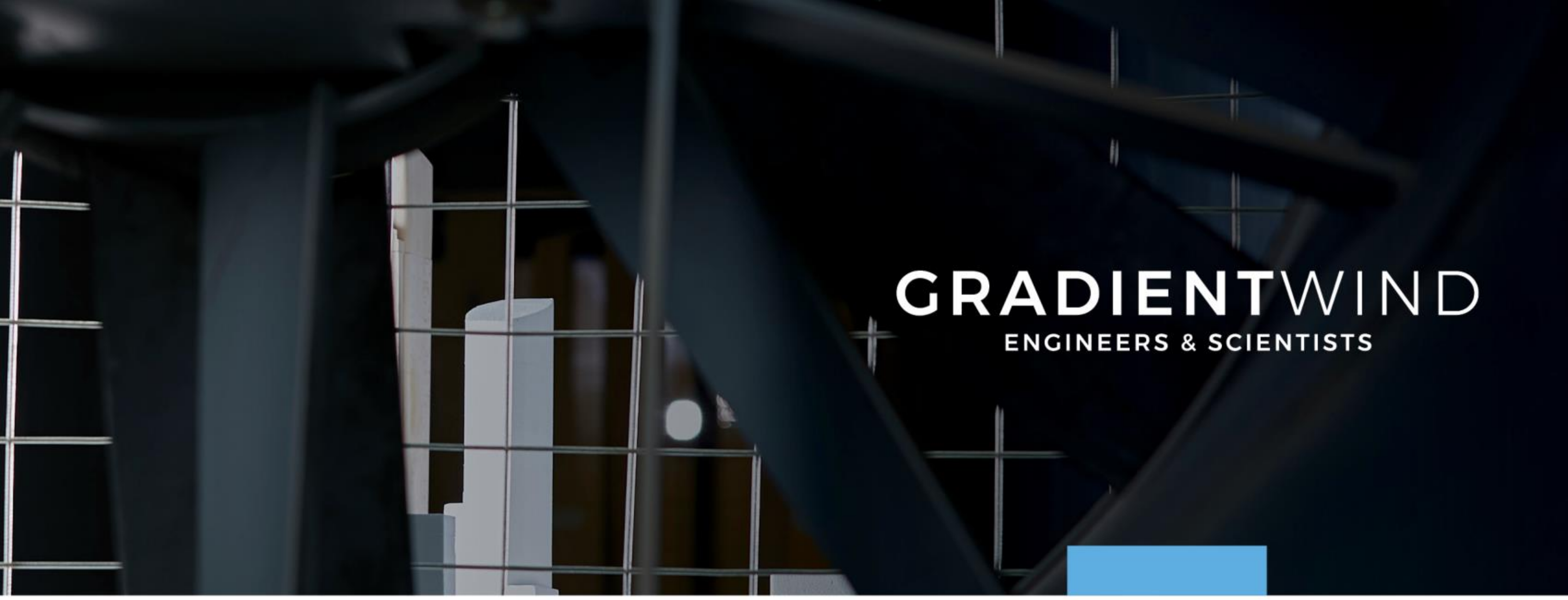
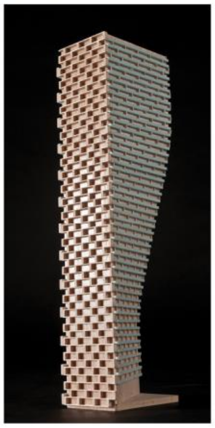
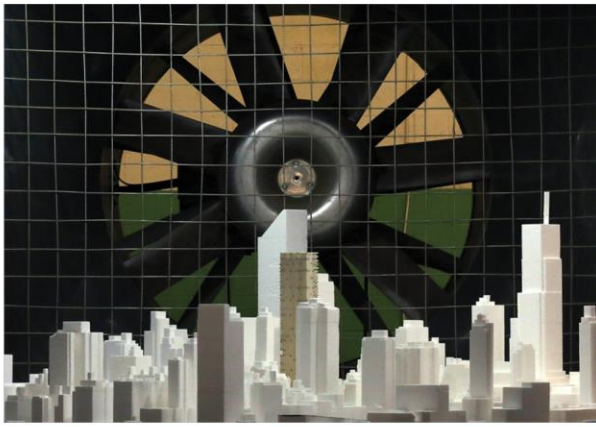


PEDESTRIAN LEVEL WIND STUDY

6310 Hazeldean Road
Ottawa, Ontario

Report: 20-303-PLW-2023





December 21, 2023

PREPARED FOR

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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study to satisfy Zoning By-law Amendment (ZBLA) application requirements for the proposed residential development located at 6310 Hazeldean Road in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

The study involves simulation of wind speeds for selected wind directions in a three-dimensional (3D) computer model using the computational fluid dynamics (CFD) technique, combined with meteorological data integration, to assess pedestrian wind comfort and safety within and surrounding the subject site according to City of Ottawa wind comfort and safety criteria. The results and recommendations derived from these considerations are detailed in the main body of the report (Section 5), illustrated in Figures 3A-5, and summarized as follows:

1) Most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, laneway, surface parking, walkways, green spaces to the east and south, and in the vicinity of building access points, are considered acceptable. The areas that are predicted to experience windy conditions are described as follows:

    a. **Northwest Corner of Building B**. Following the introduction of the proposed development, the above noted area is predicted to experience uncomfortable wind conditions, exceeding the walking threshold by a maximum of approximately 3% of the time during the winter season. While the noted conditions, which are illustrated in Figure 3D, are predicted to impact a section of the proposed walkway adjacent to the northwest corner of Building B, the majority of the windier conditions are mostly located over the road surface where pedestrian access is expected to be limited.

- Notably, landscaping elements that could not be implemented in the simulation model, specifically the proposed trees at the north corner of the development, may improve wind comfort conditions at the northwest corner of Building B.

- Comfort conditions may be further improved with the implementation of mitigation in the form of a canopy along a portion of the north and west elevations of Building B, as well as wind screens strategically placed near the northwest corner of the building to reduce downwash effects incident on the 25-storey tower and to reduce corner acceleration effects, respectively.

- As noted in the addendum below, following the current study, a canopy at the northwest corner of Building B has been adopted by the design team.

- The mitigation strategy for the noted area will continue to be developed in collaboration with the building and landscape architects for the future Site Plan Control application submission.

b. **Building Access Points Serving Building B**: Due to the windy conditions predicted to occur near the northwest corner of Building B, it is recommended that the building access point serving Building B at the northwest corner be either recessed into the façade by at least 1.5 m or be relocated further to the east where conditions are suitable for standing, or better, throughout the year. Regarding the building access points serving Building B along its south elevation, conditions are considered acceptable in the vicinity of these access points as they serve as secondary access points, and an increase in the separation distance between Building B and the parking podium serving Building A would be expected to provide some improvement in the wind conditions between the two buildings.

    - As noted in the addendum below, following the current study, the building access at the northwest corner of Building B has been relocated to the east.

2) Regarding the common amenity terrace serving Building A at Level 3, conditions during the typical use period are predicted to be suitable for sitting. The noted conditions are considered acceptable.

3) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events, (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

Addendum: The PLW study was completed based on architectural drawings that were prepared by Figurr Architects Collective in September 2023. An updated architectural design was distributed to the consultant team in December 2023. In the updated architectural design, the parking podium to the rear of Building A has been shifted to the southwest, increasing the separation distance between the parking podium and Building B. In addition, a canopy above grade has been added to the northwest corner of Building B and the building access point serving the indoor amenity at the northwest corner of Building B has been relocated to the east, which incorporate the recommendations of the current study.

Notably, the noted changes are expected to result in a minor improvement in the predicted wind conditions between Buildings A and B, and the results and recommendations provided in this study are expected to be representative of the current architectural design. No formal updates to the PLW study are required.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by 9441-6302 Quebec Inc. to satisfy Zoning By-law Amendment (ZBLA) application requirements for the proposed residential development located at 6310 Hazeldean Road in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). A PLW study was conducted in March 2022[1] for a previous architectural design of the proposed development. The noted study includes detailed descriptions of the predicted wind conditions under the existing massing conditions. Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, City of Ottawa wind comfort and safety criteria, architectural drawings prepared by Figurr Architects Collective in September 2023, surrounding street layouts and existing and approved future building massing information obtained from the City of Ottawa, recent satellite imagery, and experience with numerous similar developments.

2. TERMS OF REFERENCE

The subject site is located at 6310 Hazeldean Road in Ottawa, situated centrally on a triangular parcel of land at the southwest intersection of Hazeldean Road and Carp Road. The parcel of land is bound by Hazeldean Road to the northwest, an existing low-rise building and Carp Road to the northeast, and existing low-rise dwellings and green spaces within the remaining compass directions. The proposed development comprises two buildings, referred to as "Building A" and "Building B" throughout this report. Building A rises to nine storeys, inclusive of a 2-storey podium, to the south of the subject site while Building B rises to 25 storeys, inclusive of a 9-storey podium, to the north of the subject site. The two buildings share a below-grade underground parking level. Surface parking is located central to the subject site and to the east of Building B.

The ground floor of Building A is nearly trapezoidal shaped and includes residential units along the south and west elevations, a main entrance at the northwest corner, and indoor parking spaces throughout the

[1] Gradient Wind Engineering Inc., '6310 Hazeldean Road– *Pedestrian Level Wind Study*', [Mar 25, 2022]

remainder of the level. Access to the indoor parking is provided by an entrance near the northeast corner and access to below-grade parking is provided by a ramp nearly central within Building A, via a laneway from Hazeldean Road. Level 2 includes residential units along the south and west elevations and indoor parking spaces throughout the remainder of the level. Level 3 includes indoor amenities to the east and residential units throughout the remainder of the level. The building steps back from the east elevation at Level 3 to accommodate an amenity terrace. Levels 4-9 are reserved for residential occupancy. The building steps back from the east elevation at Level 4 accommodate private terraces. A building setback is located to the south at Level 7.

Building B is nearly rectangular, and the ground floor includes a main entrance at the southwest corner, an indoor amenity at the northwest corner, residential units along the north and east elevations, and shared building support spaces along the south elevation. Residential units occupy all upper levels of Building B. The northwest corner of the building extends at Level 2 and the building steps back from the south elevation at Level 3 and from the east elevation at Levels 4 and 10.

Regarding wind exposures, the near-field surroundings (defined as an area falling within a 200-metre (m) radius of the subject site) include three low-rise commercial buildings with surface parking to the northeast, north, and northwest, respectively, low-rise dwellings from the east clockwise to south-southwest, green space to the southwest, and low-rise dwellings to the west. The far-field surroundings (defined as the area beyond the near field and within a 2-kilometre (km) radius) are characterized primarily by suburban exposures to the northwest, as well as north-northeast clockwise to south-southeast, and by hybrid open-suburban exposures for the remaining compass directions. Notably, a future mixed-use subdivision comprising 20 single-detached dwellings, townhouse dwellings, five low-rise apartment buildings, and a nine-storey mixed-use building is proposed at 6171 Hazeldean Road (Application #D07-16-20-0026), located approximately 450 m to the northeast of the subject site.

A site plan for the proposed massing scenario is illustrated in Figure 1, while Figures 2A-2D illustrate the computational model used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level wind conditions at key areas within and surrounding the development site; (ii) identify areas where wind conditions may interfere with the intended uses of outdoor spaces; and (iii) recommend suitable mitigation measures, where required.

4. METHODOLOGY

The approach followed to quantify pedestrian wind conditions over the site is based on CFD simulations of wind speeds across the subject site within a virtual environment, meteorological analysis of the Ottawa area wind climate, and synthesis of computational data with City of Ottawa wind comfort and safety criteria[2]. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

4.1 Computer-Based Context Modelling

A computer based PLW study was performed to determine the influence of the wind environment on pedestrian comfort over the proposed development site. Pedestrian comfort predictions, based on the mechanical effects of wind, were determined by combining measured wind speed data from CFD simulations with statistical weather data obtained from Ottawa Macdonald-Cartier International Airport. The general concept and approach to CFD modelling is to represent building and topographic details in the immediate vicinity of the subject site on the surrounding model, and to create suitable atmospheric wind profiles at the model boundary. The wind profiles are designed to have similar mean and turbulent wind properties consistent with actual site exposures.

An industry standard practice is to omit trees, vegetation, and other existing and planned landscape elements from the model due to the difficulty of providing accurate seasonal representation of vegetation. The omission of trees and other landscaping elements produces slightly stronger wind speeds.

[2] City of Ottawa Terms of References: Wind Analysis
https://documents.ottawa.ca/sites/default/files/torwindanalysis_en.pdf

4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 12 wind directions. The CFD simulation model was centered on the proposed development, complete with surrounding massing within a radius of 480 m. The process was performed for the proposed massing scenario, as noted in Section 2.

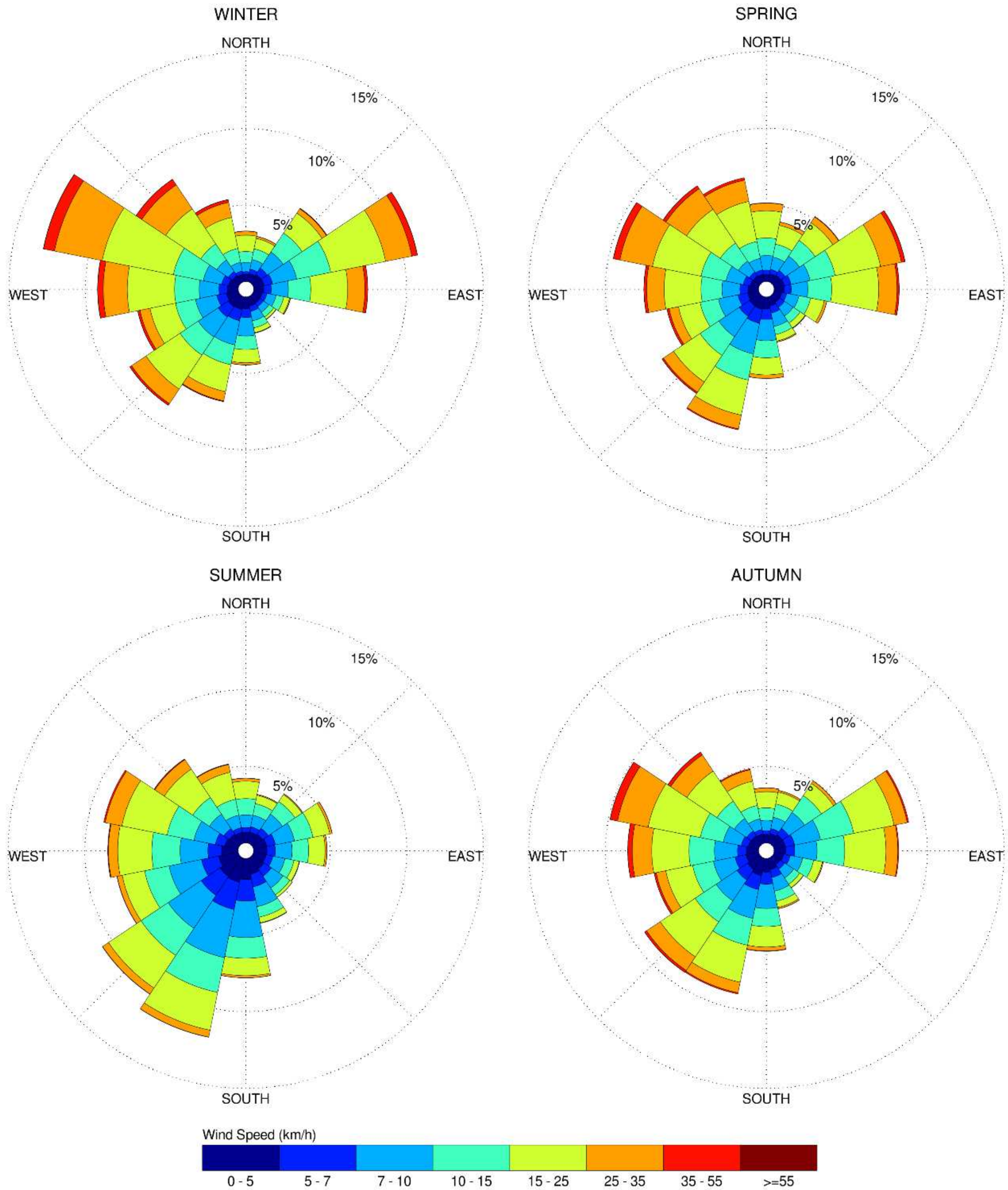
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the common amenity terrace serving Building A at Level 3 were referenced to the wind speed at gradient height to generate mean and peak velocity ratios, which were used to calculate full-scale values. Gradient height represents the theoretical depth of the boundary layer of the earth's atmosphere, above which the mean wind speed remains constant. Further details of the wind flow simulation technique are presented in Appendix A.

4.3 Historical Wind Speed and Direction Data

A statistical model for winds in Ottawa was developed from approximately 40 years of hourly meteorological wind data recorded at Ottawa Macdonald-Cartier International Airport and obtained from Environment and Climate Change Canada. Wind speed and direction data were analyzed for each month of the year to determine the statistically prominent wind directions and corresponding speeds, and to characterize similarities between monthly weather patterns.

The statistical model of the Ottawa area wind climate, which indicates the directional character of local winds on a seasonal basis, is illustrated on the following page. The plots illustrate seasonal distribution of measured wind speeds and directions in kilometers per hour (km/h). Probabilities of occurrence of different wind speeds are represented as stacked polar bars in sixteen azimuth divisions. The radial direction represents the percentage of time for various wind speed ranges per wind direction during the measurement period. The prominent wind speeds and directions can be identified by the longer length of the bars. For Ottawa, the most common winds occur for westerly wind directions, followed by those from the east, while the most common wind speeds are below 36 km/h. The directional prominence and relative magnitude of wind speed changes somewhat from season to season.

SEASONAL DISTRIBUTION OF WIND
OTTAWA MACDONALD-CARTIER INTERNATIONAL AIRPORT



Notes:

1. Radial distances indicate percentage of time of wind events.
2. Wind speeds are mean hourly in km/h, measured at 10 m above the ground.

4.4 Pedestrian Wind Comfort and Safety Criteria – City of Ottawa

Pedestrian wind comfort and safety criteria are based on the mechanical effects of wind without consideration of other meteorological conditions (that is, temperature and relative humidity). The comfort criteria assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Five pedestrian comfort classes based on 20% non-exceedance mean wind speed ranges are used to assess pedestrian comfort: (1) Sitting; (2) Standing; (3) Strolling; (4) Walking; and (5) Uncomfortable. The gust speeds, and equivalent mean speeds, are selected based on the Beaufort scale, which describes the effects of forces produced by varying wind speed levels on objects. Wind conditions suitable for sitting are represented by the colour blue, standing by green, strolling by yellow, and walking by orange; uncomfortable conditions are represented by the colour magenta. Specifically, the comfort classes, associated wind speed ranges, and limiting criteria are summarized as follows:

PEDESTRIAN WIND COMFORT CLASS DEFINITIONS

Wind Comfort Class	GEM Speed (km/h)	Description
SITTING	≤ 10	Mean wind speeds no greater than 10 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 16 km/h.
STANDING	≤ 14	Mean wind speeds no greater than 14 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 22 km/h.
STROLLING	≤ 17	Mean wind speeds no greater than 17 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 27 km/h.
WALKING	≤ 20	Mean wind speeds no greater than 20 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 32 km/h.
UNCOMFORTABLE	> 20	Uncomfortable conditions are characterized by predicted values that fall below the 80% target for walking. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this criterion.

Regarding wind safety, the pedestrian safety wind speed criterion is based on the approximate threshold that would cause a vulnerable member of the population to fall. A 0.1% exceedance gust wind speed of 90 km/h is classified as dangerous. From calculations of stability, it can be shown that gust wind speeds of 90 km/h would be the approximate threshold wind speed that would cause an average elderly person in good health to fall. Notably, pedestrians tend to be more sensitive to wind gusts than to steady winds for lower wind speed ranges. For strong winds approaching dangerous levels, this effect is less important because the mean wind can also create problems for pedestrians.

Experience and research on people's perception of mechanical wind effects has shown that if the wind speed levels are exceeded for more than 20% of the time, the activity level would be judged to be uncomfortable by most people. For instance, if a mean wind speed of 10 km/h (equivalent gust wind speed of approximately 16 km/h) were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting. Similarly, if mean wind speed of 20 km/h (equivalent gust wind speed of approximately 32 km/h) at a location were exceeded for more than 20% of the time, walking or less vigorous activities would be considered uncomfortable. As these criteria are based on subjective reactions of a population to wind forces, their application is partly based on experience and judgment.

Once the pedestrian wind speed predictions have been established throughout the subject site, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for discrete regions within and surrounding the subject site. This step involves comparing the predicted comfort classes to the target comfort classes, which are dictated by the location type for each region (that is, a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their typical windiest target comfort classes are summarized on the following page. Depending on the programming of a space, the desired comfort class may differ from this table.

TARGET PEDESTRIAN WIND COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Walking
Public Sidewalk / Bicycle Path	Walking
Outdoor Amenity Space	Sitting / Standing
Café / Patio / Bench / Garden	Sitting / Standing
Transit Stop (Without Shelter)	Standing
Transit Stop (With Shelter)	Walking
Public Park / Plaza	Sitting / Standing
Garage / Service Entrance	Walking
Parking Lot	Walking
Vehicular Drop-Off Zone	Walking

5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-3D, which illustrate conditions at grade level for the proposed massing scenario, and by Figures 4A-4D, which illustrate conditions over the common amenity terrace serving Building A at Level 3. Conditions are presented as continuous contours of wind comfort within and surrounding the subject site and correspond to the various comfort classes noted in Section 4.4.

Wind comfort conditions are also reported for the typical use period, which is defined as May to October, inclusive. Figure 5 illustrates wind comfort conditions over the Level 3 common amenity terrace serving Building A, consistent with the comfort classes in Section 4.4. The details of these conditions are summarized in the following pages for each area of interest.

5.1 Wind Comfort Conditions – Grade Level

Sidewalks along Hazeldean Road: Following the introduction of the proposed development, wind comfort conditions over the nearby public sidewalks along Hazeldean Road are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, during the autumn, and suitable for a mix of standing and strolling with isolated regions suitable for walking during the spring and winter. The noted conditions are considered acceptable.

While the introduction of the proposed development produces windier conditions over Hazeldean Road in comparison to existing conditions (refer to Section 5 of the noted previous PLW report mentioned in Section 1 for a detailed description of the predicted wind comfort conditions for the existing massing scenario), wind comfort conditions are nevertheless considered acceptable.

Green Space East and South of Subject Site: Following the introduction of the proposed development, wind comfort conditions over the green space to the east, situated between the subject site and low-rise dwellings to the east, and to the south of the subject site are predicted to be suitable mostly for sitting during the summer, becoming suitable standing, or better, throughout the remainder of the year with small, isolated regions suitable for walking during the winter and spring. The noted conditions are considered acceptable.

While the introduction of the proposed development produces windier conditions over the noted green spaces in comparison to existing conditions (refer to Section 5 of the noted previous PLW report mentioned in Section 1 for a detailed description of the predicted wind comfort conditions for the existing massing scenario), wind comfort conditions are nevertheless considered acceptable.

Private Laneway, Surface Parking, and Walkways Within Subject Site: Wind comfort conditions over the private laneway situated central to the subject site are predicted to be suitable for standing during the summer, becoming suitable for strolling, or better, during the autumn, and suitable for walking, or better, during the winter and spring. Conditions over the surface parking between Building A and Building B are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing and strolling during the autumn, and suitable for a mix of strolling and walking during the winter and spring. Conditions over the surface parking to the east of Building B are predicted to be suitable for standing, or better, during the summer, becoming suitable for a mix of standing and strolling during the spring and autumn, and suitable for a mix of standing, strolling, and walking during the winter. While the noted areas are predicted to experience windy conditions owing to channelling effects and downwash incident on the 25-storey tower, the wind comfort conditions are considered satisfactory for the intended pedestrian uses throughout the year.

Conditions over the walkways within the subject site are predicted to be suitable for a mix of sitting and standing with a small, isolated region suitable for strolling near the northwest corner of Building B during the summer, becoming suitable for strolling, or better, with a small, isolated region suitable for walking near the northwest corner of Building B during the autumn, and suitable for walking, or better, during the winter and spring. The windiest conditions are situated near the northwest corner of Building B, where an isolated region of uncomfortable conditions is predicted to occur during the winter. Specifically, conditions during the winter season at the northwest corner of Building B are predicted to be suitable for walking for approximately 77% of the time, representing a 3% exceedance of the walking threshold. While the noted conditions are predicted to impact a section of the proposed walkway, the majority of the windier conditions are mostly located over the road surface where pedestrian access is expected to be limited.

Notably, landscaping elements that could not be implemented in the simulation model, specifically the proposed trees at the north corner of the development, may improve the wind comfort conditions at the northwest corner of Building B. Comfort conditions may be further improved with the implementation of mitigation in the form of a canopy along a portion of the north and west elevations of Building B, as well as wind screens strategically placed near the northwest corner of the building to reduce downwash effects incident on the 25-storey tower and to reduce corner acceleration effects, respectively. An appropriate mitigation strategy will be developed in collaboration with the building and landscape architects for the future Site Plan Control application submission.

Building Access Points: Conditions in the vicinity of all building access points serving Building A, and in the vicinity of the main building access at the southwest corner of Building B are predicted to be suitable for standing, or better, throughout the year. The noted conditions considered acceptable.

Conditions in the vicinity of the building access points serving Building B along the south elevation are predicted to be suitable for standing during the summer and autumn, becoming suitable for a mix of standing and strolling during the winter and spring. As the noted building access points along the south elevation serve as secondary entrances and exits to Building B, the noted conditions are considered acceptable.

Conditions in the vicinity of the indoor amenity access near the northwest corner of Building B are predicted to be suitable for a mix of mostly sitting and standing throughout the year, with conditions that may be considered uncomfortable for walking near the northwest corner of Building B. Due to the windy conditions predicted to occur near the northwest corner of Building B, it is recommended that the noted building access point be recessed into the façade by at least 1.5 m to provide calmer wind conditions, or relocated further to the east along the north elevation of Building B to where conditions are suitable for standing, or better, throughout the year.

5.2 Wind Comfort Conditions – Level 3 Common Amenity Terrace

Wind comfort conditions within the common amenity terrace serving Building A at Level 3 are predicted to be suitable for sitting during the typical use period, as illustrated in Figure 5. The noted conditions are considered acceptable.

5.3 Wind Safety

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no pedestrian areas within or surrounding the subject site are expected to experience conditions that could be considered dangerous, as defined in Section 4.4.

5.4 Applicability of Results

Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the subject site. Future changes (that is, construction or demolition) of these surroundings may cause changes to the wind effects in two ways, namely: (i) changes beyond the immediate vicinity of the subject site would alter the wind profile approaching the subject site; and (ii) development in proximity to the subject site would cause changes to local flow patterns.

6. CONCLUSIONS AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 of this report and illustrated in Figures 3A-5. Based on computer simulations using the CFD technique, meteorological data analysis, and experience with numerous similar developments, the study concludes the following:

1) Most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, laneway, surface parking, walkways, green spaces to the east and south, and in the vicinity of building access points, are considered acceptable. The areas that are predicted to experience windy conditions are described as follows:

    a. **Northwest Corner of Building B**. Following the introduction of the proposed development, the above noted area is predicted to experience uncomfortable wind conditions, exceeding the walking threshold by a maximum of approximately 3% of the time during the winter season. While the noted conditions, which are illustrated in Figure 3D, are predicted to impact a section of the proposed walkway adjacent to the northwest corner of Building B, the majority of the windier conditions are mostly located over the road surface where pedestrian access is expected to be limited.

- Notably, landscaping elements that could not be implemented in the simulation model, specifically the proposed trees at the north corner of the development, may improve wind comfort conditions at the northwest corner of Building B.

- Comfort conditions may be further improved with the implementation of mitigation in the form of a canopy along a portion of the north and west elevations of Building B, as well as wind screens strategically placed near the northwest corner of the building to reduce downwash effects incident on the 25-storey tower and to reduce corner acceleration effects, respectively.

- As noted in the addendum below, following the current study, a canopy at the northwest corner of Building B has been adopted by the design team.

- The mitigation strategy for the noted area will continue to be developed in collaboration with the building and landscape architects for the future Site Plan Control application submission.

b. **Building Access Points Serving Building B**: Due to the windy conditions predicted to occur near the northwest corner of Building B, it is recommended that the building access point serving Building B at the northwest corner be either recessed into the façade by at least 1.5 m or be relocated further to the east where conditions are suitable for standing, or better, throughout the year. Regarding the building access points serving Building B along its south elevation, conditions are considered acceptable in the vicinity of these access points as they serve as secondary access points, and an increase in the separation distance between Building B and the parking podium serving Building A would be expected to provide some improvement in the wind conditions between the two buildings.

   - As noted in the addendum below, following the current study, the building access at the northwest corner of Building B has been relocated to the east.

2) Regarding the common amenity terrace serving Building A at Level 3, conditions during the typical use period are predicted to be suitable for sitting. The noted conditions are considered acceptable.

3) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events, (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

Sincerely,

Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. D. FERRARO
100158495
Dec 21, 2023
PROVINCE OF ONTARIO

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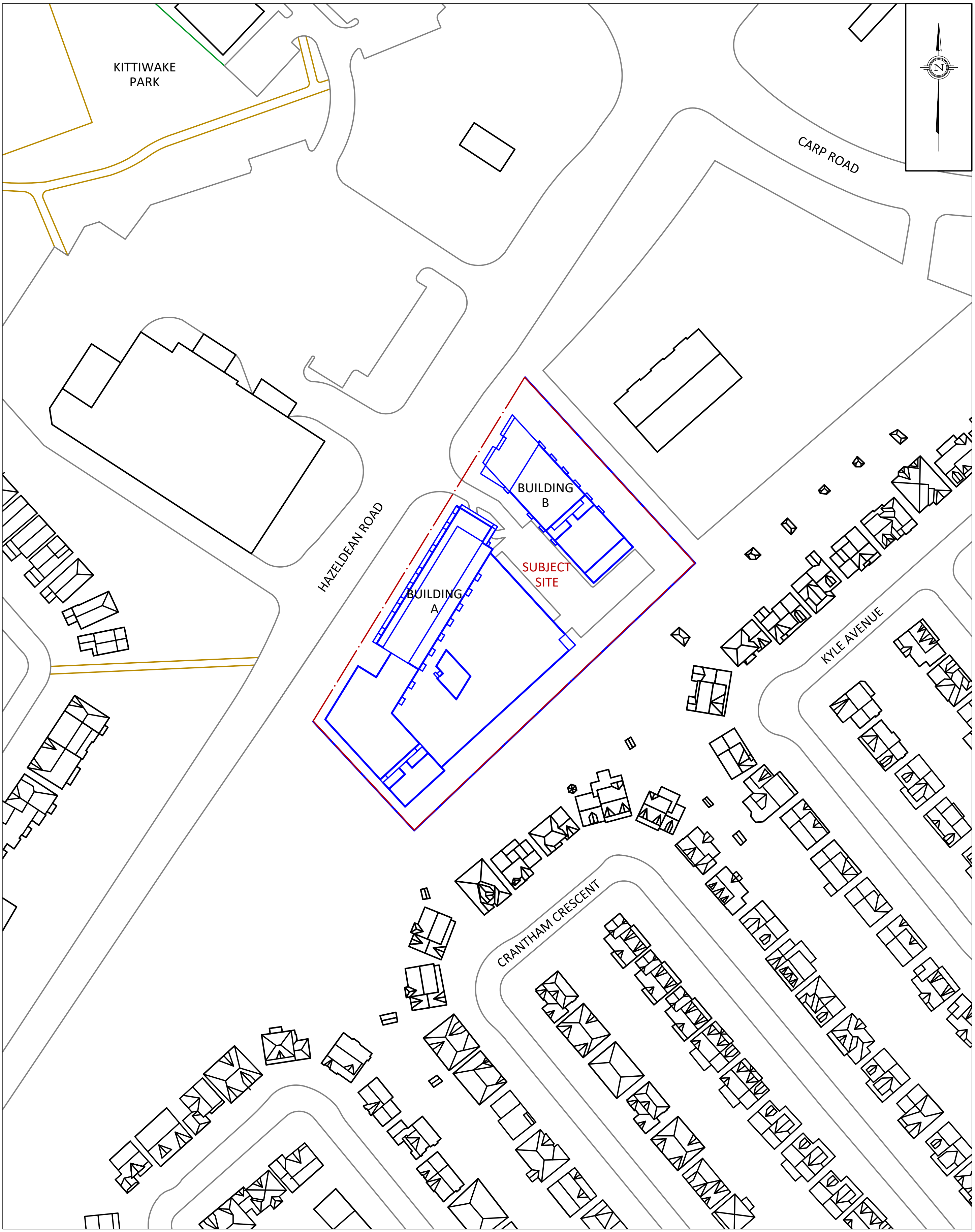

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PROJECT: 6310 HAZELDEAN ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 1: PROPOSED SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:1500	DRAWING NO.: 20-303-PLW-2023-1	
DATE: OCTOBER 6, 2023	DRAWN BY: S.K.	

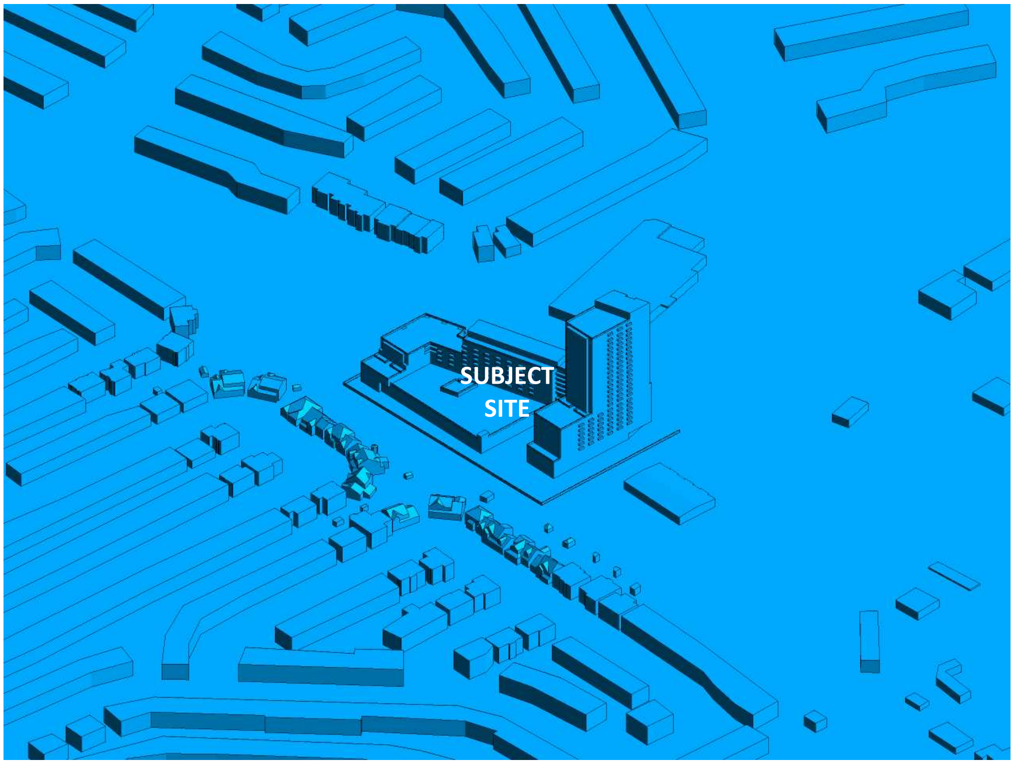

FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, EAST PERSPECTIVE

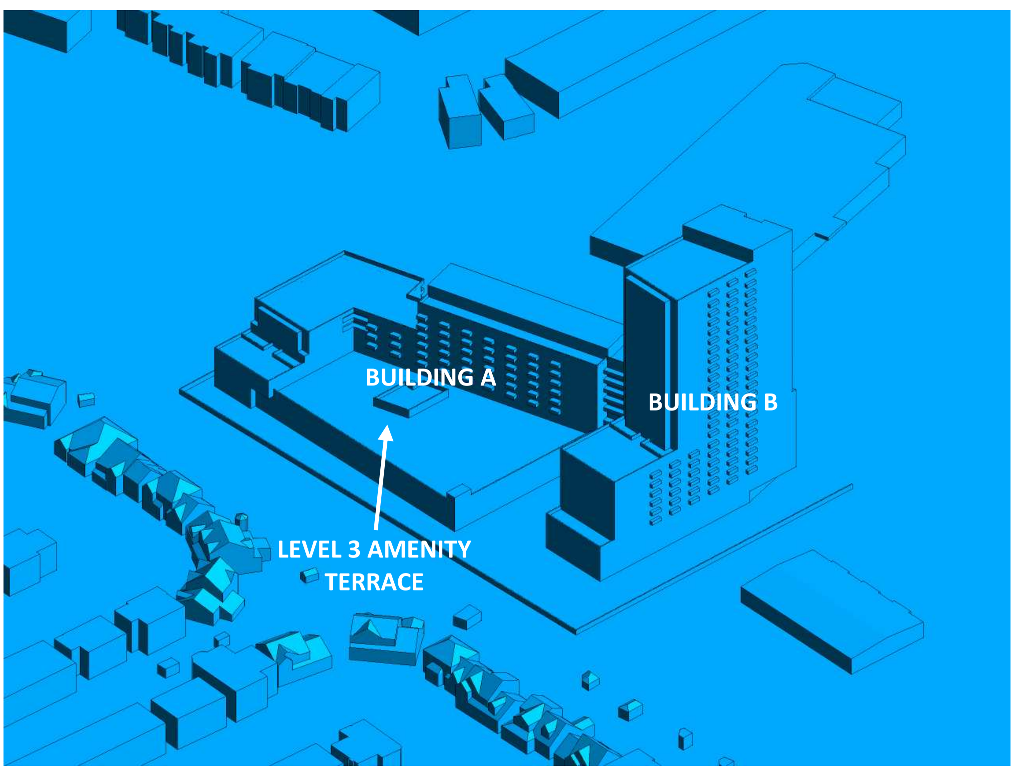

FIGURE 2B: CLOSE-UP VIEW OF FIGURE 2A

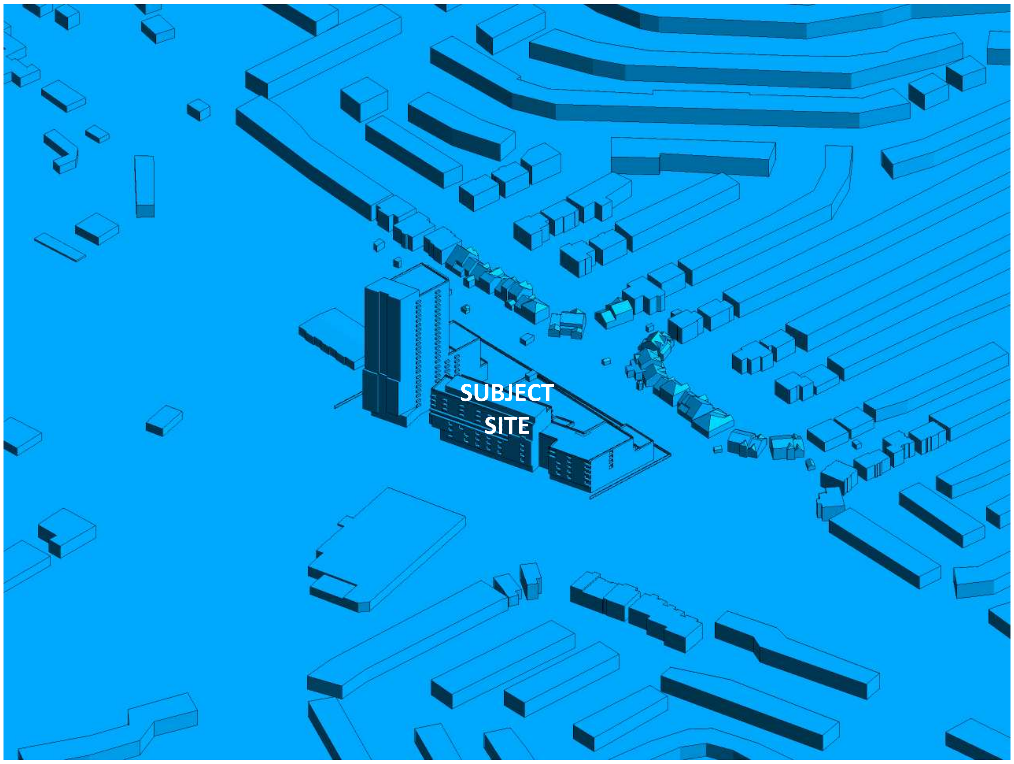

FIGURE 2C: COMPUTATIONAL MODEL, PROPOSED MASSING, WEST PERSPECTIVE

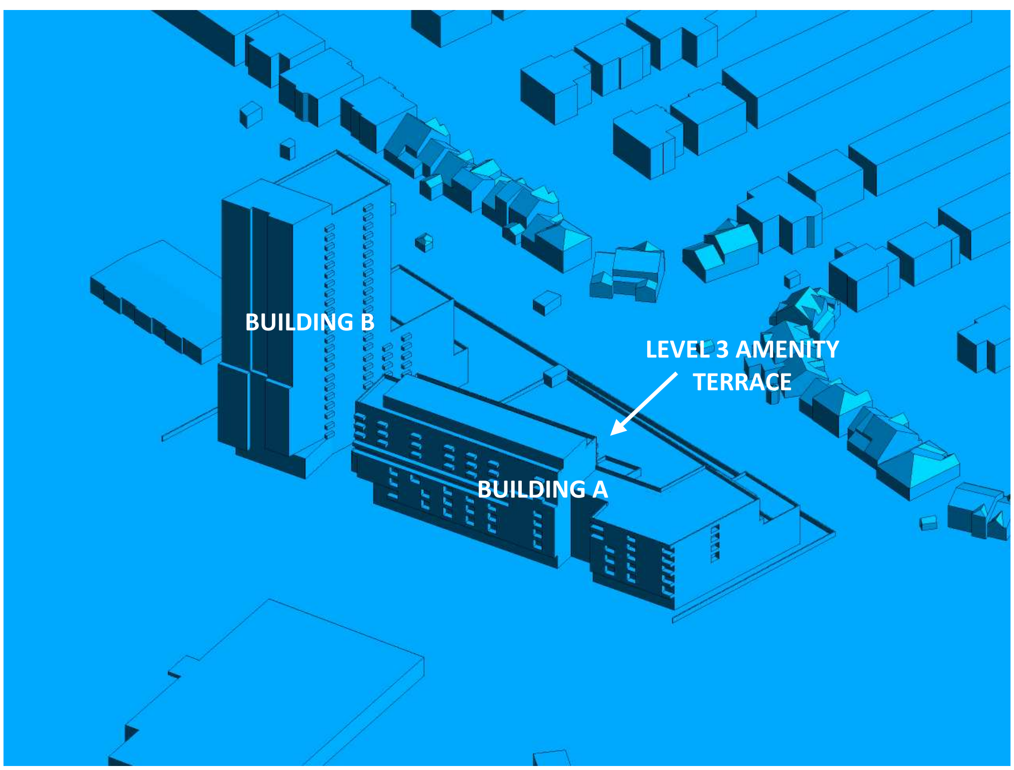

FIGURE 2D: CLOSE-UP VIEW OF FIGURE 2C

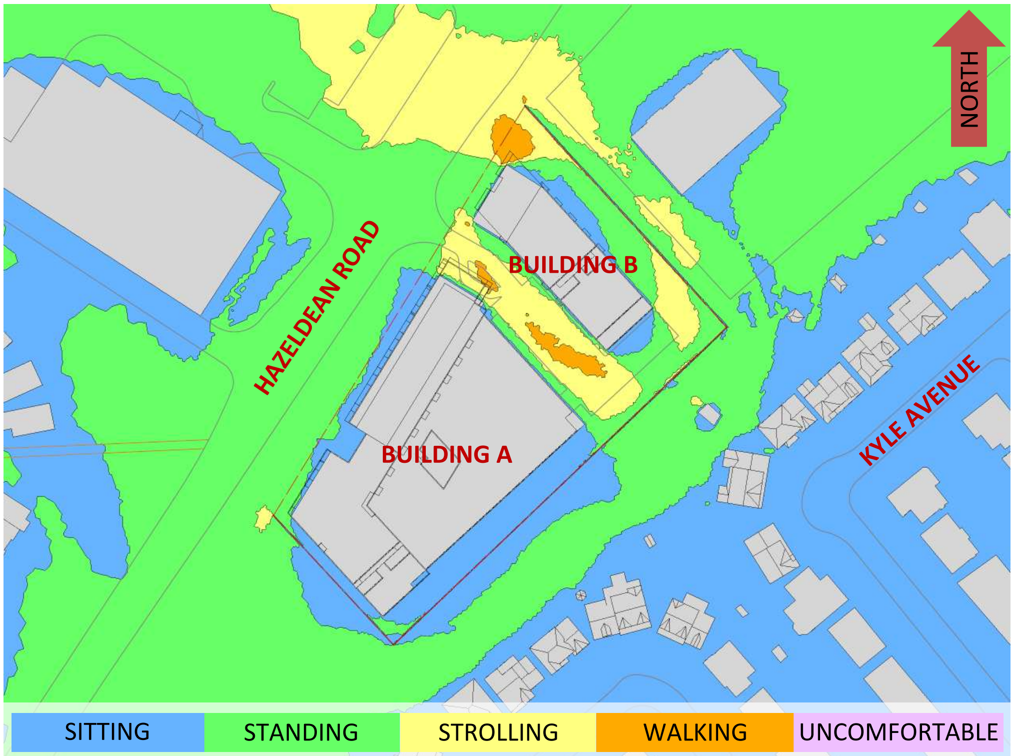

FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

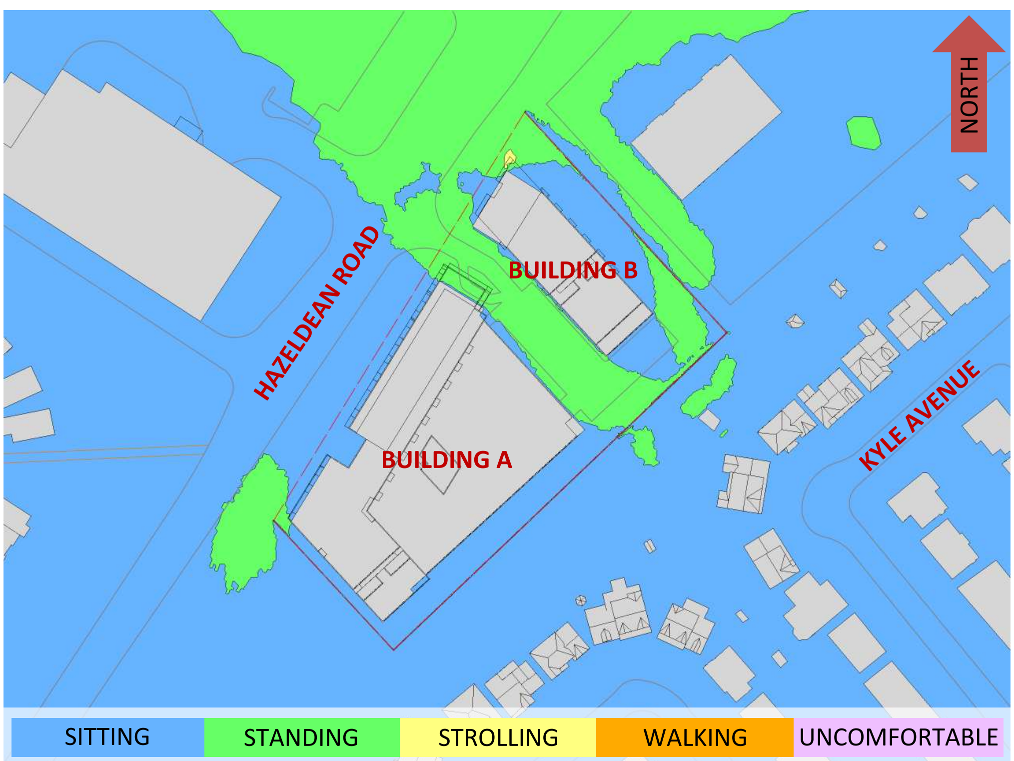

FIGURE 3B: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

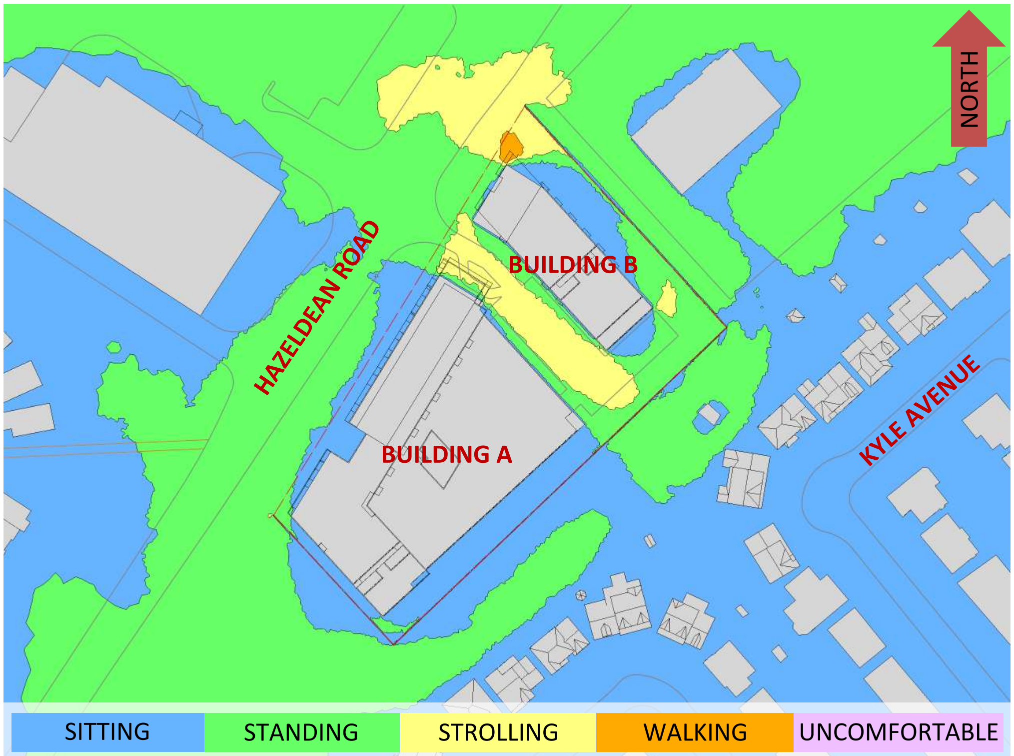

FIGURE 3C: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

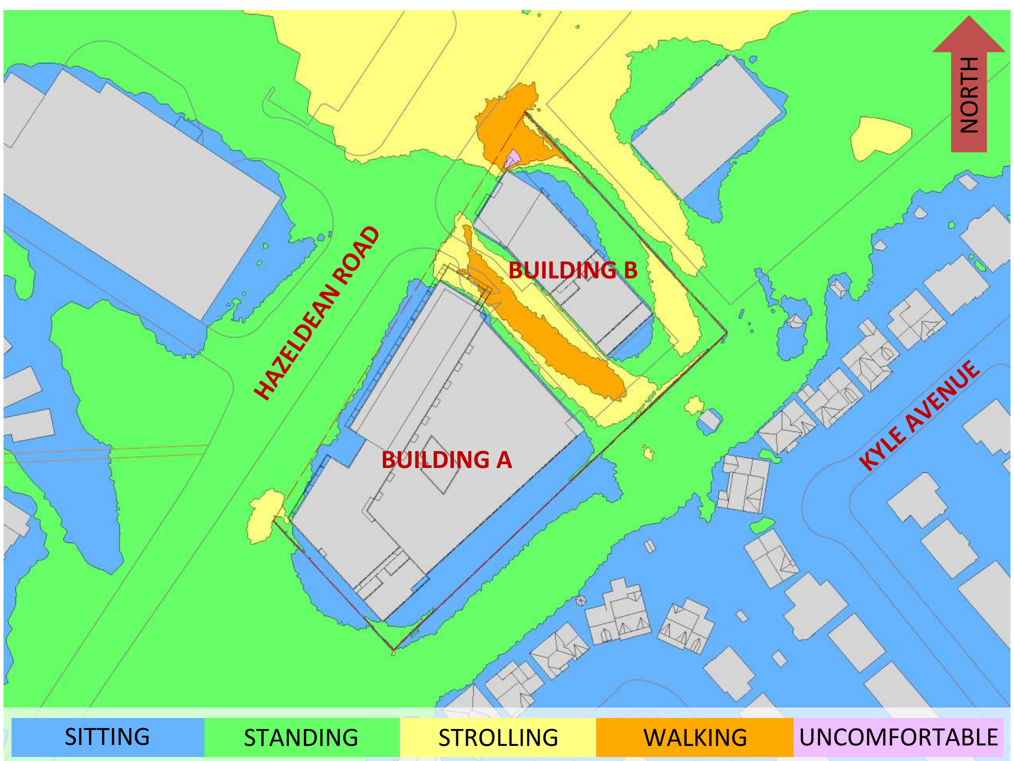

FIGURE 3D: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

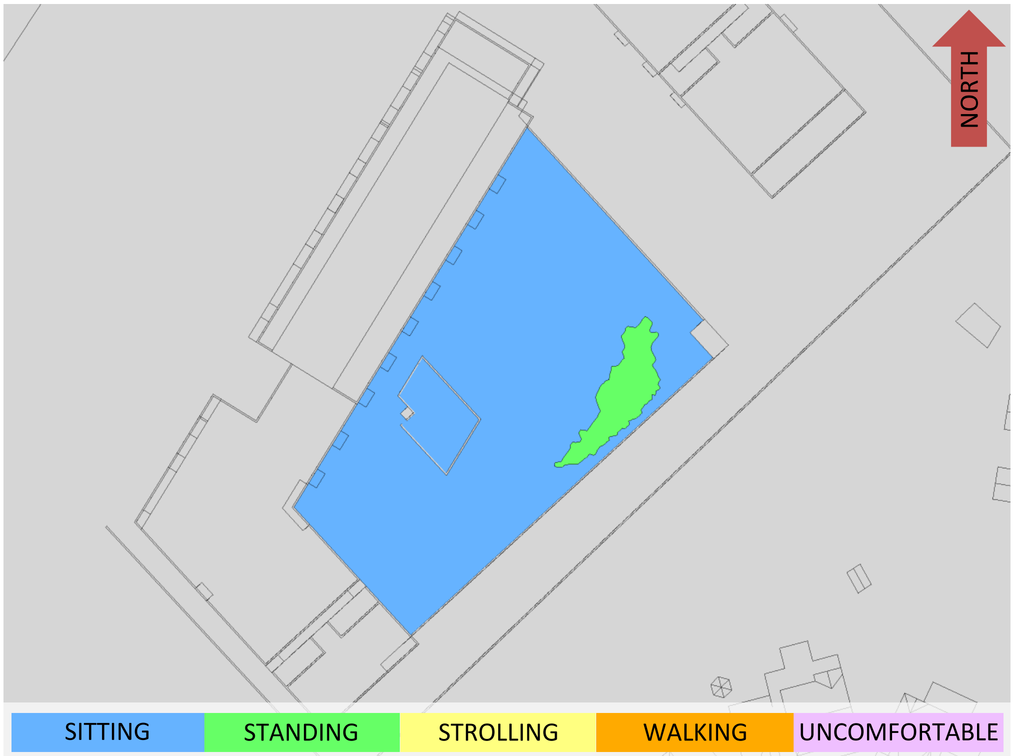

FIGURE 4A: SPRING – WIND COMFORT, LEVEL 3 COMMON AMENITY TERRACE

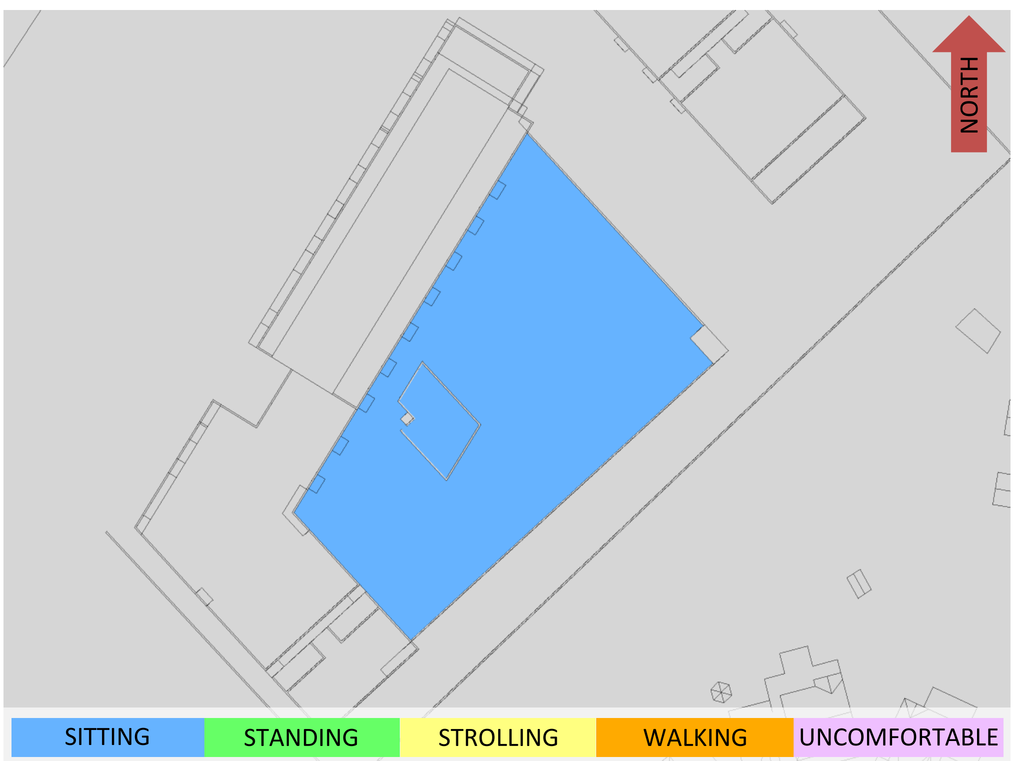

FIGURE 4B: SUMMER – WIND COMFORT, LEVEL 3 COMMON AMENITY TERRACE

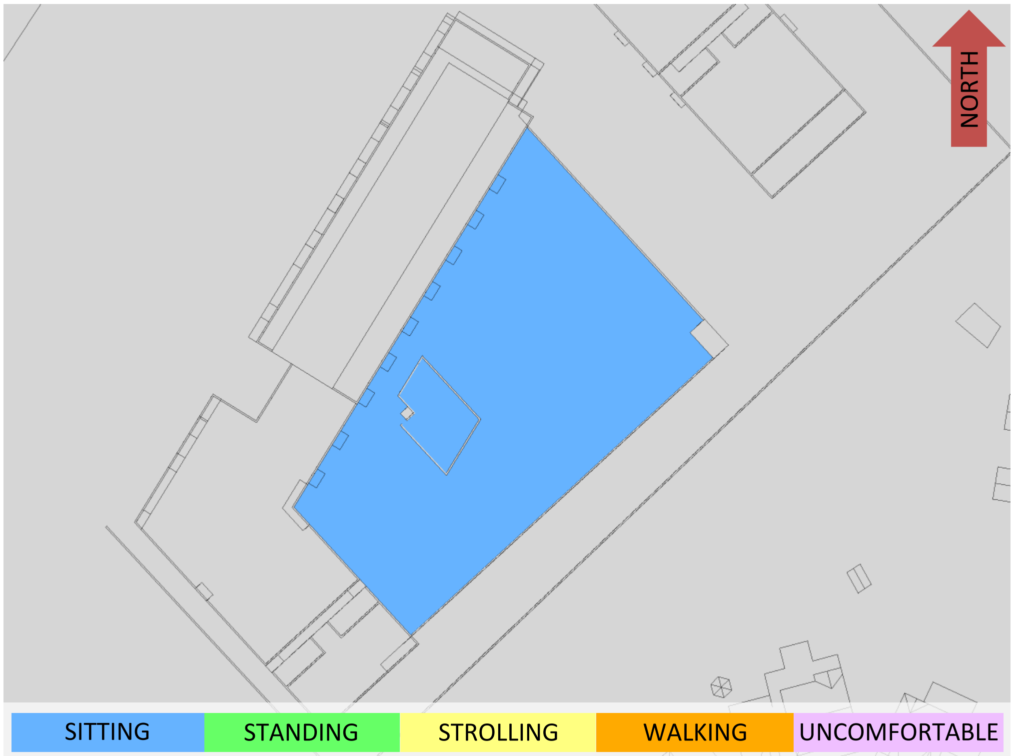

FIGURE 4C: AUTUMN – WIND COMFORT, LEVEL 3 COMMON AMENITY TERRACE

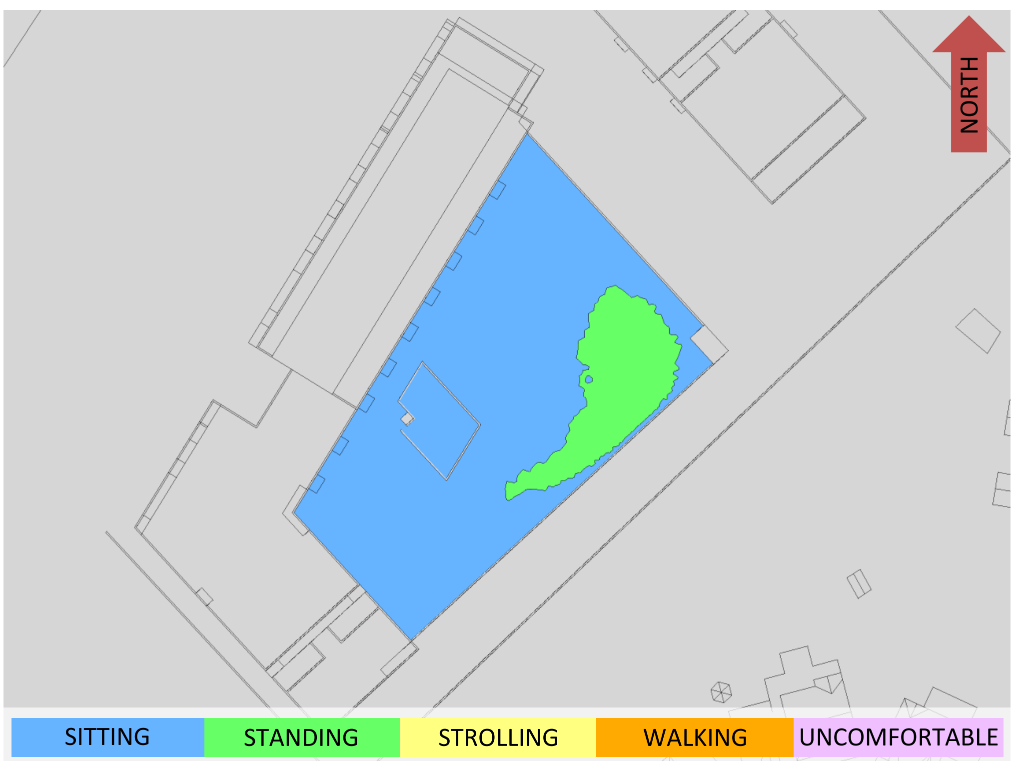

FIGURE 4D: WINTER – WIND COMFORT, LEVEL 3 COMMON AMENITY TERRACE

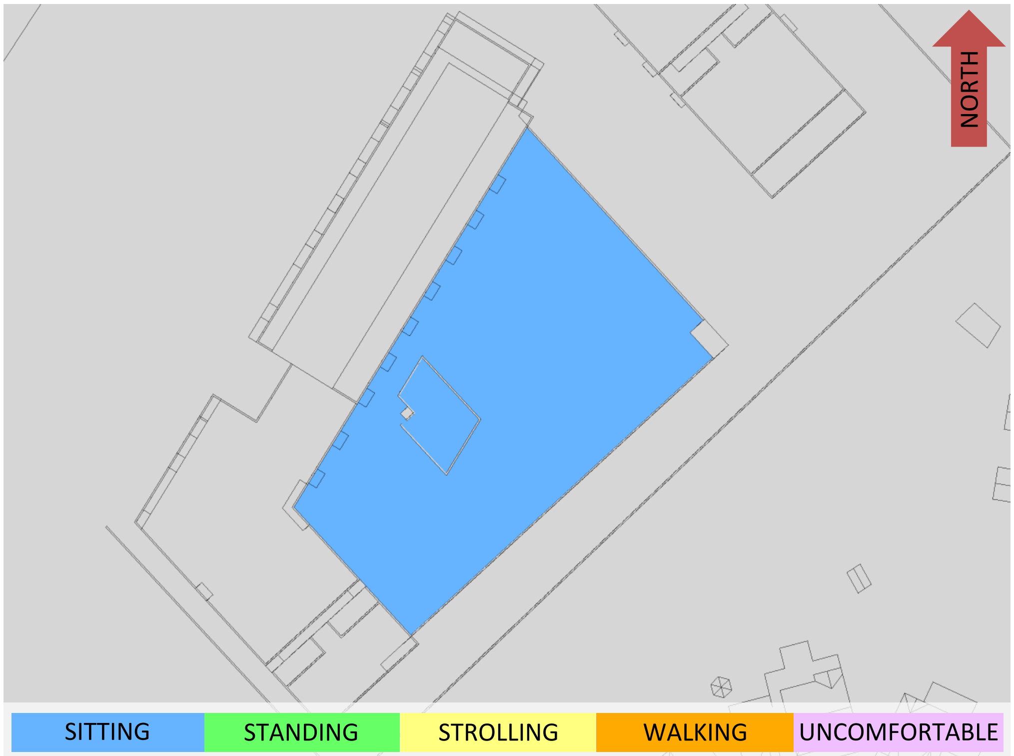

FIGURE 5: TYPICAL USE PERIOD – WIND COMFORT, LEVEL 3 COMMON AMENITY TERRACE

APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

The atmospheric boundary layer (ABL) is defined by the velocity and turbulence profiles according to industry standard practices. The mean wind profile can be represented, to a good approximation, by a power law relation, Equation (1), giving height above ground versus wind speed (1), (2).

$$U = U_g \left(\frac{Z}{Z_g}\right)^{\alpha} \qquad \text{Equation (1)}$$

where, $\boldsymbol{U}$ = mean wind speed, $\boldsymbol{U_g}$ = gradient wind speed, $\boldsymbol{Z}$ = height above ground, $\boldsymbol{Z_g}$ = depth of the boundary layer (gradient height), and α is the power law exponent.

For the model, U_g is set to 6.5 metres per second (m/s), which approximately corresponds to the 60% mean wind speed for Ottawa based on historical climate data and statistical analyses. When the results are normalized by this velocity, they are relatively insensitive to the selection of gradient wind speed.

Z_g is set to 540 m. The selection of gradient height is relatively unimportant, so long as it exceeds the building heights surrounding the subject site. The value has been selected to correspond to our physical wind tunnel reference value.

α is determined based on the upstream exposure of the far-field surroundings (that is, the area that it not captured within the simulation model).

Table 1 presents the values of α used in this study, while Table 2 presents several reference values of α. When the upstream exposure of the far-field surroundings is a mixture of multiple types of terrain, the α values are a weighted average with terrain that is closer to the subject site given greater weight.

TABLE 1: UPSTREAM EXPOSURE (ALPHA VALUE) VS TRUE WIND DIRECTION

Wind Direction (Degrees True)	Alpha Value (α)
0	0.20
49	0.22
74	0.22
103	0.23
167	0.20
197	0.19
217	0.19
237	0.19
262	0.19
282	0.19
301	0.20
324	0.20

TABLE 2: DEFINITION OF UPSTREAM EXPOSURE (ALPHA VALUE)

Upstream Exposure Type	Alpha Value (α)
Open Water	0.14-0.15
Open Field	0.16-0.19
Light Suburban	0.21-0.24
Heavy Suburban	0.24-0.27
Light Urban	0.28-0.30
Heavy Urban	0.31-0.33

The turbulence model in the computational fluid dynamics (CFD) simulations is a two-equation shear-stress transport (SST) model, and thus the ABL turbulence profile requires that two parameters be defined at the inlet of the domain. The turbulence profile is defined following the recommendations of the Architectural Institute of Japan for flat terrain (3).

$$I(Z) = \begin{cases} 0.1\left(\frac{Z}{Z_g}\right)^{-\alpha-0.05}, & Z > 10 \text{ m} \\ 0.1\left(\frac{10}{Z_g}\right)^{-\alpha-0.05}, & Z \leq 10 \text{ m} \end{cases} \qquad \text{Equation (2)}$$

$$L_t(Z) = \begin{cases} 100 \text{ m}\sqrt{\frac{Z}{30}}, & Z > 30 \text{ m} \\ 100 \text{ m}, & Z \leq 30 \text{ m} \end{cases} \qquad \text{Equation (3)}$$

where, ***I*** = turbulence intensity, L_t = turbulence length scale, ***Z*** = height above ground, and α is the power law exponent used for the velocity profile in Equation (1).

Boundary conditions on all other domain boundaries are defined as follows: the ground is a no-slip surface; the side walls of the domain have a symmetry boundary condition; the top of the domain has a specified shear, which maintains a constant wind speed at gradient height; and the outlet has a static pressure boundary condition.

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[3] Y. Tamura, H. Kawai, Y. Uematsu, K. Kondo and T. Okhuma, "Revision of AIJ Recommendations for Wind Loads on Buildings," in *The International Wind Engineering Symposium, IWES 2003*, Taiwan, 2003.