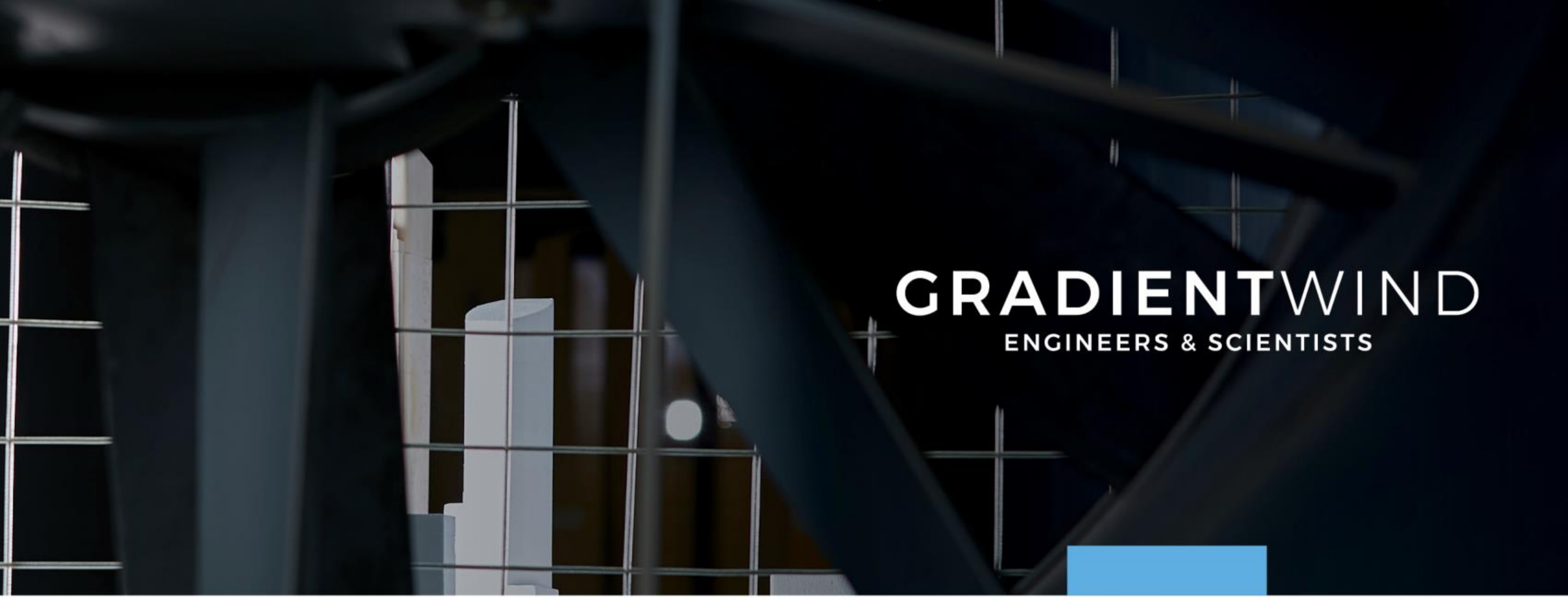
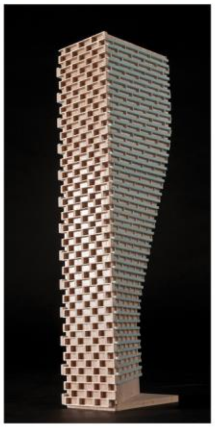
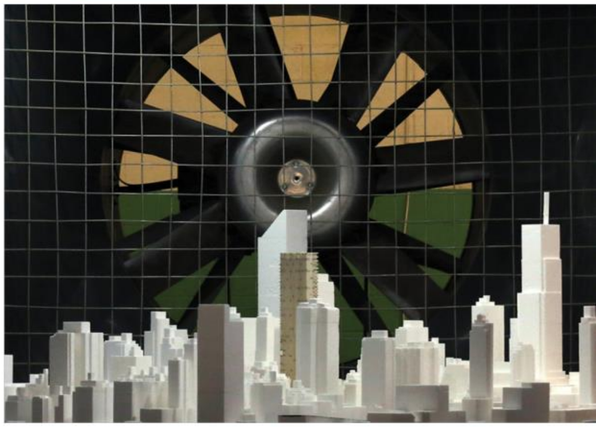


PEDESTRIAN LEVEL WIND STUDY

1137 Ogilvie Road
Ottawa, Ontario

Report: 24-126-PLW





July 17, 2024

PREPARED FOR
TCU Development Corporation
1207-150 Isabella Street
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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Zoning By-Law Amendment (ZBLA) application submission requirements for the proposed mixed-use residential development located at 1137 Ogilvie 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-7, 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, transit stops, neighbouring existing surface parking lots, proposed drive aisles, walkways, surface parking, the unloading area and drop-off/pick-up area, the grade-level exterior amenity (entry courtyard), and in the vicinity of most building access points, are considered acceptable.

2) Prevailing east-northeasterly, westerly, and west-northwesterly winds are predicted to channel through the accessible volume beneath the podium, introducing windier conditions over the area. Following the introduction of the proposed development, a region over the covered drive aisle along the north elevation of the subject site is predicted to experience conditions that may occasionally be considered uncomfortable for walking, exceeding the walking threshold for approximately 5% of the time during the spring season and approximately 6% of the time during the winter season. The noted wind conditions are considered satisfactory, as the uncomfortable conditions during the spring and winter are limited to over the roadway surface where pedestrian access and use is limited.

3) Wind conditions along the south elevation of the stairwell and vestibule to the south of the parking ramp are predicted to be suitable for standing, or better, during the summer, becoming suitable for a mix of standing, strolling, and walking during the spring, autumn, and winter. If a building access point is to be located along the south elevation of the noted stairwell or vestibule, it is recommended to recess the entrance into the building façade by 1.5 m.

4) During the typical use period (May to October, inclusive), wind conditions within the POPS and the exterior commercial terrace space are predicted to be suitable for mostly sitting, with standing conditions at the south elevation of the POPS and at the southeast and southwest corners of the proposed development. If the windier areas that are suitable for standing will include designated seating or lounging, it is recommended to implement targeted wind barriers adjacent to these areas. These barriers may take the form of wind screens or dense arrangements of coniferous plantings that are targeted around seating areas, in combination with canopy structures above designated seating areas.

5) 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.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by TCU Development Corporation to undertake a pedestrian level wind (PLW) study to satisfy Zoning By-Law Amendment (ZBLA) application submission requirements for the proposed mixed-use residential development located at 1137 Ogilvie 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.

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 Roderick Lahey Architect Inc in June 2024, surrounding street layouts and existing and approved future building massing information obtained from the City of Ottawa, as well as recent satellite imagery.

2. TERMS OF REFERENCE

The subject site is located at 1137 Ogilvie Road in Ottawa, situated at the northeast corner of the intersection of Ogilvie Road and Cummings Avenue. Throughout this report, Ogilvie Road is considered as project south. The proposed development comprises a 24-storey mixed-use residential building, inclusive of a 4-storey podium, topped with a mechanical penthouse (MPH). Drive aisles extending from Cummings Avenue provide access to a parking ramp and surface parking to the north, a rear unloading area to the east, and a drop-off/pick-up area and surface parking located to the west of the subject site. A privately-owned publicly accessible spaces (POPS) is located along the southeast elevation of the subject site.

Above two underground parking levels, the ground floor of the proposed development includes a commercial space along the south elevation, a residential main entrance to the west, shared building support spaces to the east, and indoor amenities throughout the remainder of the level. An exterior commercial terrace space and an exterior amenity (entry courtyard) are located at the southeast corner and to the west, respectively. Levels 2-24 are reserved for residential occupancy. At Level 2, the building extends from the north elevation over the drive aisle below. Setbacks from the north elevation at Level 2 and from all elevations at Level 5 accommodate private terraces.

Considering Ogilvie Road as project south, the near-field surroundings, defined as an area within a 200-metre (m) radius of the subject site, include low-rise commercial buildings with surface parking lots from the east clockwise to the south, a high-rise building to the south, a gas station to the west, low-rise residential dwellings from the west clockwise to the north, and the forested areas of Ken Steele Park from the north-northeast clockwise to the east. Notably, a 6-storey residential development has been approved at 1184 Cummings Avenue, to the immediate northwest, and a mixed-use hotel/residential development comprising two towers (25 and 27 storeys) is approved at 1098 Ogilvie Road and 1178 Cummings Avenue, approximately 80 m to the southwest. The far-field surroundings, defined as an area beyond the near-field but within a 2-kilometre (km) radius of the subject site, are characterized primarily by low-rise massing in all compass directions, with isolated mid- and high-rise buildings to the east and southwest clockwise to the north-northwest.

Site plans for the proposed and existing massing scenarios are illustrated in Figures 1A and 1B, while Figures 2A-2H illustrate the computational models used to conduct the study. The existing massing scenario includes the existing massing and any changes which have been approved by the City of Ottawa.

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[1]. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

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

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.

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 16 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 two context massing scenarios, as noted in Section 2.

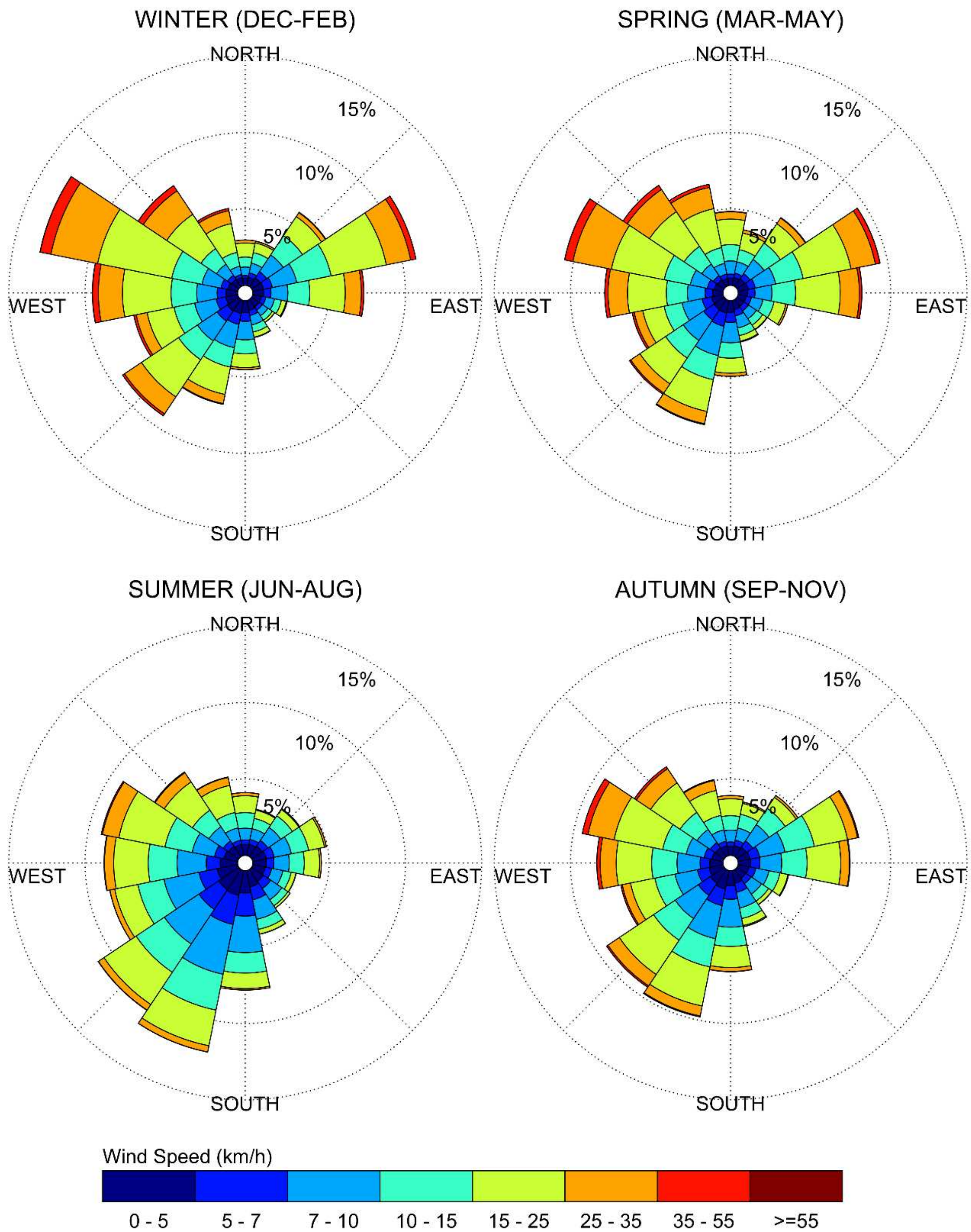
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade were referenced to the wind speed at gradient height to generate 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 during the appropriate hours of pedestrian usage (that is, between 06:00 and 23:00) and divided into four distinct seasons, as stipulated in the wind criteria. Specifically, the spring season is defined as March through May, the summer season is defined as June through August, the autumn season is defined as September through November, and the winter season is defined as December through February, inclusive.

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	Mean 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	Target 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-6B, which illustrate wind conditions at grade level for the proposed and existing massing scenarios. Conditions are presented as continuous contours of wind comfort throughout the subject site and correspond to the comfort classes presented in Section 4.4.

Wind conditions are also reported for the typical use period, which is defined as May to October, inclusive. Figure 7 illustrates wind comfort conditions at grade level, 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

Sidewalks and Transit Stops along Ogilvie Road: Following the introduction of the proposed development, wind conditions over the public sidewalks along Ogilvie Road are predicted to be suitable for standing, or better, during the summer and autumn, with isolated regions suitable for strolling to the south of the proposed development during the autumn, becoming suitable for a mix of standing and strolling, during the spring and winter, with isolated regions suitable for walking to the south of the proposed development. Conditions in the vicinity of the nearby eastbound transit stop to the south of Ogilvie Road, which is served by a typical transit shelter, are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for a mix of standing and strolling during the spring and winter. Conditions in the vicinity of the nearby westbound transit stop to the north of Ogilvie Road are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, during the autumn, and suitable for standing during the spring and winter. The noted conditions are considered acceptable.

Conditions over the sidewalks along Ogilvie Road under the existing massing are predicted to be suitable for mostly sitting during the summer, becoming suitable for a mix of sitting and standing during the autumn, and suitable for mostly standing during the spring and winter. Under the existing massing, conditions in the vicinity of the nearby sheltered eastbound transit stop are predicted to be suitable for sitting during the summer and autumn, becoming suitable for standing during the spring and winter, while conditions in the vicinity of the nearby westbound transit stop are predicted to be suitable for sitting during the summer, becoming suitable for standing during the spring, autumn, and winter. While the introduction of the proposed development produces slightly windier conditions over Ogilvie Road, conditions over the nearby westbound transit stop are predicted to improve in comparison to existing conditions and the predicted wind comfort conditions with the proposed development are nevertheless considered acceptable.

Sidewalks along Cummings Avenue: Following the introduction of the proposed development, wind conditions over the public sidewalks along Cummings Avenue are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for strolling, or better, during the spring and winter. The noted conditions are considered acceptable.

Conditions over the sidewalks along Cummings Avenue under the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, the predicted wind comfort conditions with the proposed development are nevertheless considered acceptable.

Neighbouring Existing Surface Parking Lots: Prior to and following the introduction of the proposed development, conditions over the existing surface parking lot to the west are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year. The noted conditions are considered acceptable.

Following the introduction of the proposed development, wind conditions over the existing surface parking lot to the northeast are predicted to be suitable for sitting during the summer and autumn, becoming suitable for a mix of sitting and standing during the spring and winter. Conditions over the existing surface parking lots to the east and southeast are predicted to be suitable for a mix of sitting and standing during the summer and autumn, becoming suitable for strolling, or better, during the spring and winter. The noted conditions are considered acceptable.

Under the existing massing, conditions over the surface parking lot to the northeast are predicted to be suitable for mostly sitting throughout the year, while conditions over the surface parking lots to the east and southeast are predicted to be suitable for sitting during the summer and autumn, becoming suitable for a mix of sitting and standing during the spring and winter. While the introduction of the proposed development produces slightly windier conditions over these areas in comparison to existing conditions, the predicted wind comfort conditions following the introduction of the proposed development are nevertheless considered acceptable.

Exterior Amenity (Entry Courtyard) and Exterior Commercial Terrace Space: Wind comfort conditions over the exterior amenity (entry courtyard) situated to the west of the proposed development are predicted to be suitable for sitting throughout the year, which is considered acceptable.

As illustrated in Figure 7, wind comfort conditions during the typical use period over the exterior commercial terrace space are predicted to be suitable for mostly sitting, with conditions suitable for standing at the southeast and southwest corners of the proposed development. If seating areas will be programmed at the southwest or southeast corners of the proposed development, targeted wind barriers are recommended at these locations, which may take the form of targeted wind screens or dense arrangements of coniferous plantings, in combination with overhead canopy structures.

POPS: During the typical use period, wind comfort conditions within the POPS are predicted to be suitable for sitting over a majority of the space, with conditions suitable for standing to the south. If the southern extent of the POPS will include seating or lounging areas, it is recommended to implement wind barriers that are targeted adjacent to the seating areas, which may take the form of targeted wind screens or dense arrangements of coniferous plantings, in combination with canopy structures above designated seating areas.

Proposed Drive Aisles, Walkways, Surface Parking, Unloading Area, Drop-off/Pickup Area: Wind conditions over the drive aisles and walkways within the subject site are predicted to be suitable for a mix of sitting and standing during the summer and autumn, with an isolated windier region suitable for strolling during the summer and a mix of strolling and standing during the autumn along the covered drive aisle to the south of the parking ramp, becoming suitable for walking, or better, during the spring and winter.

Owing to the channeling of prevailing east-northeasterly, westerly, and west-northwesterly winds beneath the podium and over the covered drive aisle, an isolated region of conditions that may occasionally be considered uncomfortable for walking is predicted over the covered drive aisle during the spring and winter, where pedestrian access is expected to be limited. Conditions over the noted area are predicted to be suitable for walking for approximately 75% and 74% of the time during the spring and winter seasons, respectively, representing 5% and 6% exceedances of the walking threshold. The noted wind conditions are considered satisfactory, as the uncomfortable conditions are limited to over the roadway surface.

Wind conditions over the surface parking to the north and the unloading area to the east are predicted to be suitable for sitting during the summer and autumn, becoming suitable for standing, or better, during the spring and winter, while conditions over the drop-off/pick-up area and the surface parking to the west are predicted to be suitable for standing, or better, throughout the year. The noted conditions are considered acceptable.

Building Access Points: Wind conditions along the south elevation of the stairwell and adjoining vestibule located to the south of the parking ramp are predicted to be suitable for standing, or better, during the summer, becoming suitable for a mix of standing, strolling, and walking during the spring, autumn, and winter. If a building access point is to be located along the south elevation of the noted stairwell or vestibule, it is recommended to recess the entrance into the building façade by 1.5 m.

Wind conditions in the vicinity of the remaining building access points serving the proposed development are predicted to be suitable for standing, or better, throughout the year, which is considered acceptable.

5.2 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.

5.3 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 and illustrated in Figures 3A-7. Based on computer simulations using the CFD technique, meteorological data analysis of the Ottawa wind climate, City of Ottawa wind comfort and safety criteria, 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, transit stops, neighbouring existing surface parking lots, proposed drive aisles, walkways, surface parking, the unloading area and drop-off/pick-up area, the grade-level exterior amenity (entry courtyard), and in the vicinity of most building access points, are considered acceptable.

2) Prevailing east-northeasterly, westerly, and west-northwesterly winds are predicted to channel through the accessible volume beneath the podium, introducing windier conditions over the area. Following the introduction of the proposed development, a region over the covered drive aisle along the north elevation of the subject site is predicted to experience conditions that may occasionally be considered uncomfortable for walking, exceeding the walking threshold for approximately 5% of the time during the spring season and approximately 6% of the time during the winter season. The noted wind conditions are considered satisfactory, as the uncomfortable conditions during the spring and winter are limited to over the roadway surface where pedestrian access and use is limited.

3) Wind conditions along the south elevation of the stairwell and vestibule to the south of the parking ramp are predicted to be suitable for standing, or better, during the summer, becoming suitable for a mix of standing, strolling, and walking during the spring, autumn, and winter. If a building access point is to be located along the south elevation of the noted stairwell or vestibule, it is recommended to recess the entrance into the building façade by 1.5 m.

4) During the typical use period (May to October, inclusive), wind conditions within the POPS and the exterior commercial terrace space are predicted to be suitable for mostly sitting, with standing conditions at the south elevation of the POPS and at the southeast and southwest corners of the proposed development. If the windier areas that are suitable for standing will include designated seating or lounging, it is recommended to implement targeted wind barriers adjacent to these areas. These barriers may take the form of wind screens or dense arrangements of coniferous plantings that are targeted around seating areas, in combination with canopy structures above designated seating areas.

5) 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
D. T. HUITEMA
100561777
July 17, 2024
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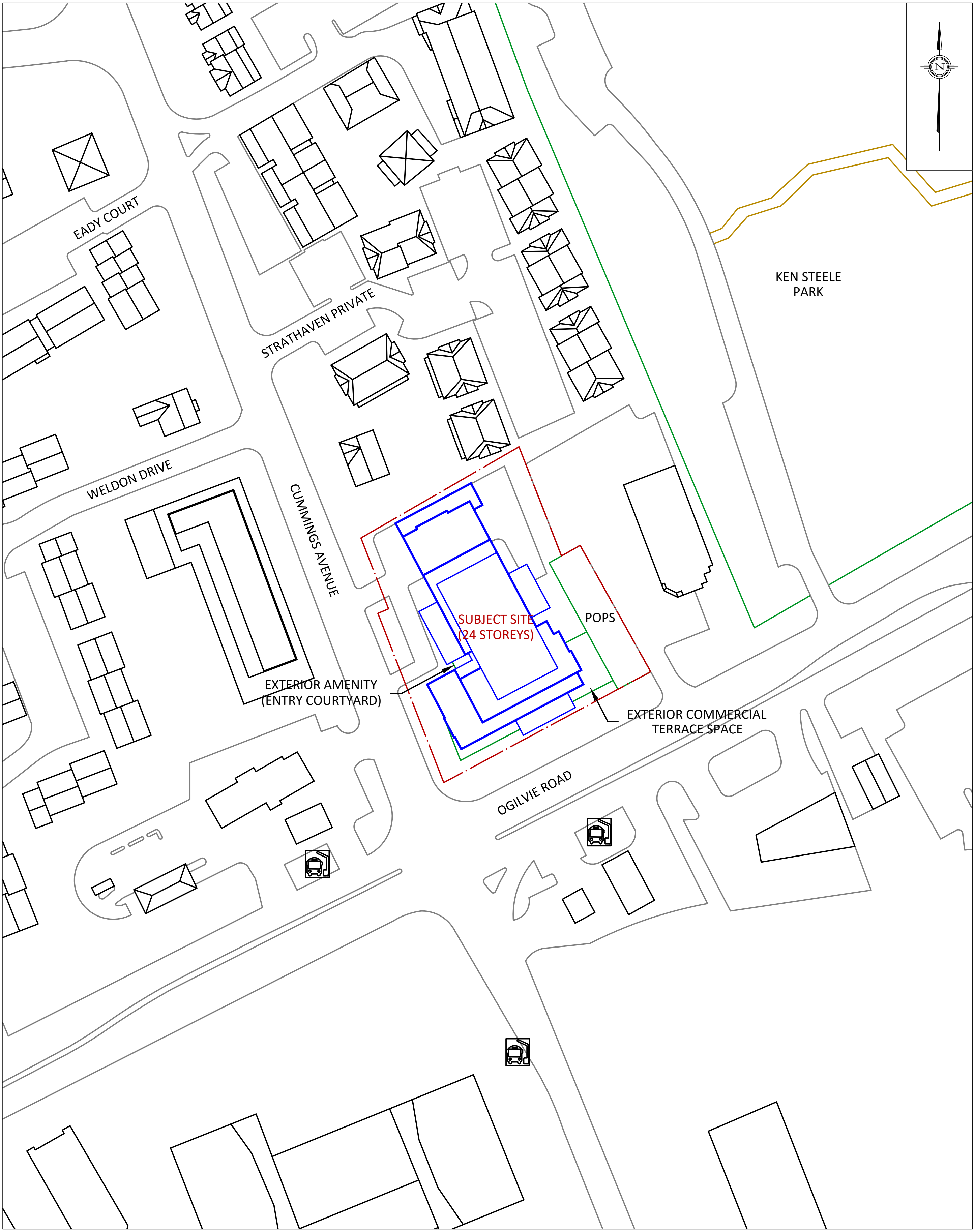

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PROJECT: 1137 OGILVIE ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 1A: PROPOSED SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:1500	DRAWING NO.: 24-126-PLW-1A	
DATE: JULY 17, 2024	DRAWN BY: S.K.	

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PROJECT	1137 OGILVIE ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION
SCALE	1:1500	DRAWING NO. 24-126-PLW-1B	FIGURE 1B: EXISTING SITE PLAN AND SURROUNDING CONTEXT
DATE	JULY 17, 2024	DRAWN BY S.K.	

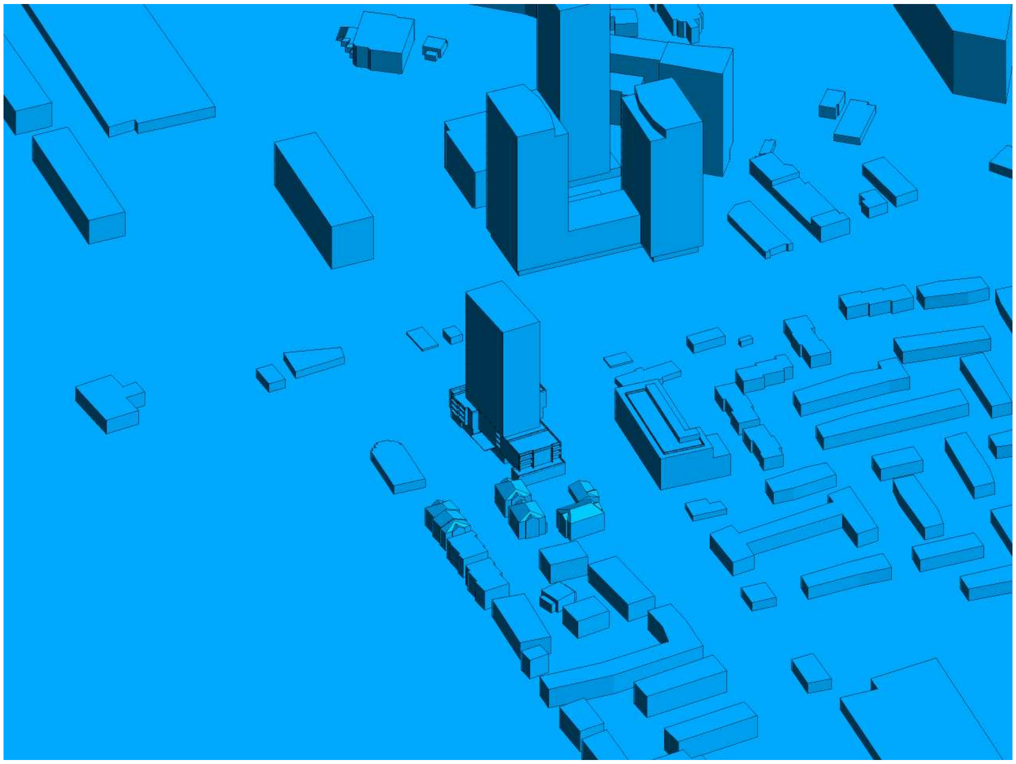

FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

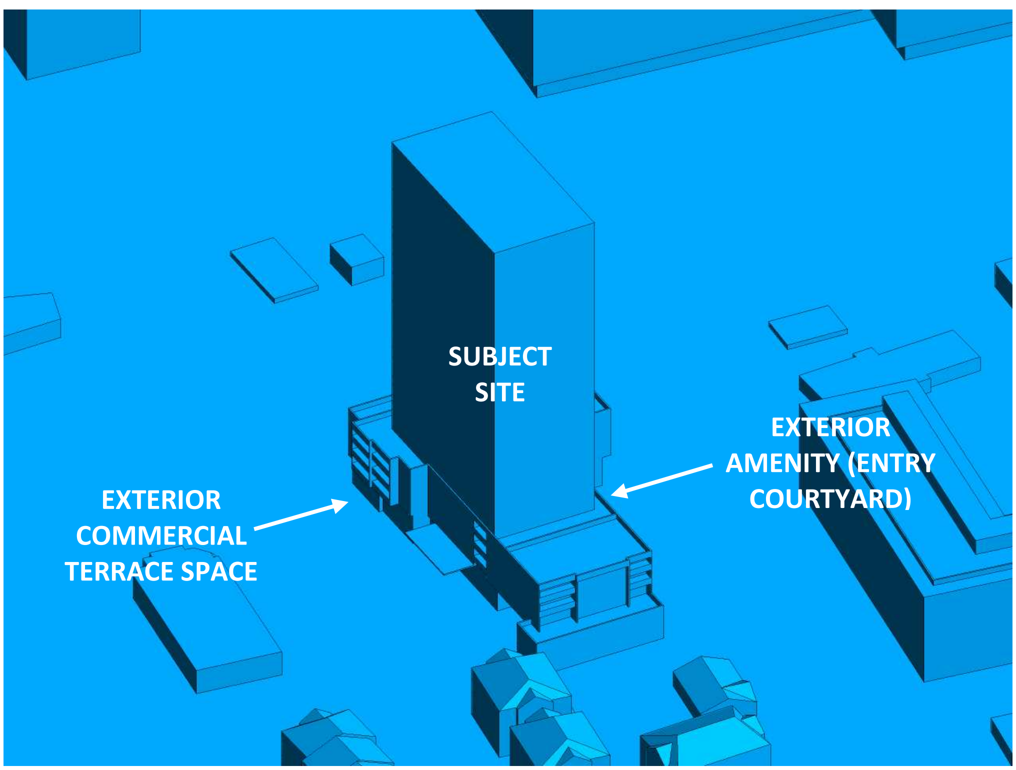

FIGURE 2B: CLOSE UP OF FIGURE 2A

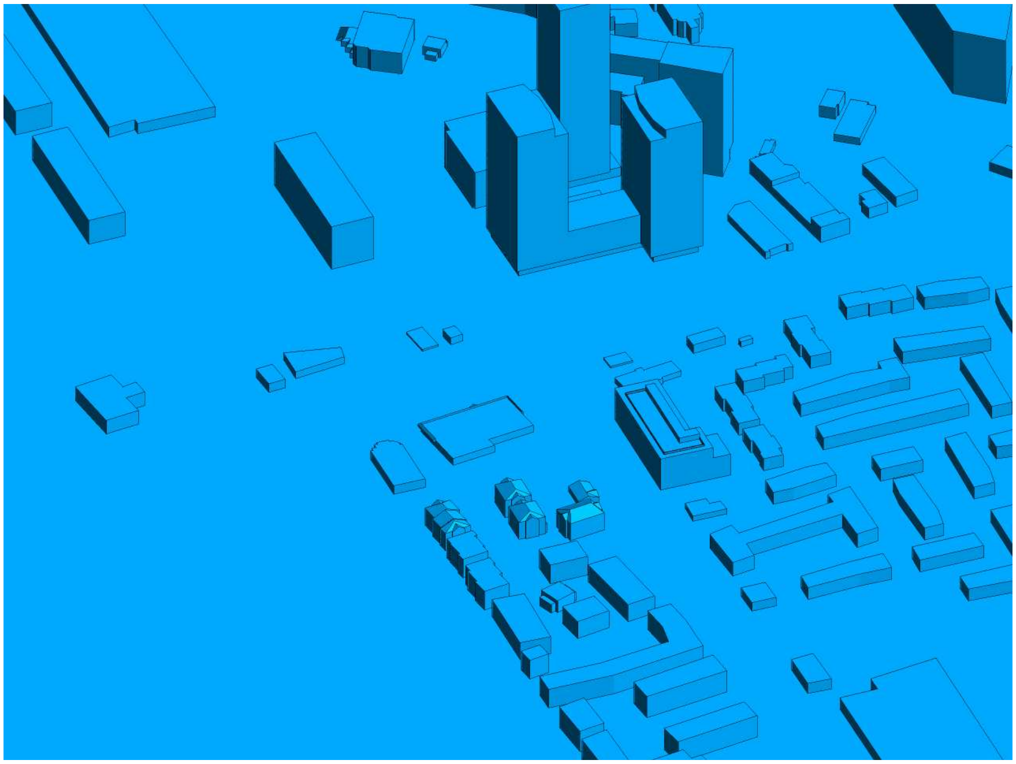

FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

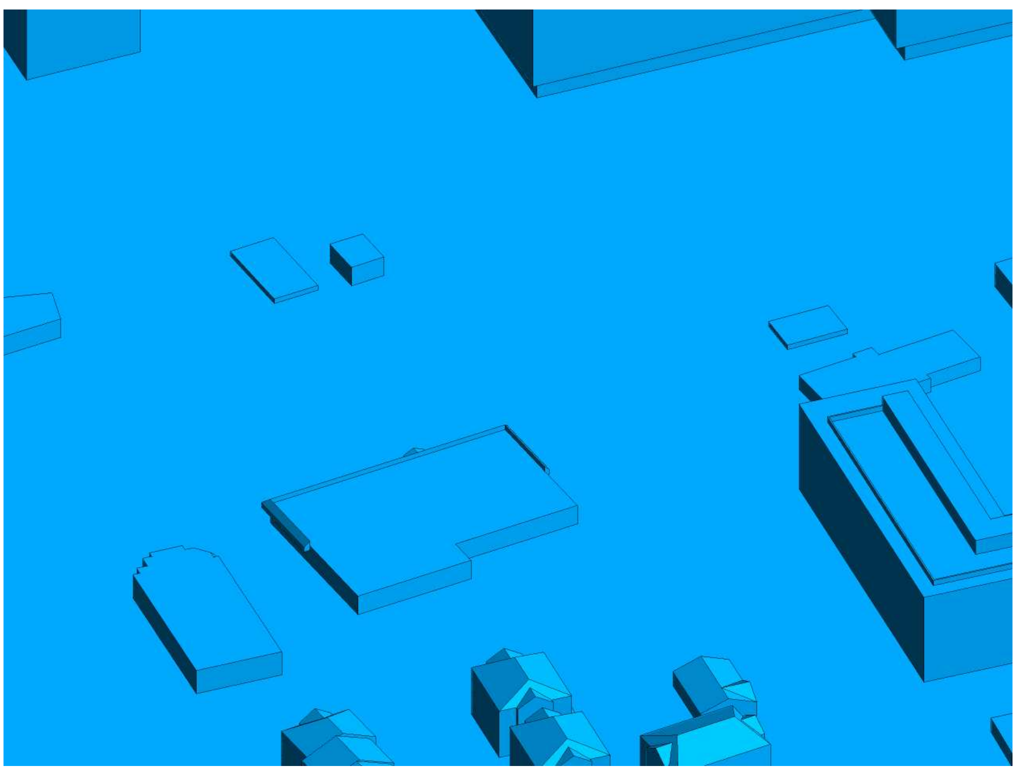

FIGURE 2D: CLOSE UP OF FIGURE 2C

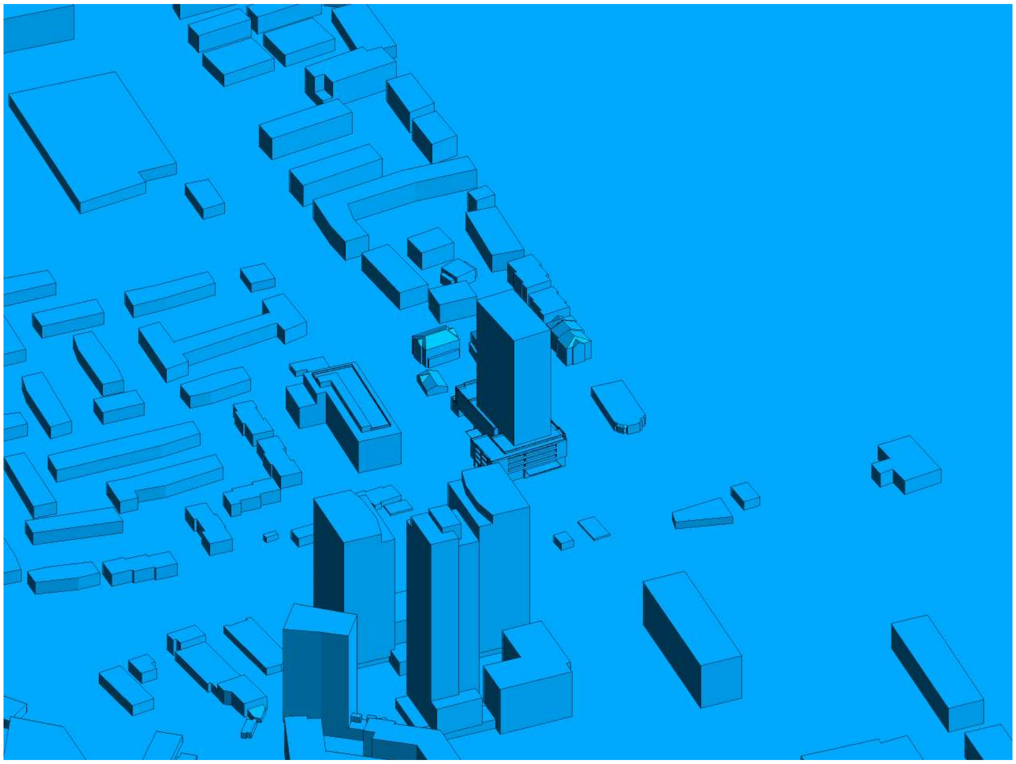

FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

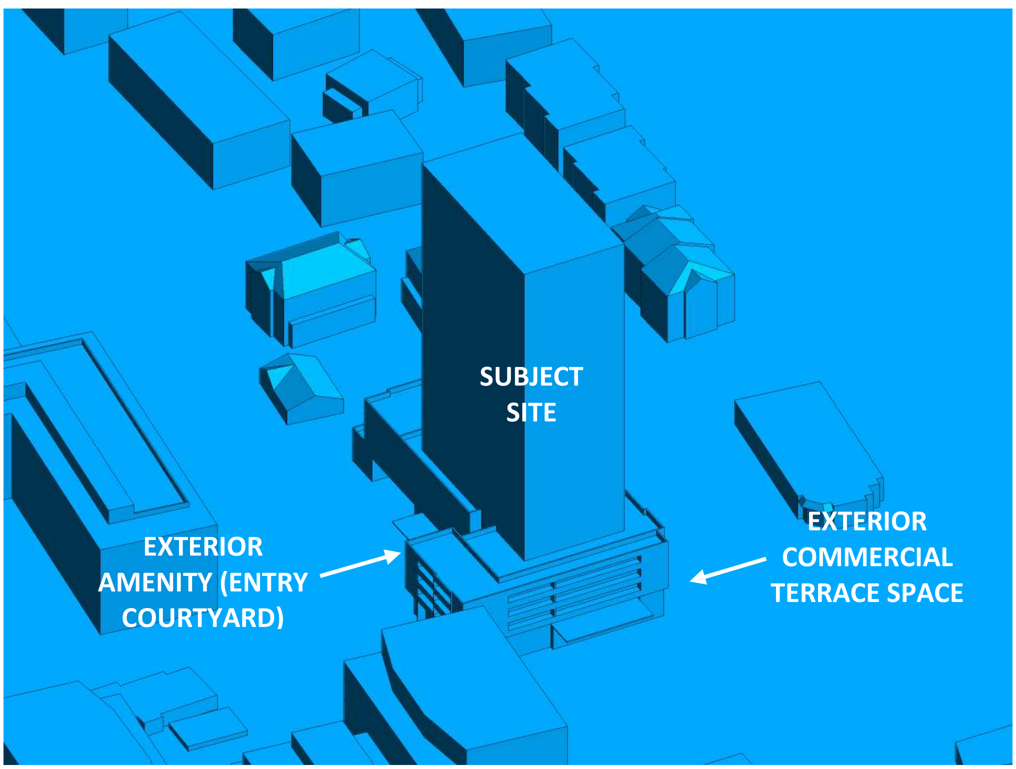

FIGURE 2F: CLOSE UP OF FIGURE 2E

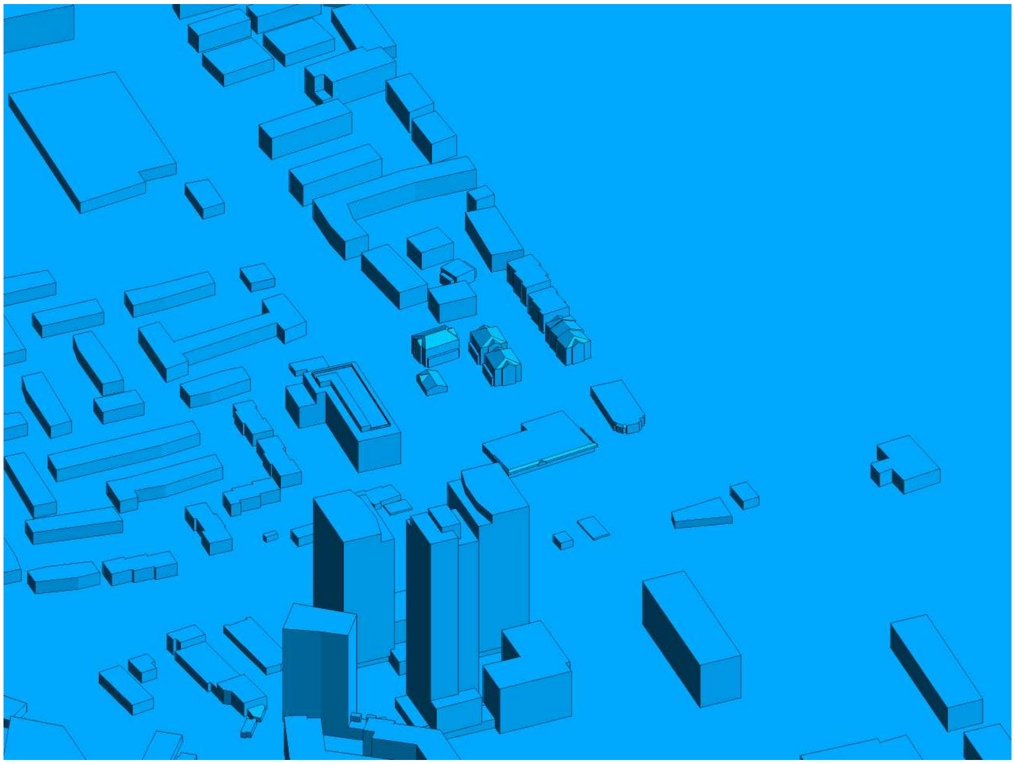

FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

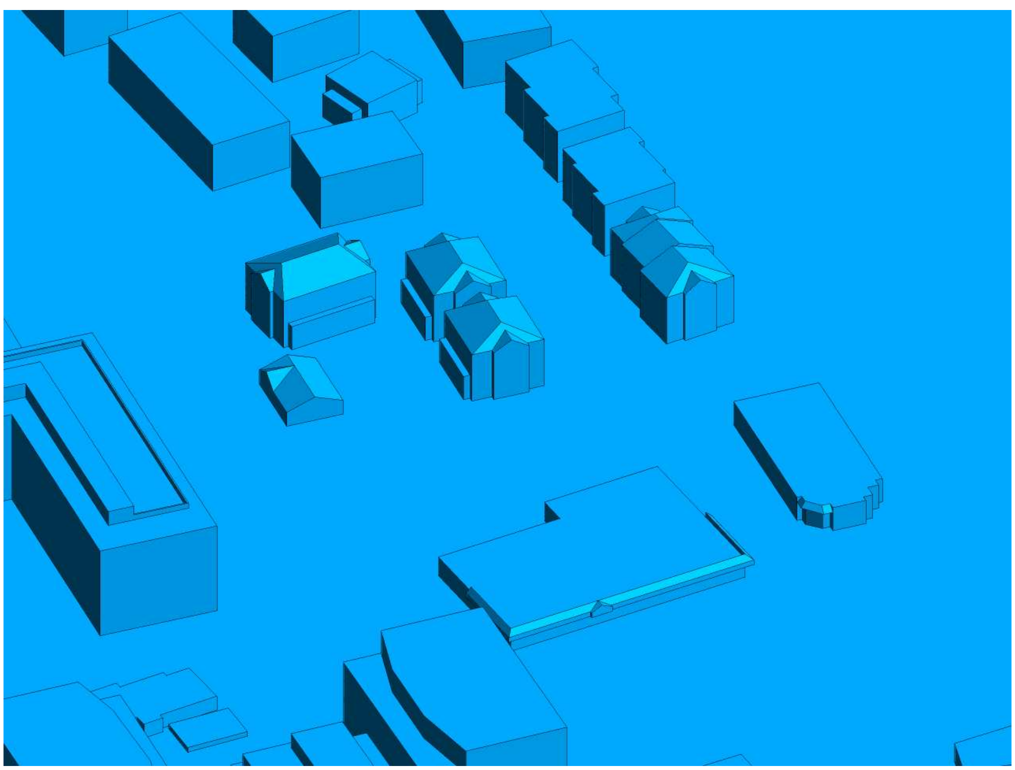

FIGURE 2H: CLOSE UP OF FIGURE 2G

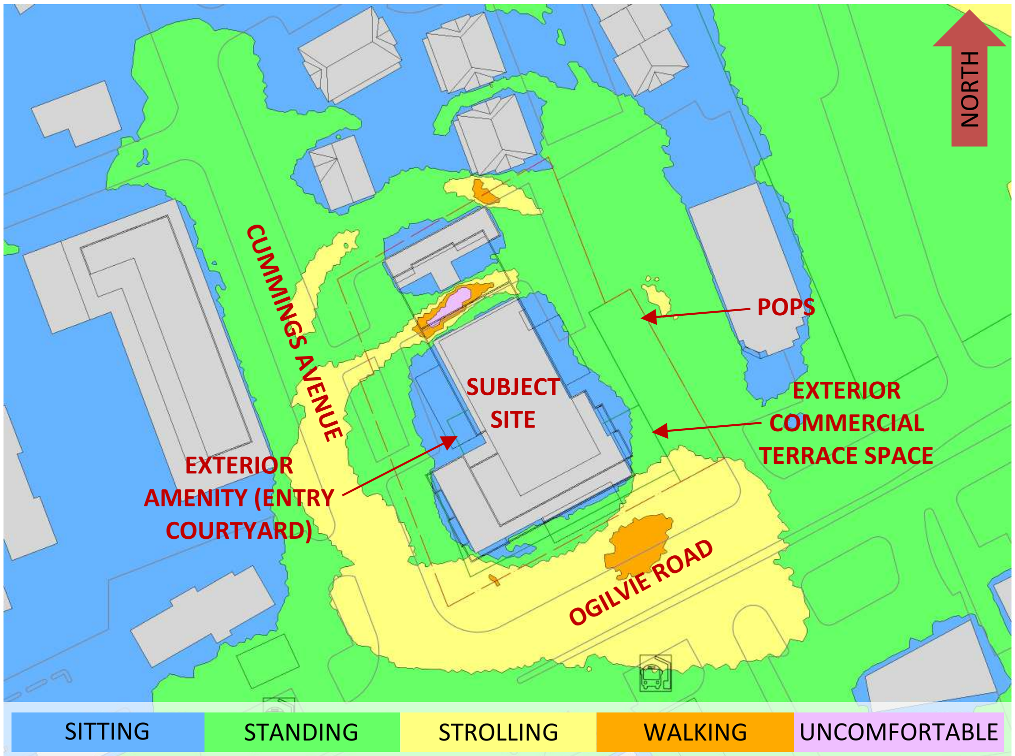

FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

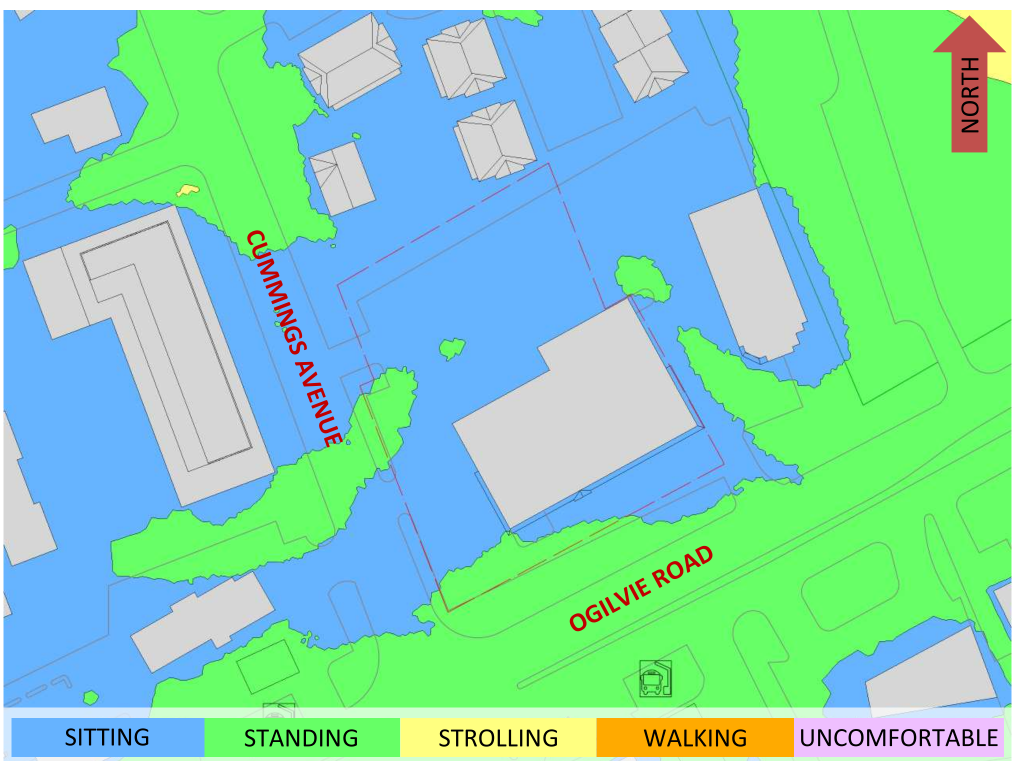

FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

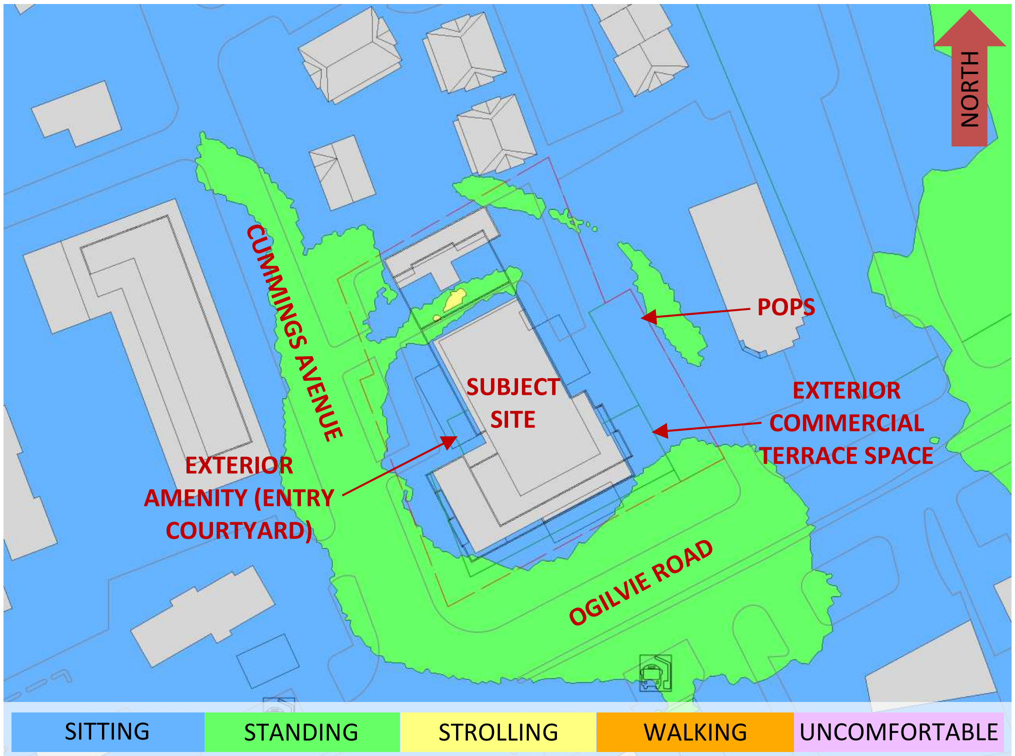

FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

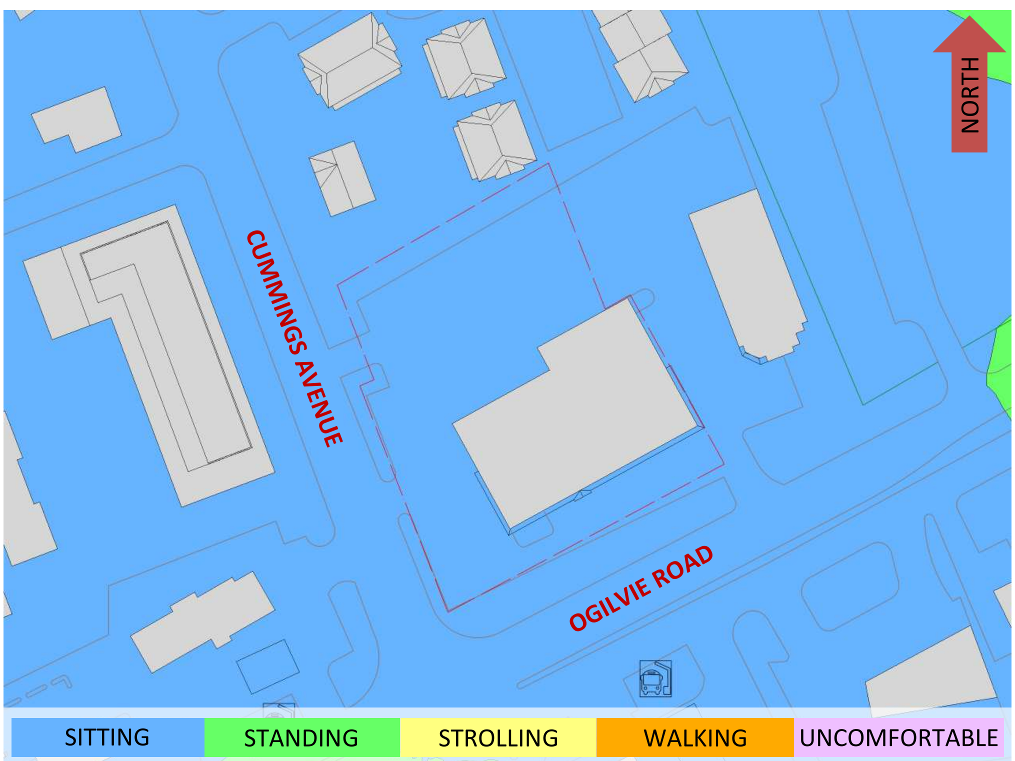

FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

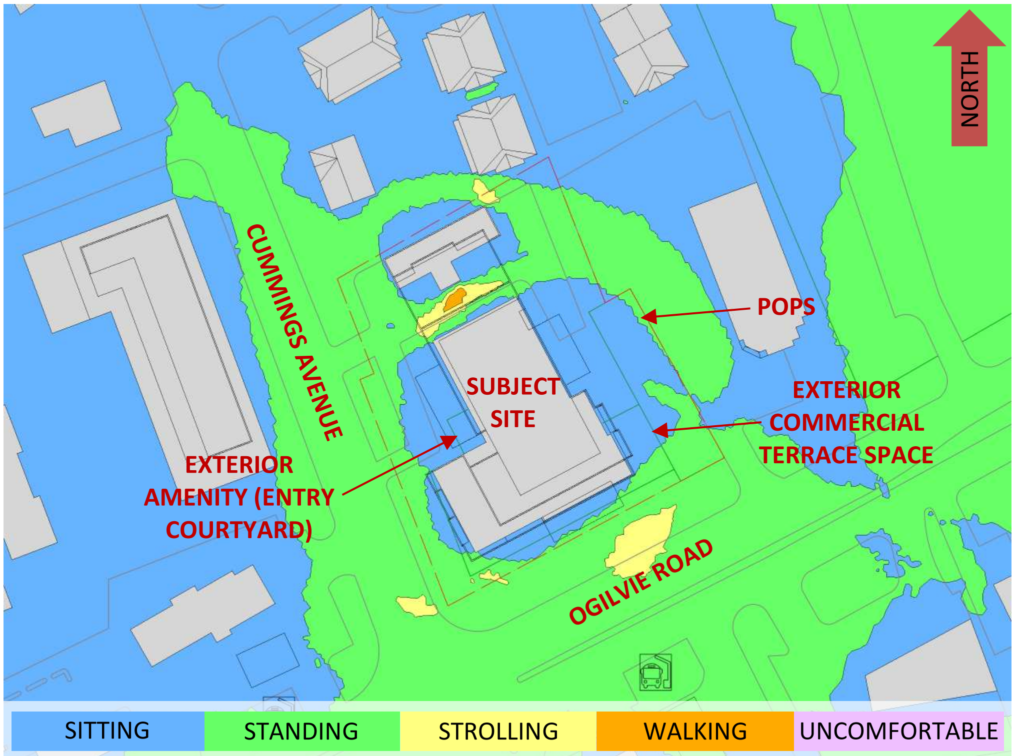

FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

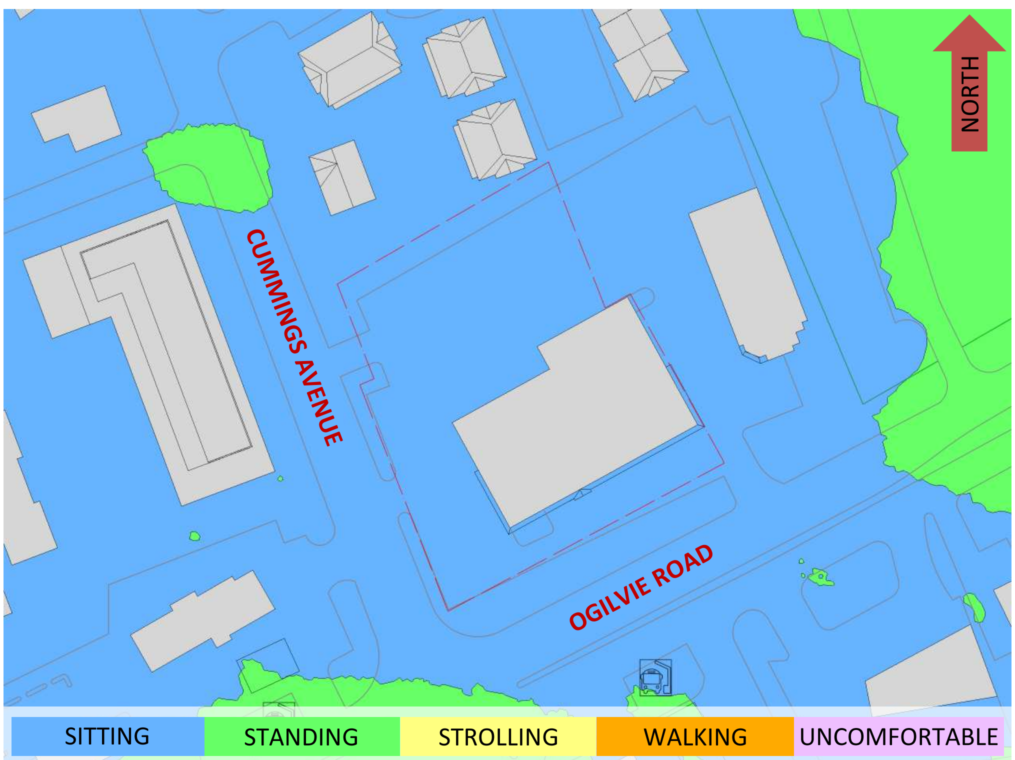

FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

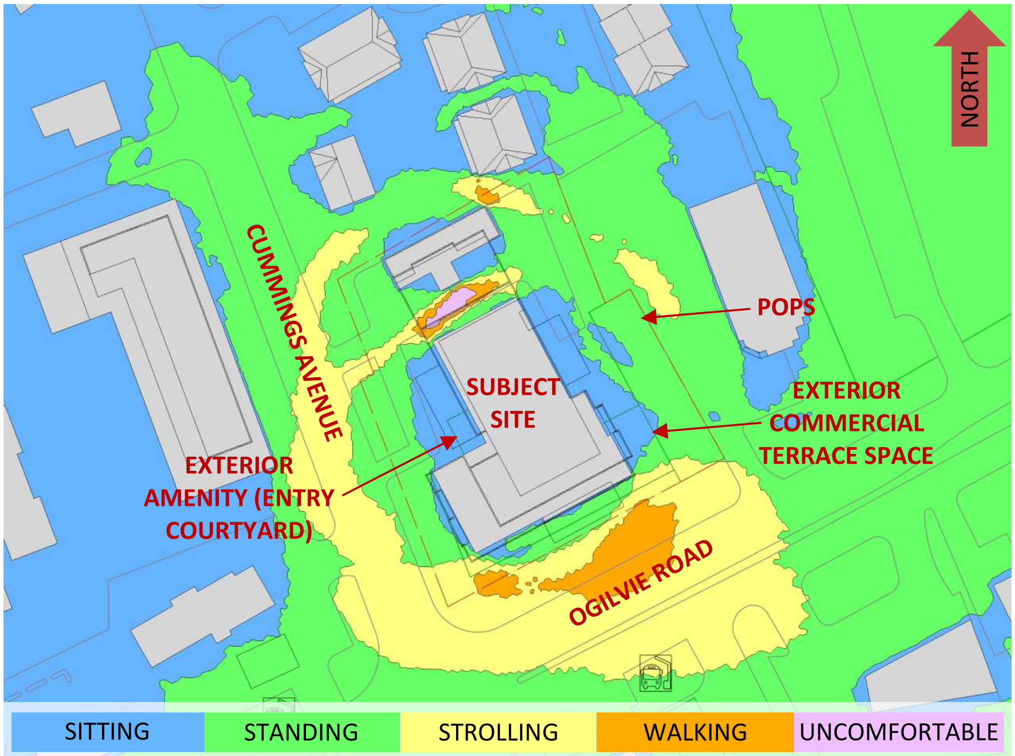

FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

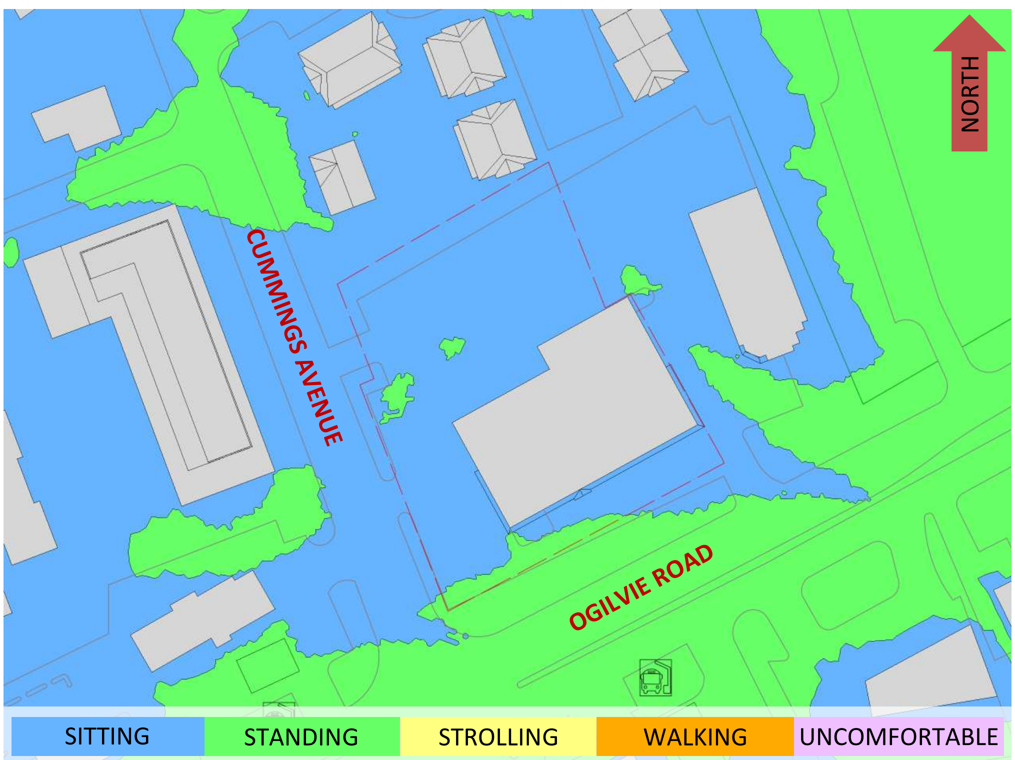

FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

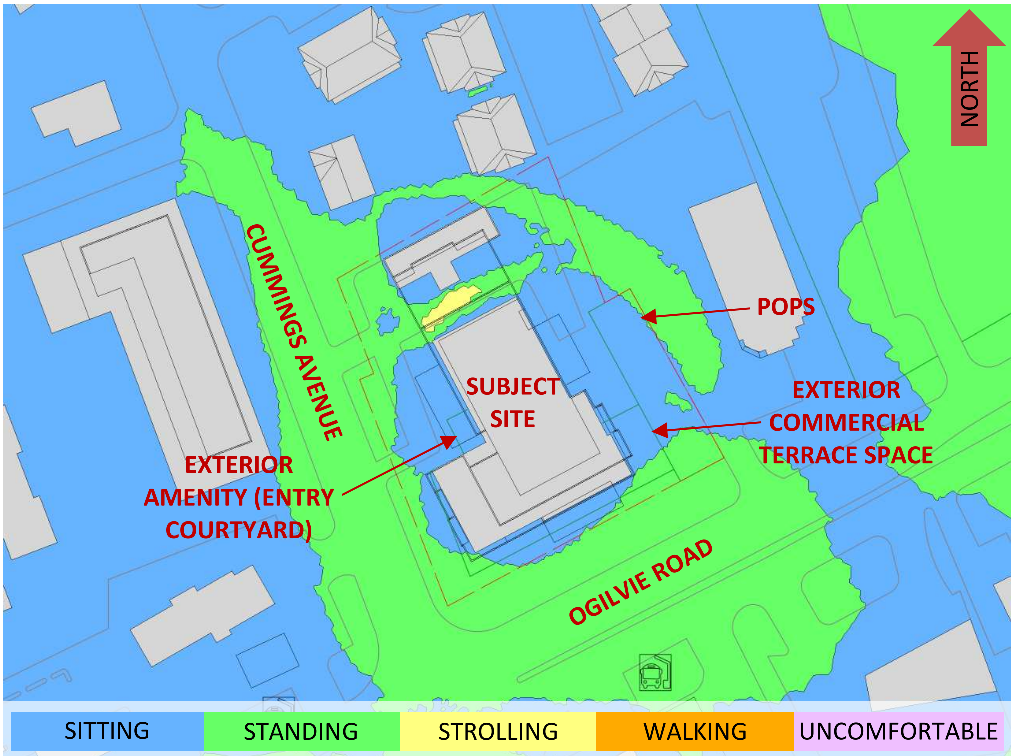

FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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	0.23
22.5	0.24
45	0.24
67.5	0.23
90	0.22
112.5	0.22
135	0.23
157.5	0.24
180	0.24
202.5	0.24
225	0.24
247.5	0.24
270	0.25
292.5	0.25
315	0.24
337.5	0.24

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).

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

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

where, $\boldsymbol{I}$ = turbulence intensity, $\boldsymbol{L_t}$ = turbulence length scale, $\boldsymbol{Z}$ = 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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[1] P. Arya, "Chapter 10: Near-neutral Boundary Layers," in *Introduction to Micrometeorology*, San Diego, California, Academic Press, 2001.

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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.