

# GRADIENTWIND

ENGINEERS & SCIENTISTS

## PEDESTRIAN LEVEL WIND STUDY

1137 Ogilvie Road  
Ottawa, Ontario

Report: 24-126-PLW-2025-SPA-R1



June 2, 2025

PREPARED FOR  
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## EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Site Plan Control application (SPA) submission requirements for Phase 1 of 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-9, 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 most sidewalks, transit stops, neighbouring existing surface parking lots, surface parking, the loading area, the drop-off/pick-up area, the outdoor amenity patio to the south, and in the vicinity of the building access points, are considered acceptable.
  - a. An isolated region that may be considered occasionally uncomfortable for walking is predicted to the southwest of the subject site, where conditions are predicted to be comfortable for walking approximately 79% and 77% of the spring and winter seasons, respectively, representing marginal exceedances of 1% and 3% of the walking comfort threshold. The introduction of the future Phase 2 massing is predicted to eliminate the uncomfortable wind conditions in this area. As such, the noted conditions may be considered as satisfactory.



- b. At the northeast corner of the proposed development, a similar windier region is predicted to occasionally exceed the walking comfort criteria during the spring and winter seasons; this region is similarly eliminated following the introduction of the future Phase 2 massing and is limited to the driveway surface and away from pedestrian accessible areas.
- 2) During the typical use period (May to October, inclusive), wind conditions within the POPS are predicted to be suitable for mostly standing. In the interim condition, the POPS comprises an open lawn and a programmable space/event area with moveable planters with small trees. Of note, the programmable space includes deciduous trees in planters along its west elevation, while similar trees in planters are located at the south and west elevations of the open lawn.
- 3) Regarding the Level 7 amenity terrace serving the proposed development, conditions during the typical use period are predicted to be suitable for a mix of sitting and standing over the eastern portion of the terrace and a mix of standing and strolling to the west, with walking areas in the vicinity of the southwest corner of the tower. During the same period, conditions within the Penthouse Level amenity terrace, which was modelled with 1.8-m-tall wind screens along its outer perimeter, are predicted to be suitable for a mix of sitting and standing.
  - a. In combination with the landscaping elements within the Level 7 terrace, as illustrated on the proposed landscape plan, conditions within the Level 7 terrace may be further improved with the implementation of tall wind screens, such as those rising to at least 2 m above the terrace perimeter, an overhead canopy extending from the west elevation of the tower that wraps around its southwest corner, and mitigation inboard of the terrace perimeter such as wind screens, overhead shade structures, and other common landscape elements.
  - b. Comfort conditions within the Penthouse terrace may be improved with the implementation of taller wind screens, rising to at least 2.4 m above the terrace perimeter, as well as similar mitigation inboard of the terrace perimeter.
  - c. The extent of mitigation is dependent on the programming of the terraces.

- 4) 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.

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## **1. INTRODUCTION**

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Soul Aviation LP to undertake a pedestrian level wind (PLW) study to satisfy Site Plan Control application (SPA) submission requirements for Phase 1 of the proposed mixed-use residential development located at 1137 Ogilvie Road in Ottawa, Ontario (hereinafter referred to as “subject site” or “proposed development”). A PLW study was conducted in July 2024 for the previous design of the 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 February and May 2025, 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 30-storey mixed-use residential building, inclusive of a 4-storey podium to the north of the building and a 6-storey podium to the south, which includes an exterior amenity space. The building is topped with a mechanical penthouse (MPH). A drive aisle extends from Cummings Avenue to the northwest of the subject site, providing access to a parking ramp, surface parking to the north, a loading area, and a drop-off/pick-up area to the east of the proposed building. A privately-owned publicly accessible space (POPS) is located along the southeast elevation of the subject site.

Above three underground parking levels, the ground floor of the proposed development includes an amenity/commercial space along the south elevation, a residential main entrance with a lobby to the inner northeastern corner of the building, shared building support spaces to the northeast, and residential spaces throughout the remainder of the level. Levels 2-30 are reserved for residential occupancy, while the Penthouse Level includes mechanical spaces, as well as interior and exterior amenity spaces.

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 is under construction 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<sup>1</sup>. 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.

### **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 approximately 500 m. The process was performed for two context massing scenarios, as noted in Section 2.

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<sup>1</sup> City of Ottawa Terms of References: Wind Analysis  
[https://documents.ottawa.ca/sites/default/files/torwindanalysis\\_en.pdf](https://documents.ottawa.ca/sites/default/files/torwindanalysis_en.pdf)



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 terraces serving the proposed development 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.

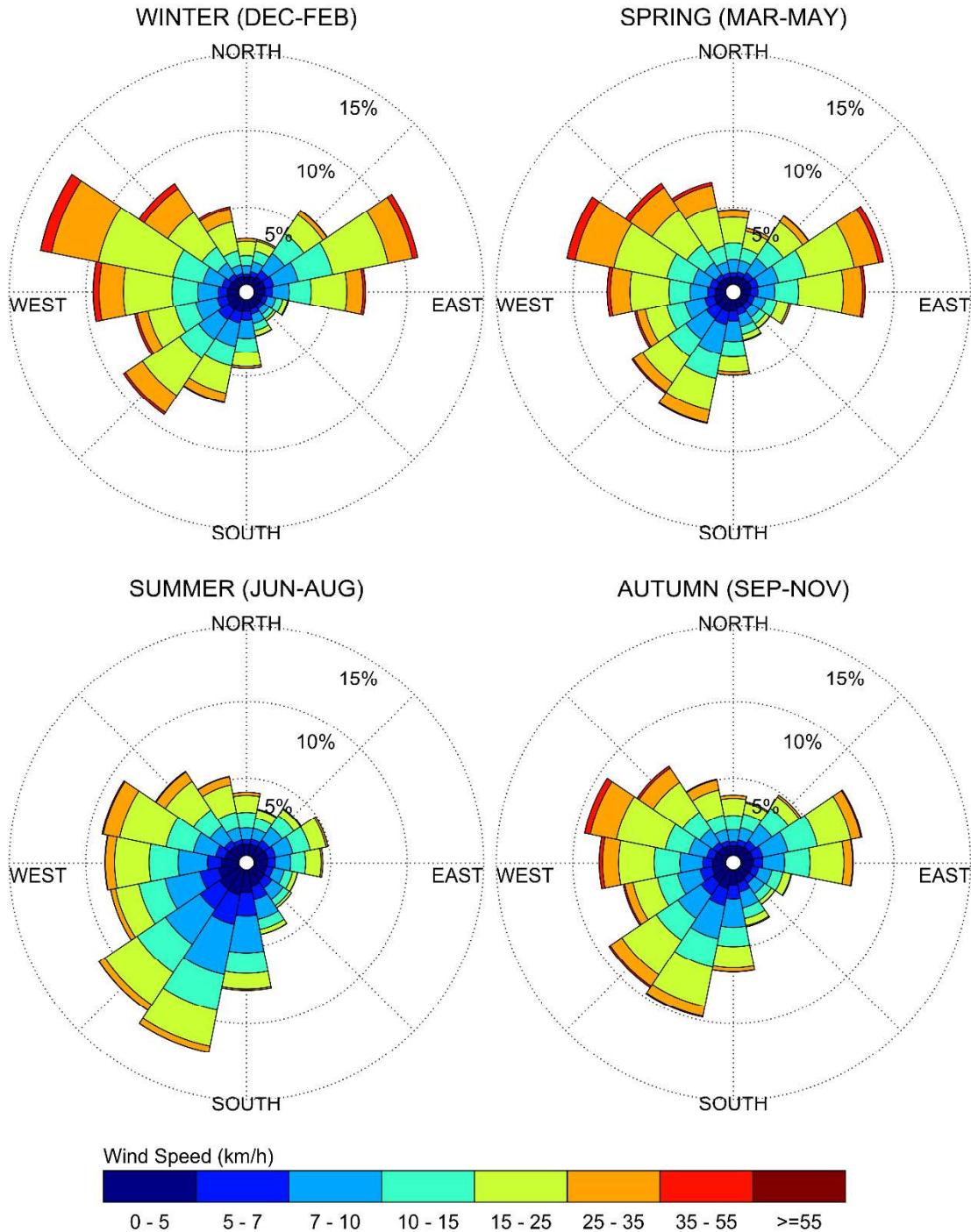
### 4.3 Historical Wind Speed and Direction Data

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	$\leq 10$	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	$\leq 14$	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	$\leq 17$	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	$\leq 20$	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 and by Figures 8A-D, which illustrate wind conditions over the common amenity terraces serving the proposed development at Level 7 and at the Penthouse Level. 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 comfort conditions are also reported for the typical use period, which is defined as May to October, inclusive. Figures 7 and 9 illustrate wind comfort conditions at grade level and over the noted common amenity terraces during this period, respectively, consistent with the comfort classes illustrated 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 and Transit Stops along Ogilvie Road:** Following the introduction of the proposed development, wind comfort conditions over the nearby public sidewalks along Ogilvie Road are predicted to be suitable for strolling, or better, during the summer and autumn, becoming suitable for mostly walking, or better, during the spring and winter, with isolated regions that may be considered occasionally uncomfortable for walking situated to the southwest of the subject site. Specifically, conditions over the noted area during the spring and winter seasons are predicted to be comfortable for walking for approximately 79% and 77% of the spring and winter seasons, respectively, representing exceedances of 1% and 3% of the walking comfort threshold. The noted exceedances may be considered as marginal. Furthermore, the introduction of the future Phase 2 massing, as described in a separate wind study report for the rezoning submission of the full site, is predicted to eliminate the uncomfortable wind conditions in this area. As such, the noted conditions may be considered as satisfactory.

Following the introduction 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 strolling, or better, throughout the year, while conditions in the vicinity of the westbound transit stop along Ogilvie Road are predicted to be suitable for standing, or better, throughout the year. The noted conditions are considered acceptable.

Conditions over the sidewalks along Ogilvie Road under the existing massing are predicted to be suitable for strolling, or better, throughout the year. Under the existing massing, conditions in the vicinity of the nearby transit stops along Ogilvie Road are predicted to be suitable for standing, or better, throughout the year.

While the introduction of the proposed development produces windier conditions over Ogilvie Road in comparison to existing conditions, the predicted wind comfort conditions over the sidewalks and nearby transit stops with the proposed development are nevertheless considered satisfactory.

**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 strolling, or better, during the summer and autumn, becoming suitable for mostly walking, 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 standing, or better, throughout the year. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, the predicted wind comfort conditions along Cummings Avenue with the proposed development are nevertheless considered acceptable.

**Neighbouring Existing Surface Parking Lots:** Following the introduction of the proposed development, conditions over the nearby existing surface parking lots to the west, northeast, and south are predicted to be suitable for strolling, or better, throughout the year. The noted conditions are considered acceptable.

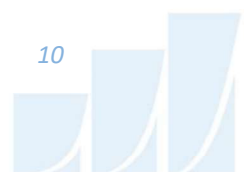
Under the existing massing, conditions over the noted areas are predicted to be suitable for standing, or better, throughout the year. While the introduction of the proposed development produces slightly windier conditions over the noted areas in comparison to existing conditions, the predicted wind comfort conditions following the introduction of the proposed development are nevertheless considered acceptable for surface parking lots.

**POPS:** Wind comfort conditions during the typical use period within the proposed POPS are predicted to be suitable for standing over a majority of the space. It is noted that the POPS in this interim condition, that is prior to the introduction of the 1151 Ogilvie Phase 2 massing, is programmed with an open lawn to the south<sup>2</sup>, and a programmable space/event area to the north with moveable planters with small trees. Of note, the programmable space/events areas also includes a row of three deciduous trees in planters along its west elevation, while similar trees in planters are located at the south and west elevations of the open lawn.

**Proposed Drive Aisle, Loading Area, and Drop-off/Pick-up area:** Wind conditions over the drive aisle along the north elevation of the subject site are predicted to be suitable for mostly walking, or better, throughout the year, with the exception of an isolated windier region at the northeast corner of the proposed development, where conditions that may be considered occasionally uncomfortable for walking are predicted during the spring and winter.

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<sup>2</sup> NAK Design Strategies, '1137, 1151 Ogilvie Road, Ottawa, ON, Landscape Plan, Sheet L1.0,' [Apr 24, 2025]





Specifically, conditions over the noted area are predicted to be suitable for walking for approximately 73% of the time during the spring season and 72% of the time during the winter season, representing exceedances of 7% and 8% of the walking comfort threshold. The noted wind conditions are considered satisfactory, as the uncomfortable conditions are limited over the driveway surface and away from pedestrian accessible areas.

Conditions over the loading area and the drop-off/pick-up area to the east of the proposed development are predicted to be suitable for mostly standing, or better, throughout the year. The noted conditions are considered acceptable.

**Building Access Points:** Wind conditions in the vicinity of the building access points serving the proposed development are predicted to be suitable for mostly standing, or better, throughout the year. The noted conditions are considered acceptable.

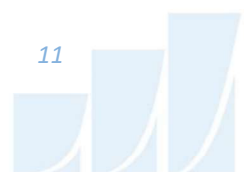
## 5.2 Wind Comfort Conditions – Common Amenity Terraces

**Level 7:** Wind conditions within the Level 7 common amenity terrace during the typical use period are predicted to be suitable for mostly sitting to the east and along the south elevation of the façade of Level 7, standing to the southeast and northwest, and a mix of standing, strolling, and walking to the west.

Of note, the proposed landscape plan for the Level 7 amenity terrace<sup>3</sup> includes a shade structure over a dining area to the west, tree planting in planters to the southwest and southeast. Comfort conditions within the terrace may be further improved with the implementation of tall wind screens, such as those rising to at least 2 m above the terrace perimeter, and an overhead canopy extending from the west elevation of the tower, wrapping around the southwest corner of the tower overhead, in combination with mitigation inboard of the terrace perimeter such as wind screens, overhead shade structures, and other common landscape elements. The extent of mitigation is dependent on the programming of the terrace.

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<sup>3</sup> NAK Design Strategies, '1137 Ogilvie Road, Ottawa, ON, Roof Terrace, Sheet L2.0,' [Apr 23, 2025]





**Penthouse Level:** The amenity terrace serving the proposed development at the Penthouse Level was modelled with 1.8-m-tall wind screens along the full terrace perimeter, which is recommended to provide shielding against direct winds from the northwest compass quadrant.

Wind conditions within the noted common amenity terrace are predicted to be suitable for a mix of sitting and standing during the typical use period, with the standing areas situated over the central portion of the terrace and conditions suitable for sitting to the northwest and along the terrace perimeter. Where conditions are suitable for standing, they are also predicted to be suitable for sitting at least 72% of the time, where the target is 80% to achieve the sitting comfort class.

Comfort conditions within the terrace may be improved with the implementation of taller wind screens, such as those rising to at least 2.4 m above the terrace perimeter, as well as mitigation inboard of the terrace perimeter such as wind screens, overhead canopies, or other common landscape elements. The extent of mitigation is dependent on the programming of the terrace.

### 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 and illustrated in Figures 3A-9. 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 most sidewalks, transit stops, neighbouring existing surface parking lots, surface parking, the loading area, the drop-off/pick-up area, the outdoor amenity patio to the south, and in the vicinity of the building access points, are considered acceptable.
  - a. An isolated region that may be considered occasionally uncomfortable for walking is predicted to the southwest of the subject site, where conditions are predicted to be comfortable for walking approximately 79% and 77% of the spring and winter seasons, respectively, representing marginal exceedances of 1% and 3% of the walking comfort threshold. The introduction of the future Phase 2 massing is predicted to eliminate the uncomfortable wind conditions in this area. As such, the noted conditions may be considered as satisfactory.
  - b. At the northeast corner of the proposed development, a similar windier region is predicted to occasionally exceed the walking comfort criteria during the spring and winter seasons; this region is similarly eliminated following the introduction of the future Phase 2 massing and is limited to the driveway surface and away from pedestrian accessible areas.
- 2) During the typical use period (May to October, inclusive), wind conditions within the POPS are predicted to be suitable for mostly standing. In the interim condition, the POPS comprises an open lawn and a programmable space/event area with moveable planters with small trees. Of note, the programmable space includes deciduous trees in planters along its west elevation, while similar trees in planters are located at the south and west elevations of the open lawn.



- 3) Regarding the Level 7 amenity terrace serving the proposed development, conditions during the typical use period are predicted to be suitable for a mix of sitting and standing over the eastern portion of the terrace and a mix of standing and strolling to the west, with walking areas in the vicinity of the southwest corner of the tower. During the same period, conditions within the Penthouse Level amenity terrace, which was modelled with 1.8-m-tall wind screens along its outer perimeter, are predicted to be suitable for a mix of sitting and standing.
- a. In combination with the landscaping elements within the Level 7 terrace, as illustrated on the proposed landscape plan, conditions within the Level 7 terrace may be further improved with the implementation of tall wind screens, such as those rising to at least 2 m above the terrace perimeter, an overhead canopy extending from the west elevation of the tower that wraps around its southwest corner, and mitigation inboard of the terrace perimeter such as wind screens, overhead shade structures, and other common landscape elements. Comfort conditions within the Penthouse terrace may be improved with the implementation of taller wind screens, rising to at least 2.4 m above the terrace perimeter, as well as similar mitigation inboard of the terrace perimeter. The extent of mitigation is dependent on the programming of the terraces.
- 4) 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.

Sincerely,

***Gradient Wind Engineering Inc.***

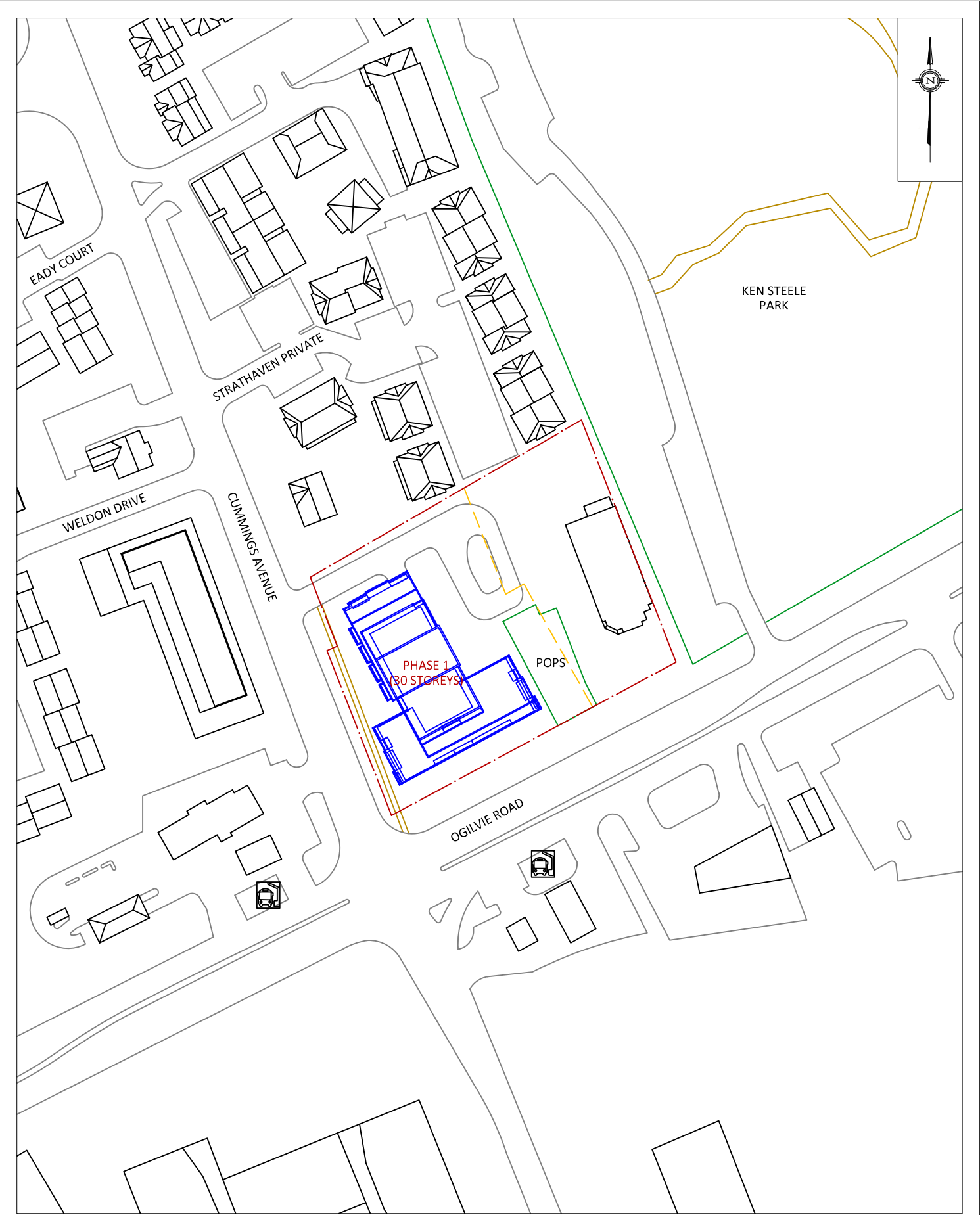


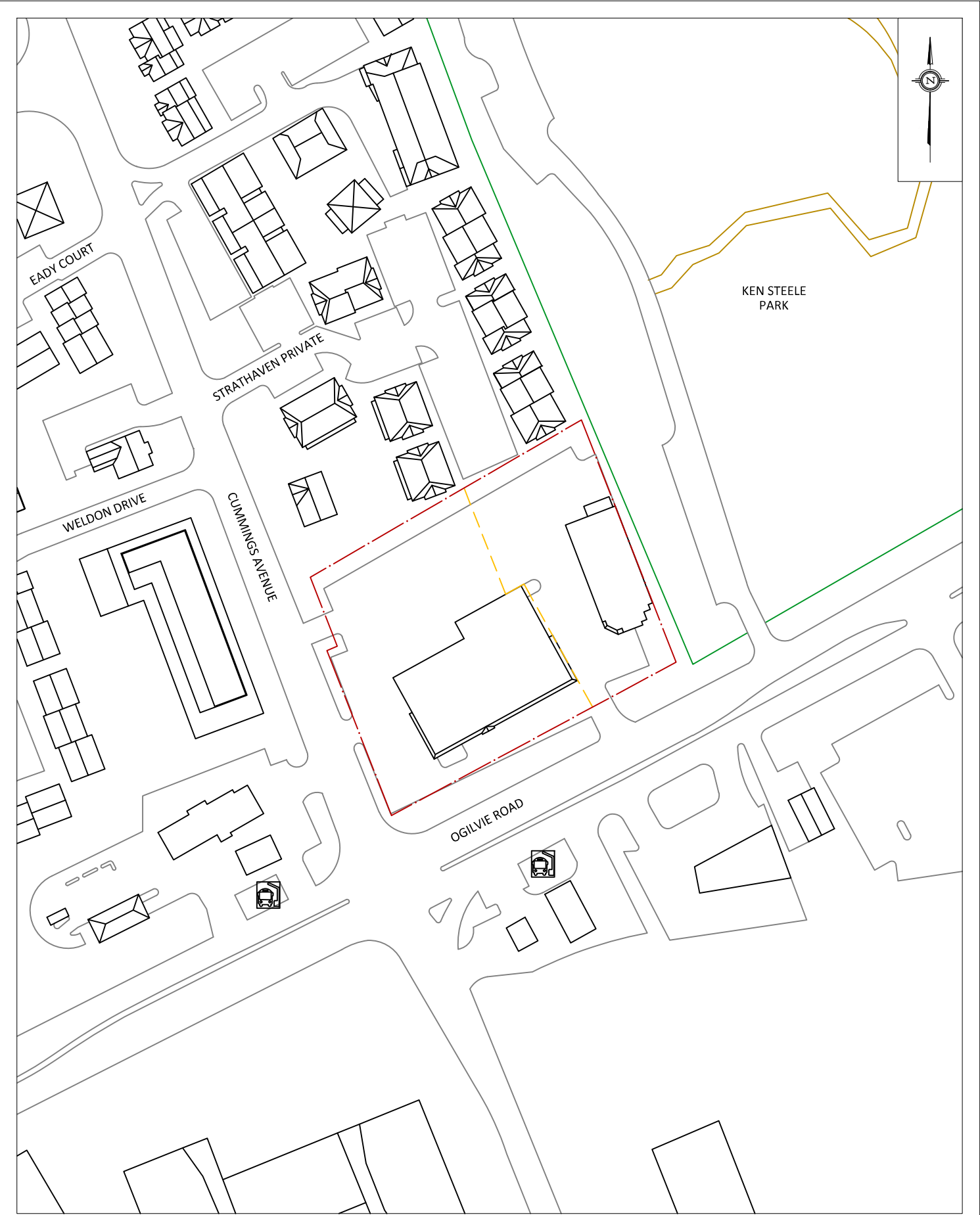
Omar Rioseco, B.Eng.  
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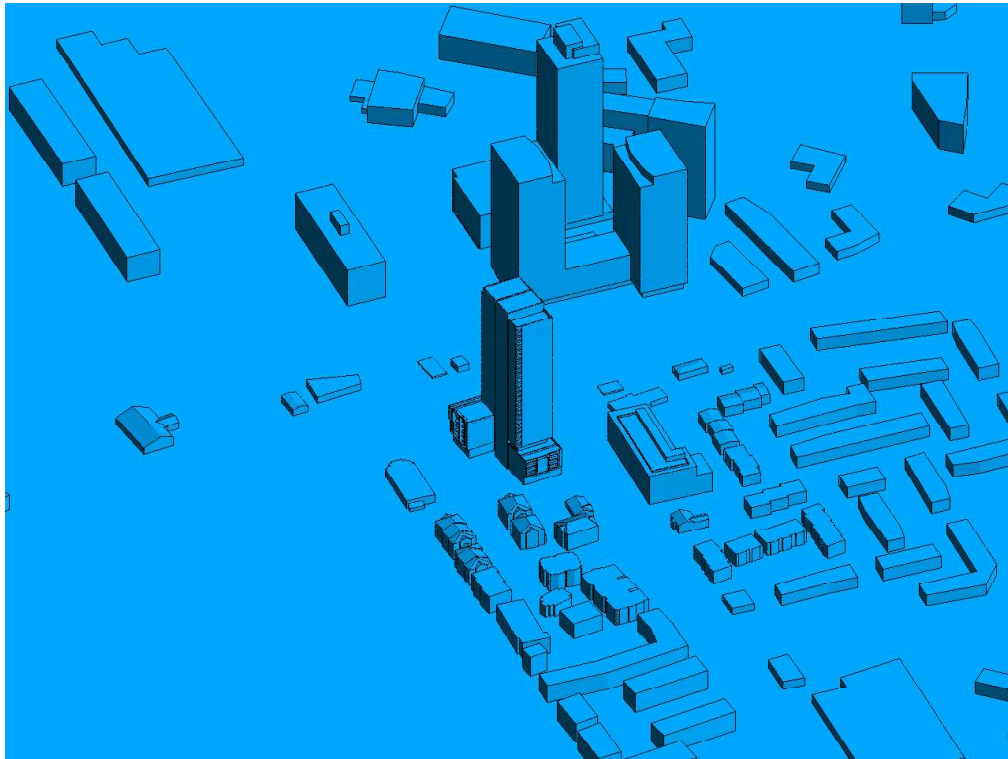


David Huitema, M.Eng., P.Eng.  
CFD Lead Engineer

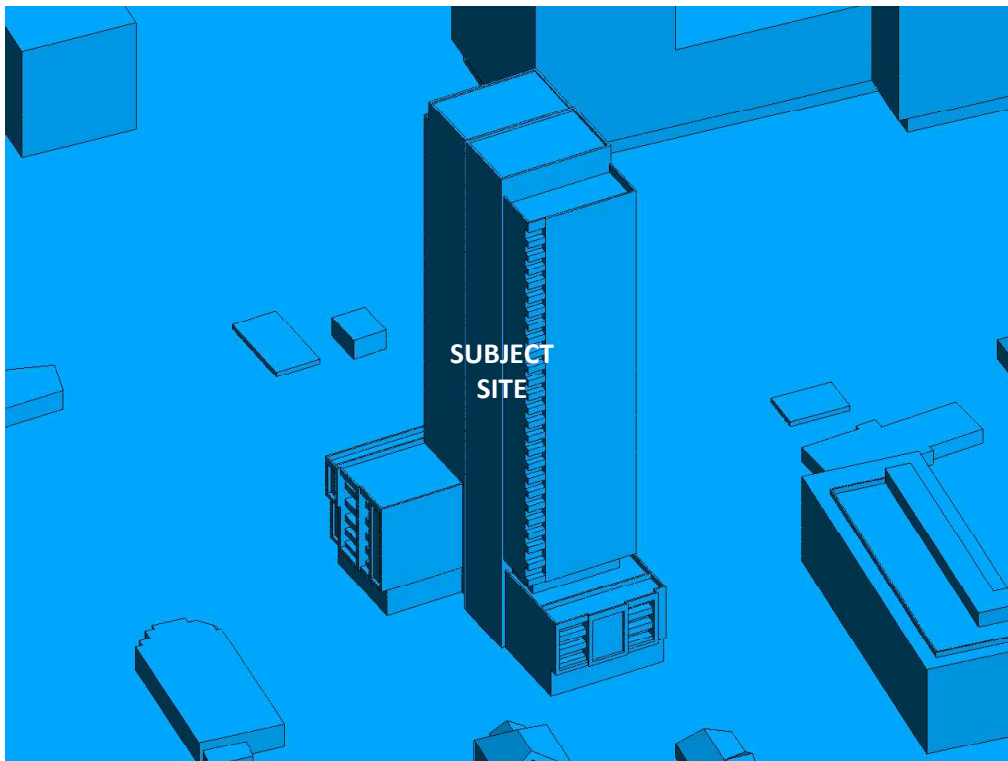








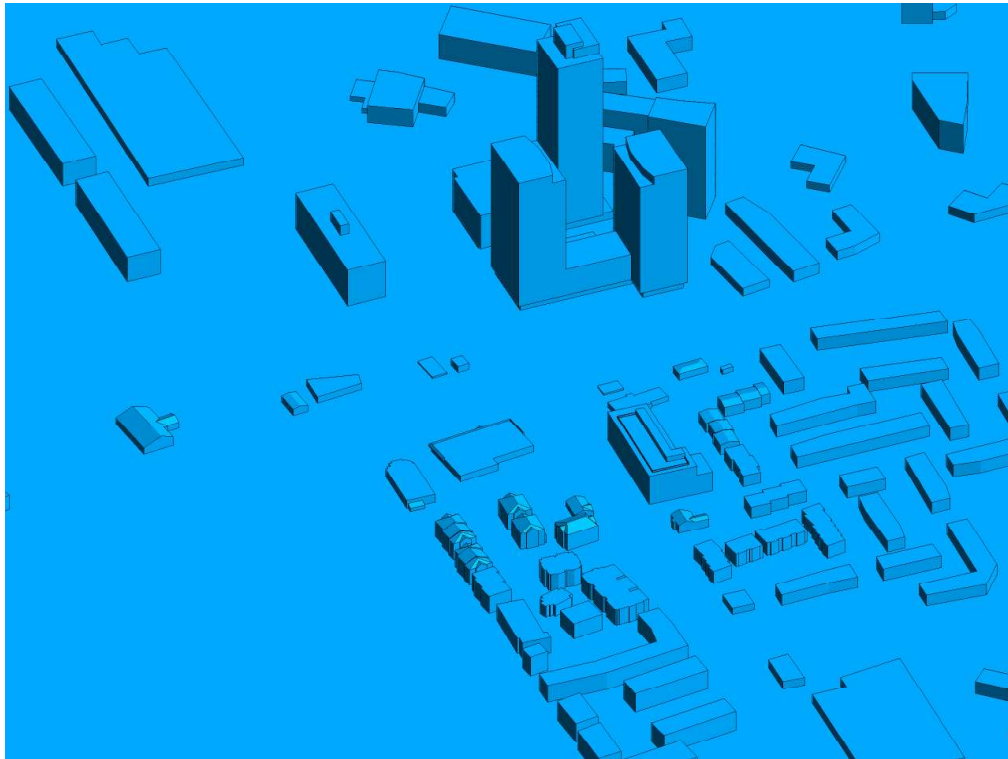
**FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE**



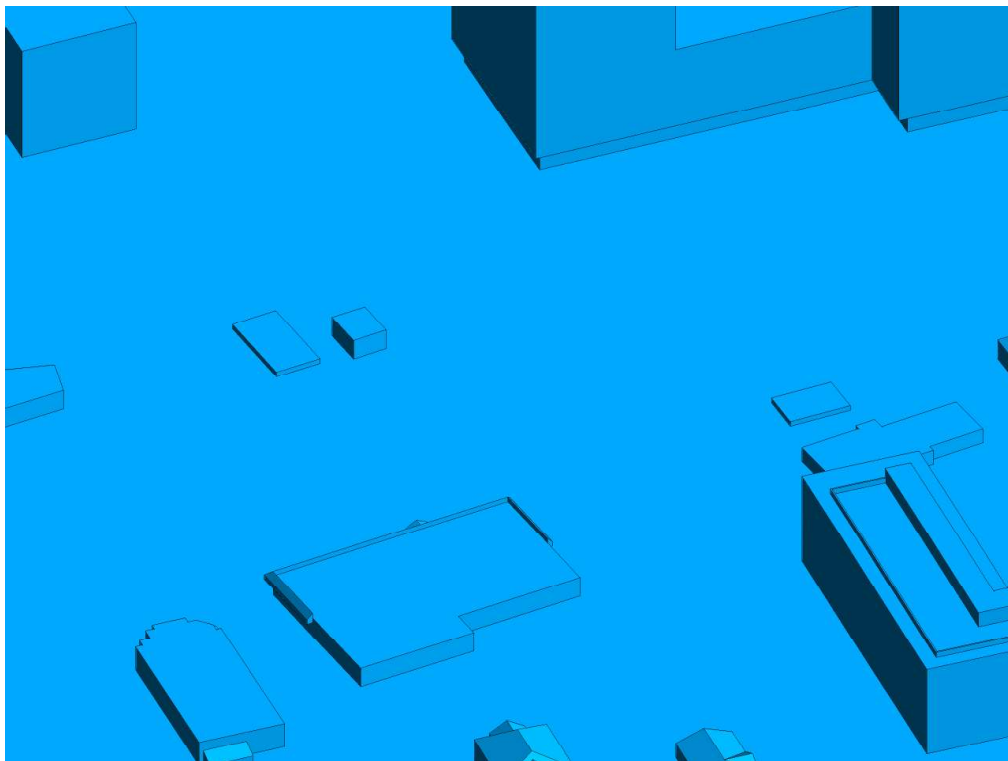
**FIGURE 2B: CLOSE UP OF FIGURE 2A**





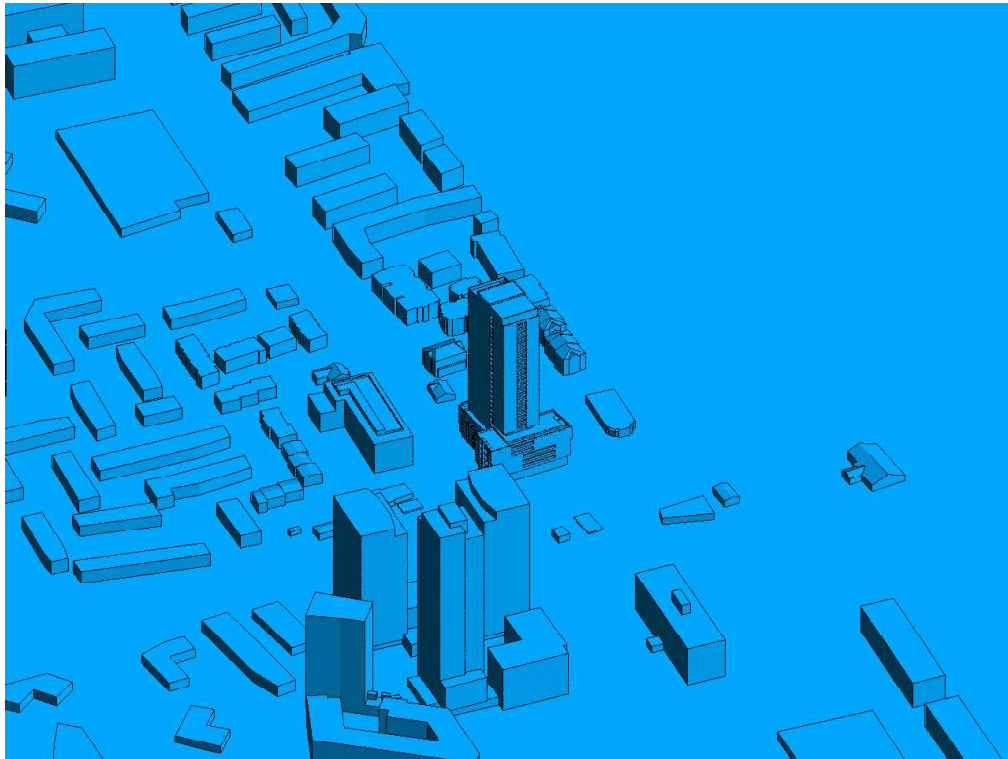


**FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE**

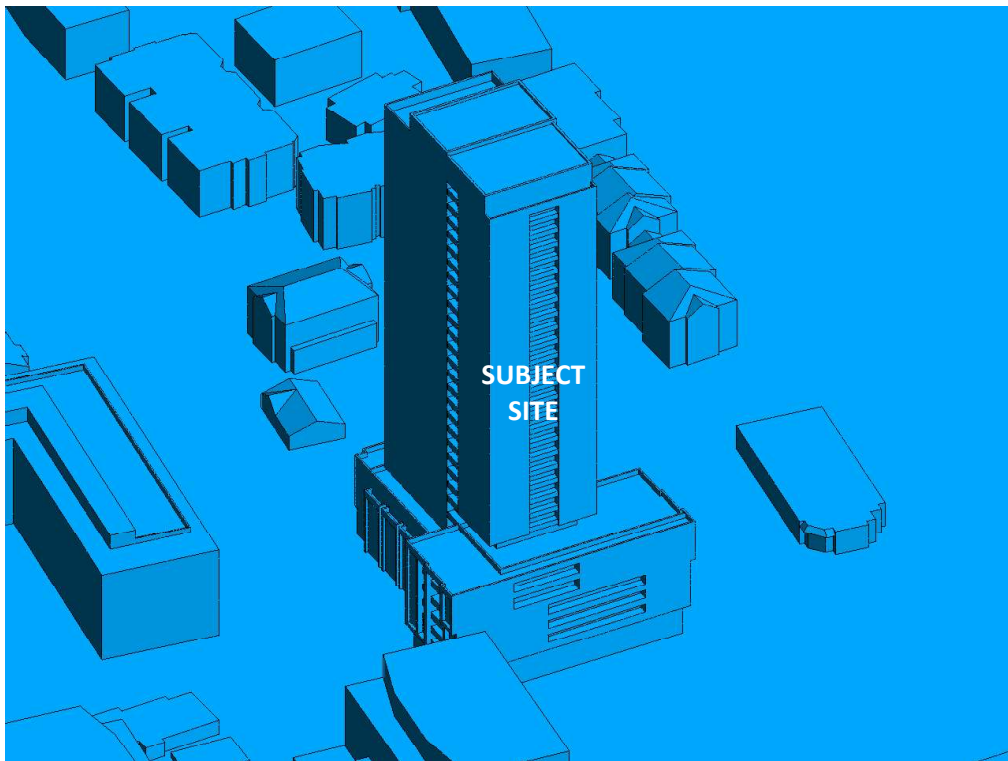


**FIGURE 2D: CLOSE UP OF FIGURE 2C**





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



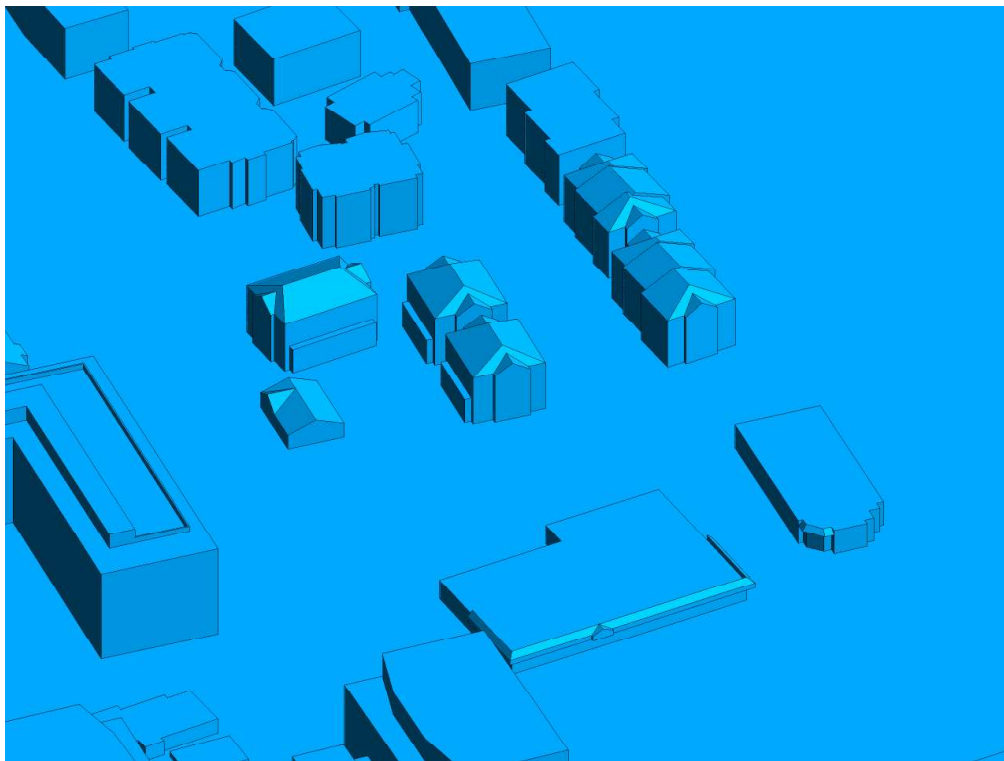
**FIGURE 2F: CLOSE UP OF FIGURE 2E**





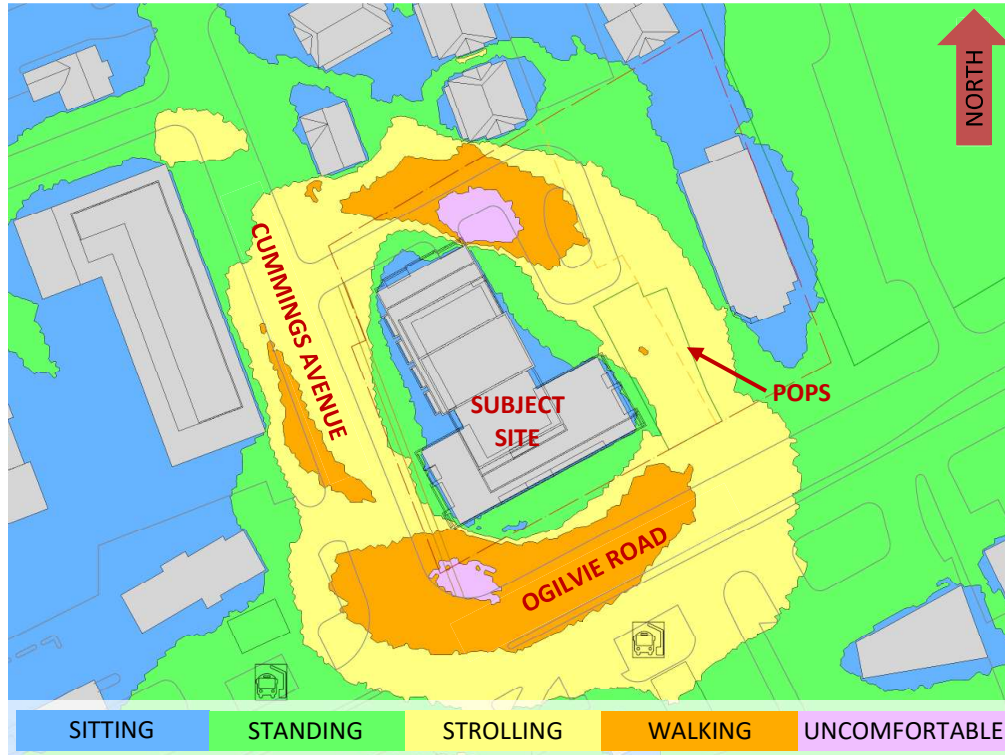


**FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE**

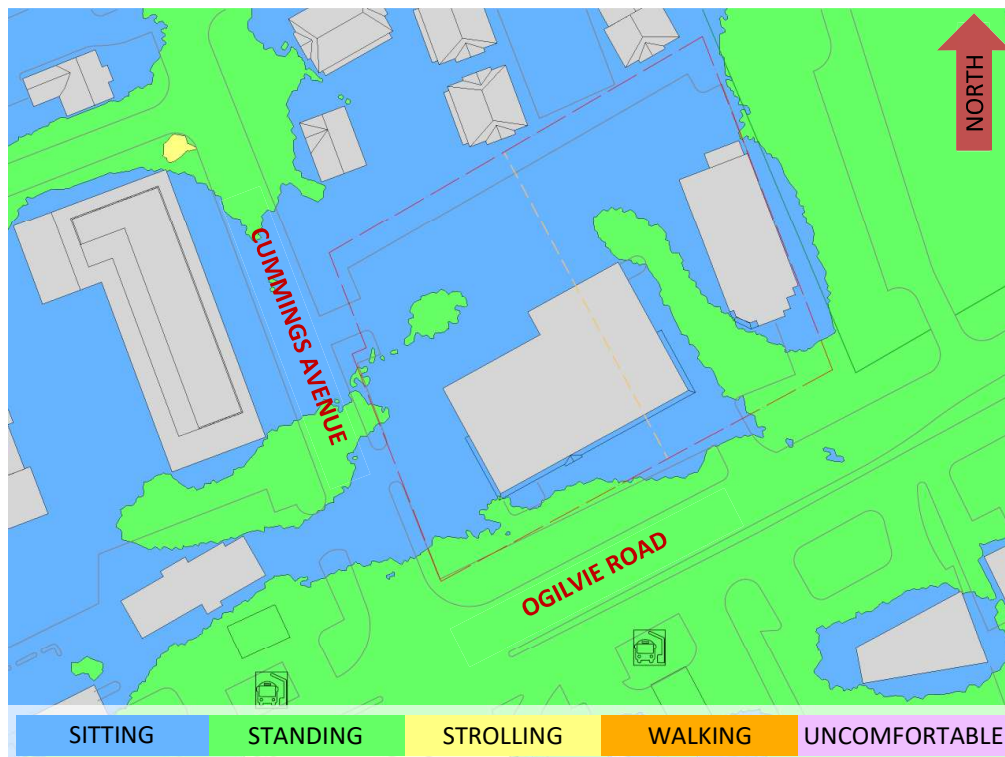


**FIGURE 2H: CLOSE UP OF FIGURE 2G**

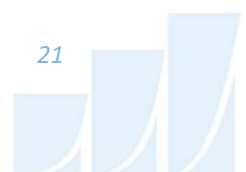


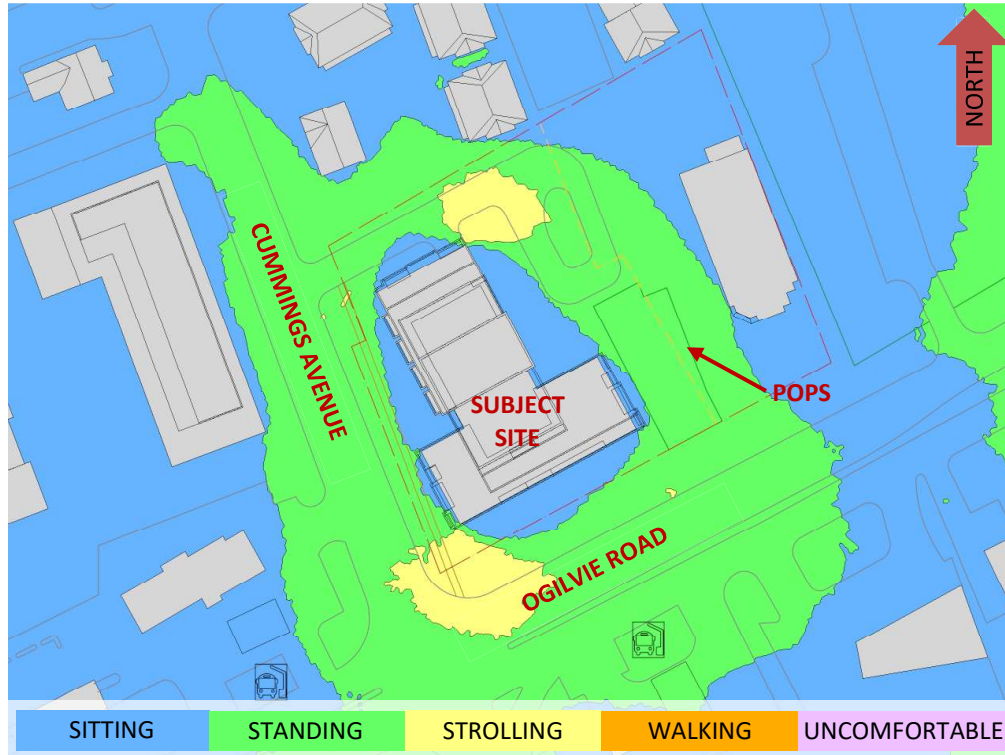


**FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING**

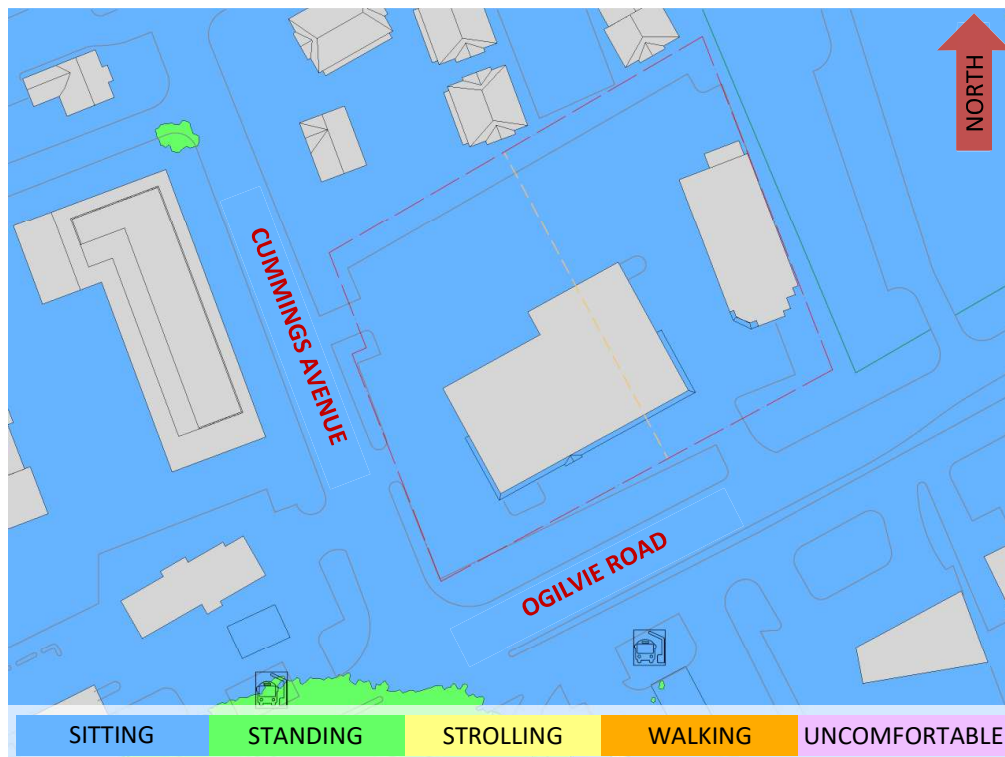


**FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL– EXISTING MASSING**



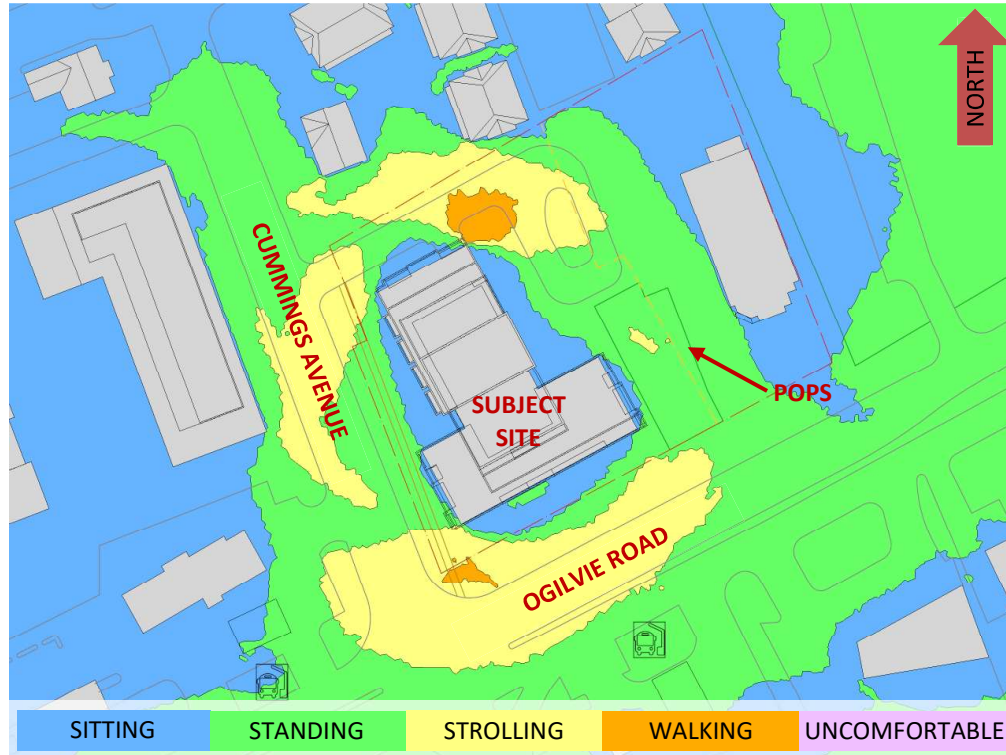


**FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING**

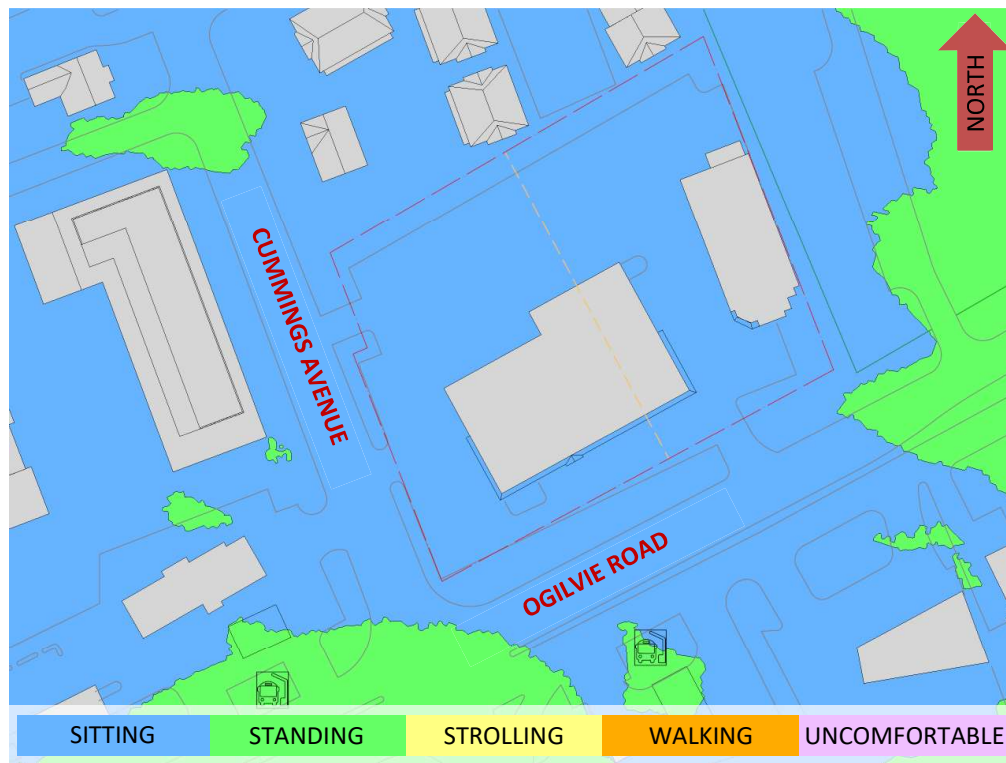


**FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING**



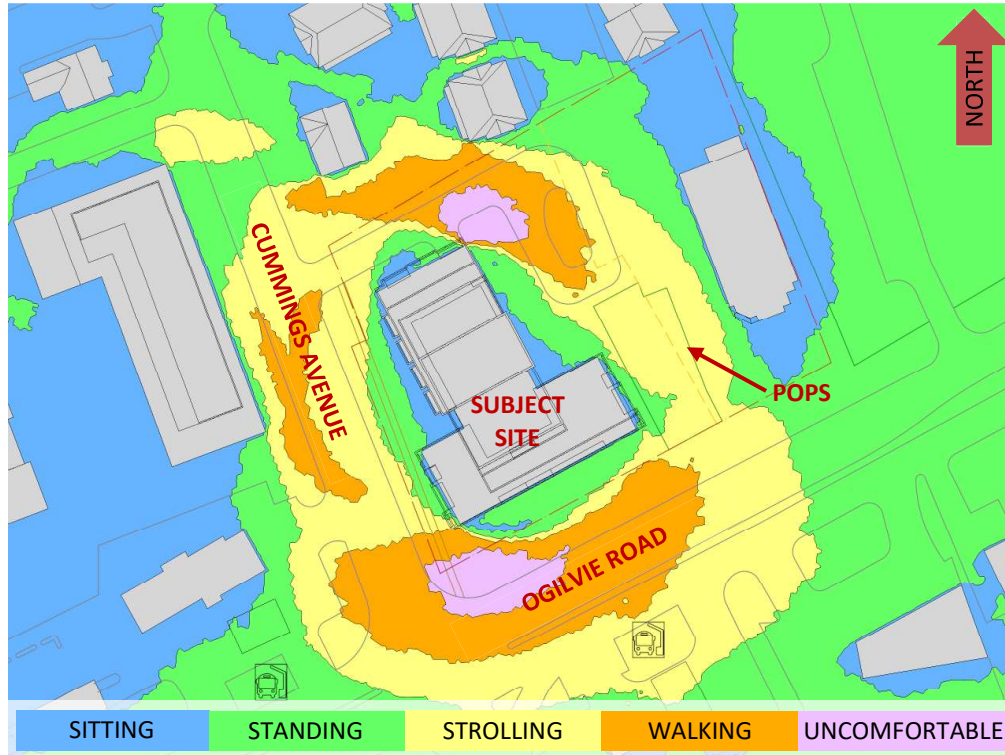


**FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING**

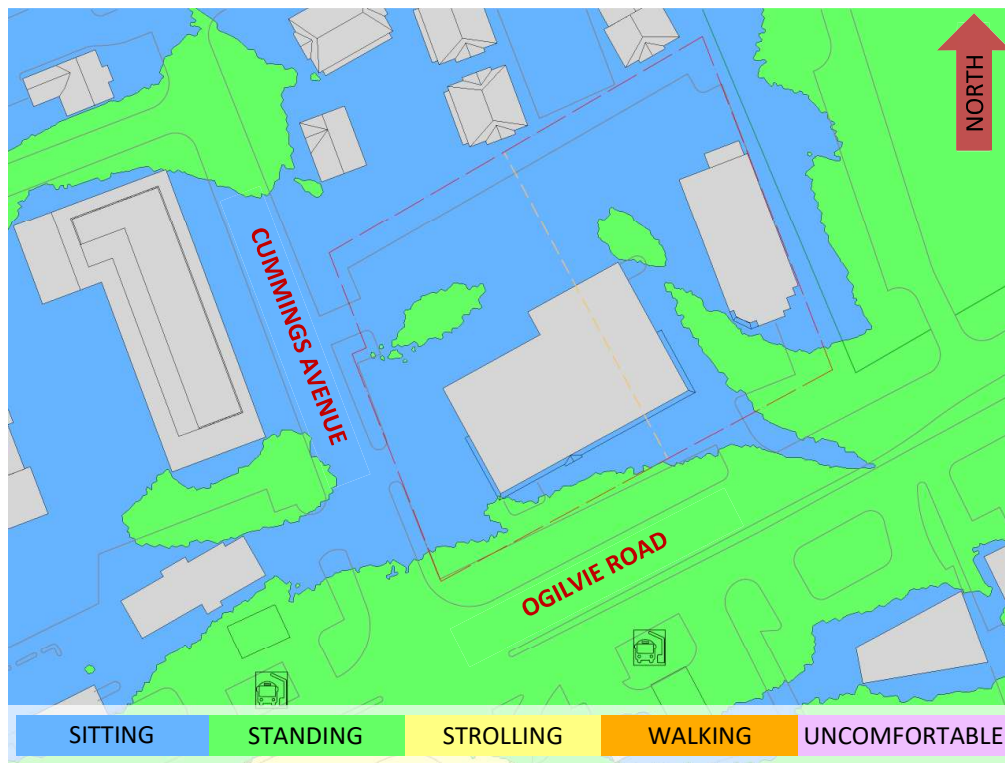


**FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL– EXISTING MASSING**



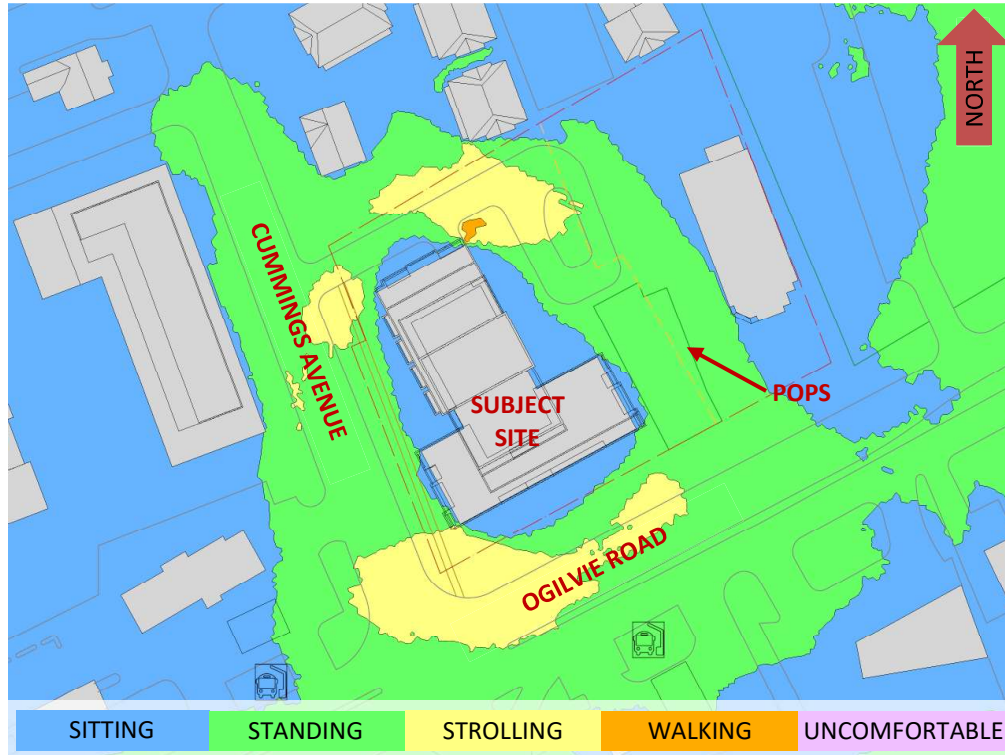


**FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING**



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

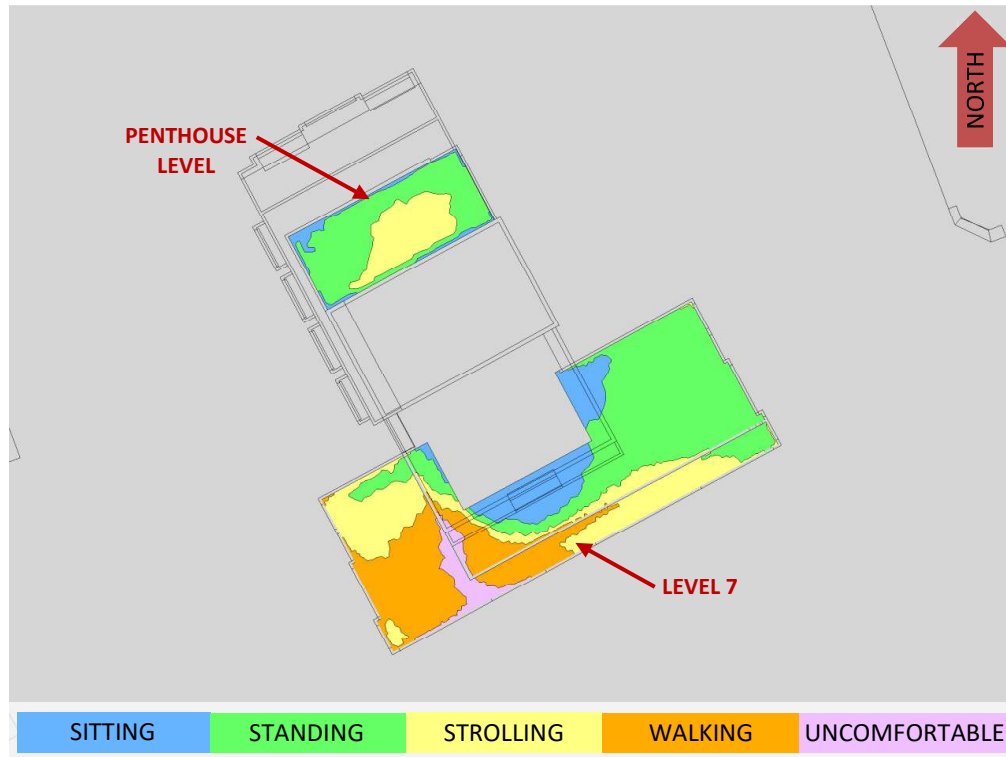




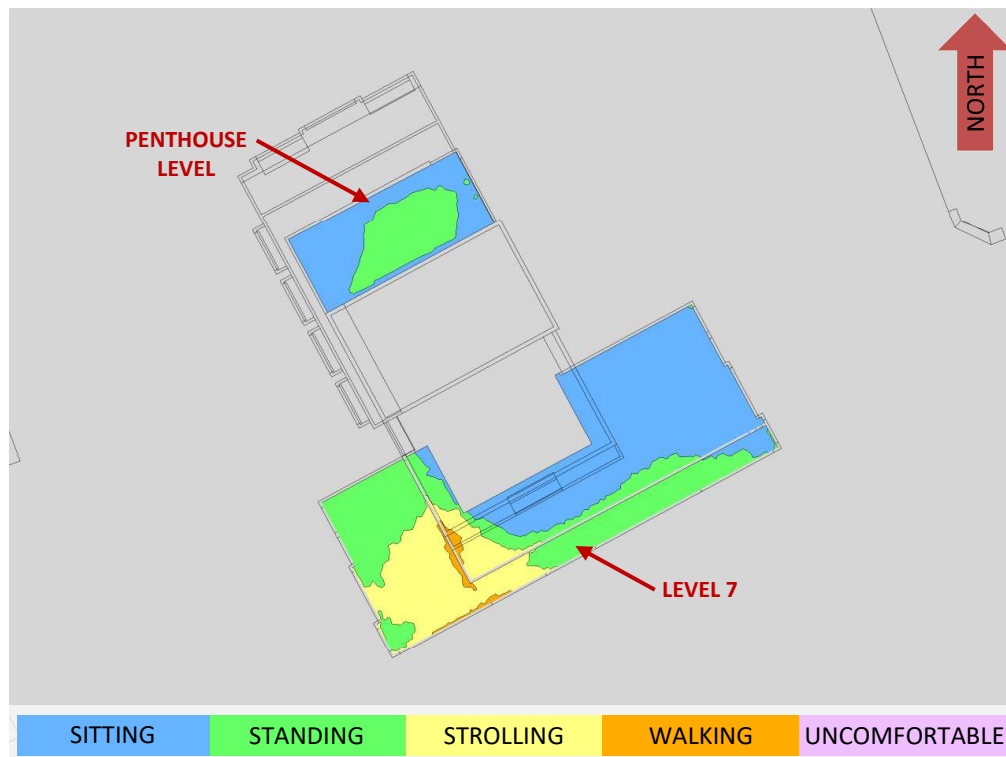
**FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING**



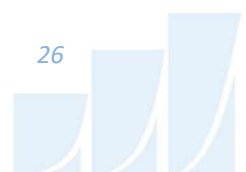


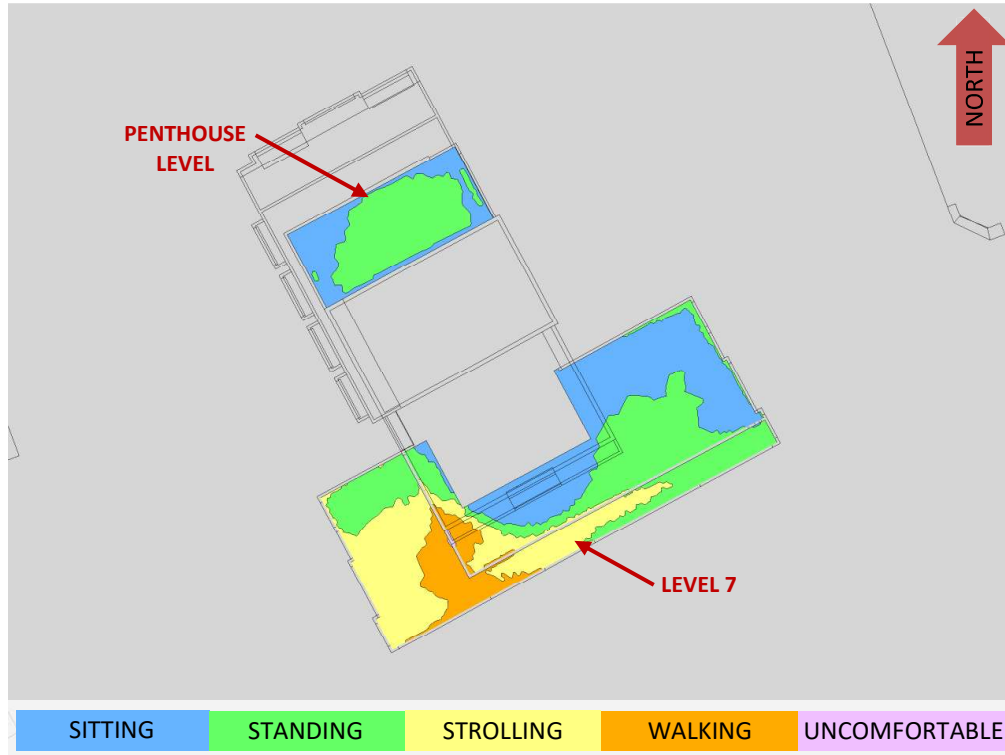


**FIGURE 8A: SPRING – WIND COMFORT, COMMON AMENITY TERRACES**

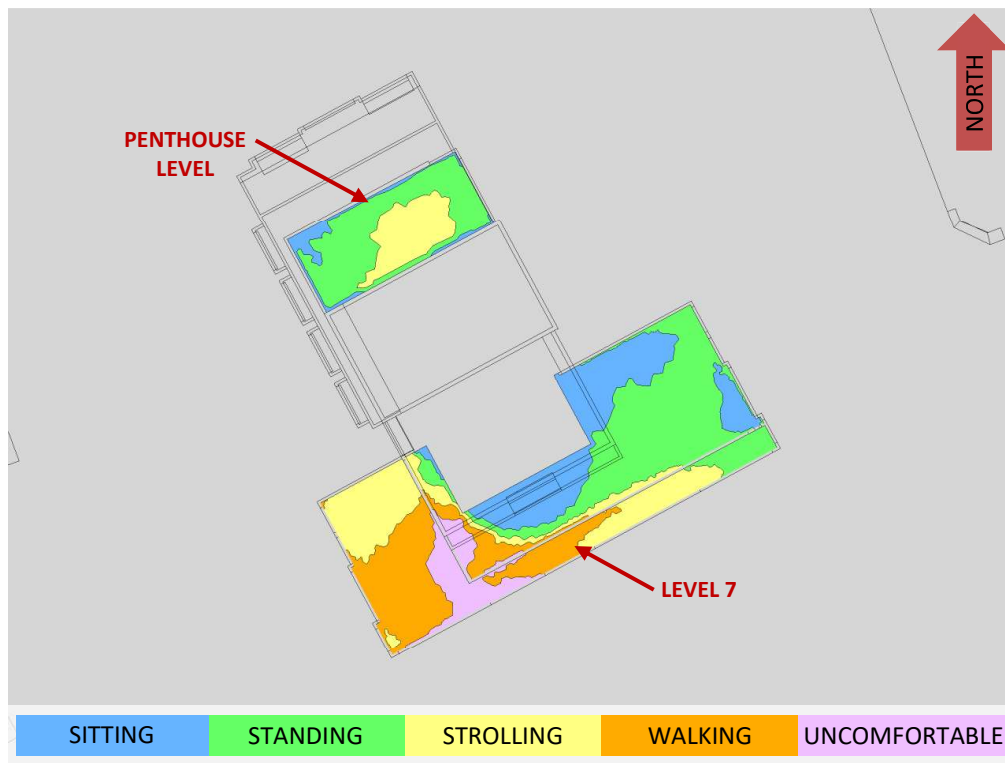


**FIGURE 8B: SUMMER – WIND COMFORT, COMMON AMENITY TERRACES**





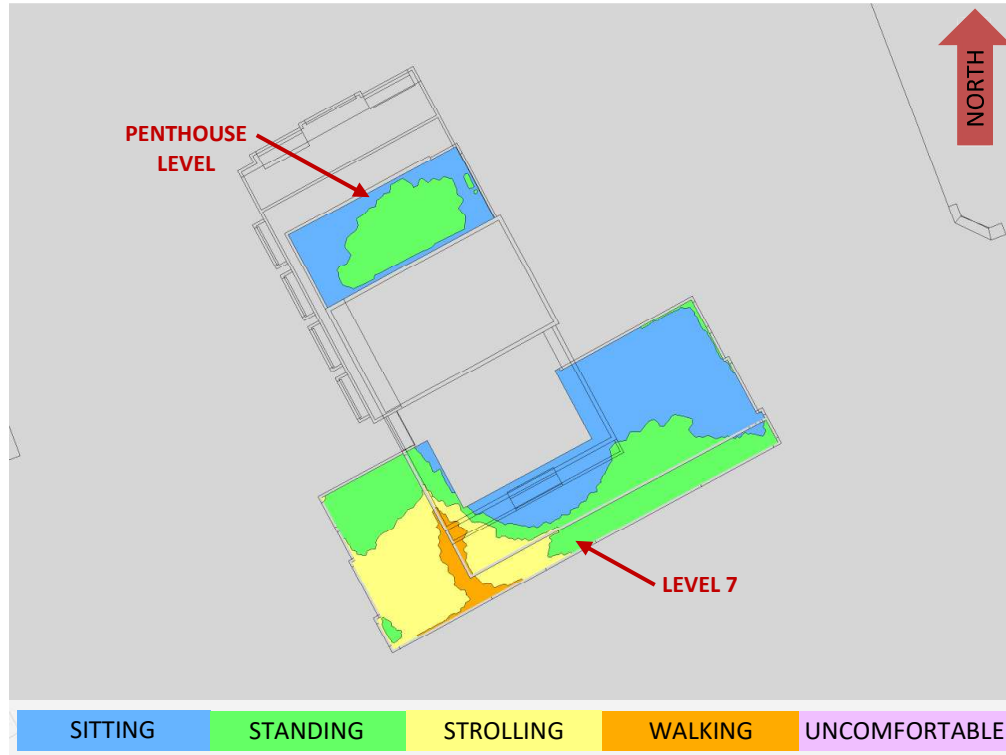
**FIGURE 8C: AUTUMN – WIND COMFORT, COMMON AMENITY TERRACE**



**FIGURE 8D: WINTER – WIND COMFORT, COMMON AMENITY TERRACES**





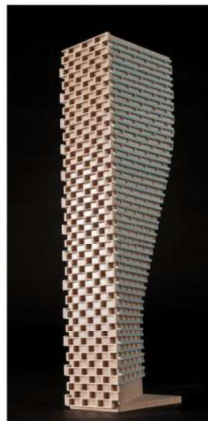


**FIGURE 9: TYPICAL USE PERIOD, COMMON AMENITY TERRACES**



# GRADIENTWIND

ENGINEERS & SCIENTISTS



## 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).

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

where  $U$  = mean wind speed,  $U_g$  = gradient wind speed,  $Z$  = height above ground,  $Z_g$  = depth of the boundary layer (gradient height), and  $\alpha$  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.

$\alpha$  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  $\alpha$  used in this study, while Table 2 presents several reference values of  $\alpha$ . When the upstream exposure of the far-field surroundings is a mixture of multiple types of terrain, the  $\alpha$  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 ( $\alpha$ )
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 ( $\alpha$ )
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).

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

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

where  $I$  = turbulence intensity,  $L_t$  = turbulence length scale,  $Z$  = height above ground, and  $\alpha$  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.

## REFERENCES

- [1] P. Arya, "Chapter 10: Near-neutral Boundary Layers," in *Introduction to Micrometeorology*, San Diego, California, Academic Press, 2001.
- [2] S. A. Hsu, E. A. Meindl and D. B. Gilhousen, "Determining the Power-Law Wind Profile Exponent under Near-neutral Stability Conditions at Sea," vol. 33, no. 6, 1994.
- [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.