

**PEDESTRIAN LEVEL
WIND STUDY**

3277 St Joseph Boulevard
Ottawa, Ontario

Report: 21-401-PLW



December 17, 2021

PREPARED FOR
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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Site Plan Control application submission requirements for the proposed residential development located at 3277 St Joseph Boulevard in Ottawa, Ontario (hereinafter referred to as “subject site” or “proposed development”). Our mandate within this study is to investigate pedestrian wind comfort and safety 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.

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-4D, and summarized as follows:

- 1) All 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, walkways, laneways, nearby bus stops, and in the vicinity of building access points are considered acceptable.
- 2) Regarding the common amenity terrace serving Building A at Level 6, conditions during the summer are predicted to be calm and suitable for sitting, which are considered acceptable according to the City of Ottawa wind criteria.
- 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, (e.g., 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.



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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Landric Homes to undertake a pedestrian level wind (PLW) study to satisfy Site Plan Control application submission requirements for the proposed residential development located at 3277 St Joseph Boulevard in Ottawa, Ontario (hereinafter referred to as “subject site” or “proposed development”). Our mandate within this study is to investigate pedestrian wind comfort and safety 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.

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 Rossman Architecture Inc., in November 2021, 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 3277 St Joseph Boulevard in Ottawa, Ontario; situated within the northwest intersection of St Joseph Boulevard and Tenth Line Road. Highway 174 is to the north of the subject and extends east-northeast to west-southwest. The proposed development comprises two near rectangular residential buildings, “Building A” to the east, closest to Tenth Line Road, and “Building B” to the west, both rising to nine-storeys, and each topped by a mechanical penthouse. Building A is nearly twice the length of Building B. Residential units occupy all floor levels. Above three shared below-grade parking levels, Building A includes indoor amenities within the southwest quadrant while Building B includes two central recreational rooms and a service space. Access to the shared below-grade parking at the street level (Level 2) is provided by a ramp at the southwest corner of Building B with access from St Joseph Boulevard via a laneway; lower vehicular access at Level P2 is provided at the northwest corner of Building A with access from Recolte Private via a laneway. Level 2 includes a main entrance to the southeast of Building A and to the south of Building B, and a gym to the southwest of Building A. An outdoor central pedestrian walkway runs north-south between the two buildings. Level 6 of Building A is served by a common outdoor amenity terrace at the north end.



Regarding wind exposures, the near-field surroundings (defined as an area falling within a 200-metre (m) radius of the subject site) are characterized by a police station to the east, three low-rise residential homes to the southwest, rows of three-storey townhouses to the west and southwest, and a mid-rise residential building to the north. Notably, a residential development comprising five three-storey buildings are proposed within the Orléans Town Centre East subdivision, referred to as Blocks 3, 4, and 5, situated to the southeast of the Vieux-Silo Street and Recolte Private intersection approximately 130 m to the west of the subject site. The far-field surroundings (defined as the area beyond the near field and within a 2-kilometre (km) radius) are characterized primarily by a few mid-rise residential buildings to the southwest, low-rise commercial buildings to the far northeast, south, and southwest, and low-rise residential buildings in all compass directions. Large green spaces and dense forestry are to the far southwest and along the Ottawa River approximately 1.2 km to the north.

Figure 1 illustrates the subject site and surrounding context, representing the proposed future massing scenario. Figures 2A-2D illustrate the computational models used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level wind comfort and safety 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 study 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 criteria¹. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

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 study 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 more conservative (i.e., windier) wind speed values.

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 study building, complete with surrounding massing within a radius of 480 m.

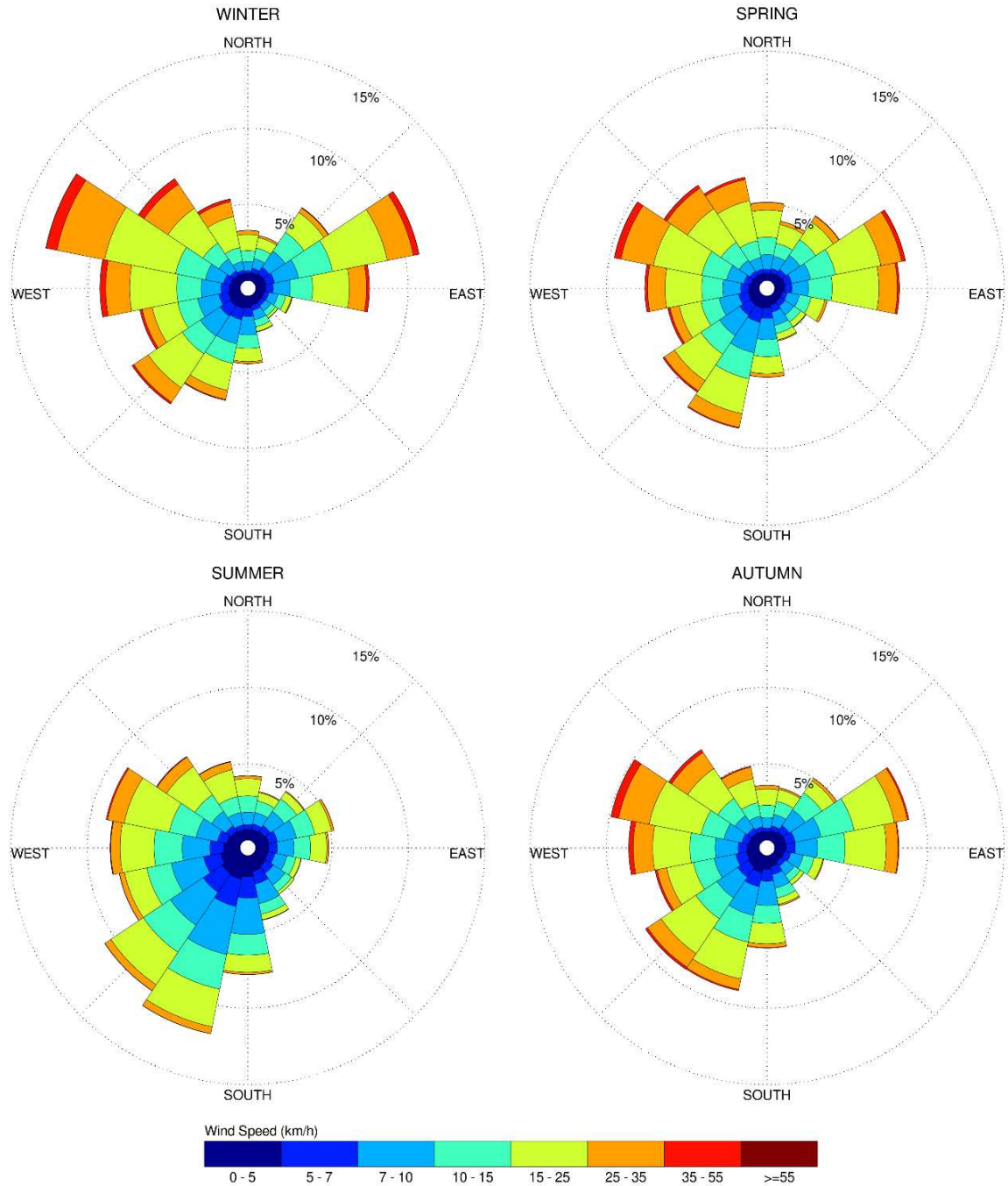
Mean and peak wind speed data obtained over the study site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the Level 6 common amenity terrace serving Building A were 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 preferred 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 preference 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 Comfort and Safety Criteria – City of Ottawa

Pedestrian comfort and safety criteria are based on the mechanical effects of wind without consideration of other meteorological conditions (i.e., temperature, relative humidity). The comfort criteria assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Five pedestrian comfort classes are based on 20% non-exceedance mean wind speed ranges, which include (1) Sitting; (2) Standing; (3) Strolling; (4) Walking; and (5) Uncomfortable. More specifically, the comfort classes and associated mean wind speed ranges are summarized as follows:

- 1) **Sitting:** 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.
- 2) **Standing:** 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.
- 3) **Strolling:** 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.
- 4) **Walking:** 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.
- 5) **Uncomfortable:** 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.

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. The gust speeds, and equivalent mean speeds, are selected based on 'The Beaufort Scale', presented on the following page, which describes the effects of forces produced by varying wind speed levels on objects. Gust speeds are included because 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.

THE BEAUFORT SCALE

Number	Description	Gust Wind Speed (km/h)	Description
2	Light Breeze	9-17	Wind felt on faces
3	Gentle Breeze	18-29	Leaves and small twigs in constant motion; wind extends light flags
4	Moderate Breeze	30-42	Wind raises dust and loose paper; small branches are moved
5	Fresh Breeze	43-57	Small trees in leaf begin to sway
6	Strong Breeze	58-74	Large branches in motion; Whistling heard in electrical wires; umbrellas used with difficulty
7	Moderate Gale	75-92	Whole trees in motion; inconvenient walking against wind
8	Gale	93-111	Breaks twigs off trees; generally impedes progress

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 30 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 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 desired comfort classes, which are dictated by the location type for each region (i.e., a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their desired comfort classes are summarized on the following page.

DESIRED PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Desired Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Standing / Strolling / Walking
Primary Public Sidewalk	Strolling / Walking
Secondary Public Sidewalk / Bicycle Path	Walking
Outdoor Amenity Space	Sitting / Standing / Strolling
Café / Patio / Bench / Garden	Sitting
Bus/Transit Stop	Sitting / Standing
Public Park / Plaza	Standing / Strolling
Garage / Service Entrance	Walking
Parking Lot	Strolling / Walking
Vehicular Drop-Off Zone	Standing / Strolling / Walking

5. RESULTS AND DISCUSSION

The following discussion of predicted pedestrian wind conditions is accompanied by Figures 3A-3D illustrating seasonal wind comfort conditions at grade level, as well as by Figures 4A-4D illustrating seasonal wind conditions over the common amenity terrace serving Building A at Level 6. Conditions are presented as continuous contours of wind comfort within and surrounding the subject site. The colour contours indicate predicted regions of the various comfort classes noted in Section 4.4. 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. 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 Bus Stop along Tenth Line Road: Following the introduction of the proposed development, the nearby public sidewalk areas along Tenth Line Road are predicted to be suitable mostly for sitting during the summer, a mix of sitting and standing during the autumn, becoming suitable mostly for standing during the winter and spring. Wind conditions over the nearby bus stop to the east of the proposed development are predicted to be suitable for sitting during the summer, suitable for a mix of

sitting and standing during the autumn, becoming suitable for standing during the winter and spring. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Sidewalks, Bus Stop, and Building Access along St Joseph Boulevard: Following the introduction of the proposed development, the nearby public sidewalk areas along St Joseph Boulevard are predicted to be suitable for sitting during the summer, suitable for standing during the spring and autumn, becoming suitable mostly for a mix of standing and strolling during the winter. Wind conditions over the nearby bus stop to the southwest of the proposed development are predicted to be suitable for sitting during the summer, becoming suitable for standing during the remaining three seasons. Wind conditions in the vicinity of building access points are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Existing Parking Lot West of Subject Site: Following the introduction of the proposed development, the existing parking lot west of the subject site is predicted to be suitable mostly for sitting during the summer, becoming suitable mostly for standing during the remaining three seasons. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Proposed Laneway North of Subject Site: Following the introduction of the proposed development, the proposed laneway extending from Recolte Private, which leads to the entrance of the below-grade parking level northwest of Building A, is predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the remaining three seasons. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Pedestrian Walkway and Building Access Central to Subject Site: Following the introduction of the proposed development, the central pedestrian walkway is predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the remaining three seasons. In the vicinity of the adjacent building access points (west of Building A and east of Building B), conditions are predicted to be suitable for sitting during the spring, summer, and autumn, becoming suitable for a mix of sitting and standing during the winter. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

5.2 Wind Comfort Conditions – Common Amenity Terrace

Level 6 Common Amenity Terrace: Conditions over the common amenity terrace serving Building A at Level 6 are predicted to be suitable mostly for sitting during the summer, suitable mostly for sitting during the autumn, becoming suitable mostly for standing during the winter and spring. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

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 and surrounding the subject site were found to experience conditions that could be considered dangerous, as defined in Section 4.4.

5.4 Applicability of Results

Wind conditions over surrounding sidewalks beyond the subject site, as well as at nearby primary building entrances, will be acceptable for their intended pedestrian uses during each seasonal period upon the introduction of the subject site. Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the study site. Future changes (i.e., 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 site would alter the wind profile approaching the site; and (ii) development in proximity to the site would cause changes to local flow patterns.

Regarding primary and secondary building access points, wind conditions predicted in this study are only applicable to pedestrian comfort and safety. As such, the results should not be construed to indicate wind loading on doors and associated hardware.

6. CONCLUSIONS AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 and illustrated in Figures 3A-4D. 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) All 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, walkways, laneways, nearby bus stops, and in the vicinity of building access points are considered acceptable.
- 2) Regarding the common amenity terrace serving Building A at Level 6, conditions during the summer are predicted to be calm and suitable for sitting, which are considered acceptable according to the City of Ottawa wind criteria.
- 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, (e.g., 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.

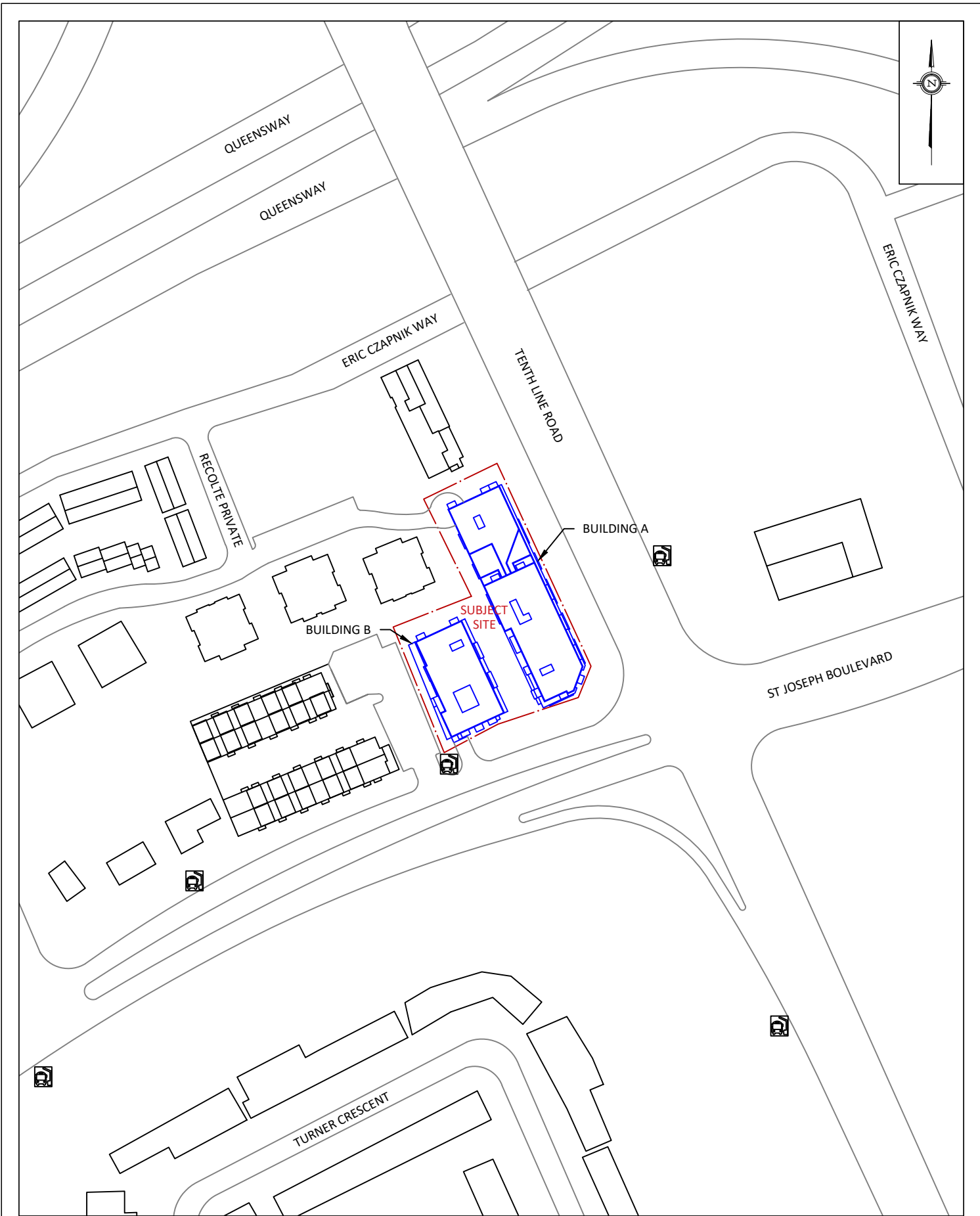


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PROJECT	3277 ST JOSEPH BOULEVARD, OTTAWA PEDESTRIAN LEVEL WIND STUDY	
SCALE	1:1500	DRAWING NO. 21-401-PLW-1
DATE	DECEMBER 17, 2021	DRAWN BY S.K.

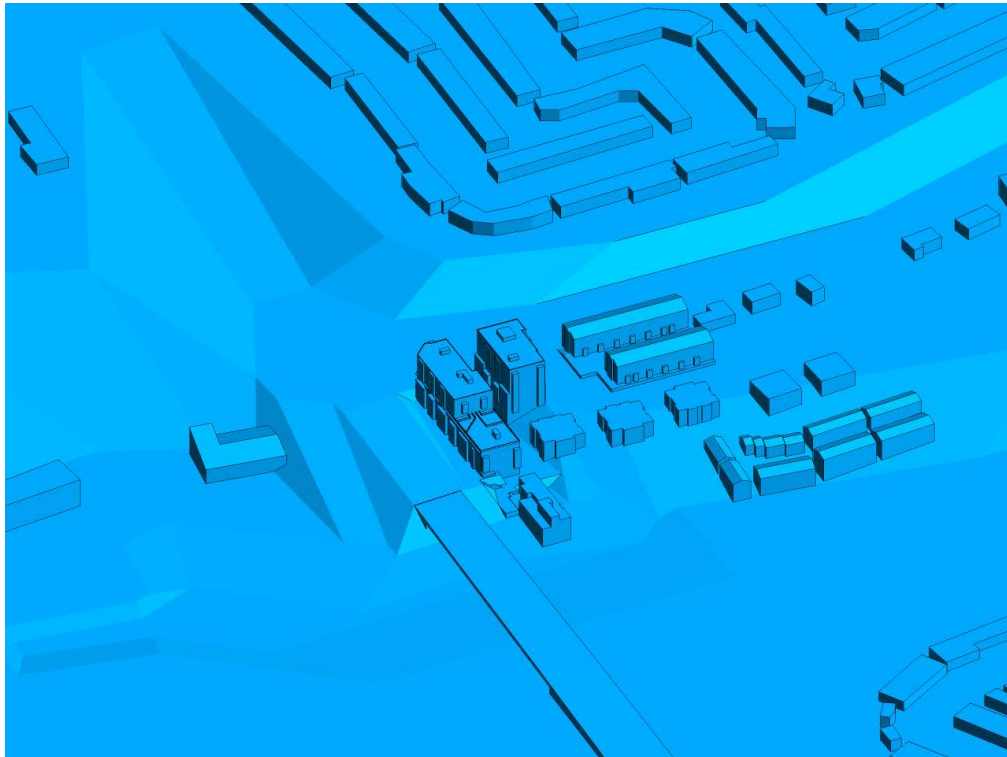


FIGURE 2A: COMPUTATIONAL MODEL, NORTH PERSPECTIVE



FIGURE 2B: CLOSE UP OF FIGURE 2A



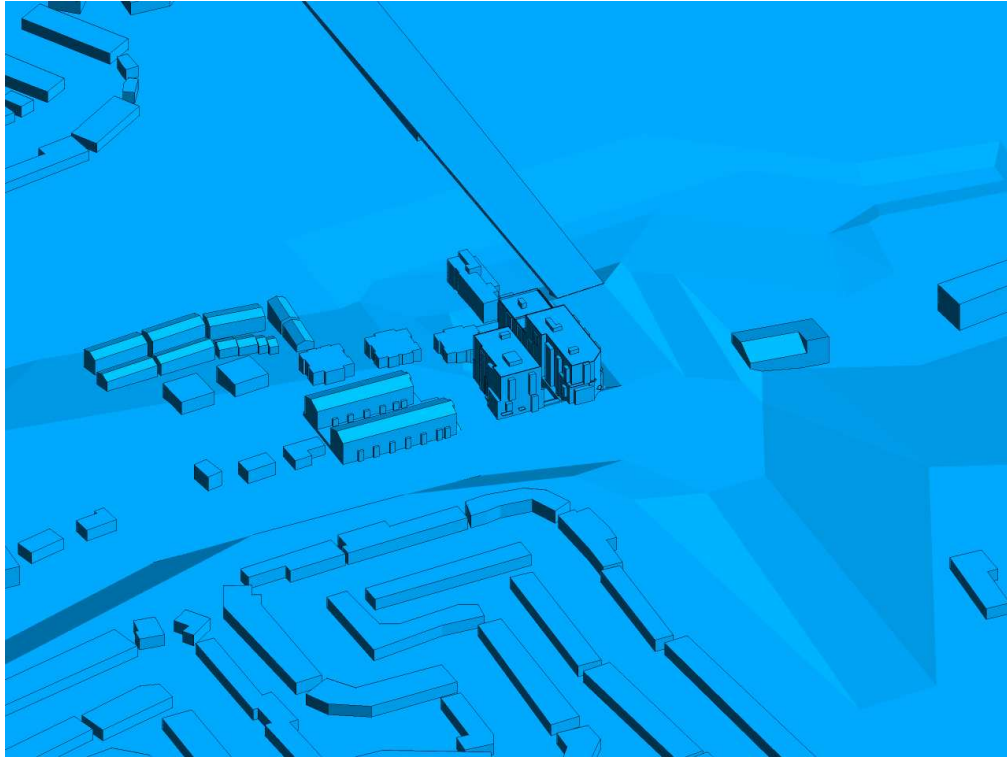


FIGURE 2C: COMPUTATIONAL MODEL, SOUTH PERSPECTIVE

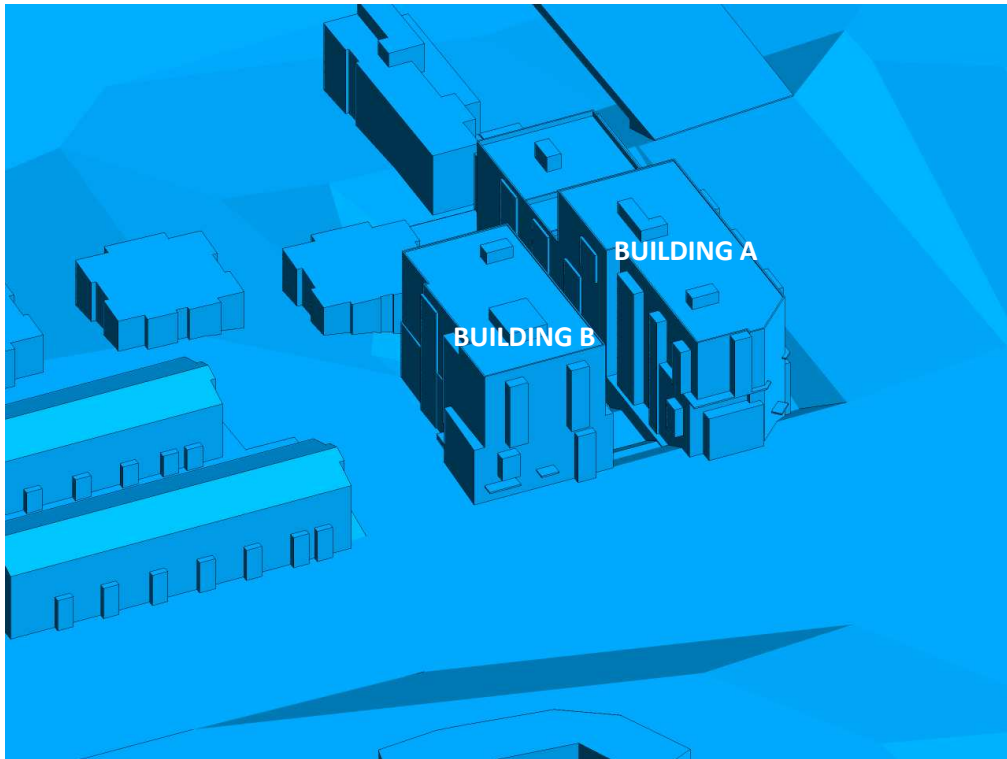


FIGURE 2D: CLOSE UP OF FIGURE 2C



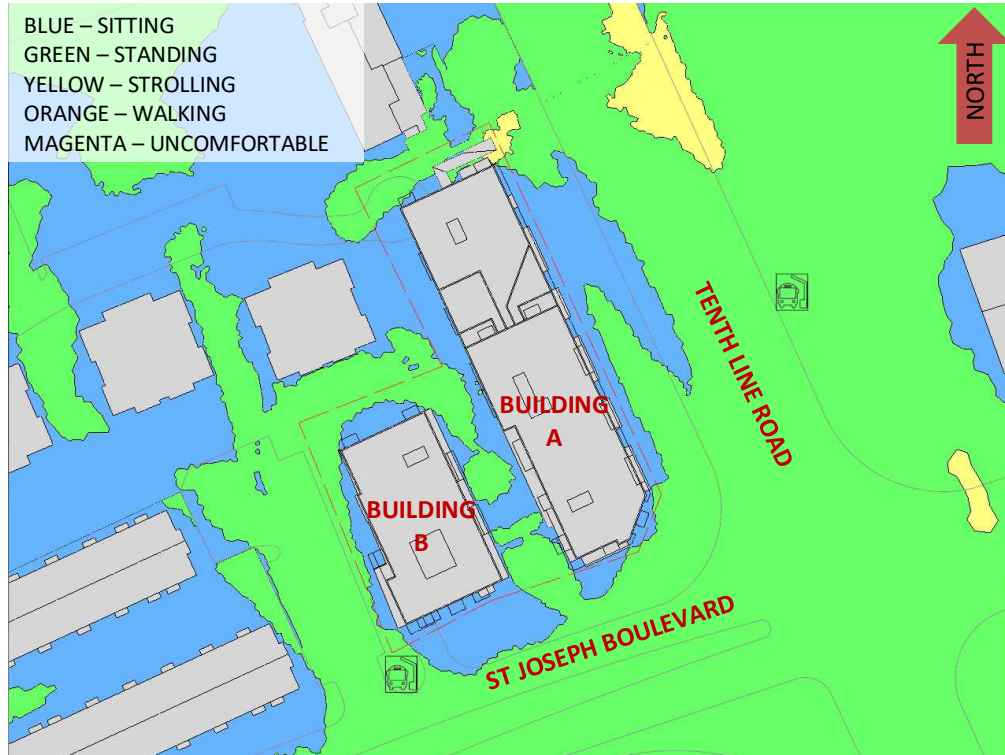


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL

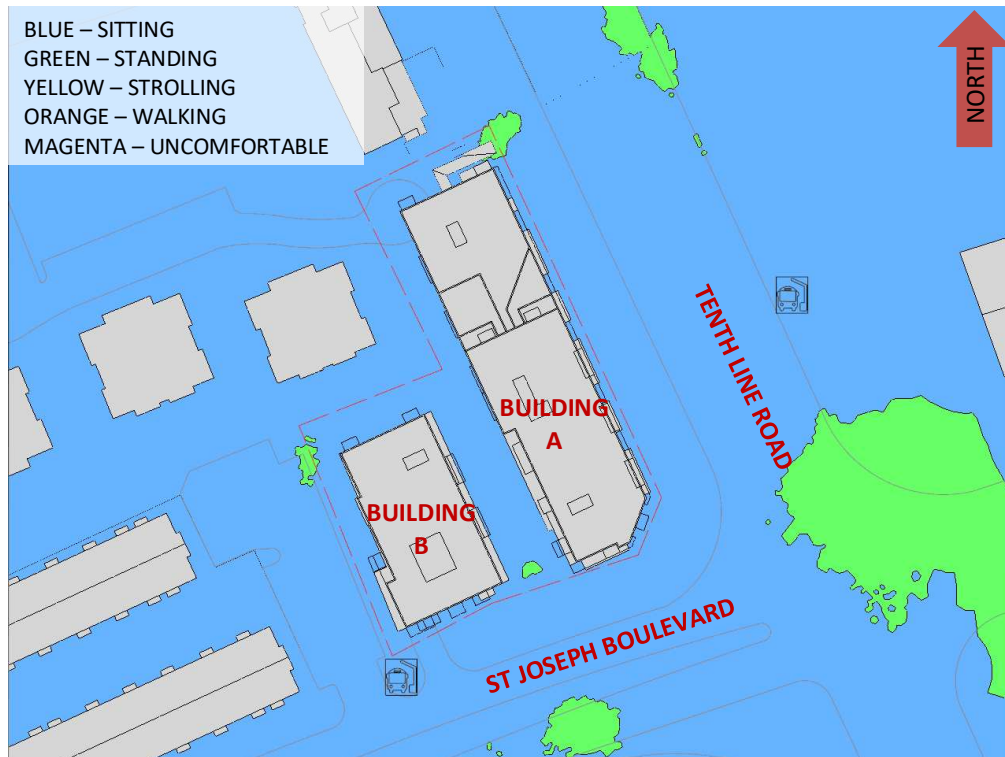


FIGURE 3B: SUMMER – WIND COMFORT, GRADE LEVEL



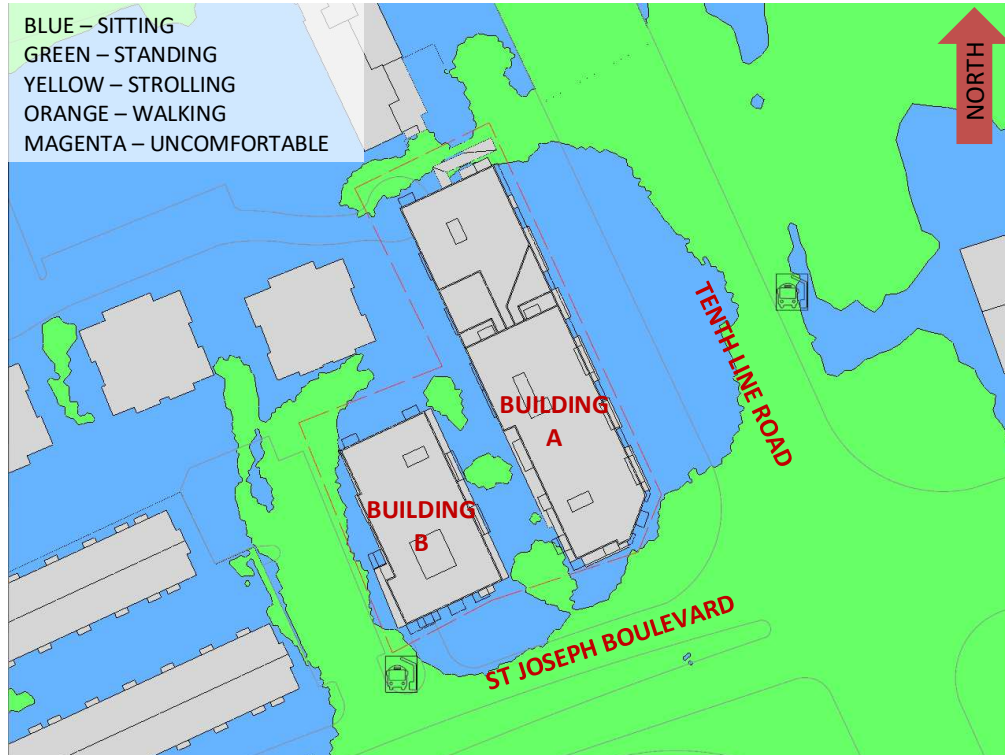


FIGURE 3C: AUTUMN – WIND COMFORT, GRADE LEVEL

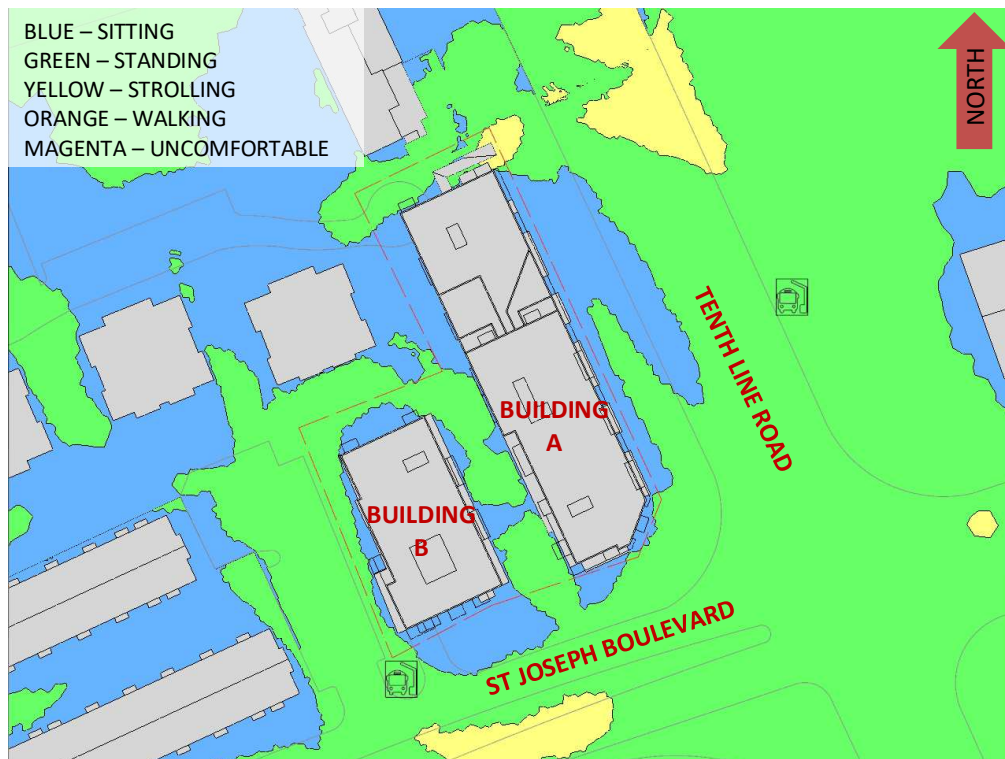


FIGURE 3D: WINTER – WIND COMFORT, GRADE LEVEL





FIGURE 4A: SPRING - WIND COMFORT, LEVEL 6 AMENITY TERRACE (BUILDING A)



FIGURE 4B: SUMMER - WIND COMFORT, LEVEL 6 AMENITY TERRACE (BUILDING A)

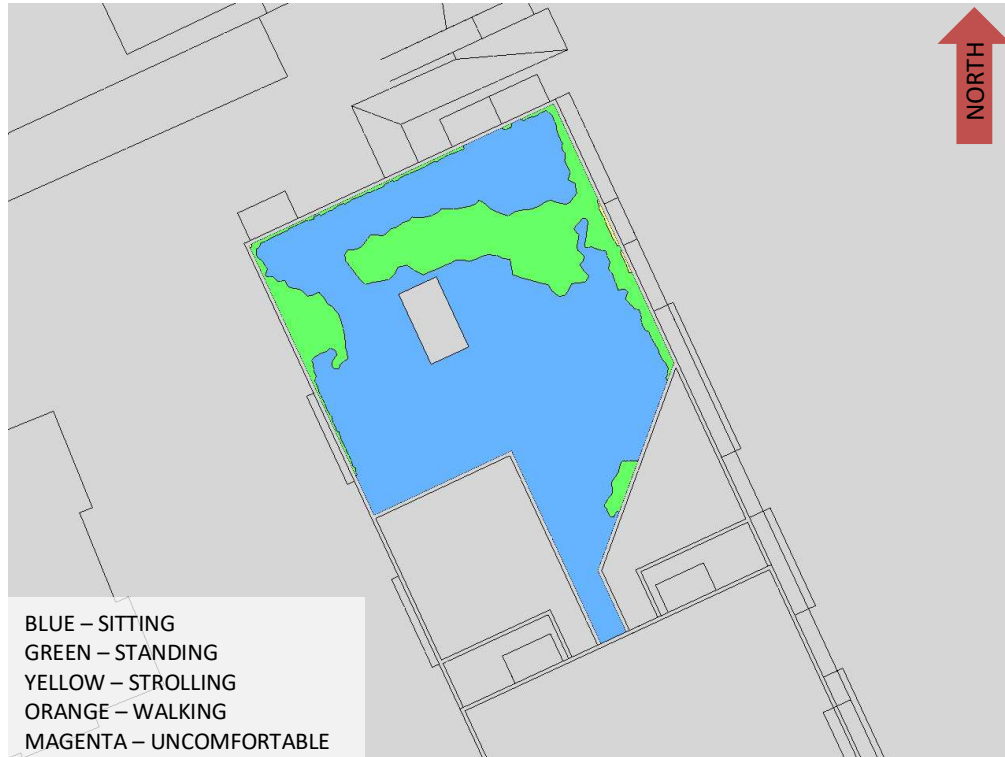


FIGURE 4C: AUTUMN - WIND COMFORT, LEVEL 6 AMENITY TERRACE (BUILDING A)



FIGURE 4D: WINTER - WIND COMFORT, LEVEL 6 AMENITY TERRACE (BUILDING A)

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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 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 (i.e., 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	0.21
74	0.23
103	0.24
167	0.24
197	0.24
217	0.24
237	0.24
262	0.23
282	0.23
302	0.22
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).

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

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

where, I = turbulence intensity, L_t = turbulence length scale, Z = height above ground, and 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.
- [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.
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