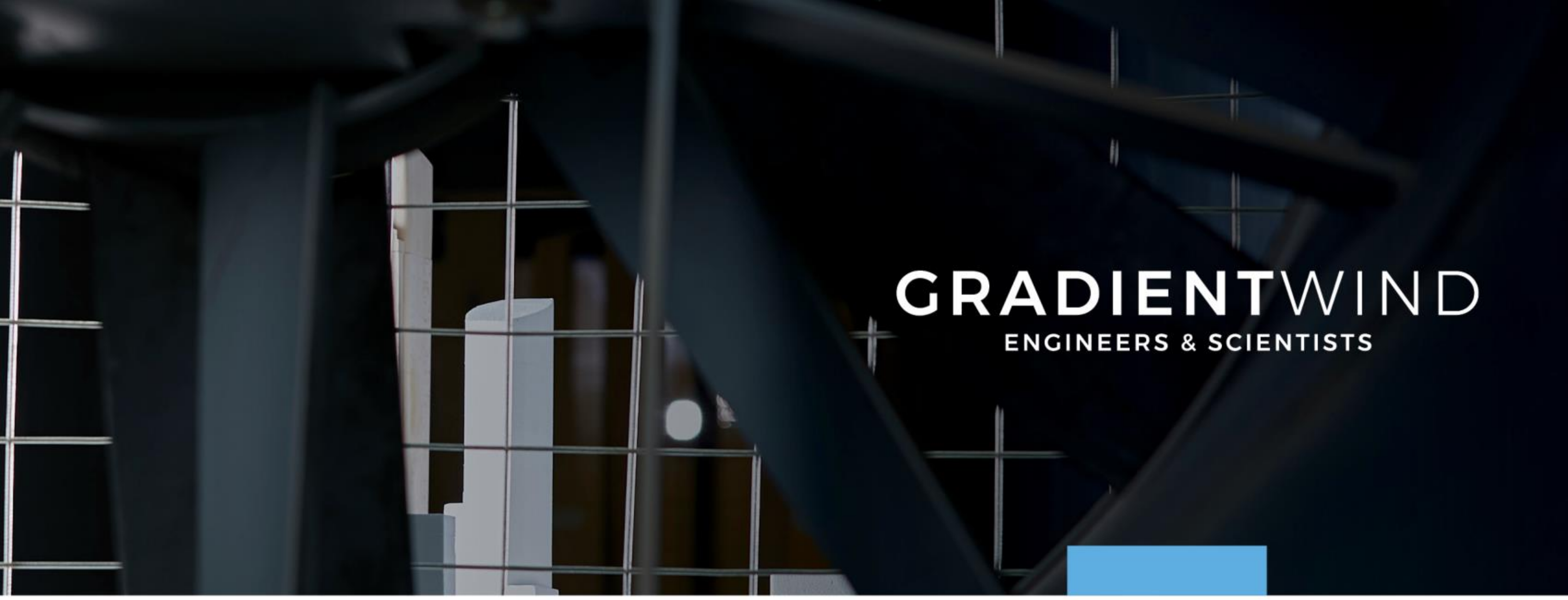
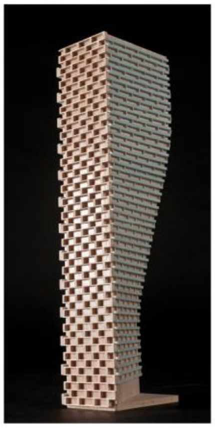
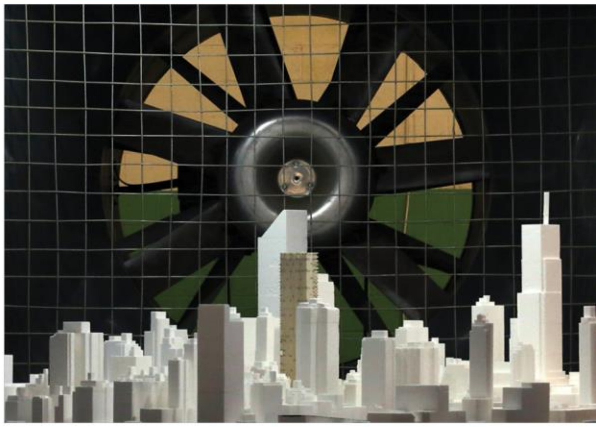


PEDESTRIAN LEVEL WIND STUDY

500 Coventry Road
Ottawa, Ontario

Report: 23-215-PLW





January 23, 2024

PREPARED FOR
Morguard Corporation
55 City Centre Drive, Suite 1000
Mississauga, ON L5B 1M3

PREPARED BY
Omar Rioseco, B.Eng., Junior Wind Scientist
David Huitema, M.Eng., Wind Scientist
Justin Ferraro, P.Eng., Principal

EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Site Plan Control application requirements for the proposed residential development located at 500 Coventry 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 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 sidewalks, existing surface parking lots and drive aisles, the proposed drive aisles, walkways, and park, and in the vicinity of building access points, are considered acceptable. An area of interest that is predicted to experience windier conditions is described as follows:

    a. **Grade-Level Outdoor Amenity**. During the typical use period, conditions within the outdoor amenity situated to the northwest of the proposed development are predicted to be suitable for mostly standing, with conditions suitable for sitting at the southeast corner.

    b. Landscaping elements, including high-back bench seating flanked by dense raised plantings, as detailed on the grade-level landscape plan, are expected to effective in improving wind comfort conditions at the programmed seating areas within the outdoor amenity.

2) Regarding the common amenity terrace serving the proposed development at Level 7, wind comfort conditions during the typical use period (that is, May to October, inclusive) are predicted to be suitable for mostly standing, with conditions suitable for sitting to the south.

    a. The windy conditions within the amenity terrace are primarily attributable to the exposure of the terrace to prevailing winds from several directions, and the currently mostly low-rise suburban massing surrounding the development.

    b. Notably, the current proposed development comprises the first phase of a multi-block development. The future redevelopment of the area, including future development of the multi-block masterplan to the west, north, and northeast, and a future development site comprising seven high-rise buildings under review to the west at 400 Coventry Road are expected to provide modest shielding effects from prevailing winds, reducing the exposure of the terrace to prominent winds.

    c. Since a successful wind mitigation strategy responds to the programming of the terrace, to improve comfort levels within the Level 7 amenity terrace serving the proposed development, a coordinated wind mitigation strategy and terrace programming and landscaping design is required. Elements of the wind mitigation strategy may include 2-m-tall wind screens (as measured from the local walking surface), typically glazed, along select terrace perimeters, in combination with mitigation inboard of the terrace perimeters, which may take the form of wind screens or other common landscape elements.

    d. An appropriate mitigation strategy will be developed in collaboration with the design team, including the building and landscape architects, as the design of the proposed development and the programming of the terrace progresses.

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.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Morguard Corporation to undertake a pedestrian level wind (PLW) study to satisfy Site Plan Control application requirements for the proposed residential development located at 500 Coventry Road in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate wind conditions within and surrounding the subject site, and to identify areas where conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, City of Ottawa wind comfort and safety criteria, architectural drawings prepared by Turner Fleischer Architects Inc. in December 2023, 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

Architectural Rendering, Southeast Perspective (Courtesy of Turner Fleischer Architects Inc.)

The subject site is located at 500 Coventry Road in Ottawa, situated to the south of a parcel of land bordered by Coventry Road to the north, the St. Laurent Shopping Centre to the east, Highway 417 to the south, and a Government of Canada building at 440 Coventry Road to the west. The proposed development comprises a 28-storey residential building, inclusive of a 6-storey podium, topped with a mechanical penthouse (MPH). A park serving the proposed development is located to the northeast of the subject site, fronting Coventry Road. The existing surface parking on the subject site is to remain.

Above below-ground parking, the ground floor comprises a nominally 'L'-shaped planform, with its long axis oriented to the east, and includes a central lobby with main entrances to the north and west, a rental office to the west, a staging/loading space and bike storage to the east, and indoor amenities throughout the remainder of the level. An outdoor amenity is located at the northwest corner of the building. Access to the underground parking is provided by a ramp to the east via a drive aisle from Coventry Road. Levels 2-6 are reserved for residential use. Setbacks accommodating private terraces are located to the south and west at Level 2 and along the west, north, and northeast elevations at Level 6. Level 7 comprises a rectangular planform with setbacks from the north and west elevations which accommodate a common amenity terrace and a private terrace, respectively, atop the podium. This level includes an indoor amenity at the northwest corner and residential units throughout the remainder of the level. Levels 8-28 rise with a rectangular planform comprised of residential units.

The near-field surroundings, defined as an area within 200 m of the subject site, include low-rise office and commercial buildings with surface parking lots from the west clockwise to the east-northeast, a mid-rise office building to the east, and low-rise residential dwellings in the remaining directions. Highway 417 extends from the southeast to the southwest to the immediate south of the subject site. 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 by low-rise suburban massing with isolated mid- and high-rise buildings in all compass directions. The Rideau River flows from the west-southwest to the west-northwest approximately 1.6 km to the west of the proposed development. Notably, a development comprising four buildings (ranging in height from 6 to 20 storeys) is approved (Zoning By-Law Amendment) at 453 & 455 Coventry Road, approximately 260 m to the northwest of the proposed development.

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 future developments 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.

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 12 wind directions. The CFD simulation model was centered on the proposed development, complete with surrounding massing within a radius of 480 m. The process was performed for two context massing scenarios, as noted in Section 2.

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

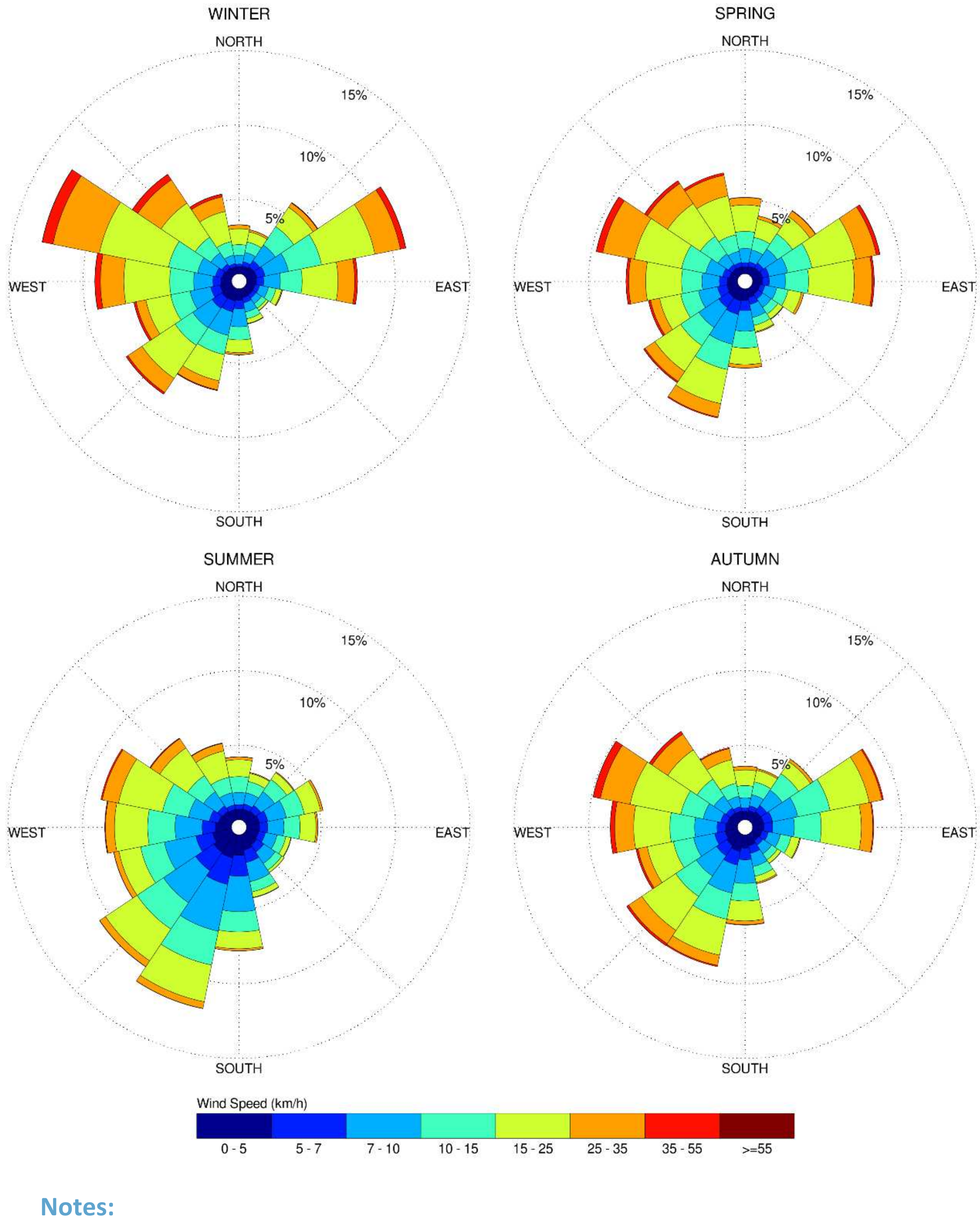
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and over the Level 7 common amenity terrace serving the proposed 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 for each month of the year to determine the statistically prominent wind directions and corresponding speeds, and to characterize similarities between monthly weather patterns.

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

SEASONAL DISTRIBUTION OF WIND
OTTAWA MACDONALD-CARTIER INTERNATIONAL AIRPORT



Notes:

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

4.4 Pedestrian Wind Comfort and Safety Criteria – City of Ottawa

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

PEDESTRIAN WIND COMFORT CLASS DEFINITIONS

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

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

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

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

TARGET PEDESTRIAN WIND COMFORT CLASSES FOR VARIOUS LOCATION TYPES

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

5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-6B, illustrating wind conditions at grade level for the proposed and existing massing scenarios, and by Figures 8A-8D, which illustrate conditions over the common amenity terrace serving the proposed development at Level 7. 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 comfort conditions at grade level and over the noted common amenity terrace serving the proposed development, respectively, consistent with the comfort classes in Section 4.4. The details of these conditions are summarized in the following pages for each area of interest.

5.1 Wind Comfort Conditions – Grade Level

Highway 417: Following the introduction of the proposed development, wind conditions along Highway 417 are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for a mix of standing and strolling throughout the remainder of the year, with an isolated region suitable for walking during the winter. The noted conditions are considered acceptable.

Wind conditions along Highway 417 with the existing massing are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for mostly standing throughout the remainder of the year. While the introduction of the proposed development produces windier conditions over Highway 417 in comparison to existing conditions, conditions with the proposed development are nevertheless considered acceptable.

Sidewalks along Coventry Road: Prior to the introduction of the proposed development, wind comfort conditions over the public sidewalks along Coventry Road are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year. The noted conditions are predicted to remain practically unchanged following the introduction of the proposed development and are considered acceptable for public sidewalks.

Neighbouring Existing Drive Aisles and Surface Parking Lots: Prior to the introduction of the proposed development, wind conditions over the nearby neighbouring existing surface parking lot and drive aisles to the northeast of the subject site serving the St. Laurent Shopping Centre are predicted to be suitable for mostly sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year. The noted conditions remain practically unchanged following the introduction of the proposed development, and the wind conditions with the proposed development are considered acceptable.

Following the introduction of the proposed development, wind conditions over the nearby neighbouring existing surface parking lot and drive aisles to the north and west of the subject site are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for standing, or better, throughout the remainder of the year, with isolated regions suitable for strolling during the winter and spring. Conditions over the nearby neighbouring existing drive aisle and surface parking to the east of the subject site serving the neighbouring mid-rise medical and office building are predicted to be suitable for standing, or better, during the summer, becoming suitable for strolling, or better, throughout the remainder of the year, with a small, isolated region suitable for walking during the winter. The noted conditions are considered acceptable.

Conditions over the existing surface parking lot and drive aisles to the north and west with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year. Conditions over the existing drive aisle and surface parking to the east with the existing massing are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for standing, or better, throughout the remainder of the year, with isolated regions suitable for strolling during the winter and spring. Notably, the introduction of the proposed development produces similar wind conditions over the noted areas, with windier conditions over the neighbouring laneway to the east with the proposed development. The wind conditions with the proposed development over the noted areas are nevertheless considered acceptable.

Park and Outdoor Amenity: Wind conditions within the park situated to the northeast of the subject site are predicted to be suitable for mostly sitting during the typical use period, with conditions suitable for standing to the south. The area that is predicted to be suitable for standing is also predicted to be suitable for sitting for at least 79% of the time during the same period, where the target is 80% to achieve the sitting comfort class. As conditions are predicted to be suitable for sitting over most of the park, and the sitting percentage exceedance is considered marginal, the noted conditions are considered acceptable.

During the typical use period, wind conditions within the outdoor amenity situated to the northwest of the proposed development are predicted to be suitable for mostly standing, with conditions suitable for sitting at the southeast corner.

The extent of mitigation measures is dependent on the programming of the noted space. Landscaping elements, including high-back bench seating flanked by dense plantings on raised planters, as detailed on the grade-level landscape plan[2], are expected to effective in improving wind comfort conditions at the programmed seating areas within the outdoor amenity.

[2] Fotenn Planning + Design, '*500 Coventry Road, Landscape Plan, Drawing L1*', [Dec 22, 2023]

Drive Aisles and Walkways Within Subject Site: Wind conditions over the drive aisles serving the subject site 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. Conditions over the walkways within the subject site are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, throughout the remainder of the year, with an isolated region suitable for walking at the southwest corner of the proposed development. 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 sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year. The noted conditions are considered acceptable.

5.2 Wind Comfort Conditions – Level 7 Common Amenity Terrace

Level 7 Amenity Terrace: During the typical use period, conditions over the common amenity terrace serving the proposed development at Level 7 are predicted to be suitable for mostly standing, with conditions suitable for sitting to the south, as illustrated in Figure 9.

The windy conditions within the amenity terrace are primarily attributable to the exposure of the terrace to prevailing winds from several directions, and the currently mostly low-rise suburban massing surrounding the development. Notably, the current proposed development comprises the first phase of a multi-block development. The future redevelopment of the area, including future development of the multi-block masterplan to the west, north, and northeast, and a future development site comprising seven high-rise buildings under review to the west at 400 Coventry Road are expected to provide modest shielding effects from prevailing winds, reducing the exposure of the terrace to prominent winds.

A successful wind mitigation strategy responds to the programming of the terrace. To improve comfort levels within the Level 7 amenity terrace serving the proposed development, a wind mitigation strategy developed in concert with the terrace programming and landscape design is recommended, elements of which may include mitigation inboard of the terrace perimeters that is targeted around sensitive areas, in combination with 2-m-tall wind screens (as measured from the local walking surface), typically glazed, along select perimeters of the terrace. Inboard mitigation could take the form of wind screens or other common landscape elements.

An appropriate mitigation strategy will be developed in collaboration with the design team, including the building and landscape architects, as the design of the proposed development and the programming of the terrace progresses.

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 sidewalks, existing surface parking lots and drive aisles, the proposed drive aisles, walkways, and park, and in the vicinity of building access points, are considered acceptable. An area of interest that is predicted to experience windier conditions is described as follows:

a. **Grade-Level Outdoor Amenity**. During the typical use period, conditions within the outdoor amenity situated to the northwest of the proposed development are predicted to be suitable for mostly standing, with conditions suitable for sitting at the southeast corner.

b. Landscaping elements, including high-back bench seating flanked by dense raised plantings, as detailed on the grade-level landscape plan, are expected to effective in improving wind comfort conditions at the programmed seating areas within the outdoor amenity.

2) Regarding the common amenity terrace serving the proposed development at Level 7, wind comfort conditions during the typical use period (that is, May to October, inclusive) are predicted to be suitable for mostly standing, with conditions suitable for sitting to the south.

a. The windy conditions within the amenity terrace are primarily attributable to the exposure of the terrace to prevailing winds from several directions, and the currently mostly low-rise suburban massing surrounding the development.

b. Notably, the current proposed development comprises the first phase of a multi-block development. The future redevelopment of the area, including future development of the multi-block masterplan to the west, north, and northeast, and a future development site comprising seven high-rise buildings under review to the west at 400 Coventry Road are expected to provide modest shielding effects from prevailing winds, reducing the exposure of the terrace to prominent winds.

c. Since a successful wind mitigation strategy responds to the programming of the terrace, to improve comfort levels within the Level 7 amenity terrace serving the proposed development, a coordinated wind mitigation strategy and terrace programming and landscaping design is required. Elements of the wind mitigation strategy may include 2-m-tall wind screens (as measured from the local walking surface), typically glazed, along select terrace perimeters, in combination with mitigation inboard of the terrace perimeters, which may take the form of wind screens or other common landscape elements.

d. An appropriate mitigation strategy will be developed in collaboration with the design team, including the building and landscape architects, as the design of the proposed development and the programming of the terrace progresses.

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.

Sincerely,

Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. D. FERRARO
100158495
Jan 23, 2024
PROVINCE OF ONTARIO

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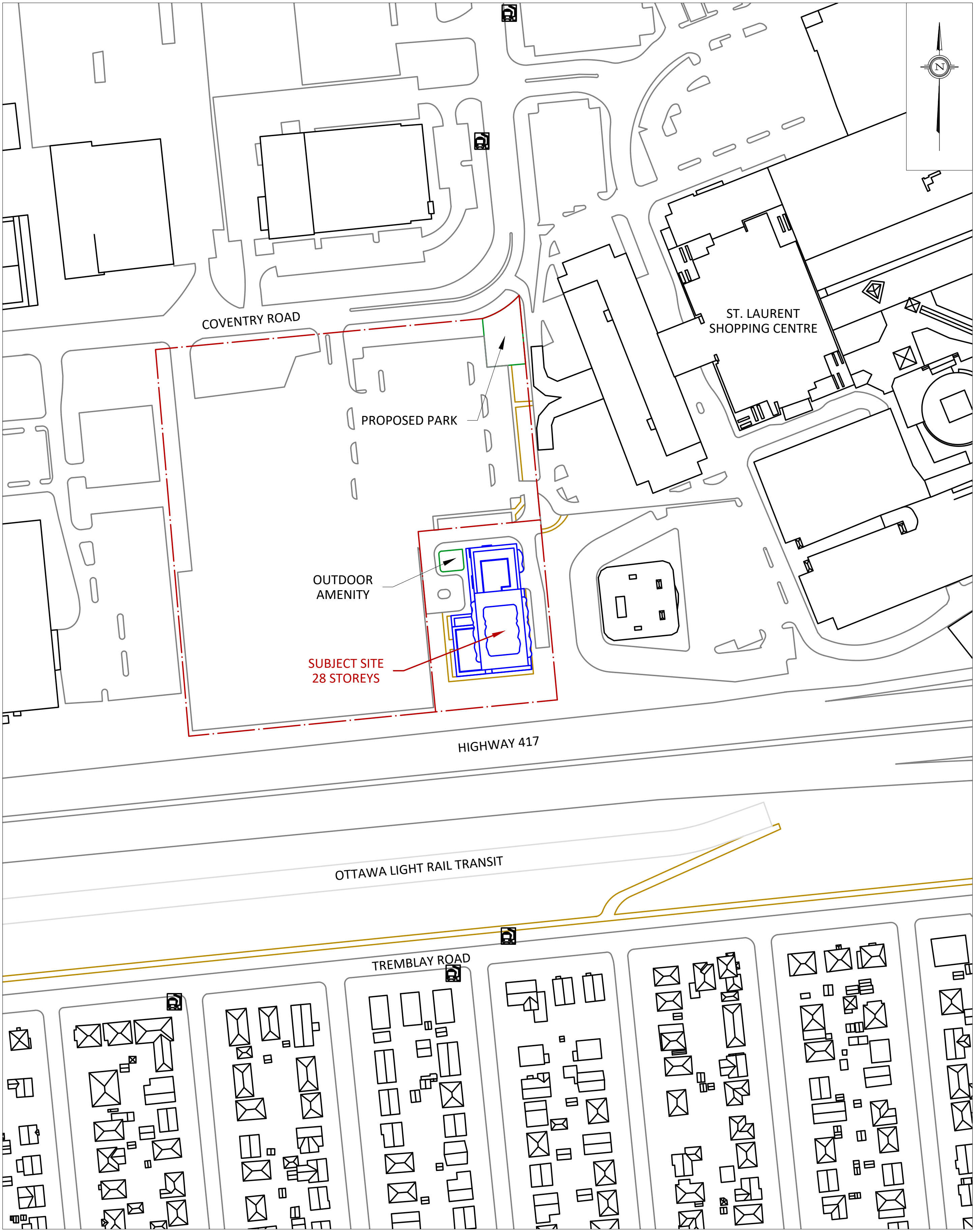

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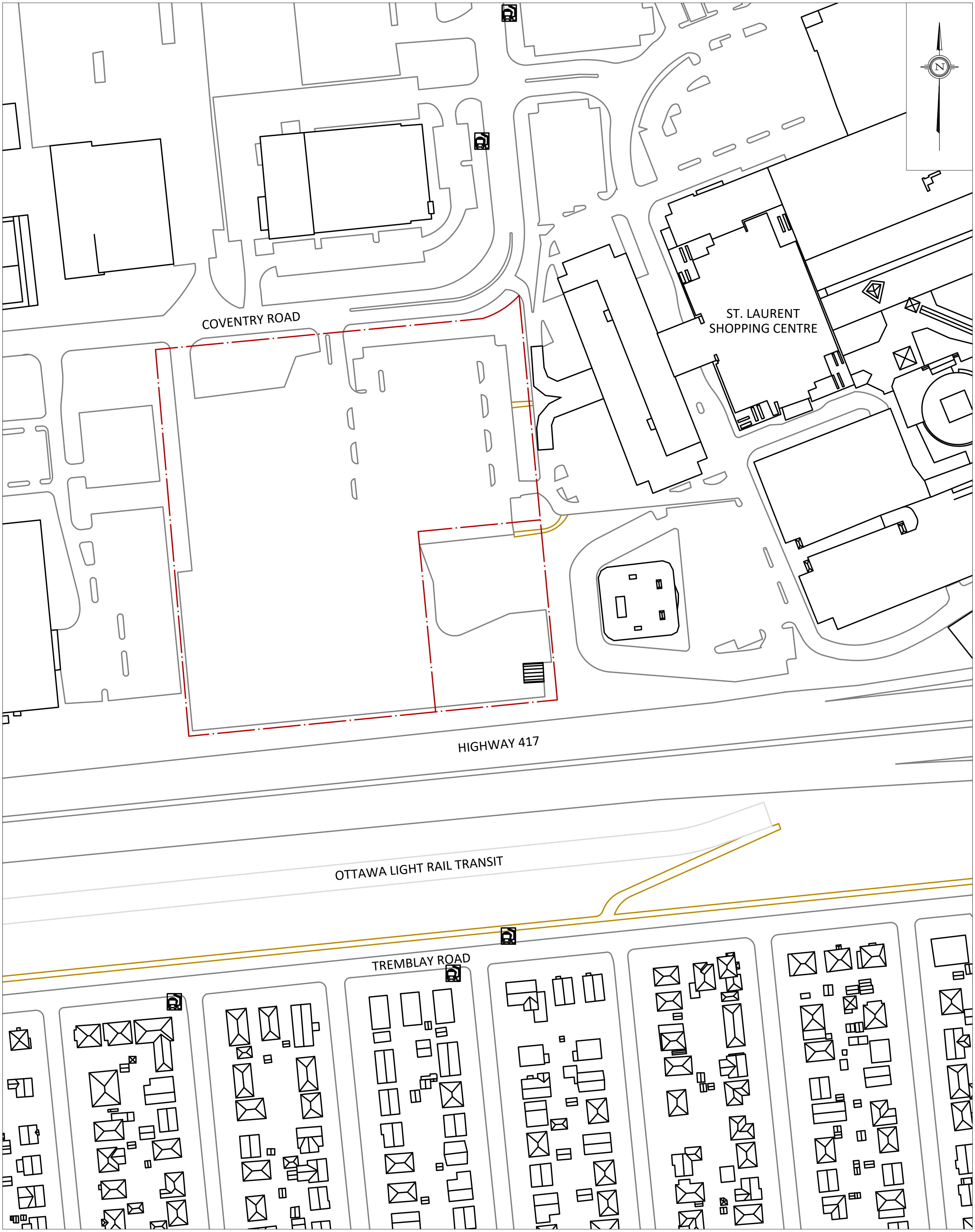
613 836 0934 • GRADIENTWIND.COM

PROJECT	500 COVENTRY ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2500	DRAWING NO.	23-215-PLW-1A
DATE	JANUARY 23, 2024	DRAWN BY	N.M.P.

DESCRIPTION

FIGURE 1A:
PROPOSED SITE PLAN AND SURROUNDING CONTEXT



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PROJECT	500 COVENTRY ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2500	DRAWING NO.	23-215-PLW-1B
DATE	JANUARY 23, 2024	DRAWN BY	N.M.P.

DESCRIPTION

FIGURE 1B:
EXISTING SITE PLAN AND SURROUNDING CONTEXT

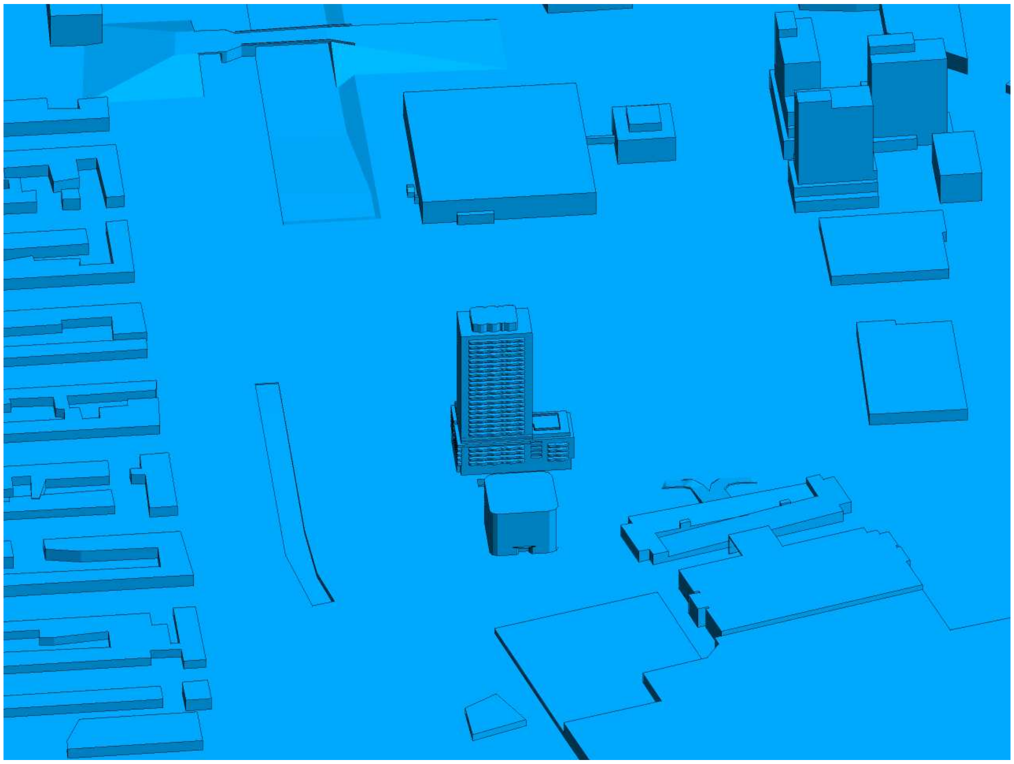


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, EAST PERSPECTIVE

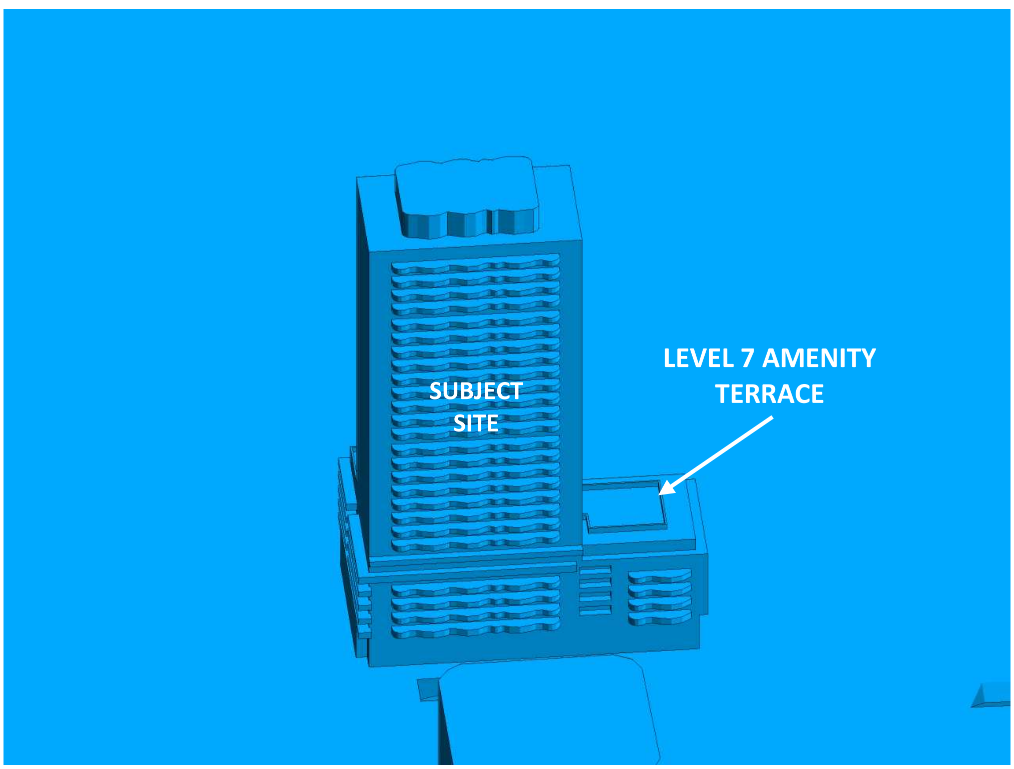


FIGURE 2B: CLOSE UP OF FIGURE 2A

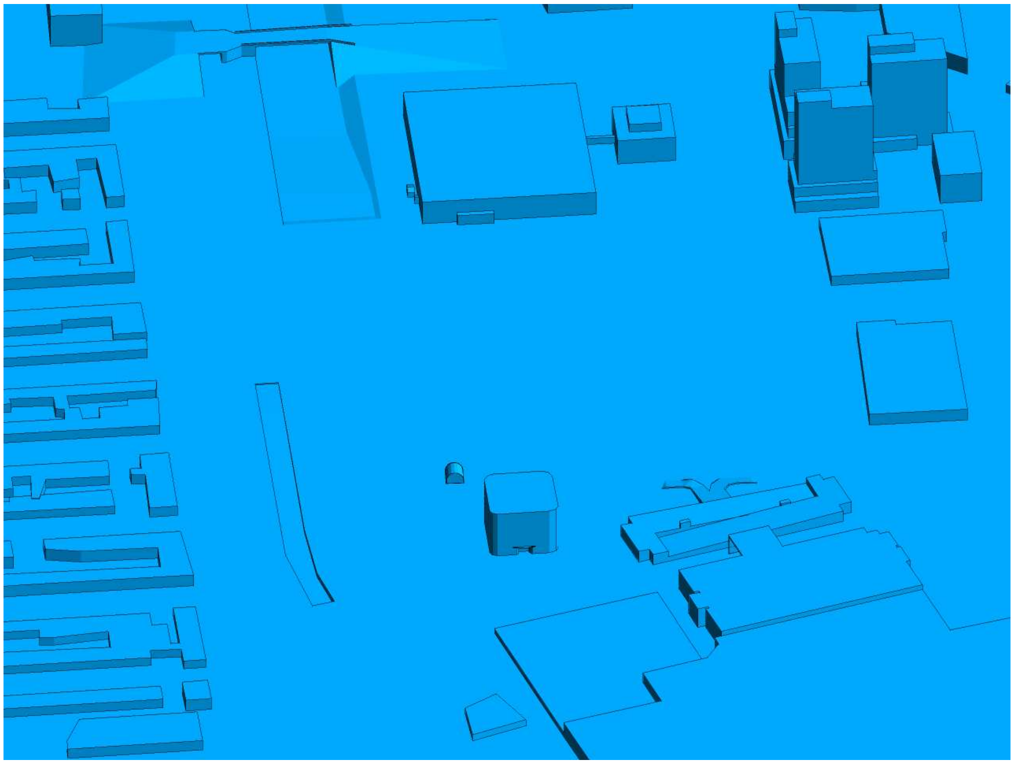


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, EAST PERSPECTIVE

FIGURE 2D: CLOSE UP OF FIGURE 2C

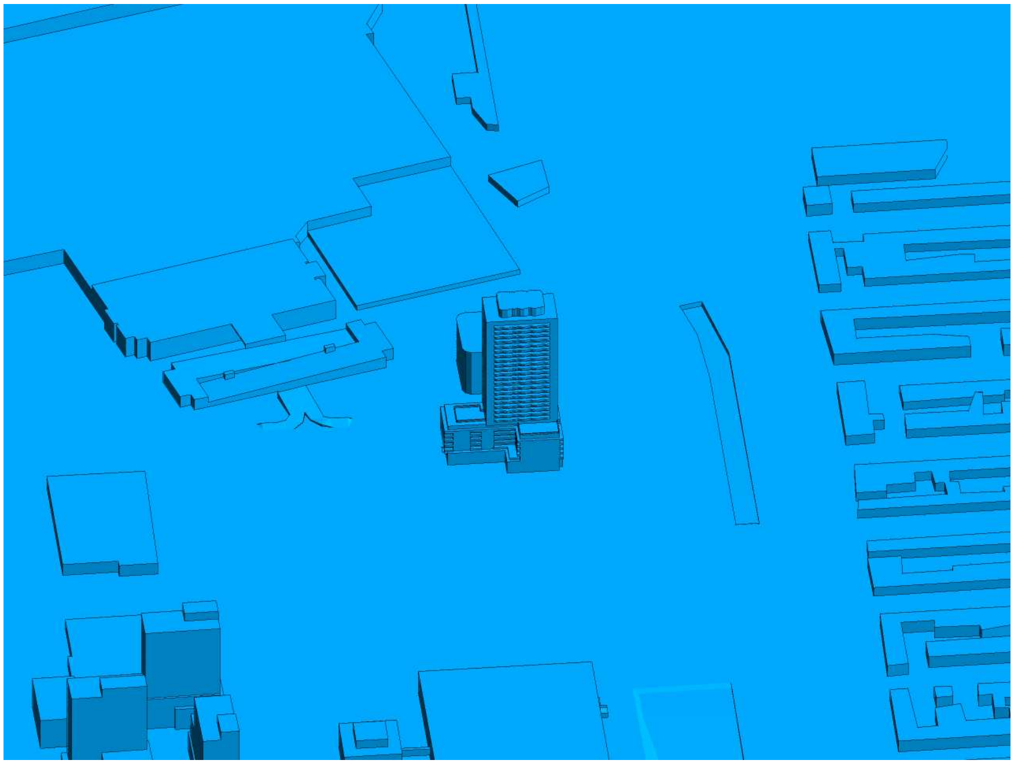


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, WEST PERSPECTIVE

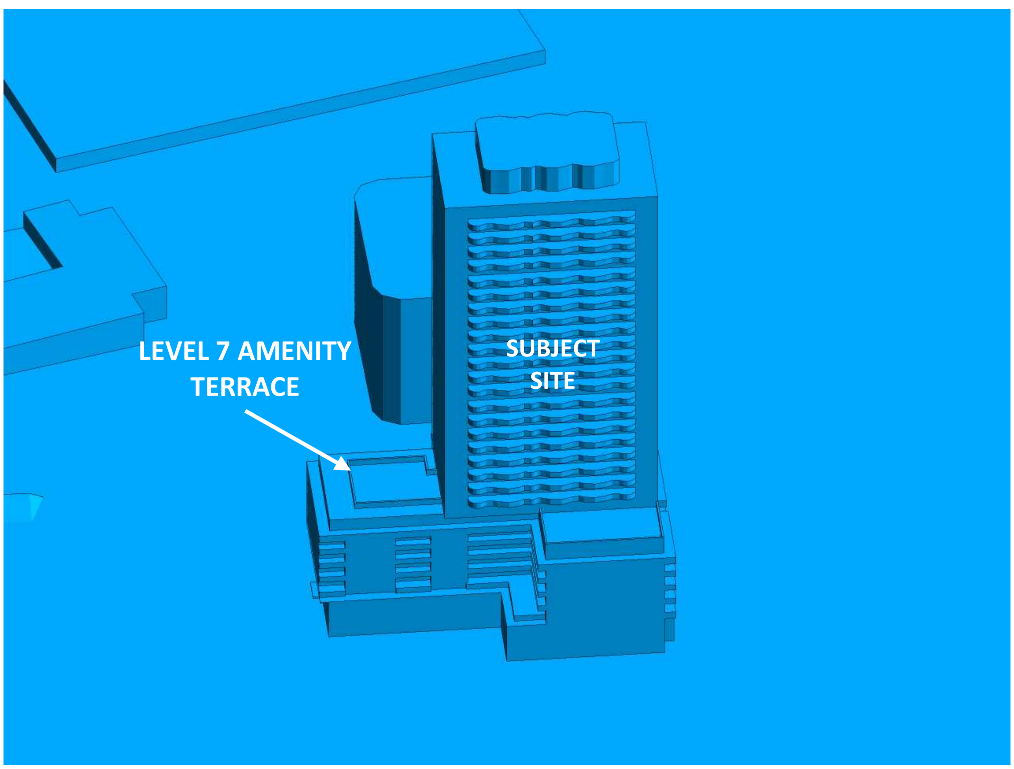


FIGURE 2F: CLOSE UP OF FIGURE 2E

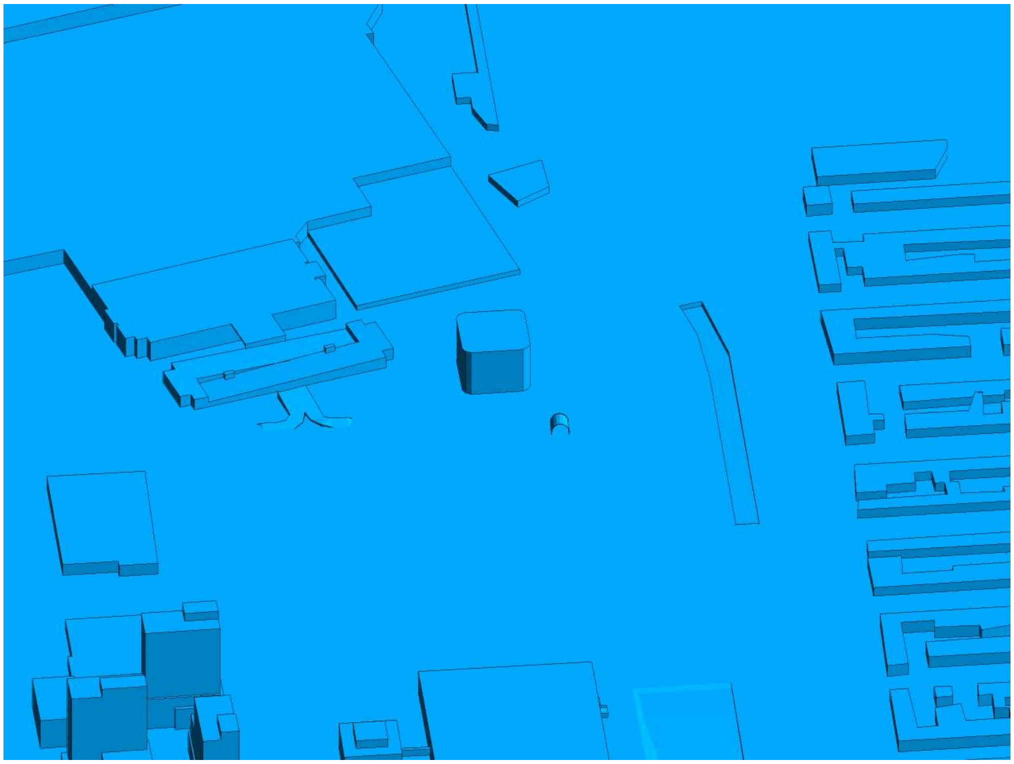


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, WEST PERSPECTIVE

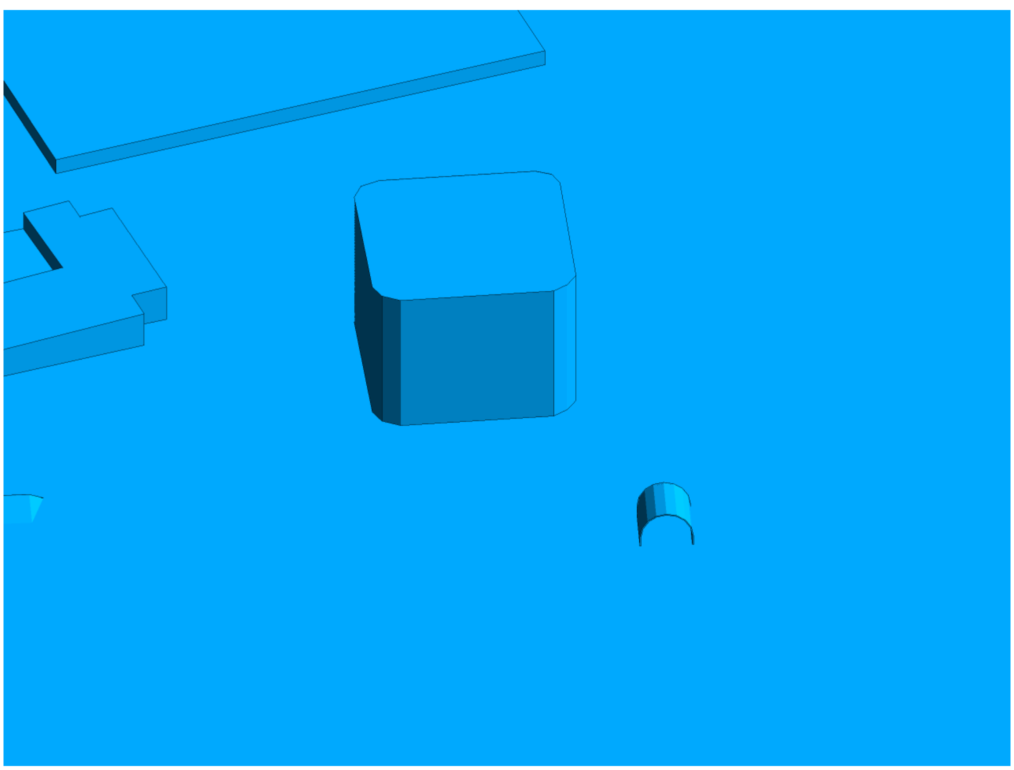


FIGURE 2H: CLOSE UP OF FIGURE 2G

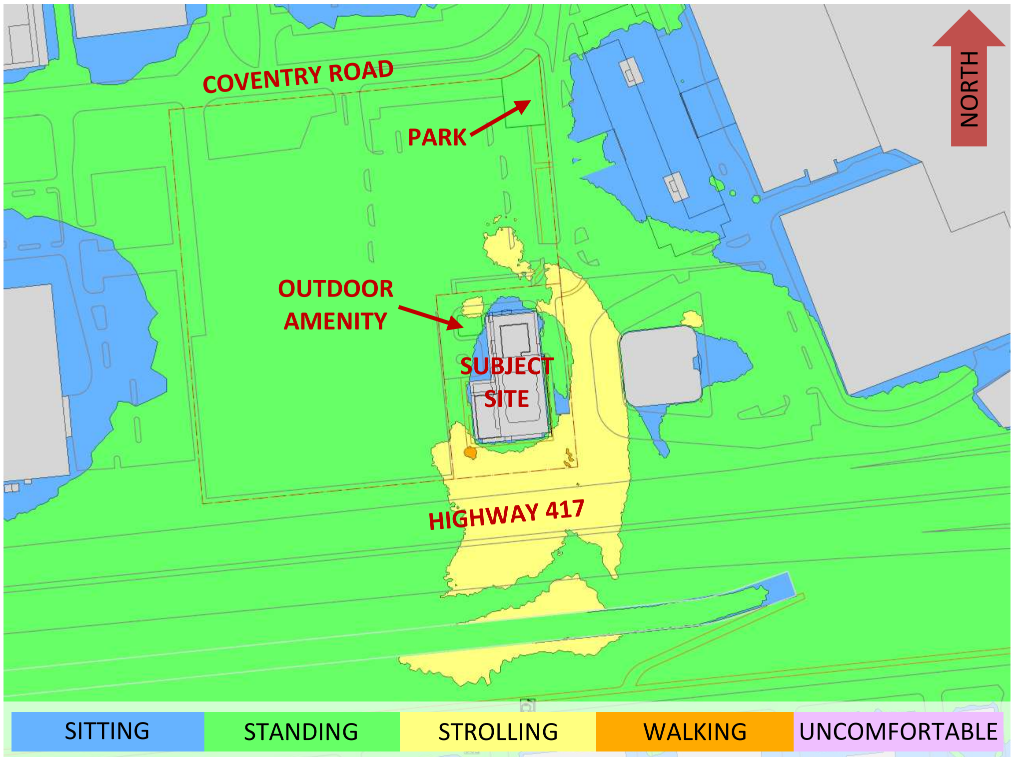


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

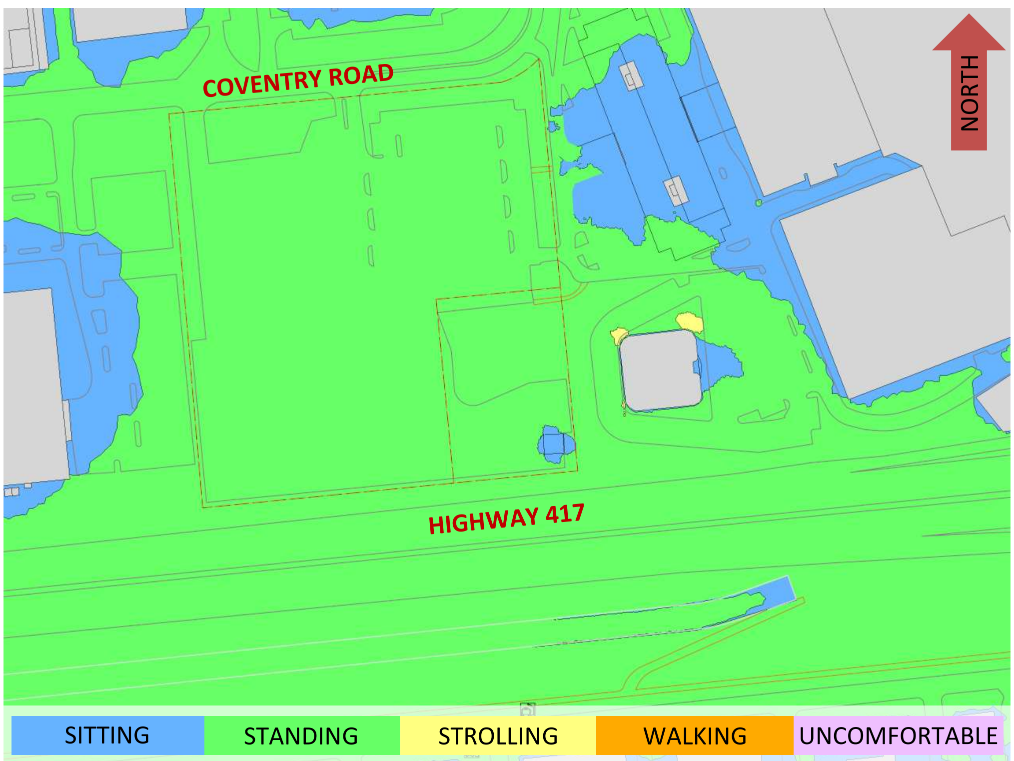


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

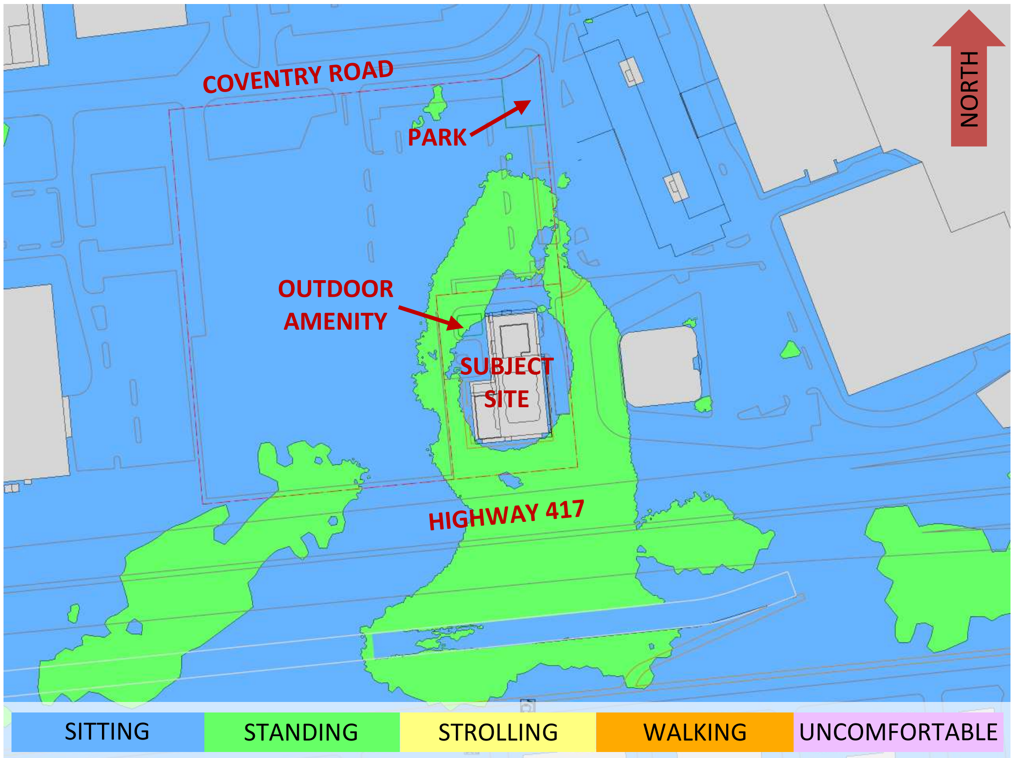


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

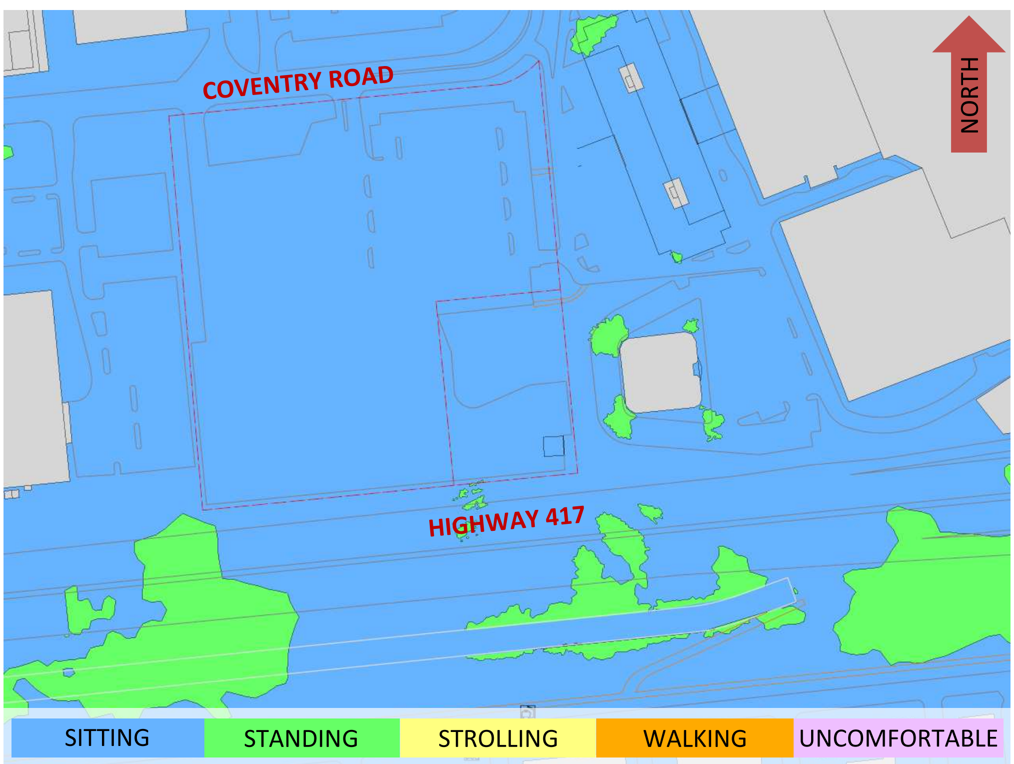


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

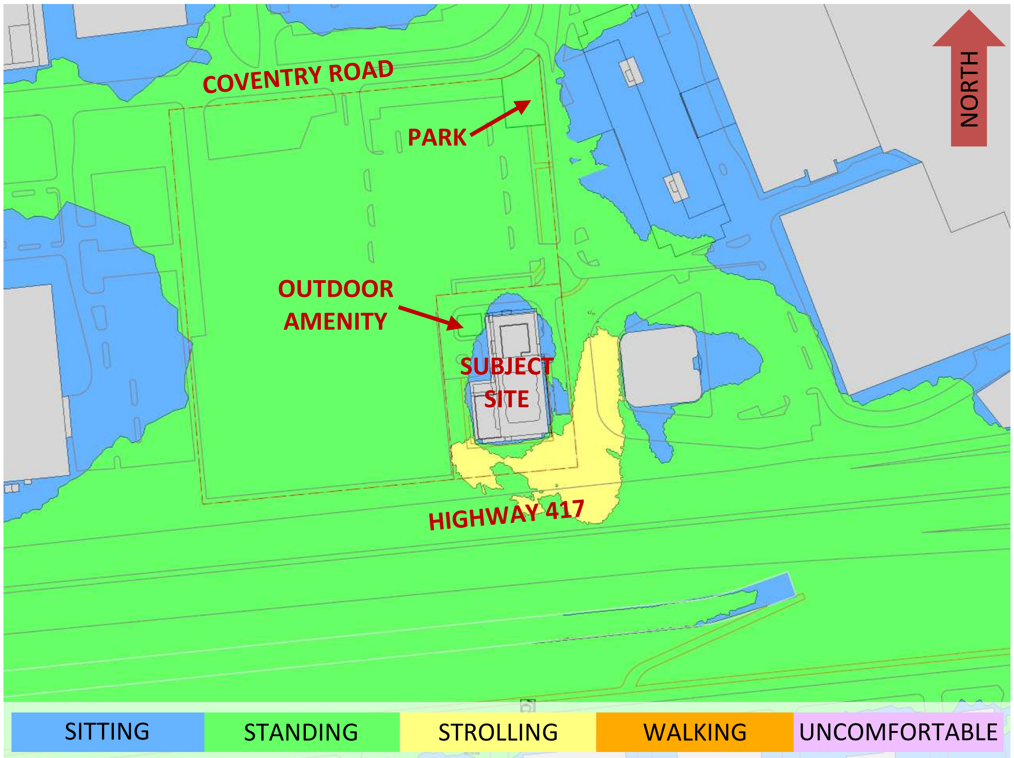


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

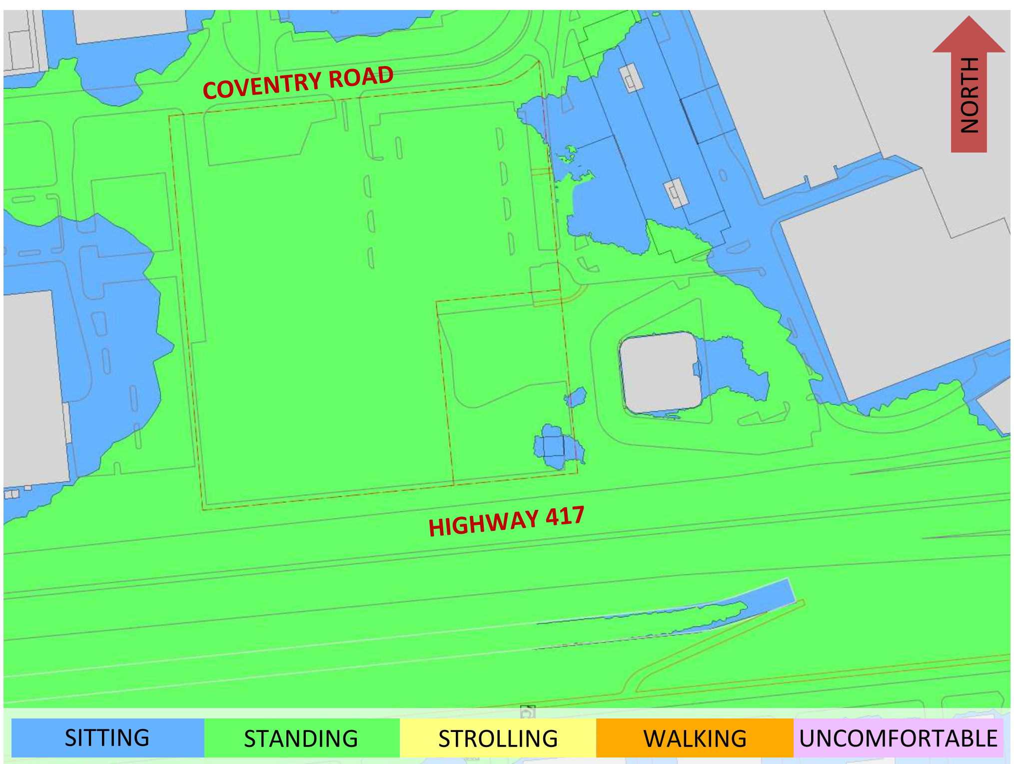


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

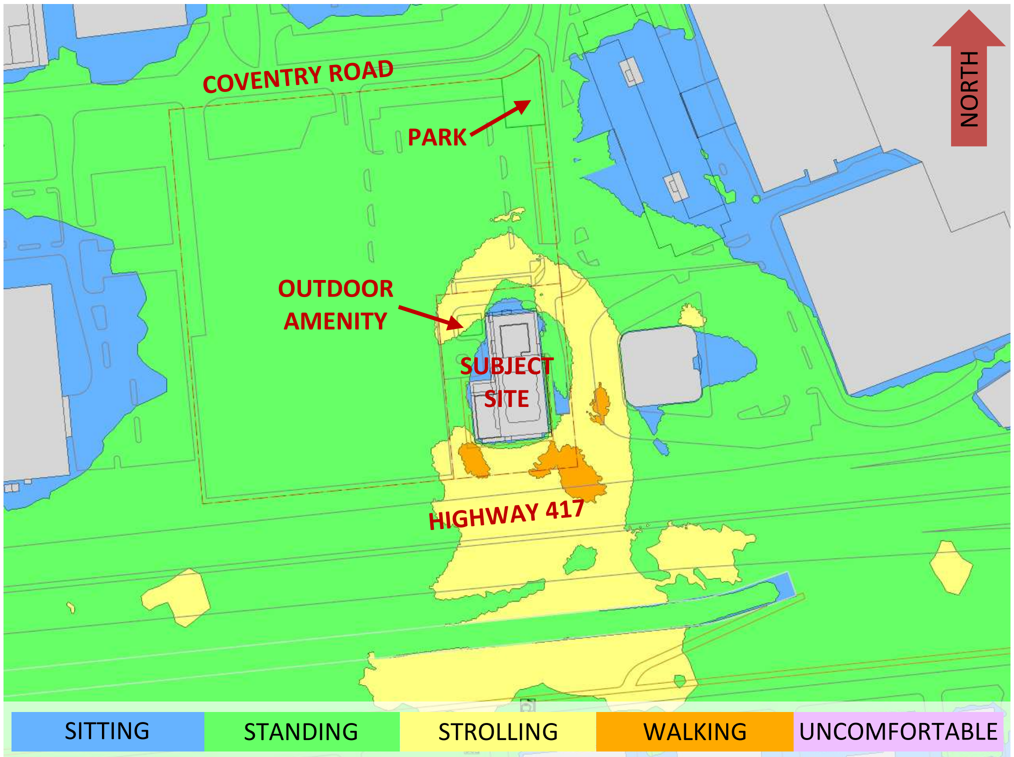


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

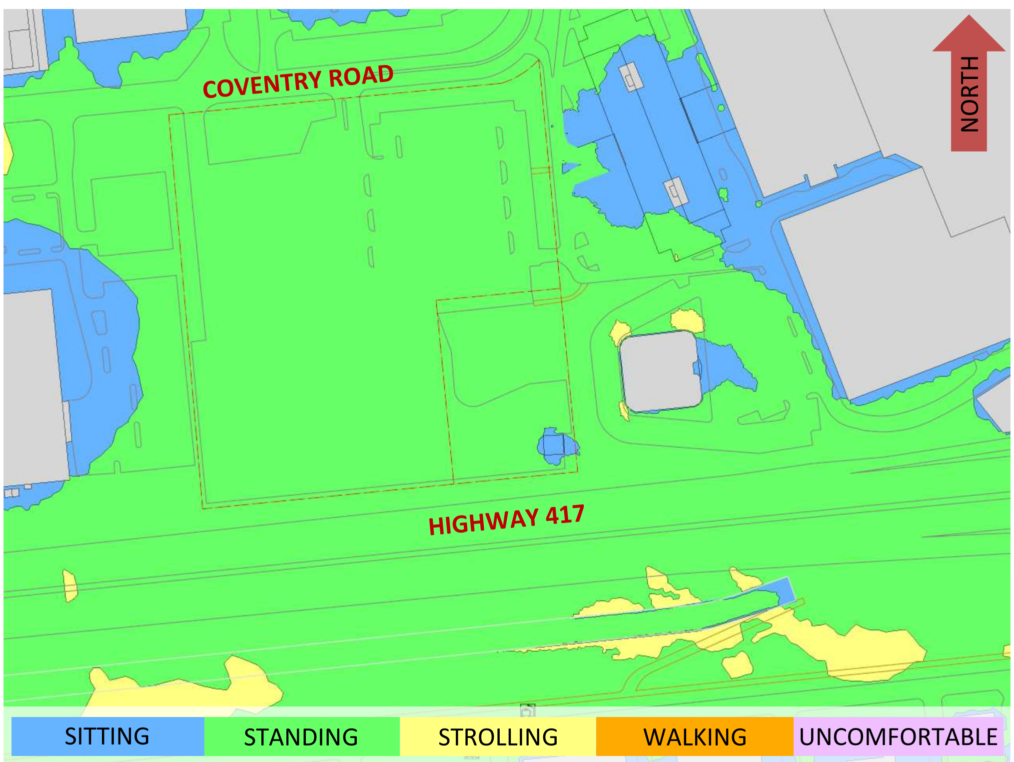


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

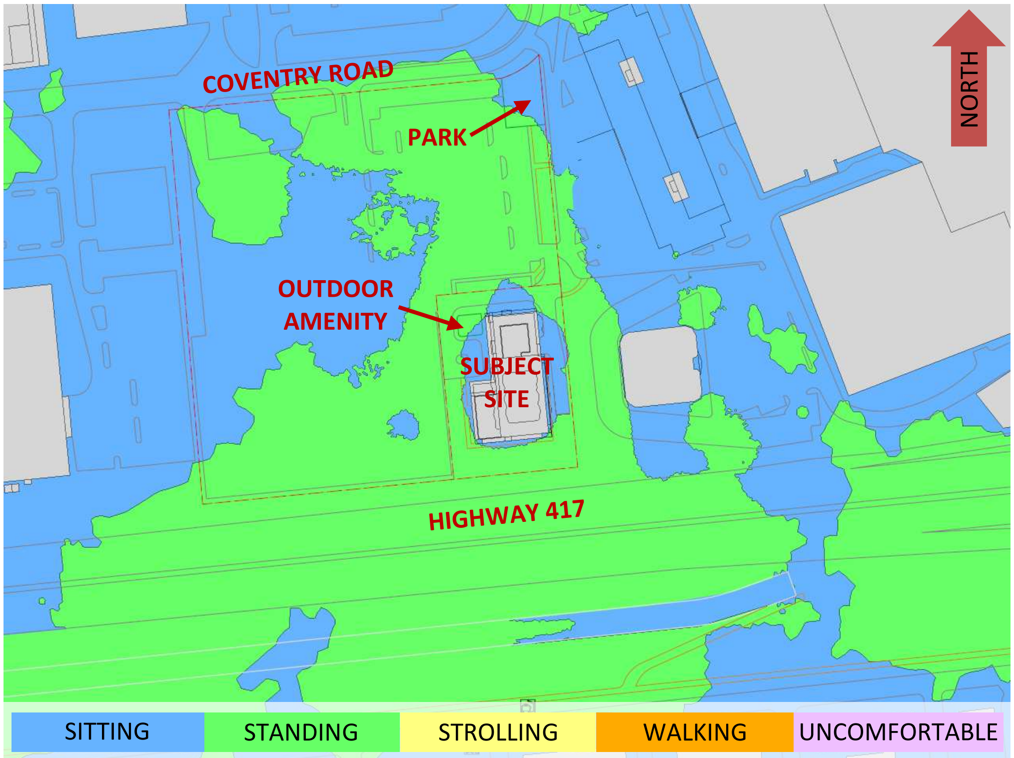


FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

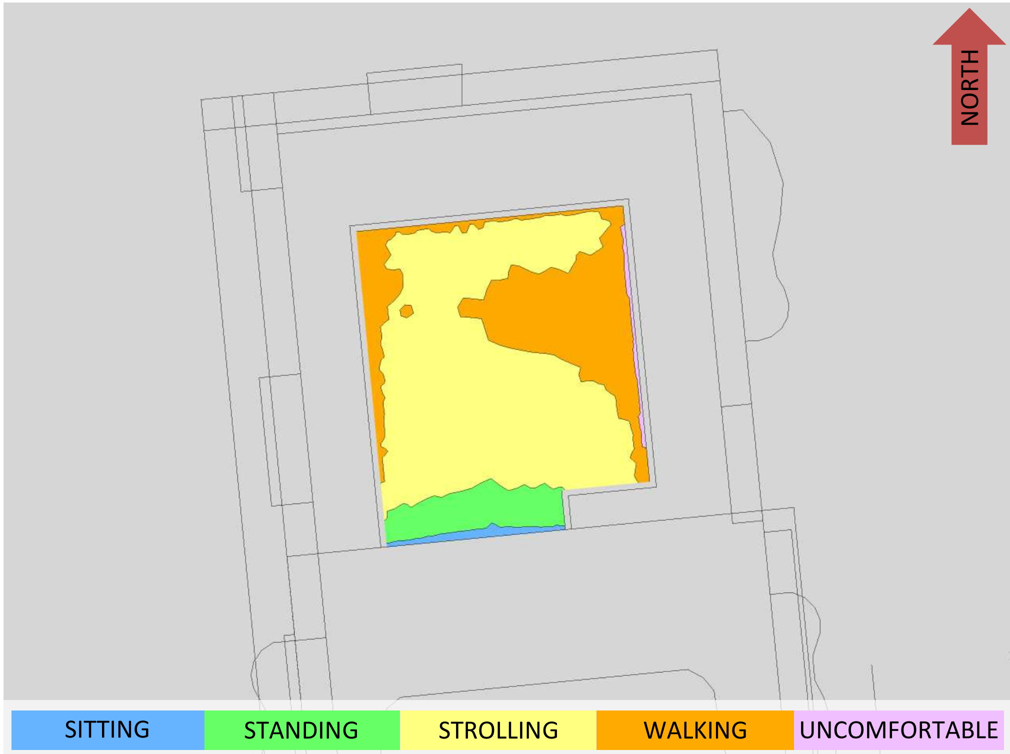


FIGURE 8A: SPRING – WIND COMFORT, LEVEL 7 AMENITY TERRACE

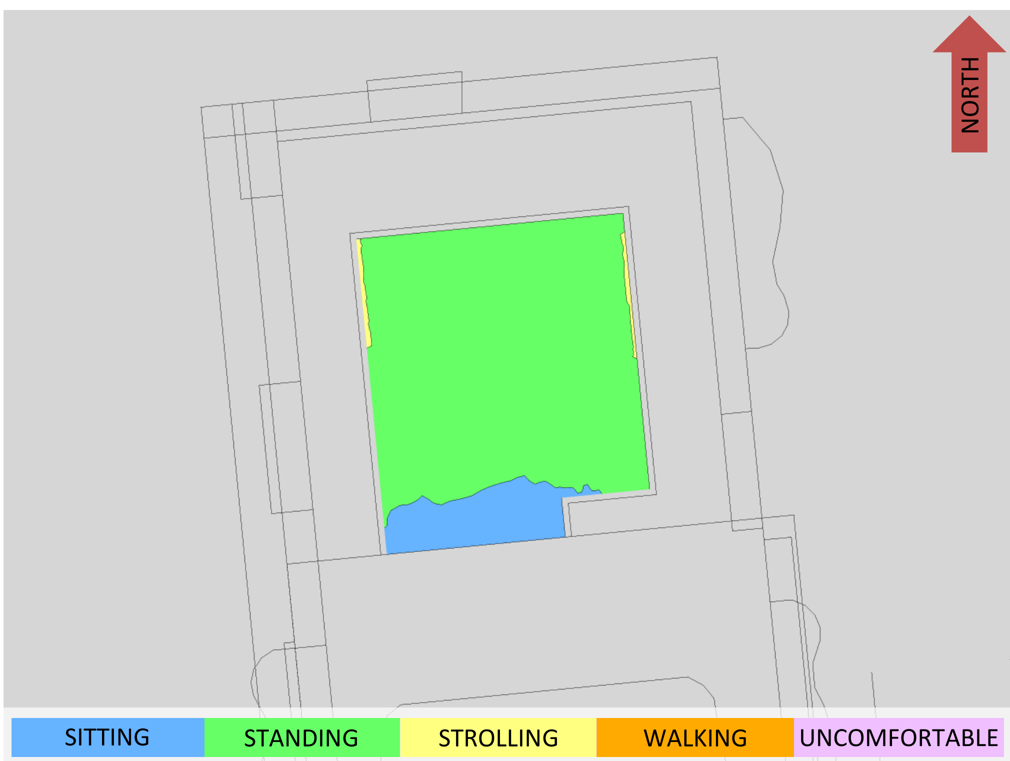


FIGURE 8B: SUMMER – WIND COMFORT, LEVEL 7 AMENITY TERRACE

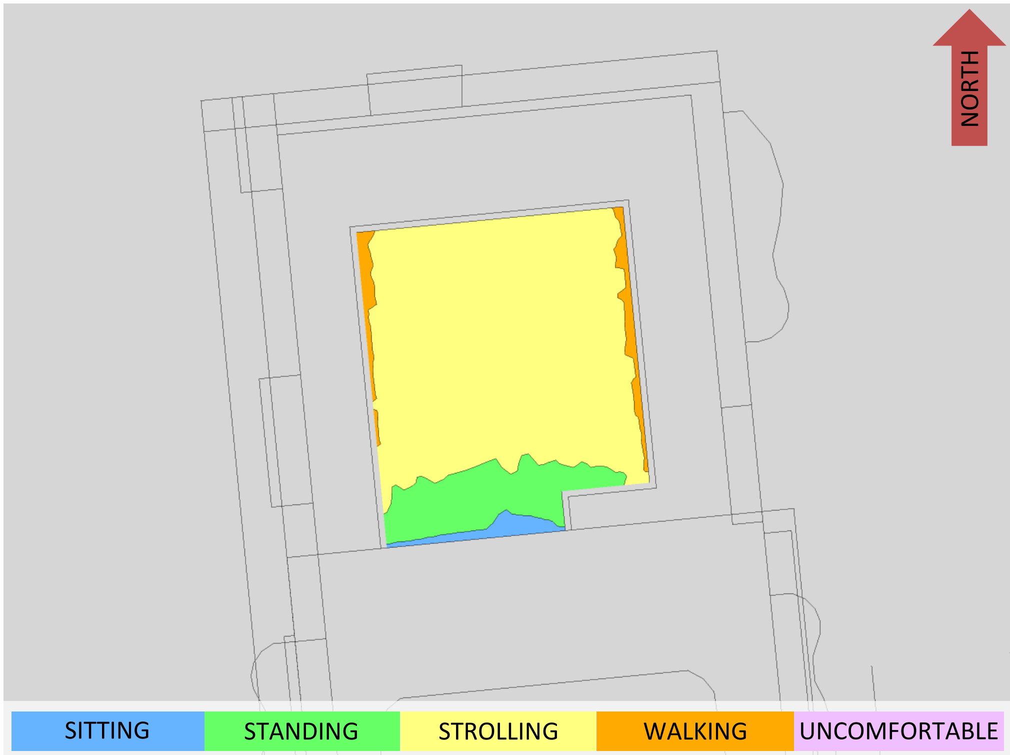
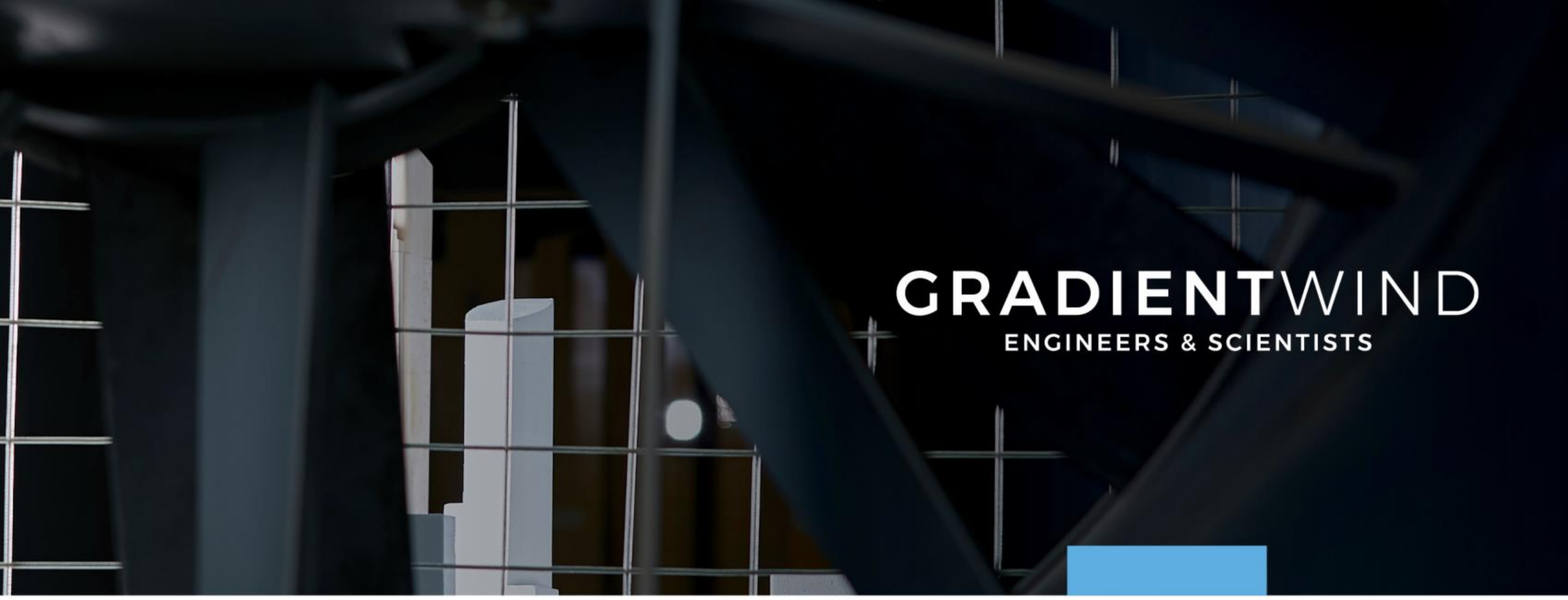


FIGURE 8C: AUTUMN – WIND COMFORT, LEVEL 7 AMENITY TERRACE

FIGURE 8D: WINTER – WIND COMFORT, LEVEL 7 AMENITY TERRACE

FIGURE 9: TYPICAL USE PERIOD – WIND COMFORT, LEVEL 7 AMENITY TERRACE



APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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

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

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

For the model, U_g is set to 6.5 metres per second, 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	0.25
49	0.24
74	0.24
103	0.23
167	0.24
197	0.24
217	0.23
237	0.23
262	0.24
282	0.24
301	0.25
324	0.25

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).

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

Equation (2)

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

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.

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.