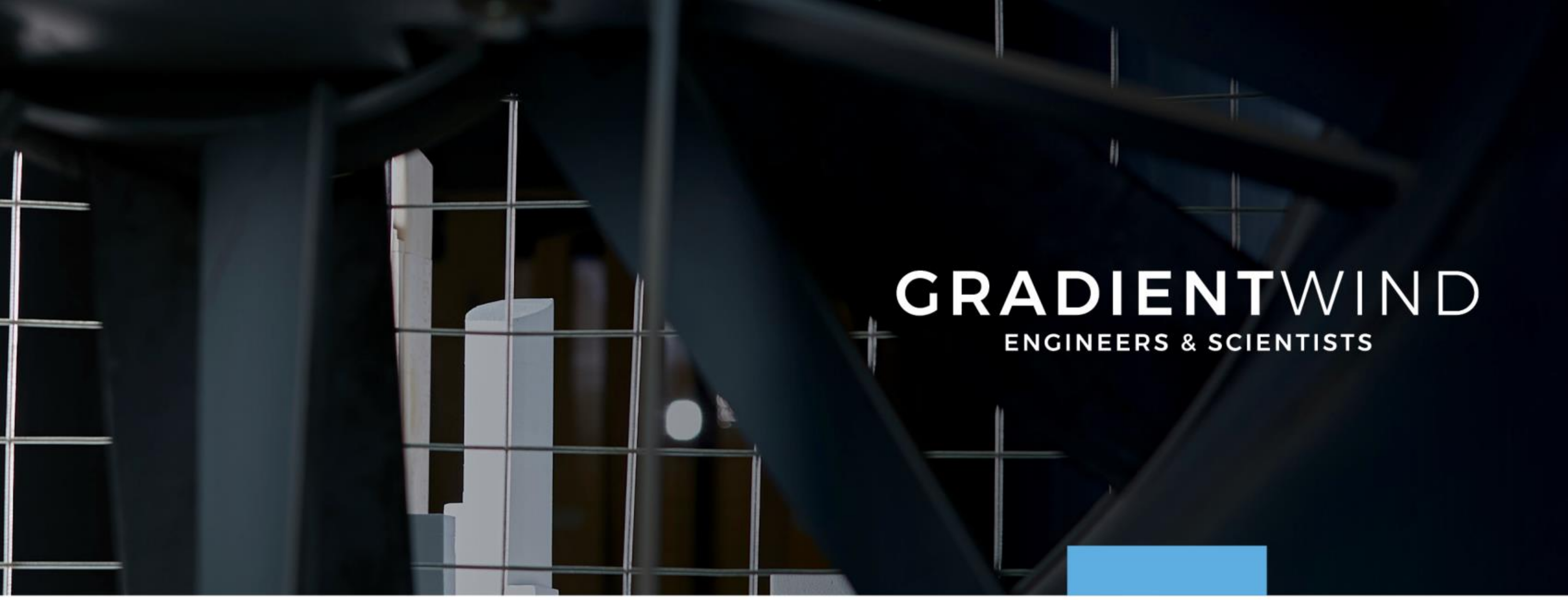
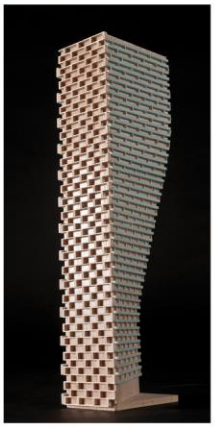
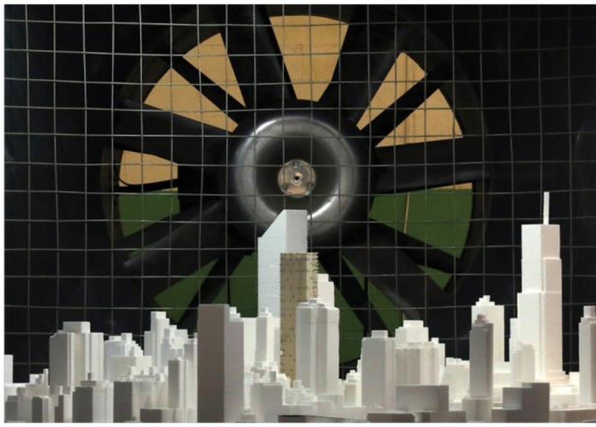


PEDESTRIAN LEVEL WIND STUDY

400 Coventry Road
Ottawa, Ontario

Report: 22-272-PLW





October 20, 2022

PREPARED FOR
400 Coventry Investments Inc.
110-85 Rue Bellehumeur
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PREPARED BY
Daniel Davalos, MASc., Junior Wind Scientist
Steven Hall, M.A.Sc., P.Eng., Senior Wind Engineer

EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Zoning By-law Amendment application requirements for the proposed multi-building residential development located at 400 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-7, 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, laneways, walkways, transit stops, the parkland, existing parking lots, surface parking, and in the vicinity of building access points, are considered acceptable. An exception is as follows:

    a. Owing to channeling of winds between Towers C and D and between Towers D and E1, conditions in the vicinity of the primary entrances serving Tower D are predicted to experience somewhat windy conditions. As such, it is recommended these entrances be recessed within the façade or flanked by tall wind screens.

2) 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.

Addendum: The detailed PLW study was performed based on architectural drawings received in August 2022. An updated set of drawings from NEUF Architect(e)s was received in October 2022. The notable changes include that Towers A and B are no longer connected by a shared podium, and that the Towers B and C1 are now connected by a shared 6-storey podium. As such, the wind patterns around Towers A, B, and C1 are expected to be somewhat different. Notably, prominent northwesterly winds will not have a direct grade-level north-south flow path between Towers A and B and Towers C1 and C2, which may improve wind conditions in the area. However, southwesterly winds will be able to pass between Towers A and B, which may lead to increased wind speeds around Tower A. The remainder of the changes to the updated drawings are mostly considered minor for the purposes of this study. Outside of the above comments, the noted changes are not expected to change the main conclusions of the study.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by 400 Coventry Investments Inc. to undertake a pedestrian level wind (PLW) study to satisfy Zoning By-law Amendment application requirements for the proposed multi-building residential development located at 400 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.

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 NEUF architect(e)s, in August 2022, 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 400 Coventry Road in Ottawa; situated at the southwest intersection of Coventry Road and Belfast Road and bordered by Highway 417 to the south and existing low-rise commercial buildings and parking lots to the west. A central east-west laneway is proposed to extend from Belfast Road to the existing parking lots.

Architectural Rendering, Northwest Perspective (Courtesy of NEUF architect(e)s)

The proposed development comprises seven nominally rectangular towers; beginning from the west and rotating counter-clockwise around the site, the towers are referred to as Tower A, B, C1, C2, D, E1, and E2. Tower A, B, C1 and C2 are situated to the south of the central laneway and share two below-grade parking levels. Tower D, E1, and E2 are situated to the north of the central laneway and share two below-grade parking levels. A parkland is situated to the west of the subject site, bordered by Tower E2 to the north, Tower D to the east, the central laneway to the south, and the existing parking lot to the west.

Tower A (23 storeys) and Tower B (30 storeys) share a common six-storey podium. Above below-grade parking, the ground floor of the shared podium includes a main entrance and drop off zone to the east, elevator core to the south, residential units from the southeast corner clockwise to the west, elevator core to the north, and lobby/indoor amenity from the northwest corner clockwise to the east. Surface parking is provided along the south side of the central laneway and along the laneway situated in between Tower A and Tower C2. Access to below-grade parking (shared by Tower A, B, C1 and C2) is provided by a ramp at the northwest corner of the shared podium via the central laneway from Belfast Road. Levels 2-23 of Tower A and Levels 2-30 of Tower B are reserved for residential use.

Tower C1 (27 storeys) and Tower C2 (27 storeys) share a common six-storey podium. Above below-grade parking, the ground floor of the shared podium includes a main entrance and drop off zone to the west, lobby/indoor amenity from the west clockwise to the northeast, elevator core to the north, residential units from the northeast corner clockwise to the southwest corner, and elevator core to the south. Levels 2-27 of Tower C1 and Tower C2 are reserved for residential use. A floorplate setback is situated to the west at Level 4.

Tower D (25 storeys) rises above a six-storey podium. Above below-grade parking, Tower D comprises a near rectangular planform with insets at the northwest and northeast corners, and includes a main entrance to the north, residential units from the northeast clockwise to the southeast, a main entrance and lobby/indoor amenity to the south, residential units from the southwest clockwise to the northwest, and a central elevator core. Levels 2-25 are reserved for residential use. A floorplate setback is situated to the north at Level 4 and in all compass directions at Level 7.

Tower E1 (20 storeys) and Tower E2 (18 storeys) share a common six-storey podium. Above below-grade parking, the ground floor of the shared podium includes retail space to the north, main entrance, lobby/indoor amenity, and elevator core to the east, townhouse units to the south, and lobby/indoor amenity and elevator core to the west with main entrances at the southwest and northwest corners. Levels 2-20 of Tower E1 and Levels 2-18 of Tower E1 are reserved for residential use. Floorplate setbacks are situated to the north at Level 2 and to the south at Level 3.

The shortest distance between the podium serving Towers A and B and the podium serving Towers C1 and C2 is approximately 18.4 metres (m). The shortest distance between the podium serving Tower C1 and Tower C2 and the podium serving Tower D is approximately 19.3 m, while the shortest distance between Tower C2 and Tower D above the podia is approximately 25.1 m. The shortest distance between the podium serving Tower D and the podium serving Tower E1 and Tower E2 is approximately 13.2 m. The shortest distance between Tower A and Tower B, between Tower C1 and Tower C2, between Tower D and Tower E1, and between Tower E1 and Tower E2 above the podia is approximately 24 m.

The near-field surroundings, defined as an area within 200-m of the subject site, include low-rise commercial buildings from the west clockwise to the east, with parking lots to the west, Presland Park approximately 150 m to the north, and Highway 417 extending from the southeast 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 by a mix of low-rise residential and commercial buildings with isolated mid- and high-rise residential buildings in all compass directions. Notably, St. Laurent Shopping Centre is situated approximately 510 m to the east and the Ottawa River flows from the west-southwest to the northwest, approximately 1.3 km to the west of the subject site.

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 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 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 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 stronger wind speeds.

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

4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 12 wind directions. The CFD simulation model was centered on the study building, complete with surrounding massing within a radius of 610 m. The process was performed for two context massing scenarios, as noted in Section 2.

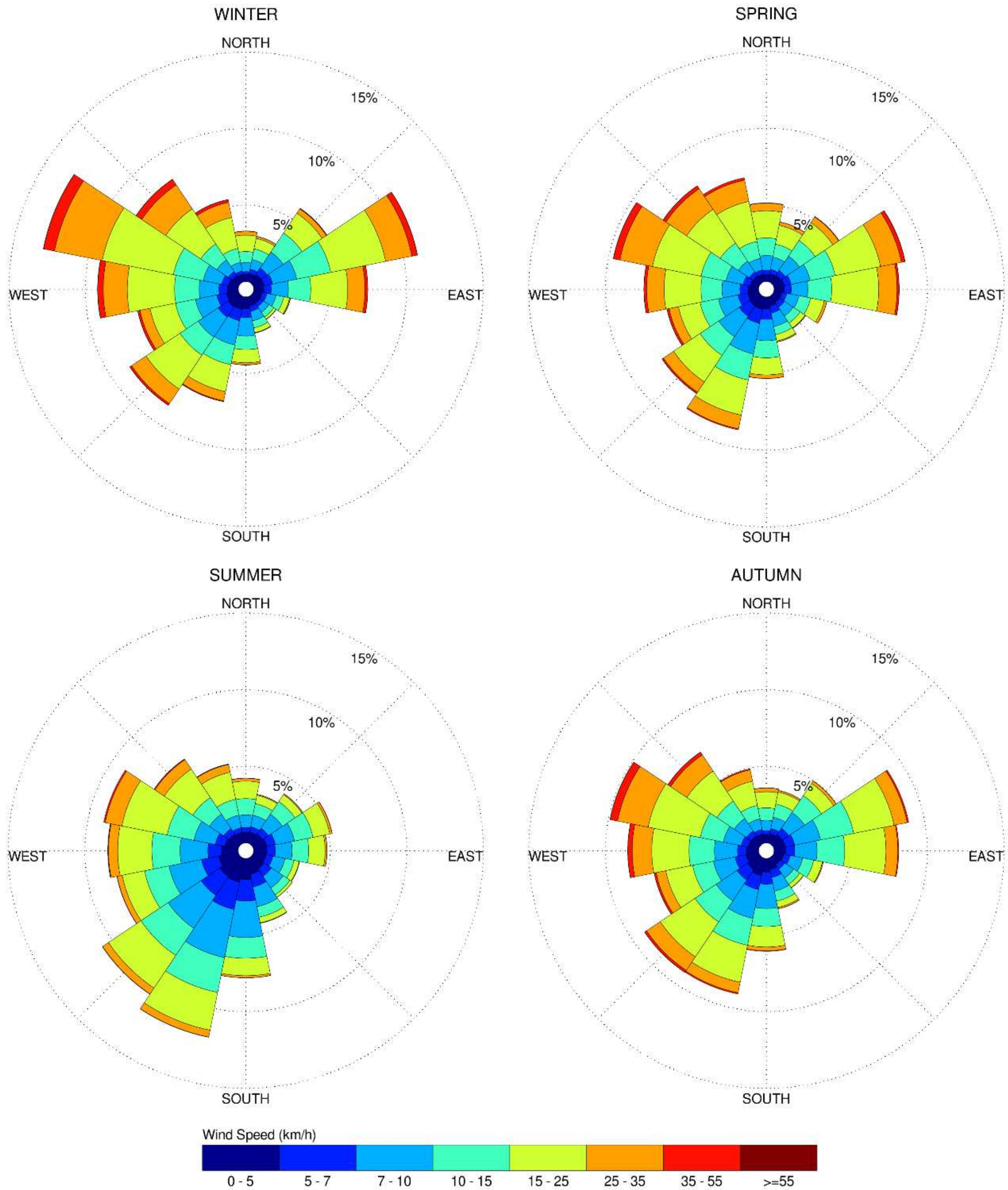
Mean and peak wind speed data obtained over the study site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade were referenced to the wind speed at gradient height to generate 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 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 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 typical windiest desired comfort classes are summarized on the following page. Depending on the programming of a space, the desired comfort class may differ from this table.

DESIRED PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Desired Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Walking
Public Sidewalk / Bicycle Path	Walking
Outdoor Amenity Space	Sitting (Typical Use Period)
Café / Patio / Bench / Garden	Sitting (Typical Use Period)
Transit Stop (Without Shelter)	Standing
Transit Stop (With Shelter)	Walking
Public Park / Plaza	Sitting (Typical Use Period)
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. Conditions are presented as continuous contours of wind comfort throughout the subject site and correspond to the comfort classes presented 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.

Wind comfort conditions within the parkland are also reported for the typical use period, which is defined as May to October, inclusive. Figure 7 illustrates wind comfort conditions 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 – Ground Floor

Sidewalks and Transit Stops Along Coventry Road: Following the introduction of the proposed development, conditions over the sidewalk areas along Coventry Road are predicted to be mostly suitable for sitting with isolated regions of standing primarily over the road during the summer, becoming suitable for a mix of sitting and standing during the autumn, and mostly suitable for standing with isolated regions of strolling primarily over the road during the spring and winter. Conditions over the nearby transit stop north of Coventry Road are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year. Conditions over the nearby transit stop south of Coventry Road are predicted to be suitable for sitting during the summer and autumn, becoming suitable for standing during the spring and winter. The noted conditions are considered acceptable according to the City of Ottawa wind comfort criteria.

Conditions over the sidewalk areas along Coventry Road with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year. Conditions over the nearby transit stops along Coventry Road are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year. While the introduction of the proposed development results in windier conditions over the sidewalk areas along Coventry Road and the nearby transit stop to the north of Coventry Road, conditions are predicted to improve over the nearby transit stop to the south of Coventry Road, in comparison to existing conditions. The noted conditions are considered acceptable according to the City of Ottawa wind comfort criteria.

Sidewalks Along Belfast Road: Following the introduction of the proposed development, conditions over the sidewalk areas along Belfast Road are predicted to be mostly suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year with isolated regions of strolling during the spring and winter. Conditions over the nearby transit stop along Belfast Road are predicted to be suitable for sitting during the summer and autumn, becoming suitable for a mix of sitting and standing during the winter, and suitable for standing during the spring. The noted conditions are considered acceptable according to the City of Ottawa wind comfort criteria.

Conditions over the sidewalk areas along Belfast Road with the existing massing are predicted to be mostly suitable for sitting during the summer with standing conditions near the bridge of Belfast Road which extends over Highway 417, becoming suitable for a mix of sitting and standing throughout the remainder of the year with isolated regions of strolling during the spring and winter. Conditions over the nearby transit stop along Belfast Road are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year. While conditions over the sidewalk areas along Belfast Road remain practically unchanged following the introduction of the proposed development, conditions are predicted to improve over the nearby transit stop along Belfast Road, in comparison to existing conditions. The noted conditions are considered acceptable according to the City of Ottawa wind comfort criteria.

Walkways and MTO Permit Controlled Area Along South Elevation: Conditions along the south elevation of the subject site are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year, with an isolated region of strolling during the winter. The noted conditions are considered acceptable according to the City of Ottawa wind comfort criteria.

Walkways and Surface Parking Between Towers A and C2: Conditions over the walkways and surface parking between Towers A and C2 are predicted to be mostly suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year, with a small region of strolling over the walkway during the winter. The noted conditions are considered acceptable according to the City of Ottawa wind comfort criteria.

Sidewalks and Surface Parking Along Central Laneway: Conditions over the sidewalk areas along the central east-west laneway are predicted to be suitable for a mix of sitting and standing during the summer, becoming mostly suitable for a mix of standing and strolling throughout the remainder of the year, with an isolated region of walking primarily over the road during the spring and winter. Conditions over the surface parking along the central laneway to the north of Tower A are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the autumn, and suitable for standing during the spring and winter. Conditions over the surface parking along the central laneway to the north of Tower C2 are predicted to be suitable for standing during the summer, becoming suitable for strolling during the spring and autumn, and suitable for a mix of strolling and walking during the winter. The noted conditions are considered acceptable according to the City of Ottawa wind comfort criteria.

Parkland West of Subject Site: Conditions over the majority of the parkland at the west of the subject site are predicted to be suitable for sitting during the typical use period, as illustrated in Figure 7. As such, conditions over the parkland may be considered acceptable.

Existing Parking Lots West of Subject Site: Following the introduction of the proposed development, conditions over the existing parking lots serving the adjacent low-rise commercial buildings to the west of the subject site are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year. The noted conditions are considered acceptable according to the City of Ottawa wind comfort criteria.

Conditions over the noted existing parking lot with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the autumn, and mostly suitable for standing during the spring and winter. Notably, the introduction of the proposed development is predicted to improve comfort levels over the existing parking lots to the west of the subject site, in comparison to existing conditions, and wind conditions with the proposed development are considered acceptable according to the City of Ottawa wind criteria.

Walkways Between Tower D and Tower E1: Owing to channelling of winds between Towers D and E1, conditions over the walkways between the noted towers are predicted to be suitable for standing during the summer, becoming suitable for strolling throughout the remainder of the year. Regardless, the noted conditions are considered acceptable according to the City of Ottawa wind comfort criteria.

Building Access Points: Conditions in the vicinity of the most 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 according to the City of Ottawa wind comfort criteria.

The exception to the above is the entrances between Towers C2 and D, and between Towers D and E1. Owing to channeling of winds between the noted towers, conditions in these areas are predicted to be suitable for standing during the summer, becoming suitable for strolling, or better, throughout the remainder of the year. The noted conditions are considered acceptable for secondary entrances. It is recommended that the primary entrances serving Tower D be recessed within the façade or flanked by tall wind screens to ensure acceptable conditions.

5.2 Wind Safety

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

5.3 Applicability of Results

Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the subject site. Future changes (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 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.

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-7. Based on computer simulations using the CFD technique, meteorological data analysis of the Ottawa wind climate, City of Ottawa wind comfort and safety criteria, and experience with numerous similar developments, the study concludes the following:

1) 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, laneways, walkways, transit stops, the parkland, existing parking lots, surface parking, and in the vicinity of building access points, are considered acceptable. An exception is as follows:

    a. Owing to channeling of winds between Towers C and D and between Towers D and E1, conditions in the vicinity of the primary entrances serving Tower D are predicted to experience somewhat windy conditions. As such, it is recommended these entrances be recessed within the façade or flanked by tall wind screens.

2) 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.

LICENSED PROFESSIONAL ENGINEER
S. R. HALL
100197168
Oct. 20, 2022
PROVINCE OF ONTARIO

Daniel Davalos, MASc.
Junior Wind Scientist

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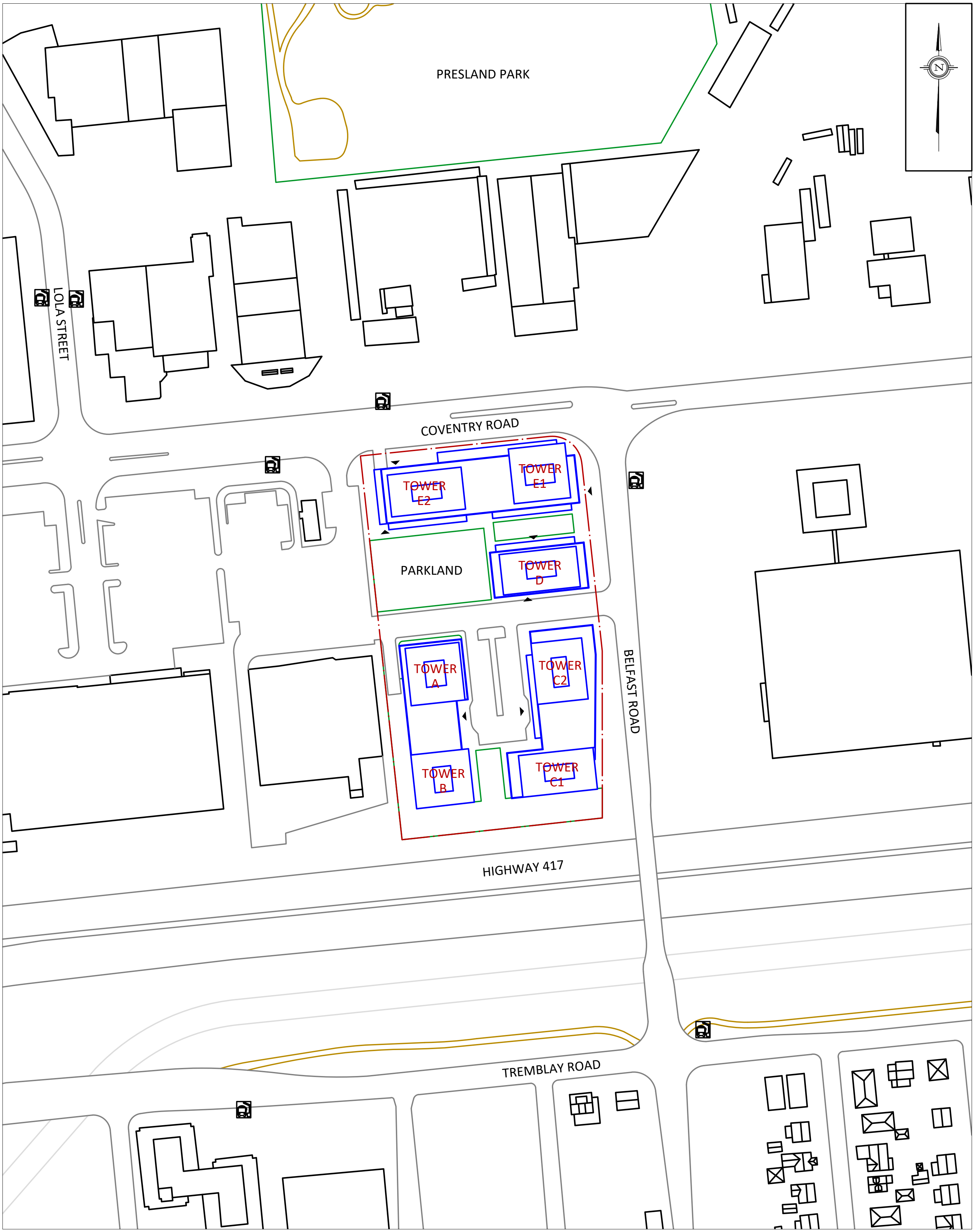

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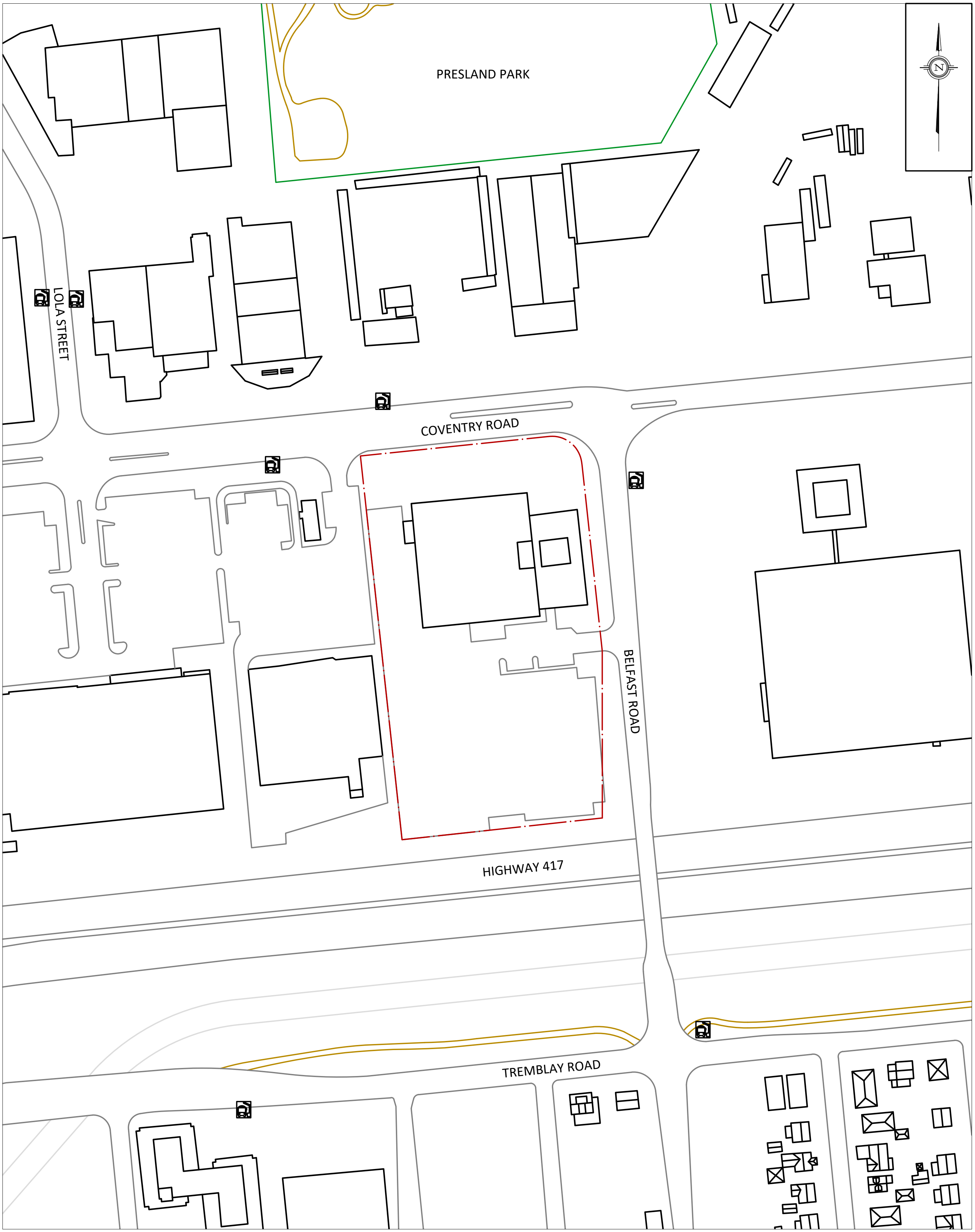
613 836 0934 • GRADIENTWIND.COM

PROJECT	400 COVENTRY ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2500	DRAWING NO.	22-272-PLW-1A
DATE	SEPTEMBER 16, 2022	DRAWN BY	S.K.

DESCRIPTION

FIGURE 1A:
PROPOSED SITE PLAN AND SURROUNDING CONTEXT



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PROJECT	400 COVENTRY ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2500	DRAWING NO.	22-272-PLW-1B
DATE	SEPTEMBER 16, 2022	DRAWN BY	S.K.

DESCRIPTION

FIGURE 1B:
EXISTING SITE PLAN AND SURROUNDING CONTEXT

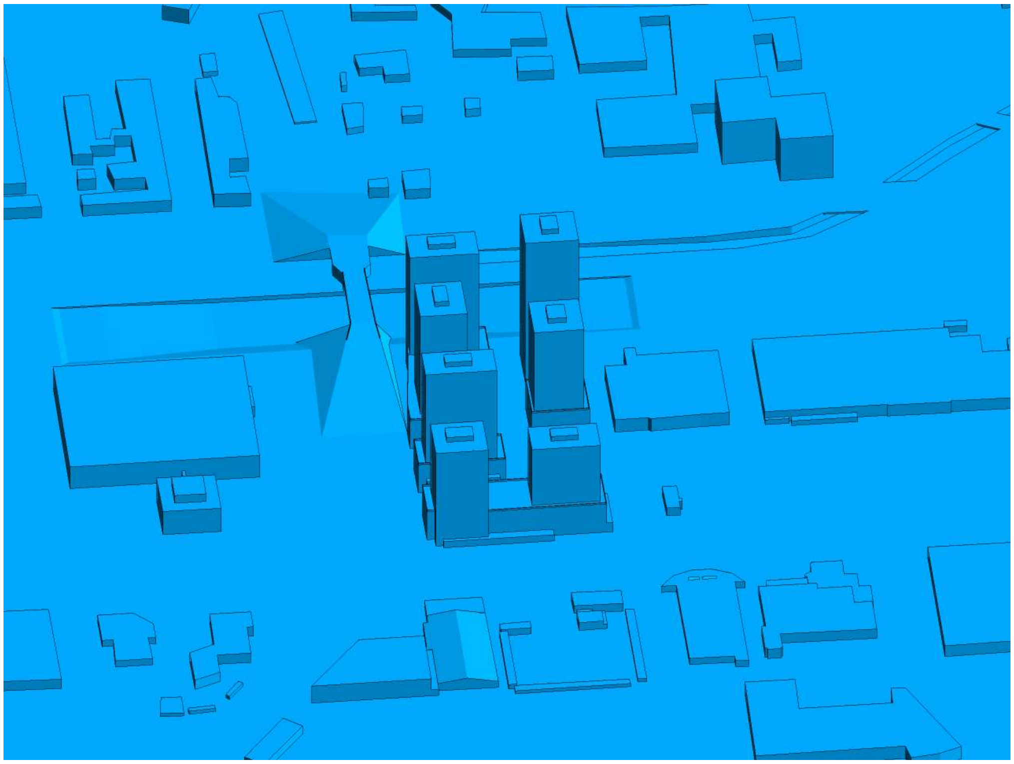


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

FIGURE 2B: CLOSE UP OF FIGURE 2A

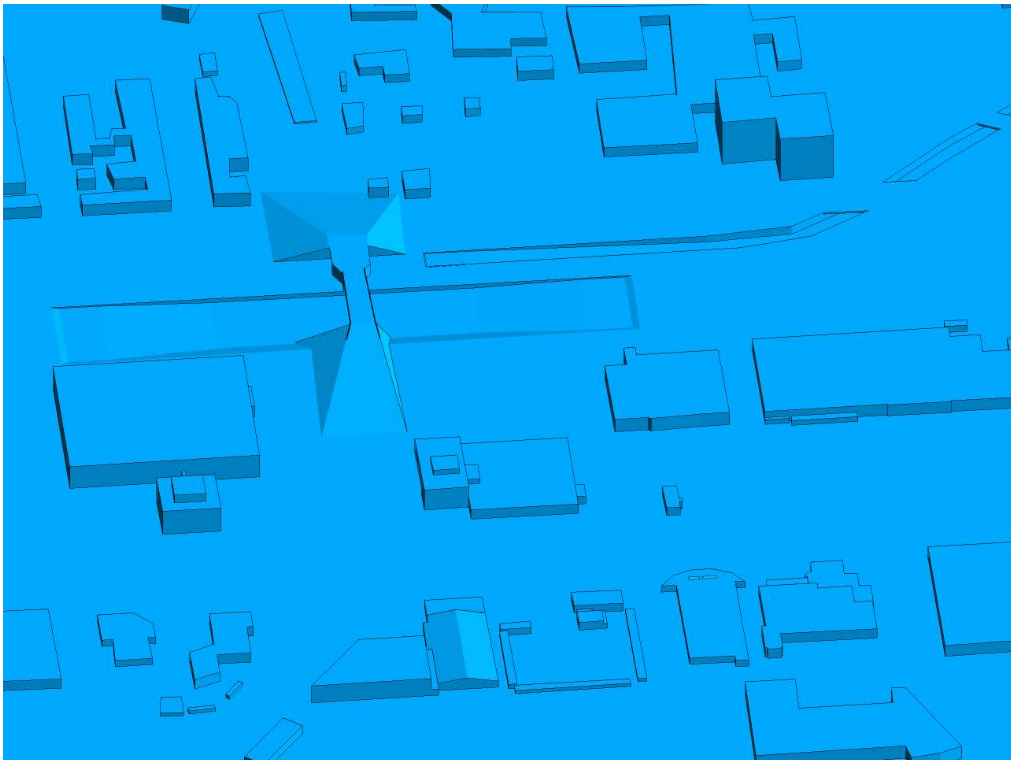


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

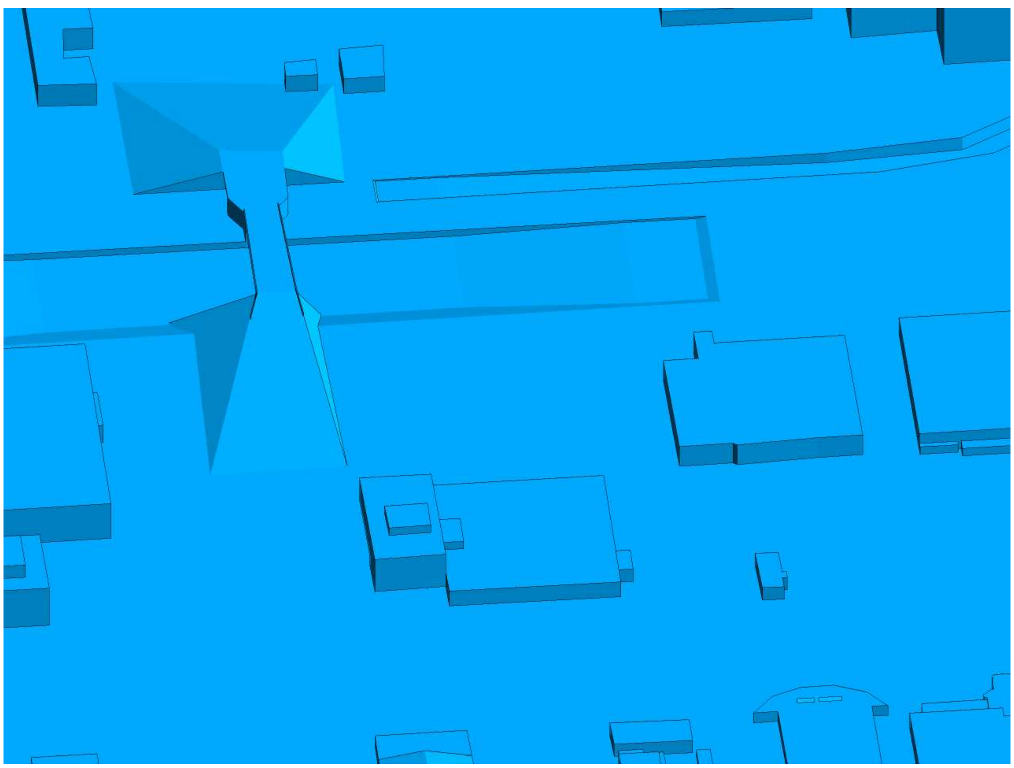


FIGURE 2D: CLOSE UP OF FIGURE 2C

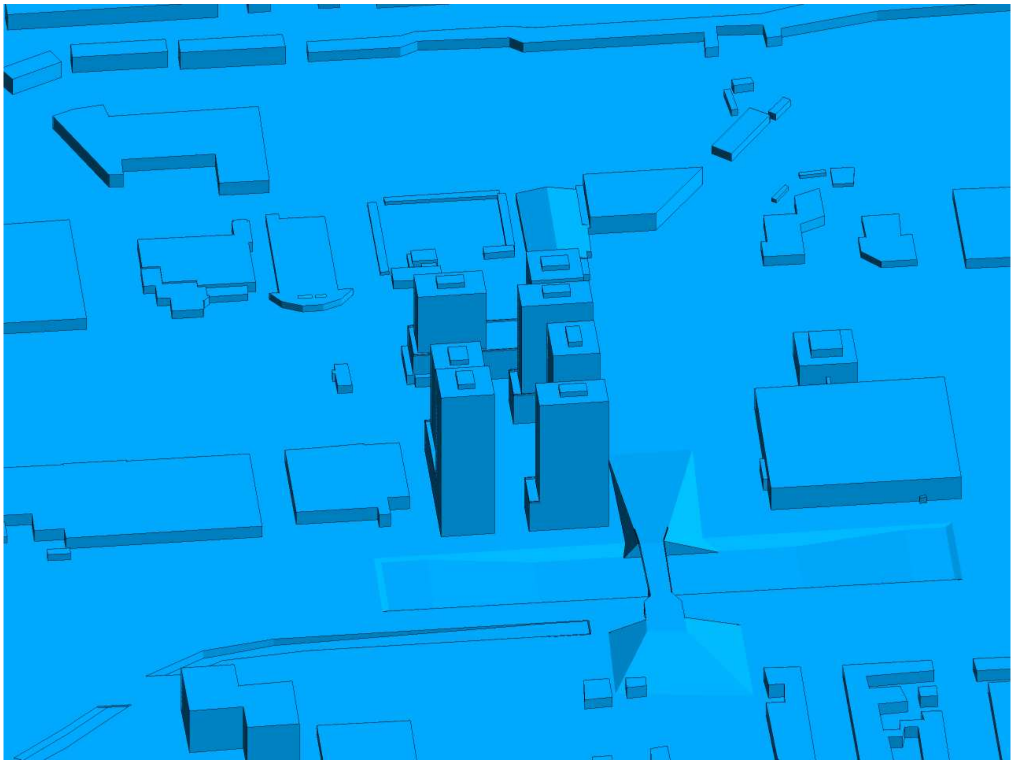


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

FIGURE 2F: CLOSE UP OF FIGURE 2E

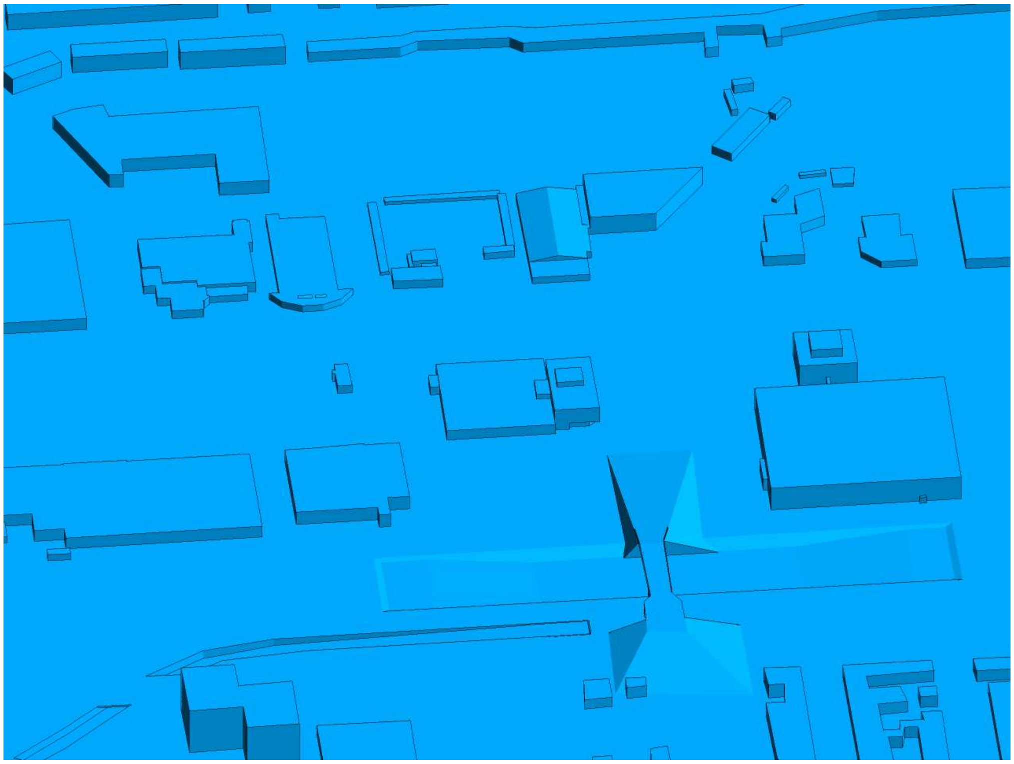


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

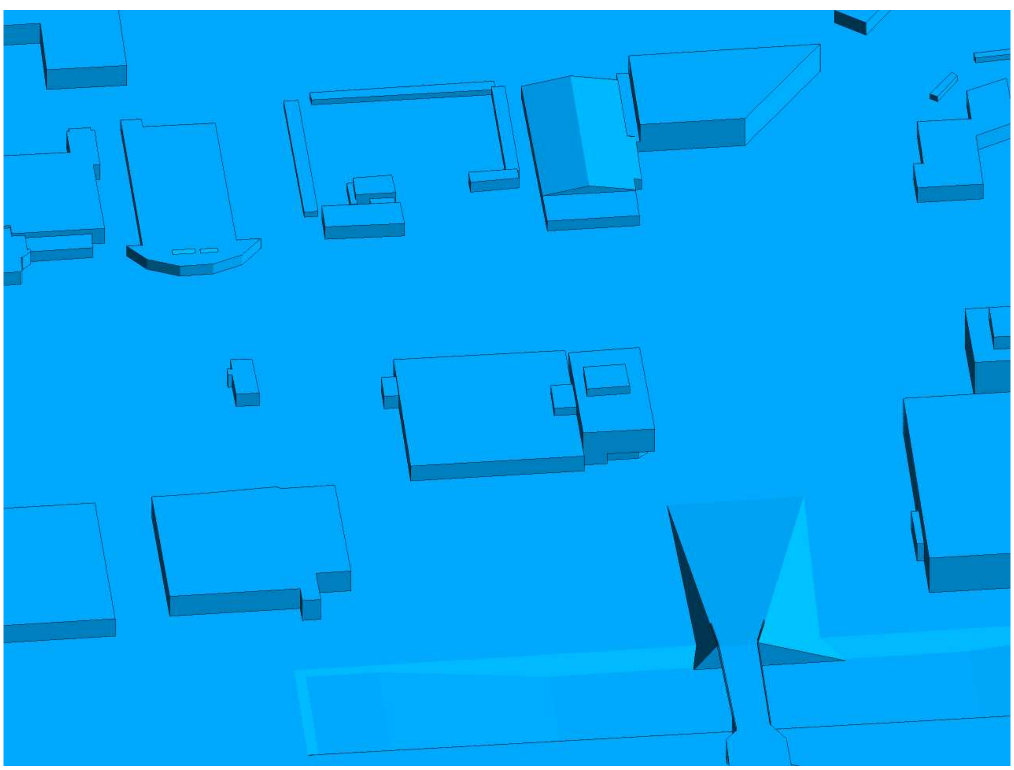


FIGURE 2H: CLOSE UP OF FIGURE 2G

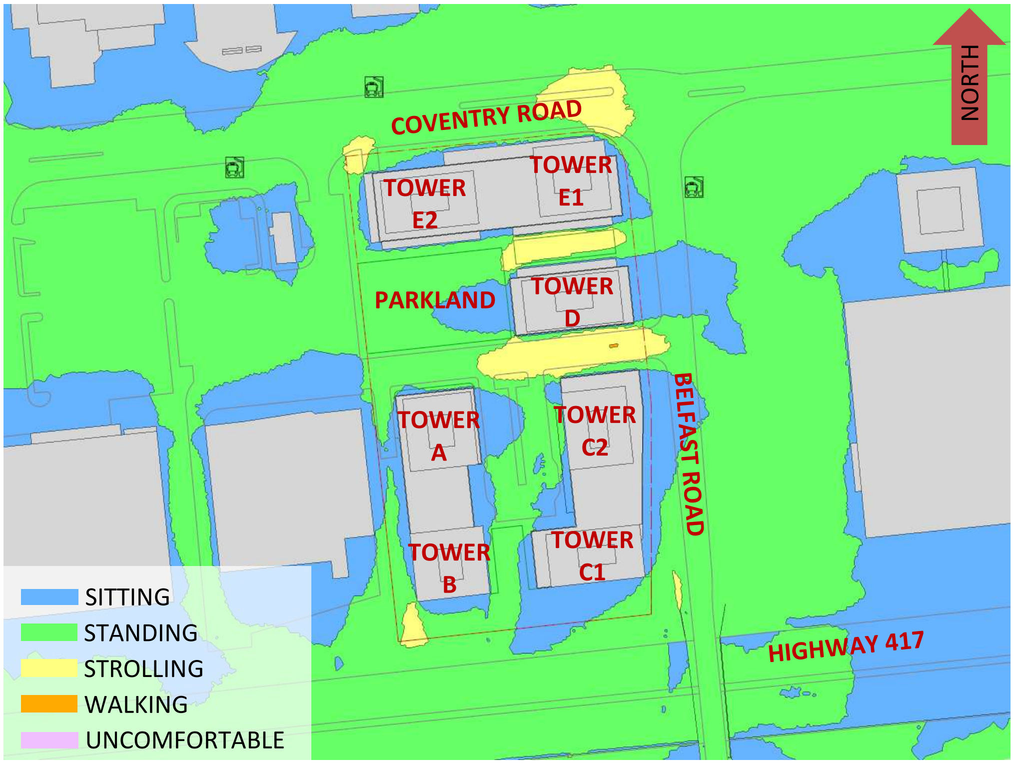


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

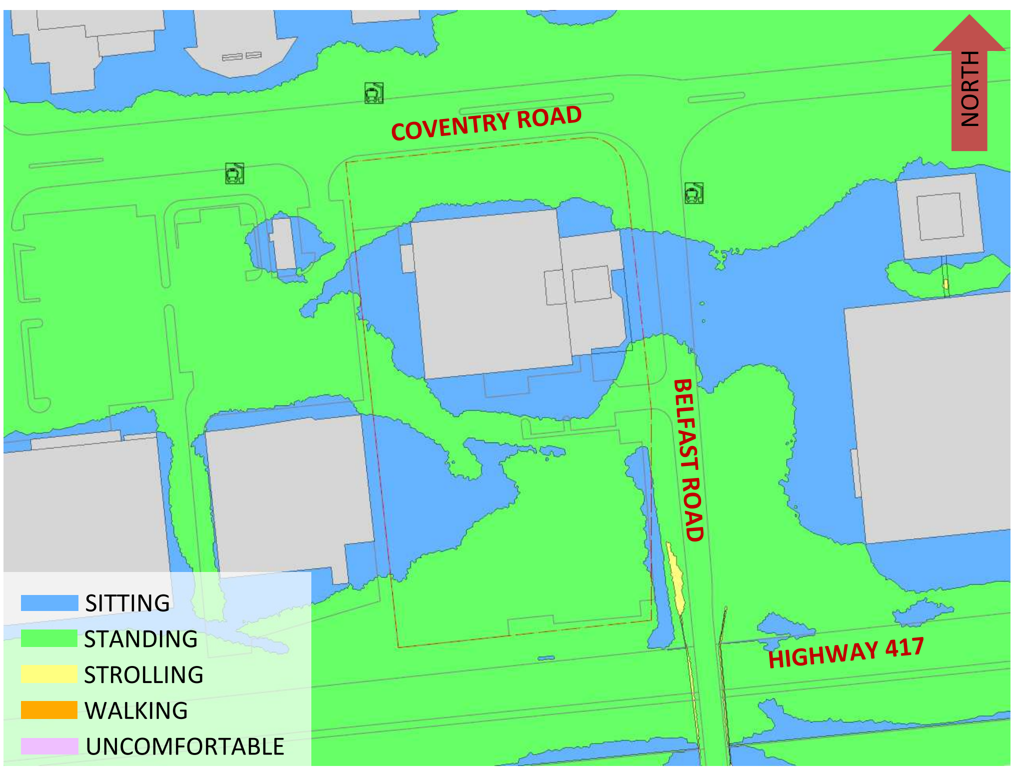
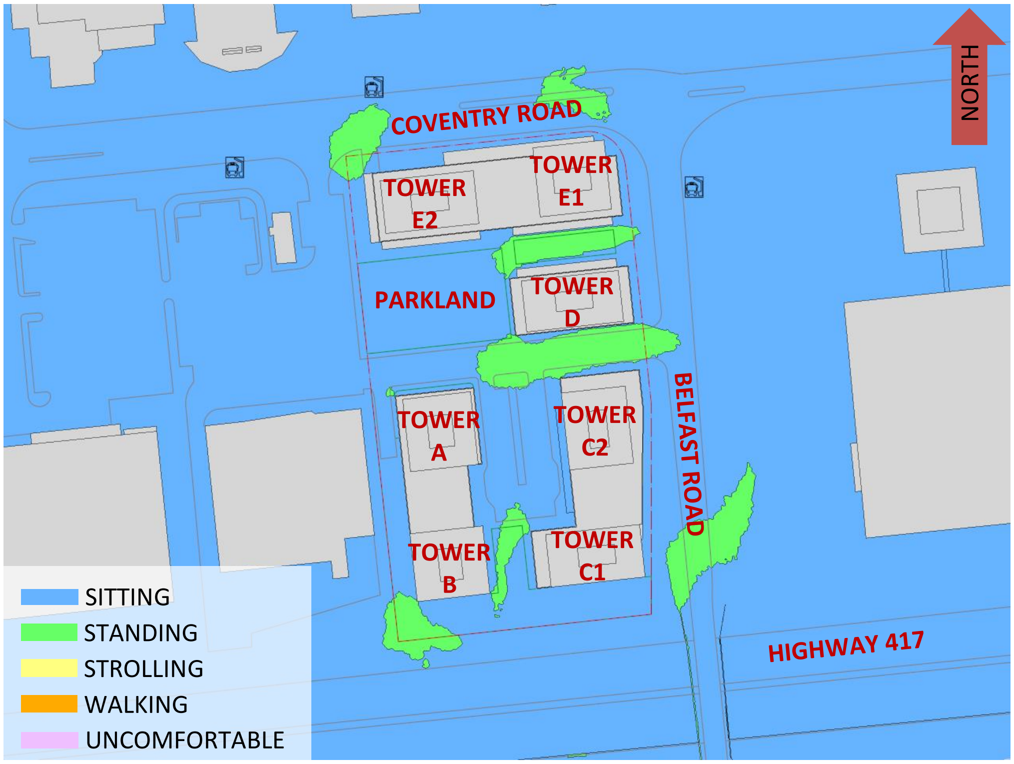


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING



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

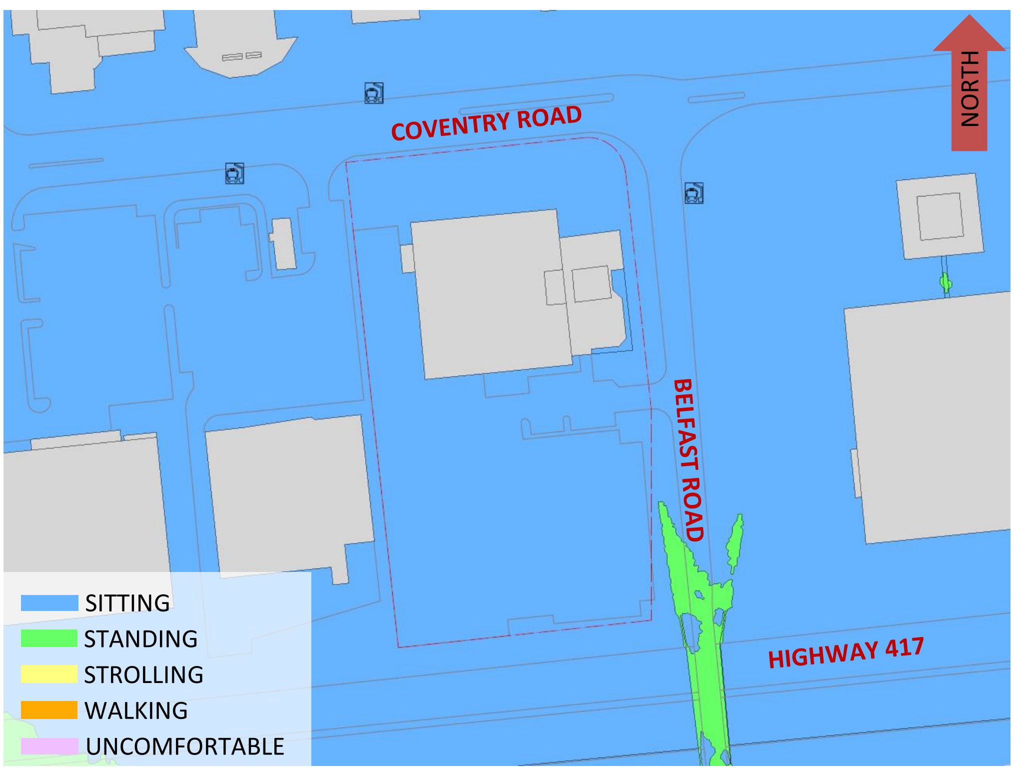


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

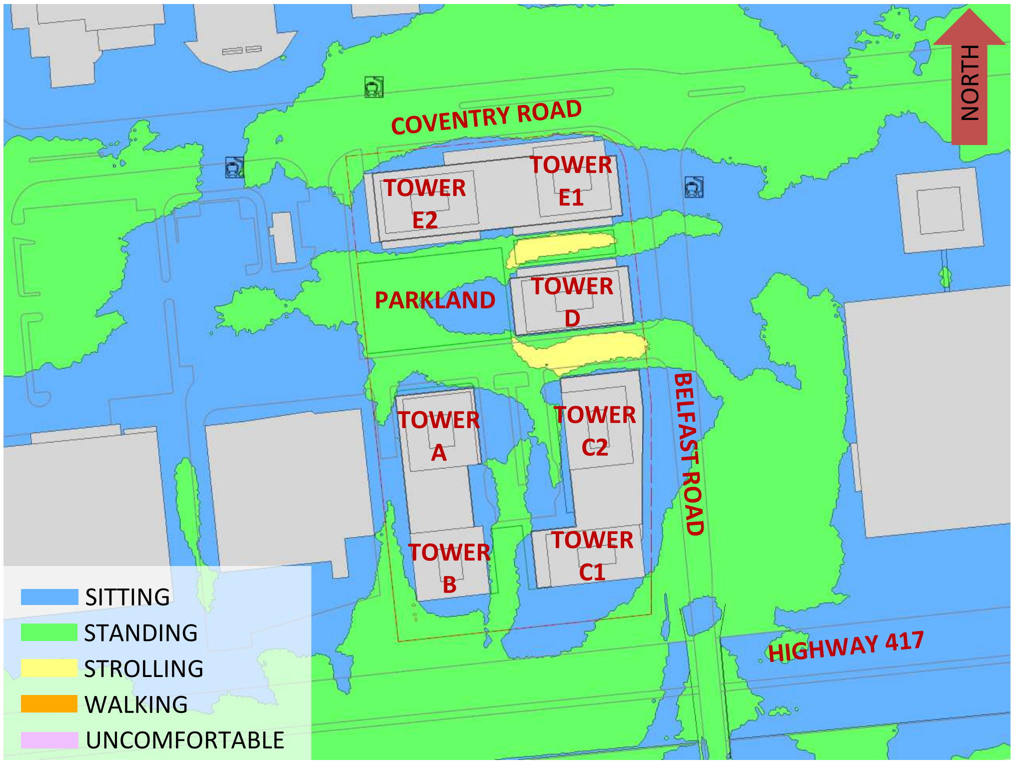


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

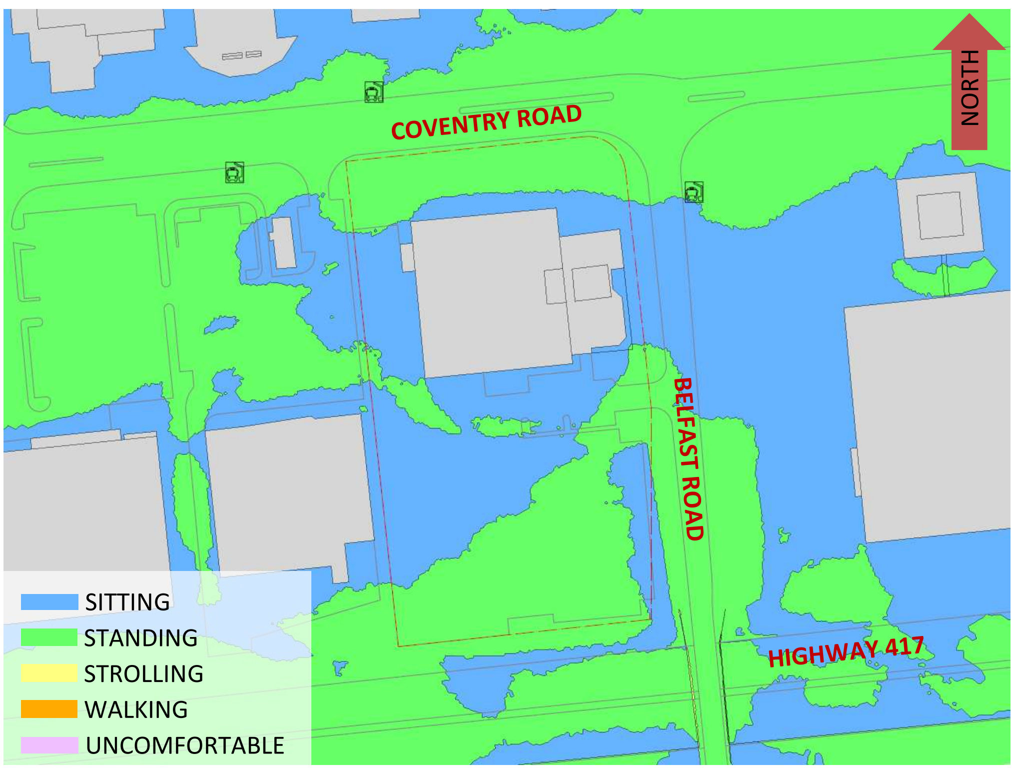


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

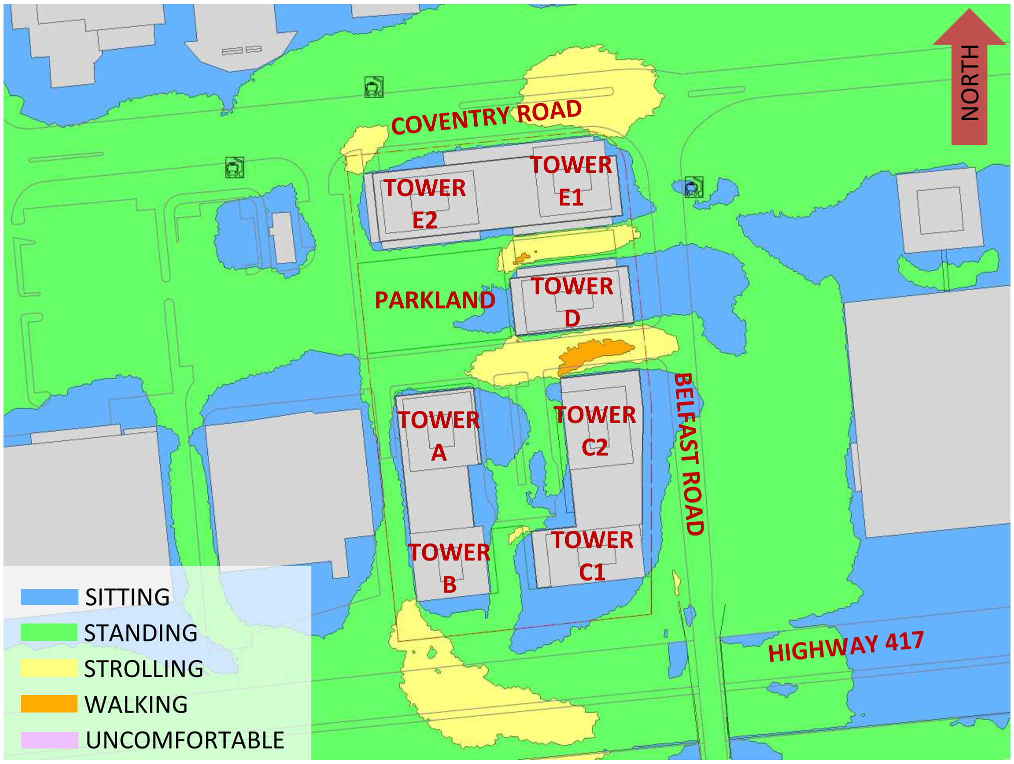


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

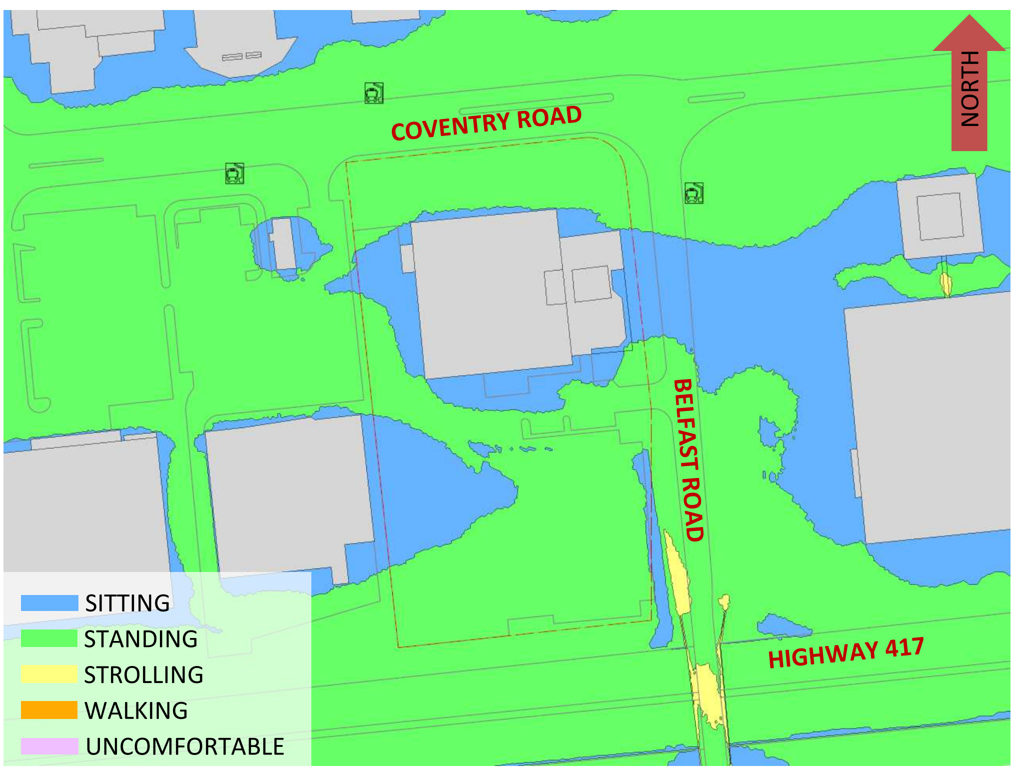


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

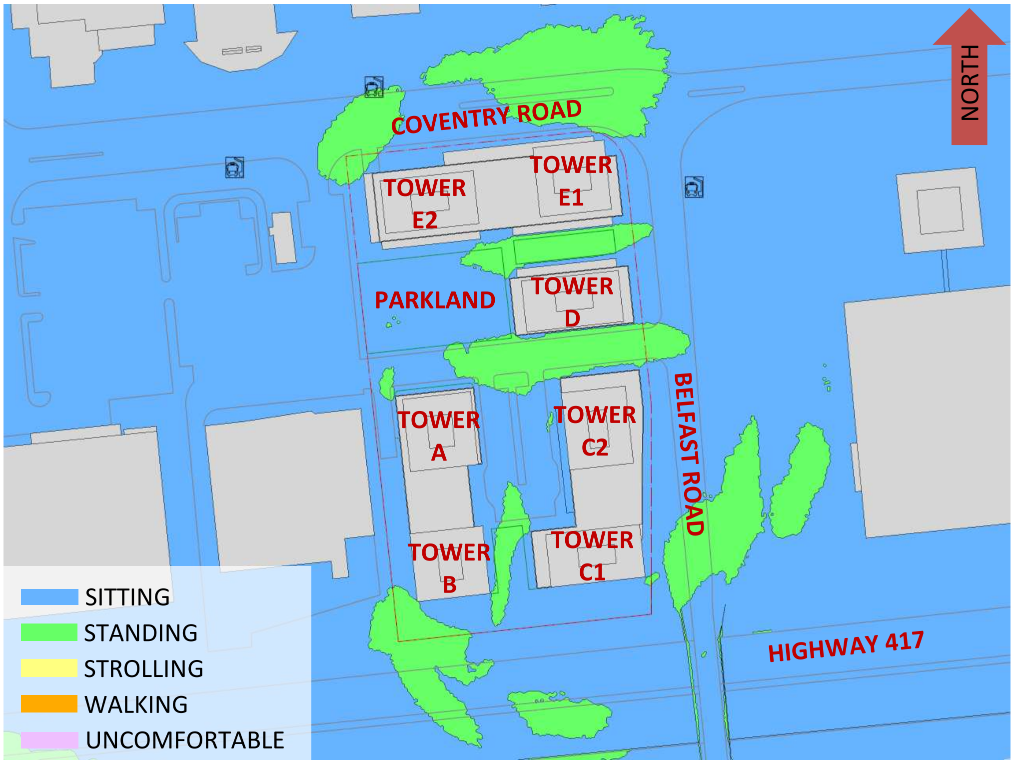
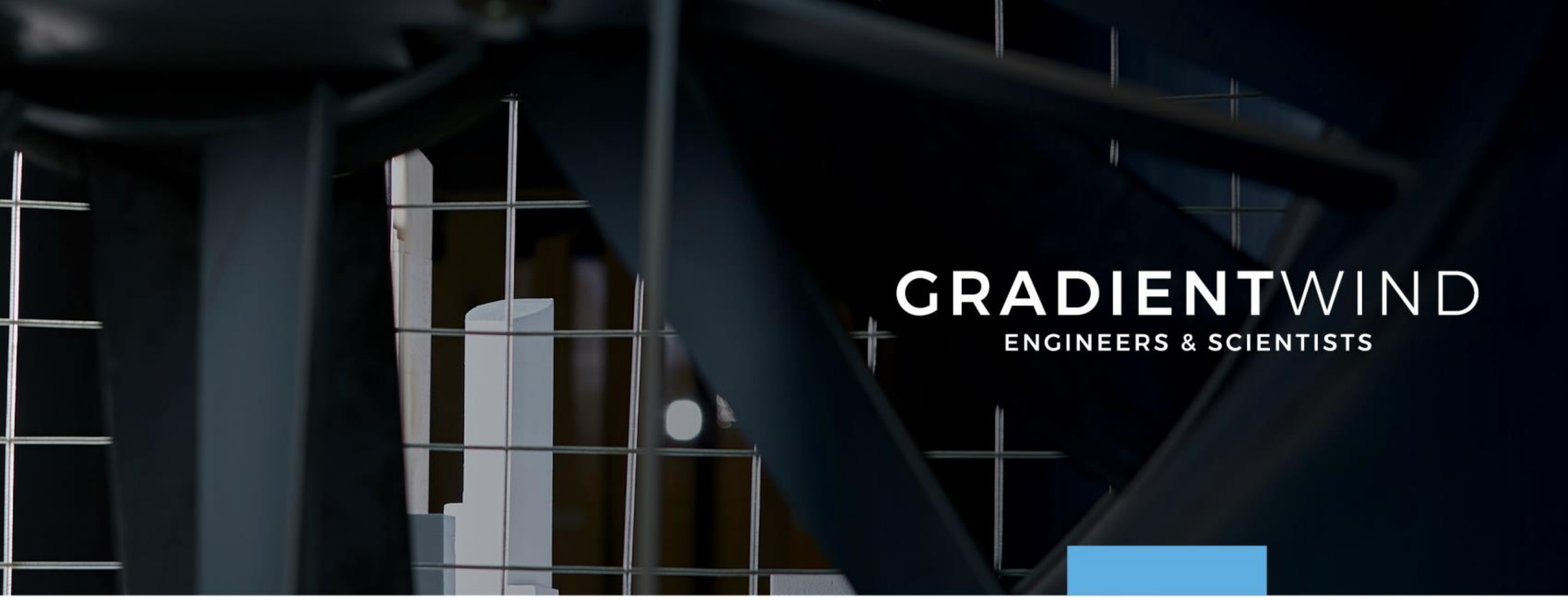
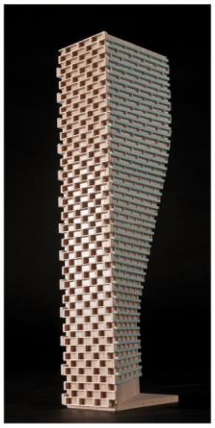
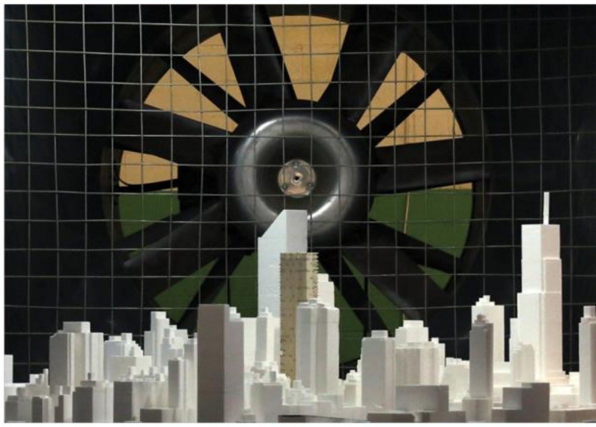


FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING







APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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

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

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

For the model, U_g is set to 6.5 metres per second, 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	0.25
49	0.25
74	0.24
103	0.24
167	0.24
197	0.24
217	0.25
237	0.23
262	0.26
282	0.25
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.