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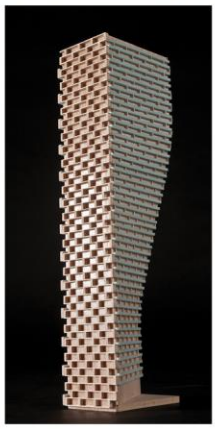
ENGINEERS & SCIENTISTS

PEDESTRIAN LEVEL WIND STUDY

1081 Carling Avenue
Ottawa, Ontario

Report: 21-162-PLW



August 27, 2021

PREPARED FOR

1081 Carling Avenue 2019 Co-tenancy
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PREPARED BY

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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy the requirements for a Zoning By-law Amendment (ZBLA) application submission for the proposed residential development located at 1081 Carling Avenue 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 any areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

The study involves simulation of wind speeds for selected wind directions in a three-dimensional (3D) computer model using the computational fluid dynamics (CFD) technique, combined with meteorological data integration, to assess pedestrian wind comfort and safety within and surrounding the subject site according to City of Ottawa wind comfort and safety criteria. The results and recommendations derived from these considerations are detailed in the main body of the report (Section 5), illustrated in Figures 3A-6B, and summarized as follows:

1) All grade-level areas within and surrounding the subject site are predicted to be acceptable for the intended pedestrian uses throughout the year. Specifically, wind conditions over the surrounding sidewalks along Carling Avenue, Parkdale Avenue, and Hamilton Avenue South, as well as in the vicinity of the bus stops along Carling Avenue and Parkdale Avenue, adjacent to most building access points, and within the proposed landscape open area to the immediate south of the East Tower, are considered acceptable for the intended pedestrian uses throughout the year. Exceptions are as follows:

    a. The ground floor area between the West and East Towers. Moderately strong winds are predicted within the area flanked by the West and East Towers. During the typical use period, defined as May to October, inclusive, conditions are predicted to be suitable mostly for standing. Conditions are also predicted to be suitable for sitting for at least 60% of the time during the typical use period, where the criterion is 80%. The simulation model did not include planned landscape elements, which is an industry standard practice. The omission of trees and other landscaping elements produces slightly more conservative (i.e., windier) wind speed values. While the central 50% of the plan area will

be provided with seating integrated with hard and soft landscape features, wind barriers, such as glazed vertical wind screens with a minimum solidity ratio of 80%, would be required to increase comfort levels to achieve the sitting comfort criterion.

b. The proposed parkland dedication to the immediate north of the East Tower. Conditions during the typical use period are predicted to be mixed between sitting and standing. For most of the areas that do not achieve the sitting comfort class, per the wind criteria in Section 4.4, conditions are predicted to be suitable for sitting for at least 75% of the time during the typical use period.

c. Further to items (a) and (b) above, to achieve the 80% criterion for sitting during the typical use period, mitigation will be required in the form of vertical wind screens integrated with hard and soft landscape elements. Mitigation strategies will be developed in collaboration with the design team and confirmed for the Site Plan Control submission.

2) Wind conditions within the common amenity terraces serving the West Tower atop its podium (Level 7) and atop the tower component (Level 23), as well as those serving the East Tower atop its podium (Level 7) and atop the tower component (Level 29), are predicted to be moderately windy during the summer season, becoming windy during the remaining three colder seasons. Conditions during the typical use period are predicted to be mixed between sitting and standing within most areas, while some areas within the amenity terraces serving the West Tower are also predicted to receive strolling conditions.

a. For those roof areas that do not achieve the sitting comfort class, per the wind criteria in Section 4.4, conditions are predicted to be suitable for sitting for at least 60-70% of the time for the West Tower and 65-70% of the time for the East Tower during the typical use period. To achieve the 80% criterion for sitting, mitigation will be required in the form of tall, glazed vertical wind screens around the perimeter of the various roofs. Mitigation inboard of the perimeters may also be required depending on the programming of the spaces. Mitigation strategies will be explored in collaboration with the design team and confirmed for the Site Plan Control submission.

3) 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.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by 1081 Carling Avenue 2019 Co-tenancy to undertake a pedestrian level wind (PLW) study to satisfy the requirements for a Zoning By-law Amendment (ZBLA) application submission for the proposed residential development located at 1081 Carling Avenue 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, 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 Hobin Architecture Inc. (August 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 1081 Carling Avenue, at the intersection of Carling Avenue and Parkdale Avenue. The Ottawa Hospital Civic Campus is situated to the northeast of the subject site across from Carling Avenue and Parkdale Avenue. The subject site comprises two residential buildings with rectangular floorplates in the nominal north-south direction, parallel with Parkdale Avenue. The 'West Tower' rises 22 storeys above grade, while the 'East Tower' rises 28 storeys above grade. Both buildings include a 6-storey podium extending north of the West Tower and East Tower. Common amenity terraces are provided atop the podia (Level 7), as well as at Level 23 (West Tower) and Level 29 (East Tower). Additionally, a proposed landscape open space is provided to the immediate south of the East Tower, while a proposed parkland dedication is provided to the immediate north of the East Tower.

The near-field surroundings (defined as an area within 200 metres (m) of the subject site) include a dense mix of low-rise residential dwellings from the west-southwest clockwise to north, the Ottawa Hospital Civic Campus from the north clockwise to east-northeast, and open lands from the Central Experimental Farm for the remaining compass directions. Of note, the existing Duke of Devonshire (1095 Carling

Avenue) is situated to the immediate west of the subject site across Hamilton Avenue South. 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 mostly low- and mid-rise buildings from the south clockwise to east-northeast, and mostly open lands for the remaining compass directions.

Key areas under consideration include the surrounding sidewalks adjacent to the subject site, the existing bus stops on Carling Avenue and Parkdale Avenue in the vicinity of the subject site, the proposed landscape open space and parkland dedication serving the subject site, building access points, and the amenity terraces serving the West Tower and East Tower. Figure 1 illustrates the subject site and surrounding context, while Figures 2A-2D illustrate the computational model 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 criteria[1]. 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 diameter of approximately 820 m.

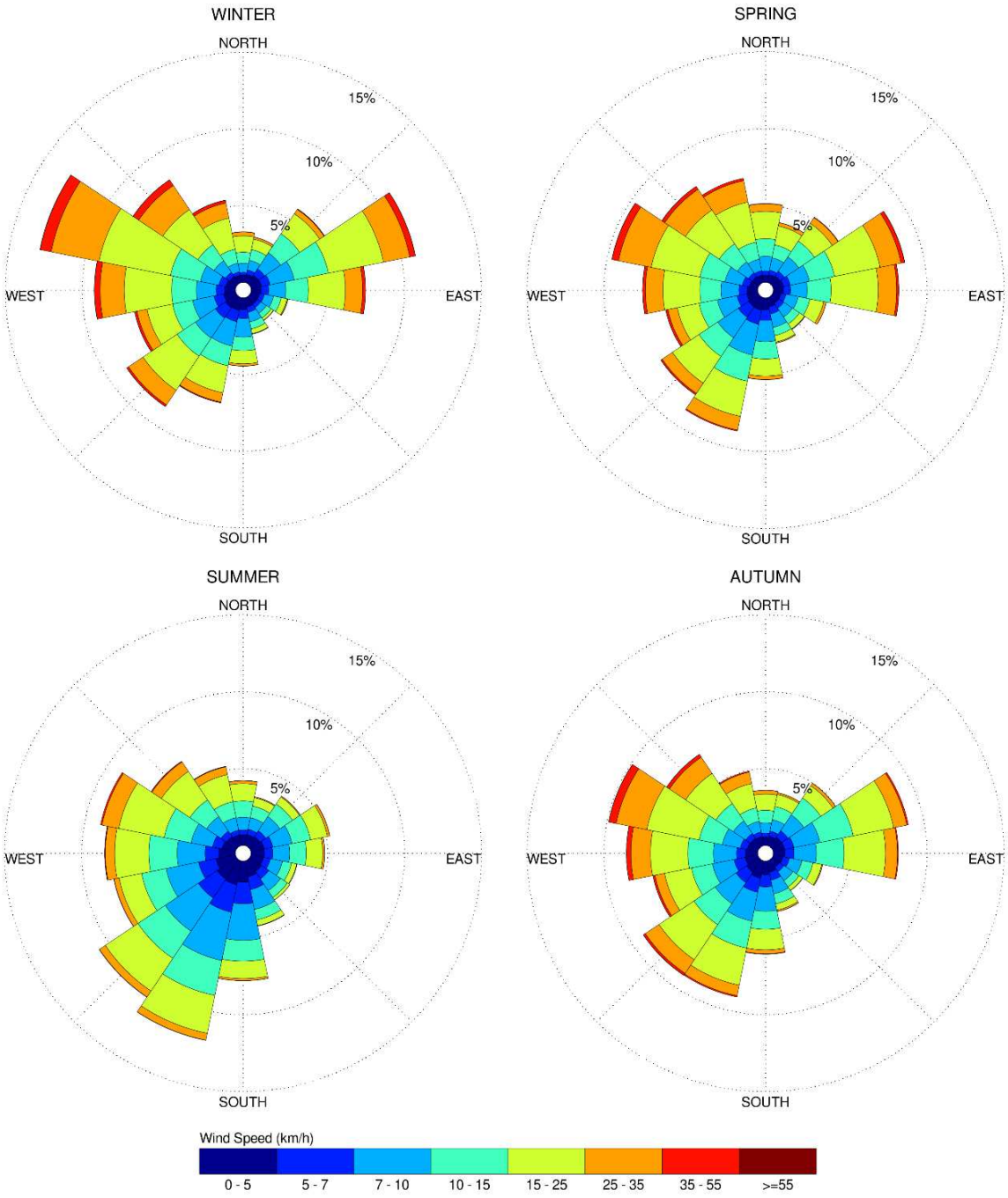
Mean and peak wind speed data obtained over the study site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the amenity terraces were referenced to the wind speed at 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 Meteorological Data Analysis

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 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 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
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 5A-5D illustrating seasonal wind conditions over the various common amenity terraces serving the proposed development. 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 green, standing by yellow, and walking by blue; uncomfortable conditions are represented by the colour magenta.

Wind conditions over grade level (particularly the proposed parkland dedication) and the elevated amenity terraces are also reported for the typical use period, which is defined as May to October, inclusive. Figures 4A and 6A illustrate wind comfort conditions during this period, consistent with the comfort classes in Section 4.4, while Figures 4B and 6B illustrate contours indicating the percentage of time the noted areas are predicted to be suitable for sitting. Pedestrian conditions are summarized in the following pages for each area of interest.

5.1 Wind Comfort Conditions – Grade Level

Sidewalk, Bus Stop, Building Access (East Tower), and Proposed Landscape Open Space along Carling Avenue: The sidewalk along Carling Avenue, adjacent to the proposed development, is predicted to be suitable for a mix of sitting and standing during the summer season, becoming suitable for a mix of standing and strolling during the remaining three colder seasons. During the winter season, the sidewalk at the intersection of Carling Avenue and Hamilton Avenue South is predicted to be suitable for walking. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Conditions at the bus stop, which is situated approximately mid block between Parkdale Avenue and Hamilton Avenue South, are predicted to be suitable for a mix of sitting and standing during the summer season, for standing during the autumn season, and a mix of standing and strolling during the winter and spring seasons. The noted conditions may be considered satisfactory since the bus stop is served by a typical shelter, thus providing pedestrians with a means to protect themselves during periods of strong wind activity.

Owing to the protection of the building façades, conditions in the vicinity of the building entrance serving the East Tower, as well as those serving the Duke of Devonshire, are predicted to be suitable for sitting during the summer season, becoming suitable for a mix of sitting and standing during the remaining three colder seasons. The noted conditions are considered acceptable according to the City of Ottawa wind criteria in Section 4.4.

Wind conditions within the proposed landscape open space, situated to the immediate south of the East Tower, are predicted to be suitable for sitting during the summer season, becoming suitable for a mix of sitting and standing during the remaining three colder seasons. Conditions during the typical use period, illustrated in Figure 4A, are predicted to be suitable mostly for sitting. For those areas that do not achieve the sitting comfort class, per the wind criteria in Section 4.4, conditions are predicted to be suitable for sitting for at least 75% of the time during the typical use period.

Sidewalk and Building Access (West Tower) along Hamilton Avenue South: The sidewalk along Hamilton Avenue South, adjacent to the proposed development, is predicted to be suitable for standing during the summer season, becoming suitable for a mix of standing and strolling during the remaining three colder seasons. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Owing to the protection of the building façade, conditions in the vicinity of the building entrance serving the West Tower are predicted to be suitable for sitting during the summer season, becoming suitable mostly for standing during the remaining three colder seasons. The noted conditions are considered acceptable according to the City of Ottawa wind criteria in Section 4.4.

Sidewalk and Bus Stops along Parkdale Avenue: The sidewalk along Parkdale Avenue, adjacent to the proposed development, is predicted to be suitable for a mix of sitting and standing during the summer season, for standing during the autumn season, becoming suitable for a mix of standing and strolling during the winter and spring seasons. During the spring and winter seasons, the sidewalk area adjacent to the northeast corner of the East Tower is predicted to be suitable for walking. The noted conditions are considered acceptable according to the City of Ottawa wind criteria in Section 4.4.

Two bus stops are provided along Parkdale Avenue in the vicinity of the subject site. Conditions at the bus stop on the west side of Parkdale Avenue are predicted to be suitable for sitting during the summer season, becoming suitable for standing during the remaining three colder seasons. Wind conditions at the bus stop on the east side of Parkdale Avenue are predicted to be suitable for standing during the summer season, for strolling during the autumn season, becoming suitable for a mix of strolling and walking during the remaining three colder seasons. The noted conditions may be considered satisfactory since both bus stops along Parkdale Avenue are served by a typical shelter, thus providing pedestrians with a means to protect themselves during periods of strong wind activity.

Area Between West and East Towers and Building Access: The area at grade between the West and East Towers is predicted to be suitable for standing during the summer season, for strolling during the autumn season, becoming suitable for a mix of strolling and walking during the winter and spring seasons. Conditions during the typical use period, illustrated in Figure 4A, are predicted to be suitable mostly for standing. Conditions are also predicted to be suitable for sitting for at least 60% of the time during the typical use period, where the criterion is 80%.

As noted in Section 4.1, 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.

According to the current landscape plan, the central 50% of the plan area will be provided with seating integrated with hard and soft landscape features. While targeted landscaping for the area could be expected to increase the noted sitting percentages by up to 10% of the time during the typical use period, wind barriers, such as glazed vertical wind screens with a minimum solidity ratio of 80%, would be required to increase comfort levels to achieve the sitting comfort criterion. Mitigation strategies will be developed in collaboration with the design team and confirmed for the Site Plan Control submission.

Owing to the protection of the building façades, conditions in the vicinity of the building access points serving the West and East Towers are predicted to be suitable for a mix of sitting and standing during the summer season, for standing during the autumn season, becoming suitable mostly for strolling during the winter and spring seasons. The noted landscaping for the area is expected to increase comfort levels in the immediate vicinity of building access points. The mitigation strategies involving the central 50% of the plan area between the proposed buildings will also consider the building access points serving the West and East Towers. Mitigation strategies will be developed in collaboration with the design team and confirmed for the Site Plan Control submission.

Proposed Parkland Dedication: Wind conditions within the proposed parkland dedication to the immediate north of the East Tower are predicted to be suitable for a mix of sitting and standing during the summer season, becoming mostly suitable for standing during the remaining three colder seasons. Conditions during the typical use period, illustrated in Figure 4A, are predicted to be mixed between sitting and standing. For most of the areas that do not achieve the sitting comfort class, per the wind criteria in Section 4.4, conditions are predicted to be suitable for sitting for at least 75% of the time during the typical use period. The only exception is the east boundary of the area, which is predicted to be suitable for sitting for at least 65-70% of the time during the typical use period.

According to the current landscape plan, the proposed parkland dedication will be provided with seating integrated with hard and soft landscape features. Since targeted landscaping for the area could be expected to increase the noted sitting percentages by up to 10% of the time during the typical use period, pedestrian comfort levels with landscaping present are expected to be acceptable. Nevertheless, mitigation strategies could be developed in collaboration with the design team and confirmed for the Site Plan Control submission.

5.2 Wind Comfort Conditions – Common Amenity Terraces

Wind conditions within the common amenity terraces serving the West Tower atop its podium (Level 7) and atop the tower (Level 23), as well as those serving the East Tower atop its podium (Level 7) and atop the tower (Level 29), illustrated in Figures 5A-5D, are predicted to be moderately windy during the summer season, becoming windy during the remaining three colder seasons.

Conditions during the typical use period, illustrated in Figure 6A, are predicted to be mixed between sitting and standing within most areas, while some areas within the amenity terraces serving the West Tower are also predicted to receive strolling conditions. For those roof areas that do not achieve the sitting comfort class, per the wind criteria in Section 4.4, conditions are predicted to be suitable for sitting for at least 60-70% of the time for the West Tower and 65-70% of the time for the East Tower during the typical use period. To achieve the 80% criterion for sitting, mitigation will be required in the form of tall, glazed vertical wind screens around the perimeter of the various roofs. Mitigation inboard of the perimeters may also be required depending on the programming of the spaces. Mitigation strategies will be explored in collaboration with the design team and confirmed for the Site Plan Control submission.

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. For example, development in urban centers generally creates reduction in the mean wind speeds and localized increases in the gustiness of the wind.

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-6B. 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 be acceptable for the intended pedestrian uses throughout the year. Specifically, wind conditions over the surrounding sidewalks along Carling Avenue, Parkdale Avenue, and Hamilton Avenue South, as well as in the vicinity of the bus stops along Carling Avenue and Parkdale Avenue, adjacent to most building access points, and within the proposed landscape open area to the immediate south of the East Tower, are considered acceptable for the intended pedestrian uses throughout the year. Exceptions are as follows:

    a. The ground floor area between the West and East Towers. Moderately strong winds are predicted within the area flanked by the West and East Towers. During the typical use period, conditions are predicted to be suitable mostly for standing. Conditions are also predicted to be suitable for sitting for at least 60% of the time during the typical use period, where the criterion is 80%. The simulation model did not include planned landscape elements, which is an industry standard practice. The omission of trees and other landscaping elements produces slightly more conservative (i.e., windier) wind speed values. While the central 50% of the plan area will be provided with seating integrated with hard and soft landscape features, wind barriers, such as glazed vertical wind screens with a minimum solidity ratio of 80%, would be required to increase comfort levels to achieve the sitting comfort criterion.

b. The proposed parkland dedication to the immediate north of the East Tower. Conditions during the typical use period are predicted to be mixed between sitting and standing. For most of the areas that do not achieve the sitting comfort class, per the wind criteria in Section 4.4, conditions are predicted to be suitable for sitting for at least 75% of the time during the typical use period.

c. Further to items (a) and (b) above, to achieve the 80% criterion for sitting during the typical use period, mitigation will be required in the form of vertical wind screens integrated with hard and soft landscape elements. Mitigation strategies will be developed in collaboration with the design team and confirmed for the Site Plan Control submission.

2) Wind conditions within the common amenity terraces serving the West Tower atop its podium (Level 7) and atop the tower component (Level 23), as well as those serving the East Tower atop its podium (Level 7) and atop the tower component (Level 29), are predicted to be moderately windy during the summer season, becoming windy during the remaining three colder seasons. Conditions during the typical use period are predicted to be mixed between sitting and standing within most areas, while some areas within the amenity terraces serving the West Tower are also predicted to receive strolling conditions.

a. For those roof areas that do not achieve the sitting comfort class, per the wind criteria in Section 4.4, conditions are predicted to be suitable for sitting for at least 60-70% of the time for the West Tower and 65-70% of the time for the East Tower during the typical use period. To achieve the 80% criterion for sitting, mitigation will be required in the form of tall, glazed vertical wind screens around the perimeter of the various roofs. Mitigation inboard of the perimeters may also be required depending on the programming of the spaces. Mitigation strategies will be explored in collaboration with the design team and confirmed for the Site Plan Control submission.

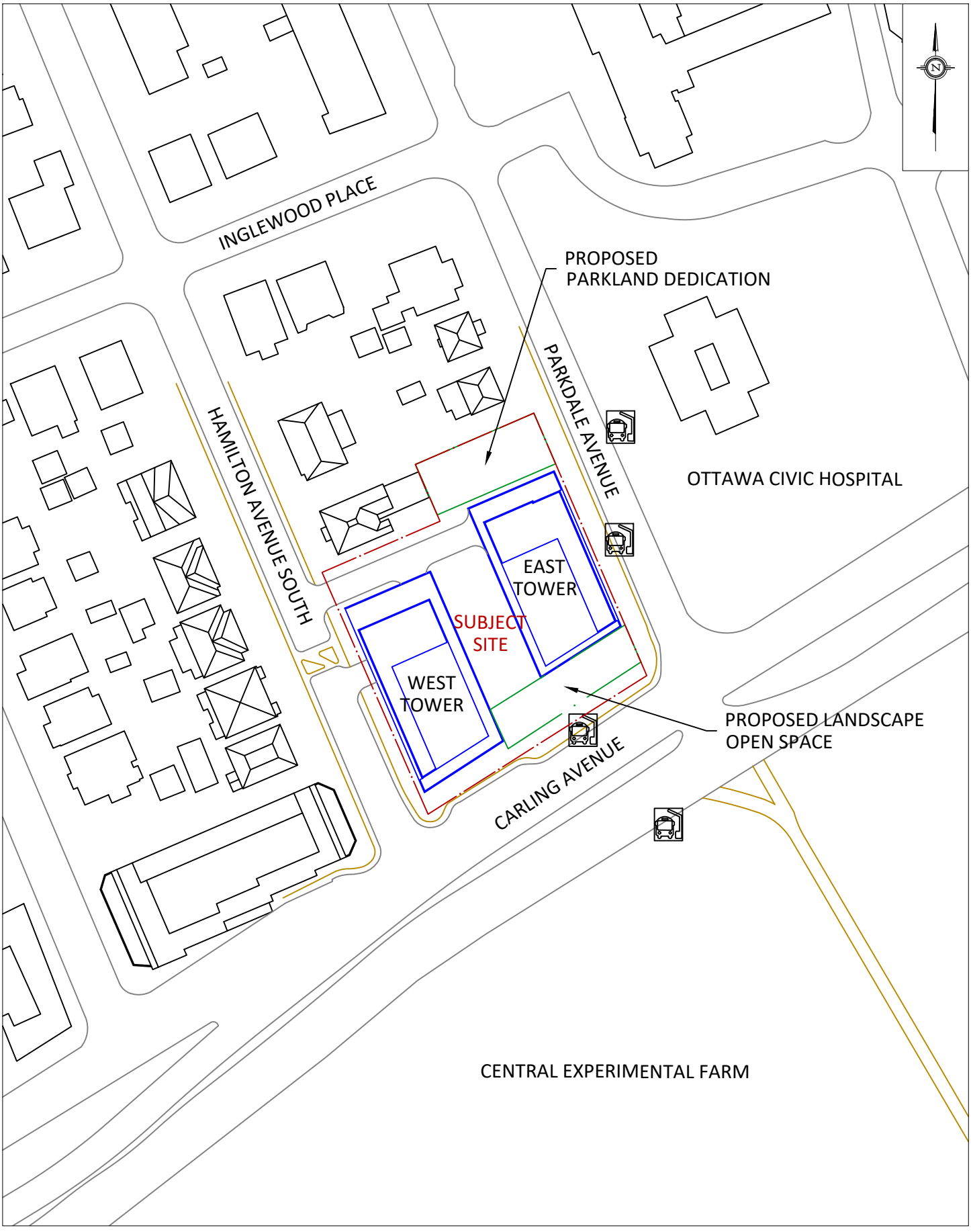
3) Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no pedestrian areas within and surrounding the subject site were found to experience conditions that could be considered dangerous.

Sincerely,

Gradient Wind Engineering Inc.

Daniel Davalos, MESc.
Junior Wind Scientist

Justin Ferraro, P.Eng.
Principal



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PROJECT	1081 CARLING AVENUE, OTTAWA PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1250
DRAWING NO.	21-162-PLW-1
DATE	AUGUST 27, 2021
DRAWN BY	N.M.P.

DESCRIPTION

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT

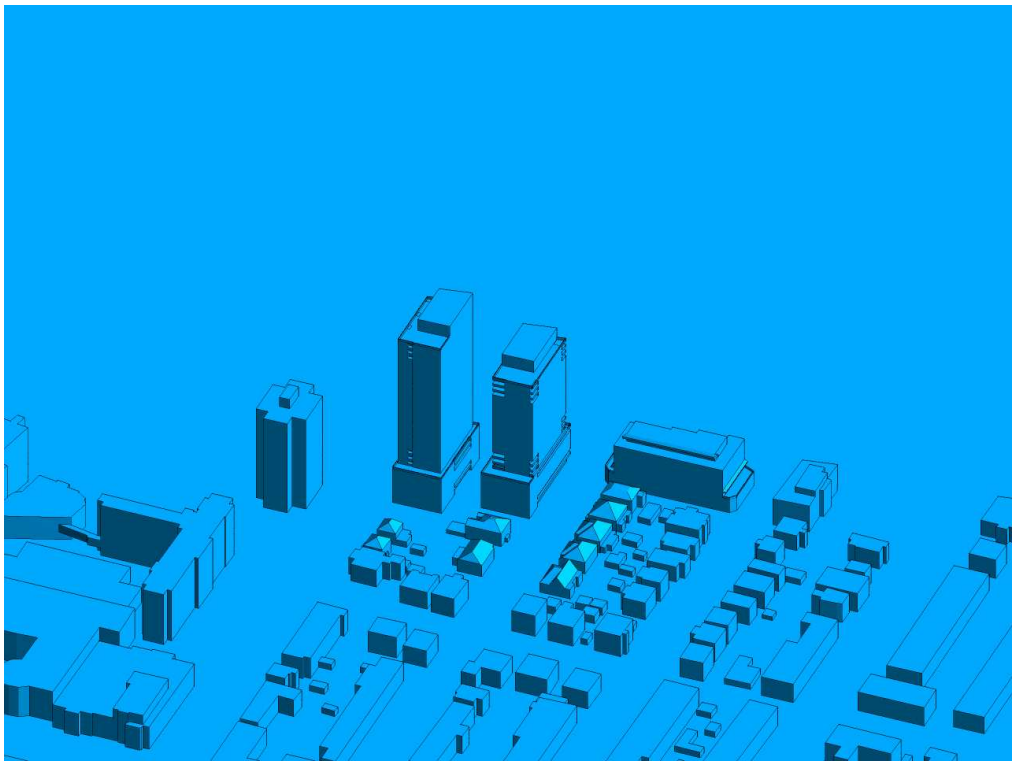

FIGURE 2A: COMPUTATIONAL MODEL, NORTHWEST PERSPECTIVE

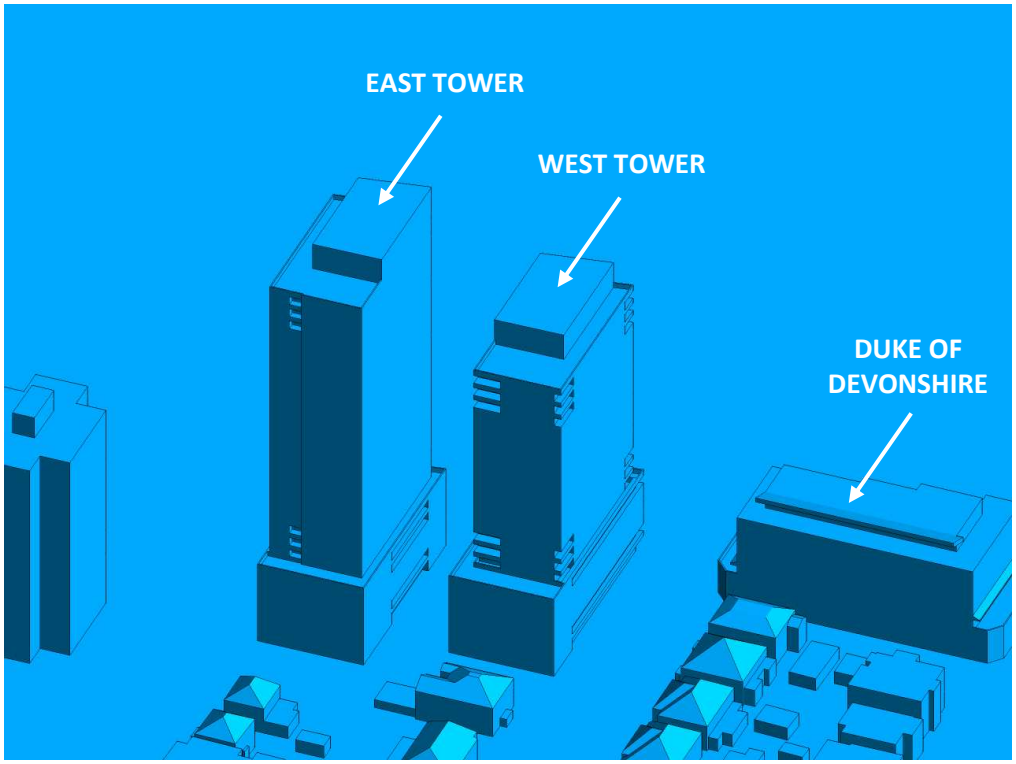

FIGURE 2B: CLOSE UP OF FIGURE 2A

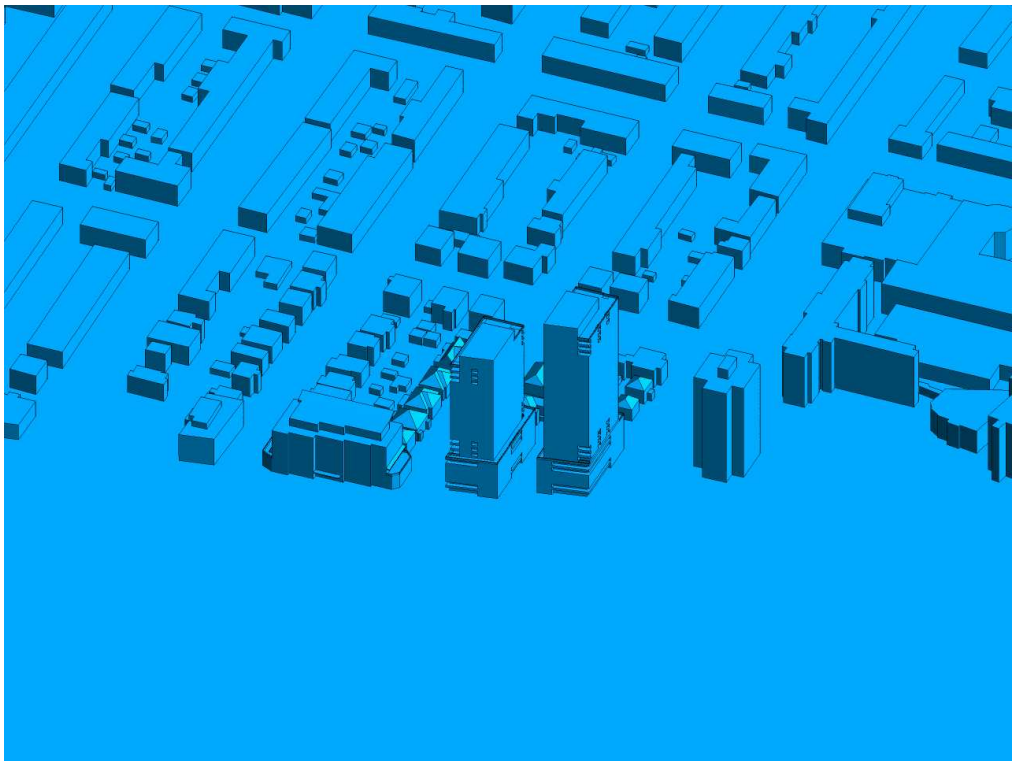

FIGURE 2C: COMPUTATIONAL MODEL, SOUTHEAST PERSPECTIVE

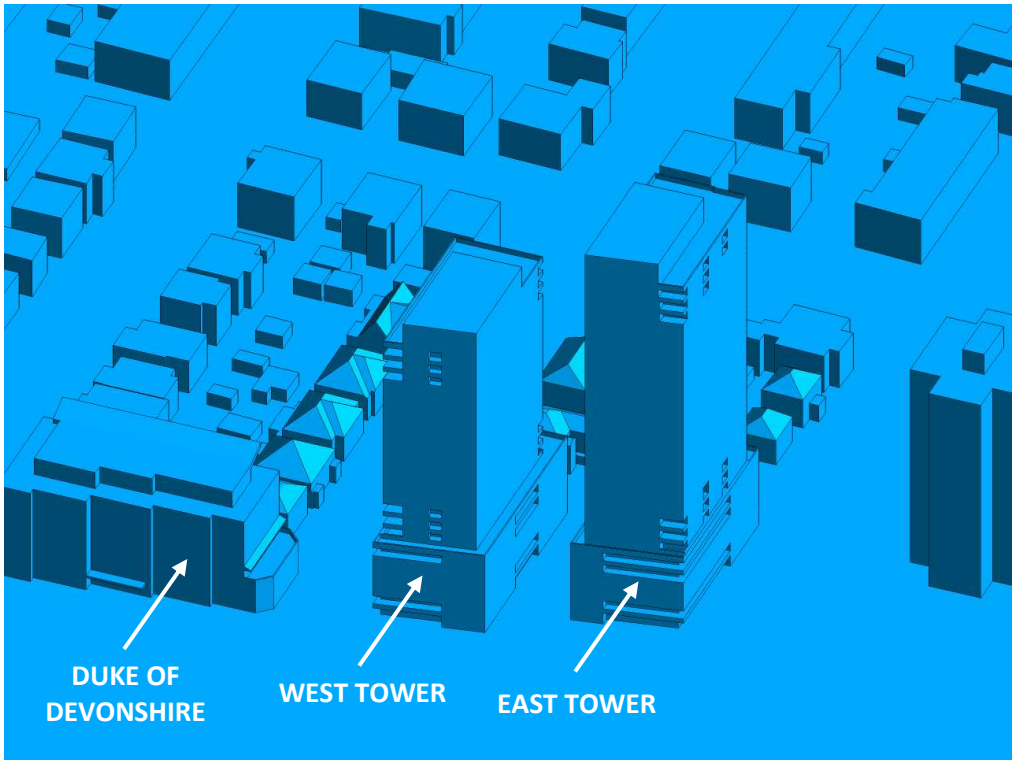

FIGURE 2D: CLOSE UP OF FIGURE 2C

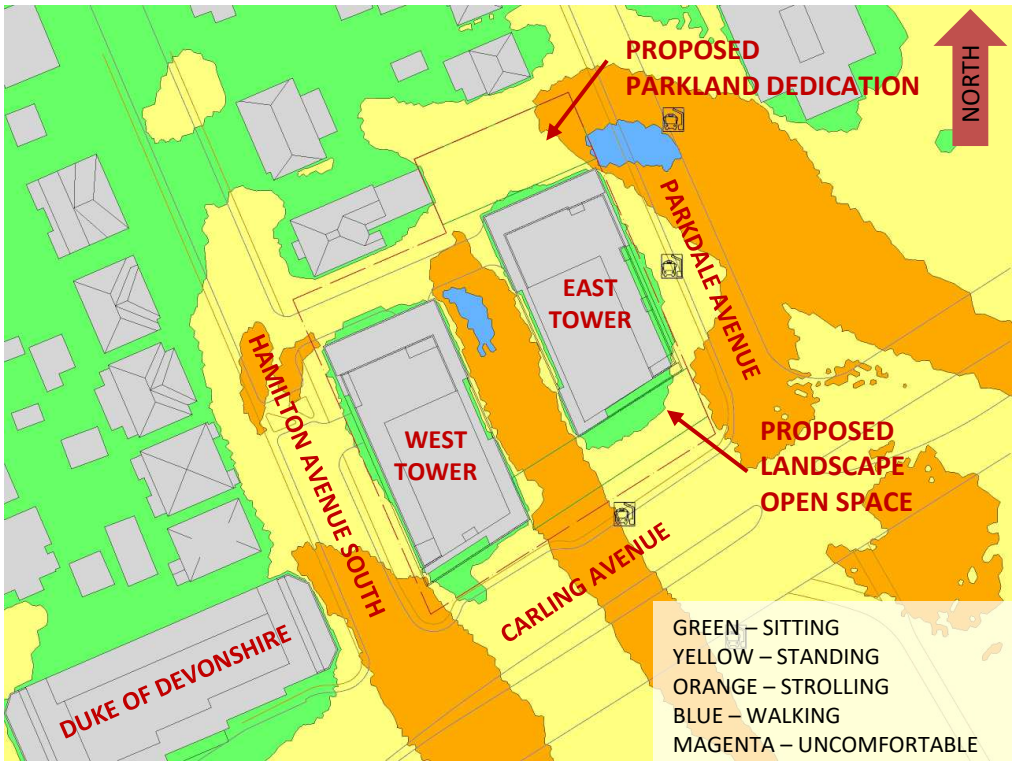

FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL

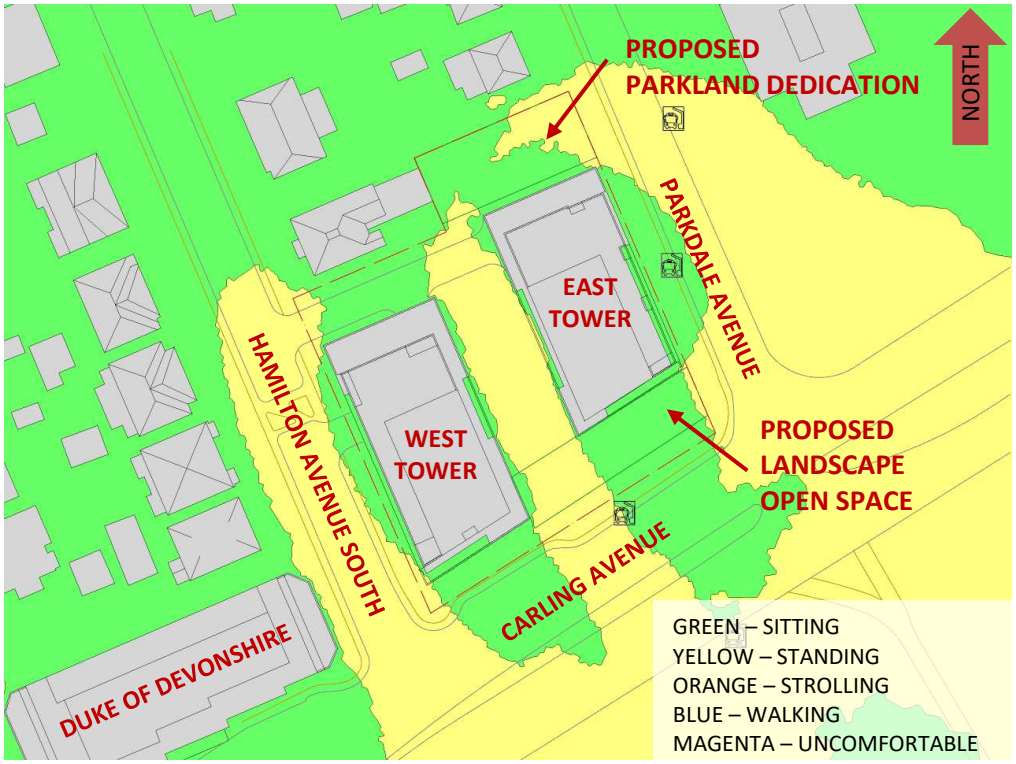

FIGURE 3B: SUMMER – WIND COMFORT, GRADE LEVEL

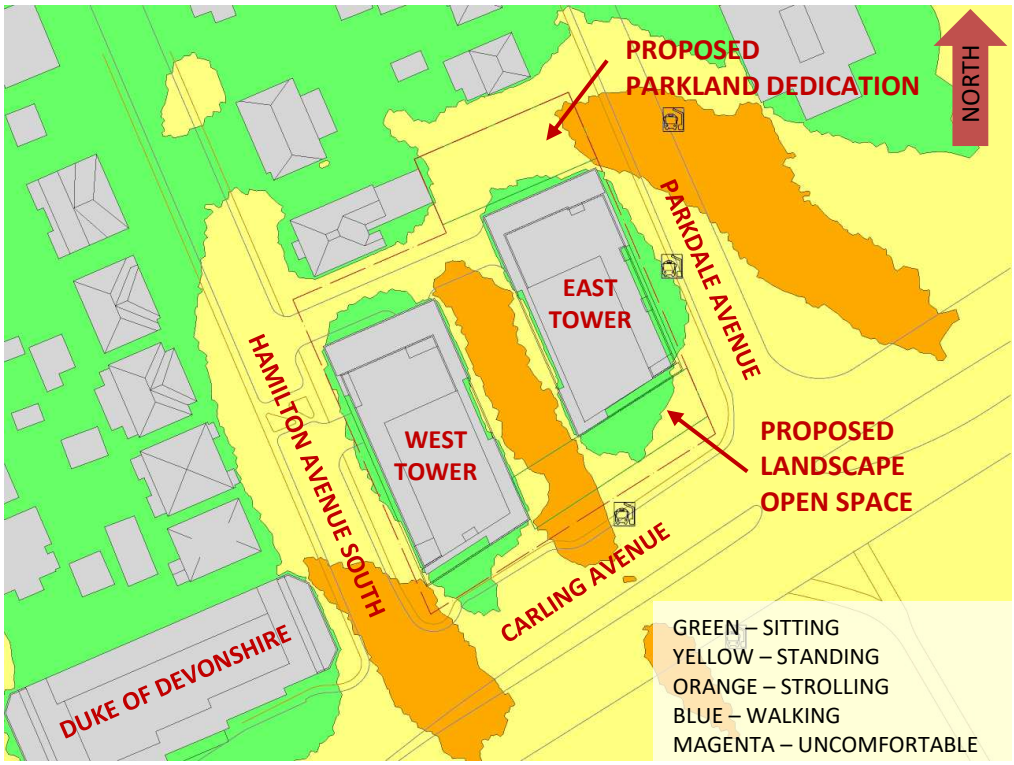

FIGURE 3C: AUTUMN – WIND COMFORT, GRADE LEVEL

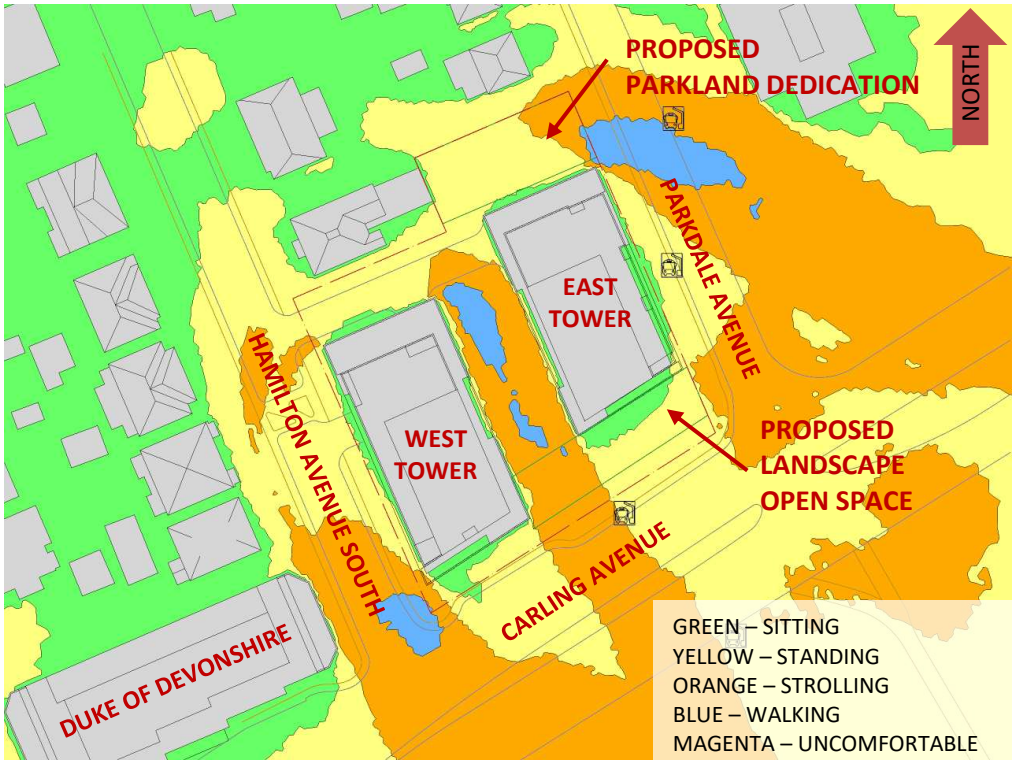

FIGURE 3D: WINTER – WIND COMFORT, GRADE LEVEL

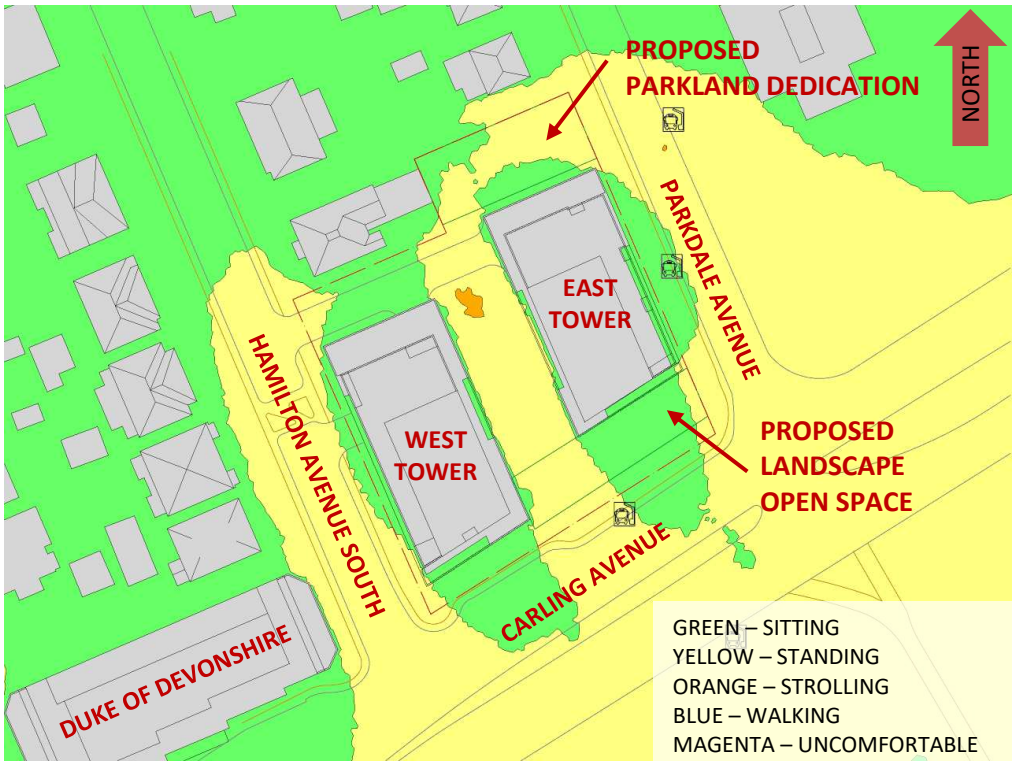

FIGURE 4A: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL

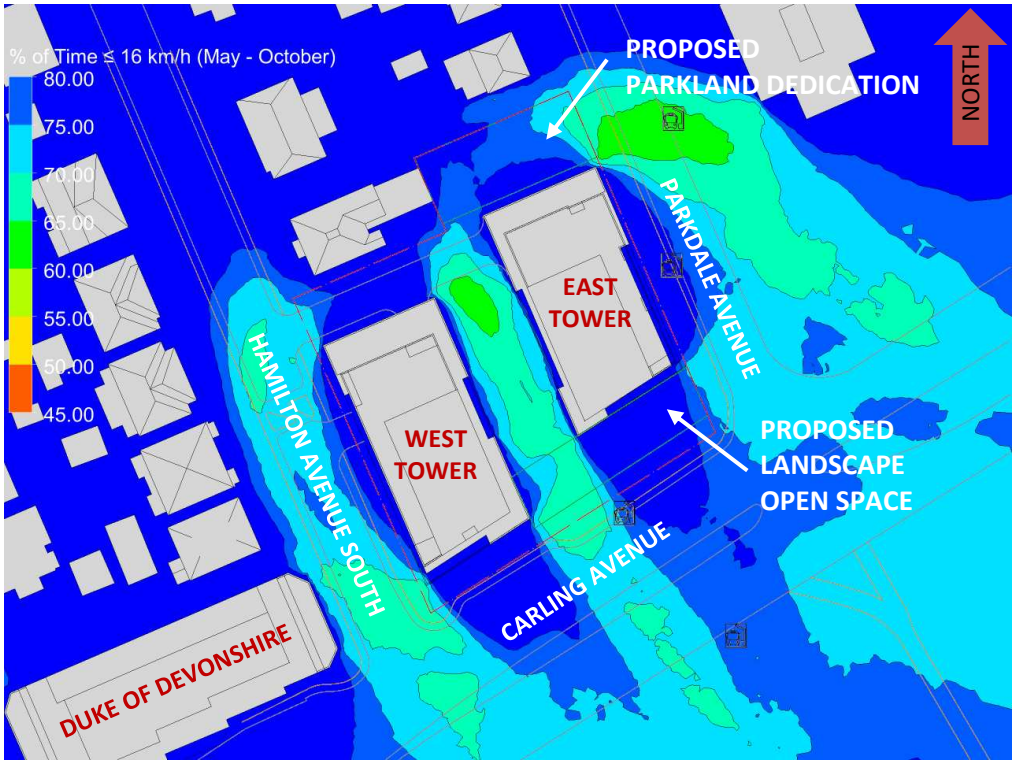

FIGURE 4B: TYPICAL USE PERIOD – % OF TIME SUITABLE FOR SITTING, GRADE LEVEL

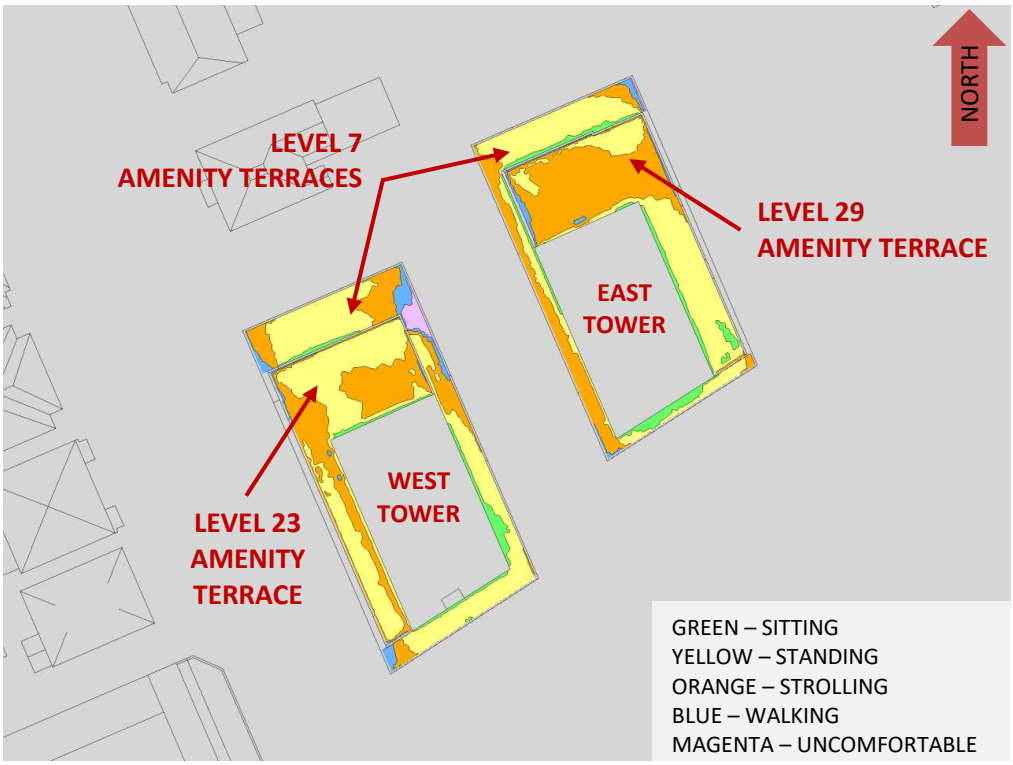

FIGURE 5A: SPRING – WIND COMFORT, AMENITY TERRACES

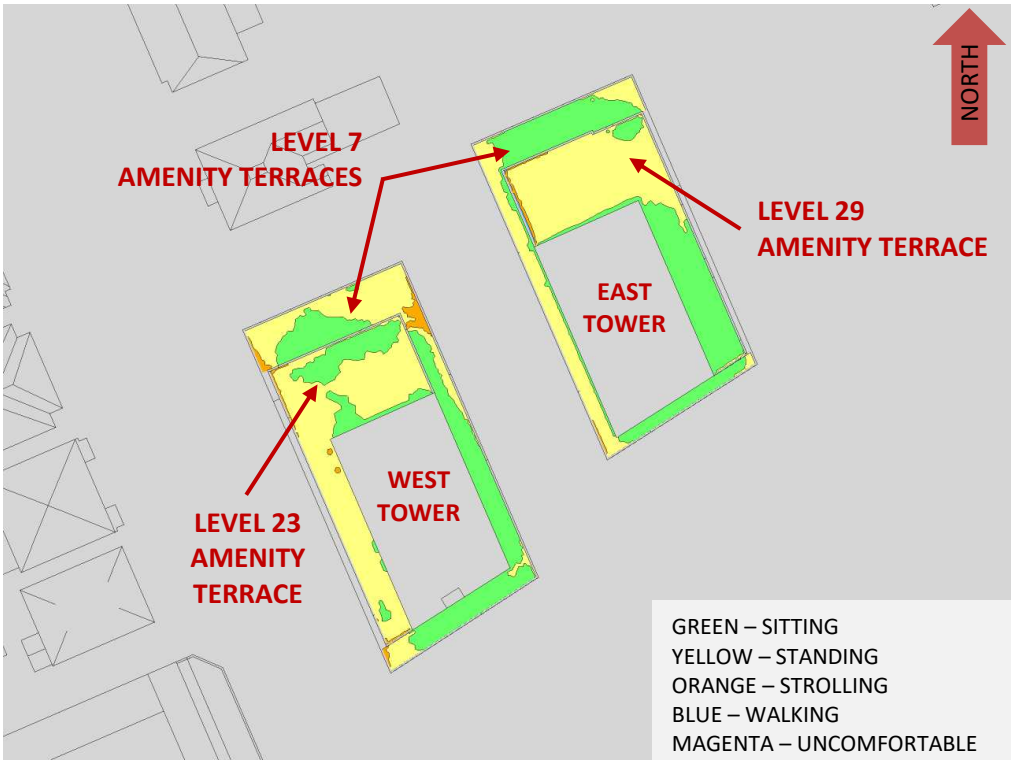

FIGURE 5B: SUMMER – WIND COMFORT, AMENITY TERRACES

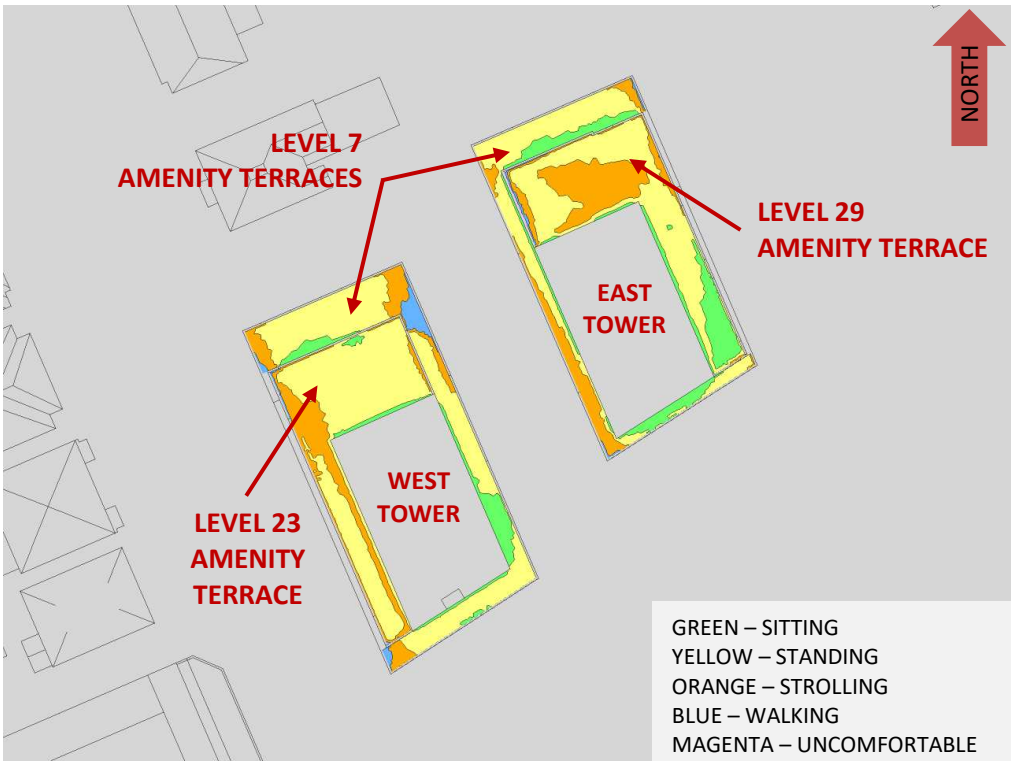

FIGURE 5C: AUTUMN – WIND COMFORT, AMENITY TERRACES

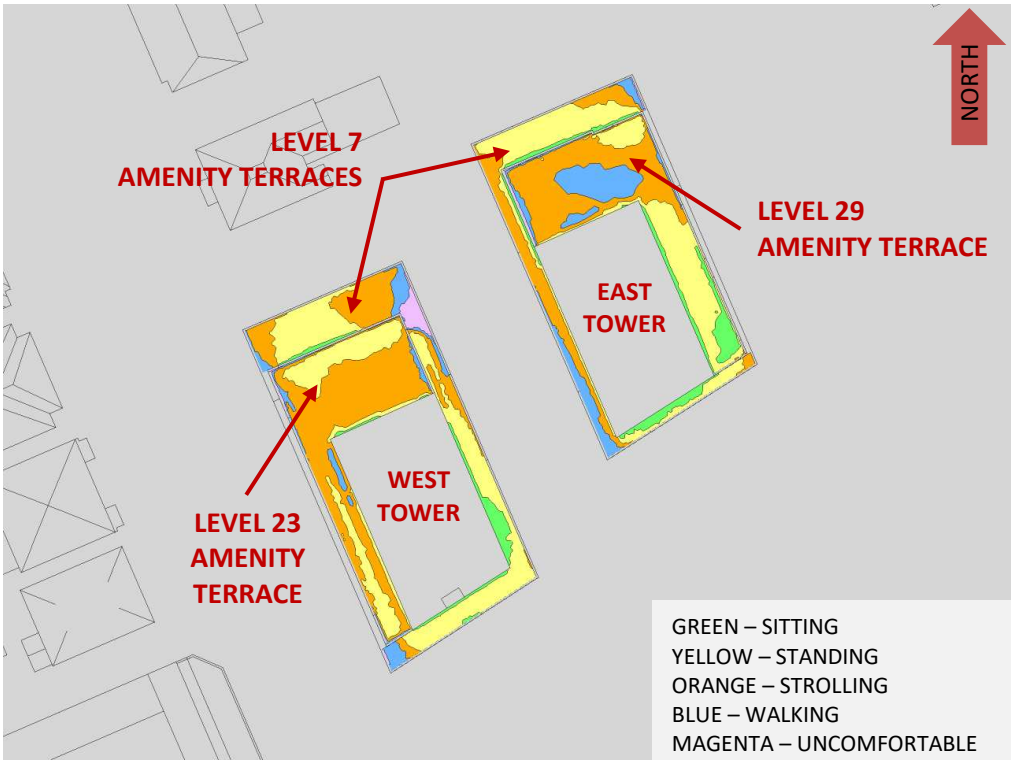

FIGURE 5D: WINTER – WIND COMFORT, AMENITY TERRACES

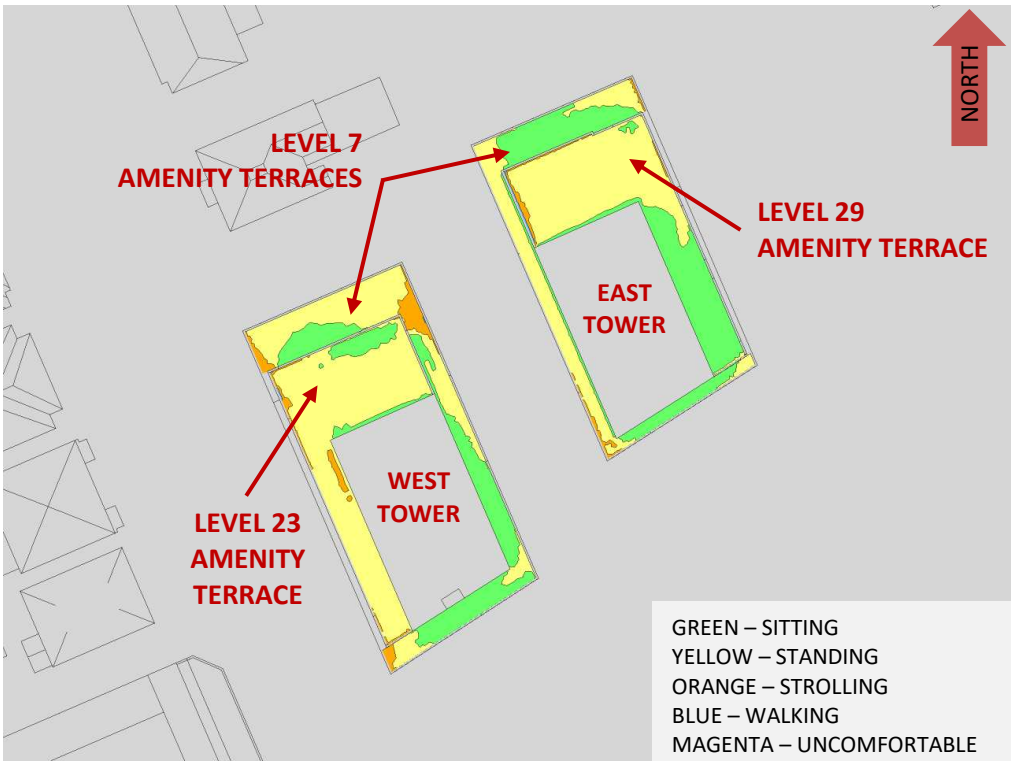

FIGURE 6A: TYPICAL USE PERIOD – WIND COMFORT, AMENITY TERRACES

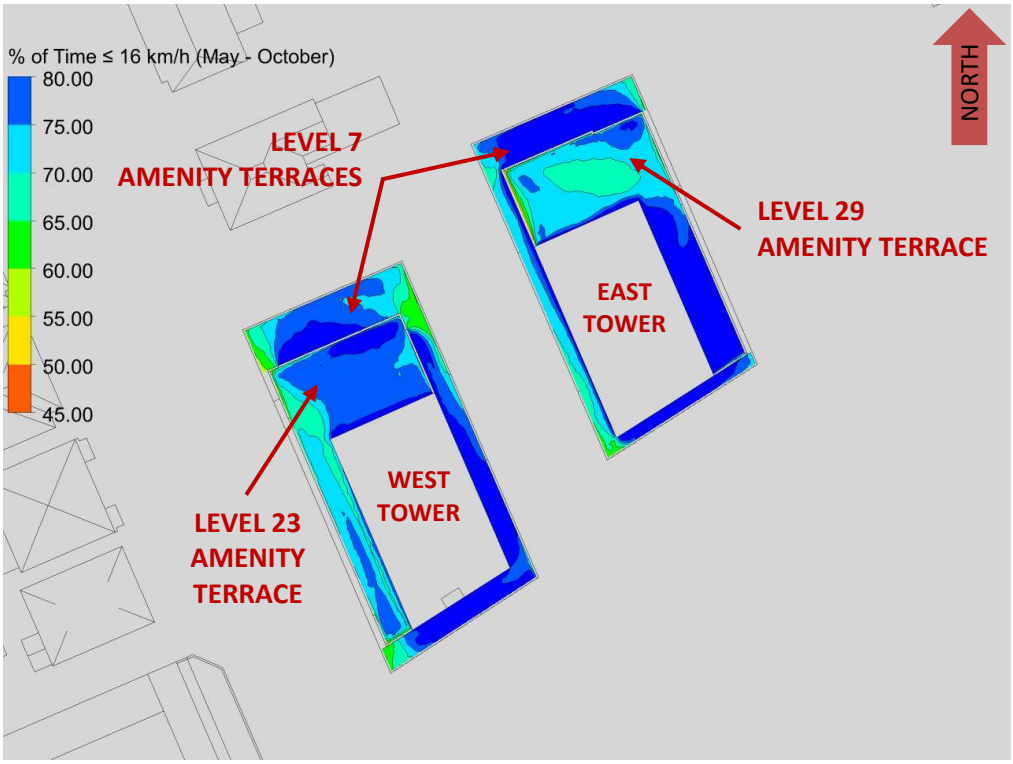

FIGURE 6B: TYPICAL USE PERIOD – % OF TIME SUITABLE FOR SITTING, AMENITY TERRACES

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 (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	0.23
49	0.25
74	0.22
103	0.21
167	0.21
197	0.22
217	0.24
237	0.24
262	0.24
282	0.24
302	0.24
324	0.23

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).

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

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

where, ***I*** = turbulence intensity, $\boldsymbol{L_t}$ = 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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[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 Engieering Symposium, IWES 2003*, Taiwan, 2003.