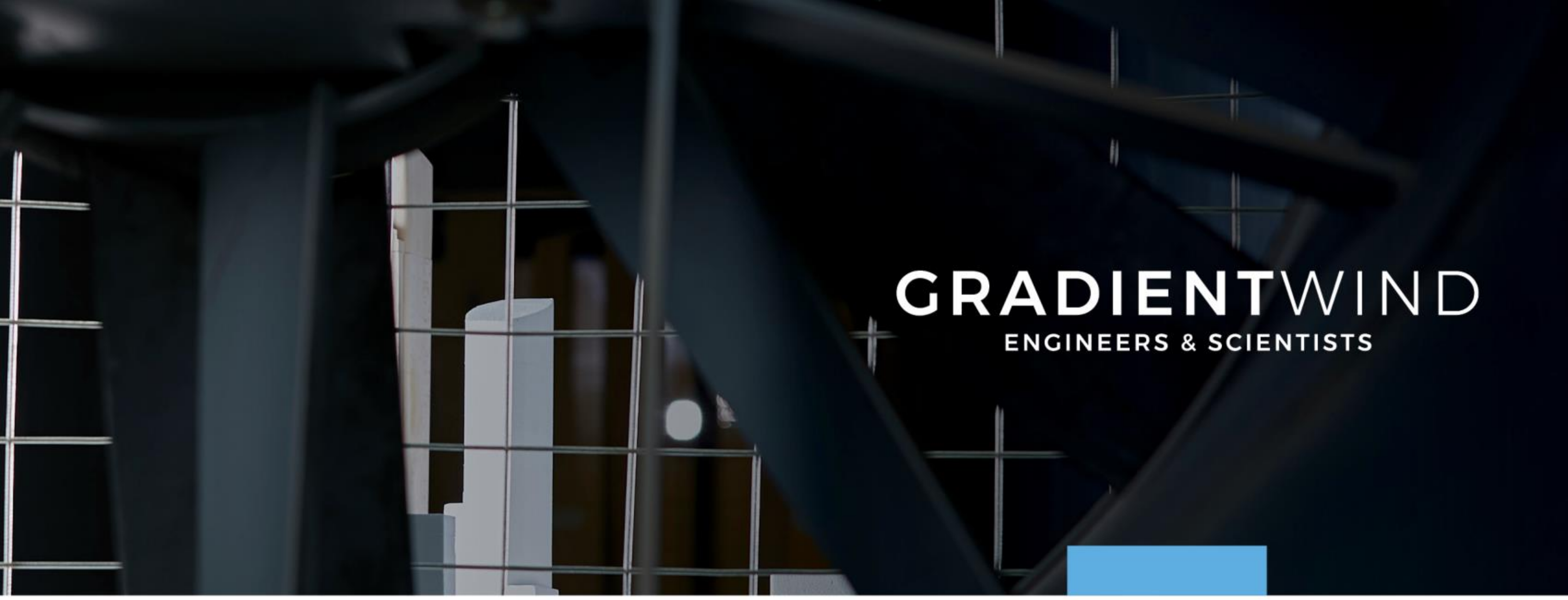
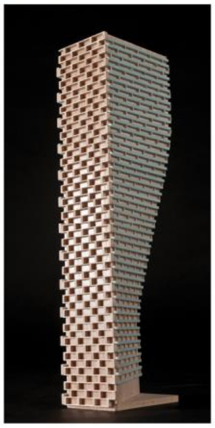
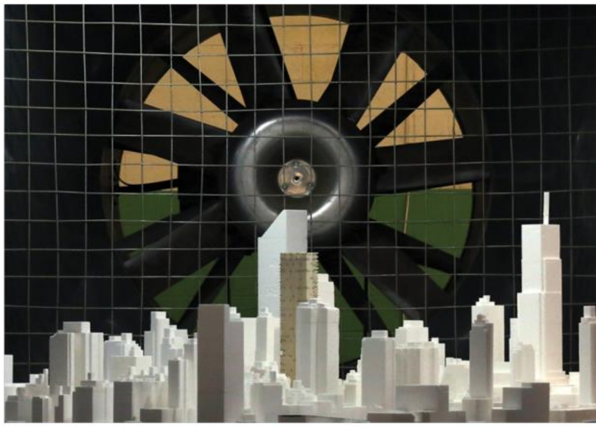


PEDESTRIAN LEVEL WIND STUDY

LeBreton Library Parcel
665 Albert Street
Ottawa, Ontario

Report: 22-064-PLW





April 21, 2022

PREPARED FOR
Dream
30 Adelaide Street East, Suite 301
Toronto, ON M5C 3H1

PREPARED BY
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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy concurrent Official Plan Amendment, Zoning By-law Amendment, and Site Plan Control application requirements for the proposed mixed-use residential development located 665 Albert Street in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind comfort and safety within and surrounding the subject site, and to identify areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered.

The study involves simulation of wind speeds for selected wind directions in a three-dimensional (3D) computer model using the computational fluid dynamics (CFD) technique, combined with meteorological data integration, to assess pedestrian wind comfort and safety within and surrounding the subject site according to City of Ottawa wind comfort and safety criteria. The results and recommendations derived from these considerations are detailed in the main body of the report (Section 5), illustrated in Figures 3A-9, and summarized as follows:

1) All grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, walkways, transit stops, and in the vicinity of building access points, are considered acceptable.

2) Wind conditions within the Wedge Park and the Gathering Circle are expected to be suitable for a mix of sitting and standing during the typical use period. Conditions within the Central Parkette are predicted to be mostly suitable for standing during the same period. The noted wind conditions do not consider landscape elements such as trees or any other wind mitigating features, as noted in Section 4.1.

    a. The architectural design of the proposed development includes elements to mitigate and enhance the experience of the three noted areas, as described in Section 5.1. While amenity spaces typically target the sitting criterion, there is a variety of pedestrian-friendly spaces which may accommodate a range of activity levels.

3) The proposed development is served by many common amenity terraces atop the podia serving the East Tower and West Tower.

   a. The childcare outdoor play area serving the East Tower at Level 3, as well as the amenity terraces serving the West Tower at Levels 4 and 5, are predicted to experience calm wind conditions suitable for sitting during the typical use period. The noted conditions consider standard height perimeter guards.

   b. With standard height perimeter guards, the remaining amenity terraces serving the East Tower and West Tower are predicted to experience wind conditions suitable for standing, or better, during the typical use period. The study also considered the influence of a 1.8-metre-tall wind screen, in the form of a physical barrier, along the full perimeters of the terraces on wind comfort conditions during the same period. Given the favourable results, as summarized in Section 5.2, we recommend that these perimeter wind screens be formally considered as the architectural design progresses.

4) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events, (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.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Dream to undertake a pedestrian level wind (PLW) study to satisfy concurrent Official Plan Amendment, Zoning By-law Amendment, and Site Plan Control application requirements for the proposed mixed-use residential development located at 665 Albert Street 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 KPMB and Perkins&Will, in March 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 665 Albert Street in Ottawa; situated at the northeast intersection of Albert Street and Booth Street. Throughout this report, Albert Street is referred to as project south.

The proposed development comprises two nominally rectangular buildings rising 31 and 36 storeys to the east and west, respectively, above a five-storey podium. Throughout this report the buildings are referred to as the "East Tower" and the "West Tower". Each building includes a mechanical penthouse (MPH) level and a high-roof parapet sloping downwards to the west. Landscaped gathering areas and walkways surround the proposed development with the parkette (referred to as "Central Parkette"), between the East Tower and West Tower, a park (referred to as "Wedge Park") to the north of the West Tower, and a formal gathering area (referred to as "Gathering Circle") to the east of the Wedge Park.

Above two shared below-grade parking levels, the ground floor of the East Tower includes a residential main entrance and an office at the southeast corner, retail space to the south, a community bike shop and public long term and residential bike storage spaces at the northwest corner, childcare entrance to the east, and central loading space and elevator core. Access to below-grade parking is provided by a ramp at the northeast corner of the East Tower via Empress Avenue Lane from Albert Street. Level 2 is reserved for lockers and residential bike storage. Level 3 includes three residential units at the southeast corner, a central shared laundry room, and childcare spaces throughout the remainder of the level. This level is also served by a green roof to the north and a childcare outdoor play area to the southwest. Level 4 includes central lockers and a kids lounge, garden support and indoor amenity at the northwest corner, and residential units throughout the remainder of the level. Level 5 houses a central fitness room, lockers, garden support and indoor amenity, and residential units throughout the remainder of the level. Levels 4 and 5 are served by a community garden to the northwest and a green roof to the southwest. Level 6 includes a lounge, party room, and community kitchen. This level is also served by a community garden to the west, and a community terrace to the east and southeast. Levels 6-31 comprise a nominally rectangular planform and Levels 7-31 are reserved for residential use.

Above two shared below-grade parking levels, the ground floor of the West Tower includes a residential main entrance at the southeast corner, a public long-term bike storage to the south, retail space to the west, a community hub at the northeast corner, and a central elevator core. Level 3 is reserved for lockers. Level 2 includes a central games room, lockers at the northeast corner, and residential units throughout the remainder of the level. This level is also served by an outdoor amenity terrace at the northeast corner. Level 4 includes central lockers, a kids lounge to the north, and residential units throughout the remainder of the level. An outdoor amenity terrace is situated to the north and a green roof is at the southeast corner of this level. Level 5 includes central lockers, co-working space to the north, and a fitness room to the south. This level is also served by an outdoor amenity terrace to the south and a green roof to the north. Level 6 includes a lounge, party room, and community kitchen. A large community garden is provided atop the podium along its west end. Levels 7-36, which are reserved for residential use, comprise a nominally rectangular planform.

The shortest distance between the podia serving the East Tower and West Tower is approximately 8.3 metres (m), while the shortest distance between the tower components, above the podia, is approximately 55.1 m.

The near-field surroundings (defined as an area within 200 m of the subject site) include low-rise residential buildings from the east clockwise southwest with a mid-rise commercial building to the east and another to the southwest. Pimisi Station is situated approximately 75 m to the northwest. Notably, a future development, referred to as "East Flats", comprising five mixed-use residential buildings with heights ranging from 25 to 45 storeys is proposed at 301 Lett Street, located approximately 110 m to the north of the subject site. The two east buildings within East Flats, which rise to 25 and 30 storeys, have been approved[1], while the remaining three buildings serving East Flats are expected to be approved. The far-field surroundings (defined as an area beyond the near-field but within a 2-kilometre (km) radius of the subject site) are characterized primarily by low-rise buildings with isolated mid- to high-rise buildings with a cluster of mid- to high-rise buildings to the north and northeast. The Rideau River flows from the northwest to the northeast, approximately 570 m to the north. Notably, Parliament Hill is situated approximately 1.4 km to the northeast and the Canadian War Museum is located approximately 470 m to the northwest. In addition, a future five-storey Central Ottawa Public Library and Library Archives Canada (OPL-LAC) Joint-Facility, also known as "Ādisōke", is approved at 555 Albert Street, approximately 230 m to the northeast[2].

Site plans for the proposed and existing massing scenarios are illustrated in Figures 1A and 1B, while Figures 2A-2H illustrate the computational models used to conduct the study. The existing massing scenario includes the existing massing and any changes which have been approved by the City of Ottawa. The proposed and existing massing scenarios also include the full East Flats development.

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.

[1] City of Ottawa, '**Application D07-12-20-0074**'
<https://devapps.ottawa.ca/en/applications/D07-12-20-0074/details> (accessed Apr 21, 2022)
[2] City of Ottawa, '**Application D07-12-20-0077**'
<https://devapps.ottawa.ca/en/applications/D07-12-20-0077/details> (accessed Apr 21, 2022)

4. METHODOLOGY

The approach followed to quantify pedestrian wind conditions over the subject 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[3]. 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.

While the industry standard practice is to omit trees, vegetation, and other existing and planned landscaping, the proposed development contemplates the use of coniferous trees and plantings to mitigate prominent westerly winds throughout the year, both at grade at within the amenity terraces. The omission of trees and other landscaping elements from the PLW study produces slightly stronger wind speeds.

[3] 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 480 m.

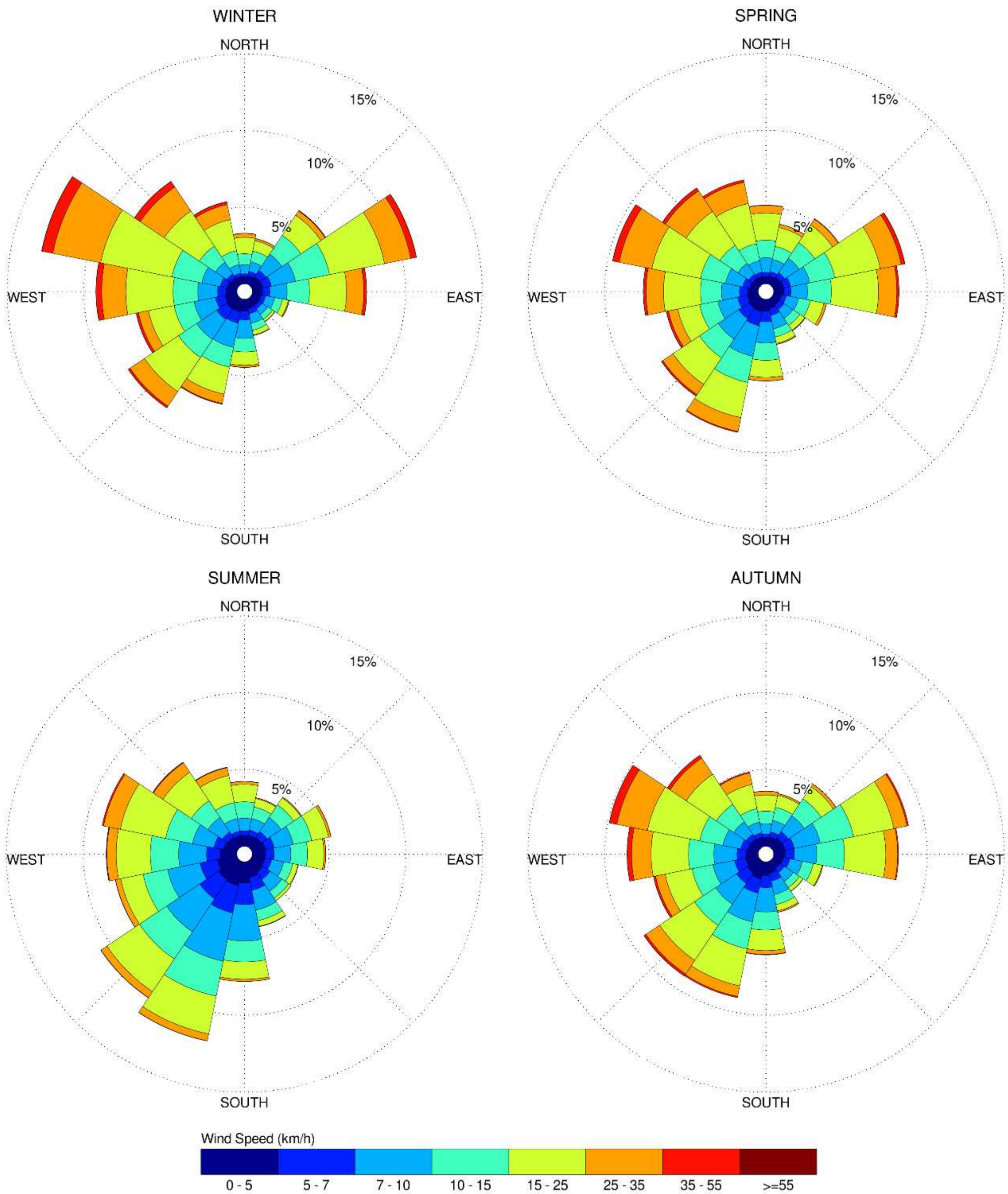
Mean and peak wind speed data obtained over the study site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the common amenity terraces serving the East Tower and West Tower at Levels 3-6 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
Café / Patio / Bench / Garden	Sitting (Summer)
Transit Stop (Without Shelter)	Standing
Transit Stop (With Shelter)	Walking
Public Park / Plaza	Sitting (Summer)
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 Figures 7A-7D, illustrating wind conditions over the common amenity terraces serving the East Tower and West Tower at Levels 3-6. Conditions are presented as continuous contours of wind comfort throughout the subject site and correspond to the comfort classes noted in Section 4.4. 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.

Wind conditions within the common amenity terraces are also reported for the typical use period, which is defined as May to October, inclusive. Figures 8 and 9 illustrates wind comfort conditions consistent with the comfort classes in Section 4.4. Figure 8 represents wind comfort conditions considering standard height perimeter guards (i.e., 1.07 m), while Figure 9 represents wind comfort conditions considering perimeter wind screens extending 1.8 m above the terraces. The details of these conditions are summarized in the following pages for each area of interest.

5.1 Wind Comfort Conditions – Ground Floor

Sidewalks, Walkways, Transit Stops, and Building Access along Albert Street: Following the introduction of the proposed development, the nearby public sidewalk areas and walkways along Albert Street are predicted to be suitable for a mix of sitting and standing during the summer, becoming mostly suitable for standing during the spring and autumn, and suitable for a mix of standing and strolling during the winter. Conditions over the transit stop along Albert Street, adjacent to the East Tower, are predicted to be suitable for sitting during the summer, becoming suitable for standing during the remaining three seasons. The transit stop at southeast intersection of Albert Street and Booth Street is predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for standing during the spring and autumn, and suitable for strolling during the winter. Conditions in the immediate vicinity of the building access points serving the East Tower and West Tower along Albert Street are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, during the remaining three seasons. The noted conditions are considered acceptable according to the wind comfort criteria.

Conditions over the sidewalks along Albert Street 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 spring and autumn, and mostly suitable for standing during the winter. Conditions over the nearby transit stops are predicted to be suitable for sitting throughout the year, except during the winter where the transit stop along the north sidewalk is predicted to be suitable for standing and the transit stop along the south sidewalk is predicted to be suitable for a mix of sitting and standing. While the introduction of the proposed development produces slightly windier conditions in comparison to existing conditions, wind comfort conditions with the proposed development are considered acceptable.

Central Parkette: Conditions over the parkette are predicted to be suitable mostly for standing during the typical use period, according to the comfort criteria in Section 4.4. The area is also predicted to be suitable for sitting in all areas for at least 65% of the time during the same period, where the target is 80%.

The parkette is predicted to receive strong winds from the south clockwise to north, inclusive. The strongest winds influencing conditions within the parkette originate from the southwest clockwise to northwest. The architectural design of the proposed development includes elements to mitigate and enhance the experience of the parkette. Specifically, the Central Parkette includes deciduous and coniferous trees throughout the area, which are expected to increase wind comfort locally. The design elements considered for the Wedge Park, noted below, are also expected to improve wind conditions within the Central Parkette.

Sidewalks, Walkways, Transit Stops, and Building Access along Booth Street: Following the introduction of the proposed development, the nearby public sidewalk areas and walkways along Booth Street are predicted to be mostly suitable sitting during the summer, becoming suitable for a mix of sitting and standing during the autumn, and suitable for strolling, or better, during the winter and spring. Conditions over the nearby Pimisi Station east of Booth Street are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the spring and autumn, and mostly suitable for standing during the winter. The transit stop west of Booth Street is predicted to be suitable for sitting during the spring, summer, and autumn, becoming suitable for a mix of sitting and standing during the winter. Conditions in the immediate vicinity of the single building access point serving the West Tower along Booth Street are predicted to be suitable for sitting during the spring, summer, and autumn, becoming mostly suitable for sitting during the winter. The noted conditions are considered acceptable according to the wind comfort criteria.

Conditions over the sidewalks along Booth Street with the existing massing are predicted to be mostly suitable sitting during the summer, becoming suitable for a mix of sitting and standing during the autumn, becoming suitable for a mix of standing and strolling during the winter and spring. Conditions over the nearby Pimisi Station transit stops are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the spring and autumn, and mostly suitable for standing during the winter. While the noted wind conditions are considered acceptable according to the comfort criteria in Section 4.4, the introduction of the proposed development is predicted to increase comfort levels in some areas, in comparison to existing conditions.

The Wedge Park: Conditions over the park without trees, berms, or any other wind mitigating features are predicted to be suitable for a mix of sitting and standing during the typical use period, according to the comfort criteria in Section 4.4. The area is also predicted to be suitable for sitting in all areas for at least 75% of the time during the same period, where the target is 80%.

The park is predicted to receive strong winds from the south-southeast clockwise to northwest, as well as from those from the north, inclusive. The strongest winds influencing conditions within the park originate from the southwest clockwise to west-northwest.

The architectural design of the proposed development includes elements to mitigate and enhance the experience of the park. Specifically, the Wedge Park includes many coniferous trees in dense arrangements throughout the area, which are expected to increase wind comfort locally. The planting strategy is also expected to reduce wind flow between the West Tower and East Tower, which would increase comfort levels within the Central Parkette.

The Gathering Circle: Conditions over the Gathering Circle are predicted to be suitable for a mix of sitting and standing during the typical use period, according to the comfort criteria in Section 4.4. The area is also predicted to be suitable for sitting in all areas for at least 75% of the time during the same period, where the target is 80%.

The Gathering Circle is predicted to receive strong winds from the south-southeast clockwise to west-northwest, inclusive. The strongest winds influencing conditions within the area are the same as those that are predicted to influence conditions within the Wedge Park, located to the west of the Gathering Circle. The planting strategy noted above for the Wedge Park is expected to reduce local wind speeds and increase comfort levels within the Gathering Circle to acceptable levels during the typical use period, and to satisfactory levels during the remaining colder months of the year.

Walkway and Building Access North of Subject Site: Conditions over the walkway situated to the north of the subject site are predicted to be mostly suitable for sitting during the summer, becoming mostly suitable for standing during the remaining three seasons. Similar conditions are predicted in the immediate vicinity of the building access points serving the East Tower and West Tower. The noted conditions are considered acceptable according to the wind comfort criteria.

Walkway and Building Access Along Empress Avenue Lane: Conditions over the walkway along Empress Avenue Lane are predicted to be mostly suitable for sitting during the summer, for a mix of sitting and standing during the autumn, becoming mostly suitable for standing during the winter and spring. Conditions in the immediate vicinity of the building access points serving the East Tower along Empress

Avenue Lane, including the daycare lobby entrance, are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable according to the wind comfort criteria.

Central Walkways and Building Access: Conditions over the walkways situated centrally 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 during the spring and autumn, and suitable for a mix of strolling and walking during the winter.

Conditions in the immediate vicinity of the building access points serving the bike shop and community space within the East Tower, and the multipurpose room within the West Tower, which both front onto the central area, are predicted to be suitable for a mix of sitting and standing during the summer, for standing during the spring and autumn, becoming suitable for a mix of standing and strolling during the winter. Given the orientation of the proposed development to prominent winds, the east elevation of the West Tower is expected to experience stronger winds throughout the year, as compared to the west elevation of the East Tower. We recommend that both noted access points be recessed into the podia by 2.0 m. Alternatively, the entrances could be flanked by wind screens protruding 2.0 m from the podia, complete with canopies extending at least 2.0 m from the podia.

5.2 Wind Comfort Conditions – Elevated Common Amenity Terraces

East Tower

1. **Childcare Outdoor Play Area (Level 3):** Wind conditions over the childcare outdoor play area serving the East Tower at Level 3 are predicted to be suitable for sitting during the typical use period. The noted conditions are considered acceptable according to the wind comfort criteria.

2. **Community Garden (Level 4):** Wind conditions over the community garden serving the East Tower at Level 4 are predicted to be suitable for a mix of sitting and standing during the typical use period, as illustrated in Figure 8. Within the areas that are predicted to be suitable for standing, according to the comfort criteria in Section 4.4, conditions are also predicted to be suitable for sitting for at least 70% of the time during the same period, where the target is 80%.

   Figure 9 illustrates the influence of a 1.8-m-tall wind screen along the full perimeter of the Level 4 terrace on wind comfort conditions during the typical use period. With the noted wind screen, conditions within all areas of the terrace are predicted to be suitable for sitting. While the proposed development contemplates the use of coniferous trees and plantings to mitigate prominent westerly winds throughout the year, the noted wind screen would be recommended to ensure sitting conditions are provided for at least 80% of the time during the typical use period.

3. **Community Garden (Level 5):** Wind conditions over the community garden serving the East Tower at Level 5 are predicted to be suitable for a mix of sitting and standing during the typical use period, as illustrated in Figure 8. Within the areas that are predicted to be suitable for standing, according to the comfort criteria in Section 4.4, conditions are also predicted to be suitable for sitting for at least 65% of the time during the same period, where the target is 80%.

   Figure 9 illustrates the influence of a 1.8-m-tall wind screen along the full perimeter of the Level 5 terrace on wind comfort conditions during the typical use period. With the noted wind screen, conditions within all areas of the terrace are predicted to be suitable for sitting. While the proposed development contemplates the use of coniferous trees and plantings to mitigate prominent westerly winds throughout the year, the noted wind screen would be recommended to ensure sitting conditions are provided for at least 80% of the time during the typical use period.

4. **Community Garden and Community Terrace (Level 6):** Wind conditions over the community garden serving the East Tower at Level 6 are predicted to be suitable for standing during the typical use period, as illustrated in Figure 8. The community garden is also predicted to be suitable for sitting for at least 65% of the time during the same period, where the target is 80%.

   Figure 9 illustrates the influence of a 1.8-m-tall wind screen along the full perimeter of the Level 6 terrace on wind comfort conditions during the typical use period. With the noted wind screen, conditions within the community garden are mostly suitable for sitting. Within most of the areas that remain suitable for standing, according to the comfort criteria in Section 4.4, conditions are also predicted to be suitable for sitting for at least 75% of the time during the same period. The only exception is the roof area adjacent to the northwest corner of the East Tower, which is predicted to be suitable for sitting for at least 70% of the time during the typical use period.

   Wind conditions over the community terrace serving the East Tower at Level 6 are predicted to be suitable for a mix of sitting and standing during the typical use period, as illustrated in Figure 8.

The community terrace is also predicted to be suitable for sitting for at least 70% of the time during the same period, where the target is 80%.

Figure 9 illustrates the influence of a 1.8-m-tall wind screen along the full perimeter of the Level 6 terrace on wind comfort conditions during the typical use period. With the noted wind screen, conditions within the community terrace are mostly suitable for sitting. Within the areas that remain suitable for standing, according to the comfort criteria in Section 4.4, conditions are also predicted to be suitable for sitting for at least 75% of the time during the same period.

Given the exposure of the above noted areas to prominent winds, a 1.8-m-tall wind screen is recommended along the full perimeter of the roof at Level 6.

West Tower

1. **Amenity Terrace (Level 3):** Wind conditions over the amenity terrace serving the West Tower at Level 3 are predicted to be suitable mostly for standing during the typical use period, as illustrated in Figure 8. The amenity terrace is also predicted to be suitable for sitting for at least 70% of the time during the same period, where the target is 80%.

   Figure 9 illustrates the influence of a 1.8-m-tall wind screen along the full perimeter of the Level 3 terrace on wind comfort conditions during the typical use period. With the noted wind screen, conditions within most areas of the terrace are predicted to be suitable for sitting. Within the small central area that is predicted to be suitable for standing, according to the comfort criteria in Section 4.4, conditions are also predicted to be suitable for sitting for at least 75% of the time during the same period, where the target is 80%. The noted tall perimeter wind screen is recommended given the intended sitting and lounging uses of the terrace.

2. **Amenity Terraces (Levels 4 and 5):** Wind conditions over the amenity terraces serving the West Tower at Levels 4 and 5 are predicted to be suitable for sitting during the typical use period. The noted conditions are considered acceptable according to the wind comfort criteria.

3. **Community Garden and Community Terrace (Level 6):** Wind conditions over the community garden serving the West Tower at Level 6 at the north end are predicted to be suitable for standing during the typical use period, as illustrated in Figure 8. The only exception is the area adjacent to

the northwest corner of the West Tower, which is predicted to be suitable for strolling. Within the areas that are predicted to be suitable for standing and strolling, according to the comfort criteria in Section 4.4, conditions are also predicted to be suitable for sitting for at least 60% of the time during the same period, where the target is 80%.

While the remainder of the roof area is also predicted to be suitable for standing during the typical use period, most of the area is predicted to be suitable for sitting for at least 70% of the time during the same period. The south end of the roof is predicted to be suitable for sitting for at least 65% of the time.

Figure 9 illustrates the influence of a 1.8-m-tall wind screen along the full perimeter of the Level 6 terrace on wind comfort conditions during the typical use period. With the noted wind screen, conditions at the northwest corner of the West Tower are predicted to achieve the standing comfort class, while the remainder of the roof area continues to be suitable for standing. Additionally, most of the area is predicted to be suitable for sitting for at least 70% of the time during the same period.

Given the exposure of the roof area to prominent winds, a 1.8-m-tall wind screen is recommended along the full perimeter of the roof at Level 6. A wind screen extending greater than 1.8 m above the local walking surface is expected to increase wind comfort levels immediately adjacent to the roof perimeter; comfort levels within the central roof area would not be expected to change compared to those illustrated in Figure 9. Given the large roof area, mitigation inboard of the perimeter, in addition to a 1.8-m-tall perimeter wind screen, would increase wind comfort to acceptable levels during the typical use period. The proposed development contemplates the use of coniferous trees and plantings to mitigate prominent westerly winds throughout the year. Additional mitigation is expected to be required and could take the form of wind screens, either solid or mostly solid, rising to a minimum height of 1.6 m above the walking surface of the terrace, overhead structures such as pergolas and trellises, or a combination of the various strategies.

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

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-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) All grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, walkways, transit stops, and in the vicinity of building access points, are considered acceptable.

2) Wind conditions within the Wedge Park and the Gathering Circle are expected to be suitable for a mix of sitting and standing during the typical use period. Conditions within the Central Parkette are predicted to be mostly suitable for standing during the same period. The noted wind conditions do not consider landscape elements such as trees or any other wind mitigating features, as noted in Section 4.1.

    a. The architectural design of the proposed development includes elements to mitigate and enhance the experience of the three noted areas, as described in Section 5.1. While amenity spaces typically target the sitting criterion, there is a variety of pedestrian-friendly spaces which may accommodate a range of activity levels.

3) The proposed development is served by many common amenity terraces atop the podia serving the East Tower and West Tower.

    a. The childcare outdoor play area serving the East Tower at Level 3, as well as the amenity terraces serving the West Tower at Levels 4 and 5, are predicted to experience calm wind conditions suitable for sitting during the typical use period. The noted conditions consider standard height perimeter guards.

b. With standard height perimeter guards, the remaining amenity terraces serving the East Tower and West Tower are predicted to experience wind conditions suitable for standing, or better, during the typical use period. The study also considered the influence of a 1.8-m-tall wind screen, in the form of a physical barrier, along the full perimeters of the terraces on wind comfort conditions during the same period. Given the favourable results, as summarized in Section 5.2, we recommend that these perimeter wind screens be formally considered as the architectural design progresses.

4) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events, (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
J. D. FERRARO
100158495
Apr 21, 2022
PROVINCE OF ONTARIO

Edward Urbanski, M.Eng.
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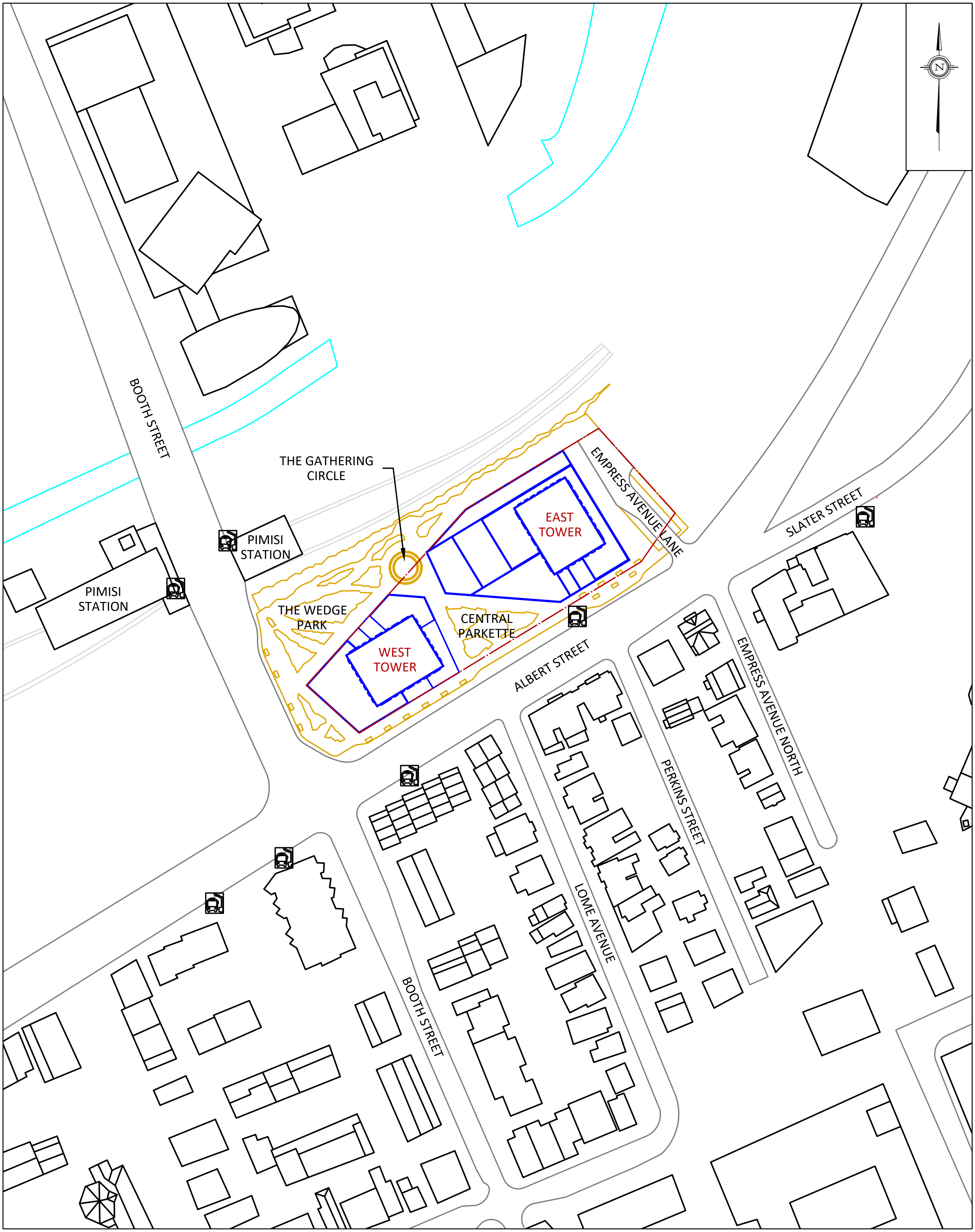

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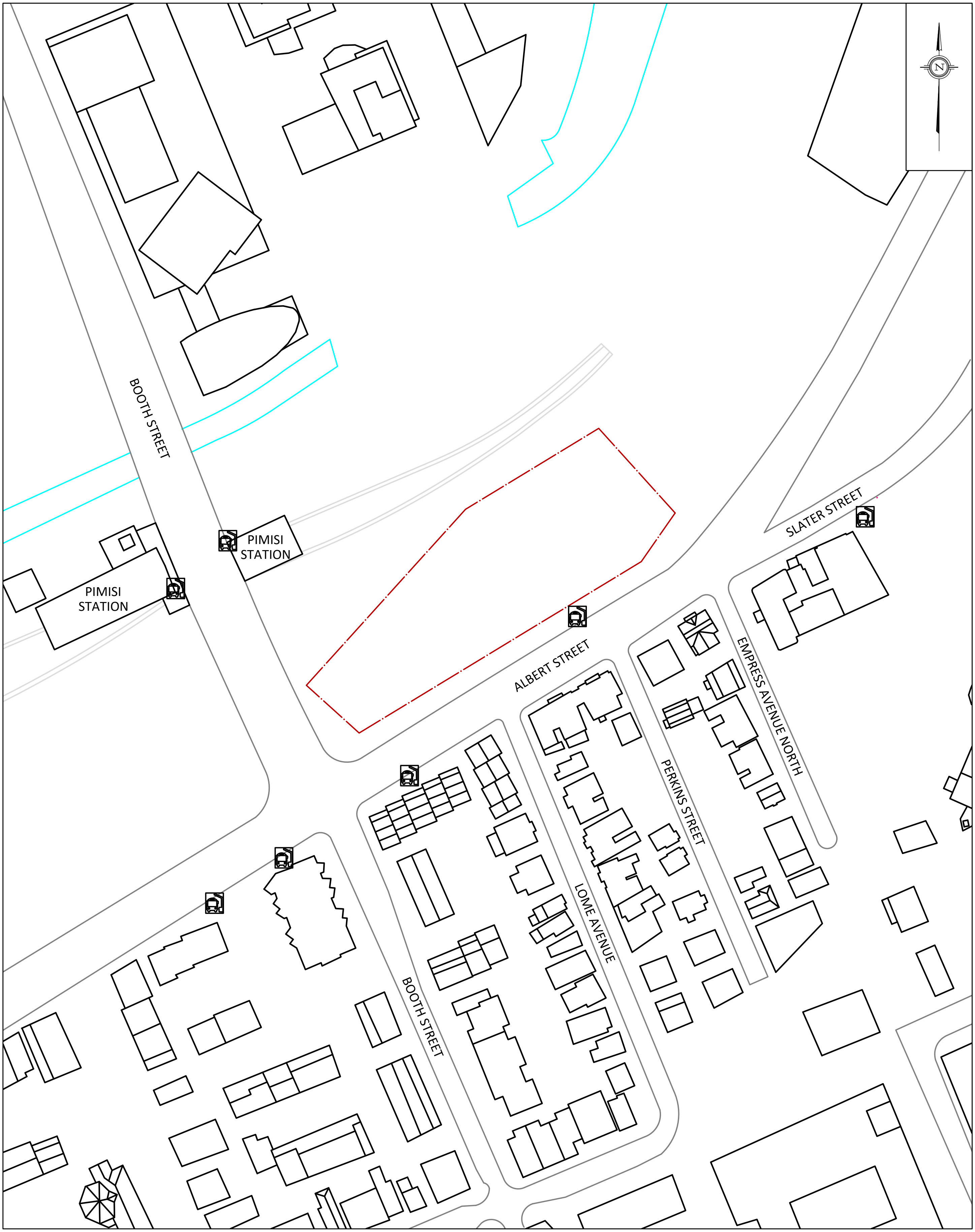
PROJECT		DESCRIPTION
665 ALBERT STREET, OTTAWA PEDESTRIAN LEVEL WIND STUDY		FIGURE 1A: PROPOSED SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:2000	DRAWING NO.: 22-064-PLW-1A	
DATE: APRIL 8, 2022	DRAWN BY: S.K.	



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PROJECT		DESCRIPTION
665 ALBERT STREET, OTTAWA PEDESTRIAN LEVEL WIND STUDY		FIGURE 1B: EXISTING SITE PLAN AND SURROUNDING CONTEXT
SCALE 1:2000	DRAWING NO. 22-064-PLW-1B	
DATE APRIL 8, 2022	DRAWN BY S.K.	

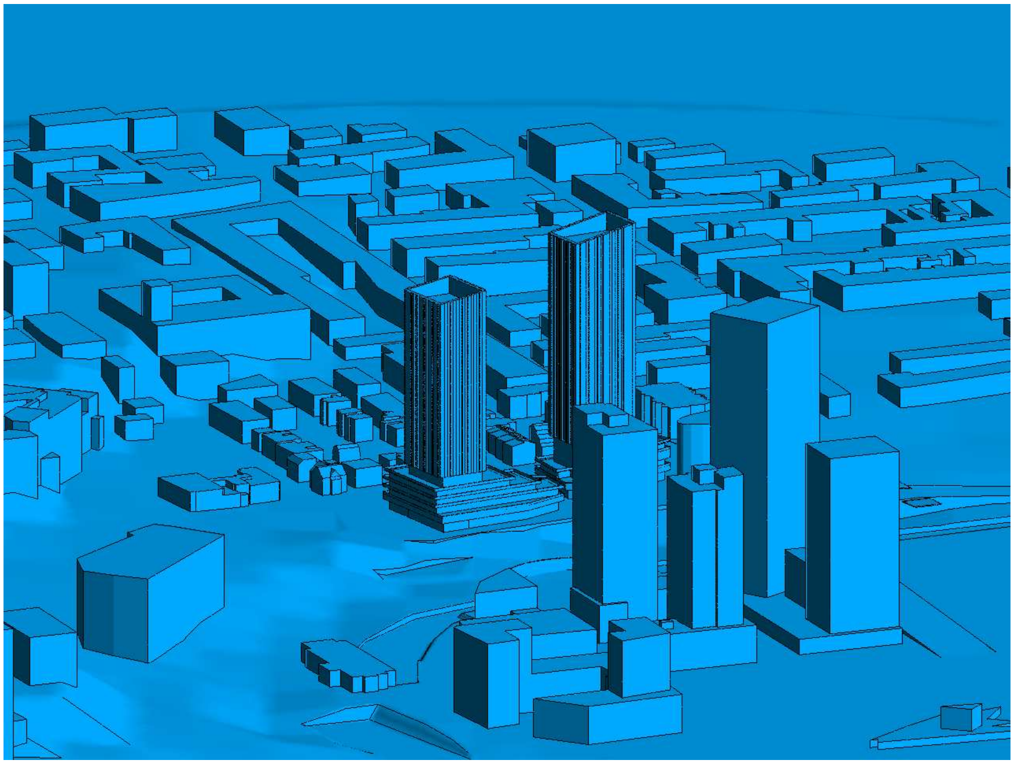


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

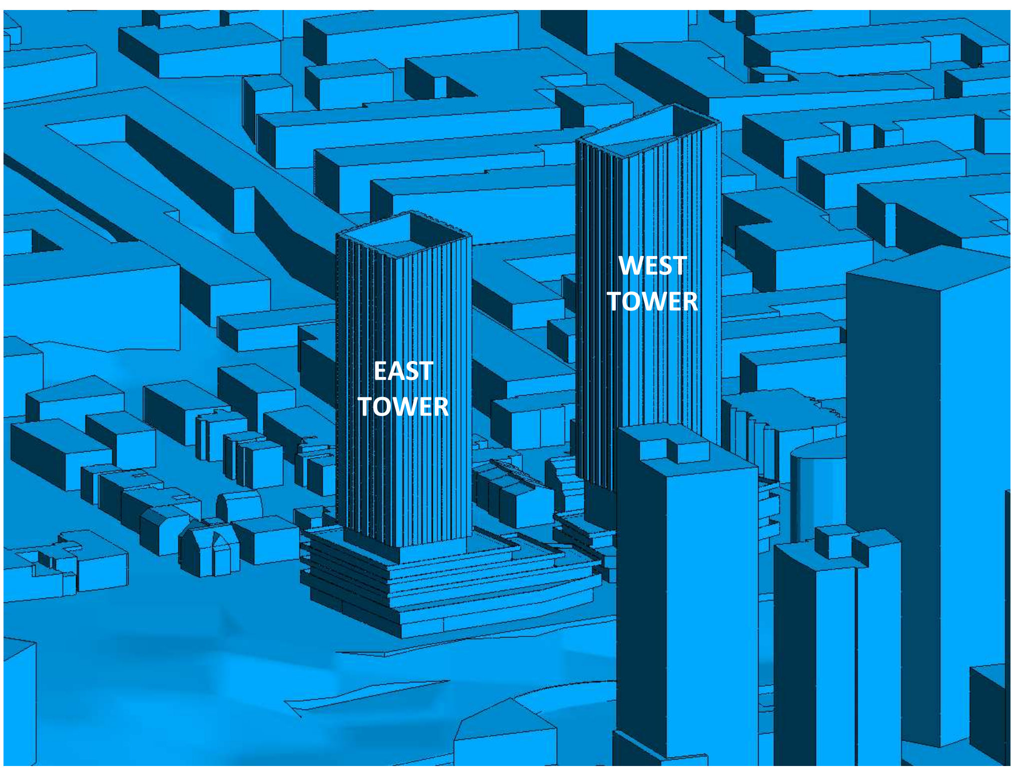


FIGURE 2B: CLOSE UP OF FIGURE 2A

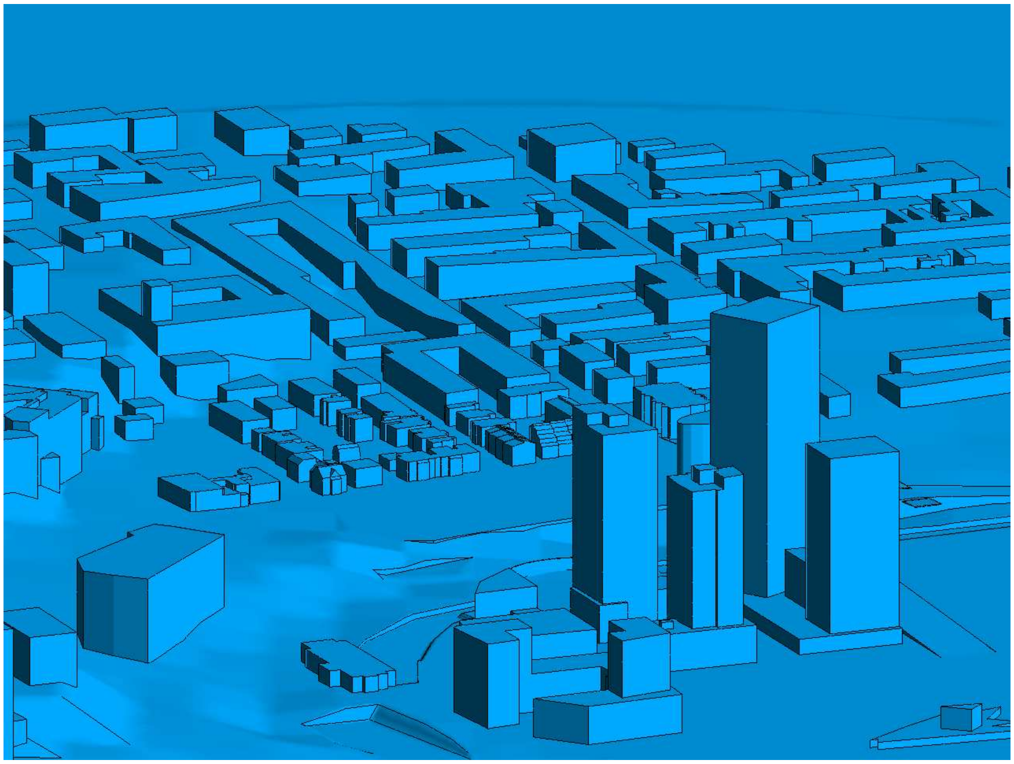


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

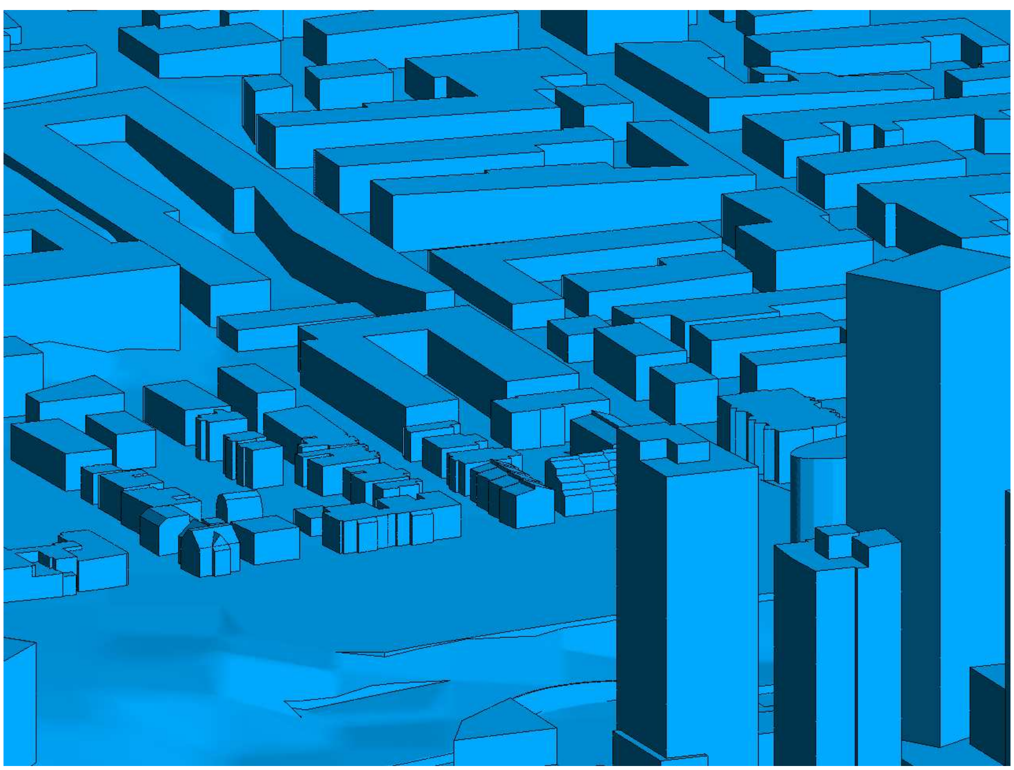


FIGURE 2D: CLOSE UP OF FIGURE 2C

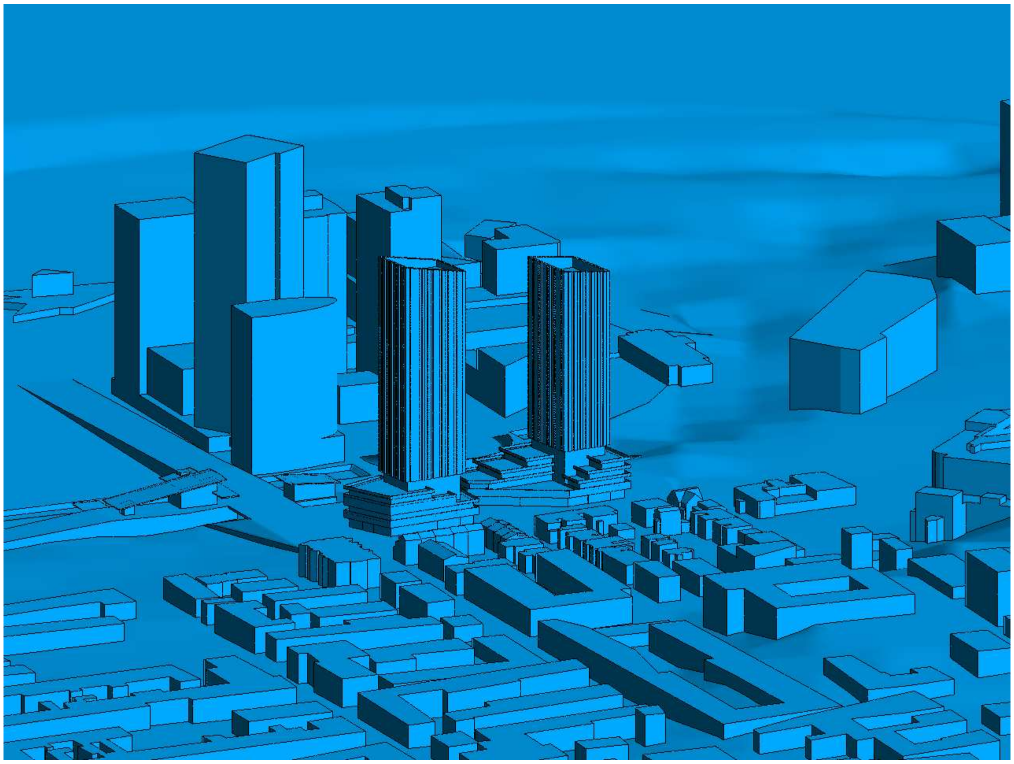


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

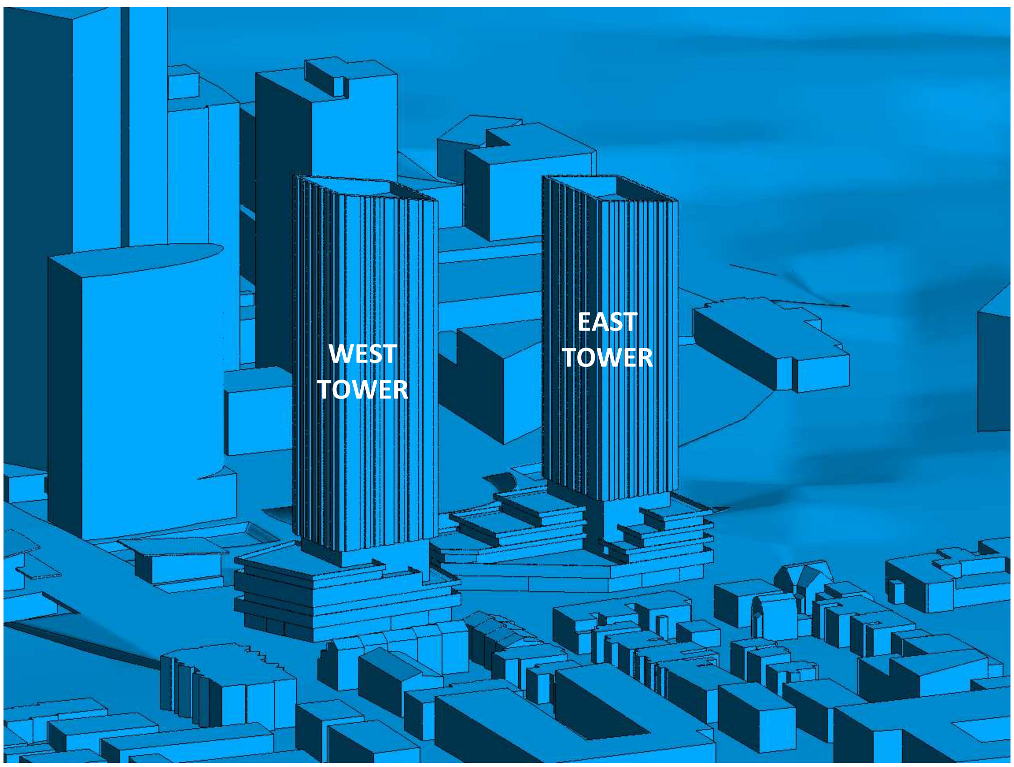


FIGURE 2F: CLOSE UP OF FIGURE 2E

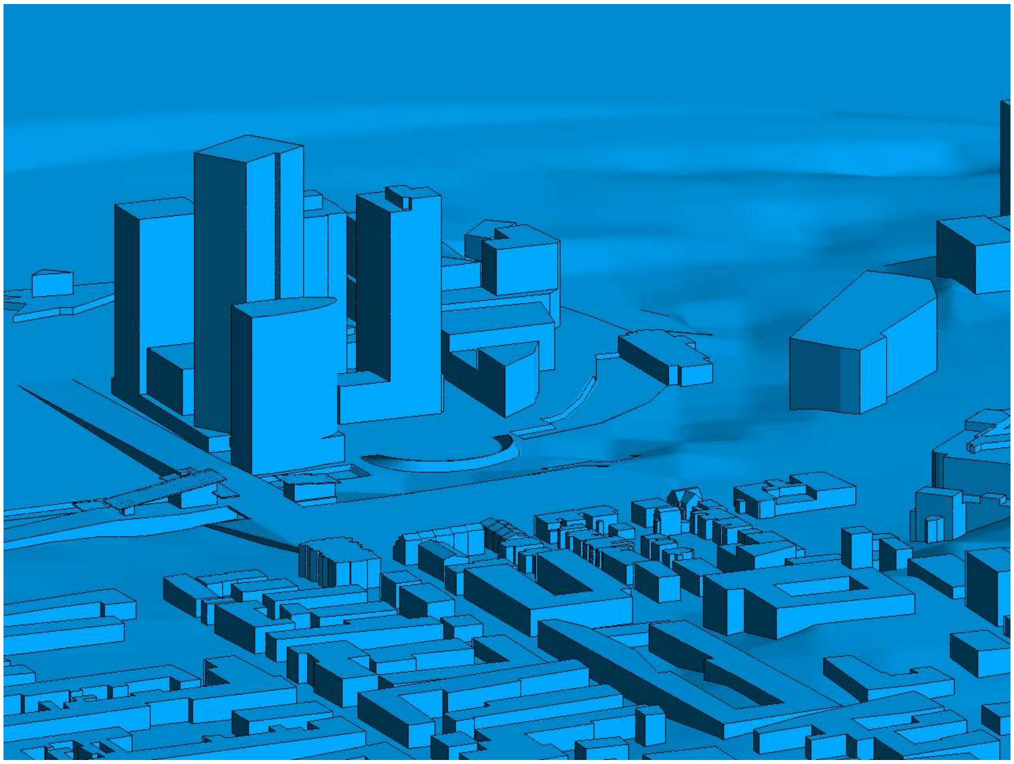


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

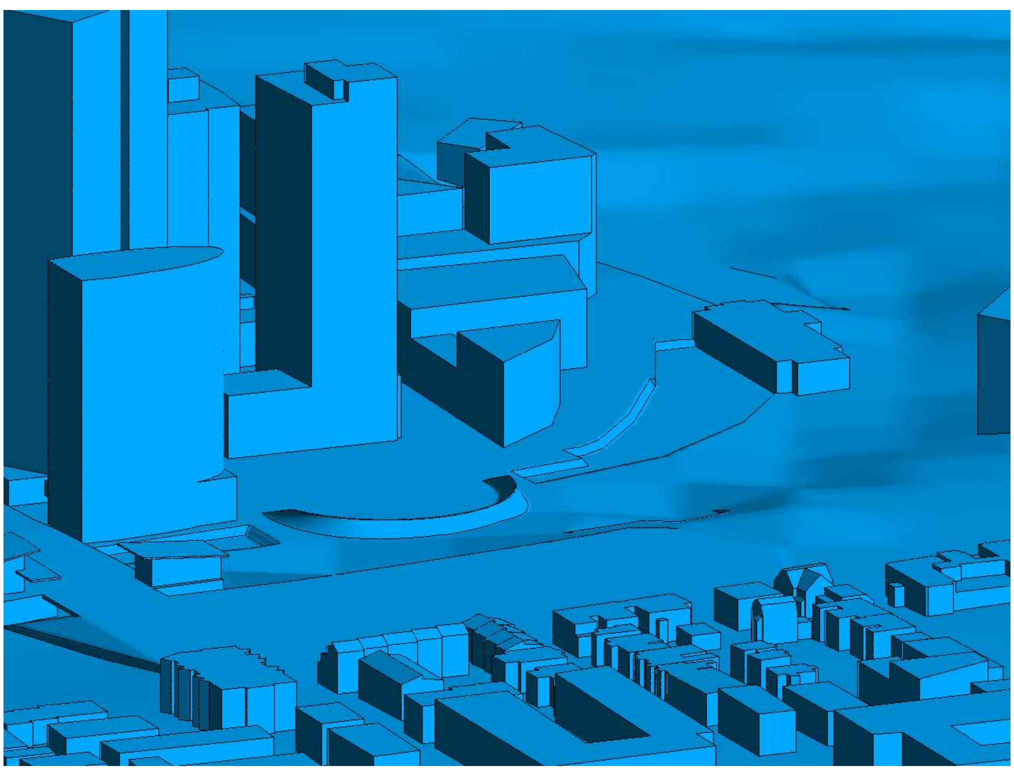


FIGURE 2H: CLOSE UP OF FIGURE 2G

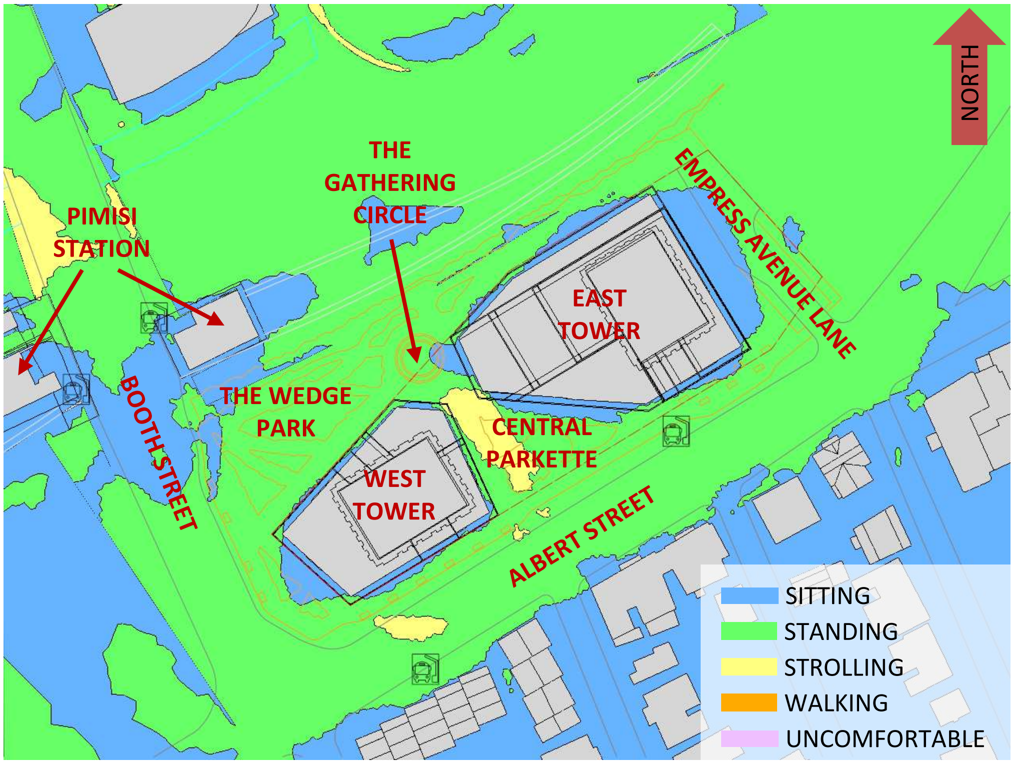


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

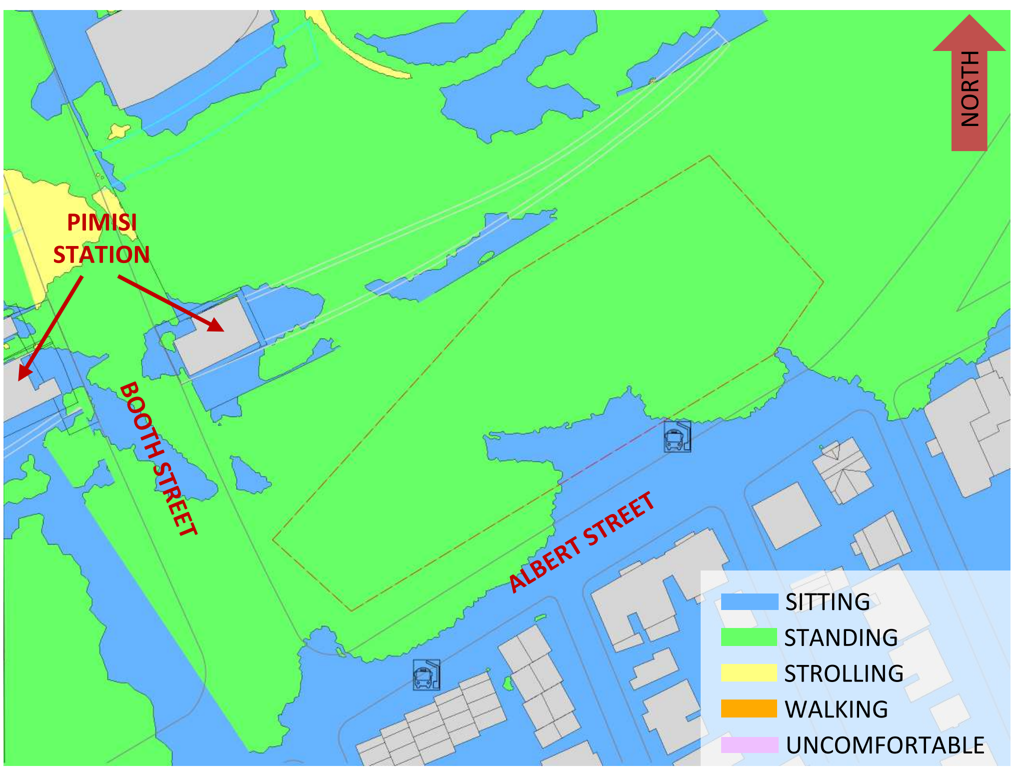


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

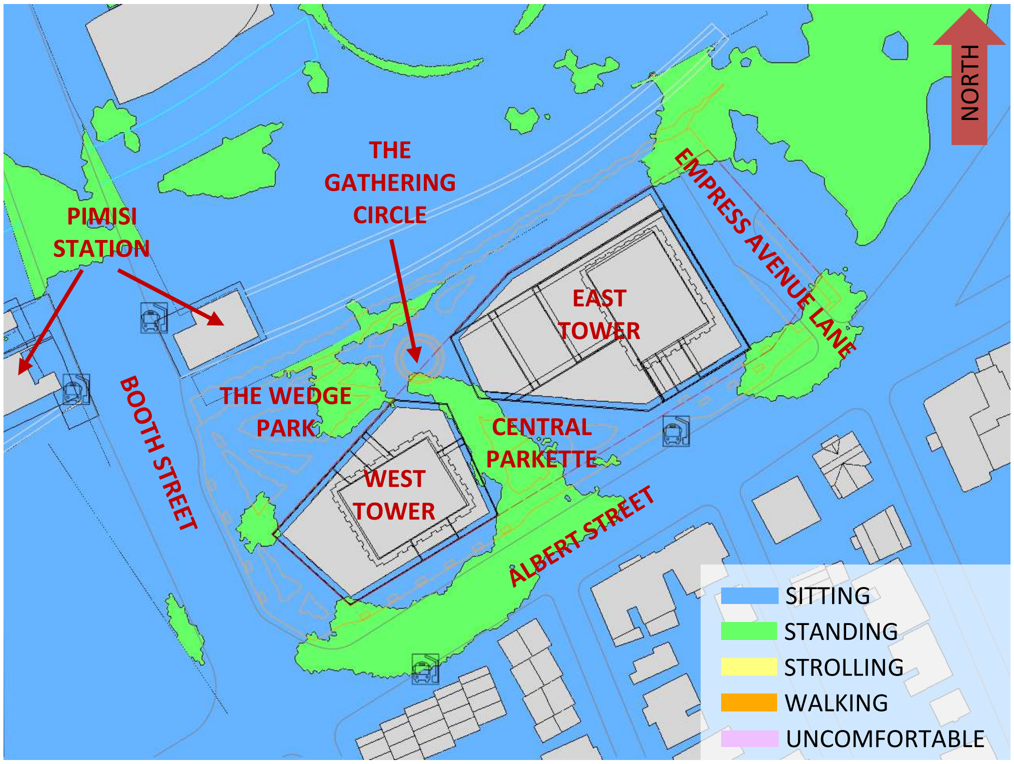


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

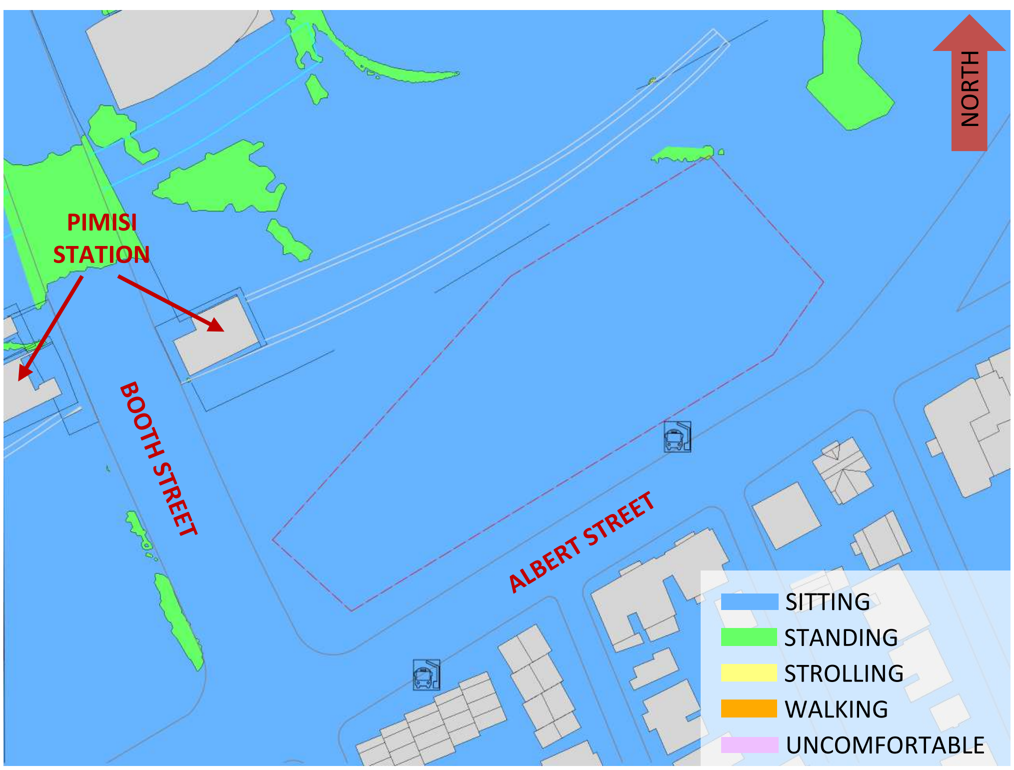


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

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

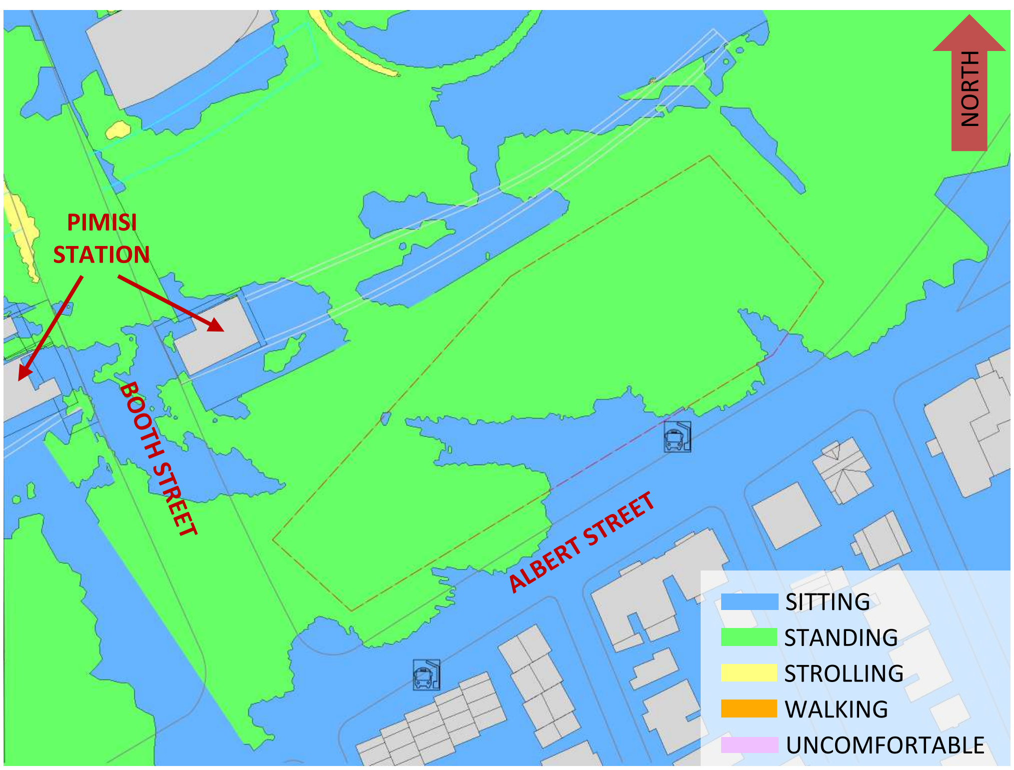


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING

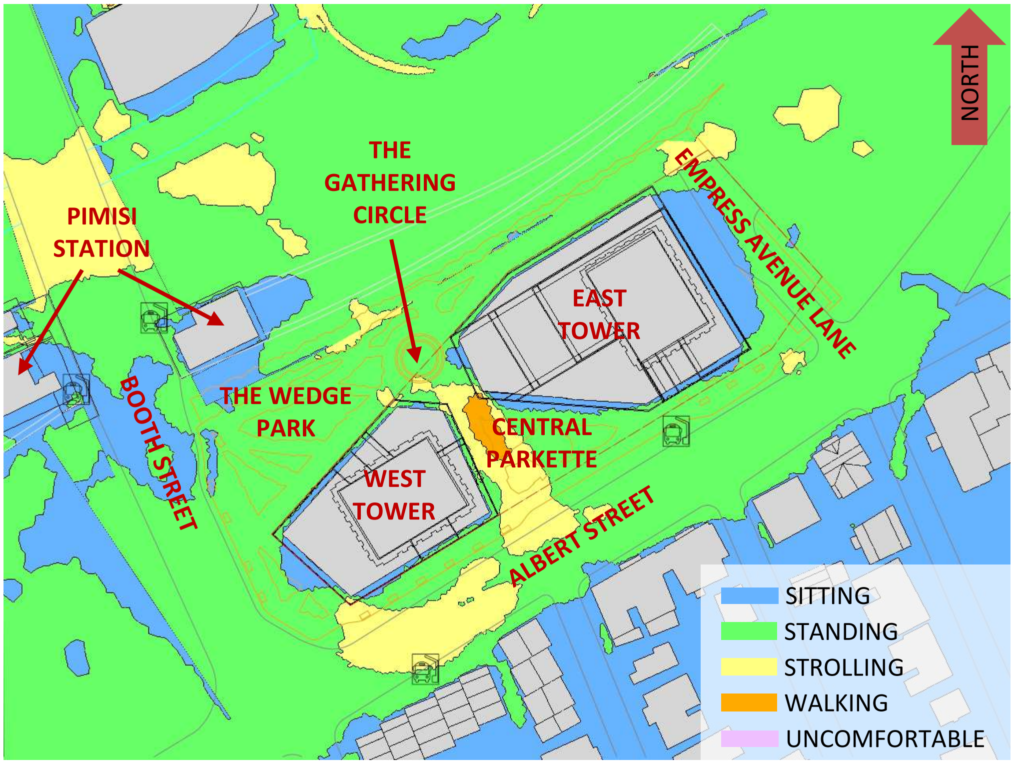


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

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

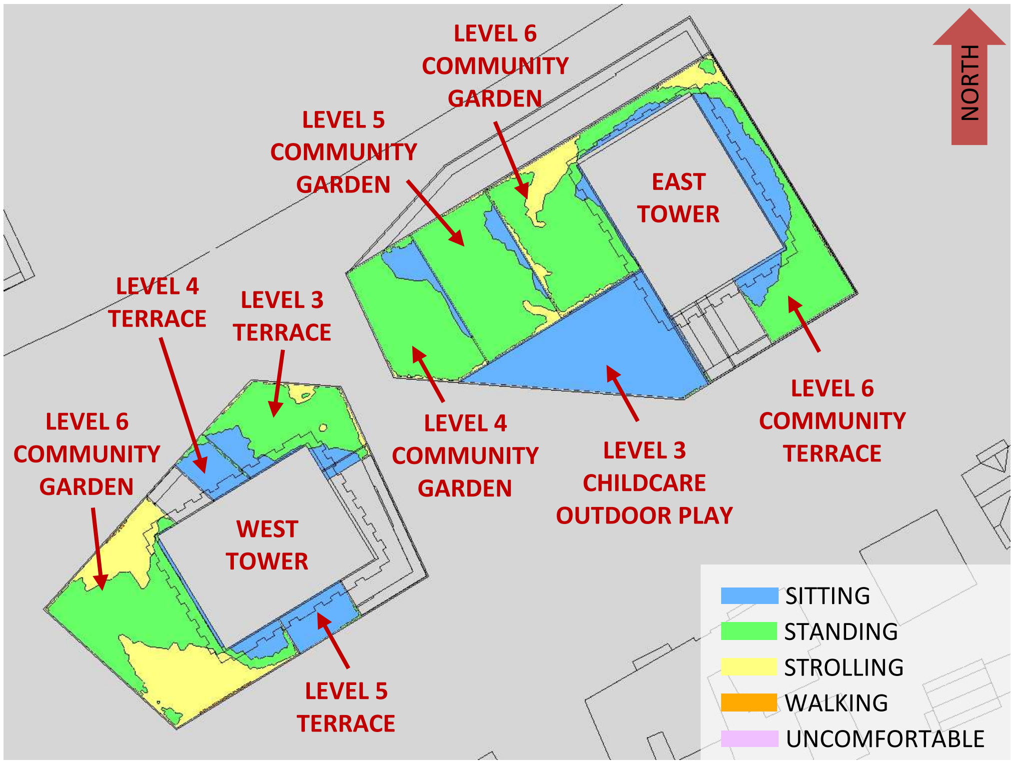


FIGURE 7A: SPRING – WIND COMFORT, COMMON AMENITY TERRACES

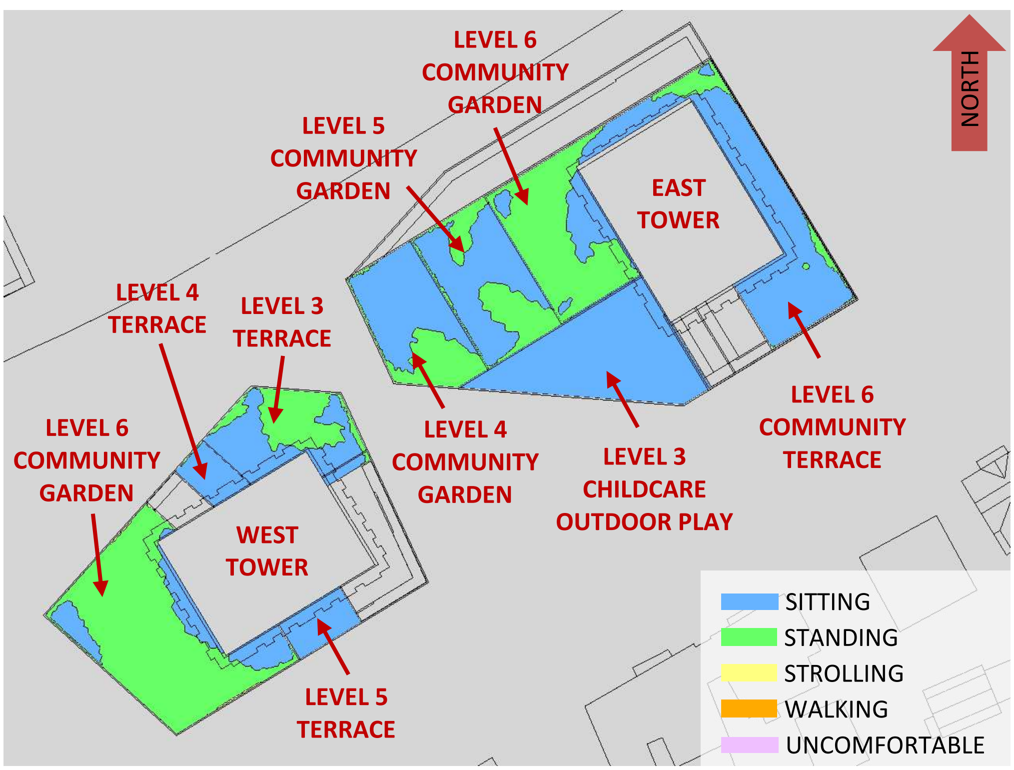


FIGURE 7B: SUMMER – WIND COMFORT, COMMON AMENITY TERRACES

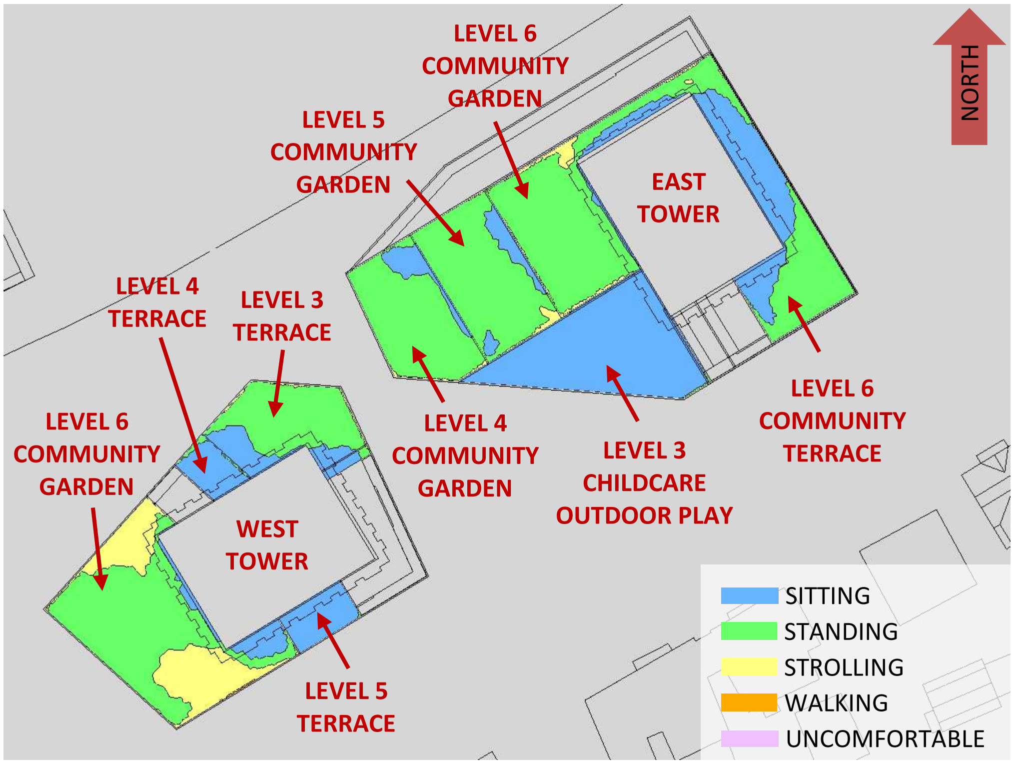


FIGURE 7C: AUTUMN – WIND COMFORT, COMMON AMENITY TERRACES

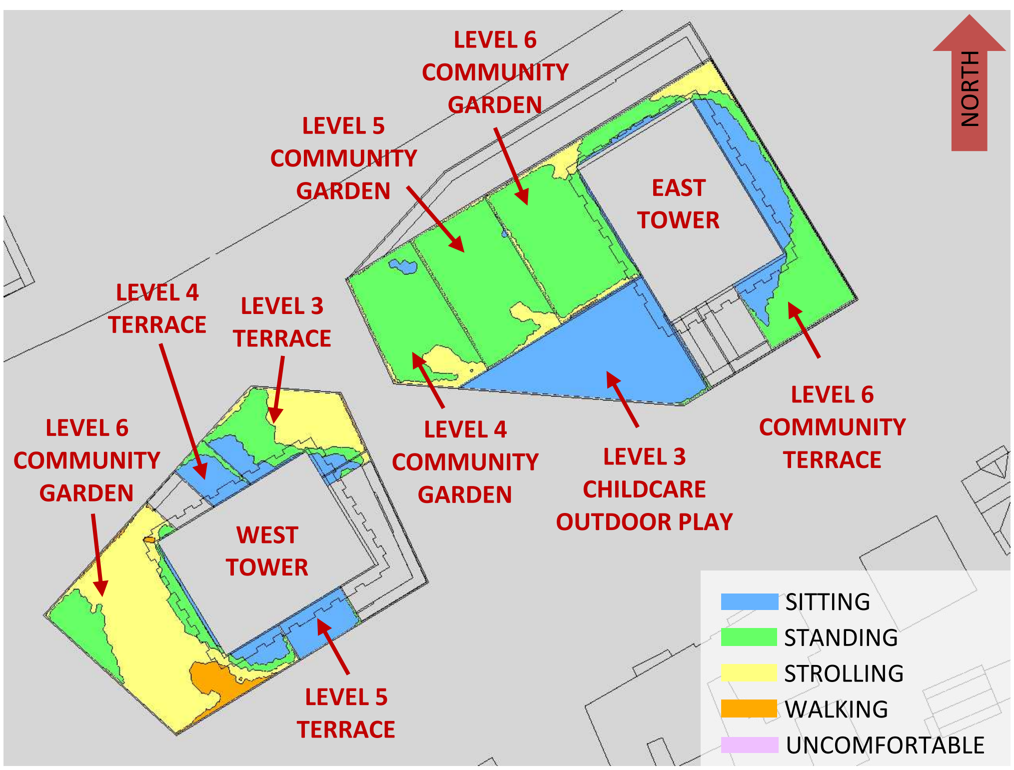


FIGURE 7D: WINTER – WIND COMFORT, COMMON AMENITY TERRACES

FIGURE 8: TYPICAL USE PERIOD – WIND COMFORT, AMENITY TERRACES

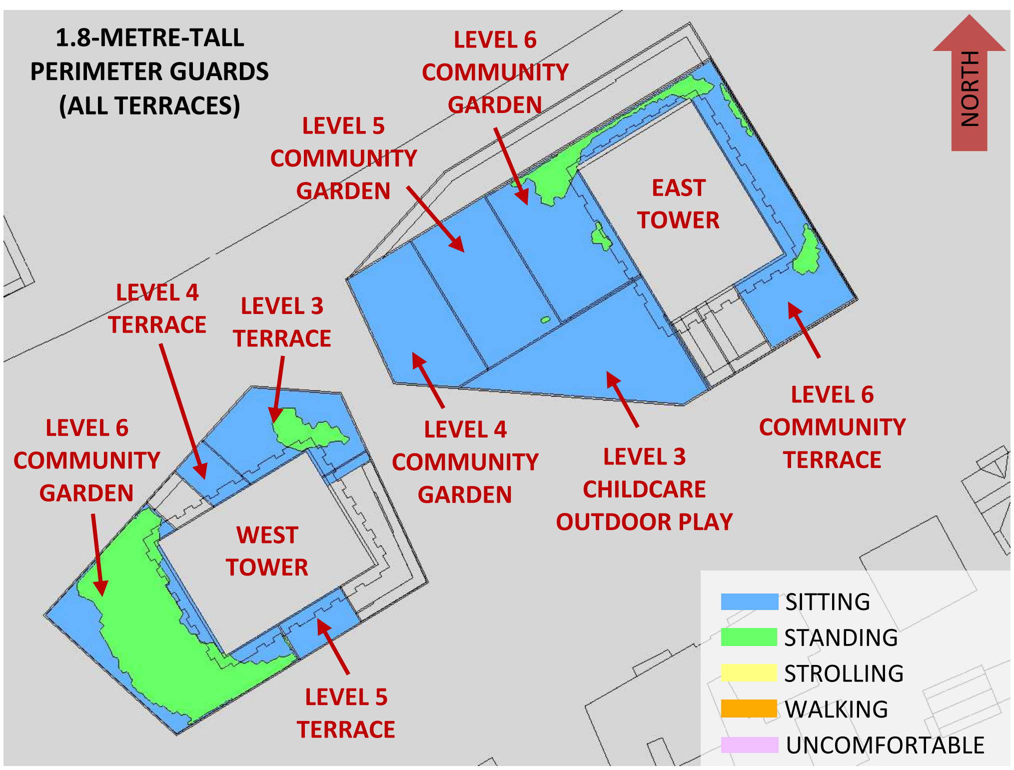
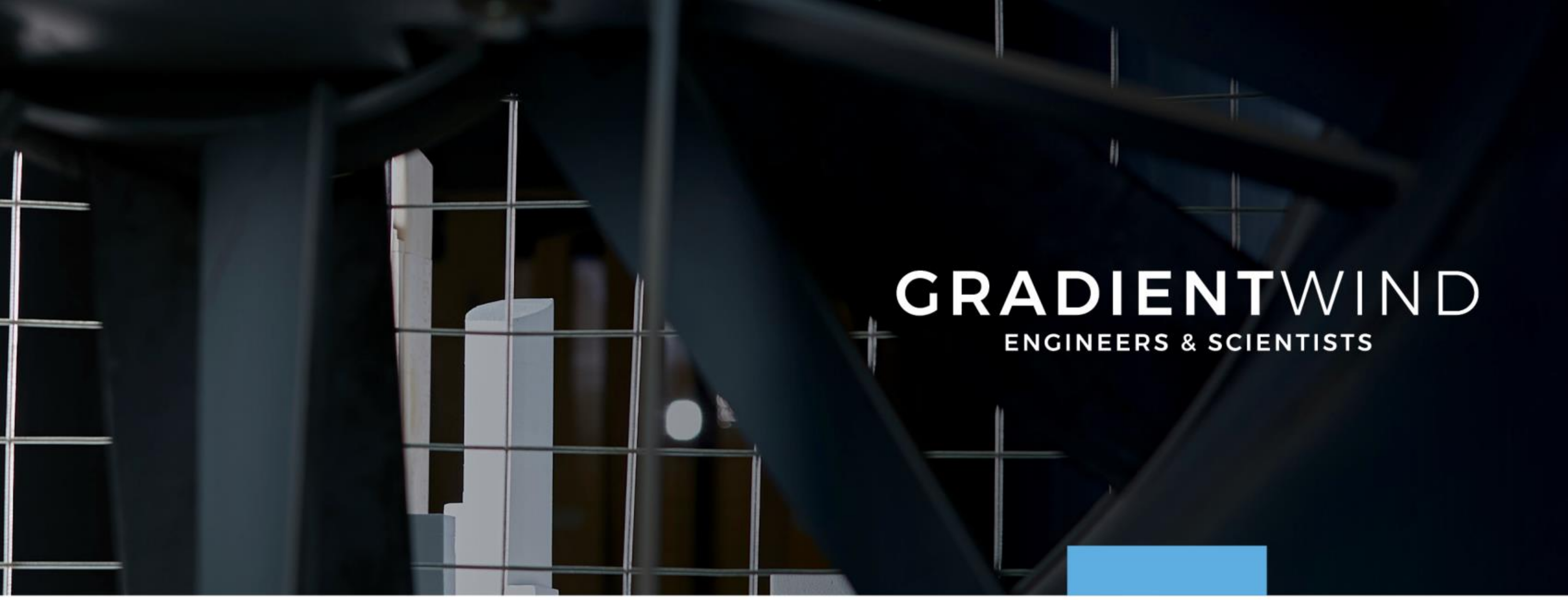


FIGURE 9: TYPICAL USE PERIOD – WIND COMFORT, AMENITY TERRACES (WITH MITIGATION)



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

For the model, U_g is set to 6.5 metres per second (m/s), which approximately corresponds to the 60% mean wind speed for Ottawa based on historical climate data and statistical analyses. When the results are normalized by this velocity, they are relatively insensitive to the selection of gradient wind speed.

Z_g is set to 540 m. The selection of gradient height is relatively unimportant, so long as it exceeds the building heights surrounding the subject site. The value has been selected to correspond to our physical wind tunnel reference value.

α is determined based on the upstream exposure of the far-field surroundings (i.e., the area that it not captured within the simulation model).

Table 1 presents the values of α used in this study, while Table 2 presents several reference values of α. When the upstream exposure of the far-field surroundings is a mixture of multiple types of terrain, the α values are a weighted average with terrain that is closer to the subject site given greater weight.

TABLE 1: UPSTREAM EXPOSURE (ALPHA VALUE) VS TRUE WIND DIRECTION

Wind Direction (Degrees True)	Alpha Value (α)
0	0.24
49	0.31
74	0.28
103	0.25
167	0.24
197	0.24
217	0.25
237	0.24
262	0.18
282	0.19
301	0.22
324	0.24

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).

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

$$L_t(Z) = \begin{cases} 100\text{ m}\sqrt{\frac{Z}{30}}, & Z > 30\text{ m} \\ 100\text{ m}, & Z \leq 30\text{ m} \end{cases}$$ 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 Engieering Symposium, IWES 2003*, Taiwan, 2003.