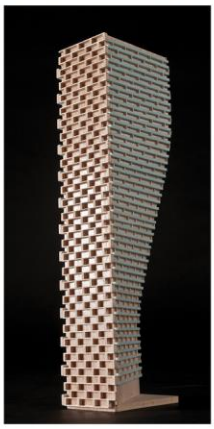
GRADIENTWIND
ENGINEERS & SCIENTISTS

PEDESTRIAN LEVEL WIND STUDY

1299 Richmond Road
Ottawa, Ontario

Report: 23-057-PLW



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PREPARED FOR
Brigil
98 Lois Street
Gatineau, ON J8Y 3R7

PREPARED BY
Daniel Davalos, MESc, Junior Wind Scientist
Justin Ferraro, P.Eng., Principal

EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy concurrent Zoning By-law Amendment (ZBLA) and Site Plan Control application requirements for the proposed mixed-use residential development located at 1299 Richmond Road in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where 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-11, and summarized as follows:

1) Most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered satisfactory for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, walkways, nearby bus stops, existing parking lot to the west, outdoor amenity, and in the vicinity of building access points, are considered acceptable. Exceptions are described as follows:

    a. **Park Land:** During the typical use period, wind conditions over the park land area to the west of the subject site are predicted to be suitable for standing, with a small region predicted to be suitable for strolling at the northeast corner of the park land, as illustrated in Figure 7. Wind comfort levels over the area may be improved by implementing landscaping features such as coniferous trees in dense arrangements along the full perimeter. Additional measures may be required to protect seating areas. The extent of mitigation measures is dependant on the programming of the space. An appropriate mitigation strategy will continue to be developed in collaboration with the building and landscape architects as the design of the proposed development progresses.

b. **Private Patios:** Wind conditions over the private patios at the northeast corner of the proposed development are predicted to be suitable for standing, or better, during the summer, with a small, isolated region predicted to be suitable for strolling at the northeast corner of the patios. During the spring, summer, and autumn, conditions are predicted to be suitable for a mix of standing, strolling, and walking, with a region predicted to be uncomfortable at the northeast corner of the patios. To improve wind comfort conditions within the private patios, we recommend implementing 1.8-m-tall wind screens along the full perimeter of the patios. Additionally, a canopy located 3 m above the private patios, and extending at least 3 m from the north and east façades, is recommended to deflect downwash incident on Tower B and on the 4-storey podium.

c. **Nearby Bus Stop:** Wind conditions in the vicinity of the nearby bus stop at the southwest intersection of Richmond Road and Assaly Road are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for strolling, or better, during the spring and winter. A typical shelter, which provides pedestrian with a means to protect themselves from inclement weather, including during periods of strong wind activity, is recommended for this transit stop.

d. **Starflower Lane Along East Elevation:** Following the introduction of the proposed development, the north end of Starflower Lane along the east elevation of the proposed development is predicted to experience uncomfortable wind conditions during the winter. The region that is predicted to be uncomfortable is also predicted to be suitable for walking for at least 78% of the time during the winter, where the target is 80% to achieve the walking comfort criterion. Since the uncomfortable conditions are predicted to occur over Starflower Lane and not over the proposed walkways, wind comfort conditions are satisfactory.

e. **Existing Parking Lot East of Subject Site:** Following the introduction of the proposed development, the existing parking lot to the east of the subject is predicted experience uncomfortable wind conditions during the winter. The small and isolated area that is predicted to be uncomfortable is also predicted to be suitable for walking for at least 79% of the time during the winter, where the target is 80% to achieve the walking comfort criterion. Since the noted area is small and is close to achieving the walking comfort class, wind comfort conditions are considered satisfactory.

f. **Building Access Along East Elevation:** Conditions in the vicinity of the secondary building access points along the east elevation of the proposed development are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for a mix of standing and strolling during the spring and winter. While the noted conditions are considered satisfactory for secondary building access points, strong wind speeds are expected to occur along the east elevation of the proposed development. As such, it is recommended that the building access points along the east elevation be recessed into the façade by at least 1.5 m.

2) The proposed development is served by three common amenity terraces at Level 5. The proposed development is also served by two common amenity balconies at the MPH Level of Tower A to the north and south, which were modelled with 1.8-m-tall wind screens along the full perimeter of the balconies. Wind comfort conditions during the typical use period within the noted areas, as illustrated in Figures 9 and 11, are described as follows:

a. The common amenity terraces serving the proposed development at Level 5 are predicted to be suitable for sitting during the typical use period, as illustrated in Figure 9. The noted conditions are considered acceptable.

b. With the noted mitigation, conditions within the common amenity balconies serving the proposed development at the MPH Level are predicted to be suitable for sitting, with regions predicted to be suitable for standing near the north elevation of Tower A within the north common amenity balcony, as illustrated in Figure 11. The noted conditions are considered acceptable.

3) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events (for example, thunderstorms, tornadoes, and downbursts), pedestrian wind safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Brigil to undertake a pedestrian level wind (PLW) study to satisfy concurrent Zoning By-law Amendment (ZBLA) and Site Plan Control application requirements for the proposed mixed-use residential development located at 1299 Richmond Road in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where 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 Quadrangle Architects Limited, in April and May 2023, surrounding street layouts and existing and approved future building massing information obtained from the City of Ottawa, as well as recent satellite imagery.

2. TERMS OF REFERENCE

The subject site is located at 1299 Richmond Road in Ottawa; situated at the northeast corner of Richmond Road and Assaly Road, and bordered by Richmond Road to the southeast, Assaly Road to the southwest, and Starflower Lane to the northeast and northwest. Throughout this report, Richmond Road is considered as project south. The proposed development comprises two towers of 32 and 28 storeys, respectively identified as "Tower A" and "Tower B", rising through a 4-storey podium with a nominally rectangular planform.

At the ground floor, the proposed development comprises residential main entrances to the north and south, indoor amenity space to the north and at the northwest corner, residential space at the northeast corner, elevator cores to the east and west, and retail space throughout the remainder of the space. Access to below grade parking is provided by a ramp via Starflower Lane to the northeast, an outdoor amenity is located central to the subject site along the north elevation, and private patios are located at the northeast corner. Additionally, park land is proposed along the west elevation of the proposed development. Levels 2-4 are reserved for residential use, and the building steps back from the north elevation at Level 2 to accommodate private terraces. Level 5 includes lounge and bar space to the west,

a central indoor pool, a gym and yoga room to the east, and residential space throughout the remainder of the level. Also, the building steps back from all elevations at Level 5 to accommodate private terraces and common amenity terraces. The common amenity terraces at Level 5 are located central to the north, and to the southeast and southwest, adjacent to the indoor pool. Levels 6-32 of Tower A and Levels 6-28 of Tower B are reserved for residential use. The MPH level of Tower A includes a party room to the east, a games room to the north, and mechanical room to the southeast. Tower A is served by two common amenity balconies to the north and south of the MPH Level.

The near-field surroundings, defined as an area within a 200-metre (m) radius of the subject site, includes two high-rise residential buildings to the immediate east, a cluster of high-rise buildings to the northeast, a cluster of mid- and high-rise residential buildings to the south across Richmond Road, two isolated high-rise buildings to the west-southwest, and a mix of primarily low-rise massing and green space from the northwest clockwise to the southeast. Notably, the Lincoln Fields Mall is located approximately 290 m to the south of the subject site. The far-field surroundings, defined as an area beyond the near-field but within a 2-kilometre (km) radius of the subject site, are characterized primarily by a mix of low- and mid-rise buildings in all compass directions, with a cluster of high-rise buildings to the northeast, and open exposure from the southwest clockwise to the northeast. The Ottawa River flows southwest to northeast approximately 780 m to the north of the subject site.

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

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.

4.1 Computer-Based Context Modelling

A computer based PLW study was performed to determine the influence of the wind environment on pedestrian comfort over the proposed development site. Pedestrian comfort predictions, based on the mechanical effects of wind, were determined by combining measured wind speed data from CFD simulations with statistical weather data obtained from Ottawa Macdonald-Cartier International Airport. The general concept and approach to CFD modelling is to represent building and topographic details in the immediate vicinity of the study site on the surrounding model, and to create suitable atmospheric wind profiles at the model boundary. The wind profiles are designed to have similar mean and turbulent wind properties consistent with actual site exposures.

An industry standard practice is to omit trees, vegetation, and other existing and planned landscape elements from the model due to the difficulty of providing accurate seasonal representation of vegetation. The omission of trees and other landscaping elements produces slightly stronger wind speeds.

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

4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 12 wind directions. The CFD simulation model was centered on the proposed development, complete with surrounding massing within a radius of 480 m. Wind simulations were performed for the two context scenarios described in Section 2.

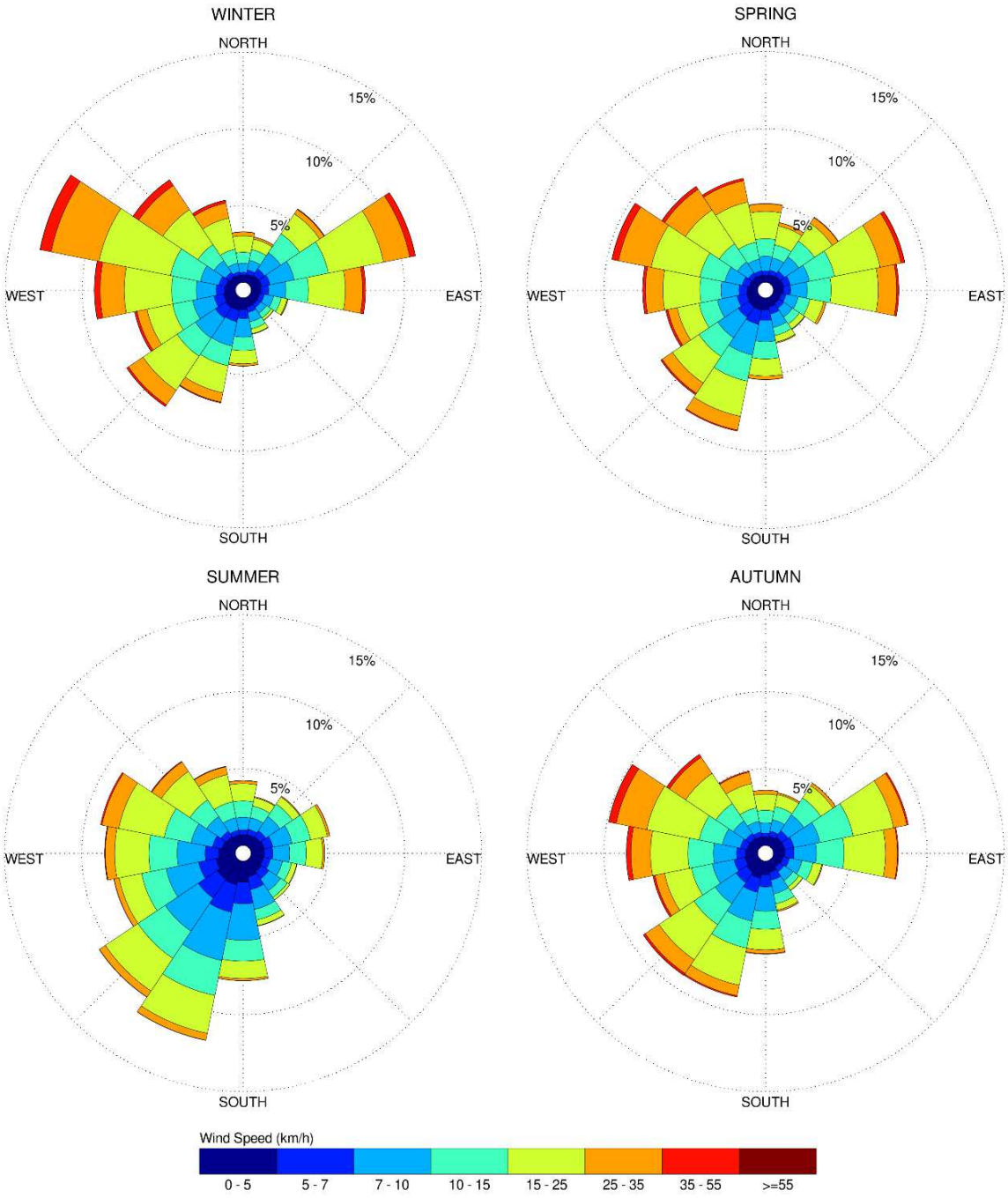
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the common amenity terraces were referenced to the wind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

A statistical model for winds in Ottawa was developed from approximately 40 years of hourly meteorological wind data recorded at Ottawa Macdonald-Cartier International Airport and obtained from Environment and Climate Change Canada. Wind speed and direction data were analyzed for each month of the year to determine the statistically prominent wind directions and corresponding speeds, and to characterize similarities between monthly weather patterns.

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

SEASONAL DISTRIBUTION OF WIND
OTTAWA MACDONALD-CARTIER INTERNATIONAL AIRPORT



Notes:

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

4.4 Pedestrian Wind Comfort and Safety Criteria – City of Ottawa

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

1) **Sitting:** Mean wind speeds no greater than 10 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 16 km/h.

2) **Standing:** Mean wind speeds no greater than 14 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 22 km/h.

3) **Strolling:** Mean wind speeds no greater than 17 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 27 km/h.

4) **Walking:** Mean wind speeds no greater than 20 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 32 km/h.

5) **Uncomfortable:** Uncomfortable conditions are characterized by predicted values that fall below the 80% target for walking. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this criterion.

The pedestrian safety wind speed criterion is based on the approximate threshold that would cause a vulnerable member of the population to fall. A 0.1% exceedance gust wind speed of 90 km/h is classified as dangerous. The gust speeds, and equivalent mean speeds, are selected based on 'The Beaufort Scale', presented on the following page, which describes the effects of forces produced by varying wind speed levels on objects. Gust speeds are included because pedestrians tend to be more sensitive to wind gusts than to steady winds for lower wind speed ranges. For strong winds approaching dangerous levels, this effect is less important because the mean wind can also create problems for pedestrians.

THE BEAUFORT SCALE

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

Experience and research on people's perception of mechanical wind effects has shown that if the wind speed levels are exceeded for more than 20% of the time, the activity level would be judged to be uncomfortable by most people. For instance, if a mean wind speed of 10 km/h (equivalent gust wind speed of approximately 16 km/h) were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting. Similarly, if mean wind speed of 20 km/h (equivalent gust wind speed of approximately 30 km/h) at a location were exceeded for more than 20% of the time, walking or less vigorous activities would be considered uncomfortable. As these criteria are based on subjective reactions of a population to wind forces, their application is partly based on experience and judgment.

Once the pedestrian wind speed predictions have been established throughout the site, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for discrete regions within and surrounding the subject site. This step involves comparing the predicted comfort classes to the desired comfort classes, which are dictated by the location type for each region (that is, 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	Walking
Public Sidewalk / Bicycle Path	Walking
Outdoor Amenity Space	Sitting / Standing
Café / Patio / Bench / Garden	Sitting / Standing
Transit Stop (Without Shelter)	Standing
Transit Stop (With Shelter)	Walking
Public Park / Plaza	Sitting / Standing
Garage / Service Entrance	Walking
Parking Lot	Walking
Vehicular Drop-Off Zone	Walking

5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-6B, illustrating wind conditions at grade level, and Figures 8A-8D and 10A-10D, illustrating wind conditions over the common amenity terraces serving the proposed development. 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 at grade and within the common amenity terraces are also reported for the typical use period, which is defined as May to October, inclusive. Figure 7 illustrates wind comfort conditions at grade level, while Figures 9 and 11 illustrate wind comfort conditions within the common amenity terraces, consistent with the comfort classes in Section 4.4. The details of these conditions are summarized in the following pages for each area of interest.

5.1 Wind Comfort Conditions – Ground Floor

Sidewalks Along Richmond Road: Following the introduction of the proposed development, wind comfort conditions over the sidewalks along Richmond Road are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, throughout the remainder of the year, with regions predicted to be suitable for walking during the winter. These conditions are considered acceptable according to the City of Ottawa Terms of Reference.

Conditions over the sidewalks along Richmond Road with the existing massing are predicted to be suitable for mostly sitting during the summer, becoming suitable for a mix of sitting, standing, and strolling throughout the remainder of the year. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions are considered acceptable.

Bus Stops Along Richmond Road: For both massing scenarios, wind conditions in the vicinity of the nearby sheltered bust stop to the north of Richmond Road are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for strolling, or better, during the spring and winter. These conditions are considered acceptable according to the City of Ottawa Terms of Reference.

Following the introduction of the proposed development, conditions in the vicinity of the nearby sheltered bus stop to the south of Richmond Road are predicted to be suitable for standing during the spring, summer, and autumn, becoming suitable for a mix of standing and strolling during the winter. Wind conditions over the noted bus stop with the existing massing are predicted to be suitable for sitting during the summer and autumn, becoming suitable for standing during the spring and winter. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions are considered acceptable.

Following the introduction of the proposed development, wind conditions in the vicinity of the nearby bus stop at the southwest intersection of Richmond Road and Assaly Road are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for strolling, or better, during the spring and winter. Conditions over the noted bus stop with the existing massing are predicted to be suitable for sitting during the summer and autumn, becoming suitable for standing during the spring and

winter. A typical shelter, which provides pedestrian with a means to protect themselves from inclement weather, including during periods of strong wind activity, is recommended for this transit stop.

Sidewalks Along Assaly Road: Following the introduction of the proposed development, the sidewalks along Assaly Road are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, during the spring, autumn, and winter, with a region predicted to be suitable for walking at the southwest corner of the proposed development during the winter. These conditions are considered acceptable according to the City of Ottawa Terms of Reference.

Conditions over the sidewalks along Assaly Road with the existing massing are predicted to be suitable for sitting during the summer and autumn, becoming suitable for a mix of sitting and standing during the spring and winter. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions are considered acceptable.

Existing Parking Lot West of Subject Site: Following the introduction of the proposed development, conditions over the existing parking lot to the west of the subject site are predicted to be suitable for a mix of sitting and standing during the summer and autumn, with a region predicted to be suitable for strolling to the southeast during the autumn. During the spring and winter, conditions are predicted to be suitable for strolling, or better, with small, isolated regions predicted to be suitable for walking to the east during the winter. These conditions are considered acceptable according to the City of Ottawa Terms of Reference.

Conditions over the existing parking lot to the west of the subject site with the existing massing are predicted to be suitable for sitting during the summer and autumn, with a region predicted to be suitable for standing to the southeast during the autumn. During the spring and winter, conditions are predicted to be suitable for a mix of sitting and standing. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions are considered acceptable.

Starflower Lane and Proposed Walkways Along North Elevation: Following the introduction of the proposed development, conditions over Starflower Lane and the proposed walkways along the north elevation of the proposed development are predicted to be suitable for a mix of sitting and standing during the summer, with a small, isolated region predicted to be suitable for strolling near the northwest

corner of the building. During the spring, autumn, and winter, conditions are predicted to be suitable for strolling, or better, with regions predicted to be suitable for walking near the northeast and northwest corners of the building during the spring and winter. These conditions are considered acceptable according to the City of Ottawa Terms of Reference.

Conditions over Starflower Lane along the north elevation with the existing massing are predicted to be suitable for sitting throughout the year. While the introduction of the proposed development produces windier conditions in comparison to existing conditions, wind comfort conditions are considered acceptable.

Starflower Lane and Proposed Walkways Along East Elevation: Following the introduction of the proposed development, conditions over Starflower Lane and the proposed walkways along the east elevation of the proposed development are predicted to be mostly suitable for standing during the summer, with small, isolated regions predicted to be suitable for strolling on the north end of Starflower Lane. During the spring, autumn, and winter, conditions are predicted to be suitable for walking, or better, with a region predicted to be uncomfortable on the north end of Starflower Lane during the winter.

The region that is predicted to be uncomfortable is also predicted to be suitable for walking for at least 78% of the time during the winter, where the target is 80% to achieve the walking comfort criterion. Since the uncomfortable conditions are predicted to occur over Starflower Lane and not over the proposed walkways, wind comfort conditions are satisfactory.

Conditions over Starflower Lane along the east elevation with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year.

Private Patios: Wind conditions over the private patios at the northeast corner of the proposed development are predicted to be suitable for standing, or better, during the summer, with a small, isolated region predicted to be suitable for strolling at the northeast corner of the patios. During the spring, summer, and autumn, conditions are predicted to be suitable for a mix of standing, strolling, and walking, with a region predicted to be uncomfortable at the northeast corner of the patios.

To improve wind comfort conditions within the private patios, we recommend implementing 1.8-m-tall wind screens along the full perimeter of the patios. Additionally, a canopy located 3 m above the private patios, and extending at least 3 m from the north and east façades is recommended to deflect downwash incident on Tower B and on the 4-storey podium.

Existing Parking Lot East of Subject Site: Following the introduction of the proposed development, wind conditions over the existing parking lot to the east of the subject site are predicted to be suitable for standing during the summer, becoming suitable for walking, or better, throughout the remainder of the year, with a small, isolated region predicted to be uncomfortable during the winter.

The area that is predicted to be uncomfortable is also predicted to be suitable for walking for at least 79% of the time during the winter, where the target is 80% to achieve the walking comfort criterion. Since the noted area is small and is close to achieving the walking comfort class, wind comfort conditions are considered satisfactory.

Wind conditions over the existing parking lot to the east of the subject site with the existing massing are predicted to be suitable for standing, or better, during the summer, becoming suitable for strolling, or better, throughout the remainder of the year.

Outdoor Amenity: During the typical use period, conditions over the outdoor amenity at grade level to the north of the subject site are predicted to be suitable for sitting, as illustrated in Figure 7. These conditions are considered acceptable according to the City of Ottawa Terms of Reference.

Park Land: Conditions over the park land area to the west of the subject site are predicted to be mostly suitable for standing during the summer, becoming suitable for strolling, or better, throughout the remainder of the year, with regions predicted to be suitable for walking to the north and south of the park land area during the winter. During the typical use period, wind conditions are predicted to be suitable for standing, with a small region predicted to be suitable for strolling at the northeast corner of the park land, as illustrated in Figure 7.

Wind comfort levels over the park land area may be improved by implementing landscaping features such as coniferous trees in dense arrangements along the full perimeter. Additional measures may be required to protect seating areas.

The extent of mitigation measures is dependant on the programming of the space. An appropriate mitigation strategy will continue to be developed in collaboration with the building and landscape architects as the design of the proposed development progresses.

Building Access: Conditions in the vicinity of all building access points serving the proposed development are predicted to be suitable for standing, or better, throughout the year. The exception are the secondary building access points along the east elevation, where conditions are predicted to be suitable for a mix of standing and strolling during the spring and winter.

While the noted conditions are considered satisfactory for secondary building access points, strong wind speeds are expected to occur along the east elevation of the proposed development. As such, it is recommended that the building access points along the east elevation be recessed into the façade by at least 1.5 m.

5.2 Wind Comfort Conditions – Common Amenity Terraces

Level 5 Common Amenity Terraces: During the typical use period, the common amenity terraces serving the proposed development at Level 5 are predicted to be suitable for sitting, as illustrated in Figure 9. These conditions are considered acceptable according to the City of Ottawa Terms of Reference.

MPH Level Common Amenity Balconies, Tower A: The common amenity balconies serving Tower A at the MPH Level to the north and south were modelled with 1.8-m-tall wind screens along their full perimeters.

With the noted mitigation, conditions within the south common amenity balcony are predicted to be suitable for sitting during the typical use period, as illustrated in Figure 11. These conditions are considered acceptable according to the City of Ottawa Terms of Reference.

With the noted mitigation, conditions within the north common amenity balcony are predicted to be suitable for sitting during the typical use period, with regions predicted to be suitable for standing near the north elevation of Tower A, as illustrated in Figure 11. The areas that are predicted to be suitable for standing are also predicted to be suitable for sitting for at least 78% of the time during the typical use period, where the target is 80% to achieve the sitting comfort criterion. Since the windiest areas are close to achieve the sitting comfort class, wind comfort conditions may be considered acceptable.

5.3 Wind Safety

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

5.4 Applicability of Results

Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the subject site. Future changes (that is, construction or demolition) of these surroundings may cause changes to the wind effects in two ways, namely: (i) changes beyond the immediate vicinity of the subject site would alter the wind profile approaching the subject site; and (ii) development in proximity to the subject site would cause changes to local flow patterns.

6. CONCLUSIONS AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 and illustrated in Figures 3A-11. Based on computer simulations using the CFD technique, meteorological data analysis of the Ottawa wind climate, City of Ottawa wind comfort and safety criteria, and experience with numerous similar developments, the study concludes the following:

1) Most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered satisfactory for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, walkways, nearby bus stops, existing parking lot to the west, outdoor amenity, and in the vicinity of building access points, are considered acceptable. Exceptions are described as follows:

    a. **Park Land:** During the typical use period, wind conditions over the park land area to the west of the subject site are predicted to be suitable for standing, with a small region predicted to be suitable for strolling at the northeast corner of the park land, as illustrated in Figure 7. Wind comfort levels over the area may be improved by implementing landscaping features such as coniferous trees in dense arrangements along the full perimeter. Additional measures may be required to protect seating areas. The extent of mitigation measures is dependant on the programming of the space. An appropriate

mitigation strategy will continue to be developed in collaboration with the building and landscape architects as the design of the proposed development progresses.

b. **Private Patios:** Wind conditions over the private patios at the northeast corner of the proposed development are predicted to be suitable for standing, or better, during the summer, with a small, isolated region predicted to be suitable for strolling at the northeast corner of the patios. During the spring, summer, and autumn, conditions are predicted to be suitable for a mix of standing, strolling, and walking, with a region predicted to be uncomfortable at the northeast corner of the patios. To improve wind comfort conditions within the private patios, we recommend implementing 1.8-m-tall wind screens along the full perimeter of the patios. Additionally, a canopy located 3 m above the private patios, and extending at least 3 m from the north and east façades, is recommended to deflect downwash incident on Tower B and on the 4-storey podium.

c. **Nearby Bus Stop:** Wind conditions in the vicinity of the nearby bus stop at the southwest intersection of Richmond Road and Assaly Road are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for strolling, or better, during the spring and winter. A typical shelter, which provides pedestrian with a means to protect themselves from inclement weather, including during periods of strong wind activity, is recommended for this transit stop.

d. **Starflower Lane Along East Elevation:** Following the introduction of the proposed development, the north end of Starflower Lane along the east elevation of the proposed development is predicted to experience uncomfortable wind conditions during the winter. The region that is predicted to be uncomfortable is also predicted to be suitable for walking for at least 78% of the time during the winter, where the target is 80% to achieve the walking comfort criterion. Since the uncomfortable conditions are predicted to occur over Starflower Lane and not over the proposed walkways, wind comfort conditions are satisfactory.

e. **Existing Parking Lot East of Subject Site:** Following the introduction of the proposed development, the existing parking lot to the east of the subject is predicted experience uncomfortable wind conditions during the winter. The small and isolated area that is predicted to be uncomfortable is also predicted to be suitable for walking for at least 79% of the time during the winter, where the target is 80% to achieve the walking comfort criterion. Since the noted area is small and is close to achieving the walking comfort class, wind comfort conditions are considered satisfactory.

f. **Building Access Along East Elevation:** Conditions in the vicinity of the secondary building access points along the east elevation of the proposed development are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for a mix of standing and strolling during the spring and winter. While the noted conditions are considered satisfactory for secondary building access points, strong wind speeds are expected to occur along the east elevation of the proposed development. As such, it is recommended that the building access points along the east elevation be recessed into the façade by at least 1.5 m.

2) The proposed development is served by three common amenity terraces at Level 5. The proposed development is also served by two common amenity balconies at the MPH Level of Tower A to the north and south, which were modelled with 1.8-m-tall wind screens along the full perimeter of the balconies. Wind comfort conditions during the typical use period within the noted areas, as illustrated in Figures 9 and 11, are described as follows:

a. The common amenity terraces serving the proposed development at Level 5 are predicted to be suitable for sitting during the typical use period, as illustrated in Figure 9. The noted conditions are considered acceptable.

b. With the noted mitigation, conditions within the common amenity balconies serving the proposed development at the MPH Level are predicted to be suitable for sitting, with regions predicted to be suitable for standing near the north elevation of Tower A within the north common amenity balcony, as illustrated in Figure 11. The noted conditions are considered acceptable.

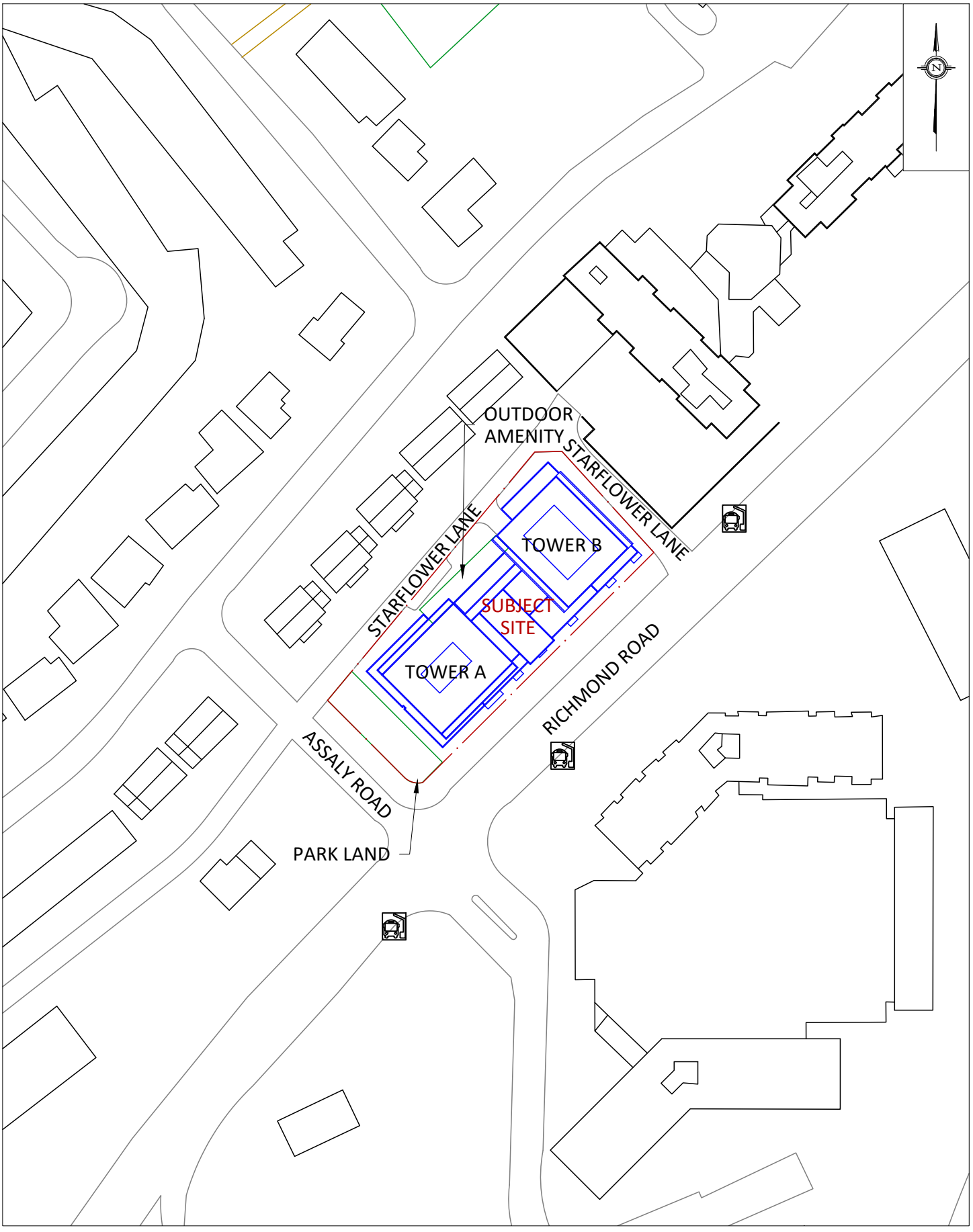
3) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events (for example, thunderstorms, tornadoes, and downbursts), pedestrian wind safety 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.

David Davalos, MESc
Junior Wind Scientist

Justin Ferraro, P.Eng.
Principal



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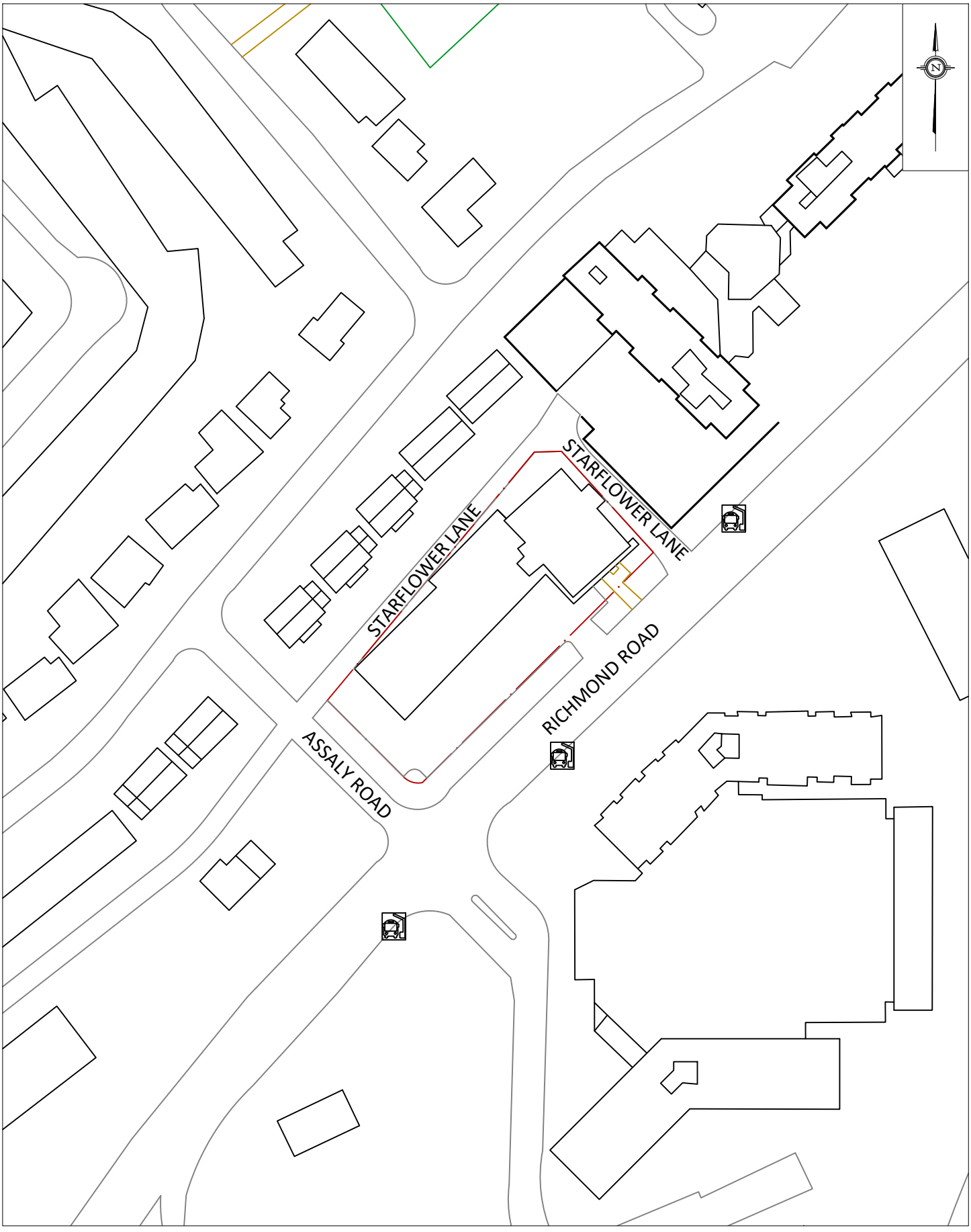
PROJECT	1299 RICHMOND ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1500
DRAWING NO.	23-057-PLW-1A
DATE	MAY 9, 2023
DRAWN BY	N.M.P.

DESCRIPTION

FIGURE 1A:
PROPOSED SITE PLAN AND SURROUNDING CONTEXT



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PROJECT	1299 RICHMOND ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION
SCALE	1:1500	DRAWING NO. 23-057-PLW-1B	FIGURE 1B: EXISITNG SITE PLAN AND SURROUNDING CONTEXT
DATE	MAY 9, 2023	DRAWN BY N.M.P.	

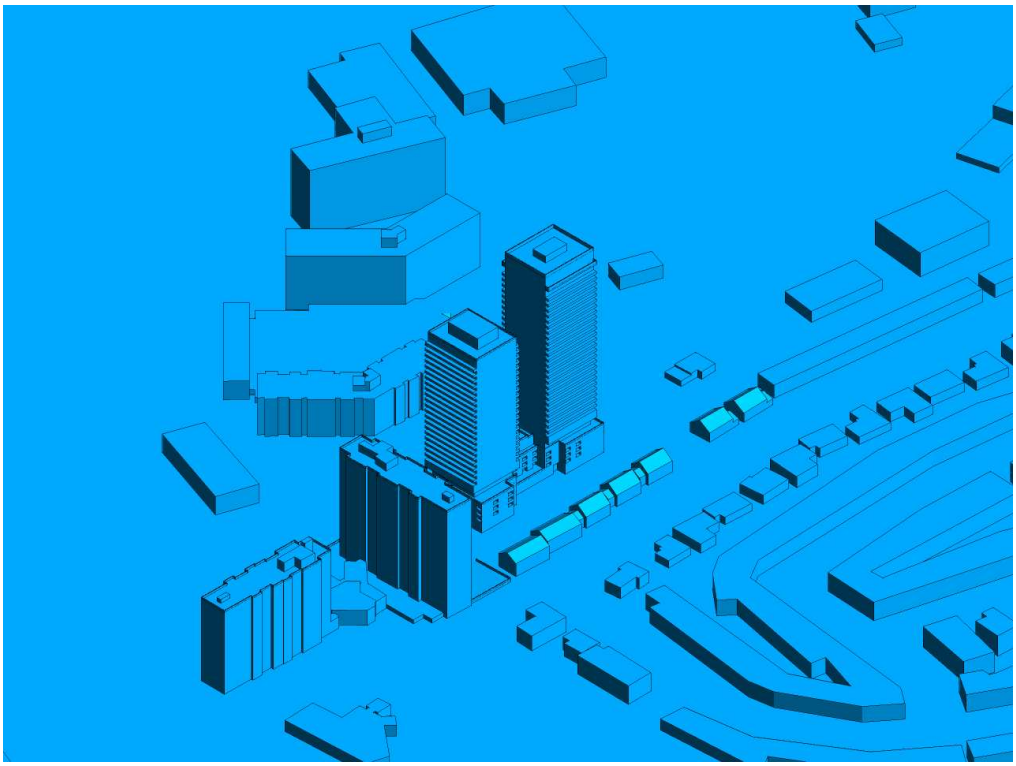

FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

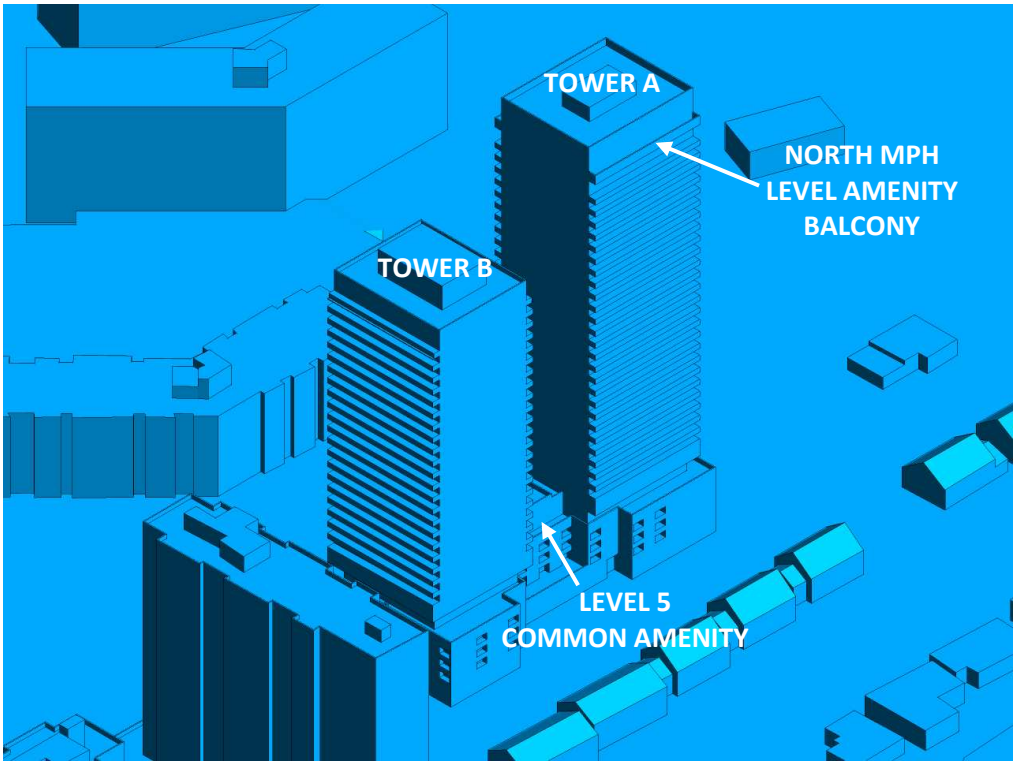

FIGURE 2B: CLOSE UP OF FIGURE 2A

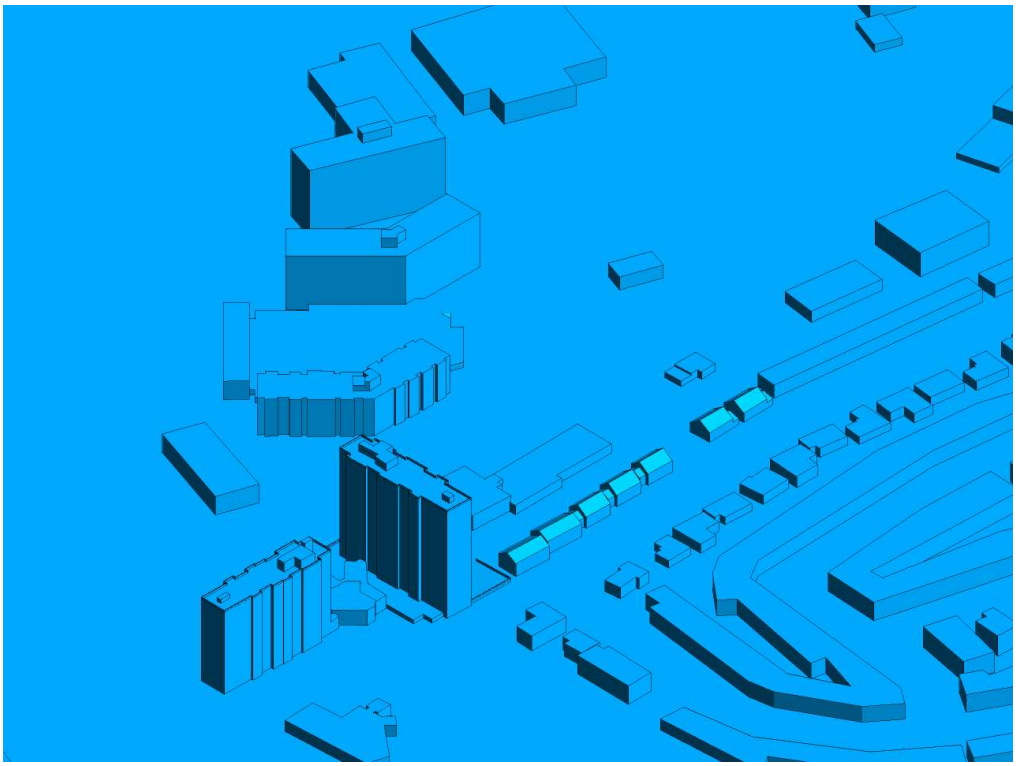

FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

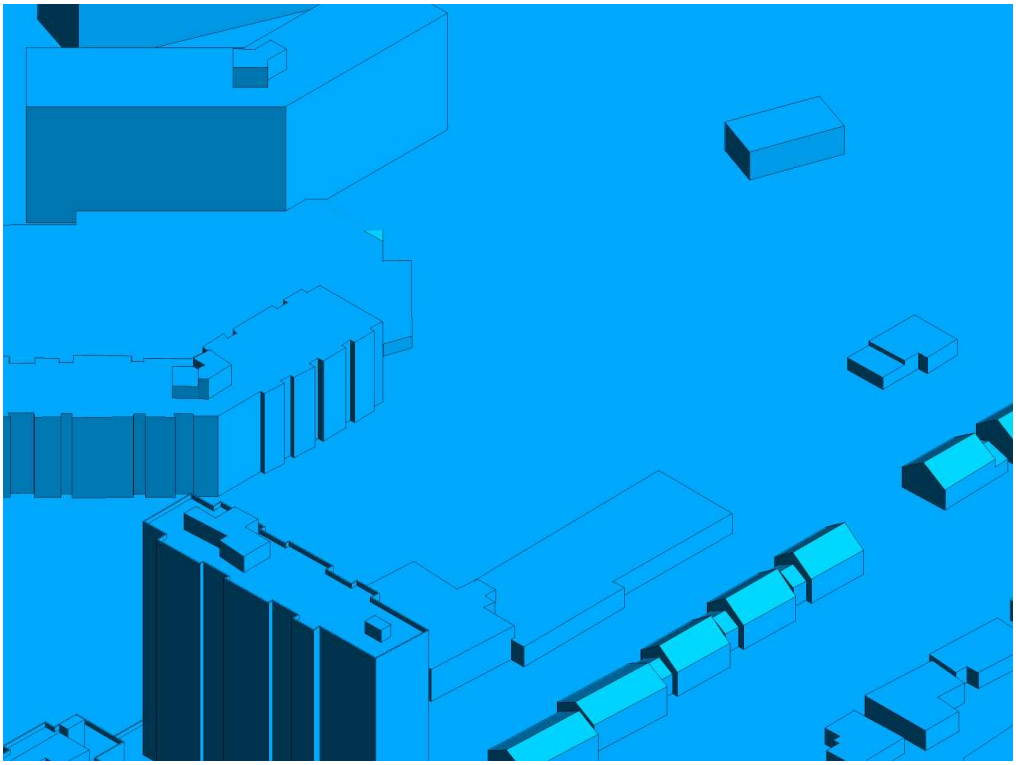

FIGURE 2D: CLOSE UP OF FIGURE 2C

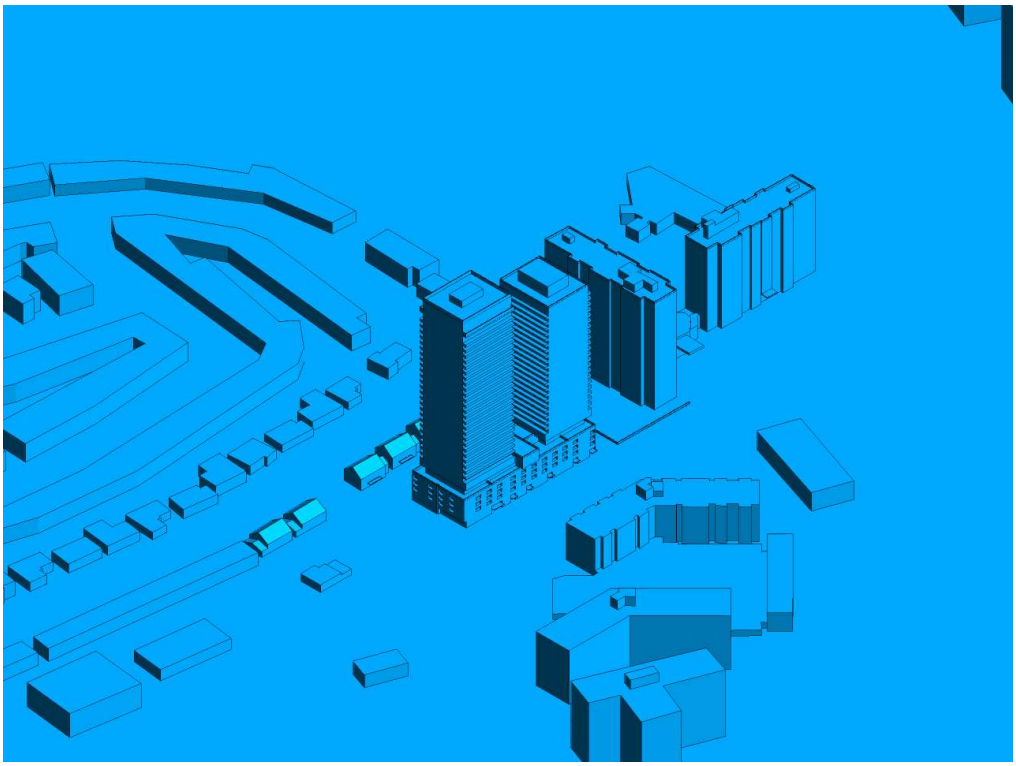

FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

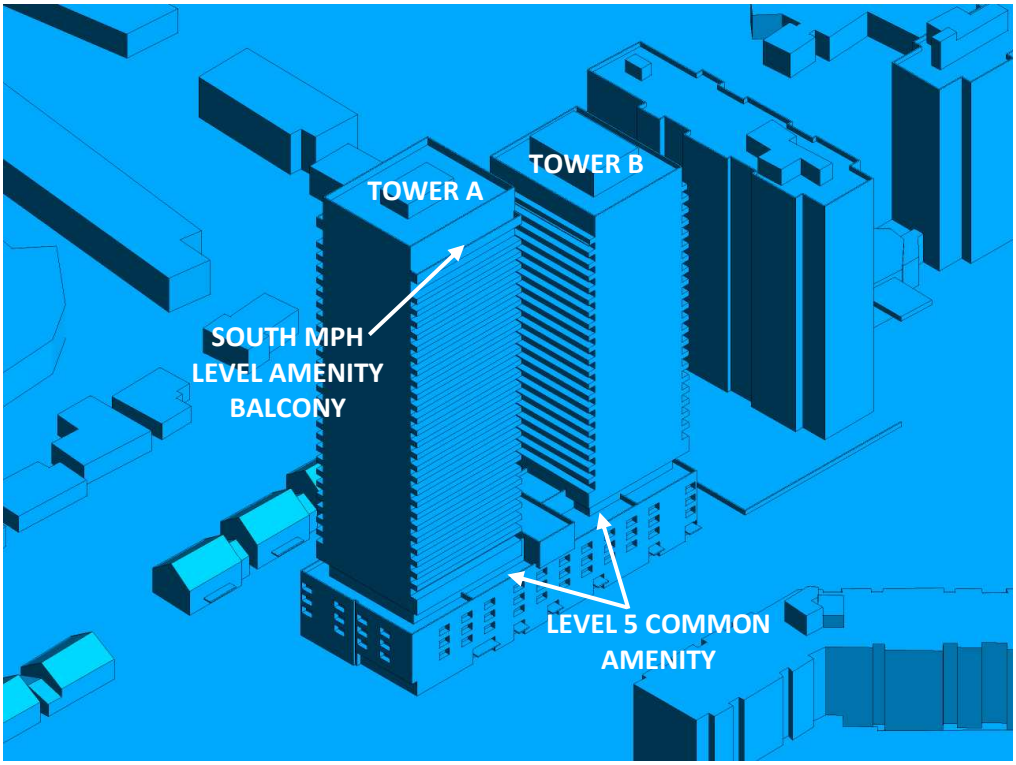

FIGURE 2F: CLOSE UP OF FIGURE 2E

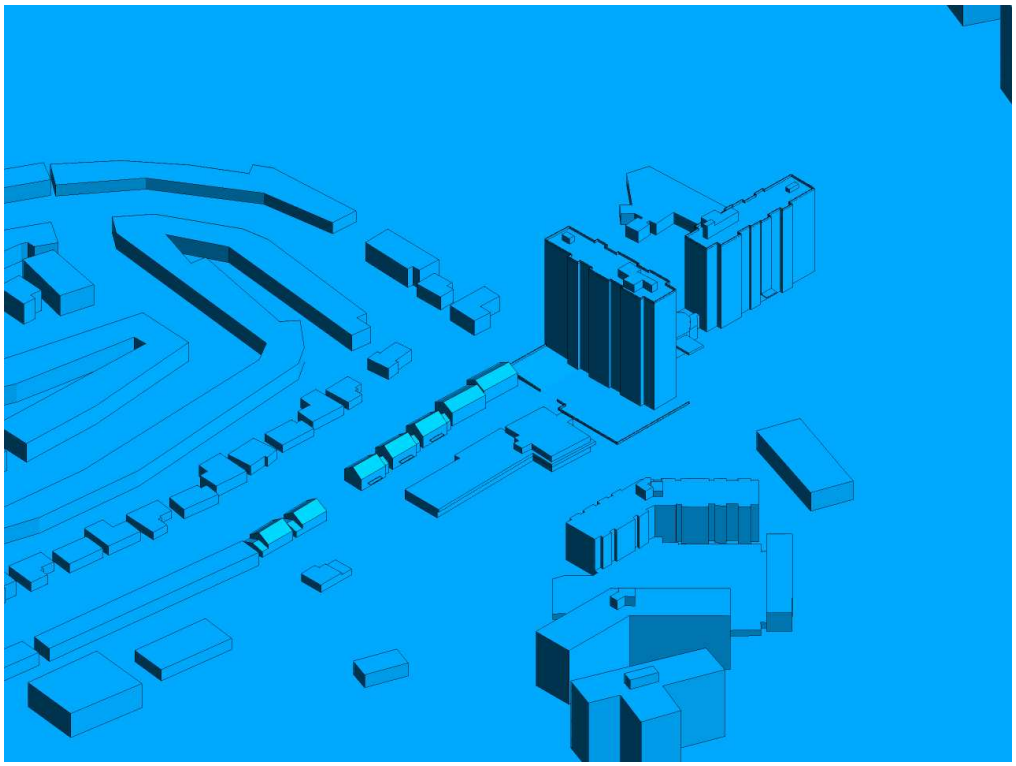

FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

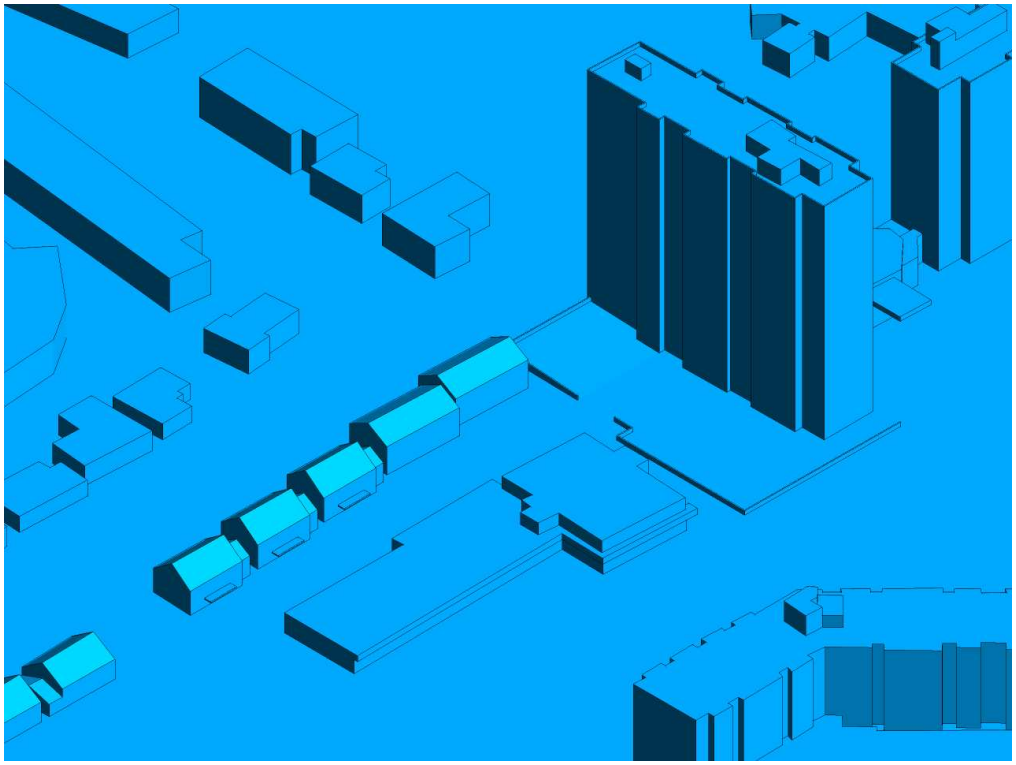

FIGURE 2H: CLOSE UP OF FIGURE 2G

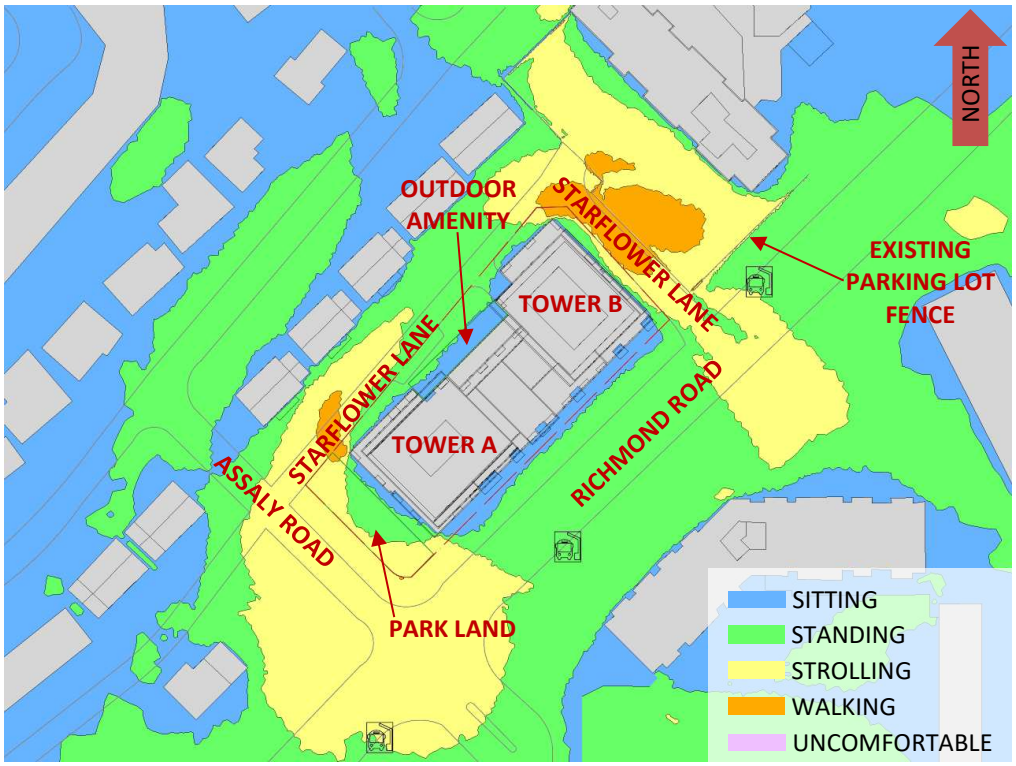

FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

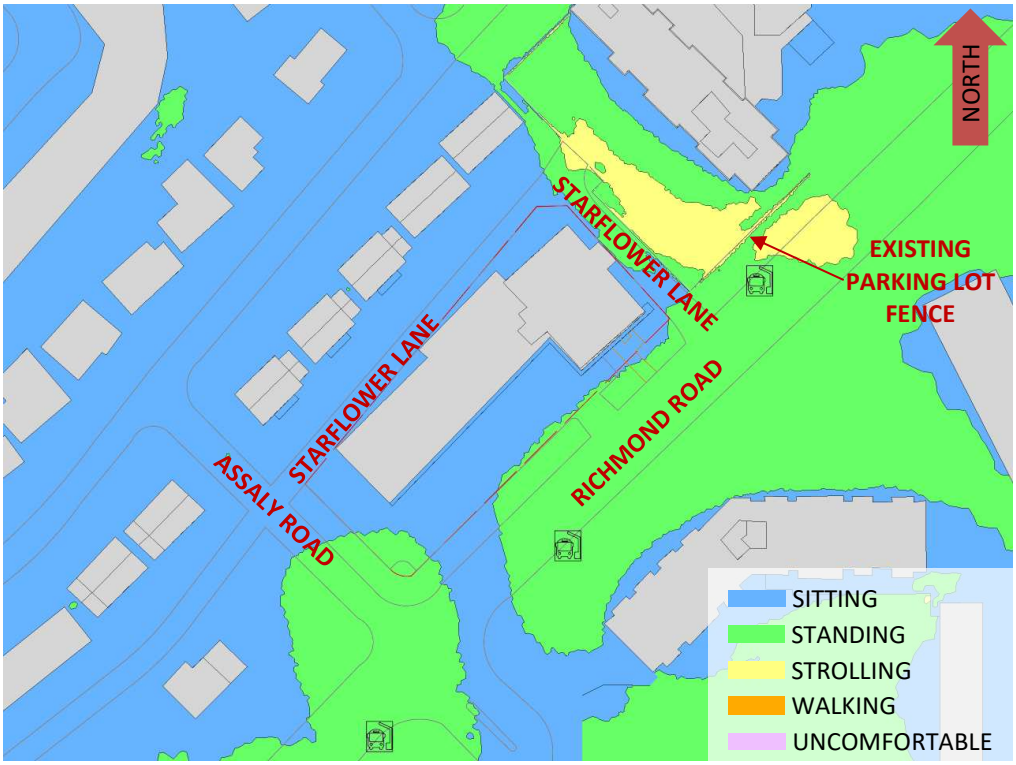

FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

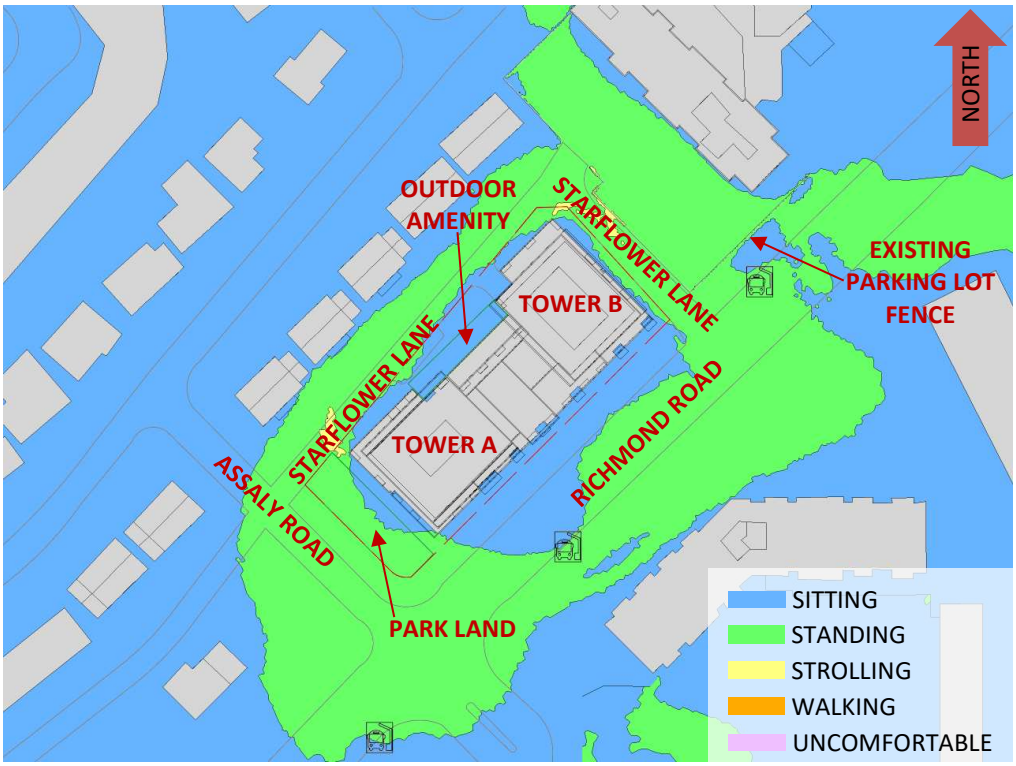

FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

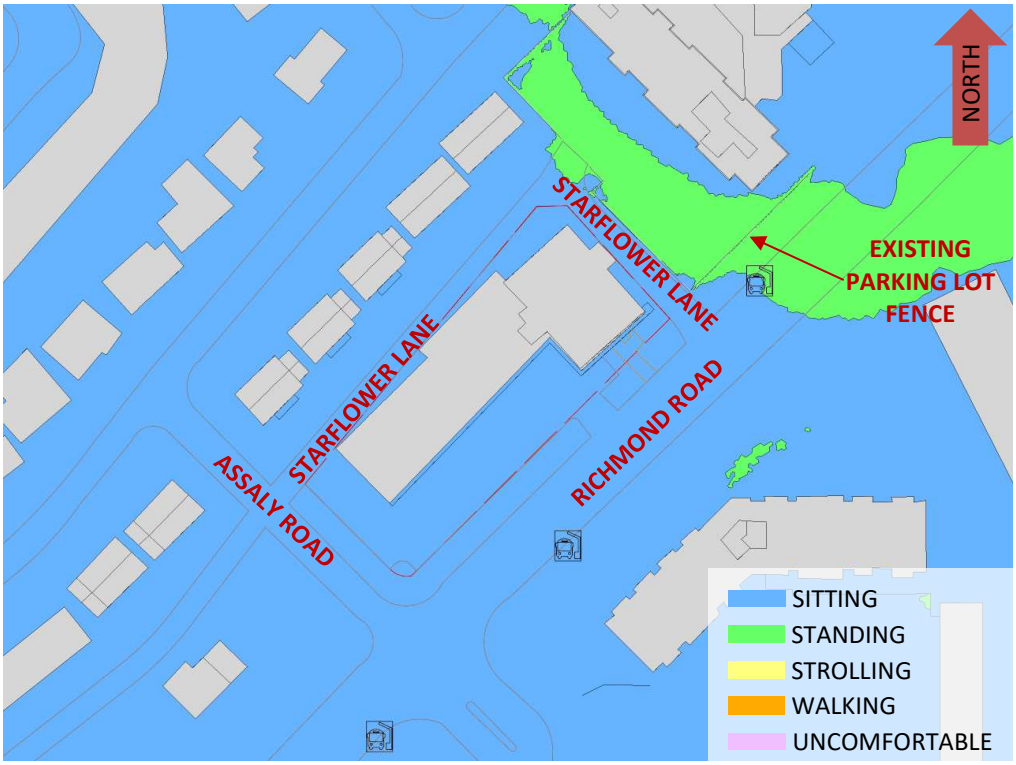

FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

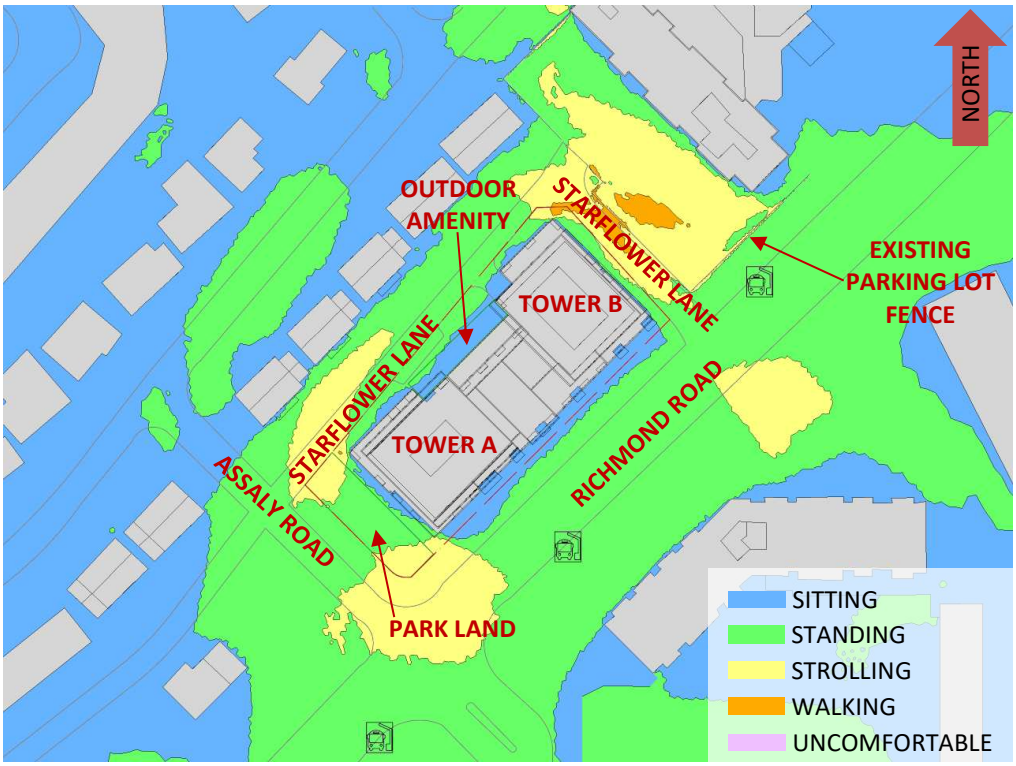

FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

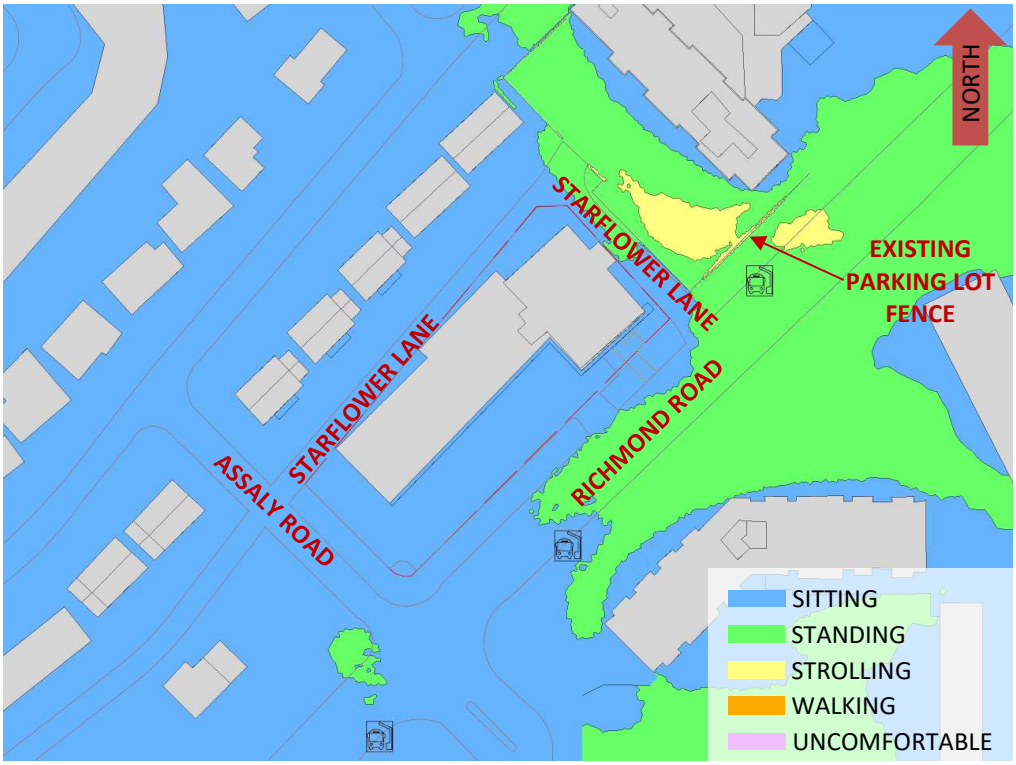

FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

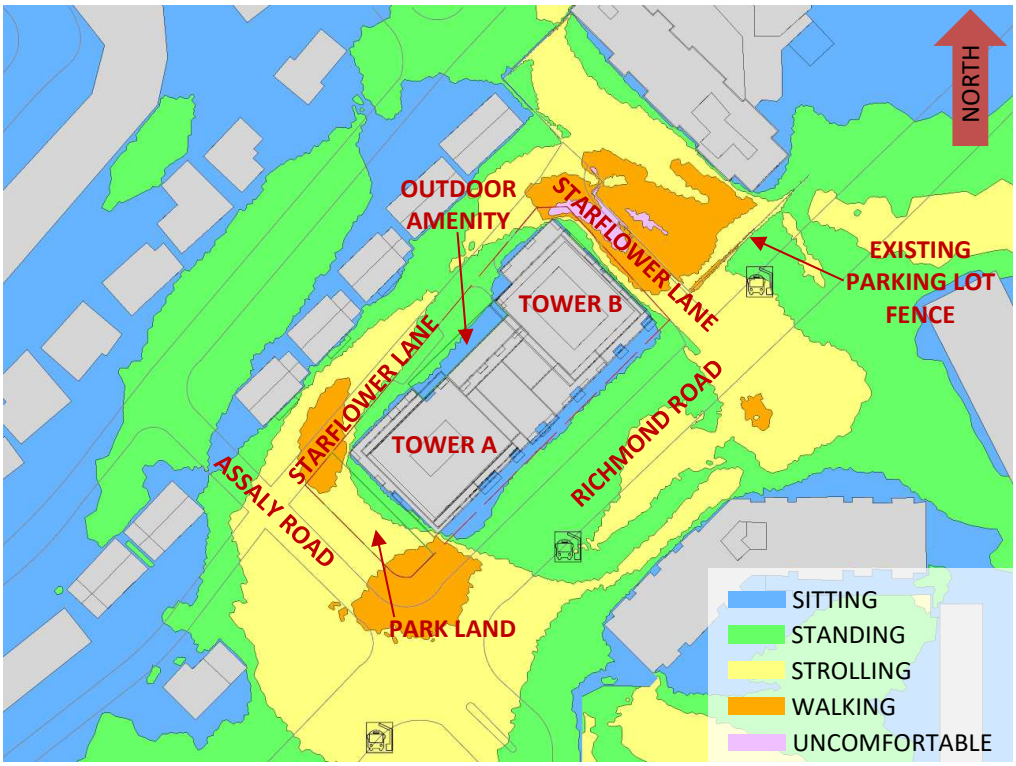

FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

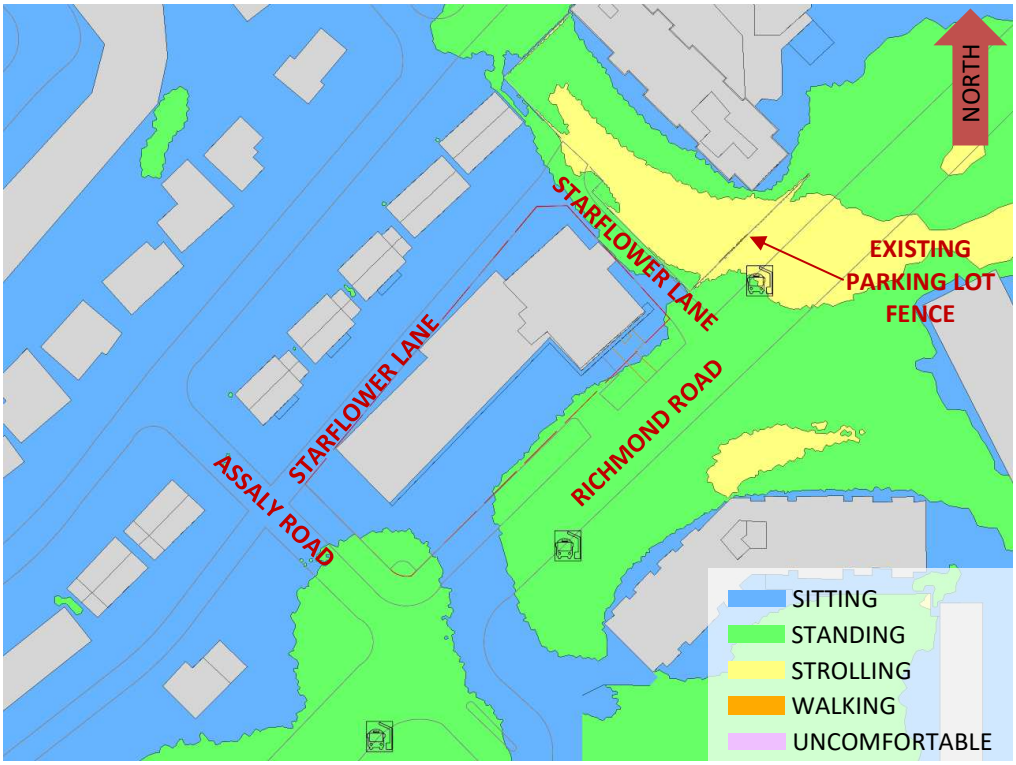

FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

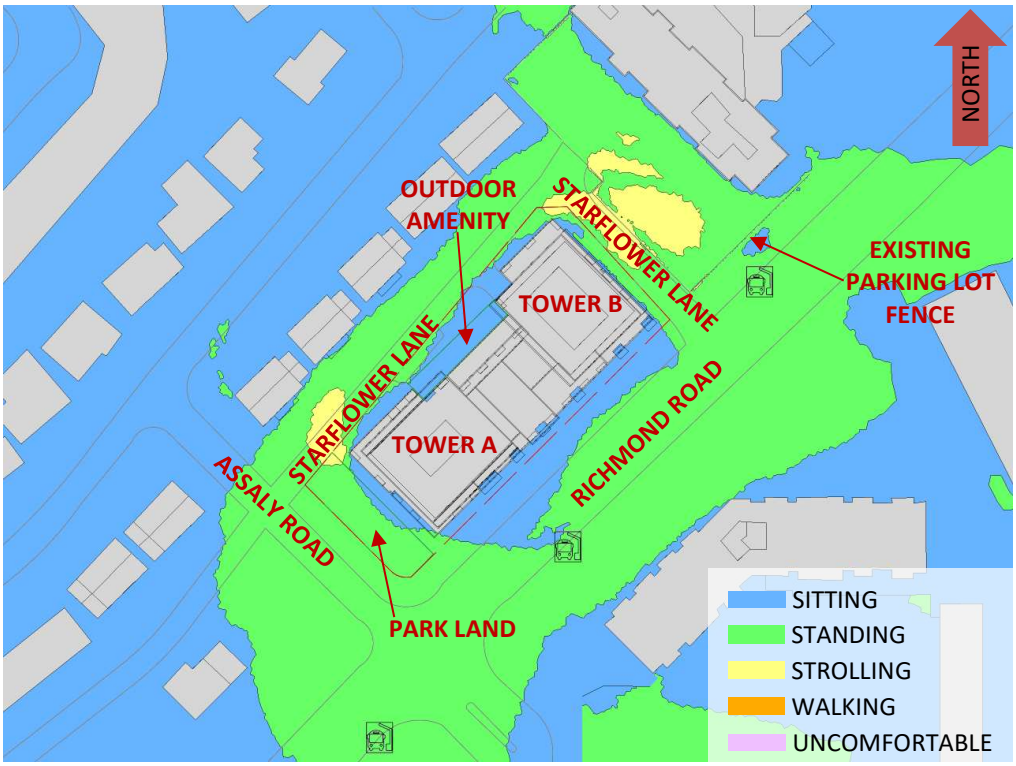

FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

FIGURE 8A: SPRING – WIND COMFORT, LEVEL 5 COMMON AMENITY TERRACES

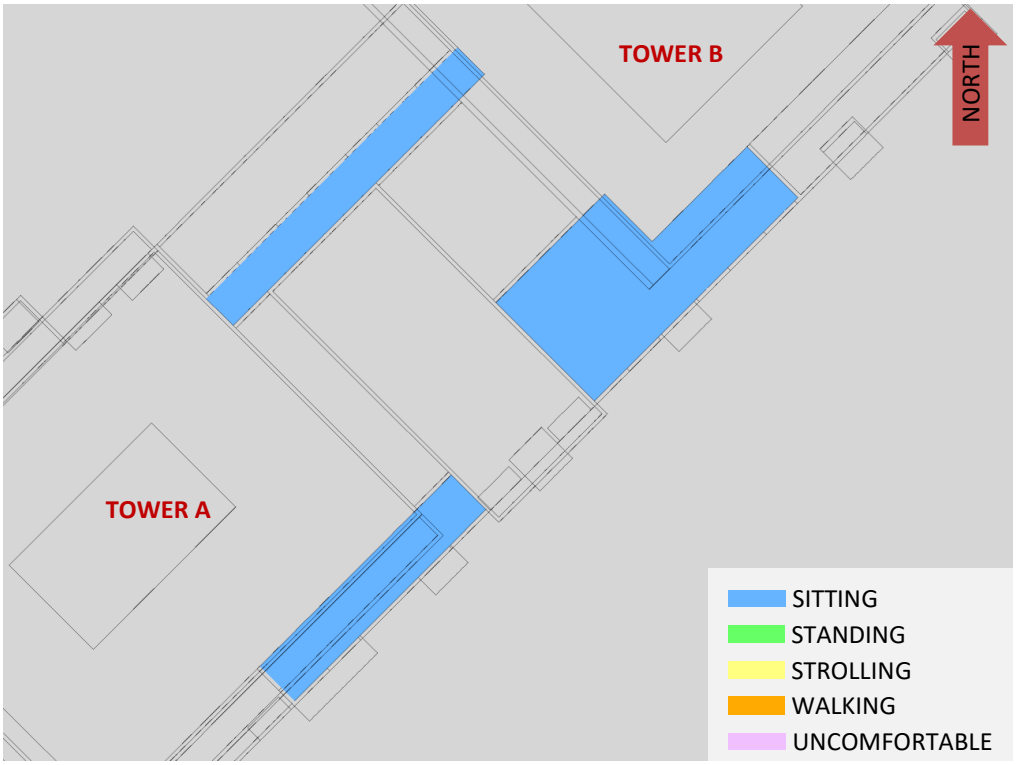

FIGURE 8B: SUMMER – WIND COMFORT, LEVEL 5 COMMON AMENITY TERRACES

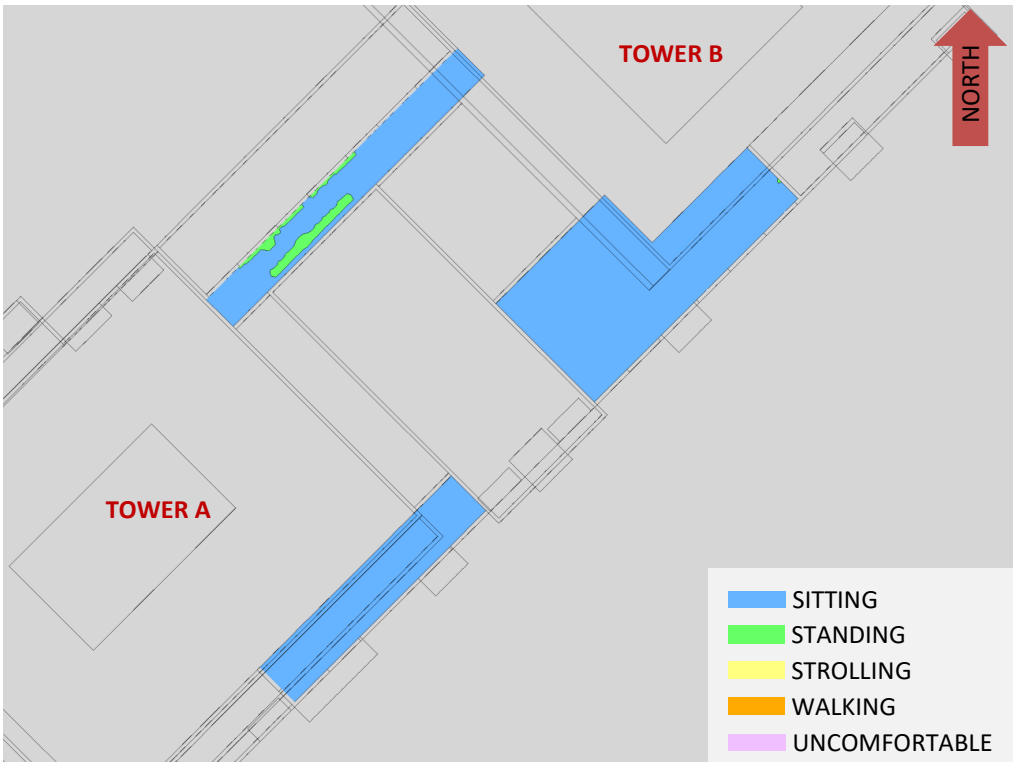

FIGURE 8C: AUTUMN – WIND COMFORT, LEVEL 5 COMMON AMENITY TERRACES

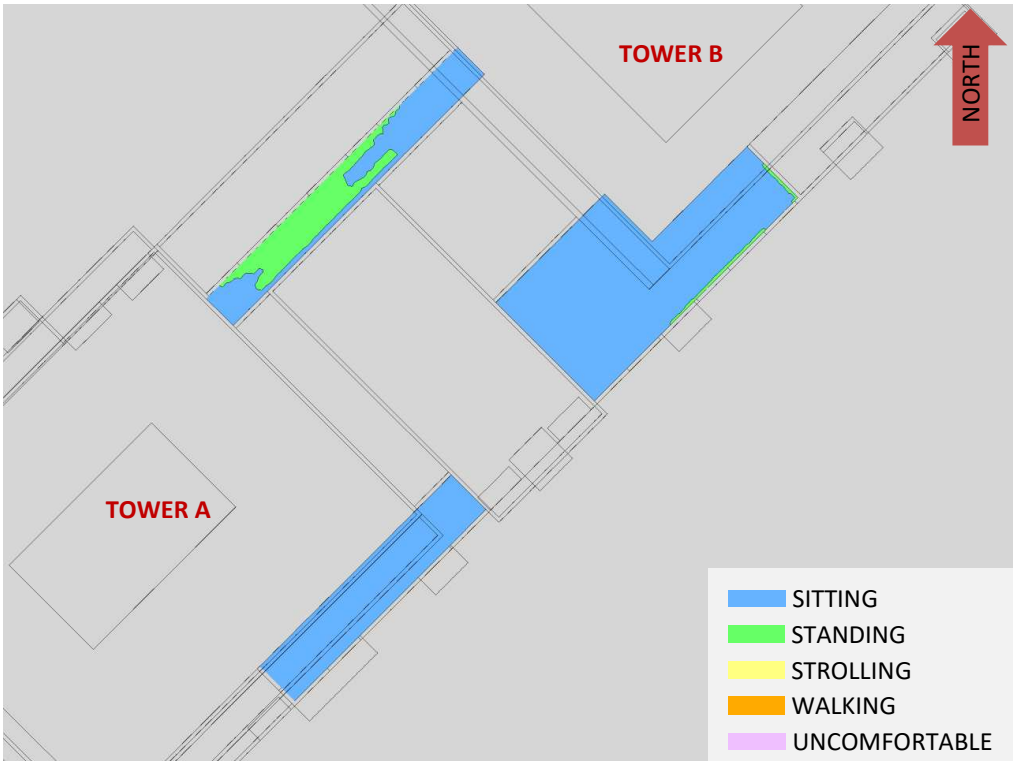

FIGURE 8D: WINTER – WIND COMFORT, LEVEL 5 COMMON AMENITY TERRACES

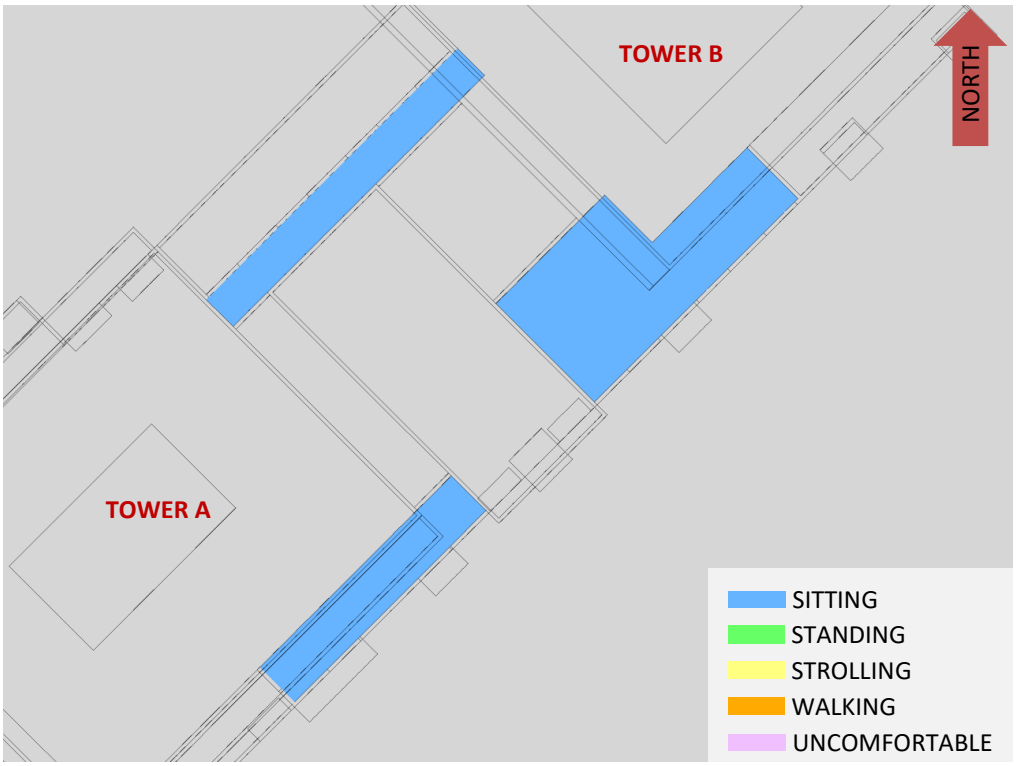

FIGURE 9: TYPICAL USE PERIOD – WIND COMFORT, LEVEL 5 COMMON AMENITY TERRACES

FIGURE 10A: SPRING – WIND COMFORT, MPH LEVEL AMENITY BALCONIES

FIGURE 10B: SUMMER – WIND COMFORT, MPH LEVEL AMENITY BALCONIES

FIGURE 10C: AUTUMN – WIND COMFORT, MPH LEVEL AMENITY BALCONIES

FIGURE 10D: WINTER – WIND COMFORT, MPH LEVEL AMENITY BALCONIES

FIGURE 11: TYPICAL USE PERIOD – WIND COMFORT, MPH LEVEL AMENITY BALCONIES

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 (that is, the area that it not captured within the simulation model).

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

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

Wind Direction (Degrees True)	Alpha Value (α)
0	0.18
49	0.24
74	0.25
103	0.25
167	0.24
197	0.25
217	0.24
237	0.23
262	0.21
282	0.20
301	0.19
324	0.19

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, 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.