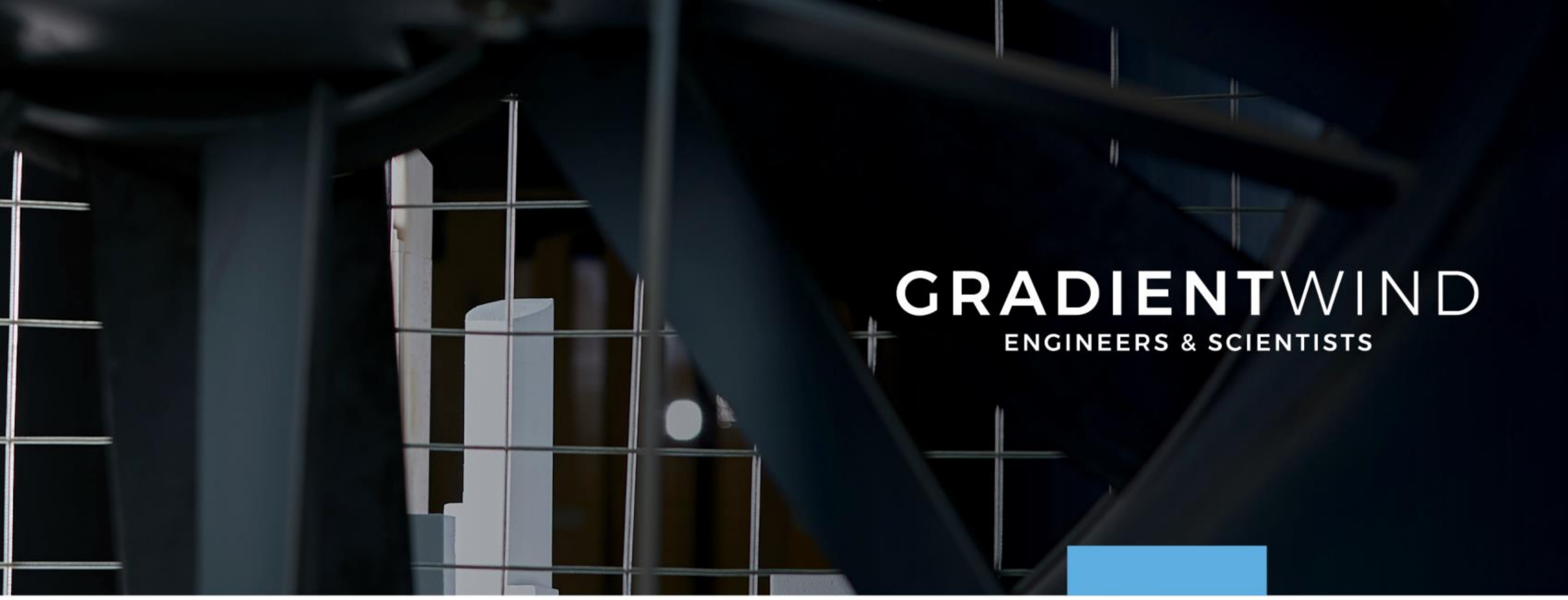
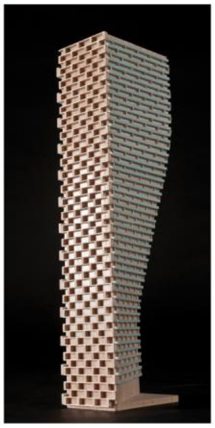
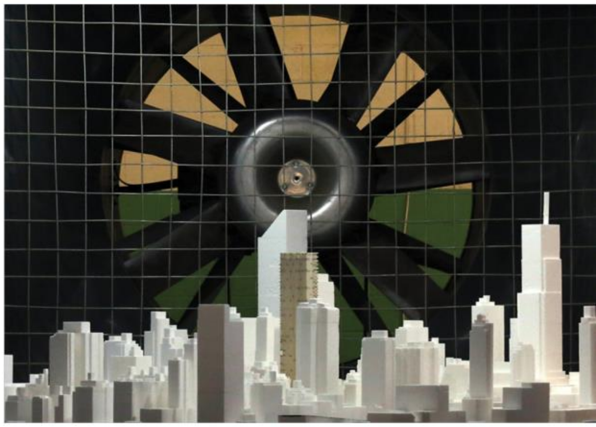



# PEDESTRIAN LEVEL WIND STUDY

3930 and 3960 Riverside Drive
Ottawa, Ontario

Report: 18-039-PLW-2022





December 22, 2022

PREPARED FOR
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# EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy concurrent Zoning By-law Amendment and Plan of Subdivision application requirements for the proposed multi-building development located at 3930 and 3960 Riverside Drive in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where conditions may interfere with certain pedestrian activities so that mitigation measures may be considered.

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-13B, and summarized as follows:

1) All grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, laneways, walkways, transit stop, surface parking, Uplands Riverside Park, and in the vicinity of building access points, are considered acceptable. An exception is described as follows:

    a. The introduction of the proposed development is predicted to improve comfort levels over the noted area, in comparison to existing conditions. However, to achieve the sitting comfort class in all areas during the typical use period, we recommend implementing targeted wind barriers installed around sensitive areas. Wind barriers could take the form of wind screens, clusters of coniferous trees in dense arrangements, or a combination of both options.

2) Regarding the common amenity terrace serving T3 at Level 6, conditions during the typical use period are predicted to be suitable for sitting within the majority of the terrace, while standing conditions at the southwest corner and within small areas near the northeast and southeast corners of the terrace.

a. Depending on the programming of the space, the noted wind conditions may be considered acceptable. Specifically, if the areas in question will not accommodate seating or lounging activities, the noted wind conditions would be considered acceptable.

b. If required, sitting percentages in the noted windier area at the southwest corner of the terrace could be increased by implementing wind screens along the south and west perimeters, extending at least 1.8 m above the walking surface of the terrace.

3) Regarding the common amenity terrace serving T3 at the MPH level, conditions during the typical use period are predicted to be suitable for sitting within the majority of the terrace, while standing conditions are predicted to occur within the northern half of the terrace.

a. Depending on the programming of the space, the noted wind conditions may be considered acceptable. Specifically, if the area in question will not accommodate seating or lounging activities, the noted wind conditions would be considered acceptable.

b. If required, sitting percentages in the noted windier area could be increased by implementing a full perimeter wind screen, extending at least 1.8 m above the walking surface of the terrace.

4) Regarding the common amenity terrace serving T4 at Level 6, conditions during the typical use period are predicted to be suitable for sitting within the majority of the terrace, while standing conditions are predicted to occur at the northwest corner, near the southeast corner, and to the south of the terrace.

a. Depending on the programming of the space, the noted wind conditions may be considered acceptable. Specifically, if the areas in question will not accommodate seating or lounging activities, the noted wind conditions would be considered acceptable.

b. If required, sitting percentages in the noted windier areas could be increased by implementing wind screen along the south and west perimeters, extending at least 1.8 m above the walking surface of the terrace, and along the north perimeter, extending at least 2 m above the walking surface of the terrace.

5) To achieve the sitting comfort class in all areas within the common amenity terrace serving T1 at Level 5 and the common amenity terrace serving T4 at the MPH level during the typical use period, we recommend implementing a full perimeter wind screen, extending at least 2 m above the walking surface of the terrace.

6) To achieve the sitting comfort class in all areas within the common amenity terrace serving T1 at the MPH level and the common amenity terraces serving T2 at Level 6 and at the MPH level during the typical use period, we recommend implementing a full perimeter wind screen, extending at least 2 m above the walking surface of the terrace.

    a. Depending on the programming of the terrace, mitigation inboard of the perimeter may also be required and could take the form of wind screens and/or other landscaping features.

7) 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 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 St. Mary's Lands Corporation, care of Taggart Realty Management (TRM), to undertake a pedestrian level wind (PLW) study to satisfy concurrent Zoning By-law Amendment and Plan of Subdivision application requirements for the proposed multi-building development located at 3930 and 3960 Riverside Drive in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where conditions may interfere with certain pedestrian activities so that mitigation measures may be considered.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, City of Ottawa wind comfort and safety criteria, architectural drawings prepared by Hobin Architecture Incorporated, in November 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 3930 and 3960 Riverside Drive in Ottawa; situated on a parcel of land at the northwest intersection of Riverside Drive and Hunt Club Road, bordered by Uplands Riverside Park to the north, Riverside Drive to the east, Hunt Club Road to the south, and the Rideau River and green space to the west.

The proposed development comprises four residential towers topped with mechanical penthouse (MPH) levels, T1, T2, T3, and T4, situated from the east clockwise to the south of the subject site, respectively, single homes to the west and at the northwest corner, and townhomes throughout the remainder of the subject site. Parks are situated at the northwest and at the northeast corner of the subject site. A laneway situated along the east side of the subject site provides access from Riverside Drive to the internal laneways serving the subject site; a central east-west laneway, which includes a round-a-bout situated to the southwest of T1, and a continuous laneway encompassing central townhouses.

T1 comprises a 17-storey residential building inclusive of a four-storey podium. The building steps back from the north clockwise to the southwest corner at Level 5 to accommodate an amenity terrace. The MPH level is also served by an amenity terrace.

T2 comprises a 14-storey residential building inclusive of a five-storey podium. The building steps back from the northwest corner clockwise to the south at Level 6 to accommodate an amenity terrace. The MPH level is also served by an amenity terrace.

T3 comprises an 11-storey residential building inclusive of a five-storey podium. The building steps back from the north clockwise to the southwest corner at Level 6 to accommodate an amenity terrace. The MPH level is also served by an amenity terrace.

T4 comprises a nine-storey residential building inclusive of a five-storey podium. The building steps back from the east clockwise to the northwest corner at Level 6 to accommodate an amenity terrace. The MPH level is also served by an amenity terrace.

The near-field surroundings, defined as an area within 200-metres (m) of the subject site, include green space in all compass directions with Uplands Riverside Park to the north, the Ottawa Hunt and Golf Club to the east, and the Rideau River to the southwest. The far-field surroundings, defined as an area beyond the near-field but within a 2-kilometre (km) radius of the subject site, include the Rideau River, which flows from the south to the north. The area west of the river is characterized by low-rise massing, and the area east of the river include a mix of low-rise massing, open fields, and green spaces. Notably, isolated mid-rise buildings are situated to the west, northwest, and north-northeast, and a high-rise building is situated to the north.

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

# 3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level wind conditions at key areas within and surrounding the development site; (ii) identify areas where wind conditions may interfere with the intended uses of outdoor spaces; and (iii) recommend suitable mitigation measures, where required.

# 4. METHODOLOGY

The approach followed to quantify pedestrian wind conditions over the site is based on CFD simulations of wind speeds across the study site within a virtual environment, meteorological analysis of the Ottawa area wind climate, and synthesis of computational data with City of Ottawa wind comfort and safety criteria[1]. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

## 4.1 Computer-Based Context Modelling

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

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

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

## 4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 12 wind directions. The CFD simulation model was centered on the subject site, complete with surrounding massing within a radius of 600 m. The process was performed for two context massing scenarios, as noted in Section 2.

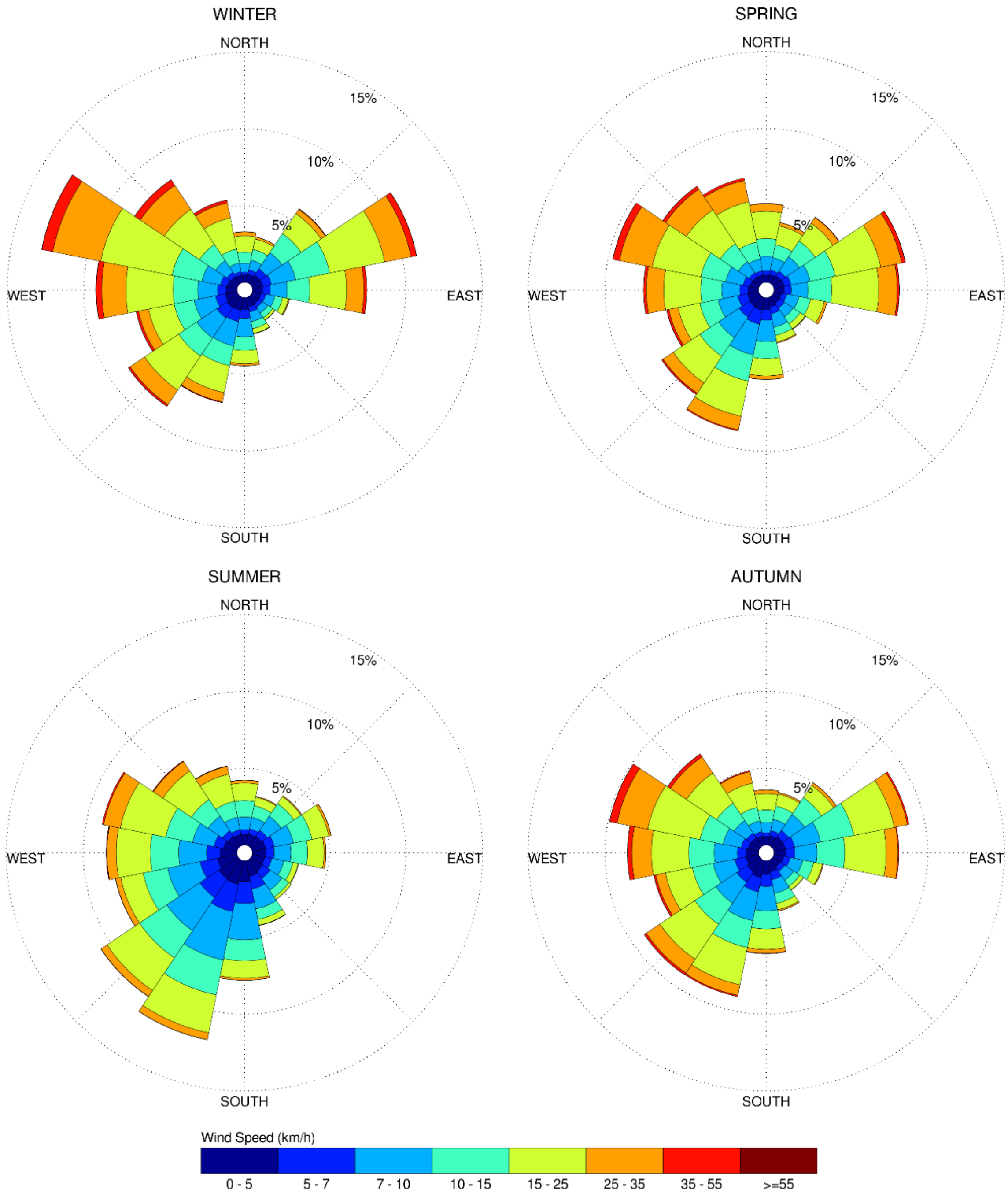
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the common amenity terraces were referenced to the wind 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 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 (that is, temperature and relative humidity). The comfort criteria assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Five pedestrian comfort classes 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 (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 Point | Walking |
| Public Sidewalk / Bicycle Path | Walking |
| Outdoor Amenity Space | Sitting (Typical Use Period) |
| Café / Patio / Bench / Garden | Sitting (Typical Use Period) |
| Transit Stop (Without Shelter) | Standing |
| Transit Stop (With Shelter) | Walking |
| Public Park / Plaza | Sitting (Typical Use Period) |
| Garage / Service Entrance | Walking |
| Parking Lot | Walking |
| Vehicular Drop-Off Zone | Walking |

## 5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-6B and 8A-11B, illustrating wind conditions at grade level for the proposed and existing massing scenarios within the northern and southern halves of the subject site, respectively, and by Figures 12A-12D, illustrating wind conditions over the common amenity terraces serving T1 at Level 5, T2, T3, and T4 at Level 6, and at the MPH Level of all four towers. Conditions are presented as continuous contours of wind comfort throughout the subject site and correspond to the comfort classes presented in Section 4.4. Conditions suitable for sitting are represented by the colour blue, standing by green, strolling by yellow, and walking by orange; uncomfortable conditions are represented by the colour magenta.

Wind comfort conditions within the common amenity terraces serving the proposed development are also reported for the typical use period, which is defined as May to October, inclusive. Figures 7 and 13A illustrate wind comfort conditions over the parks at grade and over the common amenity terraces, respectively, consistent with the comfort classes in Section 4.4, while Figure 13B illustrates contours indicating the percentage of time conditions within the terraces are predicted to be suitable for sitting during the same period. The details of these conditions are summarized in the following pages.

## 5.1 Wind Comfort Conditions – Ground Floor

**Uplands Riverside Park:** Following the introduction of the proposed development, conditions over the Uplands Riverside Park to the north of the subject site are predicted to be suitable for a mix of sitting and standing during the typical use period. The noted conditions are considered acceptable.

Conditions over Uplands Riverside Park with the existing massing are predicted to be mostly suitable for standing during the typical use period. Notably, the introduction of the proposed development is predicted to improve comfort levels over Uplands Riverside Park, in comparison to existing conditions, and wind conditions with the proposed development are considered acceptable.

**Parking Lot Serving Uplands Riverside Park:** Conditions over the proposed parking lot serving Uplands Riverside Park are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for standing throughout the remainder of the year, with an isolated region of strolling during the winter. The noted conditions are considered acceptable.

**Sidewalks Along Riverside Drive:** Following the introduction of the proposed development, conditions over the sidewalks along Riverside Drive are predicted to be suitable for a mix of sitting and standing during the summer, mostly suitable for standing during the autumn, becoming mostly suitable for a mix of standing and strolling during the winter and spring. The noted conditions are considered acceptable.

Conditions over the sidewalk areas along Riverside Drive with the existing massing are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing and strolling during the autumn, and suitable for strolling during the winter and spring. Notably, the introduction of the proposed development is predicted to improve comfort levels along Riverside Drive, in comparison to existing conditions, and wind conditions with the proposed development are considered acceptable.

**Walkways Along Laneway East of Subject Site:** Conditions over the walkways along the laneway to the east of the subject site are predicted to be suitable for a mix of sitting and standing during the spring, summer, and autumn, with isolated regions of strolling during the spring and autumn, becoming suitable for strolling, or better, during the winter. The noted conditions are considered acceptable.

**Sidewalks and Transit Stop Along Hunt Club Road:** Following the introduction of the proposed development, conditions over the sidewalks along Hunt Club Road are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for standing throughout the remainder of the year. Conditions over the nearby transit stop along Hunt Club Road are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year. The noted conditions are considered acceptable.

Conditions over the sidewalk areas along Hunt Club Road with the existing massing are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing and strolling during the autumn, and suitable for strolling during the winter and spring. Conditions over the nearby transit stop along Hunt Club Road are predicted to be suitable for standing during the summer and autumn, becoming suitable for strolling during the winter and spring. Notably, the introduction of the proposed development is predicted to improve comfort levels along Hunt Club Road, in comparison to existing conditions, and wind conditions with the proposed development are considered acceptable.

**Walkways West of Subject Site:** Conditions over the walkways along the west side of the subject site are predicted to be suitable for a mix of sitting and standing during the summer, becoming mostly suitable for standing with an isolated region of strolling situated at the northwest corner of the subject site throughout the remainder of the year. The noted conditions are considered acceptable.

**Walkways Along Central East-West Laneway (East of Round-a-Bout):** Conditions over the central east-west laneway, to the east of the round-a-bout, are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing and strolling during the spring and autumn, and suitable for a mix of strolling and walking during the winter. The noted conditions are considered acceptable.

**Walkways Along Central East-West Laneway (West of Round-a-Bout):** Conditions over the central east-west laneway, to the west of the round-a-bout, are predicted to be suitable for sitting during the summer, becoming suitable standing, or better, throughout the remainder of the year. The noted conditions are considered acceptable.

**Laneway West of T1:** Conditions over the laneway situated to the west of T1 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 standing and strolling during the winter. The noted conditions are considered acceptable.

**Walkways Along North-South Laneway West of T1 & T2:** Conditions over the walkways along the north-south laneway situated to the west of T1 and T2 are predicted to be suitable for a mix of sitting and standing during the summer and autumn, becoming suitable strolling, or better, during the winter and spring. The noted conditions are considered acceptable.

**Laneway West of T2:** Conditions over the laneway situated to the west of T2 are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year. The noted conditions are considered acceptable.

**Walkways Along Laneway South of Subject Site:** Conditions over the walkways along the laneway situated to the south of the subject site are predicted to be suitable for sitting during the summer and autumn, becoming suitable for a mix of sitting and standing, during the winter and spring. The noted conditions are considered acceptable.

**Surface Parking Along Laneway North of T3 & T4:** Conditions over the laneway serving T3 and T4 are predicted to be suitable for sitting throughout the year with an isolated region of standing during the spring and winter. Conditions over the surface parking along the noted laneway are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the remainder of the year. The noted conditions are considered acceptable.

**Walkways Along Laneway West of Subject Site:** Conditions over the walkways along the laneway situated to the west of the subject site are predicted to be suitable for sitting throughout the year, with small, isolated regions of standing during the spring and winter. The noted conditions are considered acceptable.

**Walkways Along Laneway Northwest of Subject Site:** Conditions over the walkways along the laneway situated to the northwest of the subject site are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable.

**Park Northwest of Subject Site:** Wind conditions within the park situated at the northwest corner of the subject site are predicted to be suitable for a mix of sitting and standing during the typical use period. Specifically, conditions are predicted to be suitable for sitting to the south, while standing conditions are predicted to occur throughout the remainder of the area.

The areas that are predicted to be suitable for standing, according to the comfort classification in Section 4.4, is also predicted to be suitable for sitting for at least 75% of the time within the majority of the area and for at least 70% of the time to the west, where the target is 80% to achieve the sitting comfort criterion.

Notably, the introduction of the proposed development is predicted to improve comfort levels over the noted area, in comparison to existing conditions, however, to achieve the sitting comfort class in all areas during the typical use period, we recommend implementing targeted wind barriers installed around sensitive areas. Wind barriers could take the form of wind screens, clusters of coniferous trees in dense arrangements, or a combination of both options.

**Park Northeast of Subject Site:** Wind conditions within the park situated at the northeast corner of the subject site are predicted to be suitable for a mix of sitting and standing during the typical use period. Specifically, conditions are predicted to be suitable for sitting to the west, while standing conditions are predicted to occur throughout the remainder of the area.

The areas that are predicted to be suitable for standing, according to the comfort classification in Section 4.4, is also predicted to be suitable for sitting for at least 78% of the time to the north, for at least 75% central to the area, and for at least 71% of the time to the south, where the target is 80% to achieve the sitting comfort criterion.

Notably, the introduction of the proposed development is predicted to improve comfort levels over the noted area, in comparison to existing conditions, however, to achieve the sitting comfort class in all areas during the typical use period, we recommend implementing targeted wind barriers installed around sensitive areas. Wind barriers could take the form of wind screens, clusters of coniferous trees in dense arrangements, or a combination of both options.

**Building Access Serving Proposed Development:** Conditions in the vicinity of all building access points serving T1, T2, T3, and T4 are predicted to be suitable for standing, or better, throughout the year, which are considered acceptable.

## 5.2 Wind Comfort Conditions – Common Amenity Terraces

**T1 – Level 5 Common Amenity Terrace**: Wind conditions within the common amenity terrace serving T1 at Level 5 are predicted to be suitable for a mix of sitting and standing during the typical use period, as illustrated in Figure 13A. Specifically, conditions are predicted to be suitable for sitting within the majority of the terrace, while standing conditions are predicted to occur to the north and along the south and west sides of the terrace.

The areas that are predicted to be suitable for standing, according to the comfort classification in Section 4.4, is also predicted to be suitable for sitting for at least 73% of the time to the north and for at least 65% of the time to the south, as illustrated in Figure 13B, where the target is 80% to achieve the sitting comfort criterion.

To achieve the sitting comfort class in all areas during the typical use period, we recommend implementing a full perimeter wind screen, typically glazed and preferably solid (that is, no porosity), extending at least 2 m above the walking surface of the terrace.

**T1 – MPH Level Common Amenity Terrace**: Wind conditions within the common amenity terrace serving T1 at the MPH level are predicted to be suitable for a mix of standing and strolling during the typical use period, as illustrated in Figure 13A. Specifically, conditions are predicted to be suitable for standing within the majority of the terrace, while an isolated region of strolling is predicted to occur central to the terrace.

The areas that are predicted to be suitable for standing, according to the comfort classification in Section 4.4, is also predicted to be suitable for sitting for at least 60% of the time, as illustrated in Figure 13B, where the target is 80% to achieve the sitting comfort criterion.

To achieve the sitting comfort class in all areas during the typical use period, we recommend implementing a full perimeter wind screen, typically glazed and preferably solid (that is, no porosity), extending at least 2 m above the walking surface of the terrace. Depending on the programming of the terrace, mitigation inboard of the perimeter may also be required and could take the form of wind screens and/or other landscaping features.

**T2 – Level 6 Common Amenity Terrace:** Wind conditions within the common amenity terrace serving T2 at Level 6 are predicted to be suitable for a mix of sitting and standing during the typical use period, as illustrated in Figure 13A. Specifically, conditions are predicted to be suitable for sitting within the majority of the terrace, while standing conditions are predicted to occur to the north and at the southeast corner of the terrace.

The areas that are predicted to be suitable for standing, according to the comfort classification in Section 4.4, is also predicted to be suitable for sitting for at least 75% of the time at the southeast corner of the terrace and for at least 65% of the time to the north, as illustrated in Figure 13B, where the target is 80% to achieve the sitting comfort criterion.

To achieve the sitting comfort class in all areas during the typical use period, we recommend implementing a full perimeter wind screen, typically glazed and preferably solid (that is, no porosity), extending at least 2 m above the walking surface of the terrace. Depending on the programming of the terrace, mitigation inboard of the perimeter may also be required and could take the form of wind screens and/or other landscaping features.

**T2 – MPH Level Common Amenity Terrace**: Wind conditions within the common amenity terrace serving T2 at the MPH level are predicted to be suitable for standing during the typical use period, as illustrated in Figure 13A.

The area that is predicted to be suitable for standing, according to the comfort classification in Section 4.4, is also predicted to be suitable for sitting for at least 65% of the time, as illustrated in Figure 13B, where the target is 80% to achieve the sitting comfort criterion.

To achieve the sitting comfort class in all areas during the typical use period, we recommend implementing a full perimeter wind screen, typically glazed and preferably solid (that is, no porosity), extending at least 2 m above the walking surface of the terrace. Depending on the programming of the terrace, mitigation inboard of the perimeter may also be required and could take the form of wind screens and/or other landscaping features.

**T3 – Level 6 Common Amenity Terrace**: Wind conditions within the common amenity terrace serving T3 at Level 6 are predicted to be suitable for a mix of sitting and standing during the typical use period, as illustrated in Figure 13A. Specifically, conditions are predicted to be suitable for sitting within the majority of the terrace, while standing conditions are predicted to occur at the southwest corner and within small areas near the northeast and southeast corners of the terrace.

The areas that are predicted to be suitable for standing, according to the comfort classification in Section 4.4, are also predicted to be suitable for sitting for at least 77% of the time at the northeast and southeast corners and for at least 72% of the time at the southwest corner of the terrace, as illustrated in Figure 13B, where the target is 80% to achieve the sitting comfort criterion.

Depending on the programming of the space, the noted wind conditions may be considered acceptable. Specifically, if the areas in question will not accommodate seating or lounging activities, the noted wind conditions would be considered acceptable. If required, sitting percentages in the noted windier area at the southwest corner of the terrace could be increased by implementing wind screen along the south and west perimeters, typically glazed and preferably solid (that is, no porosity), extending at least 1.8 m above the walking surface of the terrace.

**T3 – MPH Level Common Amenity Terrace**: Wind conditions within the common amenity terrace serving T3 at the MPH level are predicted to be suitable for a mix of sitting and standing during the typical use period, as illustrated in Figure 13A. Specifically, conditions are predicted to be suitable for sitting within the majority of the terrace, while standing conditions are predicted to occur within the northern half of the terrace.

The areas that are predicted to be suitable for standing, according to the comfort classification in Section 4.4, are also predicted to be suitable for sitting for at least 75% of the time, as illustrated in Figure 13B, where the target is 80% to achieve the sitting comfort criterion.

Depending on the programming of the space, the noted wind conditions may be considered acceptable. Specifically, if the area in question will not accommodate seating or lounging activities, the noted wind conditions would be considered acceptable. If required, sitting percentages in the noted windier area could be increased by implementing a full perimeter wind screen, typically glazed and preferably solid (that is, no porosity), extending at least 1.8 m above the walking surface of the terrace.

**T4 – Level 6 Common Amenity Terrace**: Wind conditions within the common amenity terrace serving T4 at Level 6 are predicted to be suitable for a mix of sitting and standing during the typical use period, as illustrated in Figure 13A. Specifically, conditions are predicted to be suitable for sitting within the majority of the terrace, while standing conditions are predicted to occur at the northwest corner, near the southeast corner, and to the south of the terrace.

The areas that are predicted to be suitable for standing, according to the comfort classification in Section 4.4, are also predicted to be suitable for sitting for at least 77% of the time near at the southeast corner, for at least 72% to the south, and for at least 65% of the time at the northwest corner of the terrace, as illustrated in Figure 13B, where the target is 80% to achieve the sitting comfort criterion.

Depending on the programming of the space, the noted wind conditions may be considered acceptable. Specifically, if the areas in question will not accommodate seating or lounging activities, the noted wind conditions would be considered acceptable. If required, sitting percentages in the noted windier areas could be increased by implementing wind screen along the south and west perimeters, typically glazed and preferably solid (that is, no porosity), extending at least 1.8 m above the walking surface of the terrace, and along the north perimeter, typically glazed and preferably solid (that is, no porosity), extending at least 2 m above the walking surface of the terrace.

**T4 – MPH Level Common Amenity Terrace**: Wind conditions within the common amenity terrace serving T4 at the MPH level are predicted to be mostly suitable for standing during the typical use period, as illustrated in Figure 13A.

The areas that are predicted to be suitable for standing, according to the comfort classification in Section 4.4, is also predicted to be suitable for sitting for at least 72% of the time within the majority of the area and for at least 70% of the time to the north, as illustrated in Figure 13B, where the target is 80% to achieve the sitting comfort criterion. To achieve the sitting comfort class in all areas during the typical use period, we recommend implementing a full perimeter wind screen, typically glazed and preferably solid (that is, no porosity), extending at least 2 m above the walking surface of the terrace.

## 5.3 Wind Safety

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

## 5.4 Applicability of Results

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

## 6. CONCLUSIONS AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 and illustrated in Figures 3A-13B. Based on computer simulations using the CFD technique, meteorological data analysis of the Ottawa wind climate, City of Ottawa wind comfort and safety criteria, and experience with numerous similar developments, the study concludes the following:

1) All grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, laneways, walkways, transit stop, surface parking, Uplands Riverside Park, and in the vicinity of building access points, are considered acceptable. An exception is described as follows:

   a. The introduction of the proposed development is predicted to improve comfort levels over the noted area, in comparison to existing conditions. However, to achieve the sitting comfort class in all areas during the typical use period, we recommend implementing targeted wind barriers installed around sensitive areas. Wind barriers could take the form of wind screens, clusters of coniferous trees in dense arrangements, or a combination of both options.

2) Regarding the common amenity terrace serving T3 at Level 6, conditions during the typical use period are predicted to be suitable for sitting within the majority of the terrace, while standing conditions at the southwest corner and within small areas near the northeast and southeast corners of the terrace.

   a. Depending on the programming of the space, the noted wind conditions may be considered acceptable. Specifically, if the areas in question will not accommodate seating or lounging activities, the noted wind conditions would be considered acceptable.

   b. If required, sitting percentages in the noted windier area at the southwest corner of the terrace could be increased by implementing wind screens along the south and west perimeters, extending at least 1.8 m above the walking surface of the terrace.

3) Regarding the common amenity terrace serving T3 at the MPH level, conditions during the typical use period are predicted to be suitable for sitting within the majority of the terrace, while standing conditions are predicted to occur within northern half of the terrace.

   a. Depending on the programming of the space, the noted wind conditions may be considered acceptable. Specifically, if the areas in question will not accommodate seating or lounging activities, the noted wind conditions would be considered acceptable.

   b. If required, sitting percentages in the noted windier area could be increased by implementing a full perimeter wind screen, extending at least 1.8 m above the walking surface of the terrace.

4) Regarding the common amenity terrace serving T4 at Level 6, conditions during the typical use period are predicted to be suitable for sitting within the majority of the terrace, while standing conditions are predicted to occur at the northwest corner, near the southeast corner, and to the south of the terrace.

   a. Depending on the programming of the space, the noted wind conditions may be considered acceptable. Specifically, if the areas in question will not accommodate seating or lounging activities, the noted wind conditions would be considered acceptable.

   b. If required, sitting percentages in the noted windier areas could be increased by implementing wind screen along the south and west perimeters, extending at least 1.8 m above the walking surface of the terrace, and along the north perimeter, extending at least 2 m above the walking surface of the terrace.

5) To achieve the sitting comfort class in all areas within the common amenity terrace serving T1 at Level 5 and the common amenity terrace serving T4 at the MPH level during the typical use period, we recommend implementing a full perimeter wind screen, extending at least 2 m above the walking surface of the terrace.

6) To achieve the sitting comfort class in all areas within the common amenity terrace serving T1 at the MPH level and the common amenity terraces serving T2 at Level 6 and at the MPH level during the typical use period, we recommend implementing a full perimeter wind screen, extending at least 2 m above the walking surface of the terrace.

a. Depending on the programming of the terrace, mitigation inboard of the perimeter may also be required and could take the form of wind screens and/or other landscaping features.

7) 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 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
Dec 22, 2022
PROVINCE OF ONTARIO

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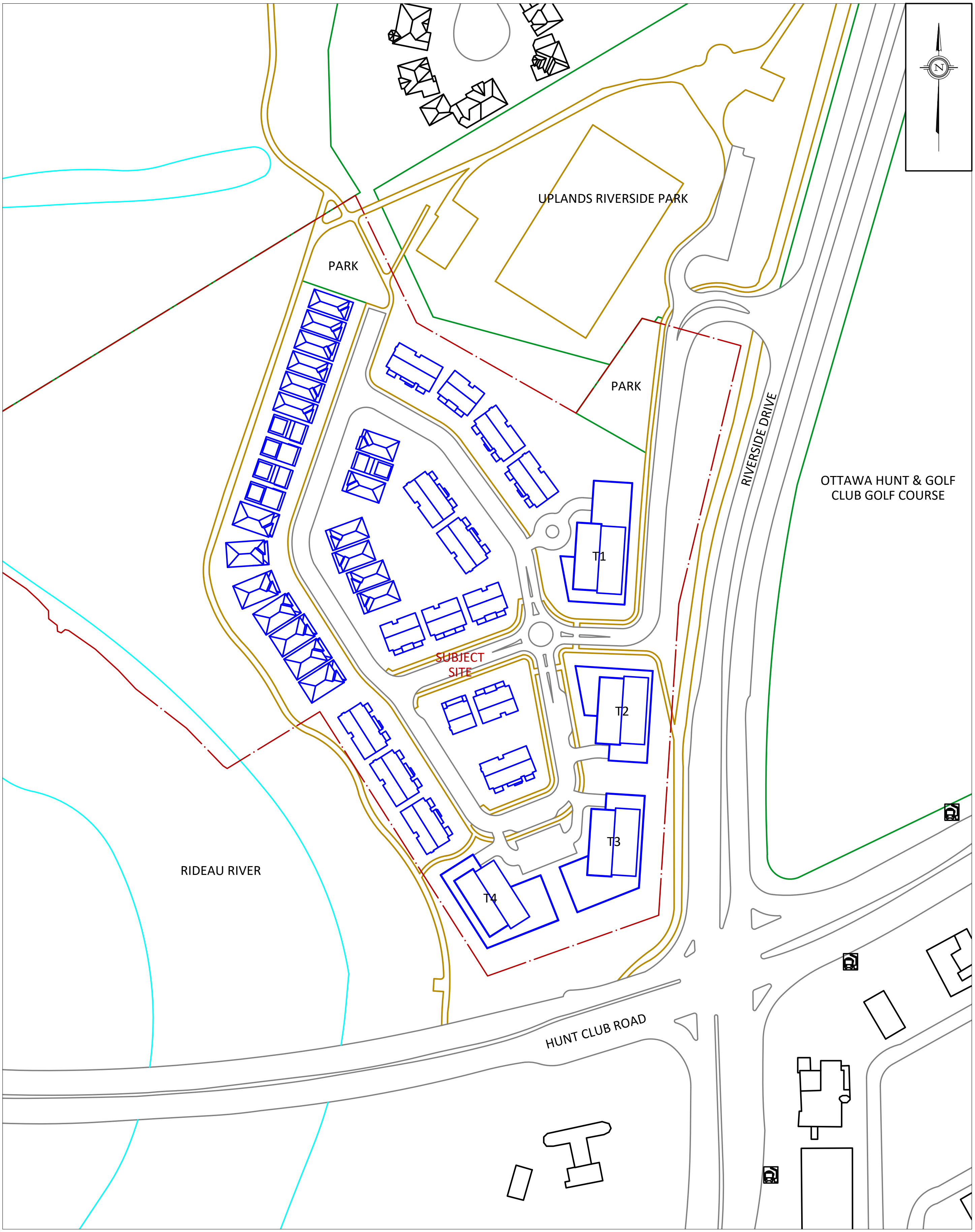
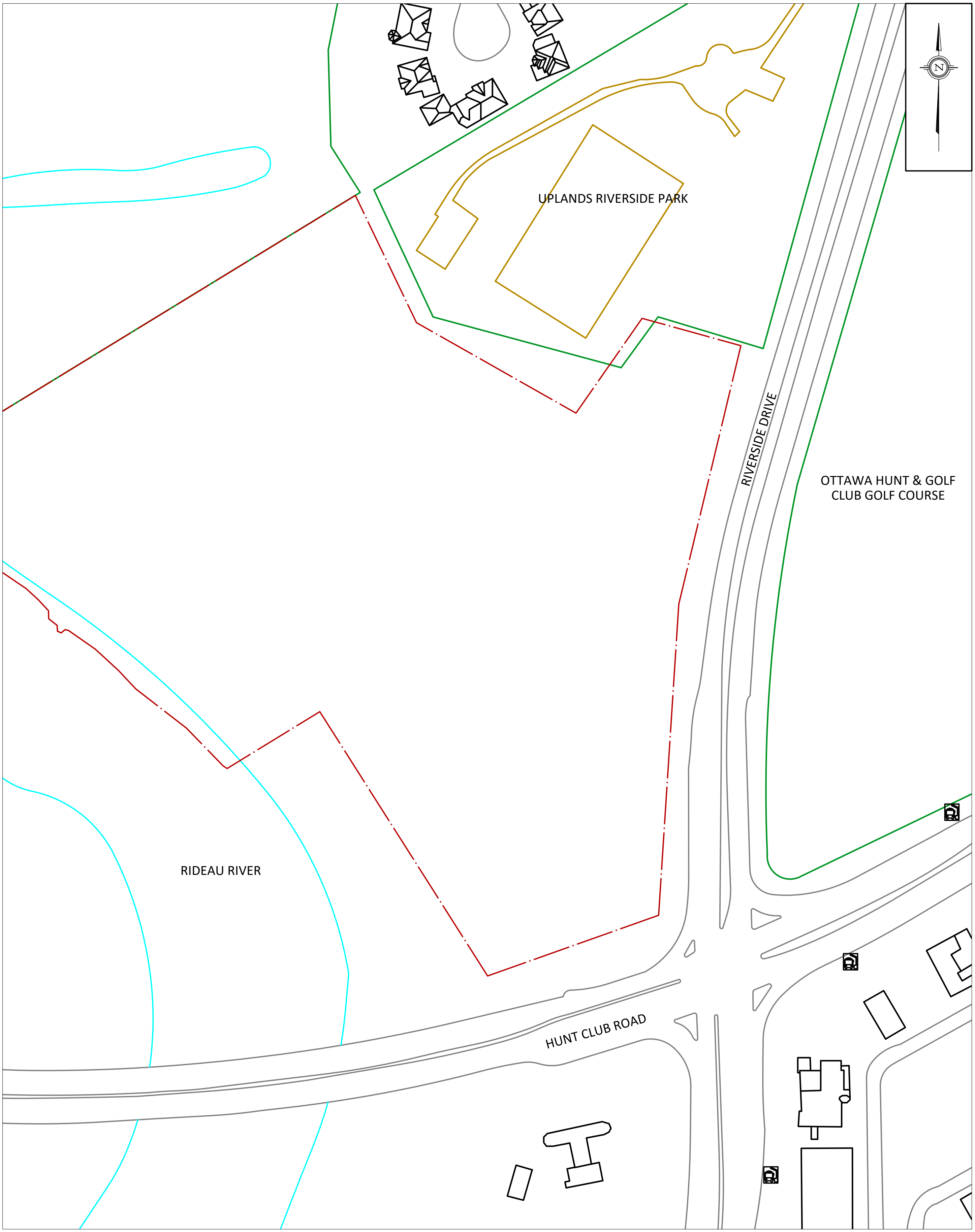



| GRADIENTWIND ENGINEERS & SCIENTISTS<br>127 WALGREEN ROAD, OTTAWA, ON<br>613 836 0934 • GRADIENTWIND.COM | PROJECT<br>HUNT CLUB & RIVERSIDE, OTTAWA<br>PEDESTRIAN LEVEL WIND STUDY | | DESCRIPTION<br>FIGURE 1A:<br>PROPOSED SITE PLAN AND SURROUNDING CONTEXT |
|---|---|---|---|
| | SCALE 1:2500 | DRAWING NO. 18-039-PLW-2022-1A | |
| | DATE DECEMBER 5, 2022 | DRAWN BY S.K. | |

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| | |
|---|---|
| PROJECT | HUNT CLUB & RIVERSIDE, OTTAWA PEDESTRIAN LEVEL WIND STUDY |
| SCALE | 1:2500 |
| DRAWING NO. | 18-039-PLW-2022-1B |
| DATE | DECEMBER 5, 2022 |
| DRAWN BY | S.K. |
| DESCRIPTION | FIGURE 1B: EXISTING SITE PLAN AND SURROUNDING CONTEXT |

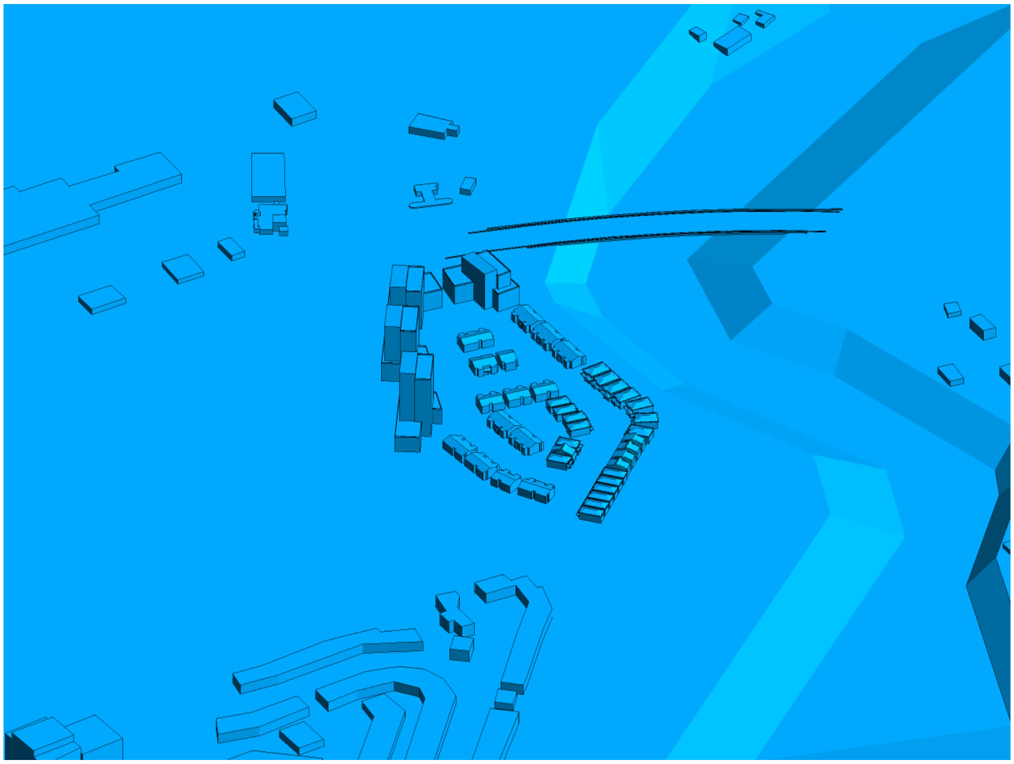


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

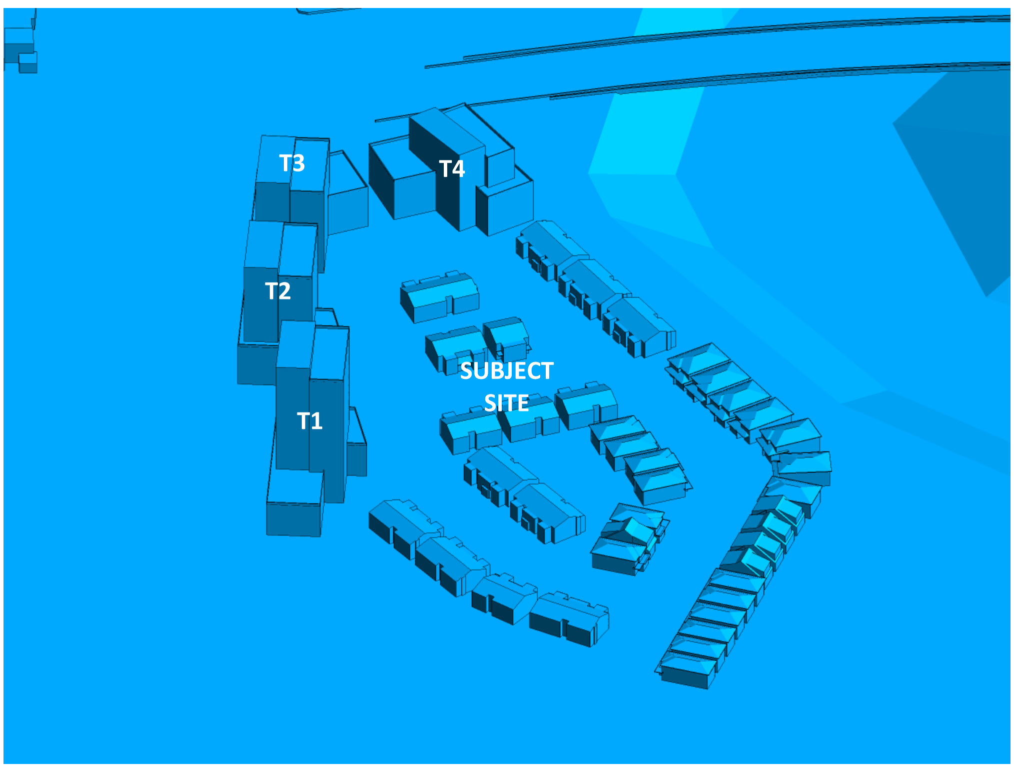



FIGURE 2B: CLOSE UP OF FIGURE 2A

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

**FIGURE 2D: CLOSE UP OF FIGURE 2C**

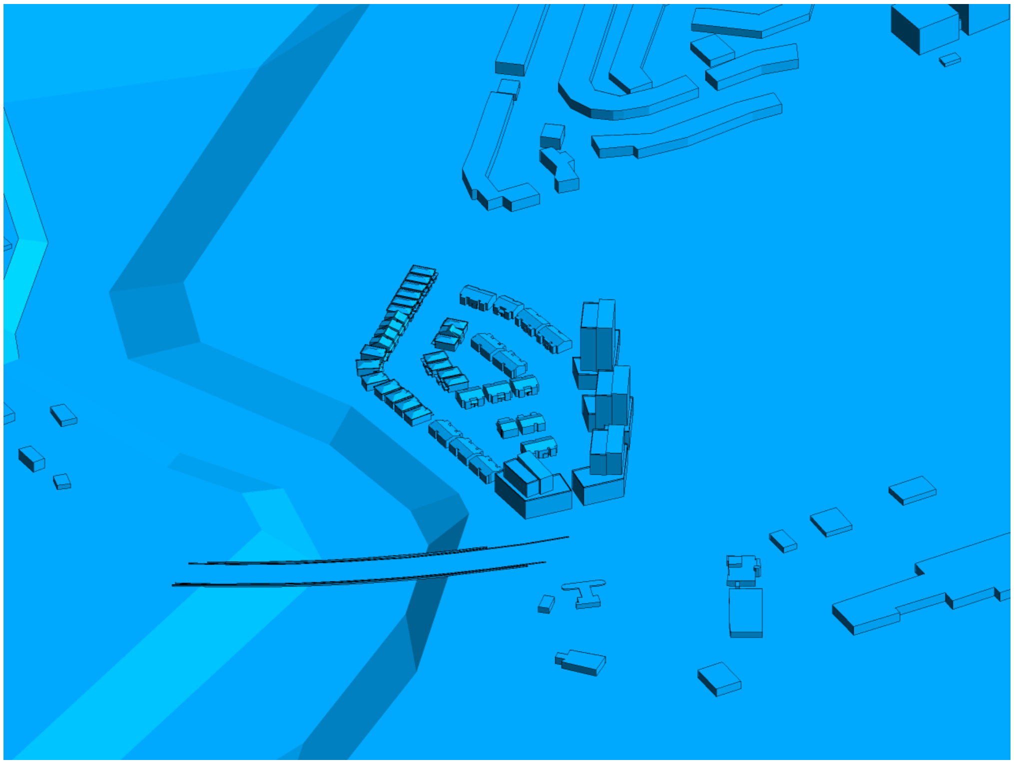


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

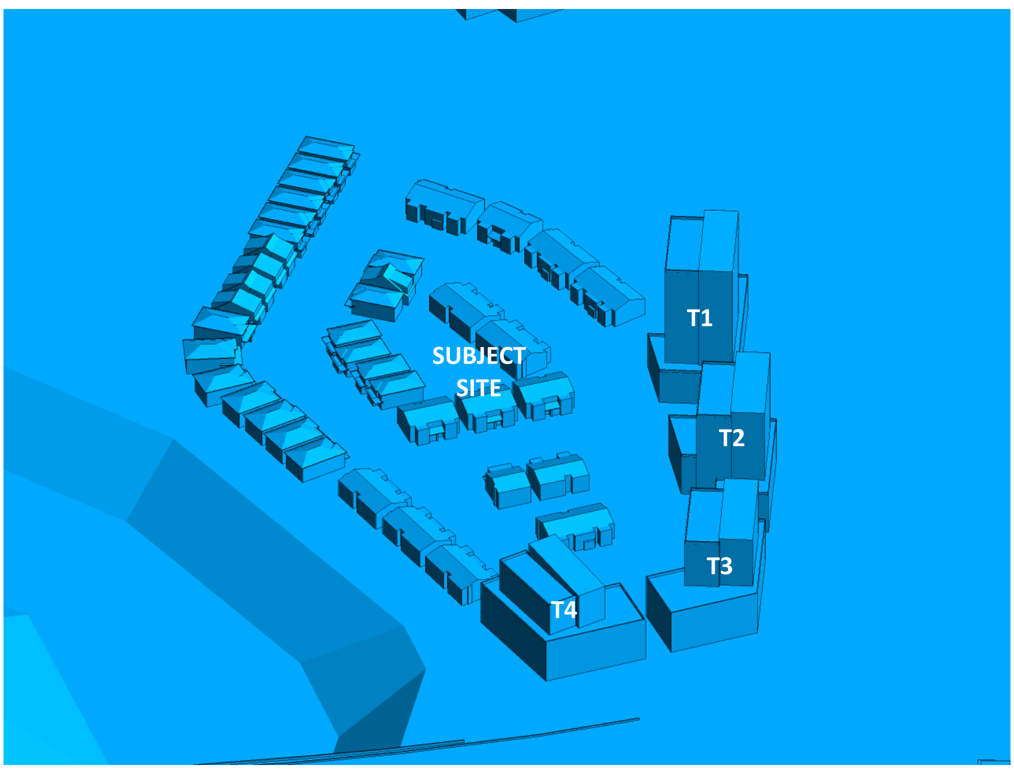



FIGURE 2F: CLOSE UP OF FIGURE 2E

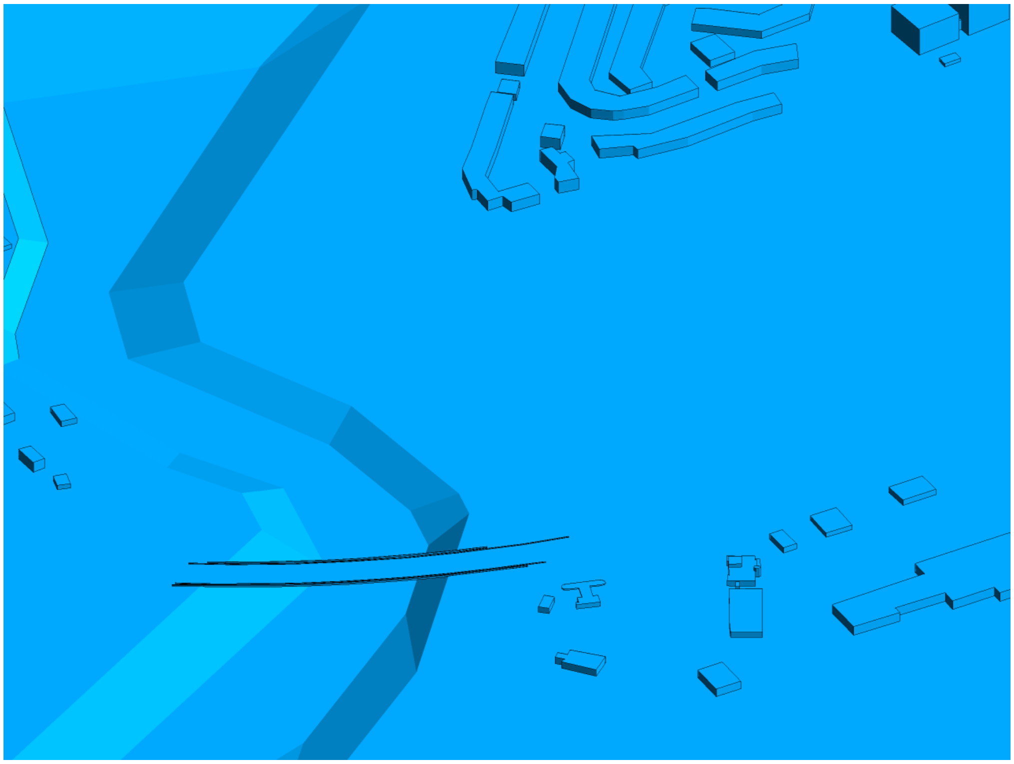


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

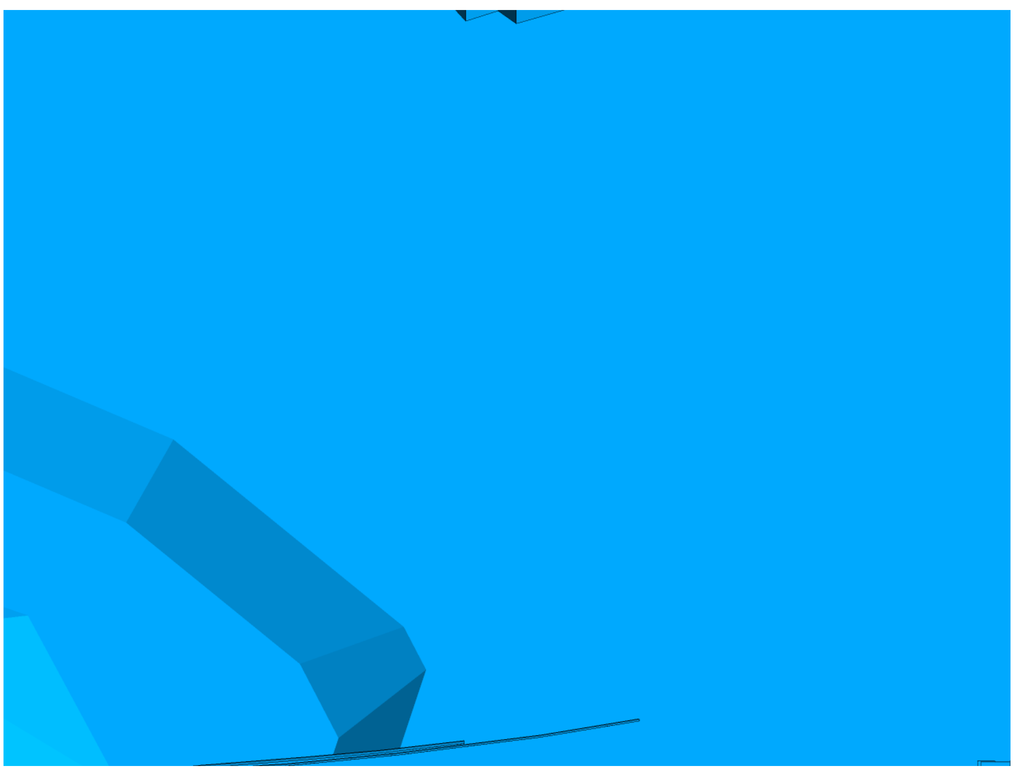


FIGURE 2H: CLOSE UP OF FIGURE 2G

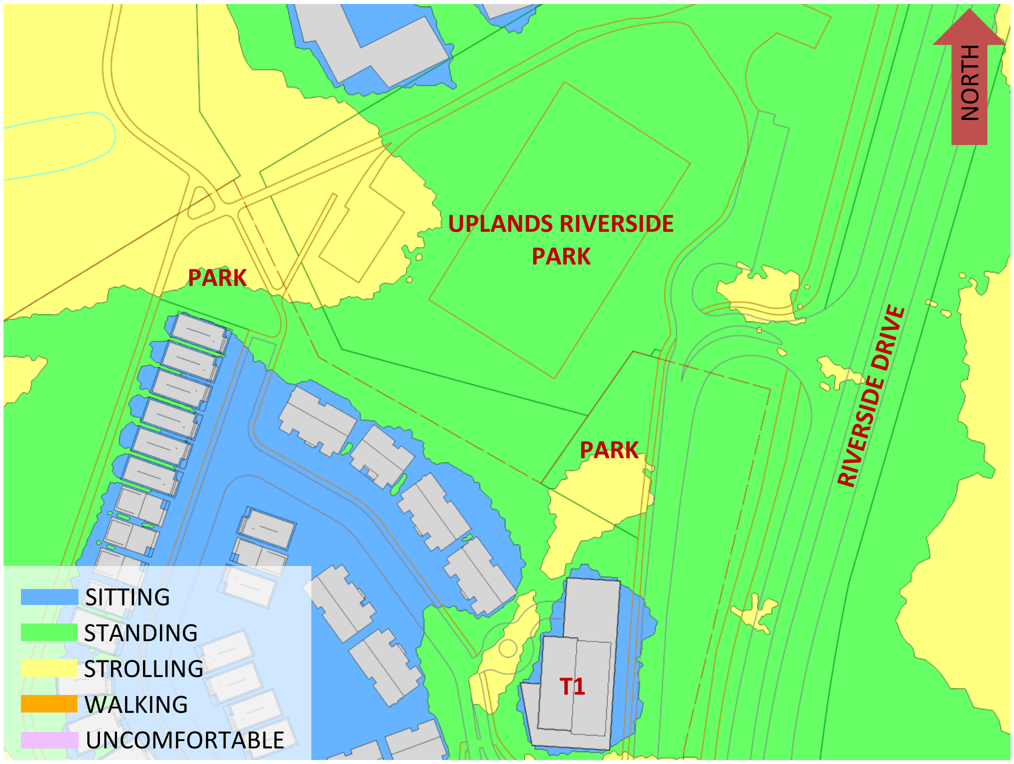



**FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING (NORTH)**

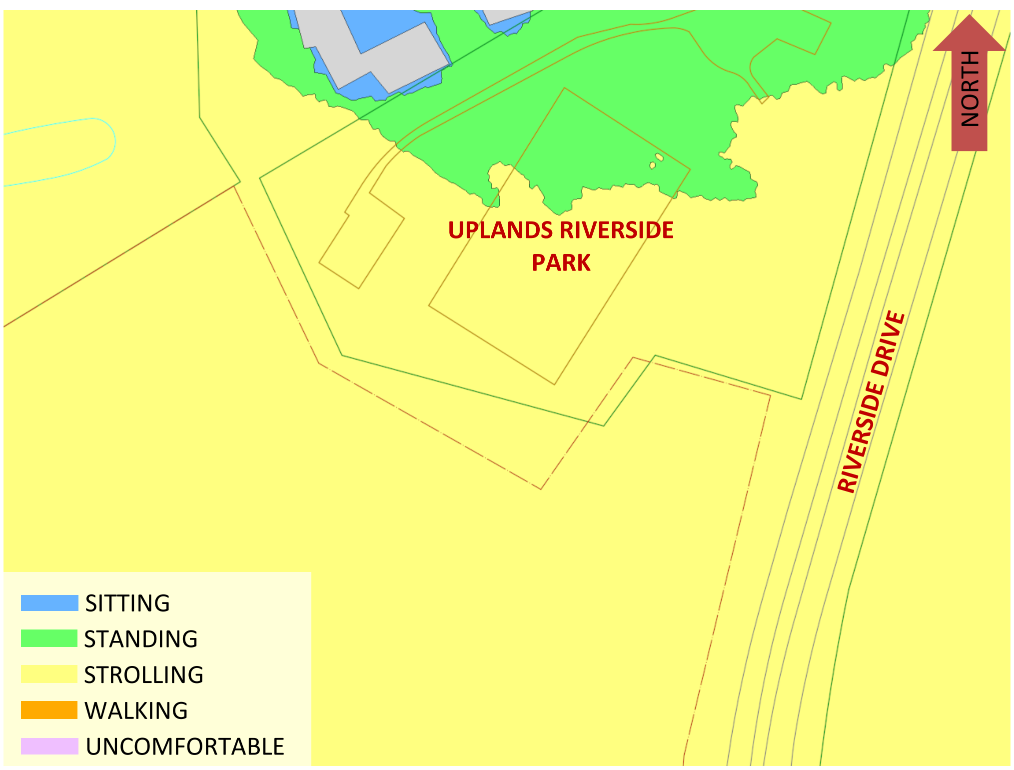



**FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING (NORTH)**

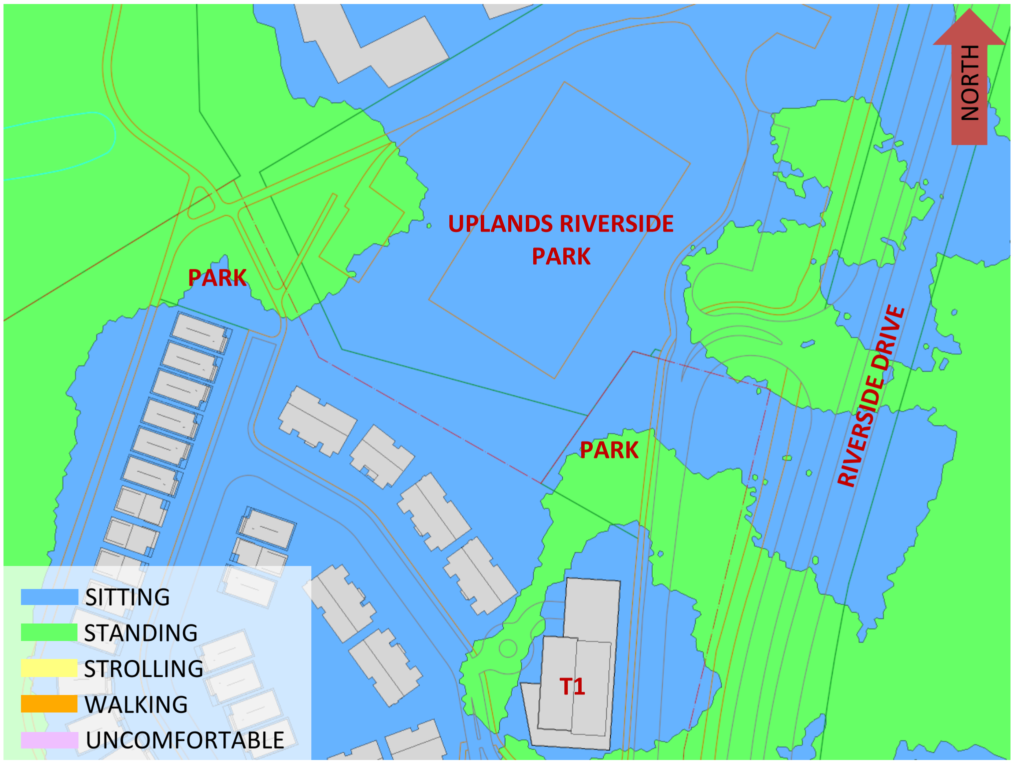



**FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING (NORTH)**

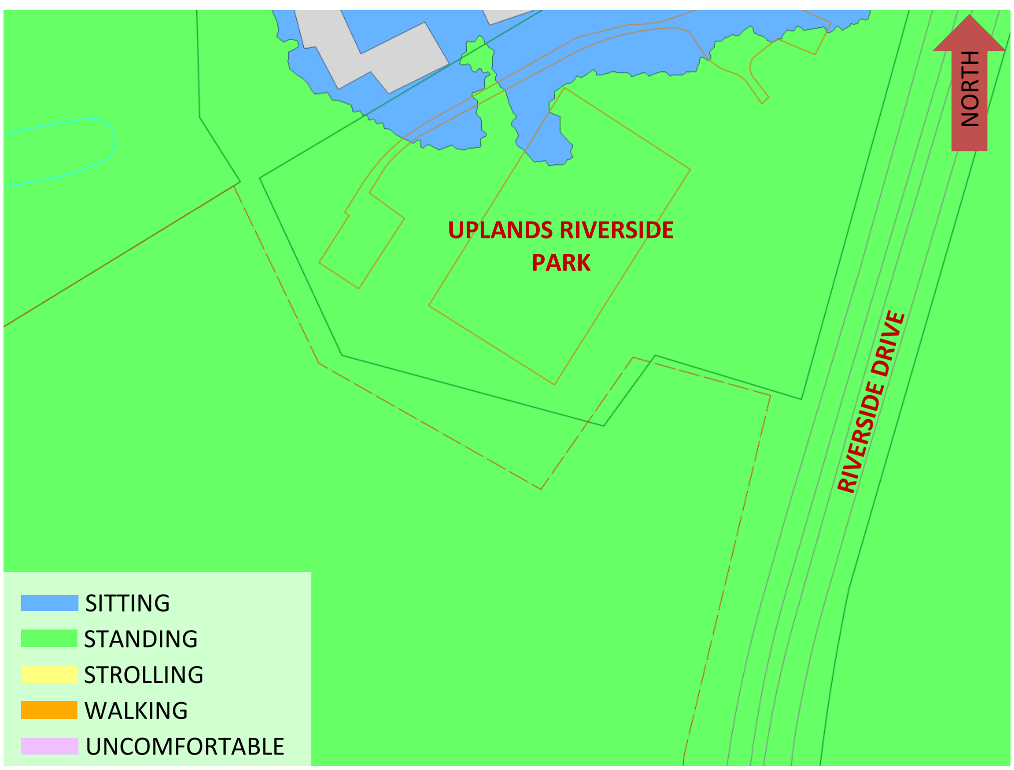



**FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING (NORTH)**

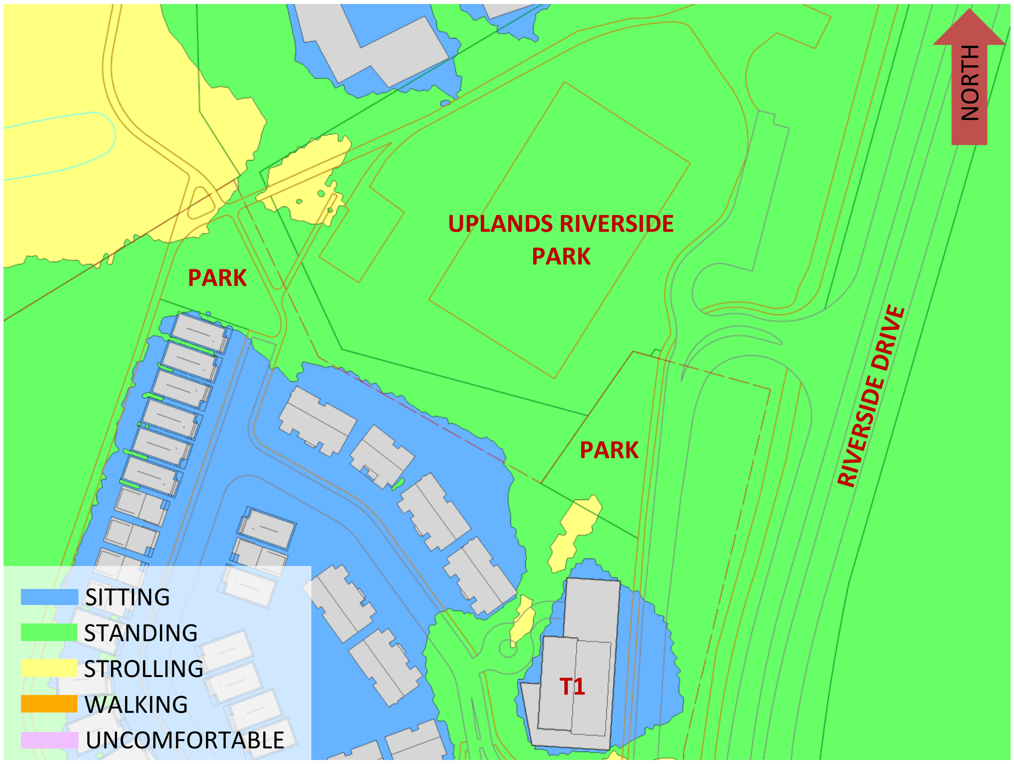



**FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING (NORTH)**

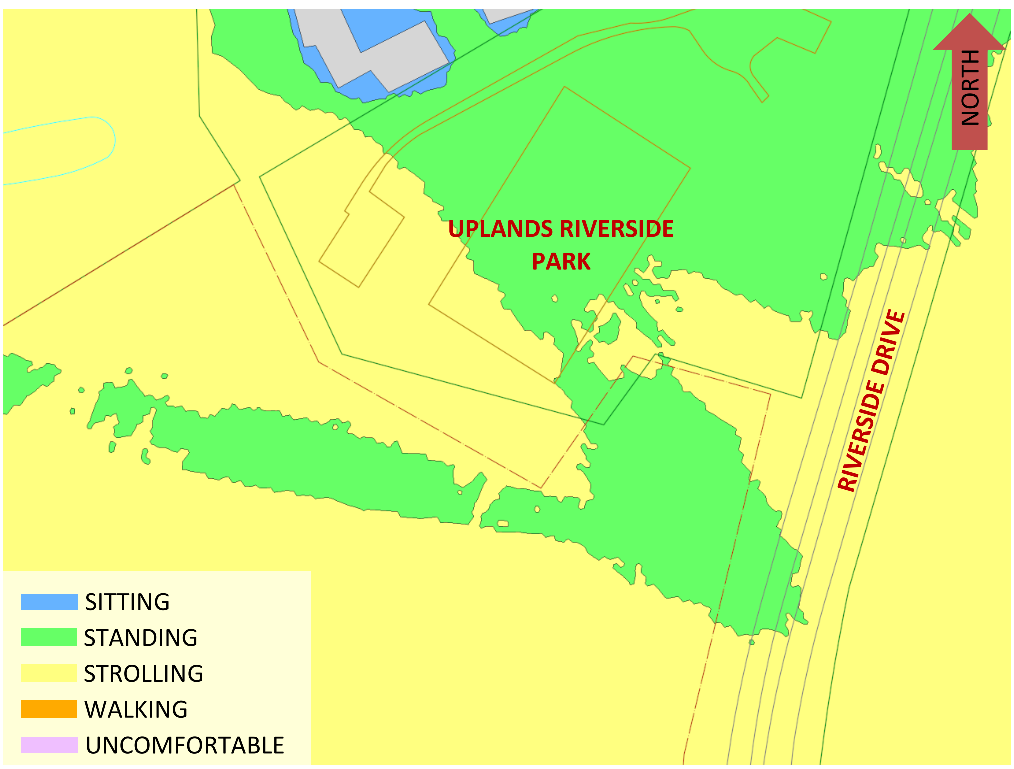



**FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING (NORTH)**

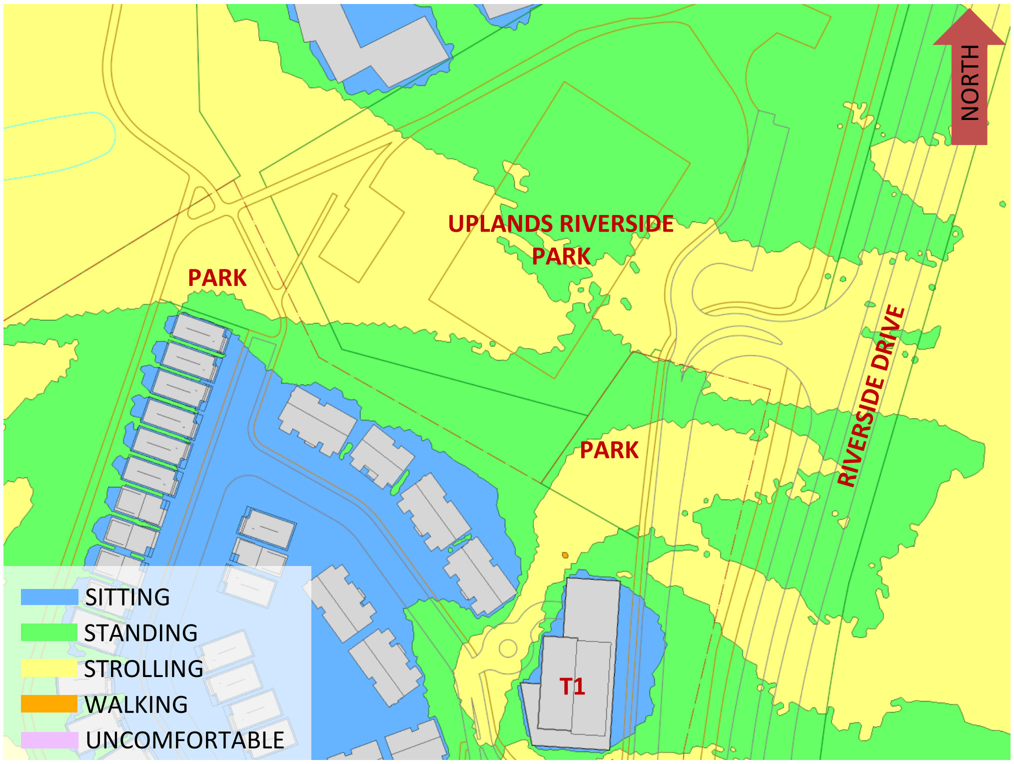



**FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING (NORTH)**

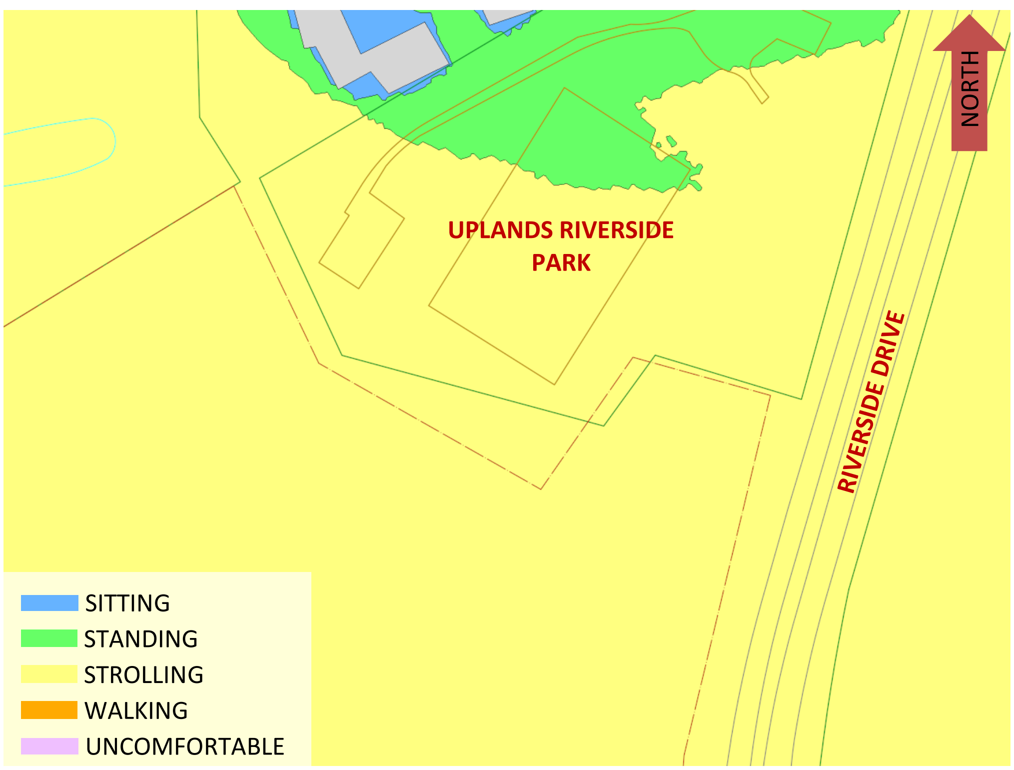



**FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING (NORTH)**

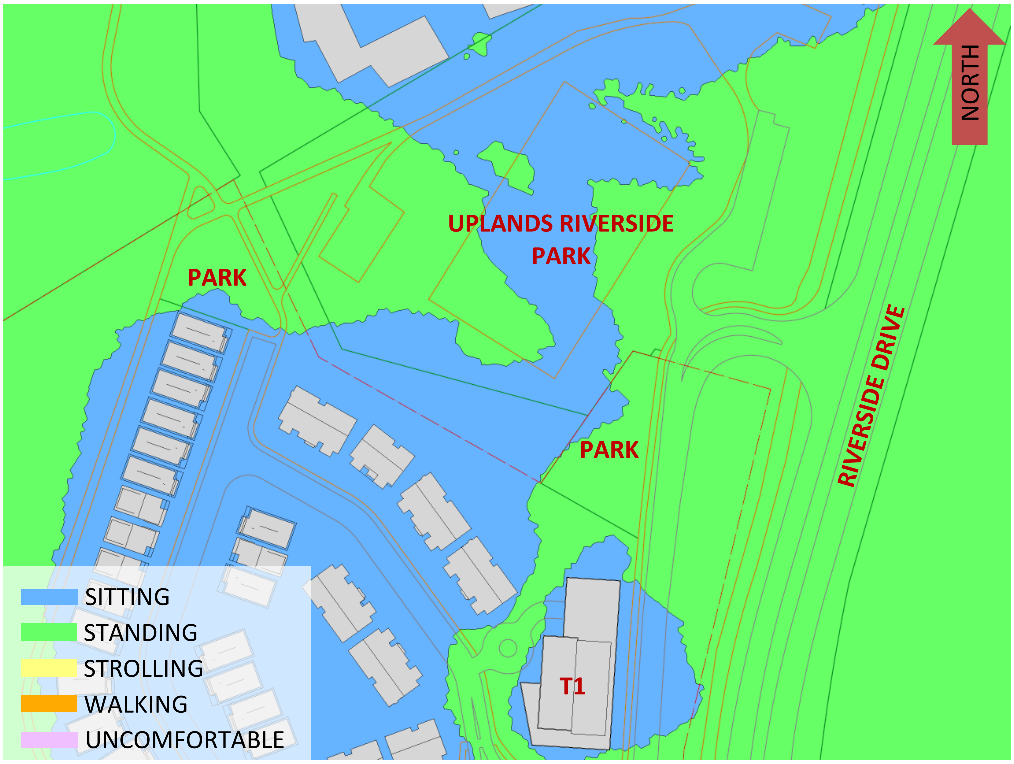



**FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING (NORTH)**

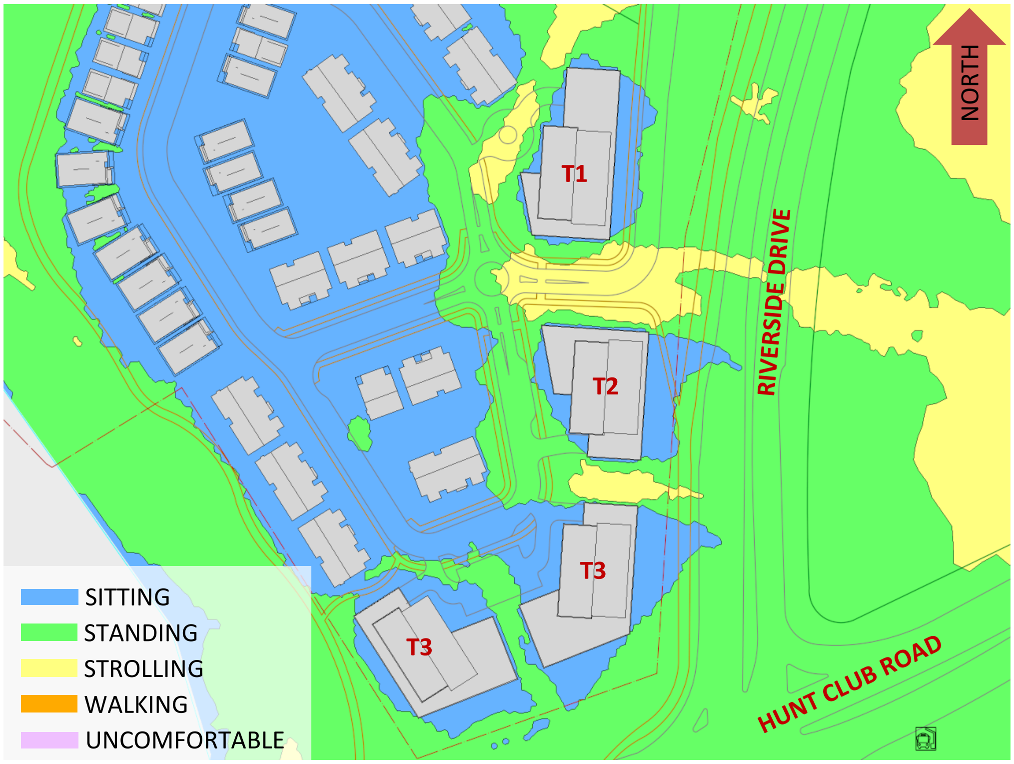



**FIGURE 8A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING (SOUTH)**

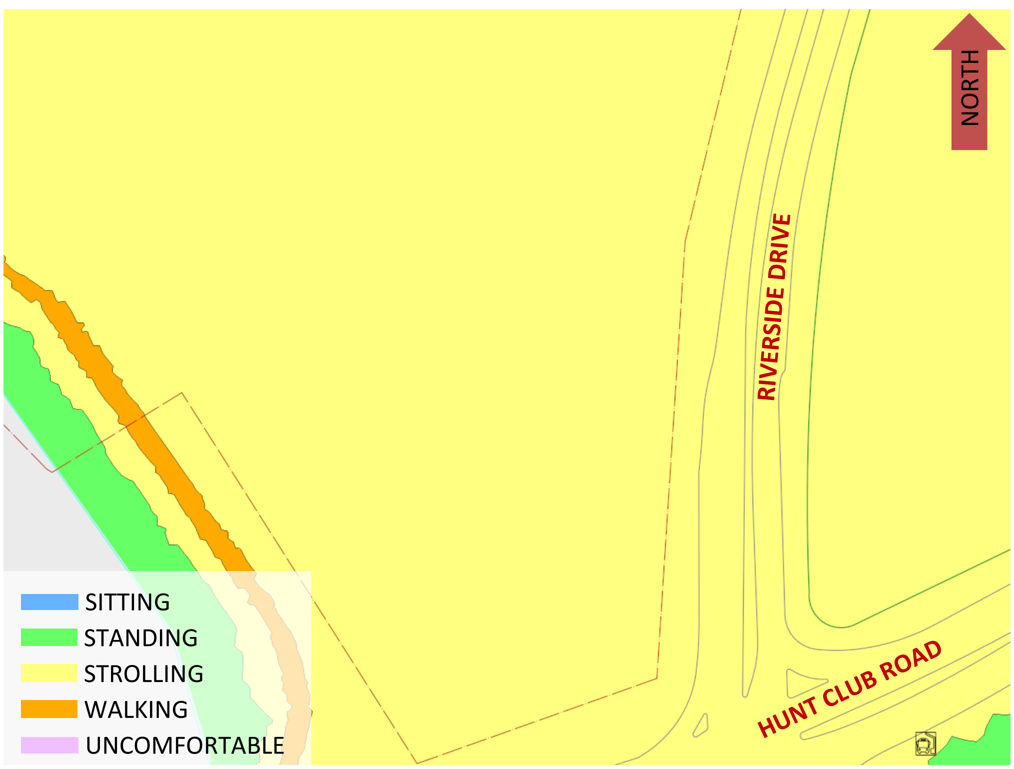



**FIGURE 8B: SPRING – WIND COMFORT, GRADE LEVEL – EXISTING MASSING (SOUTH)**

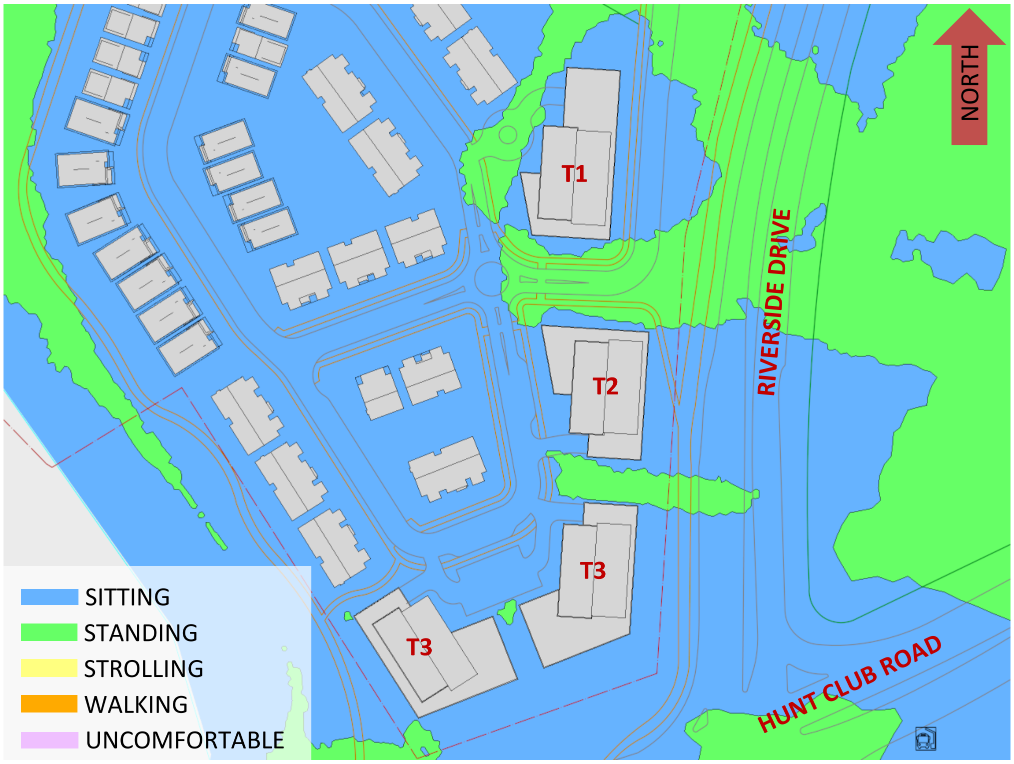



**FIGURE 9A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING (SOUTH)**


**FIGURE 9B: SUMMER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING (SOUTH)**

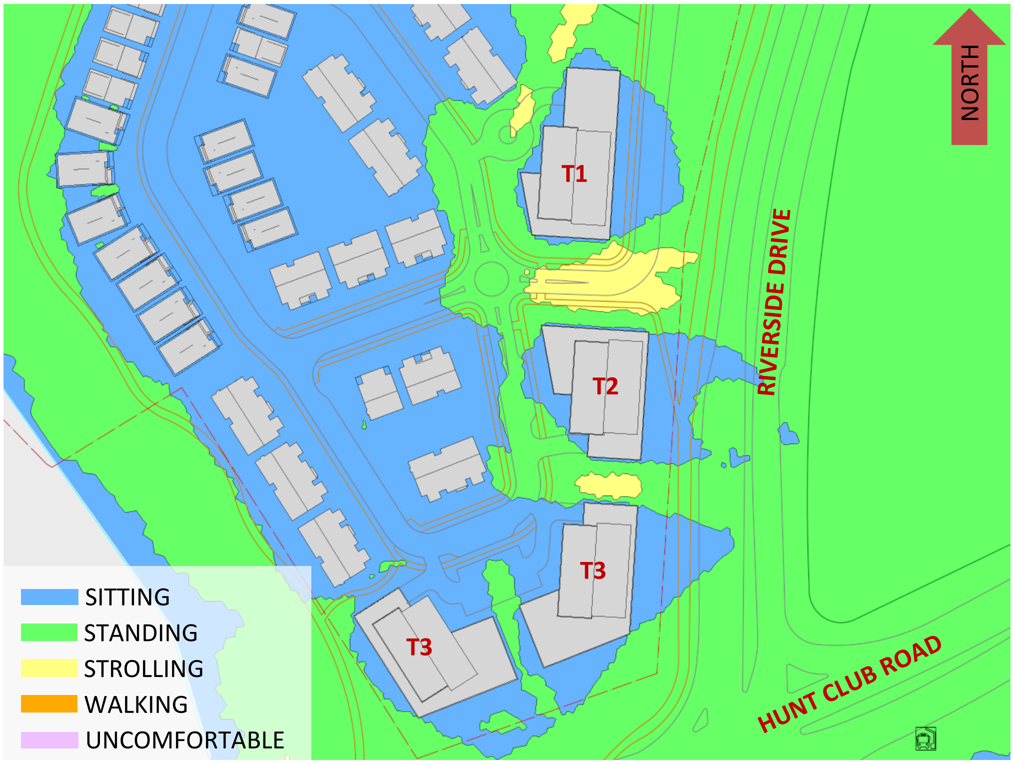



**FIGURE 10A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING (SOUTH)**

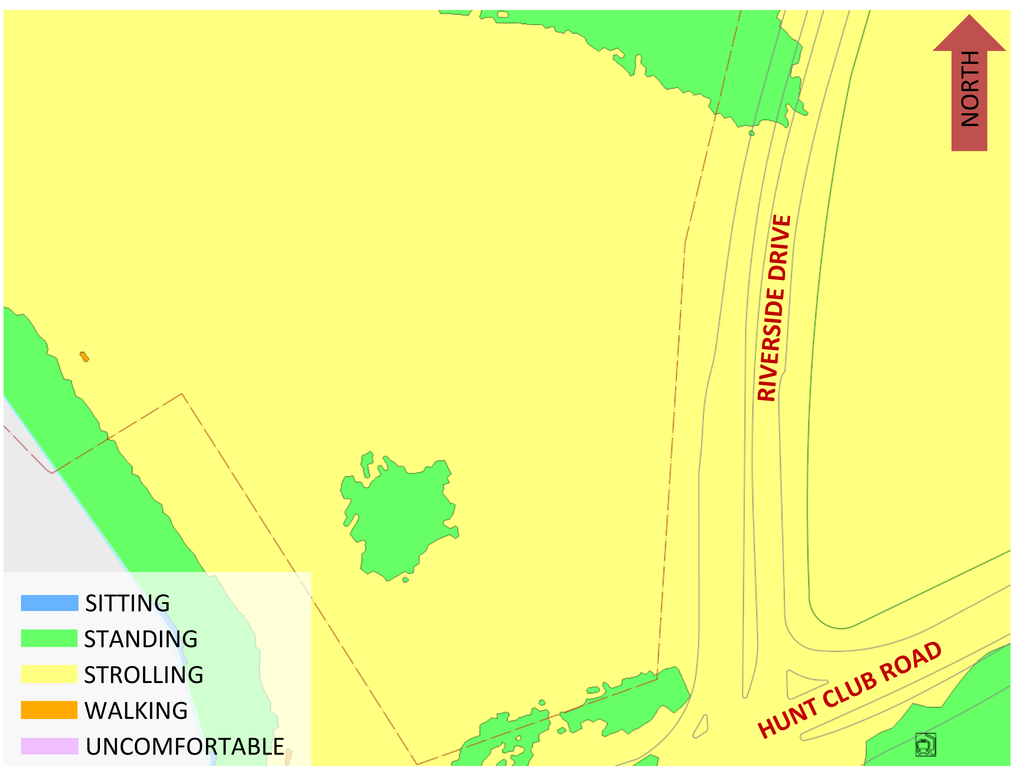



**FIGURE 10B: AUTUMN – WIND COMFORT, GRADE LEVEL – EXISTING MASSING (SOUTH)**

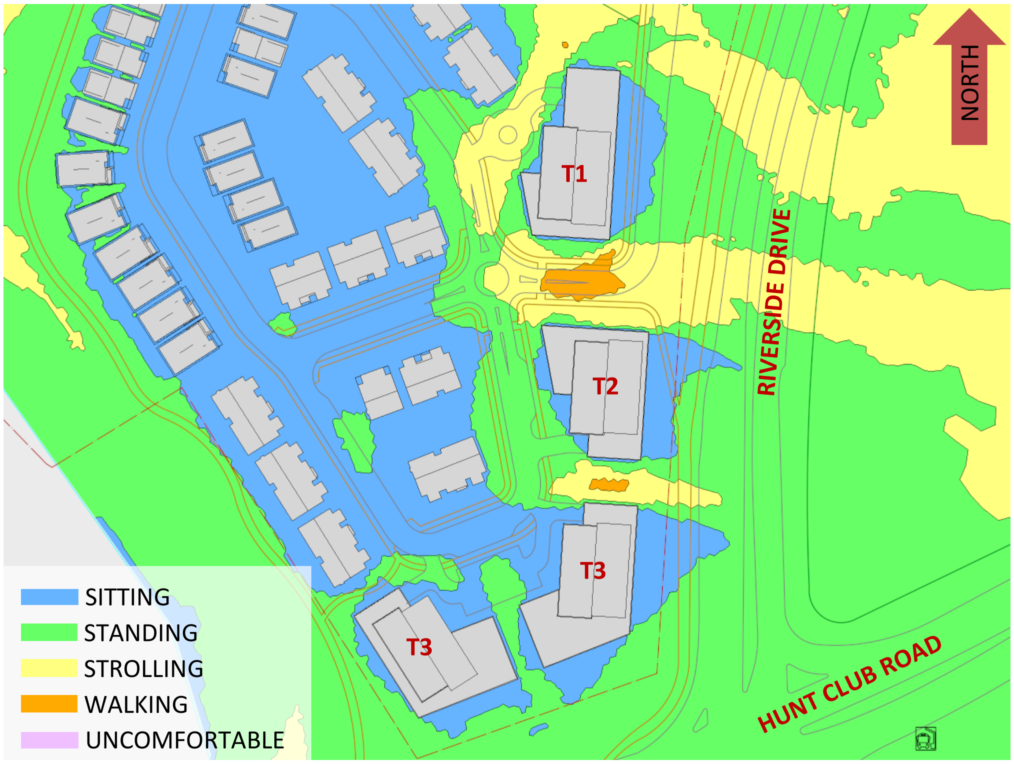



**FIGURE 11A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING (SOUTH)**

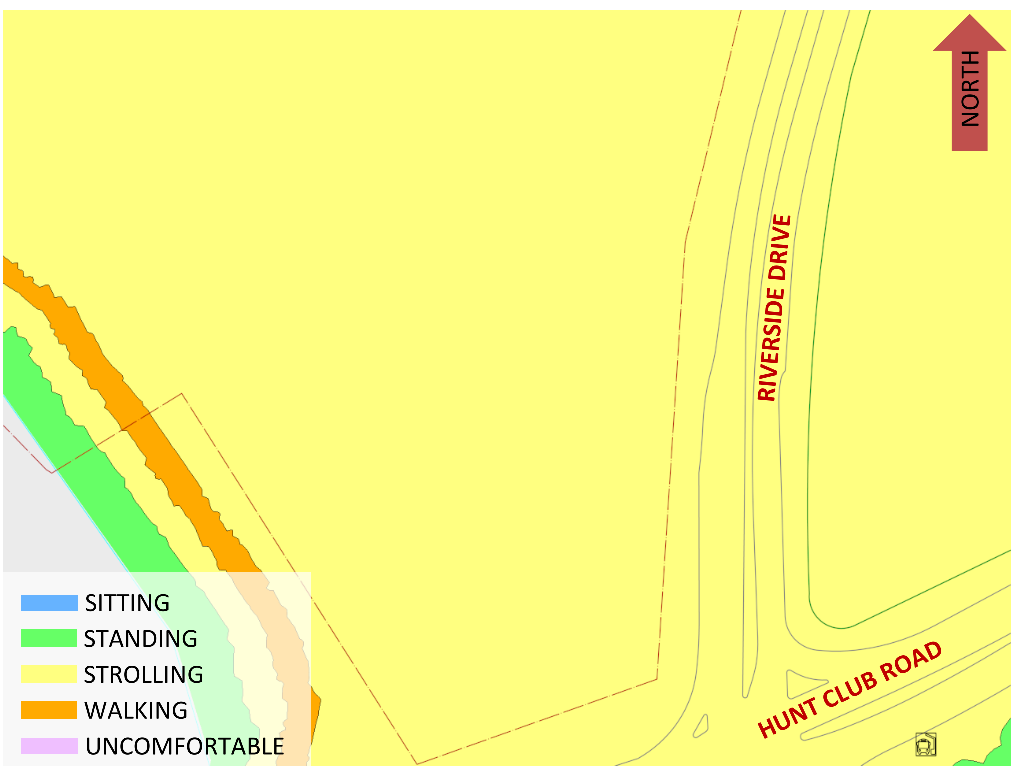



**FIGURE 11B: WINTER – WIND COMFORT, GRADE LEVEL – EXISTING MASSING (SOUTH)**

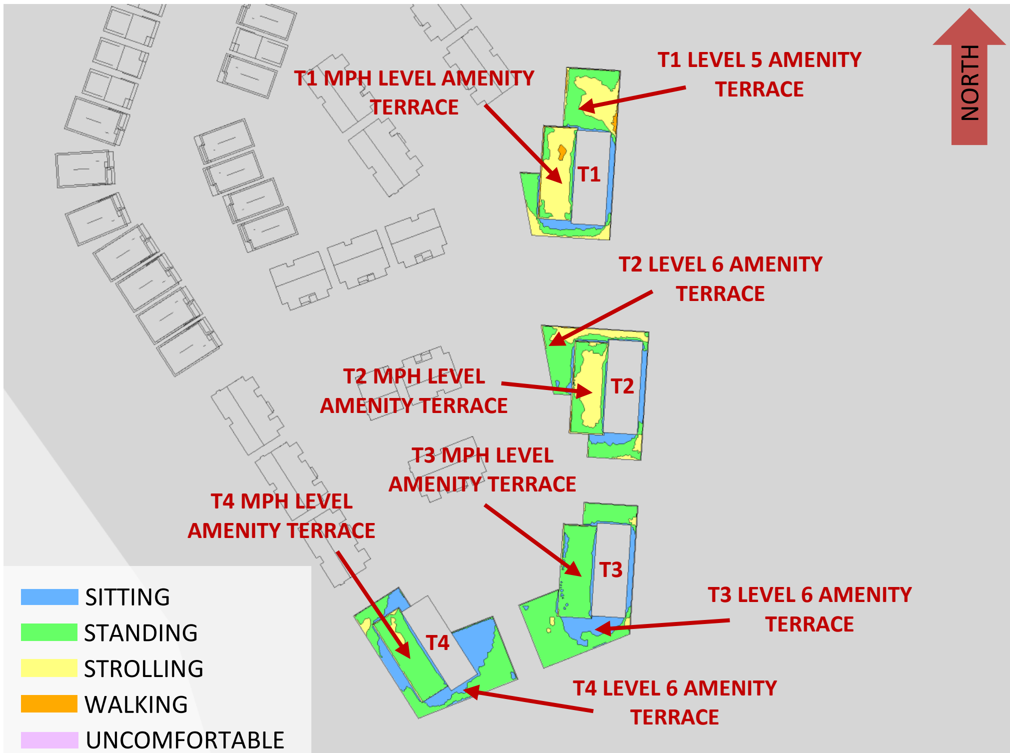



**FIGURE 12A: SPRING – WIND COMFORT, COMMON AMENITY TERRACES**

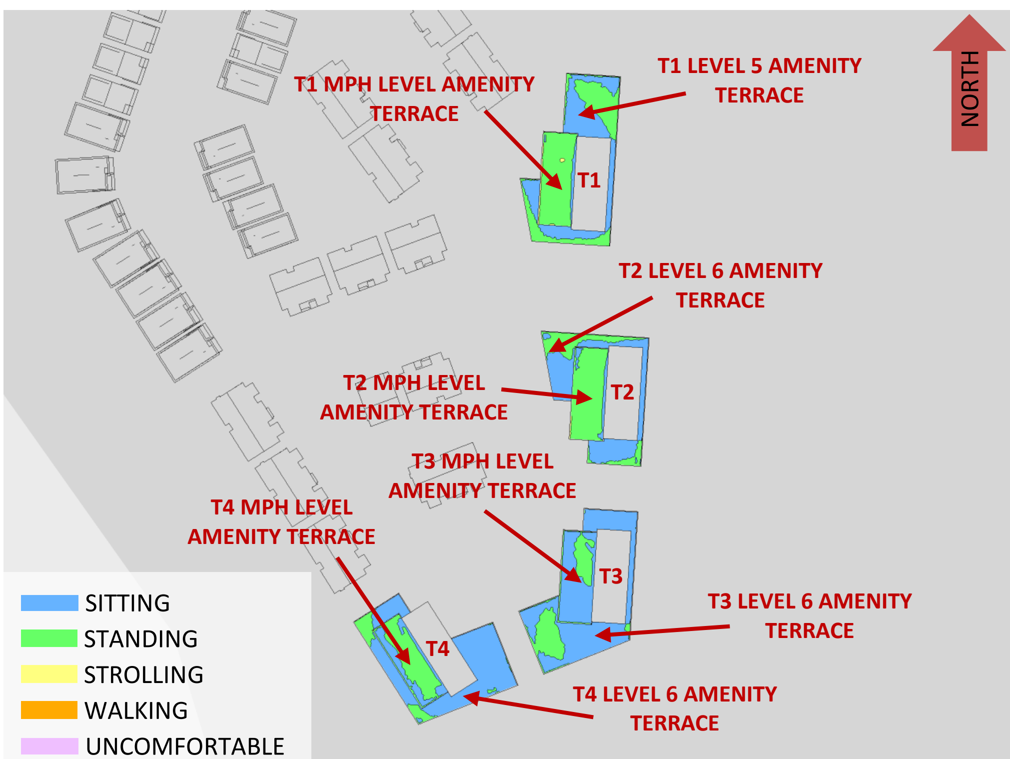



**FIGURE 12B: SUMMER – WIND COMFORT, COMMON AMENITY TERRACES**

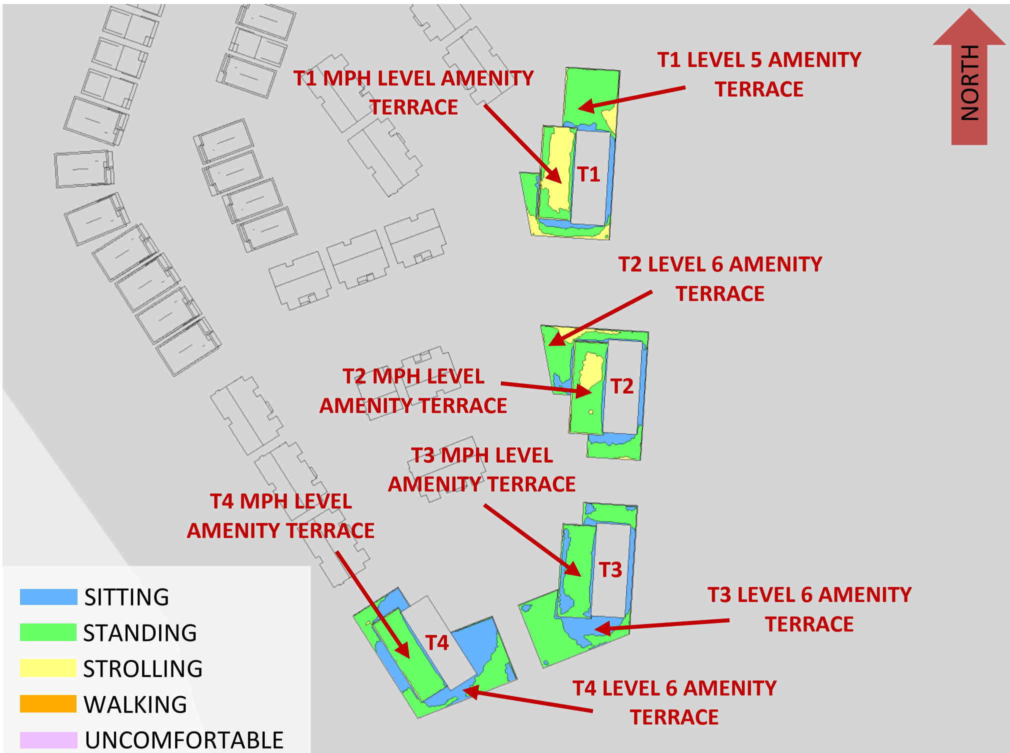



**FIGURE 12C: AUTUMN – WIND COMFORT, COMMON AMENITY TERRACES**

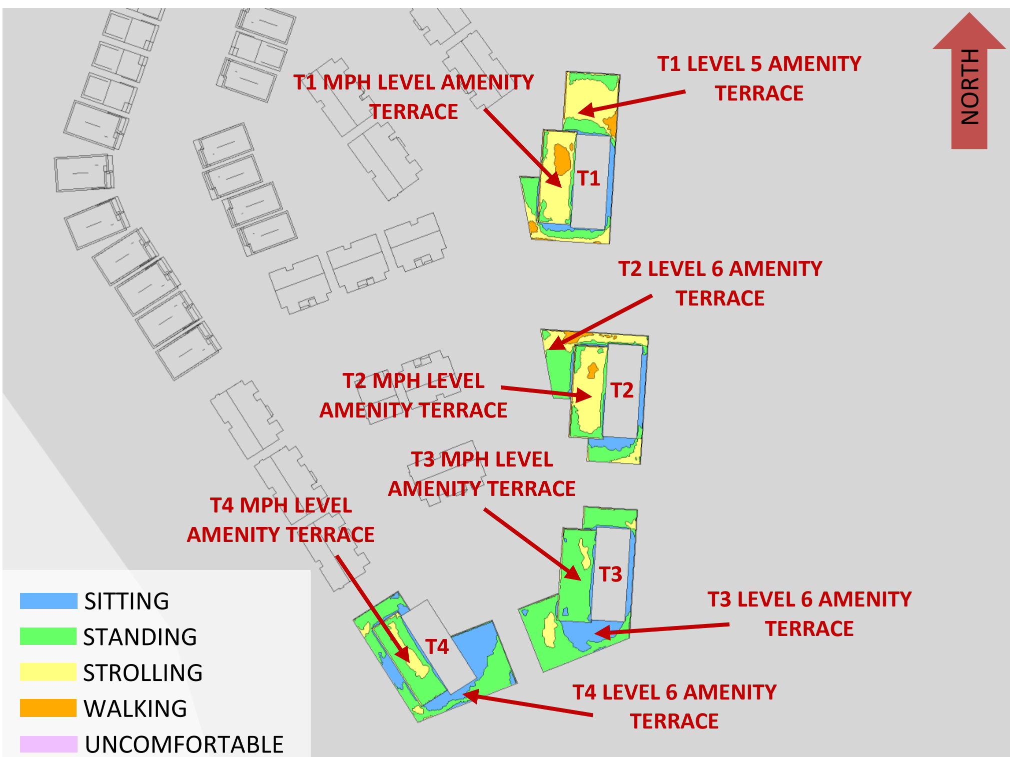



**FIGURE 12D: WINTER – WIND COMFORT, COMMON AMENITY TERRACES**

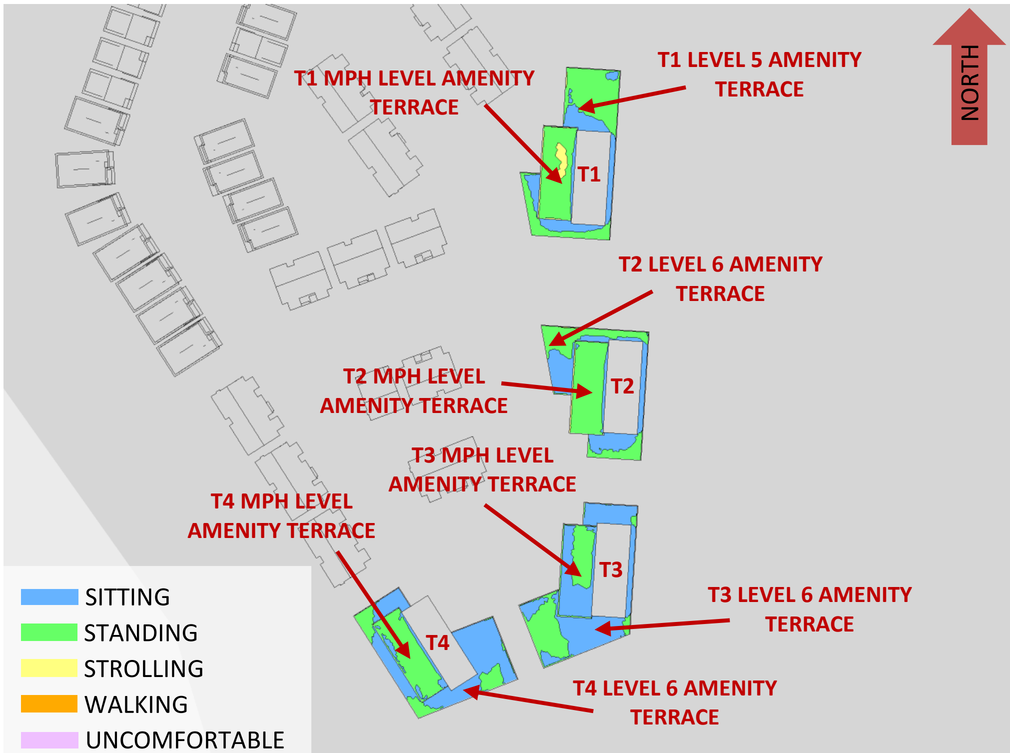



**FIGURE 13A: TYPICAL USE PERIOD – WIND COMFORT, COMMON AMENITY TERRACES**

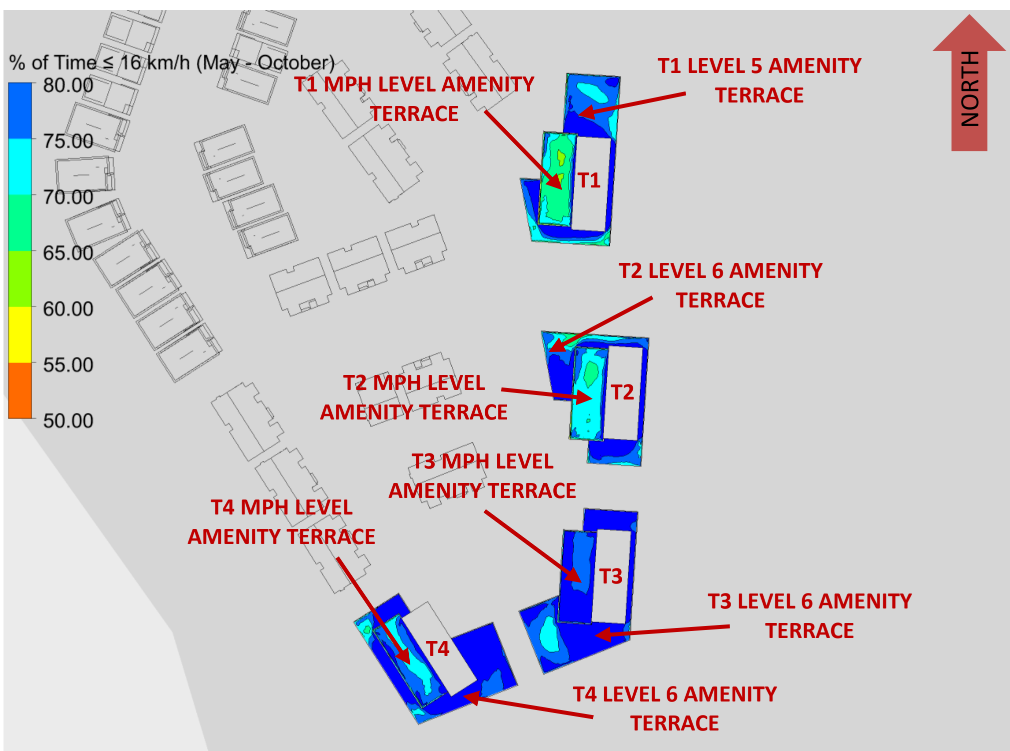
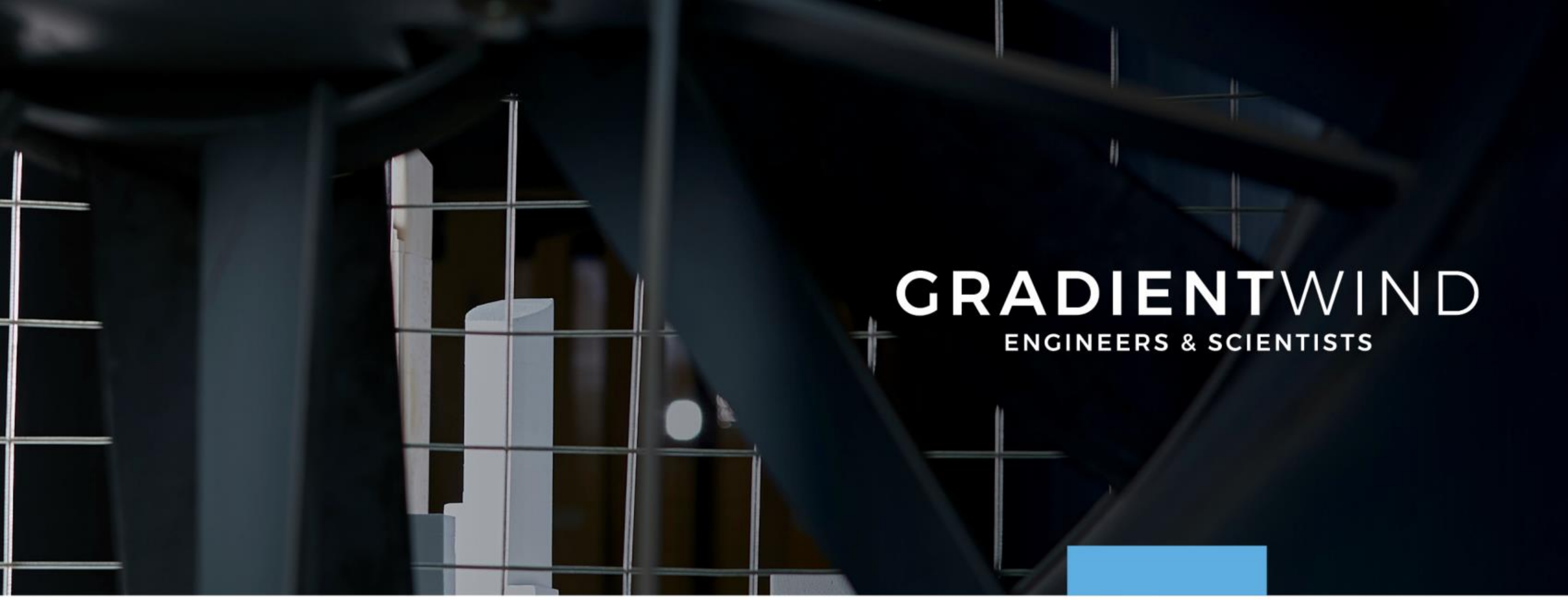
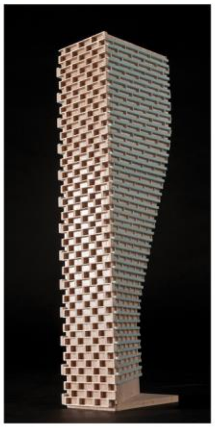
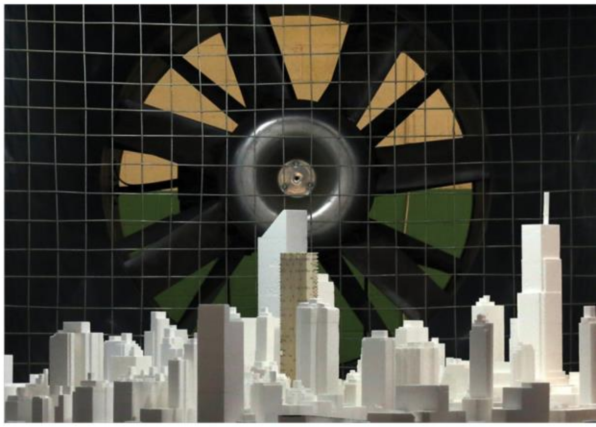



**FIGURE 13B: TYPICAL USE PERIOD – % OF TIME SUITABLE FOR SITTING IN FIGURE 13A**









# APPENDIX A

## SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

## SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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

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

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

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

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

$\alpha$ 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 | 0.22 |
| 49 | 0.22 |
| 74 | 0.20 |
| 103 | 0.20 |
| 167 | 0.18 |
| 197 | 0.19 |
| 217 | 0.22 |
| 237 | 0.23 |
| 262 | 0.23 |
| 282 | 0.23 |
| 301 | 0.23 |
| 324 | 0.23 |

### TABLE 2: DEFINITION OF UPSTREAM EXPOSURE (ALPHA VALUE)

| Upstream Exposure Type | Alpha Value (α) |
|---|---|
| Open Water | 0.14-0.15 |
| Open Field | 0.16-0.19 |
| Light Suburban | 0.21-0.24 |
| Heavy Suburban | 0.24-0.27 |
| Light Urban | 0.28-0.30 |
| Heavy Urban | 0.31-0.33 |

The turbulence model in the computational fluid dynamics (CFD) simulations is a two-equation shear-stress transport (SST) model, and thus the ABL turbulence profile requires that two parameters be defined at the inlet of the domain. The turbulence profile is defined following the recommendations of the Architectural Institute of Japan for flat terrain (3).

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

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

where, $\boldsymbol{I}$ = turbulence intensity, $\boldsymbol{L_t}$ = turbulence length scale, $\boldsymbol{Z}$ = height above ground, and $\alpha$ is the power law exponent used for the velocity profile in Equation (1).

Boundary conditions on all other domain boundaries are defined as follows: the ground is a no-slip surface; the side walls of the domain have a symmetry boundary condition; the top of the domain has a specified shear, which maintains a constant wind speed at gradient height; and the outlet has a static pressure boundary condition.

## REFERENCES

[1] P. Arya, "Chapter 10: Near-neutral Boundary Layers," in *Introduction to Micrometeorology*, San Diego, California, Academic Press, 2001.

[2] S. A. Hsu, E. A. Meindl and D. B. Gilhousen, "Determining the Power-Law WInd Profile Exponent under Near-neutral Stability Conditions at Sea," vol. 33, no. 6, 1994.

[3] Y. Tamura, H. Kawai, Y. Uematsu, K. Kondo and T. Okhuma, "Revision of AIJ Recommendations for Wind Loads on Buildings," in *The International Wind Engineering Symposium, IWES 2003*, Taiwan, 2003.