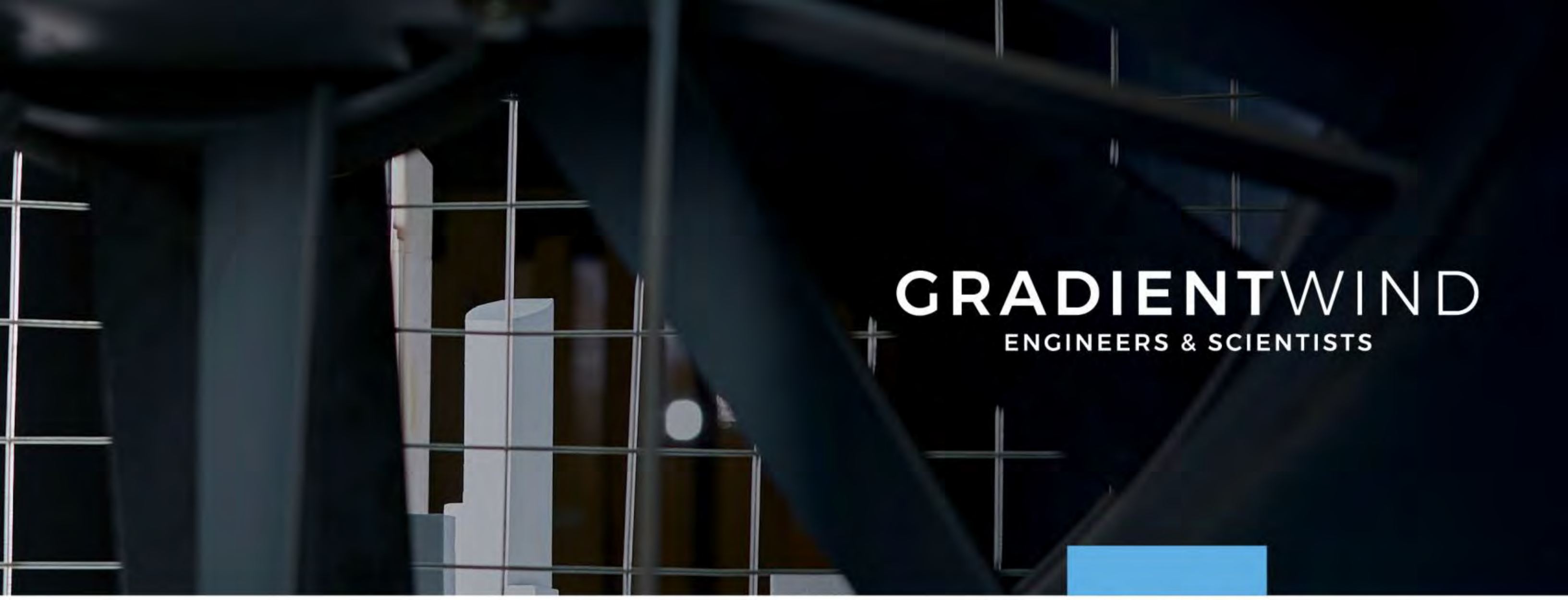
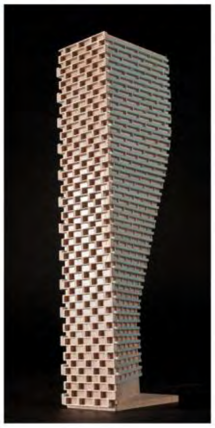


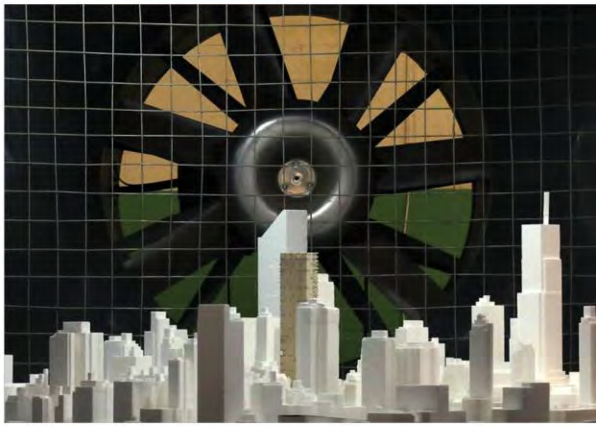
GRADIENTWIND
ENGINEERS & SCIENTISTS

PEDESTRIAN LEVEL WIND STUDY

375 Kingston Road
Pickering, Ontario

Report: 21-243-PLW





December 14, 2021

PREPARED FOR
375 Kingston Road Corporation
1806 Avenue Road, Suite 2
Toronto, ON M5M 3Z1

PREPARED BY
Daniel Davalos, MESc., Junior Wind Scientist
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GRADIENTWIND.COM

EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study to satisfy Zoning By-law Amendment (ZBA) application requirements for the proposed development located at 375 Kingston Road in Pickering, Ontario (hereinafter referred to as the "subject site" or "proposed development"). Our mandate within this study is to investigate 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.

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. A complete summary of the predicted wind conditions is provided in Section 5 and illustrated in Figures 3A-9B, and is summarized as follows:

1) While the introduction of the proposed development is predicted to generally produce windy conditions at grade, most areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, walkways, surface parking areas, and building access points are considered acceptable, without the need for mitigation. Exceptions are as follows:

    a. Conditions over the Kingston Road sidewalk during the winter are predicted to be suitable for walking at least 69% of the time during the winter, where the target is 80%. During the spring and autumn, conditions near the northeast corner of the proposed development are predicted to be suitable for walking at least 72% and 77% of the time, respectively. Given the noted exceedances of up to 11%, further investigation is required to determine an appropriate strategy to improve wind conditions in the area.

    b. Conditions over the Rougemount sidewalk during the winter are predicted to be suitable for walking at least 69% of the time during the winter, where the target is 80%. During the spring and autumn, conditions near the southwest corner of the proposed development are predicted to be suitable for walking at least 73% and 76% of the time, respectively. Given the noted exceedances of up to 11%, further investigation is required to determine an appropriate strategy to improve wind conditions in the area.

c. Conditions over the parking lot at the southwest corner of the subject site are predicted to be suitable for walking at least 73% of the time during the winter. Given the exceedance of 7%, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

d. Regarding the public landscape area at the northwest corner of the subject site, sitting conditions are predicted occur for at least 70% of the typical use period of late spring through early autumn, where the guideline is 80%. Depending on the programming of the space, mitigation may be required to create regions of calm wind conditions during the typical use period. This mitigation may include landscaping features such as glazed wind screens, dense arrangements of coniferous plantings, or topographical depressions or berms. Further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

e. Regarding the public green space at the southeast corner of the subject site, sitting conditions are predicted occur for at least 65% of the typical use period of late spring through early autumn, where the guideline is 80%. Depending on the programming of the space, mitigation may be required to create regions of calm wind conditions during the typical use period. This mitigation may include landscaping features such as glazed wind screens, dense arrangements of coniferous plantings, or topographical depressions or berms. Further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

2) Regarding the Level 6 amenity terrace, conditions are predicted to be suitable for a mix of standing, strolling, and walking during the typical use period. Additionally, the windiest conditions are located near the northeast corner of Tower B, where conditions may occasionally be uncomfortable, or potentially dangerous.

a. To increase comfort levels, and sitting percentages, during the typical use period, mitigation will be necessary. This mitigation is likely to include a tall wind barrier, typically glazed, around the perimeter of the terrace, in-board wind barriers around sensitive areas, and may also include canopies to reduce the influence of higher-level winds on the roof deck. Further investigation is required to determine an appropriate strategy to improve wind conditions.

3) Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no pedestrian areas within and surrounding the subject site at grade level were found to experience conditions that could be considered dangerous, as defined in Section 4.4.

Addendum: The detailed PLW study was performed based on drawings received in September 2021. An updated set of drawings was distributed on December 13, 2021. The changes in the updated set include an additional setback in the podium at Level 2. For the wind study, while the changes in the updated set are expected to have a beneficial effect, the main conclusions of the study are not expected to change. Further investigation is required to determine an appropriate strategy to improve wind conditions at the areas identified above.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by 375 Kingston Road Corporation to undertake a pedestrian level wind (PLW) study to satisfy Zoning By-law Amendment application requirements for the proposed development located at 375 Kingston Road in Pickering, Ontario (hereinafter referred to as the "subject site" or "proposed development"). Our mandate within this study is to investigate 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.

The PLW study is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, architectural drawings provided by Richmond Architects Limited, in September 2021, surrounding street layouts and existing and approved future building massing information obtained from the City of Pickering, recent site imagery, and experience with numerous similar developments in Toronto and elsewhere.

2. TERMS OF REFERENCE

The subject site is situated on a parcel of land bordered by Kingston Road to the north, Highway 401 to the south, Rougemount Drive to the west, and the Allison Greenwood Auto Wreckers to the east. The proposed development is located on a nominally rectangular shaped parcel of land and comprises two buildings rising 35 and 30 storeys connected through a 6-storey podium. The 35-storey building (Tower A) rises from the northeast corner of the property, while the 30-storey building (Tower B) rises from the southwest corner. Above five levels of underground parking, the ground floor for the shared podium includes retail space along the north elevation, residential and indoor amenity space at the southeast corner, indoor amenity and common lobby space at the centre of the south elevation, building services at the southeast corner of both buildings, and common area throughout the remainder of the floorplan. Levels 2 through 5 comprise residential units. At Level 6, the podium steps back from the west elevation of Tower A and the north elevation of Tower B to provide a common amenity terrace. Levels 6 and above are reserved for residential occupancy.

Regarding wind exposures, the near-field surroundings of the subject site (within a radius of 200 metres (m) of the proposed development) comprise low-rise massing from the north clockwise to the northeast, mostly the open exposure of Highway 401 from the northeast clockwise to the southeast, a mix of the open exposure of Highway 401 and low-rise massing from the southeast clockwise to the southwest, and mostly low-rise massing for the remaining compass directions. The far-field surroundings (defined as the area beyond the near field and within a 2-kilometre (km) radius of the proposed development) include mostly low-rise massing from the north clockwise to the east, a mix of low-rise buildings, green areas, and open water of Lake Ontario from the east clockwise to the southwest, mostly low-rise massing from the southwest clockwise to the west, and a mix of low-rise massing and fields for the remaining compass directions. Notably, the Rosebank Park is approximately 790 m to the southeast, the Elizabeth B. Phin Public School is approximately 840 m to the north-northeast, and the Rouge River is approximately 500 m to the west.

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

3. OBJECTIVES

The principal objectives of this study are to: (i) determine pedestrian level wind comfort and safety conditions at key outdoor areas for the two context scenarios noted in Section 2; (ii) identify areas where future 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 subject site within a virtual environment, meteorological analysis of the Greater Toronto Area (GTA) wind climate, and synthesis of computational data with industry-accepted guidelines[1]. The following sections describe the analysis procedures, including a discussion of the comfort guidelines.

[1] City of Toronto, Application Support Material: Terms of Reference

4.1 Computer-Based Context Modelling

A computer-based PLW wind study was performed to determine the influence of the wind environment on pedestrian comfort over the subject 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 Lester B. Pearson International Airport.

The general concept and approach to CFD modelling is to represent building and topographic details in the immediate vicinity of the subject site on the surrounding model, and to create suitable atmospheric wind profiles at the model boundary. The wind profiles are designed to have similar mean and turbulent wind properties consistent with actual site exposures.

An industry standard practice is to omit trees, vegetation, and other existing and planned landscape elements from the model due to the difficulty of providing accurate seasonal representation of vegetation. The omission of trees and other landscaping elements produces slightly more conservative (i.e., windier) wind speed values.

4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 12 wind directions and two massing scenarios. The CFD simulation models were centered on the subject site, complete with surrounding massing within a radius of 480 m.

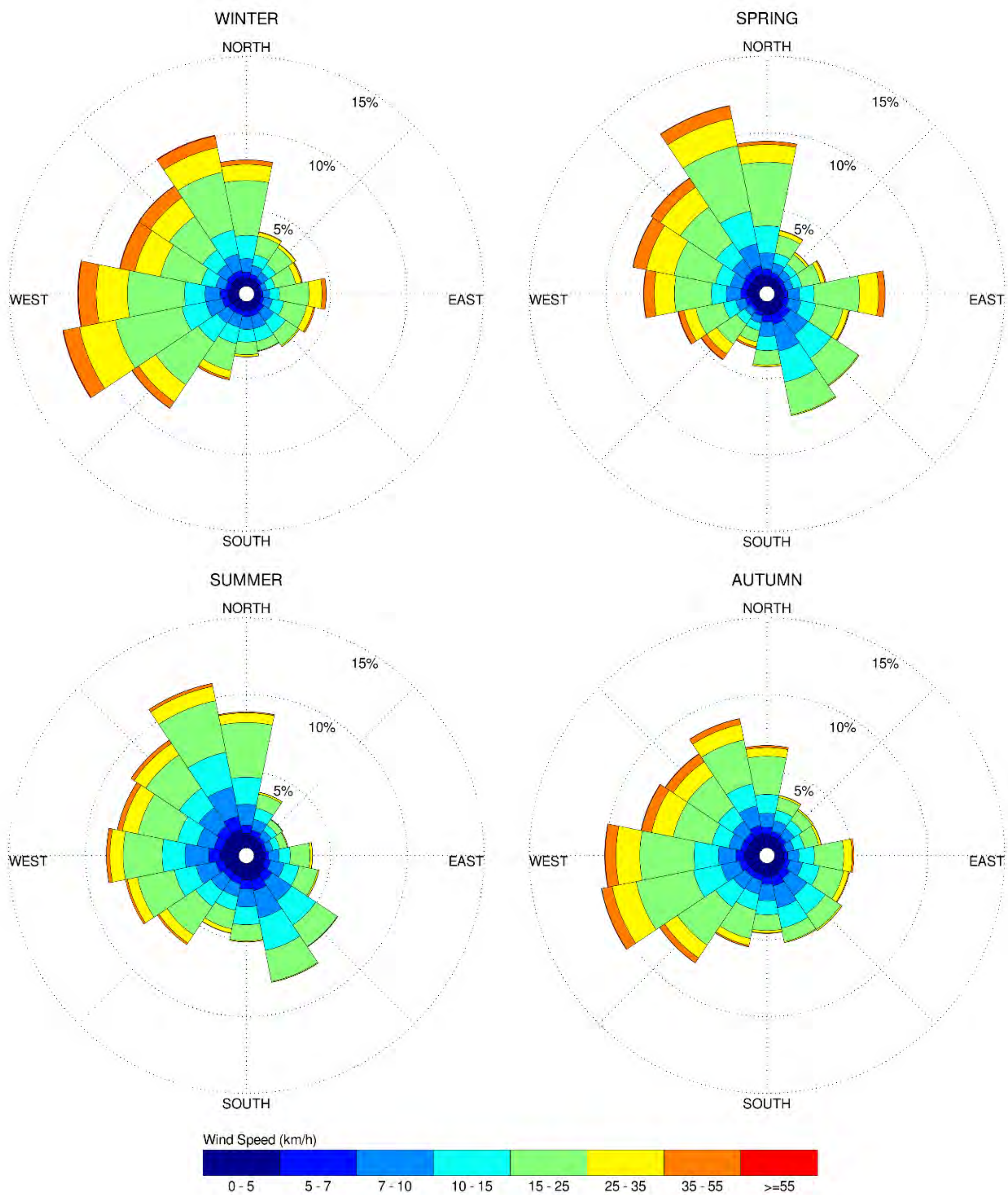
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds on a continuous measurement plane 1.5 m above local grade and the common amenity terrace were referenced to the wind speed at gradient height to generate mean and peak velocity ratios, which were used to calculate full-scale values. The 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 CFD wind flow simulation technique are presented in Appendix A.

4.3 Historical Wind Speed and Direction Data

A statistical model for winds in the Greater Toronto Area was developed from approximately 40 years of hourly wind data recorded at Lester B. Pearson 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 Greater Toronto 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 km/h. Probabilities of occurrence of different wind speeds are represented as stacked polar bars in sixteen azimuth divisions. The radial direction shows the frequency distribution of wind speeds for each wind direction during the measurement period. The preferred wind speeds and directions can be identified by the longer length of the bars. For the Greater Toronto Area, inclusive of Pickering, the most common winds concerning pedestrian comfort occur from the southwest clockwise to the north, as well as those from the east. The directional preference and relative magnitude of the wind speed varies somewhat from season to season, with the summer months displaying the calmest winds relative to the remaining seasonal periods.

SEASONAL DISTRIBUTION OF WIND
LESTER B. PEARSON INTERNATIONAL AIRPORT, MISSISSUAGA, ONTARIO



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 Guidelines

Pedestrian comfort and safety guidelines are based on the mechanical effects of wind without consideration of other meteorological conditions (i.e., temperature, relative humidity). The comfort guidelines 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 gust wind speed ranges, which include (i) Sitting; (ii) Standing; (iii) Strolling; (iv) Walking; and (v) Uncomfortable. More specifically, the comfort classes and associated gust wind speed ranges are summarized as follows:

(i) **Sitting** – A gust wind speed no greater than 16 km/h is considered acceptable for sedentary activities, including sitting.

(ii) **Standing** – A gust wind speed greater than 16 km/h but no greater than 22 km/h is considered acceptable for activities such as standing.

(iii) **Strolling** – A gust wind speed greater than 22 km/h but no greater than 27 km/h is considered acceptable for leisurely strolling.

(iv) **Walking** – A gust wind speed greater than 27 km/h but no greater than 30 km/h is considered acceptable for walking or more vigorous activities.

(v) **Uncomfortable** – A gust wind speed greater than 30 km/h is classified as uncomfortable from a pedestrian comfort standpoint. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this comfort class.

The pedestrian safety wind speed guideline 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 greater than 90 km/h is classified as dangerous. The wind speeds associated with the above categories are gust wind speeds. 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	Guts 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 wind speeds of 16 km/h were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting or more sedentary activities. Similarly, if 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 guidelines are based on subjective reactions of a population to wind forces, their application is partly based on experience and judgment.

Once the pedestrian wind speed predictions have been established throughout the site, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for discrete regions within and surrounding the subject site. This step involves comparing the predicted comfort classes to the desired comfort classes, which are dictated by the location type for each region (i.e., a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their desired comfort classes are summarized on the following page. For some of these locations, the desired comfort class depends on the programming of the space.

DESIRED PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Desired Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Standing / Strolling / Walking
Public Sidewalks / Pedestrian Walkways	Strolling / Walking
Outdoor Amenity Spaces	Sitting / Standing / Strolling
Cafés / Patios / Benches / Gardens	Sitting / Standing
Transit Stops	Sitting / Standing
Transit Stops (with Shelter)	Standing / Strolling / Walking
Public Parks	Sitting / Standing / Strolling
Garage / Service Entrances	Walking
Vehicular Drop-Off Zones	Standing / Walking
Laneways / Loading Zones	Walking

5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-6B, which illustrate seasonal wind comfort conditions at grade level for the proposed and existing massing scenarios, and Figures 8A-8D, which illustrate seasonal wind comfort conditions over the Level 6 common amenity terrace serving the proposed development. Conditions are presented as continuous contours of wind comfort within and surrounding the subject site and correspond to the various 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 level and over the common amenity terrace are also reported for the typical use period, which is defined as May to October, inclusive. Figures 7A and 9A illustrate wind comfort conditions at grade level and within the amenity terrace, respectively, for the proposed massing scenario, consistent with the comfort classes in Section 4.4, while Figures 7B and 9B illustrate contours indicating the percentage of time the noted areas are predicted to be suitable for sitting, respectively.

5.1 Wind Comfort Conditions – Grade Level

Sidewalk, Transit Stops, and Building Access Along Kingston Road: Following the introduction of the proposed development, conditions over the sidewalk along Kingston Road are predicted to be suitable for a mix of sitting, standing, and strolling during the summer, becoming suitable for a mix of standing, strolling, and walking during the spring and autumn. During the winter, the sidewalk is predicted to be suitable for walking at least 69% of the time, where the target is 80%. During the spring and autumn, there is a region near the northeast corner of the proposed development where conditions are predicted to occasionally be considered uncomfortable. Specifically, during the autumn, conditions are predicted to be suitable for walking at least 77% of the time, while during the spring conditions are predicted to be suitable for walking at least 72% of the time. In the vicinity of the nearby transit stop at the northeast intersection of Kingston Road and Rougemont Drive, which includes a standard transit shelter, conditions with the proposed massing are predicted to be suitable for a mix of standing and strolling during the summer, becoming suitable for strolling during the autumn, and suitable for walking during the spring. During the winter, conditions in the vicinity of the transit stop are predicted to be suitable for walking at least 77% of the time. Given the exceedance of the comfort guidelines by up to 11%, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable and acceptable levels.

Conditions over the Kingston Road sidewalk with the existing massing are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for mostly standing during the spring and autumn, and suitable for a mix of standing and strolling during the winter. While conditions with the proposed massing are mostly windier than existing conditions, it is expected that the introduction of any tall building massing within the property will lead to an increase in wind speeds at grade level.

Owing to the protection of the building façade, conditions in the vicinity of the primary building entrances along Kingston Road are predicted to be suitable for mostly standing throughout the year. The noted conditions in the vicinity of building entrances are considered acceptable according to the comfort guidelines in Section 4.4.

Sidewalk and Building Access Along Rougemont Drive: Following the introduction of the proposed development, conditions over the sidewalk along Rougemont Drive are predicted to be suitable for a mix of mostly standing and strolling during the summer, becoming suitable for a mix of mostly strolling and walking during the spring and autumn. During the winter, the sidewalk is predicted to be suitable for walking at least 69% of the time, where the target is 80%. During the spring and autumn, there is a region near the southwest corner of the proposed development where conditions are predicted to occasionally be considered uncomfortable. Specifically, during the autumn, conditions are predicted to be suitable for walking at least 76% of the time, while during the spring conditions are predicted to be suitable for walking at least 73% of the time. Given the exceedance of the comfort guidelines by up to 11%, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable and acceptable levels.

Conditions over the Rougemont Drive sidewalk with the existing massing are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for mostly standing during the spring and autumn, and suitable for a mix of standing and strolling during the winter. While conditions with the proposed massing are mostly windier than the existing conditions, it is expected that the introduction of any tall building massing within the property will lead to an increase in wind speeds at grade level.

Owing to the protection of the building façade, conditions in the vicinity of building entrances along Rougemont Drive are predicted to be suitable for standing, or better, throughout the year. The noted conditions in the vicinity of building entrances are considered acceptable according to the comfort guidelines in Section 4.4.

Laneway, Drop Off Area, and Building Access Along South and East Elevations: Conditions over the laneway along the south and east elevations are predicted to be suitable for a mix of sitting, standing, and strolling during the spring, summer, and autumn, becoming suitable for a mix of standing, strolling, and walking during the winter. Conditions within the drop off area 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. Owing to the protection of the building façade, conditions in the vicinity of the southeast entrance are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable according to the comfort guidelines in Section 4.4.

Parking Lot at Southwest Corner of Subject Site: Conditions over the parking lot at the southwest corner of the subject site are predicted to be suitable for a mix of standing and strolling during the summer, becoming suitable for a mix of strolling and walking during the spring and autumn. During the winter, conditions are predicted to be suitable for walking at least 73% of the time, where the target is 80%. Given the exceedance of 7%, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

Public Landscape Area at Northwest Corner of Subject Site: Conditions over the public landscape area 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, sitting conditions are predicted to occur for at least 70% of the time, as illustrated in Figure 7B, where the target is 80%. Notably, the windiest conditions are located farther from the building façade.

Depending on the programming of the space, mitigation may be required to create regions of calm wind conditions during the typical use period. This mitigation may include landscaping features such as glazed wind screens, dense arrangements of coniferous plantings, or topographical depressions or berms. Further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

Public Green Space at Southeast Corner of Subject Site: Conditions over the public green space at the southeast corner of the subject site are predicted to be suitable for mostly standing during the typical use period. Specifically, sitting conditions are predicted to occur for at least 65% of the time, as illustrated in Figure 7B, where the target is 80%.

Depending on the programming of the space, mitigation may be required to create regions of calm wind conditions during the typical use period. This mitigation may include landscaping features such as glazed wind screens, dense arrangements of coniferous plantings, or topographical depressions or berms. Further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

5.2 Wind Comfort Conditions – Common Amenity Terrace

Level 6 Amenity Terrace: Owing in part to winds accelerating between Towers A and B, as well as downwash of higher-level winds over the building façades, conditions over the Level 6 common amenity terrace are predicted to be suitable for a mix of standing, strolling, and walking during the typical use period. Additionally, the windiest conditions are located near the northeast corner of Tower B, where conditions may occasionally be uncomfortable.

To increase comfort levels and sitting percentages during the typical use period over the common amenity terrace, mitigation will be necessary and is likely to include a tall wind barrier, typically glazed, around the perimeter, in-board wind barriers around sensitive areas, and may also include canopies to reduce the influence of higher-level winds on the roof deck. Further investigation is required to determine an appropriate strategy to improve wind conditions.

5.3 Wind Safety

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

5.4 Applicability of Results

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

Regarding primary and secondary building access points, wind conditions predicted in this study are only applicable to pedestrian comfort and safety. As such, the results should not be construed to indicate wind loading on doors and associated hardware.

6. SUMMARY AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 of this report and illustrated in Figures 3A-9B. Based on computer simulations using the CFD technique, meteorological data analysis, and experience with numerous similar developments, the study concludes the following:

1) While the introduction of the proposed development is predicted to generally produce windy conditions at grade, most areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions over surrounding sidewalks, walkways, surface parking areas, and building access points are considered acceptable, without the need for mitigation. Exceptions are as follows:

    a. Conditions over the Kingston Road sidewalk during the winter are predicted to be suitable for walking at least 69% of the time during the winter, where the target is 80%. During the spring and autumn, conditions near the northeast corner of the proposed development are predicted to be suitable for walking at least 72% and 77% of the time, respectively. Given the noted exceedances of up to 11%, further investigation is required to determine an appropriate strategy to improve wind conditions in the area.

    b. Conditions over the Rougemount sidewalk during the winter are predicted to be suitable for walking at least 69% of the time during the winter, where the target is 80%. During the spring and autumn, conditions near the southwest corner of the proposed development are predicted to be suitable for walking at least 73% and 76% of the time, respectively. Given the noted exceedances of up to 11%, further investigation is required to determine an appropriate strategy to improve wind conditions in the area.

    c. Conditions over the parking lot at the southwest corner of the subject site are predicted to be suitable for walking at least 73% of the time during the winter. Given the exceedance of 7%, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

d. Regarding the public landscape area at the northwest corner of the subject site, sitting conditions are predicted occur for at least 70% of the typical use period of late spring through early autumn, where the guideline is 80%. Depending on the programming of the space, mitigation may be required to create regions of calm wind conditions during the typical use period. This mitigation may include landscaping features such as glazed wind screens, dense arrangements of coniferous plantings, or topographical depressions or berms. Further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

e. Regarding the public green space at the southeast corner of the subject site, sitting conditions are predicted occur for at least 65% of the typical use period of late spring through early autumn, where the guideline is 80%. Depending on the programming of the space, mitigation may be required to create regions of calm wind conditions during the typical use period. This mitigation may include landscaping features such as glazed wind screens, dense arrangements of coniferous plantings, or topographical depressions or berms. Further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

2) Regarding the Level 6 amenity terrace, conditions are predicted to be suitable for a mix of standing, strolling, and walking during the typical use period. Additionally, the windiest conditions are located near the northeast corner of Tower B, where conditions may occasionally be uncomfortable, or potentially dangerous.

   a. To increase comfort levels, and sitting percentages, during the typical use period, mitigation will be necessary. This mitigation is likely to include a tall wind barrier, typically glazed, around the perimeter of the terrace, in-board wind barriers around sensitive areas, and may also include canopies to reduce the influence of higher-level winds on the roof deck. Further investigation is required to determine an appropriate strategy to improve wind conditions.

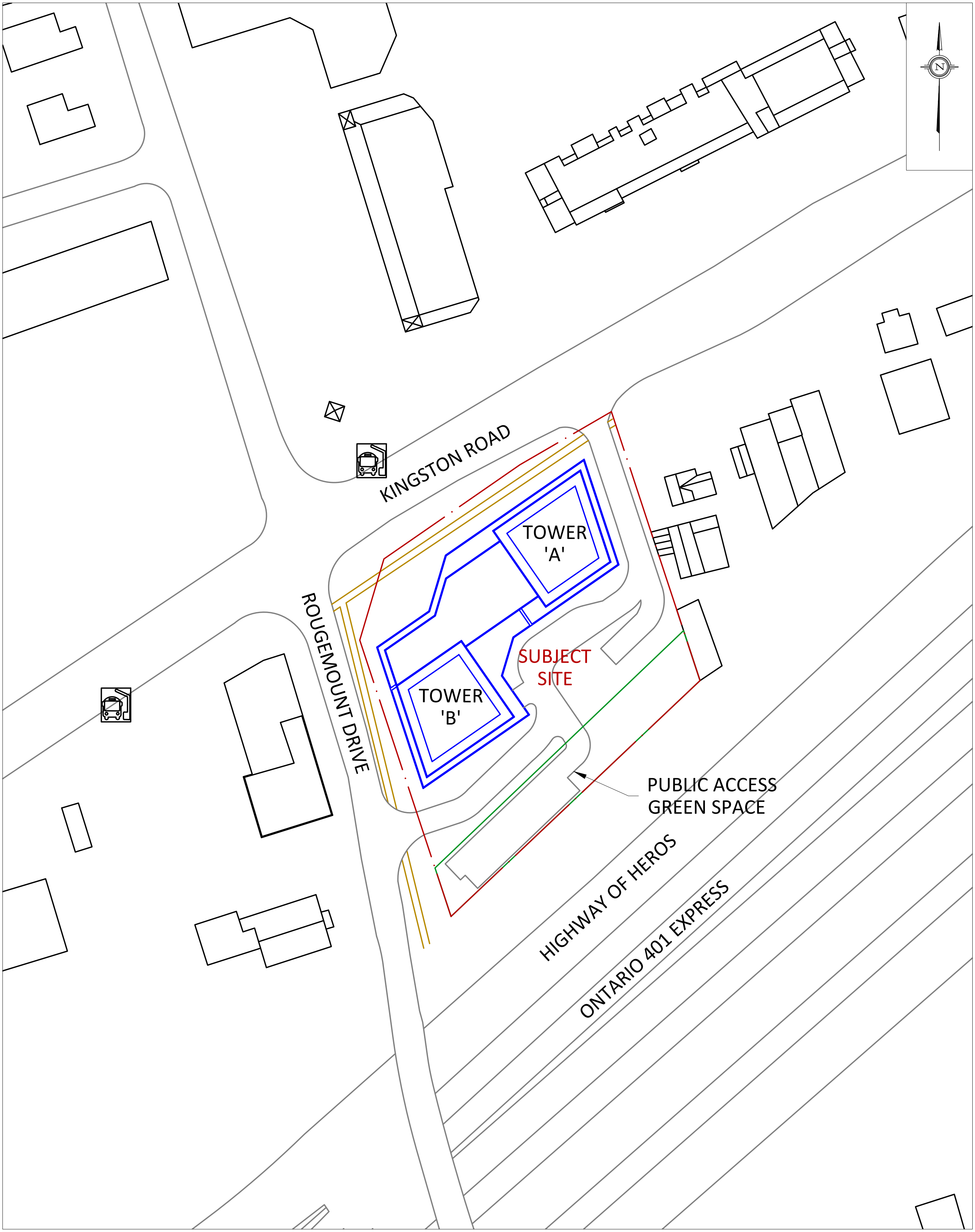
3) Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no pedestrian areas within and surrounding the subject site at grade level were found to experience conditions that could be considered dangerous, as defined in Section 4.4.

Sincerely,

Gradient Wind Engineering Inc.

Daniel Davalos, MESc.
Junior Wind Scientist

Steven Hall, M.A.Sc., P.Eng.
Senior Wind Engineer



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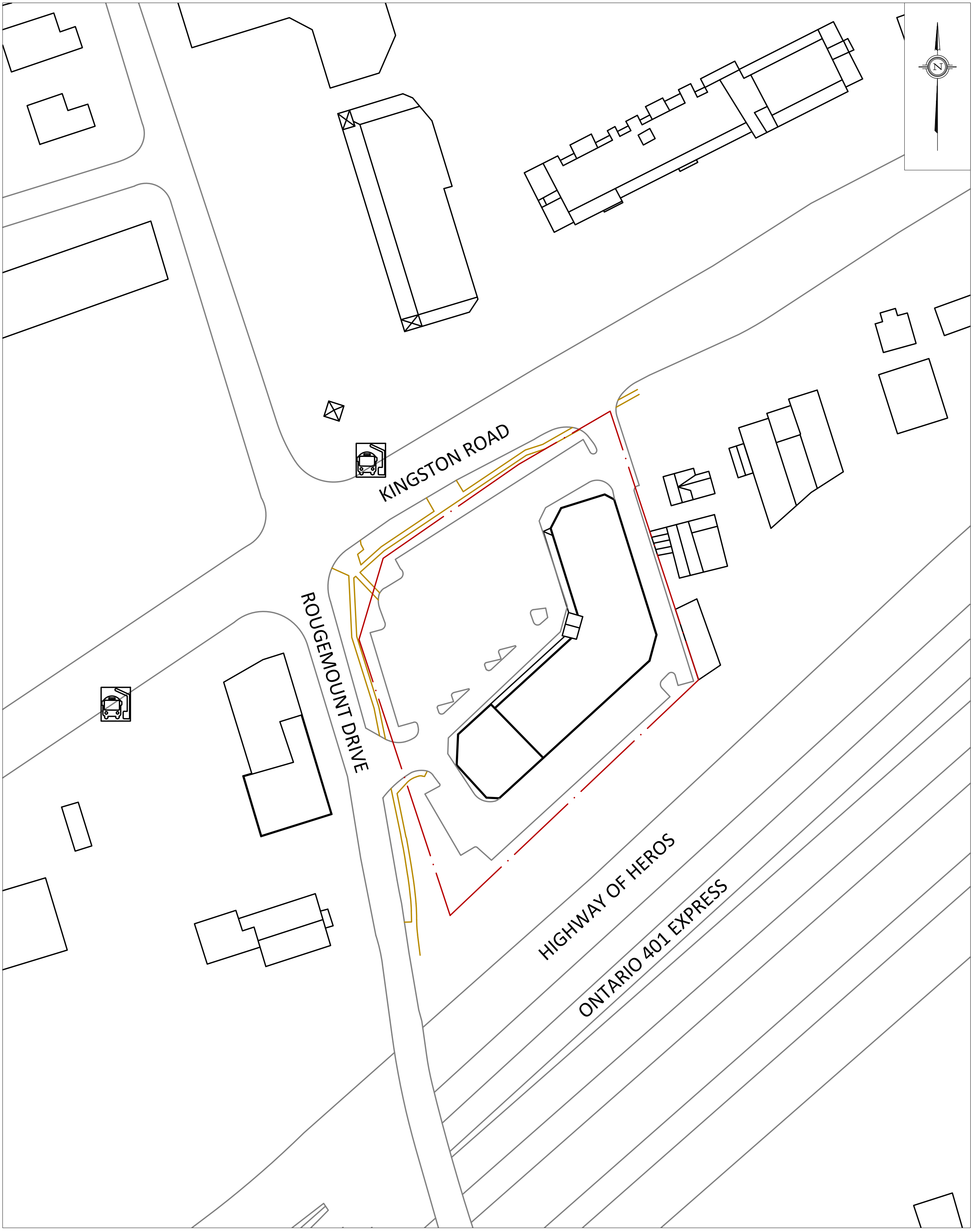
PROJECT: 375 KINGSTON ROAD, PICKERING PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 1A: PROPOSED SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:1500	DRAWING NO.: 21-243-PLW-1A	
DATE: JULY 8, 2021	DRAWN BY: N.M.P.	



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PROJECT	375 KINGSTON ROAD, PICKERING PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:1500	DRAWING NO.	21-243-PLW-1B
DATE	JULY 8, 2021	DRAWN BY	N.M.P.

DESCRIPTION

FIGURE 1B:
EXISTING SITE PLAN AND SURROUNDING CONTEXT

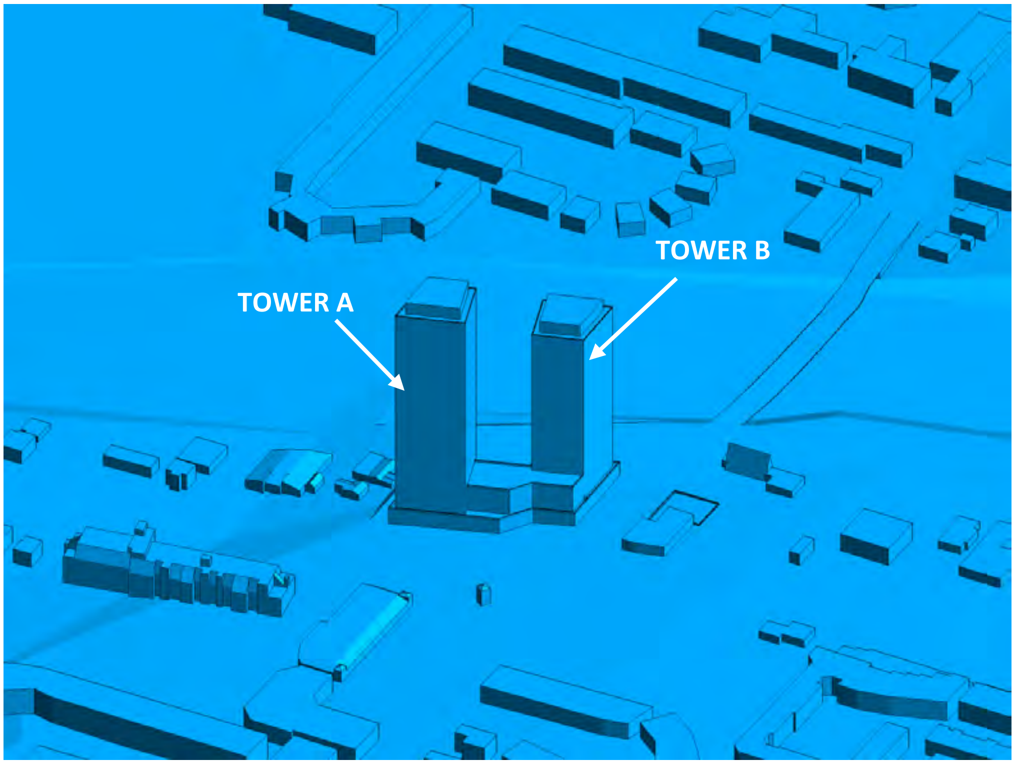

FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTHWEST PERSPECTIVE

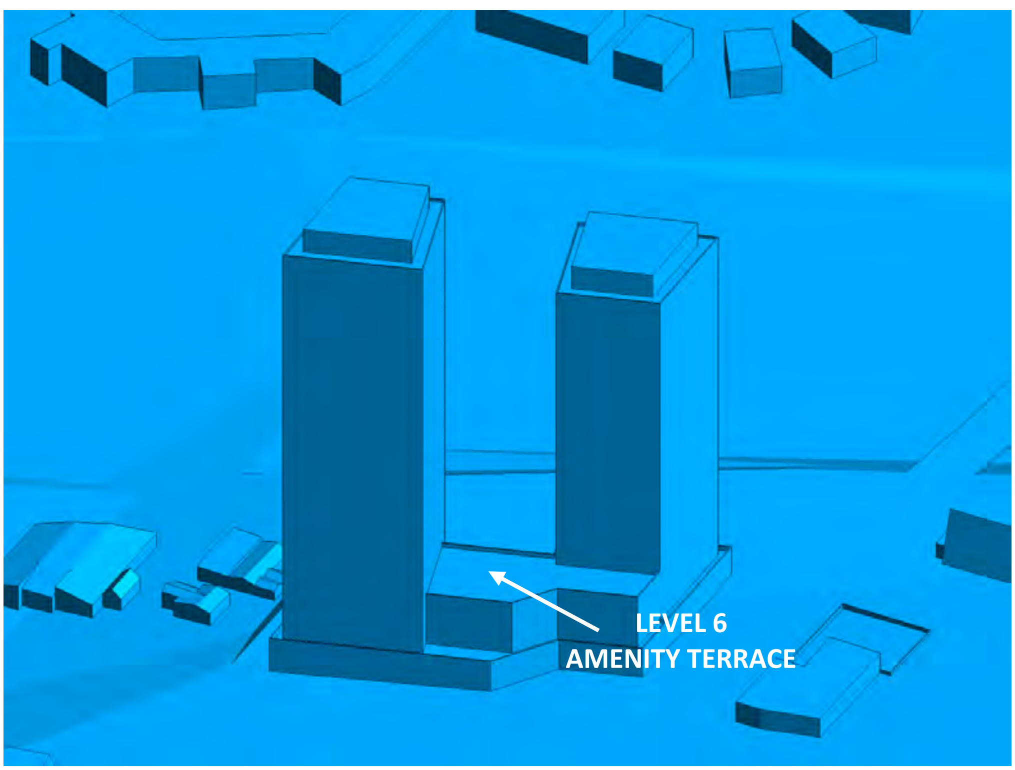

FIGURE 2B: CLOSE-UP VIEW OF FIGURE 2A

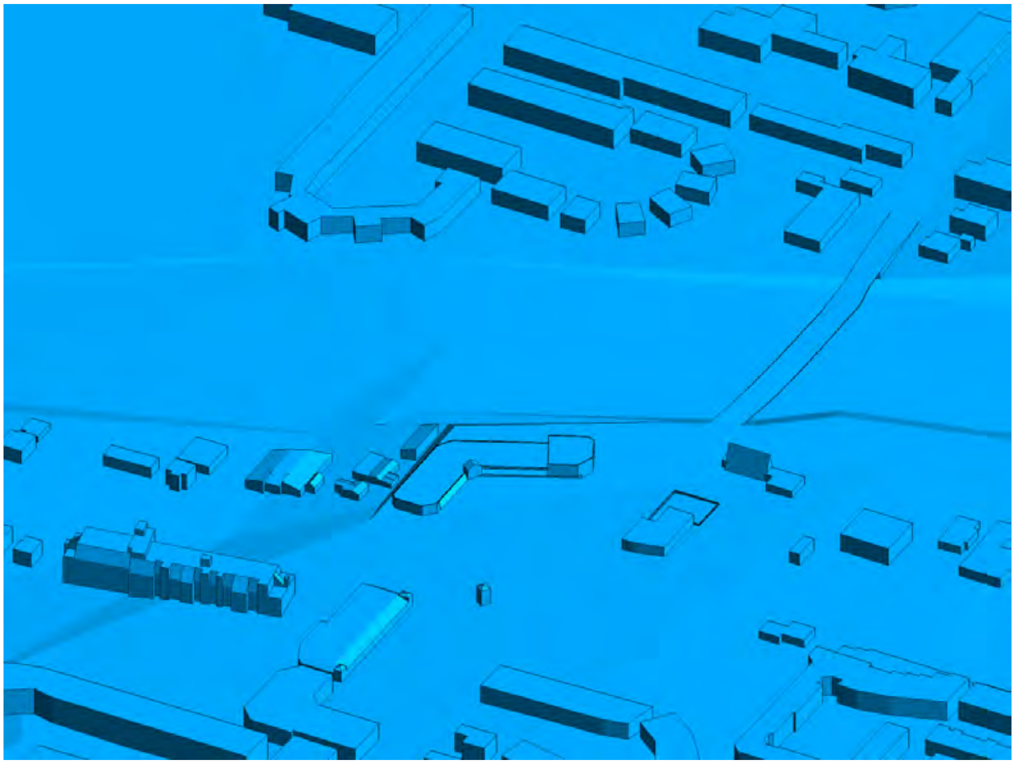

FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, NORTHWEST PERSPECTIVE

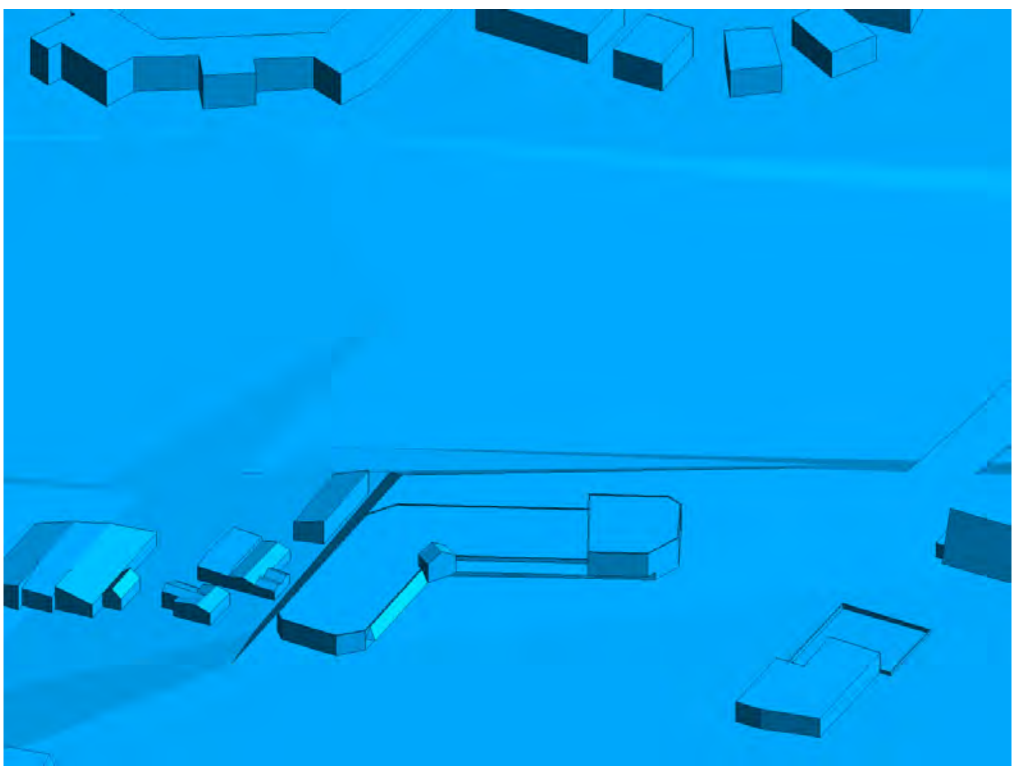

FIGURE 2D: CLOSE-UP VIEW OF FIGURE 2C

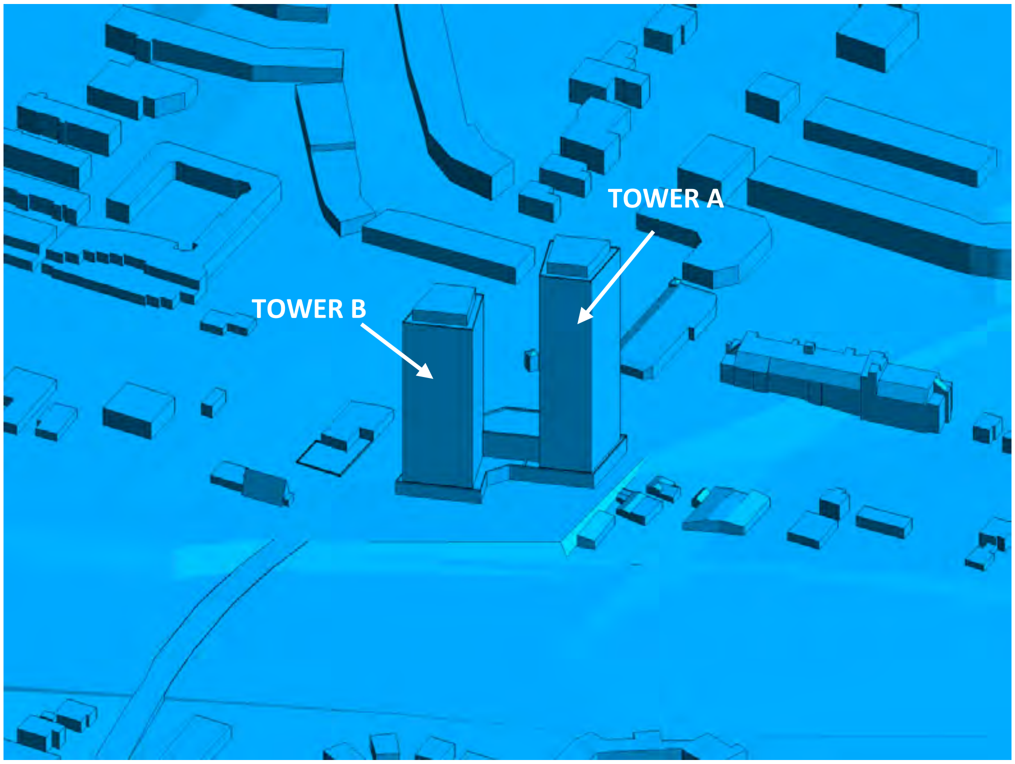

FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTHEAST PERSPECTIVE

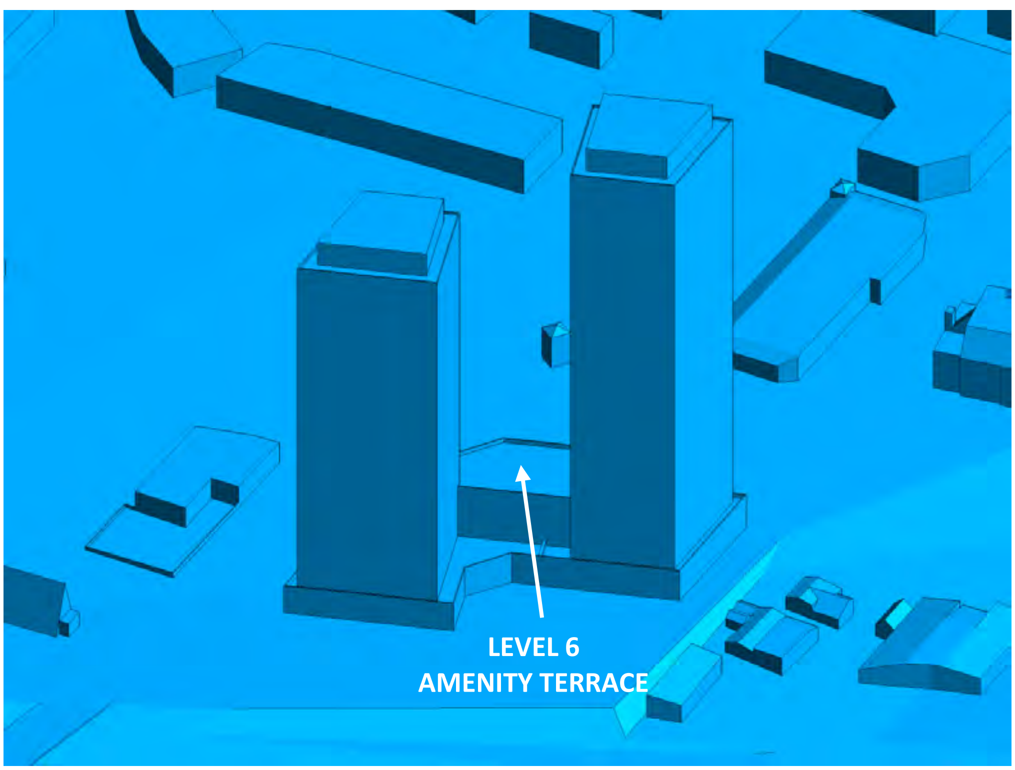

FIGURE 2F: CLOSE-UP VIEW OF FIGURE 2E

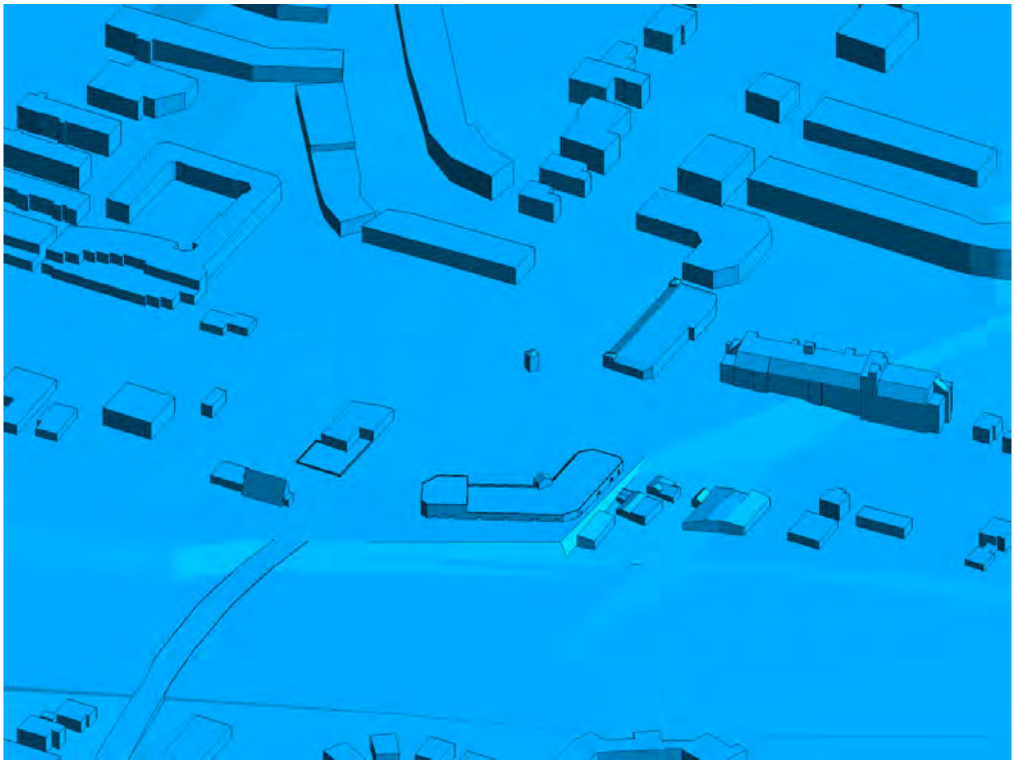

FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTHEAST PERSPECTIVE

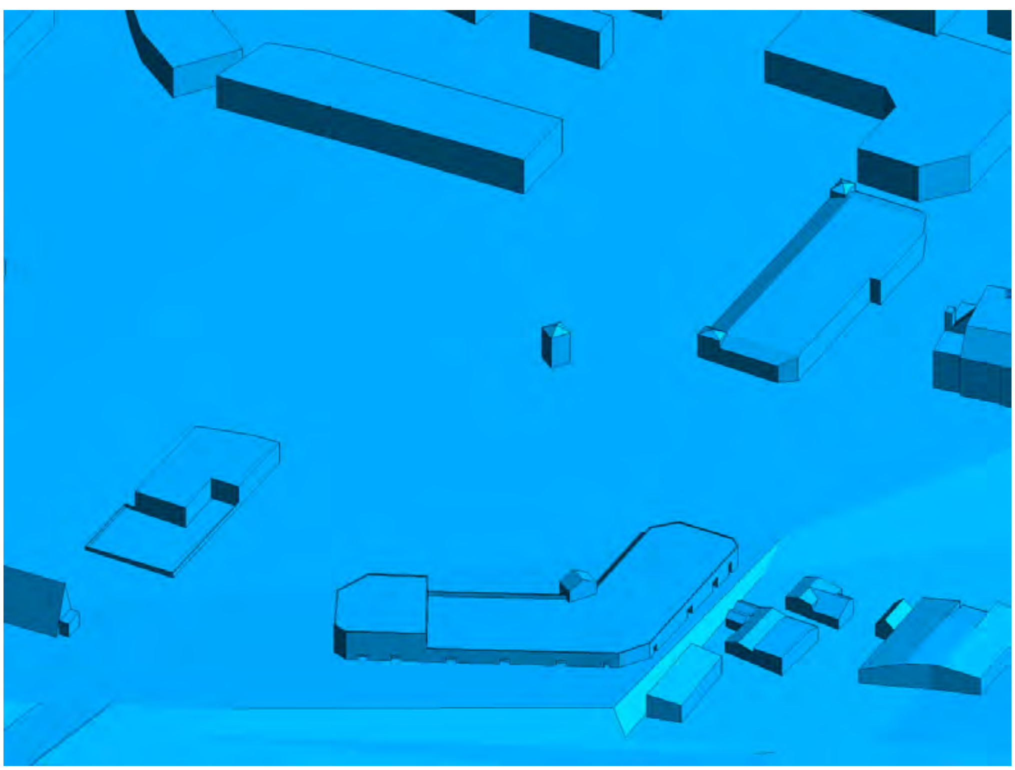

FIGURE 2H: CLOSE-UP VIEW OF FIGURE 2G

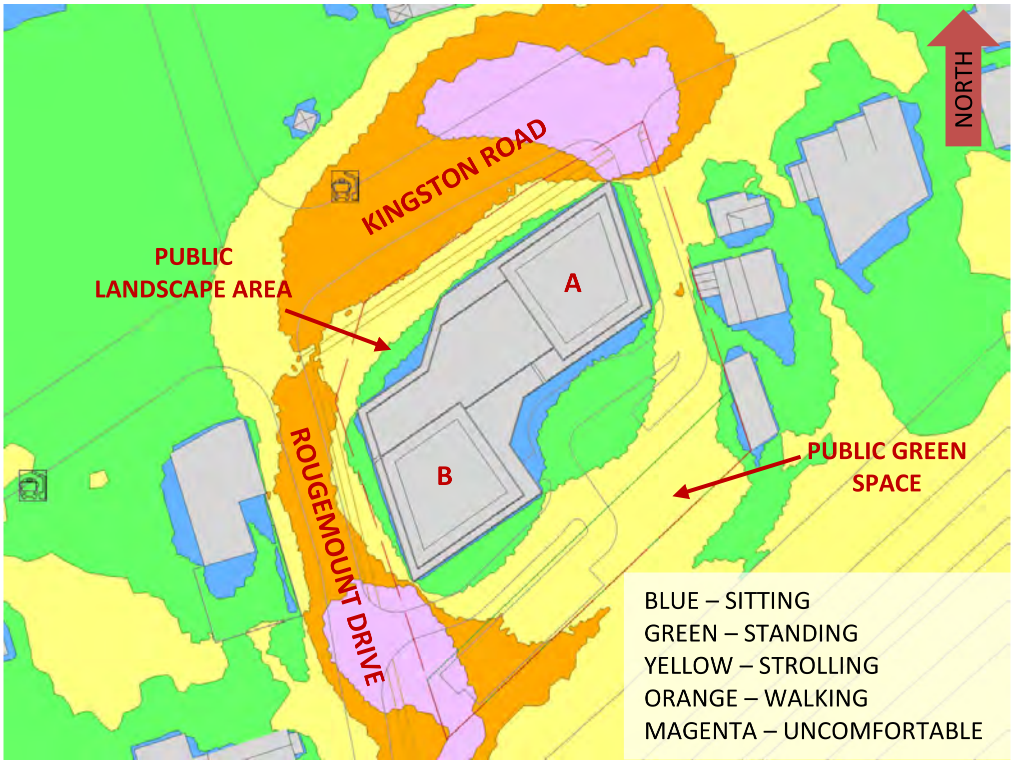

FIGURE 3A: SPRING – PROPOSED MASSING – WIND COMFORT, GRADE LEVEL

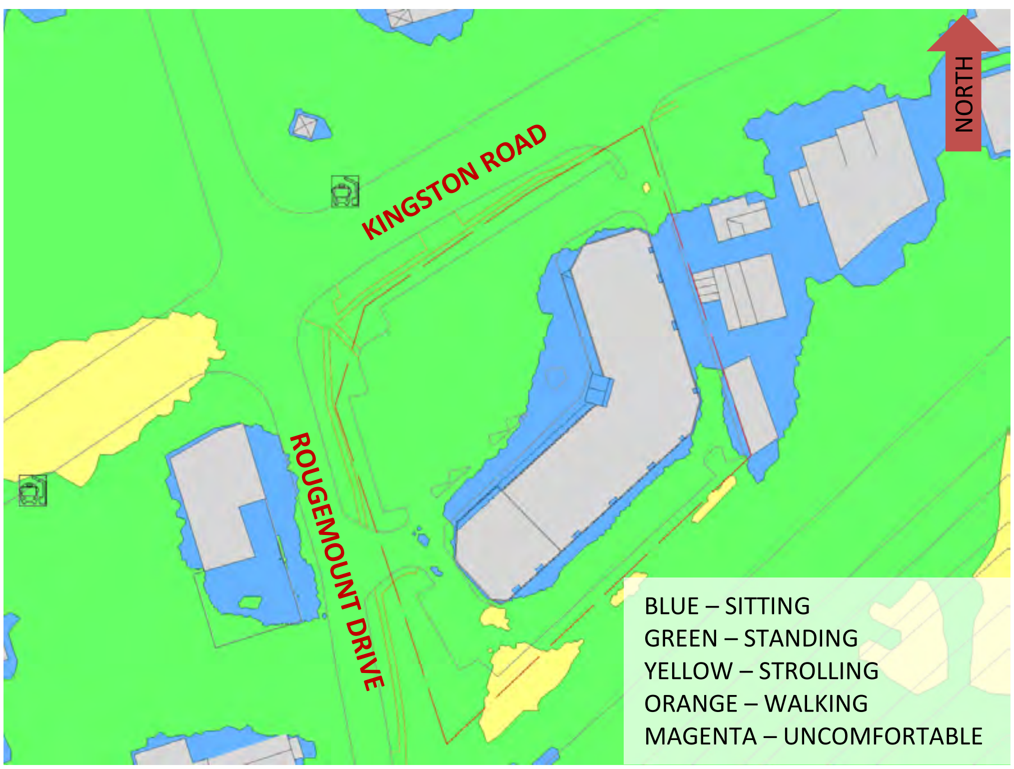

FIGURE 3B: SPRING – EXISTING MASSING – WIND COMFORT, GRADE LEVEL

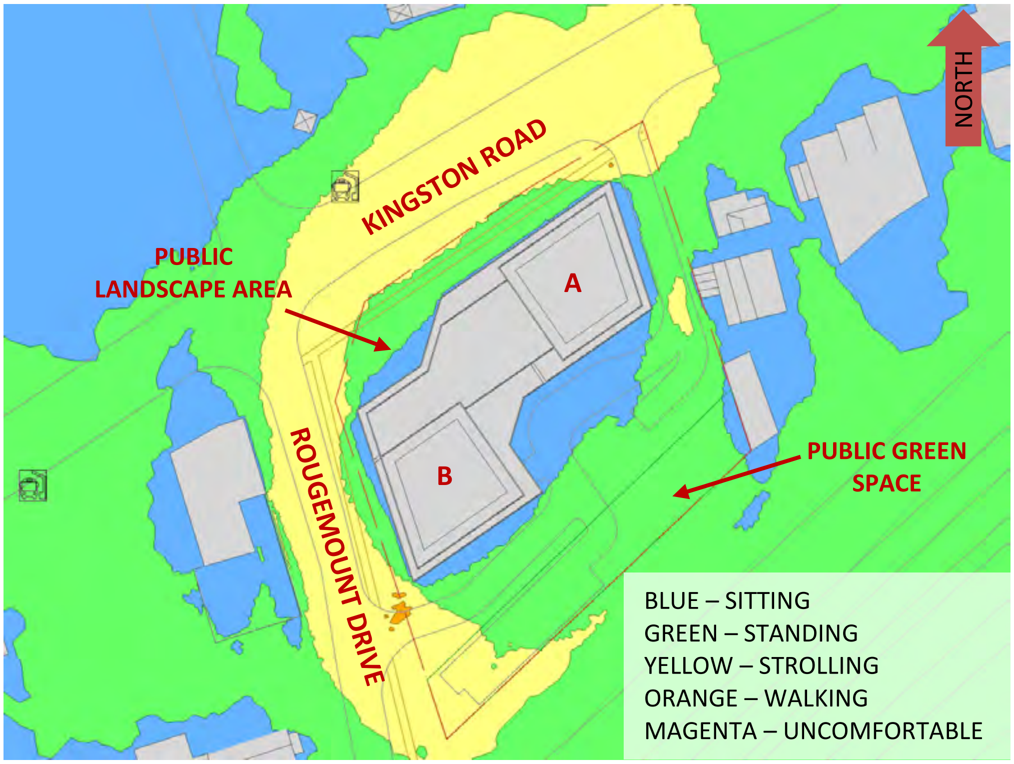

FIGURE 4A: SUMMER – PROPOSED MASSING – WIND COMFORT, GRADE LEVEL

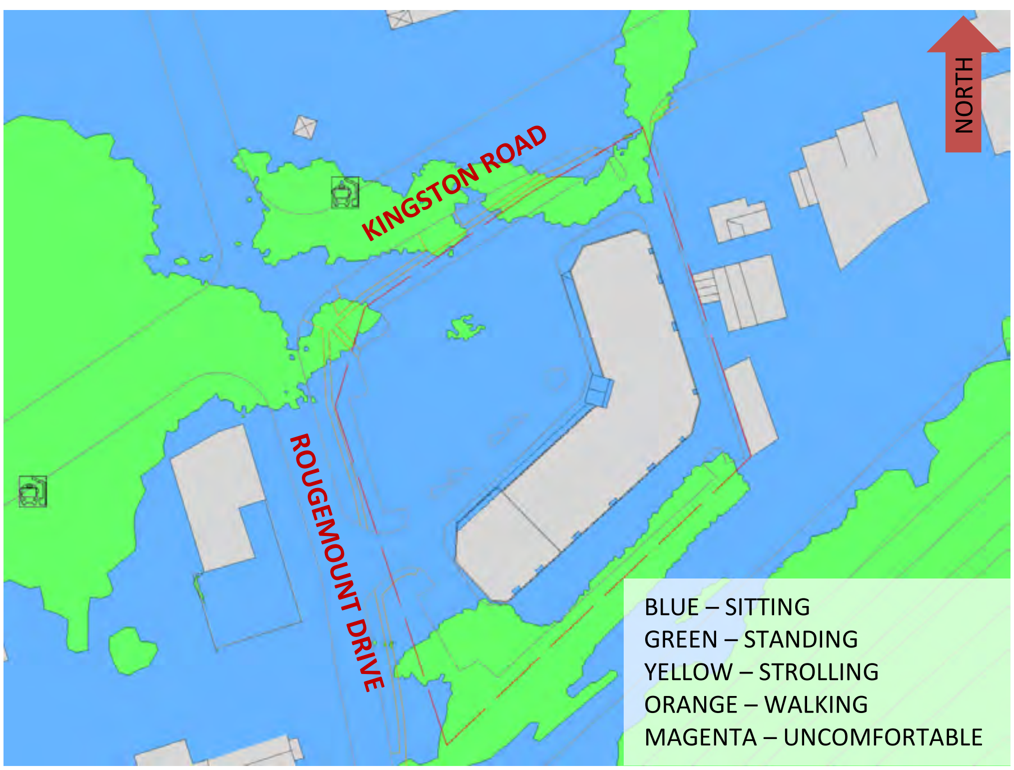

FIGURE 4B: SUMMER – EXISTING MASSING – WIND COMFORT, GRADE LEVEL

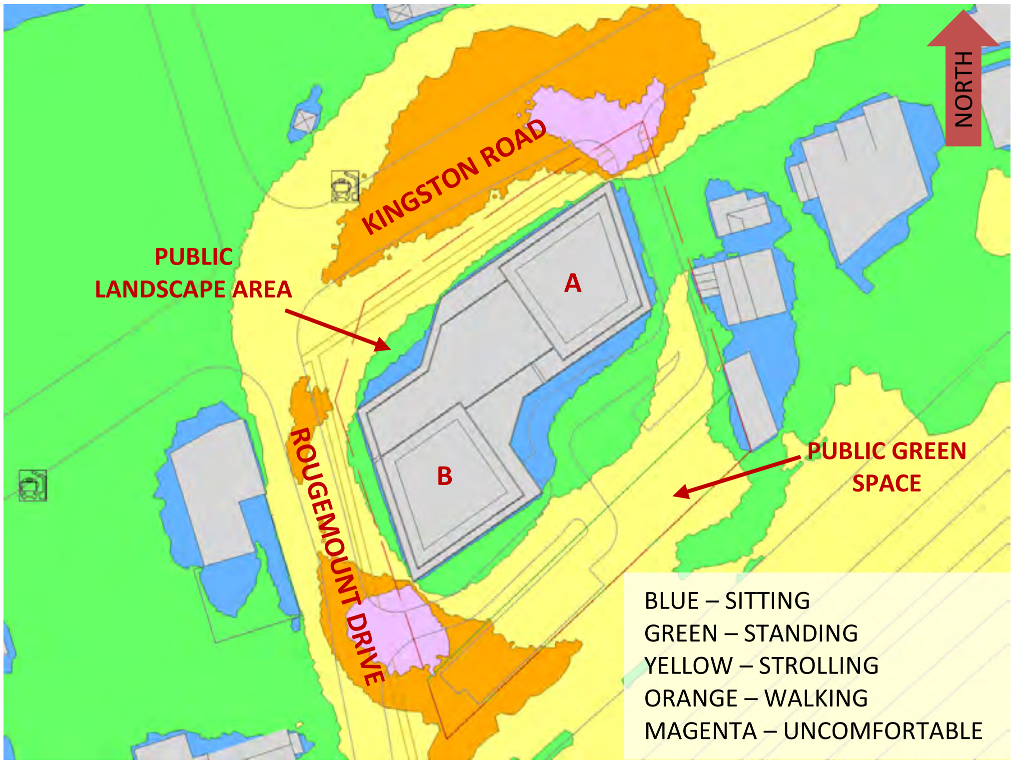

FIGURE 5A: AUTUMN – PROPOSED MASSING – WIND COMFORT, GRADE LEVEL

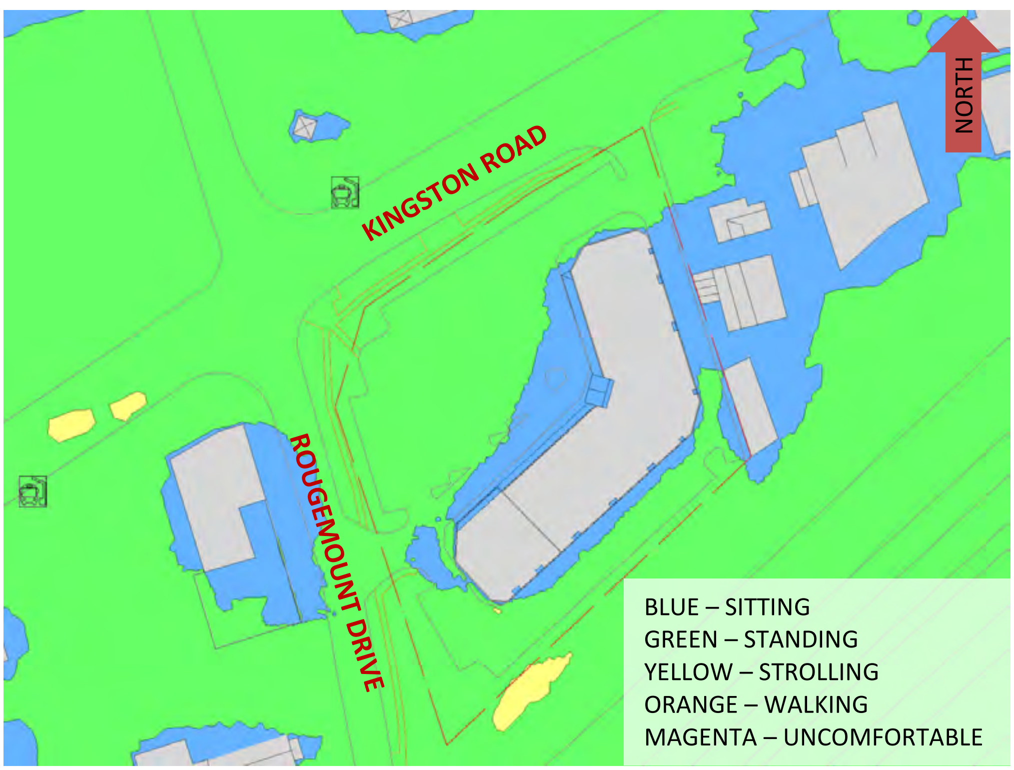

FIGURE 5B: AUTUMN – EXISTING MASSING – WIND COMFORT, GRADE LEVEL

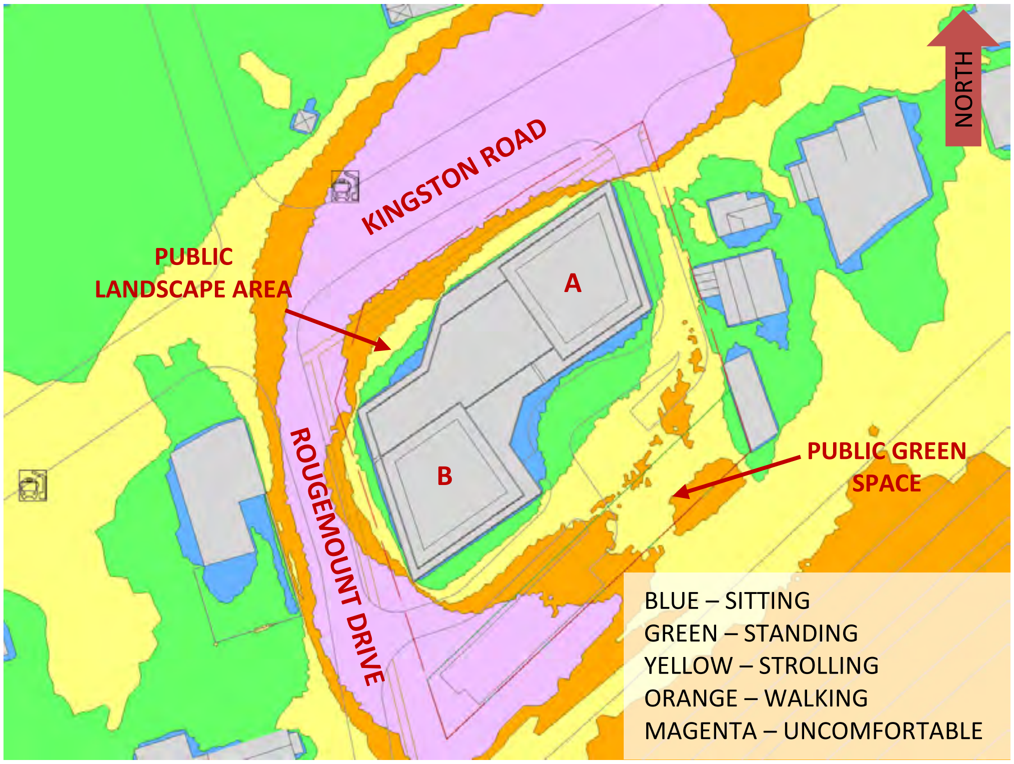

FIGURE 6A: WINTER – PROPOSED MASSING – WIND COMFORT, GRADE LEVEL

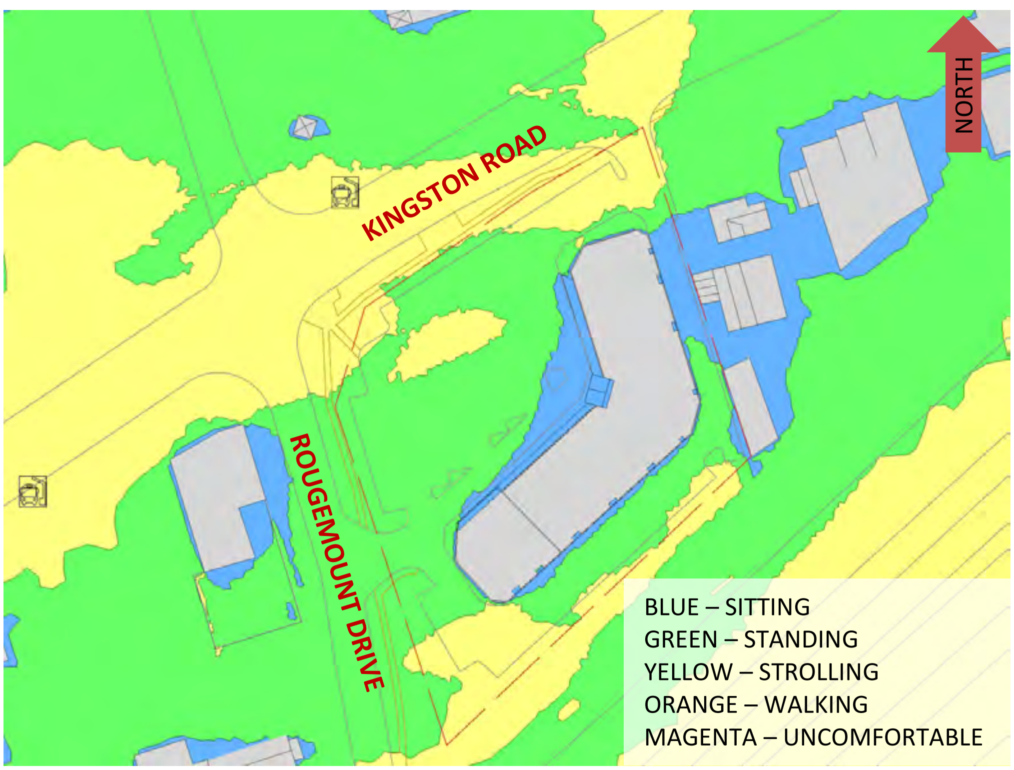

FIGURE 6B: WINTER – EXISTING MASSING – WIND COMFORT, GRADE LEVEL

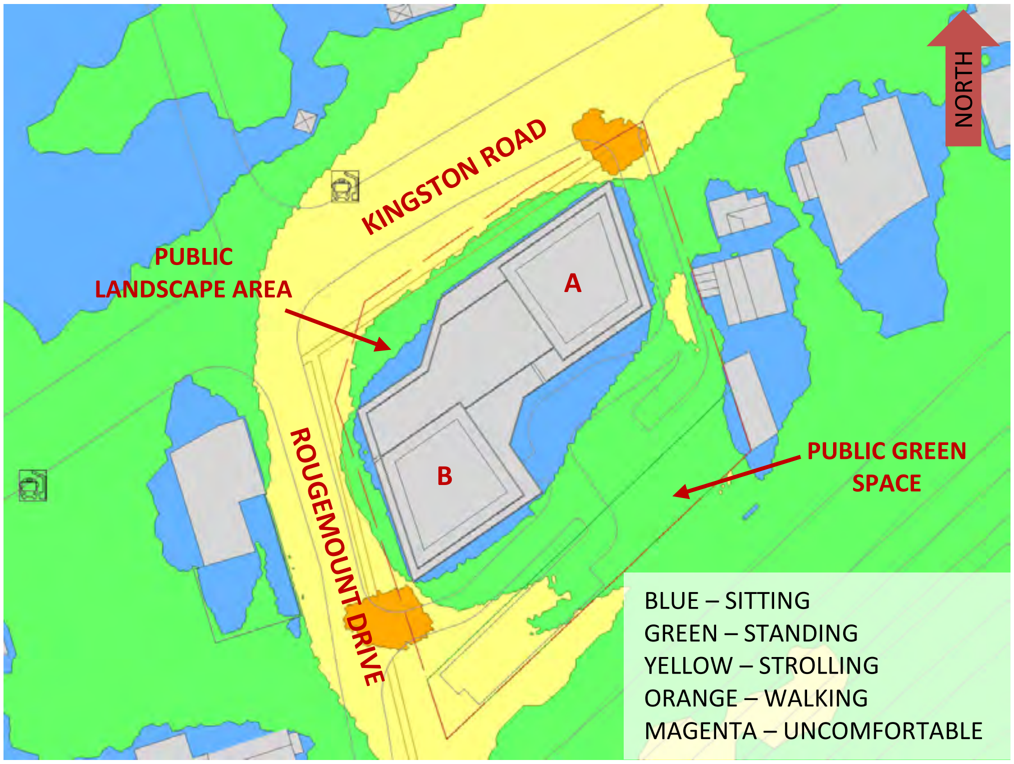

FIGURE 7A: TYPICAL USE PERIOD – PROPOSED MASSING – WIND COMFORT, GRADE LEVEL

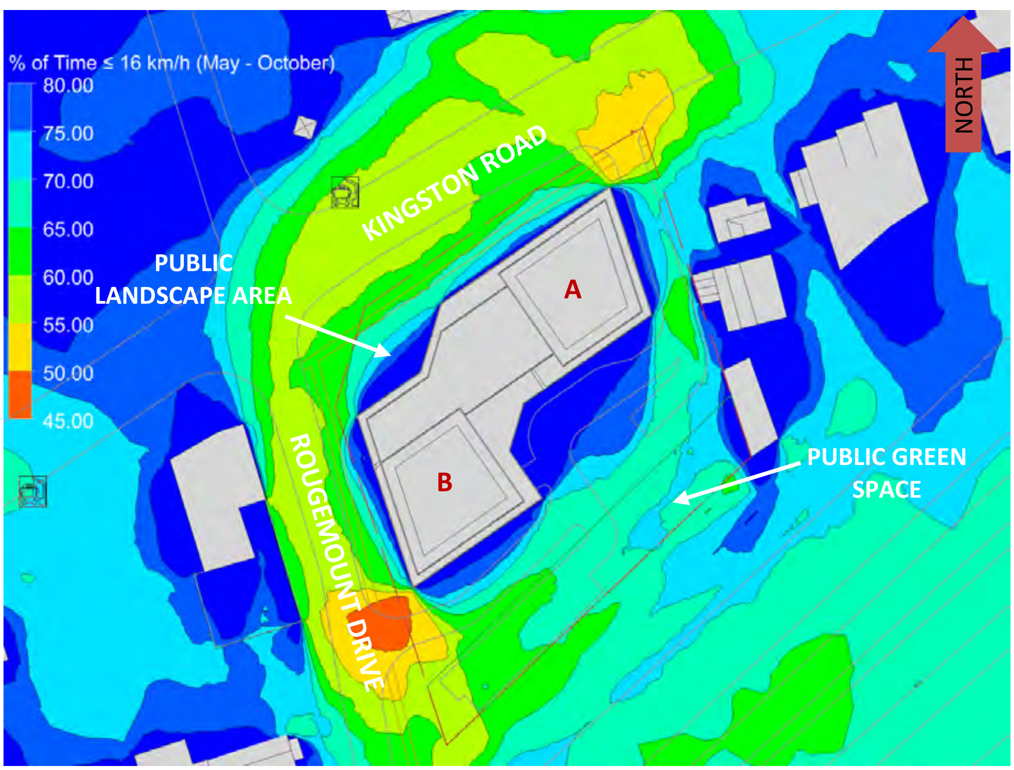

FIGURE 7B: % OF TIME SUITABLE FOR SITTING CORRESPONDING TO FIGURE 7A

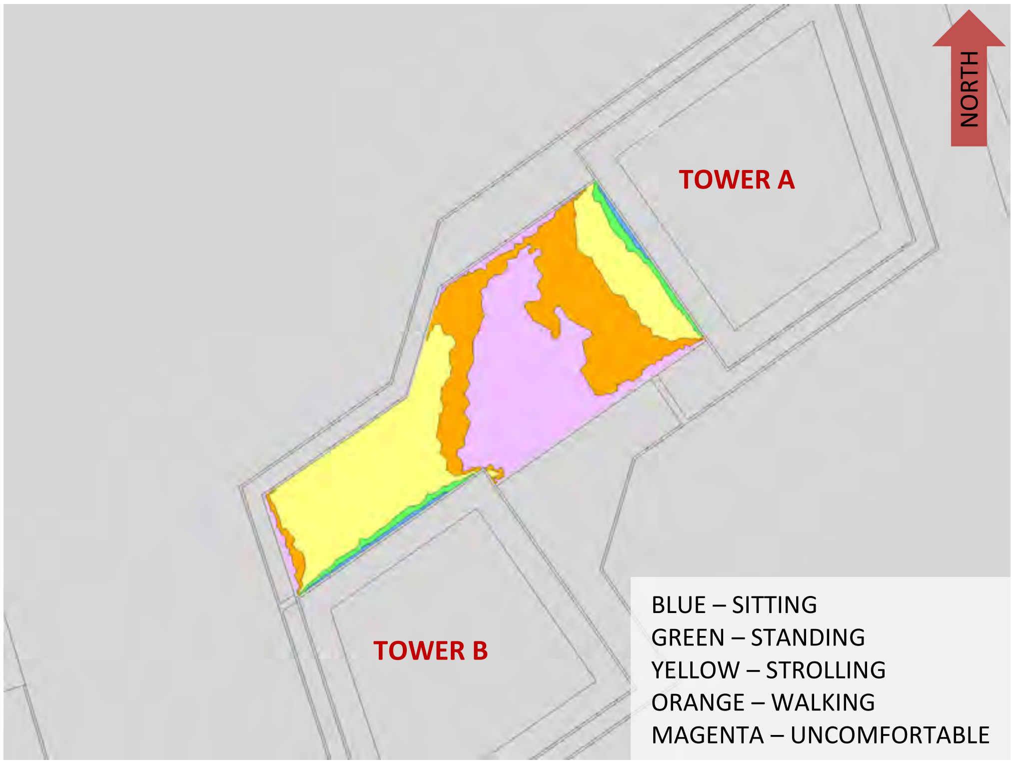

FIGURE 8A: SPRING – PROPOSED MASSING, WIND COMFORT, LEVEL 6 AMENITY TERRACE

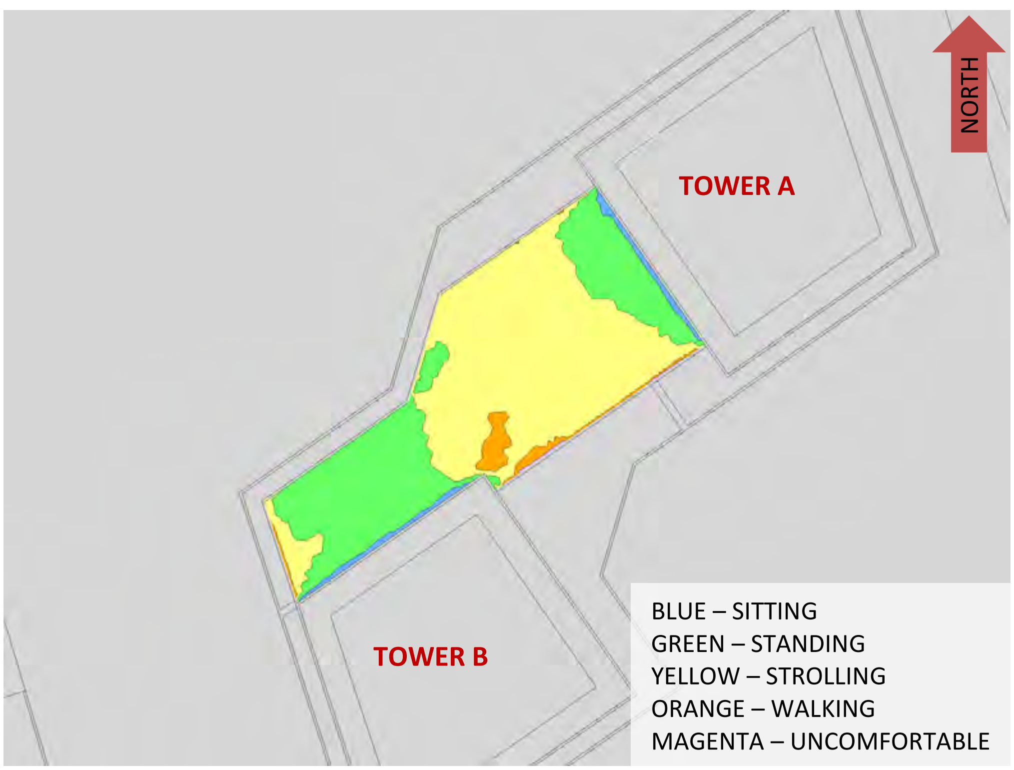

FIGURE 8B: SUMMER – PROPOSED MASSING, WIND COMFORT, LEVEL 6 AMENITY TERRACE

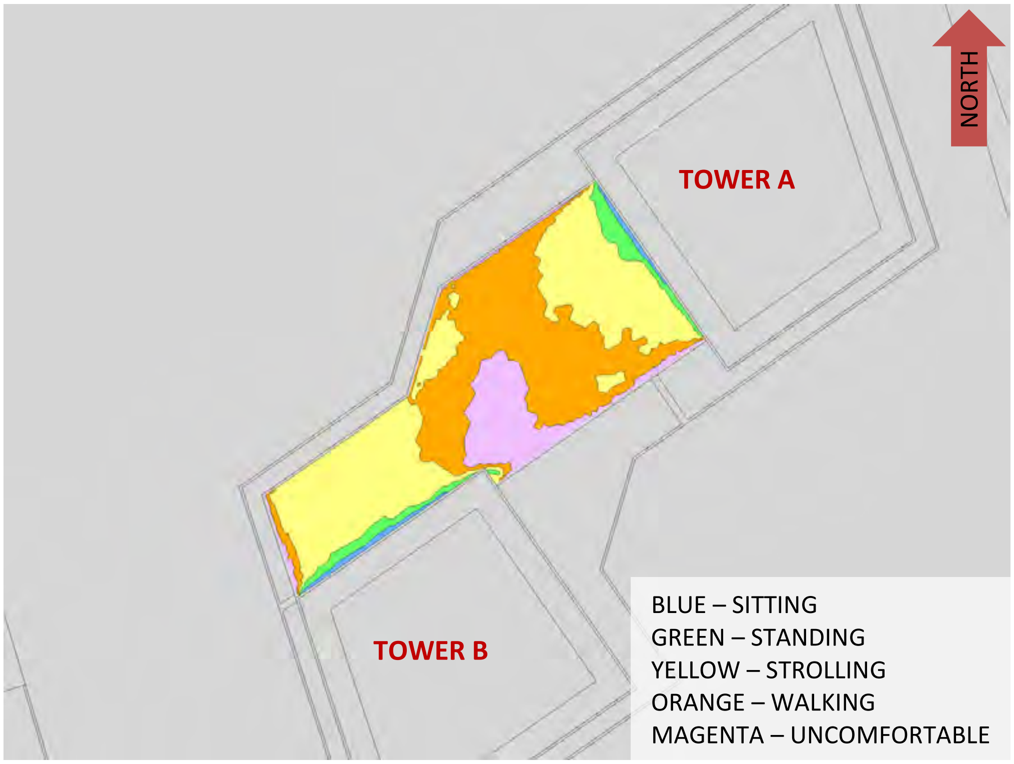

FIGURE 8C: AUTUMN – PROPOSED MASSING, WIND COMFORT, LEVEL 6 AMENITY TERRACE

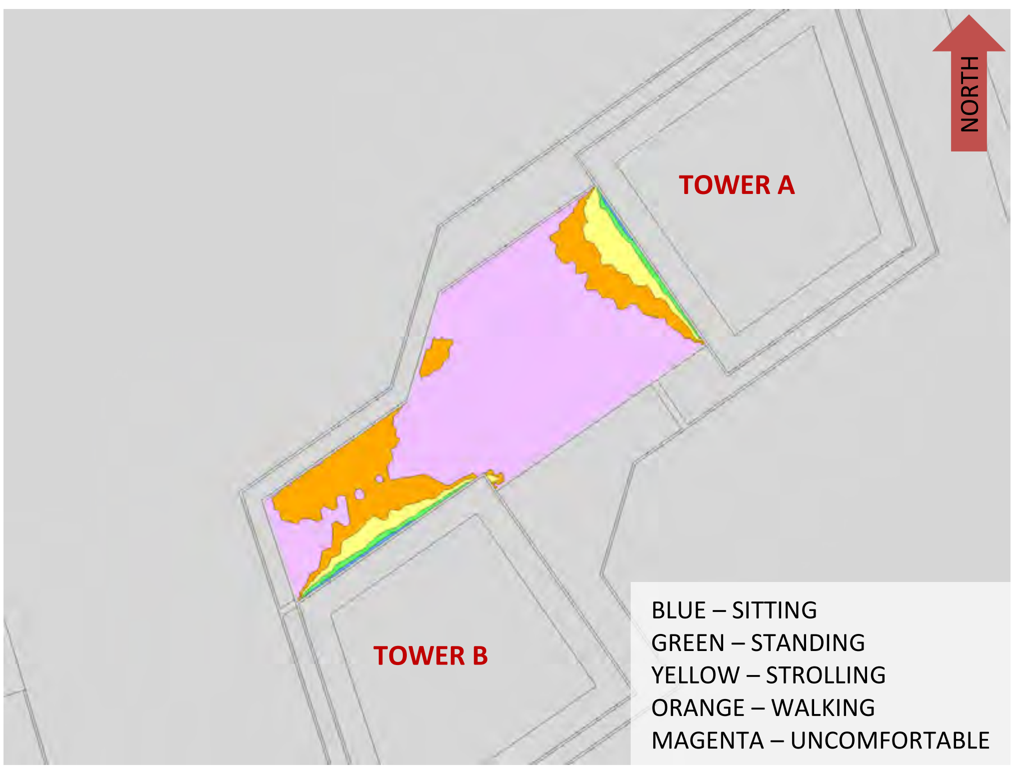

FIGURE 8D: WINTER – PROPOSED MASSING, WIND COMFORT, LEVEL 6 AMENITY TERRACE

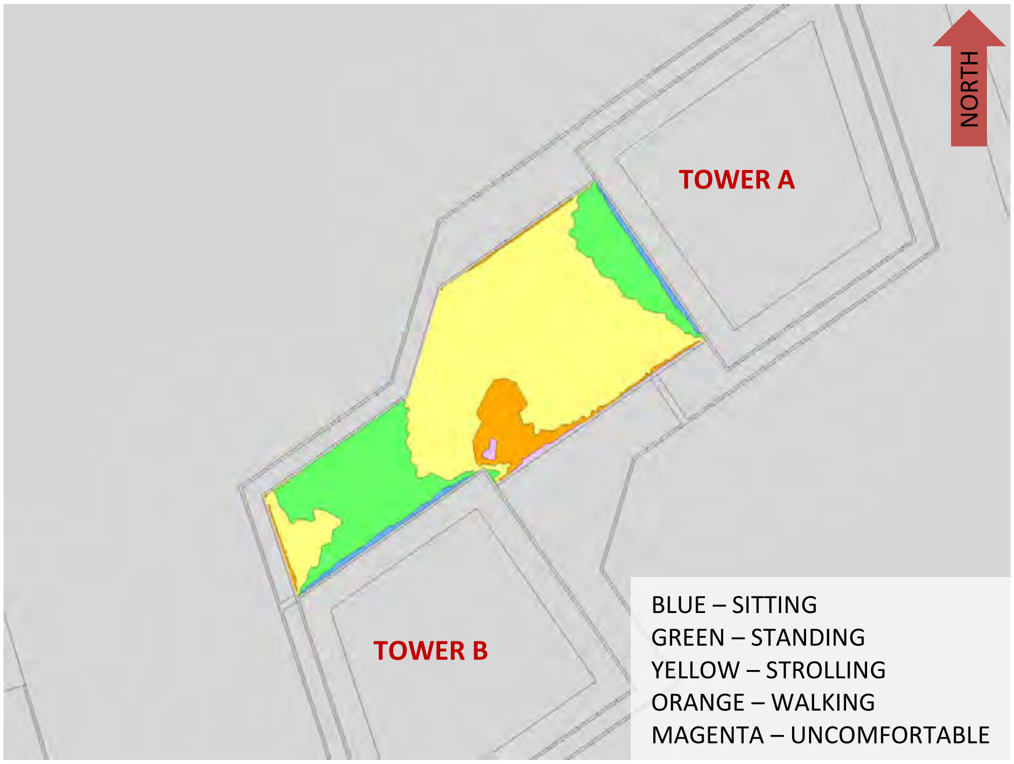

FIGURE 9A: TYPICAL USE PERIOD – PROPOSED MASSING, WIND COMFORT, TERRACE

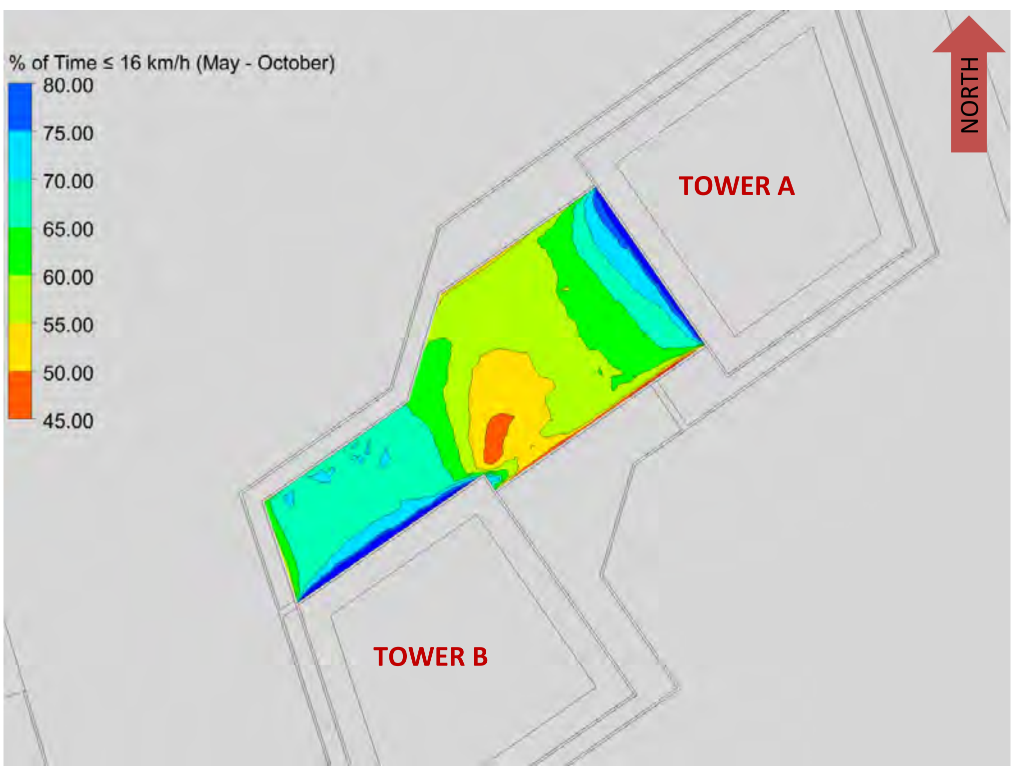

FIGURE 9B: % OF TIME SUITABLE FOR SITTING CORRESPONDING TO FIGURE 9A

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 50% mean wind speed for Toronto based on historical climate data and statistical analyses. When the results are normalized by this velocity, they are relatively insensitive to the selection of gradient wind speed.

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

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

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

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

Wind Direction (Degrees True)	Alpha Value (α)
0	0.23
40	0.23
97	0.20
136	0.20
170	0.22
210	0.23
237	0.22
258	0.22
278	0.22
300	0.23
322	0.23
341	0.23

TABLE 2: DEFINITION OF UPSTREAM EXPOSURE (ALPHA VALUE)

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

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

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

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

where, ***I*** = turbulence intensity, L_t = turbulence length scale, ***Z*** = height above ground, and α is the power law exponent used for the velocity profile in Equation (1).

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

REFERENCES

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

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

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