REPORT

875 KINGSTON ROAD

PICKERING, ON

PEDESTRIAN WIND COMFORT ASSESSMENT

PROJECT #2301194
May 17, 2023

SUBMITTED TO

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to conduct a pedestrian wind assessment for the proposed project at 875 Kingston Road in Pickering, Ontario. The objective of this assessment is to provide an evaluation of the potential wind impact of the proposed development in support of the Official Plan Amendment (OPA) and Zoning By-Law Amendment (ZBA) application.

The project site is located to the north of Ontario 401 Express, south of the Kingston Road and Fairport Road intersection. The surroundings are low-rise buildings, roadways and open fields from all directions, with Lake Ontario approximately 2 km to the south (**Image 1**).

The project is a mixed-use residential development that comprises two 55 m tall towers, each consisting of 17-storeys, joined with a 6-storey podium (**Image 2**).

In addition to sidewalks and properties near the project site, key areas of interest for this assessment include the main entrance to the buildings on Kingston Road (**Image 3**), the above-grade shared amenities at Level 6 and the rooftop.

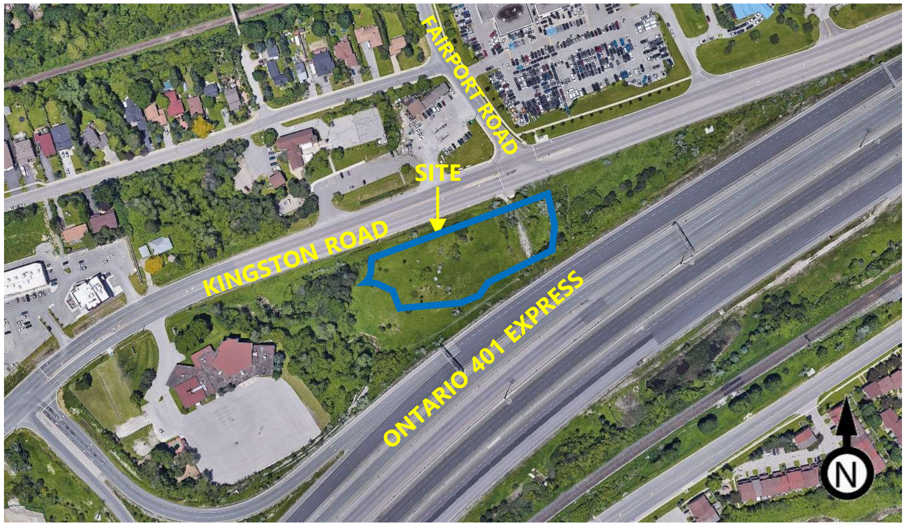


Image 1: Aerial view of the existing site and surroundings
Source: Google Maps

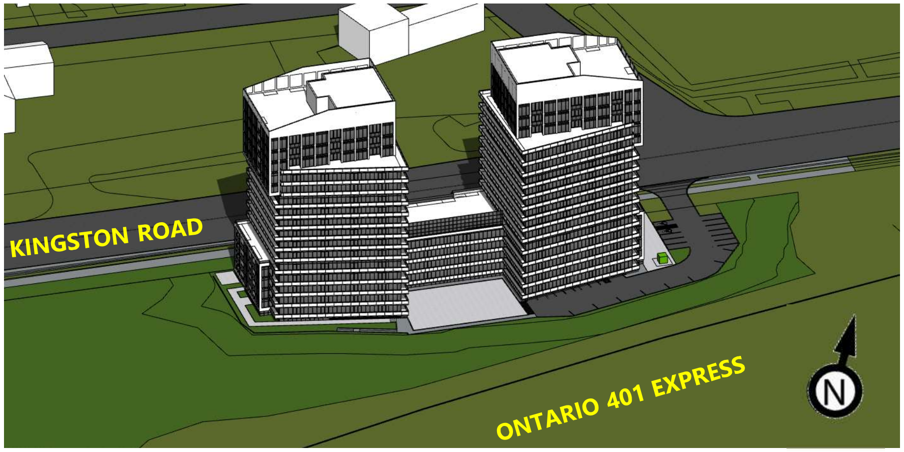
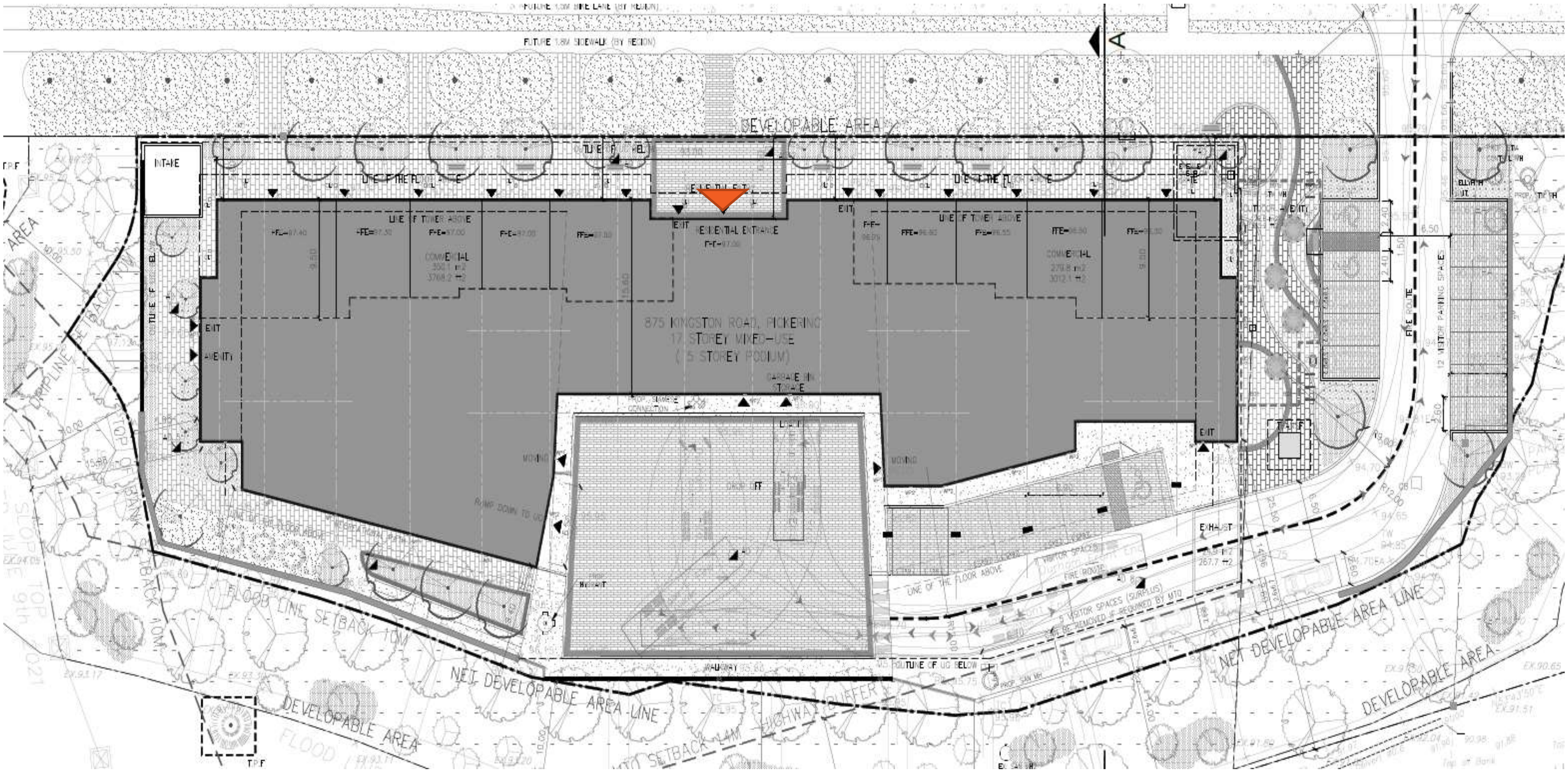


Image 2: Conceptual massing of the proposed project

1. INTRODUCTION



RESIDENTIAL ENTRANCE AT GRADE

Image 3: Roof plan identifying building entrances and key outdoor areas of interest

2. METHODOLOGY

2.1 Objective

The objective of this assessment is to provide an evaluation of the potential impact of the proposed development on wind conditions in pedestrian areas on and around it based on Computational Fluid Dynamics (CFD) modelling. The assessment is based on the following:

- A review of the regional long-term meteorological data from Oshawa Executive Airport;
- Architectural set received on September 28, 2022, and the 3D model of the proposed project received on May 3, 2023;
- The use of *Orbital Stack*, an in-house CFD tool;
- RWDI's engineering judgment, experience, and expert knowledge of wind flows around buildings[1-3]; and,
- The RWDI wind comfort and safety criteria.

Note that other microclimate issues such as those relating to cladding and structural wind loads, door operability, air quality, snow impact, noise, vibration, etc. are not part of the scope of this assessment

2.2 CFD for Wind Simulation

CFD is a numerical technique that can be used for simulating wind flow in complex environments. For modelling winds around buildings, CFD techniques are used to generate a virtual wind tunnel where flows around the site, surroundings and the study building are simulated at full scale. The computational domain that covers the site and surroundings are divided into millions of small cells where calculations are performed, which allows for the "mapping" of wind conditions across the entire study domain. CFD excels as a tool for wind modelling and presentation for providing early design advice, comparing different design and site scenarios, resolving complex flow physics, and helping diagnose problematic wind conditions.

Gust conditions are infrequent but deserve special attention due to their potential impact on pedestrian safety. The computational modelling method used in the current assessment does not quantify the transient behaviour of the wind, including wind gusts. The effect of gust, i.e., wind safety, is predicted qualitatively in this assessment using analytical methods and wind-tunnel-based empirical models[1]. The assessment has been conducted by experienced microclimate specialists in order to provide an accurate prediction of wind conditions.

In order to quantify the transient behaviour of wind and refine any conceptual mitigation measures, a more detailed assessment would be required using either a boundary-layer wind tunnel or transient computational modelling.

2. METHODOLOGY

2.3 Simulation Model

CFD simulations were completed for two scenarios:

- Existing: Existing site and surroundings; and,
- Proposed: Proposed development with the existing surroundings.

Information about the nearby approved developments was unavailable at the time of the assessment.

The computer model of the proposed building is shown in **Image 4**, and the Existing and Proposed configurations with the proximity model are shown in **Images 5a** and **5b**, respectively. The 3D models were simplified to include only the necessary building and terrain details that would affect the local wind flows in the area and around the site. Landscaping and other smaller architectural and accessory features were not included in the computer model in order to provide more conservative wind conditions (as is the norm for this level of assessment).

The wind approaching the modelled area were simulated for 16 directions (starting at 0°, at 22.5° increments around the compass), accounting for the effects of the atmospheric boundary layer and terrain impacts. Wind data were obtained in the form of ratios of wind speeds at approximately 1.5m above concerned levels, to the mean wind speed at a reference height. The data was then combined with meteorological records obtained from Oshawa Executive Airport to determine the wind speeds and frequencies in the simulated areas.

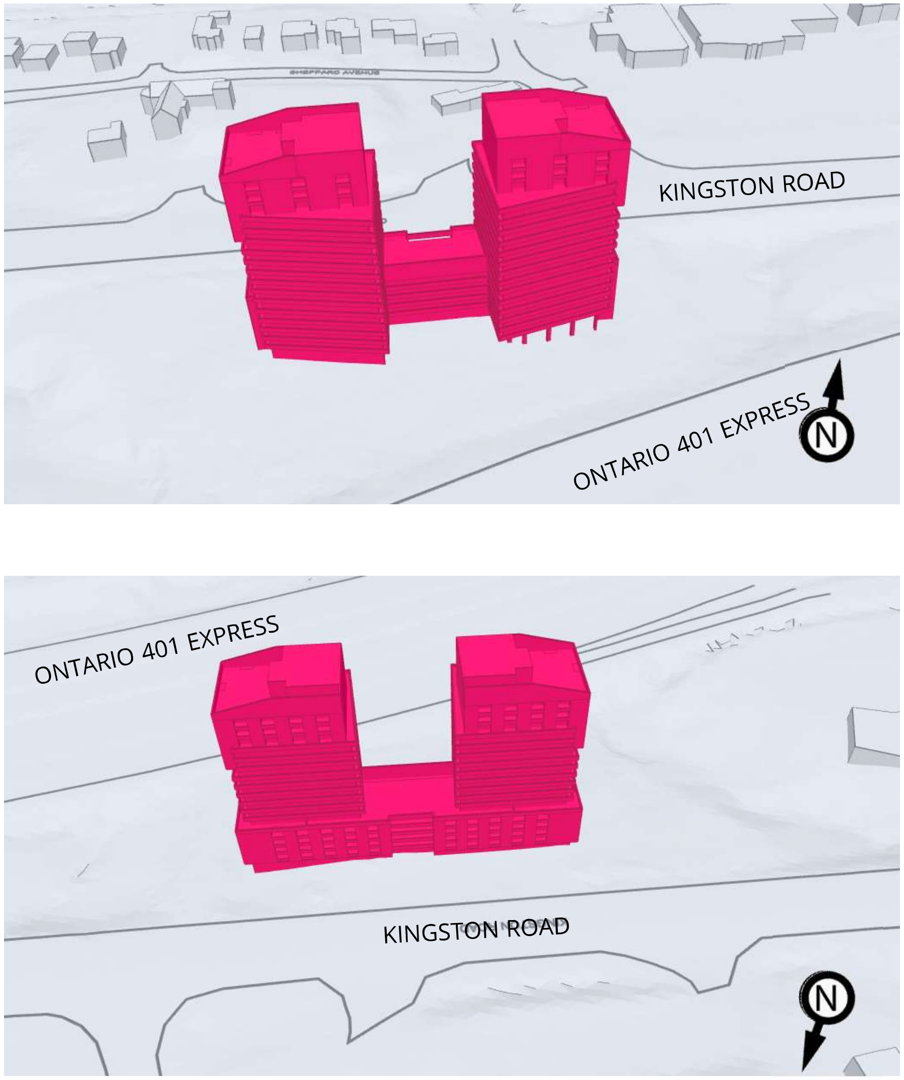


Image 4: Computer model of the proposed project

Image 5a: Computer model of the existing site and extended surroundings

2. METHODOLOGY

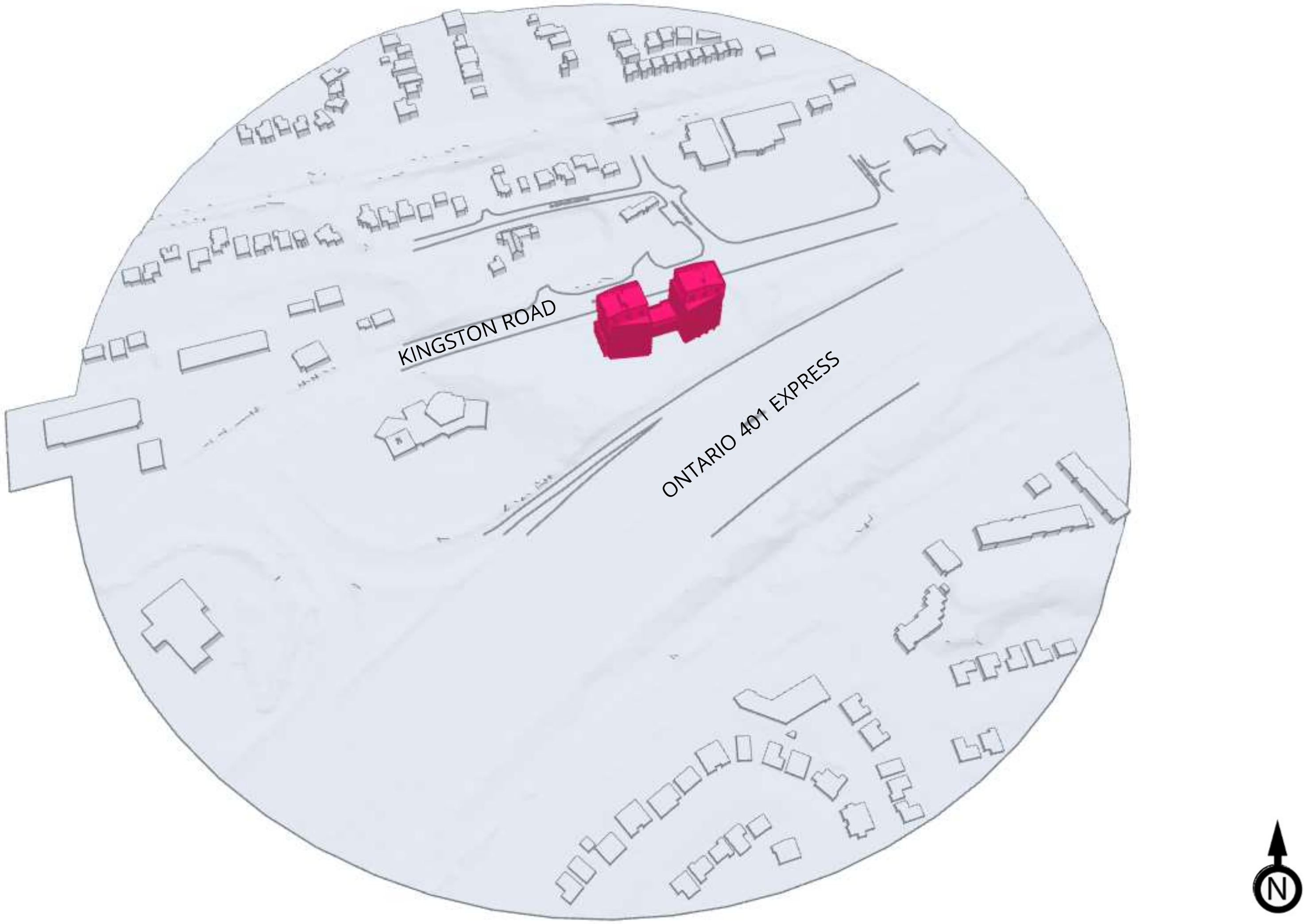


Image 5b: Computer model of the proposed building and existing surroundings

2. METHODOLOGY

Long-term wind data recorded at Oshawa Executive Airport between 2007 and 2019, inclusive, were analyzed for the summer (May to October) and winter (November to April) months. **Image 6** graphically depicts the directional distributions of wind frequencies and speeds for these periods.

In the summer, winds from the northerly directions are most frequent, with frequent winds also from the east and south-southwest. In the winter, winds from the west-southwest and east are prevalent with frequent winds from the northwest quadrant.

Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10m) are more frequent in the winter (red and yellow bands in **Image 6**). These winds potentially could be the source of uncomfortable or severe wind conditions, depending on the site exposure and development design.

Wind statistics were combined with the simulated data to predict the wind conditions at the project site and assessed against the wind criteria for pedestrian comfort.

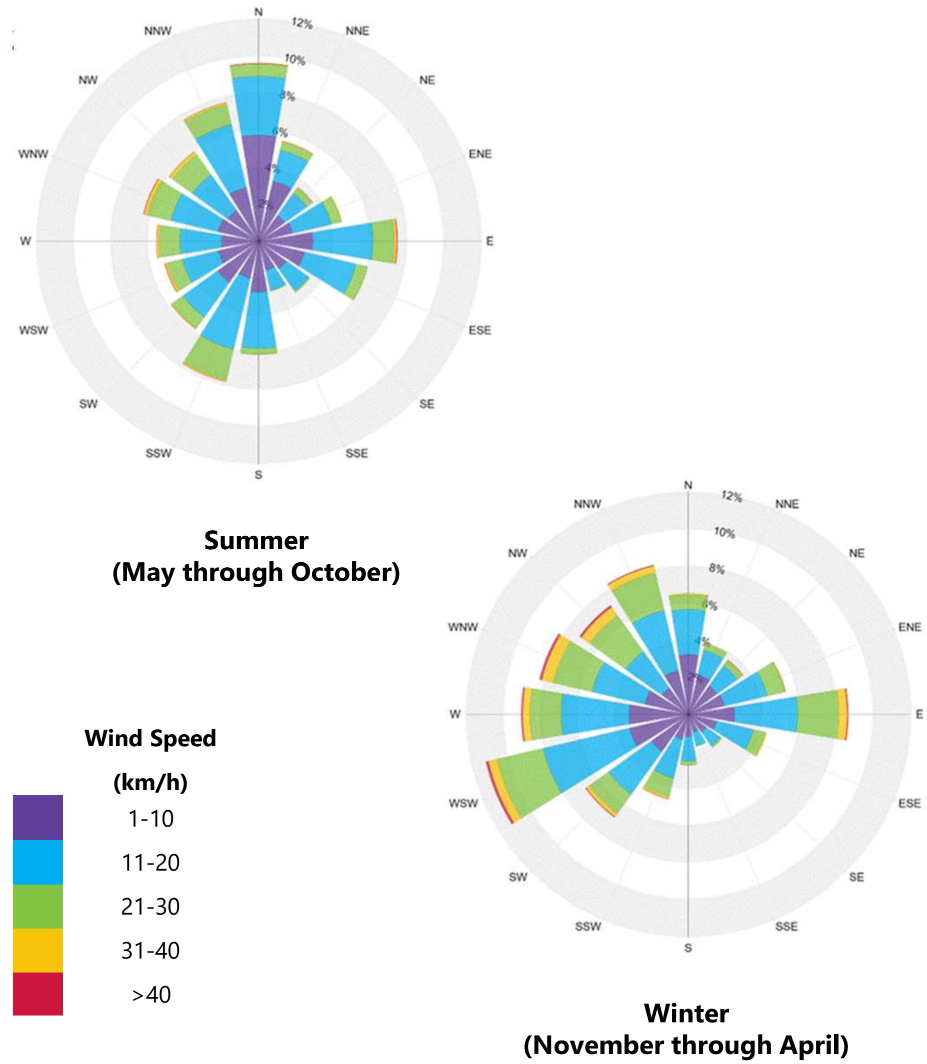


Image 6: Directional distribution of wind approaching Oshawa Executive Airport (2007 to 2019)

3. WIND CRITERIA

The RWDI pedestrian wind criteria are used in the current study; the criteria presented in the table below, addresses pedestrian safety and comfort. These criteria have been developed by RWDI through research and consulting practice since 1974. They have also been widely accepted by municipal authorities, building designers and the city planning community.

3.1 Pedestrian Comfort

Pedestrian comfort is associated with common wind speeds conducive to different levels of human activity. Wind conditions are considered suitable for sitting, standing, strolling or walking if the associated mean wind speeds (see table) are expected for at least four out of five days (80% of the time). The assessment considers winds occurring between 6 AM and midnight. Limited usage of outdoor spaces is anticipated in the excluded period. Speeds that exceed the criterion for Walking are categorized Uncomfortable. These criteria for wind forces represent average wind tolerance. They are sometimes subjective and regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. can also affect people's perception of the wind climate.

Comfort Category	GEM Speed (km/h)	Description (Based on seasonal compliance of 80%)
Sitting	**≤ 10**	Calm or light breezes desired for outdoor seating areas where one can read a paper without having it blown away
Standing	**≤ 14**	Gentle breezes suitable for main building entrances, bus stops, and other places where pedestrians may linger
Strolling	**≤ 17**	Moderate winds appropriate for window shopping and strolling along a downtown street, plaza or park
Walking	**≤ 20**	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
Uncomfortable	**> 20**	Strong winds considered a nuisance for all pedestrian activities. Wind mitigation is typically recommended

3.2 Pedestrian Safety

Pedestrian safety is associated with excessive Gust Speeds that can adversely affect a person's balance and footing. These are usually infrequent events but deserve special attention due to the potential impact on pedestrian safety.

Safety Criterion	Gust Speed (km/h)	Description (Based on annual exceedance of 9 hrs or 0.1% of time)
Exceeded	**> 90**	Excessive gusts that can adversely affect one's balance and footing. Wind mitigation is typically required.

4. RESULTS AND DISCUSSION

4.1 Wind Flow Around the Project

Wind generally tends to flow over buildings of uniform height, without disruption. Buildings that are taller than their surroundings will intercept and redirect winds around them. The mechanism in which winds are directed down the height of a building is called *Downwashing*. These flows subsequently move around exposed building corners, causing a localized increase in wind activity due to *Corner Acceleration*. Wind flow tends to accelerate through the space between buildings, or in passages through buildings due to the *channelling effect* caused by the narrow gap. The effect is intensified if the channel is aligned with the predominant wind directions. *Podium* massing, low roofs and canopies diffuse downwash and reduce the potential wind impact on the ground level. These flow patterns are illustrated in **Image 7**.

The project, consisting of two 17-storey towers sitting atop a 5-storey podium, will intercept prevailing winds causing downwashing, channelling and corner acceleration. Positively, the podium and towers' setbacks are features that will help moderate winds close to the ground level.

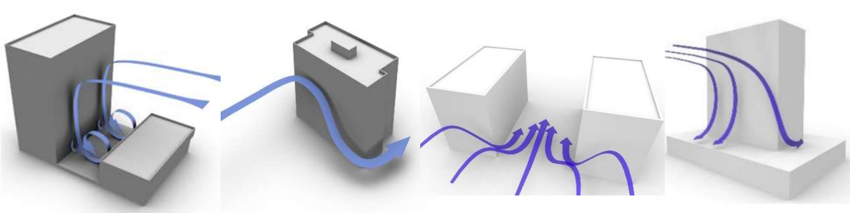


Image 7: General wind flow patterns

4.2 Simulation Results

The predicted ground-level wind comfort conditions for the existing and proposed configuration are presented in **Images 8** and **9** for the summer and winter seasons, respectively. The results are presented as colour contours of wind speeds calculated based on the wind comfort criteria (Section 3). The contours represent wind speeds at a horizontal plane approximately 1.5 m above the local grade level. The assessment against the safety criterion (Section 3) was conducted qualitatively based on the predicted wind conditions and our wind tunnel experience with similar developments.

A detailed discussion of the expected wind conditions with respect to the prescribed criteria and applicability of the results follows in Sections 4.3, 4.4 and 4.5.

<u>**Target Conditions**</u>

For the current development, wind speeds comfortable for walking or strolling are appropriate for sidewalks and walkways where pedestrians are likely to be active and moving intentionally. Lower wind speeds comfortable for standing are required for entrances and areas where people are expected to be engaged in passive activities. Calm wind speeds suitable for sitting are desired in areas where prolonged periods of passive activities are anticipated, such as outdoor amenity areas, seating areas etc., especially during the summer when these areas are typically in use.

(a) EXISTING **(b) PROPOSED**

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

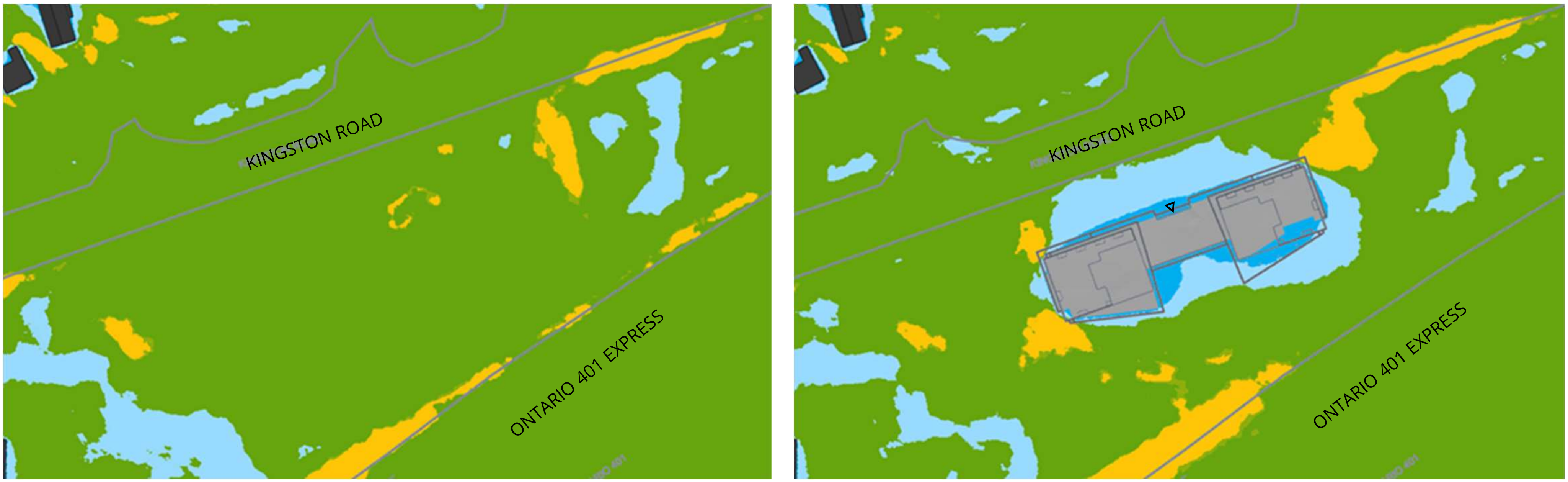
SAFETY: **The criterion will be met at all areas assessed**

N

▷ **Residential entrance**

Image 8: Predicted wind conditions – GROUND LEVEL – SUMMER

4. RESULTS AND DISCUSSION



(a) EXISTING

(b) PROPOSED

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

SAFETY: **The criterion will be met at all areas assessed**

▷ **Residential entrance**

Image 9: Predicted wind conditions – GROUND LEVEL – WINTER

4.3 Existing Scenario

The existing site is currently vacant and is surrounded by low-rise buildings, roadways and open fields from all directions. As such, wind conditions at most areas on and around the proposed site in the existing scenario are considered comfortable for standing or strolling in the summer (**Image 8a**) and for strolling or walking in the winter (**Image 9a**).

The pedestrian wind safety criterion is met at all areas assessed in the existing configuration.

4.4 Proposed Scenario – Grade Level

The proposed project, consisting of two 17-storey towers, is expected to alter wind conditions in the immediate surroundings, due to the increased wind-building interactions (refer to Section 4.1.).

During the summer, wind conditions on and around the proposed project are expected to be comfortable for sitting or standing, with slightly elevated wind speeds comfortable for strolling anticipated to the east and west along Kingston Road (**Image 8b**). During the winter, wind speeds comfortable for standing or strolling are expected on and around the project, with a few isolated areas near the northeast and westerly building corners, where elevated wind speeds comfortable for walking are expected (**Image 9b**). These conditions are considered appropriate for various pedestrian activities.

Wind speeds conducive to sitting or standing are expected near the main entrance throughout the year, which is considered appropriate.

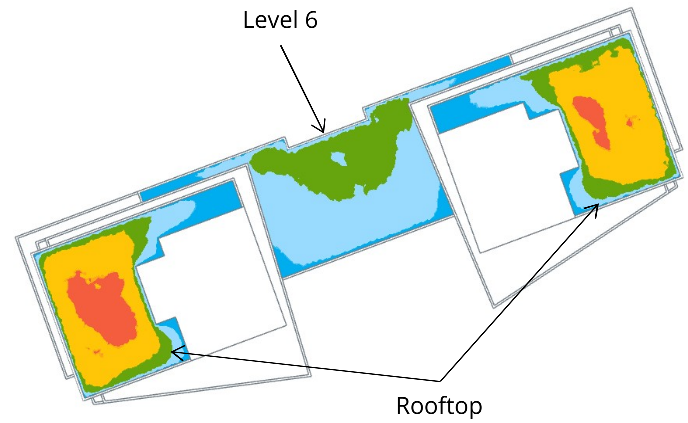
The pedestrian safety criterion is expected to be met at all areas assessed in the proposed configuration.

4.5 Proposed Scenario – Above-Grade

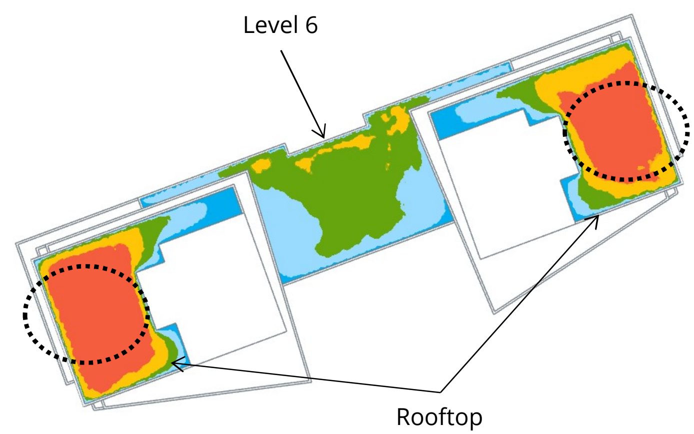
During the summer, wind conditions at the Level 6 amenity area are expected to be comfortable for standing or strolling, with wind conditions comfortable for walking or uncomfortable at the rooftop amenity (**Image 10a**). These conditions are considered higher than desired for passive pedestrian activities, and wind control measures are required to achieve appropriate comfort levels.

During the winter, wind conditions comfortable for strolling are expected at the Level 6 amenity area, with uncomfortable conditions expected at the rooftop amenity areas (**Image 10b**). The pedestrian safety criterion may also be exceeded in these areas. These wind speeds are considered higher than desired for the intended usage, but may be acceptable, as the areas will likely not be occupied in the winter.

To achieve appropriate comfort conditions and extended use of the amenity areas, we encourage the design team to consider features like taller guardrails, wind screens, tall planters and canopies/trellises, to reduce wind speeds in the summer. These features, when placed along the terrace perimeter and over and around seating areas, will help reduce the exposure of the terrace to the prevailing winds. Some examples of wind control features are shown in **Image 11**. RWDI can guide the selection and placement of such features for wind control as the design advances.



(a) SUMMER



(b) WINTER

COMFORT: SITTING STANDING STROLLING WALKING UNCOMFORTABLE

SAFETY: **Areas where the criterion may be exceeded**

Image 10: Predicted wind conditions – ABOVE-GRADE

4. RESULTS AND DISCUSSION

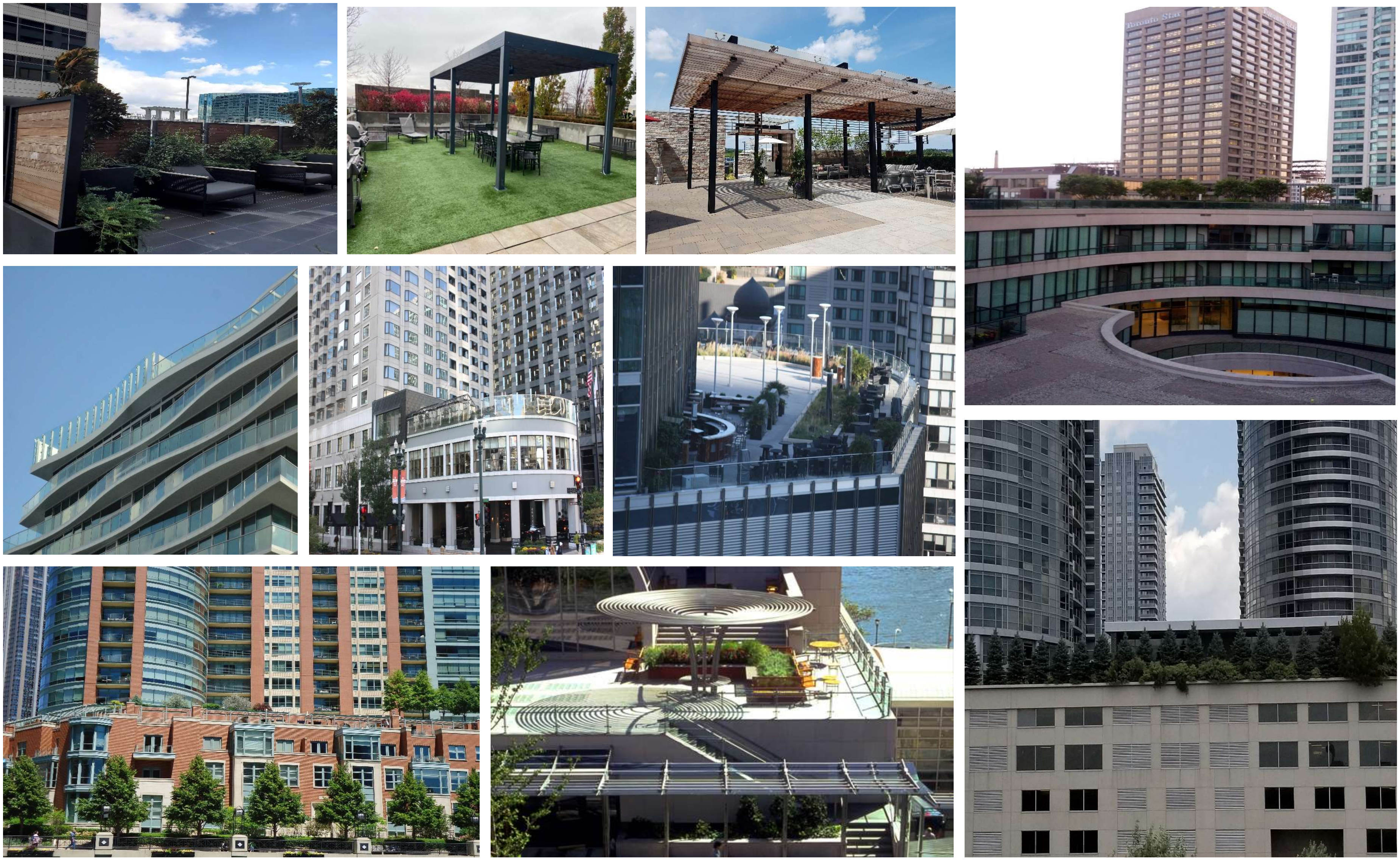


Image 11: Wind control measures applicable to the amenity area

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian wind impact of the proposed project at 875 Kingston Road in Pickering, Ontario. Our assessment was based on computational modelling, simulation and analysis of wind conditions for the proposed development design, in conjunction with the local wind climate data and the RWDI wind criteria for pedestrian comfort and safety. Our findings are summarized as follows:

- Wind conditions on and around the existing site are suitable for the intended pedestrian use throughout the year. The pedestrian wind safety criterion is met at all areas assessed.
- With the proposed development in place, wind conditions at the grade level, including the main entrance and sidewalks are expected to be comfortable for the intended pedestrian use throughout the year. The wind safety criterion is expected to be met at all locations assessed at the grade level.
- Wind speeds on the Level 6 terrace and rooftops are predicted to be higher than desired for passive pedestrian use throughout the year. The pedestrian safety criterion is expected to be exceeded at the rooftop amenity areas during the colder months. Wind control strategies have been discussed in the report.

RWDI can help guide the placement of wind control features, including landscaping, to achieve appropriate levels of wind comfort based on the programming of the various outdoor spaces.

6. DESIGN ASSUMPTIONS

The findings/recommendations in this report are based on the building geometry and architectural drawings communicated to RWDI between September 2022 and May 2023. Should the details of the proposed design and/or geometry of the building change significantly, results may vary.

File Name	File Type	Date Received (mm/dd/yyyy)
22-09-27 - 875 Kingston Rd - Architectural Set - OPA&ZBA R1	PDF	09/28/2022
23-05-03 - 875 Kingston Road	SketchUp	05/03/2023

Changes to the Design or Environment

It should be noted that wind comfort is subjective and can be sensitive to changes in building design and operation that are possible during the life of a building. These could be, for example: outdoor programming, operation of doors, elevators, and shafts pressurizing the tower, changes in furniture layout, etc.. In the event of changes to the design, construction, or operation of the building in the future, RWDI could provide an assessment of their impact on the discussions included in this report. It is the responsibility of Others to contact RWDI to initiate this process.

7. STATEMENT OF LIMITATIONS

This report was prepared by Rowan Williams Davies & Irwin Inc. for Sphere Developments ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein and authorized scope. The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.

8. REFERENCES

1. H. Wu, C.J. Williams, H.A. Baker and W.F. Waechter (2004), "Knowledge-based Desk-Top Analysis of Pedestrian Wind Conditions", *ASCE Structure Congress 2004,* Nashville, Tennessee.

2. H. Wu and F. Kriksic (2012). "Designing for Pedestrian Comfort in Response to Local Climate", *Journal of Wind Engineering and Industrial Aerodynamics*, vol.104-106, pp.397-407.

3. C.J. Williams, H. Wu, W.F. Waechter and H.A. Baker (1999), "Experience with Remedial Solutions to Control Pedestrian Wind Problems", *10th International Conference on Wind Engineering*, Copenhagen, Denmark.