REPORT

WOODSIDE CENTRE

SCARBOROUGH, ON

PEDESTRIAN LEVEL WIND ASSESSMENT

PROJECT #2000746
APRIL 1, 2020

SUBMITTED TO

Yue Zeng Guo
President

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by 95 Development Inc. to assess the pedestrian wind conditions for the proposed Woodside Square in Scarborough, ON (Image 1). This assessment is based on the following:

- A review of regional long-term meteorological data from Toronto Pearson International Airport;
- Architectural design drawings received from Graziani+Corazza Architects on January 30, February 5 and 19, 2020;
- Previous wind-tunnel studies undertaken by RWDI for similar projects in the Greater Toronto Area;
- Our engineering judgement and knowledge of wind flows around buildings[1-3]; and,
- Use of software developed by RWDI (*WindEstimator*[2]) for estimating the potential wind conditions around generalized building forms.

This qualitative approach provides a screening-level estimation of potential wind conditions. Conceptual wind control measures to improve wind comfort are recommended, where necessary. In order to quantify these conditions or refine any conceptual mitigation measures, physical scale-model tests in a boundary-layer wind tunnel would be required.

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

Image 1: Aerial View of the Site and Surroundings (Credit: Google™ Earth)

1. 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.
2. 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.
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.

2. BUILDING AND SITE INFORMATION

The project site is located at 1571 Sandhurst Circle and is bounded by Finch Avenue East to the south, Sandhurst Circle to the west and McCowan Road to the east in Scarborough, ON. The site is currently occupied by a low-rise shopping mall and parking lots. The proposed project is a mixed-use development consisting of multiple buildings ranging from 8 to 38 storeys tall, surrounding the existing mall (Image 2). Pedestrian accessible areas on and around the proposed development include main entrances, privately-owned publicly accessible spaces (POPS), open green spaces on-site and adjacent sidewalks.

The site is mainly surrounded by low-rise residential developments and open spaces in all directions, with the exception of a few tall buildings to the east, southeast and west directions. Lake Ontario is located approximately 12 km to the south of the project site.

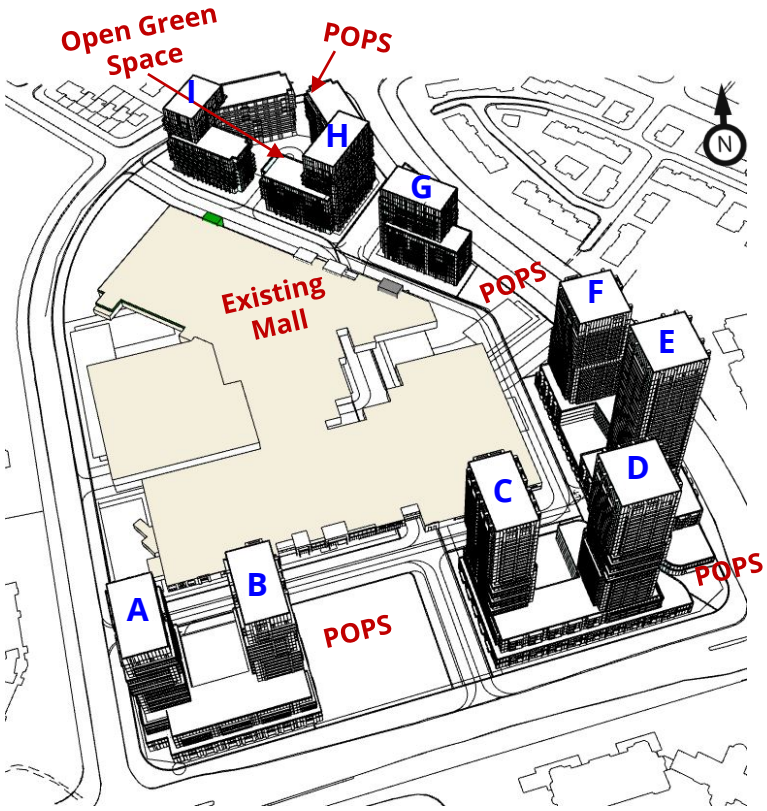


Image 2: Rendering of the Proposed Development (View from Southwest)

3. METEOROLOGICAL DATA

The long-term weather data recorded at Toronto Pearson International Airport (for the period of 1986 to 2018) were analyzed for the Summer (May through October) and Winter (November through April) seasons. Image 3 graphically depicts the directional distributions of wind frequencies and speeds for the two seasons.

Winds from the northwest and southwest quadrants are predominant in both the summer and winter as indicated by the wind roses. Winds from the southeast quadrant are also frequent during the summer, but with relatively low speeds.

Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10 m) occur more often in the winter than in the summer.

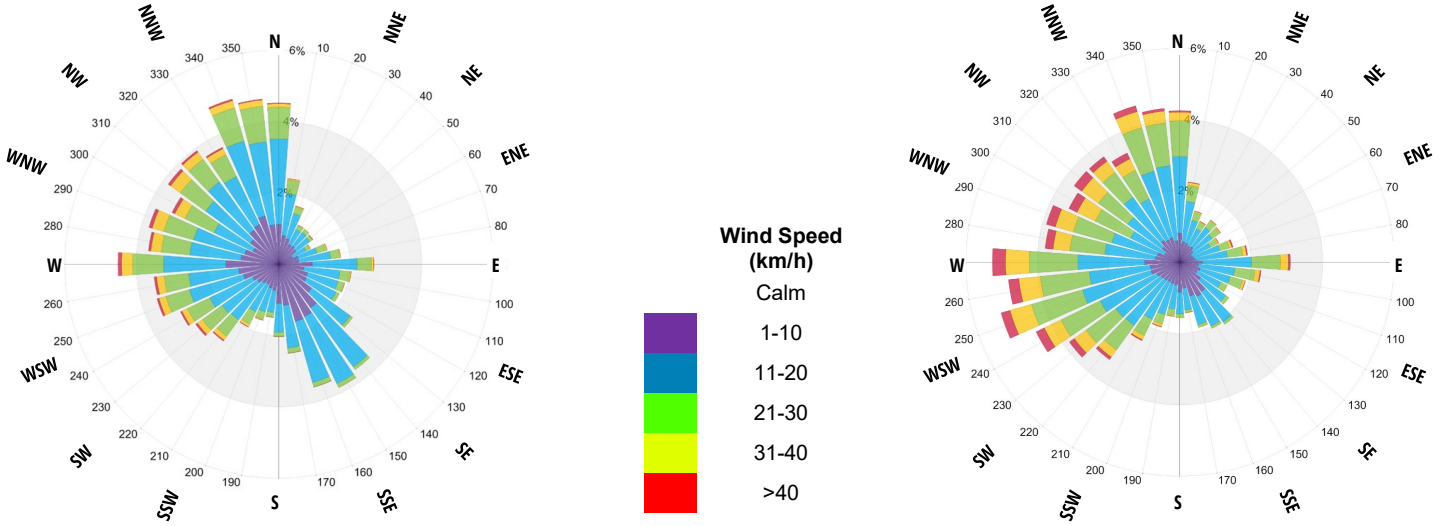


Image 3: Directional Distribution of winds Approaching Toronto Pearson International Airport (1986 – 2018)

4. PEDESTRIAN WIND CRITERIA

The RWDI pedestrian wind criteria are used in the current study. These criteria have been developed by RWDI through research and consulting practice since 1974. They have also been widely accepted by municipal authorities as well as by the building design and city planning community. The criteria are as follows:

4.1 Pedestrian Safety

Pedestrian safety is associated with excessive gust wind speeds that can adversely affect a pedestrian's balance and footing. If strong winds that can affect a person's balance (**90 km/h**) occur more than 0.1% of the time or 9 hours per year, the wind conditions are considered severe.

4.2 Pedestrian Comfort

Wind comfort can be categorized by typical pedestrian activities:

Sitting (≤ 10 km/h): Calm or light breezes desired for outdoor seating areas where one can read a paper without having it blown away.

Standing (≤ 14 km/h): Gentle breezes suitable for main building entrances and bus stops.

Strolling (≤ 17 km/h): Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park.

Walking (≤ 20 km/h): Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.

Uncomfortable: None of the comfort categories are met.

Wind conditions are considered suitable for sitting, standing, strolling or walking if the associate wind speeds are expected for at least four out of five days (80% of the time). Wind control measures are typically required at locations where winds are rated as uncomfortable or they exceed the wind safety criterion.

Note that these wind speeds are assessed at a pedestrian height (i.e., 1.5 m above grade or the concerned floor level), typically lower than those recorded in the airports (10 m height and open terrain).

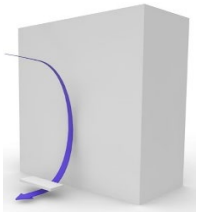
These criteria for wind forces represent average wind tolerance. They are sometimes subjective and regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. can also affect people's perception of the wind climate.

For the current development, wind speeds comfortable for walking or strolling are appropriate for sidewalks; lower wind speeds comfortable for standing are required for building entrances, where pedestrians may linger; and calm wind speeds suitable for sitting are desired in areas where passive activities are anticipated, such as the outdoor amenity areas (i.e. parks, POPS), during the summer season.

5. PREDICTED WIND CONDITIONS

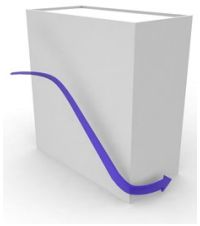
5.1 Wind Flow Around Buildings

In our discussion of wind conditions on and around the proposed Project, reference may be made to the following generalized wind flows (see Image 4a). If these building / wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and *uncomfortable* conditions.



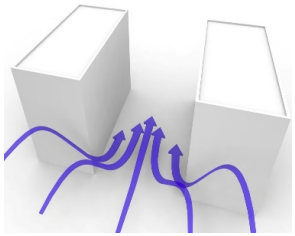
Downwashing

Tall buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level. This is often the main cause for wind accelerations around large buildings at the pedestrian level.



Corner Acceleration

Winds approach at an oblique angle to a tall façade and are deflected down causing a localized increase in the wind activity or corner acceleration around the exposed building corner(s) at pedestrian level.



Channeling

When two buildings are situated side by side, wind flow tends to accelerate through the space between the buildings due to channeling effect caused by the narrow gap.

Image 4a: Generalized Wind Flows

Design details such as; setting back a tall tower from the edges of a podium, deep canopies close to ground level, wind screens / tall trees with dense landscaping, etc. (Image 4b) can help reduce wind speeds. The choice and effectiveness of these measures would depend on the exposure and orientation of the site with respect to the prevailing wind directions and the size and massing of the proposed buildings.

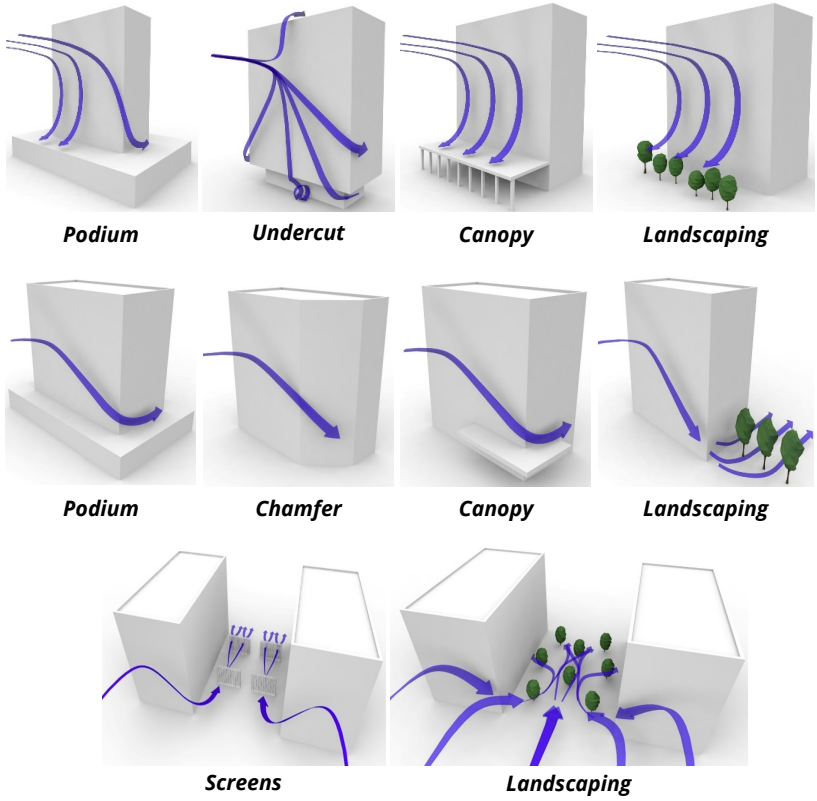


Image 4b: Examples of Common Wind Control Measures

5. PEDESTRIAN WIND CONDITIONS

5.2 Background

Predicting wind speeds and occurrence frequencies is complicated. It involves building geometry, orientation, position and height of surrounding buildings, upstream terrain and the local wind climate. Over the years, RWDI has conducted thousands of wind-tunnel model studies regarding pedestrian wind conditions around buildings, yielding a broad knowledge base. This knowledge has been incorporated into RWDI's proprietary software that allows, in many situations, for a qualitative, screening-level numerical estimation of pedestrian wind conditions without wind tunnel testing.

5.3 Existing Wind Conditions

As mentioned earlier, the project site includes a low-rise mall and the existing surroundings are also mainly low-rise, with the exception of a few isolated tall buildings (Image 5). Due to the low-rise surroundings on and off site, existing wind conditions are generally expected to be relatively calm, and to meet the comfort and safety criteria throughout the year.

Image 5: Existing Buildings on Site

5.4 Wind condition Around Proposed Development

The proposed tall towers of the development are expected to be exposed to the predominant winds considering the relatively low height of the surrounding buildings. Tower A and B of the proposed development will be mainly sheltered from the northwesterly winds by the existing tall building on the northwest side but will be exposed to the westerly and southwesterly winds, which will downwash off the west and south façade of Towers A and B and accelerate at grade level, along Finch Ave. E., Sandhurst Circle and particularly at building corners. Towers C and D will be exposed to the predominant northwesterly and southwesterly winds. These winds are expected to downwash off the north and south façade of these towers and accelerate at grade level along Finch Avenue E. and along the private driveway. The northwesterly winds would also channel through the narrow gap between Towers D and E and accelerate in the alley and building corners.

Towers E and F will be sheltered from the southwesterly winds by the proposed Towers C and D. However, they will be exposed to the northwesterly and westerly winds, that will cause high wind activity at grade level due to downwashing of these winds. Due to the low-rise surroundings, proposed Towers G, H and I would be exposed to all predominant wind directions which will cause high wind activity due to downwashing, corner accelerations and channeling wind flow in the gaps between towers.

A detailed discussion of the predicted wind conditions on and around the proposed development is provided in subsections 5.4.1. to 5.4.5

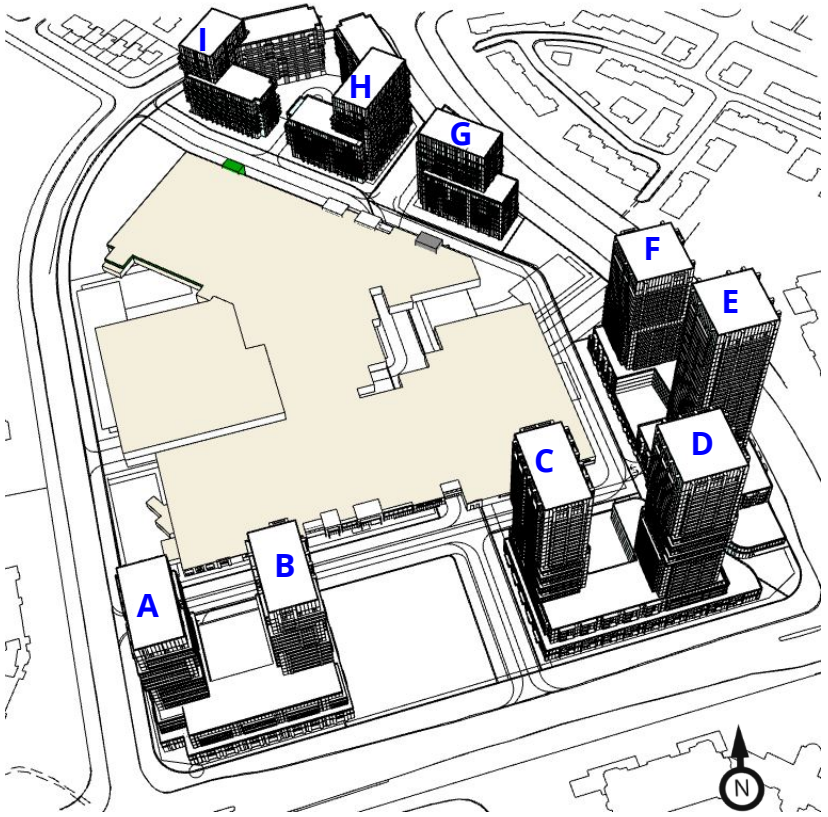


Image 5: Proposed Development

5.4.1 Main Entrances

Main entrances to the proposed development are indicated by blue triangles and marked as E1 through E12 in Image 6. The wind conditions at entrances to Towers H and I (E10 and E11 in Image 6) are expected to be suitable for the intended use, as they are sheltered from the predominant winds by the proposed development. Due to the orientation of the entrances and exposure to the predominant winds, higher than desired wind speeds are predicted at most of the other entrances of the proposed development, particularly during the winter due to the seasonal strong winds.

As general guidelines, entrances should be away from the building corners where high wind activity is typically expected. The proposed development includes some entrances close to the building corners, where higher than desired winds are predicted to occur, particularly at entrances E2, E3, E5, E9 and E12 in Image 6. If feasible, it is recommended to move these entrance away from the corners. In addition, entrances can be recessed into the building façade to achieve further protection from the strong winds.

For the entrances facing the prevailing winds, winds downwashing off the tower facade may be an issue. Horizontal features, such as canopies are beneficial to reduce the impact of downwashing winds. Most of the entrances to the proposed development include individual canopies which is favorable for wind control. If feasible, a canopy above entrance E1 should be considered. It should be noted that canopies should be at least 2m in depth and not more than 15 feet above grade level to be effective for wind control.

Additional wind control measures in the form of coniferous/ marcescent landscaping, vertical porous wind screens near the entrances can be considered for improved wind conditions. Examples of these are shown in Image 7.

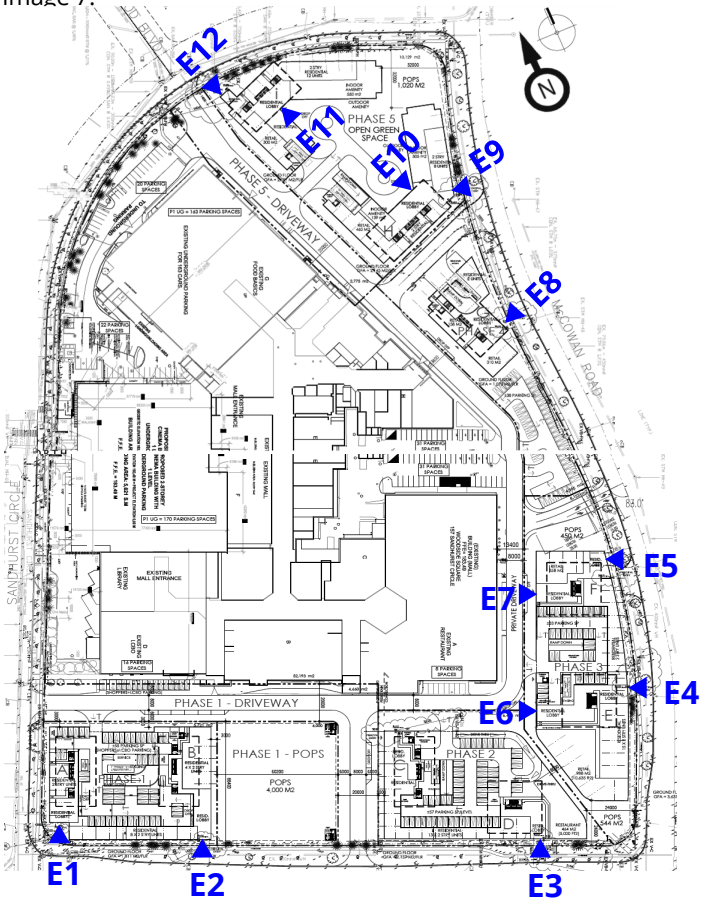
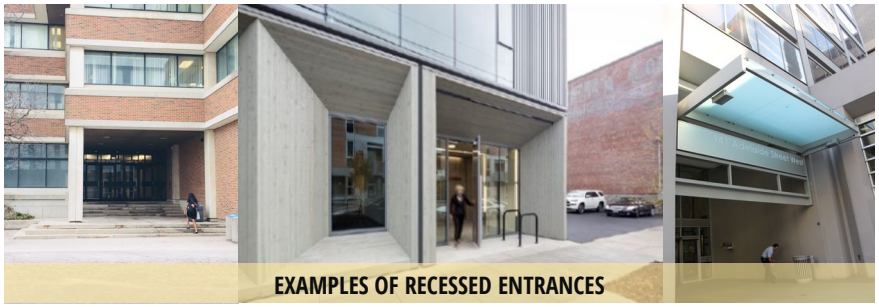
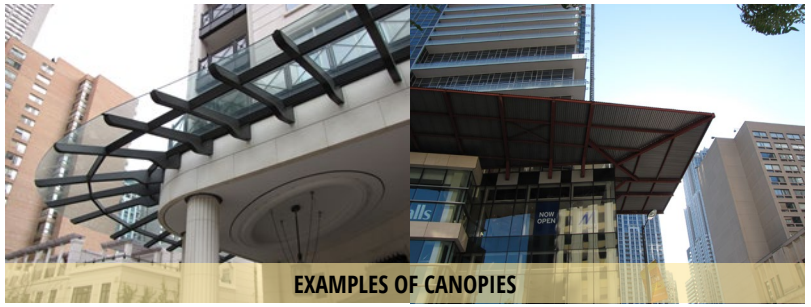


Image 6: Main Entrance Locations of the Proposed Development

5. PEDESTRIAN WIND CONDITIONS

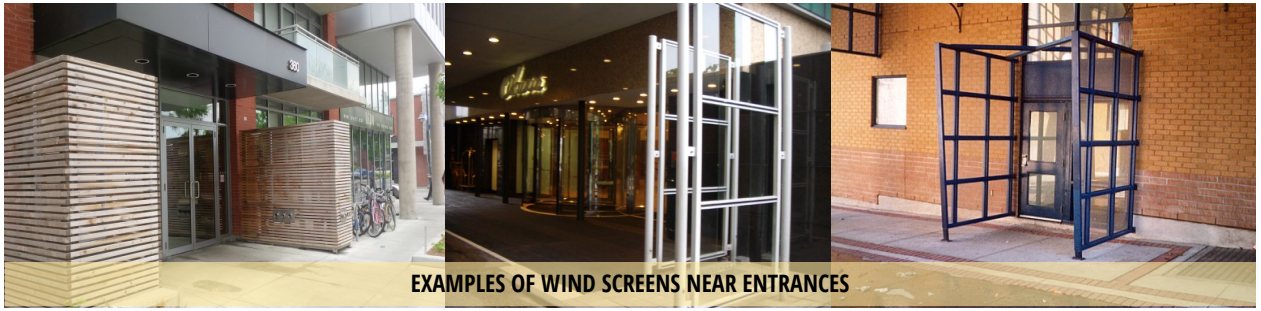


EXAMPLES OF RECESSED ENTRANCES



EXAMPLES OF CANOPIES

EXAMPLES OF LANDSCAPING NEAR ENTRANCES



EXAMPLES OF WIND SCREENS NEAR ENTRANCES

Image 7: Examples of Mitigation Measures

5.4.2 Building Perimeters and On-site Open Spaces/ POPS

Predicted wind comfort conditions around the project perimeter are graphically shown in Images 8 and 9 for summer and winter respectively. During the summer, calm wind conditions conducive to sitting or standing are predicted in the areas close to the existing mall. Due to the downwashing, channeling and corner accelerations described earlier, higher wind speeds conducive to strolling or walking are predicted at a few building corners and open spaces of the proposed development (Image 8).

During the winter, due to the seasonally stronger winds, moderate wind speeds comfortable for strolling or walking are predicted in the areas near the existing mall and some sidewalk locations along McCowan Road that are sheltered form the predominant winds. Uncomfortable and/or potentially unsafe wind conditions are expected at many building corners/ open spaces (Image 9). Proposed landscaping on-site is a positive design feature which will be beneficial to improve the overall wind comfort conditions at grade level during the summer. If the benefit of landscaping is desired during the winter, evergreen/marcescent trees can be considered as they retain their foliage throughout the year.

The proposed development also includes re-entrant corners for Towers A, B, G, H and I which is a positive design feature that would help reduce the impact of corner accelerations and should be retained in the final design.

Moderate wind speeds generally comfortable for strolling or walking are expected at the proposed POPS and open spaces throughout the year. Theses conditions are not suitable for passive activities. The use of tall dense landscaping in the POPS and open spaces will be beneficial to achieve desired wind conditions during the summer, when these areas are expected to be used frequently.

5.4.3 Sidewalks

Wind conditions along the sidewalks of Sandhurst Circle is generally predicted to be similar to the existing conditions. Higher wind speeds will likely occur near the intersection of Sandhurst Circle and Finch Avenue East and near the intersection of McCowan Road and Finch Avenue E., due to the addition of the proposed buildings. The sidewalks along McCowan Road will mostly be sheltered from the predominant winds by the proposed buildings, however as mentioned earlier, high wind activity on the sidewalks close to building corners are expected. The resultant wind speeds are still predicted to be suitable for the intended use throughout the year.

Due to the downwashing of the strong southwesterly winds, potentially uncomfortable or unsafe wind conditions are expected along the sidewalks of Finch Avenue East, particularly during the winter. To improve these wind conditions recommendations are described on Page 12.

5. PEDESTRIAN WIND CONDITIONS

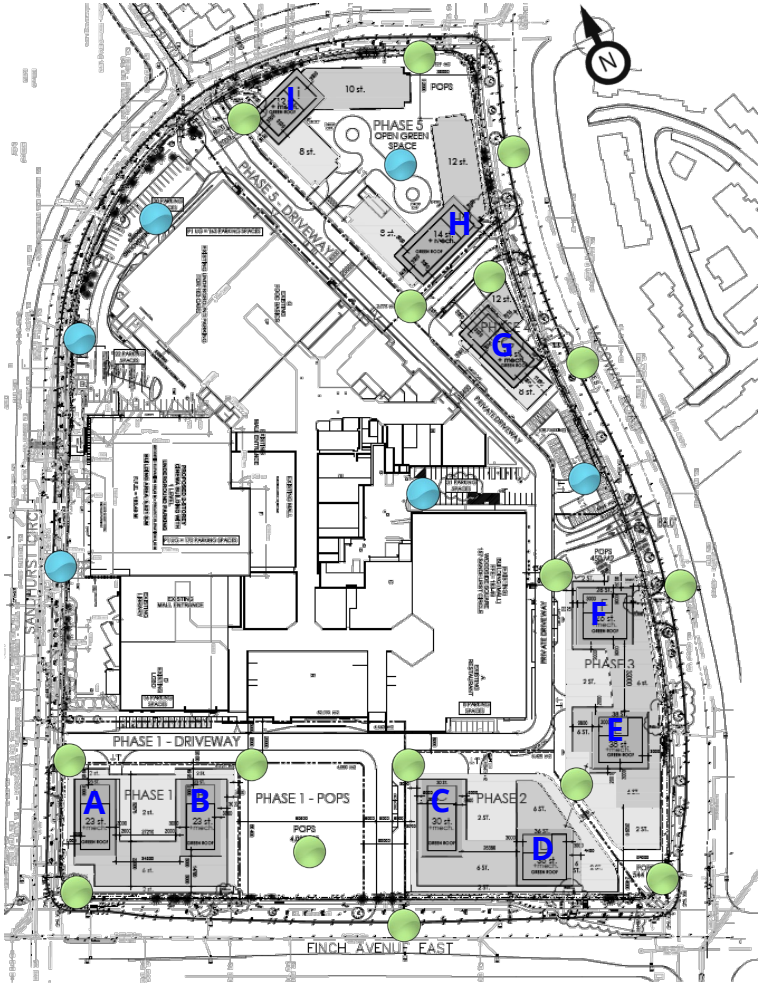


Image 8: Predicted Wind Conditions - Summer

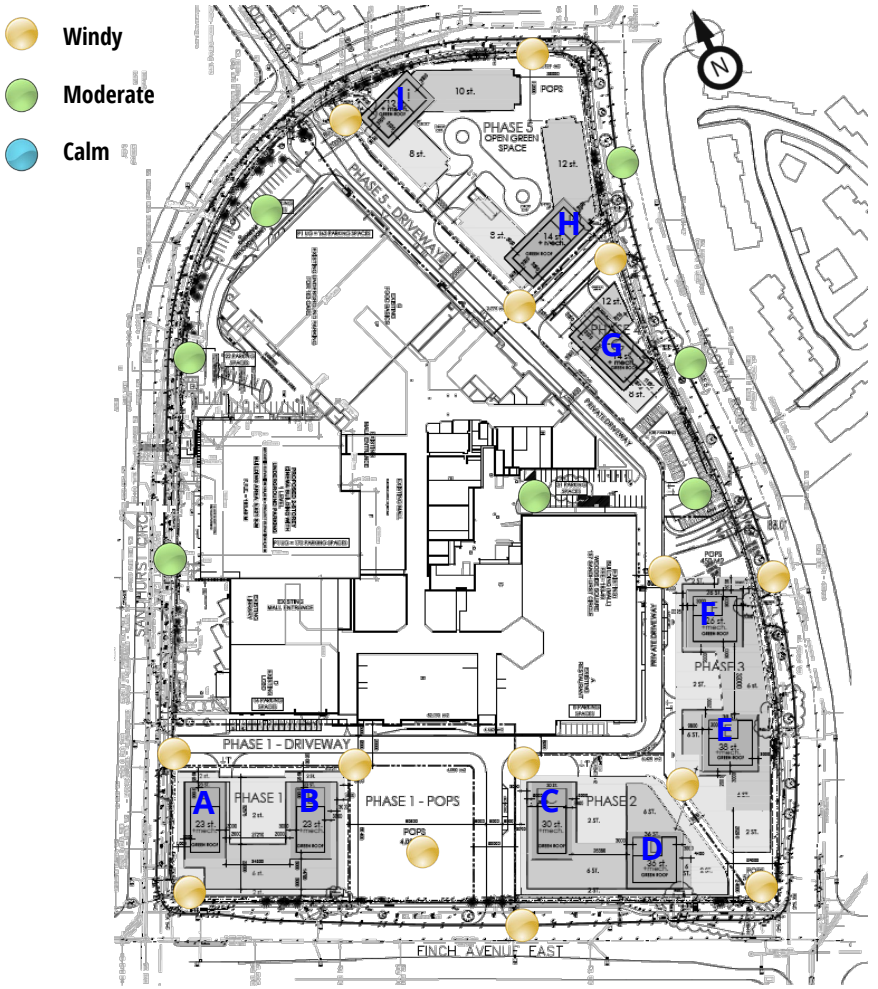


Image 9: Predicted Wind Conditions - Winter

5. PEDESTRIAN WIND CONDITIONS

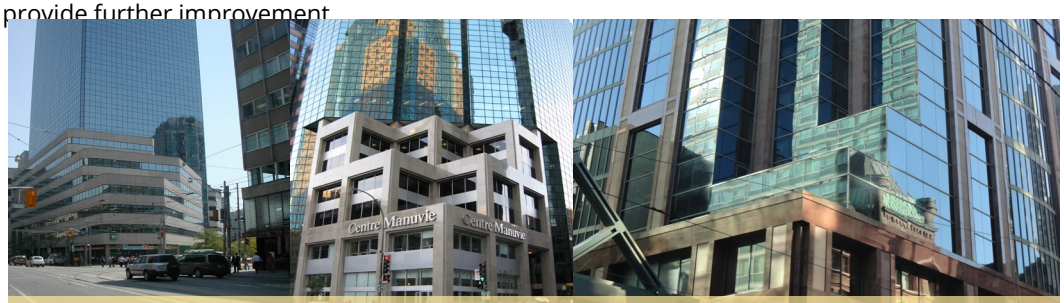
The project will be designed to include canopies around the base of the perimeters of the towers. The implementation of horizontal features such as canopies, are beneficial for favourable wind speeds as they help reduce the impact of downwashing winds. The canopies should be at least 2 m deep and at a height not taller than the first floor to be effective.

Other localized measures for wind improvement may include an arcade/colonnade around the base to provide alternate sidewalk route during windy conditions or coniferous or marcescent landscaping and localized wind breaks (screens) along the sidewalks and at exposed building corners. The efficacy of these measures will be validated through wind tunnel testing at an appropriate stage of the design.

The most effective approach will likely include the implementation of a combination of the above measures throughout the site. If necessary, some design changes (chamfered corners, rounded edges, stepped setbacks etc.) may be explored during the wind tunnel testing phase to provide further improvement.

EXAMPLES OF CONIFEROUS/ MARCESCENT LANDSCAPING

EXAMPLES OF COLONNADE



EXAMPLES OF STEPPED PODIUM FAÇADE, TOWER SETBACKS

5.4.5 Podium Roof Amenity

There is potential for above-grade terraces and amenity areas throughout the development. Rooftop areas are typically windy due to their elevation and exposure. The most common wind control measures are tall perimeter screens and parapets.

While podiums and setbacks are positive measures for reducing the wind impact at ground level, increased wind speeds are expected for podium terraces. The actual speeds vary with the exposure, locations, sizes and elevations of these areas.

In the event that undesirable conditions occur, taller perimeter screens, privacy fences and landscaping may be incorporated to provide sheltering for amenity users. Podium terraces may also be affected by vertical winds that are deflected down by the building façade. Therefore, wind control measures may also include overhead protection provided by trellises and canopies.

Image 11 provides a few examples of wind control features.

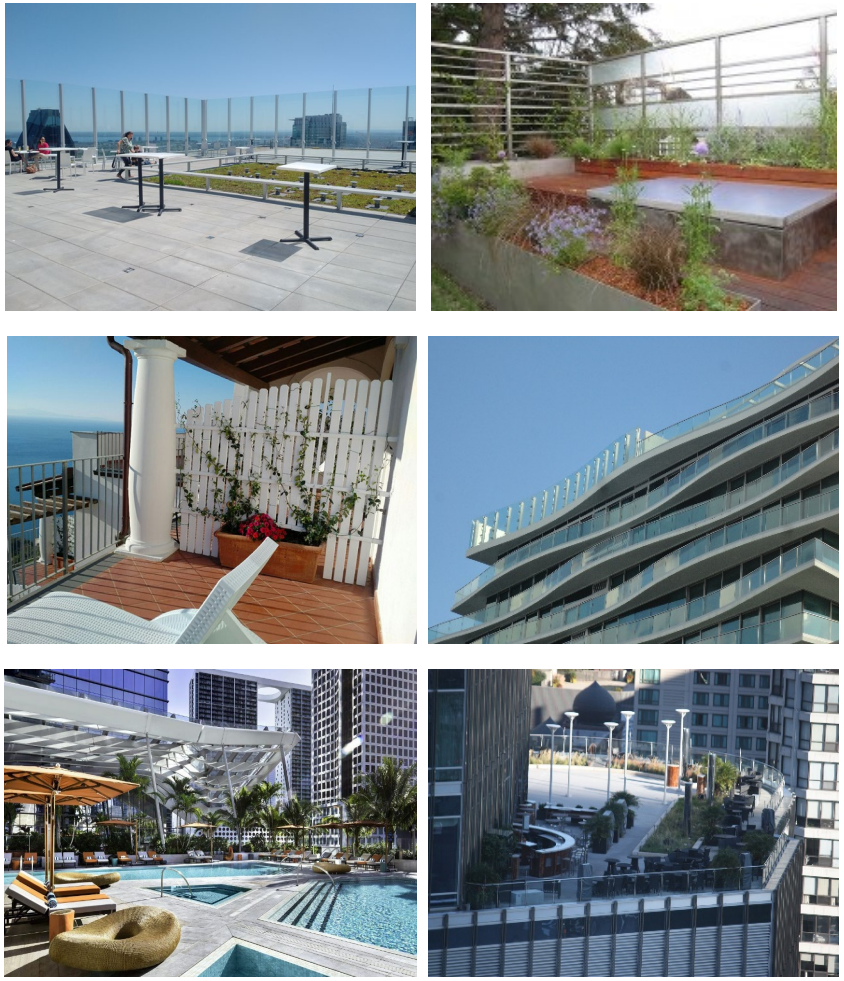


Image 11: Examples of Mitigation Measures for Above-grade Amenity Spaces

6. SUMMARY

Wind conditions on and around the proposed development of Woodside Centre development in Scarborough, ON are assessed in this report, based on the local wind climate, surrounding buildings and RWDI's past experience with wind tunnel testing of similar buildings.

The proposed development includes some positive design features such low-height podium structures, re-entrant building corners and canopies above entrances.

Given the high elevations of the proposed buildings and low-rise surroundings, the proposed development will be exposed to the prevailing winds in most areas.

Wind conditions on and around the proposed development are expected to increase but should still be suitable for the intended use in most areas during the summer. During the winter, higher than desired wind speeds are predicted at several entrances and building corners and sidewalks at grade level.

High wind activity is also expected at the podium rooftop areas of the proposed development. If these areas are used as amenity spaces, wind control measures will be required. Wind control features have been recommended for windy areas which can be applied if more comfortable conditions at these areas are desired.

Strong wind gusts (potentially unsafe) are predicted at exposed building corners and at located areas between the towers due to exposure to strong prevailing winds particularly in the winter. These conditions are expected to be improved with addition of the proposed canopies around the base of the towers.

Wind tunnel is recommended at an appropriate stage of the design to confirm the predicted conditions and the efficacy of proposed mitigation measures as well as to develop appropriate measures for wind improvement where needed.

7. APPLICABILITY OF RESULTS

The assessment presented in this report is for the proposed Woodside Centre development in Scarborough, ON based on the design drawings and documents received from Graziani+Corazza Architects on January 30 and February 5, 2020. In the event of any significant changes to the design, construction or operation of the building, or addition of surroundings in the future, RWDI could provide an assessment of their impact on the pedestrian wind conditions discussed in this report. It is the responsibility of others to contact RWDI to initiate this process.