REPORT

150 RUTLEDGE ROAD

MISSISSAUGA, ONTARIO

PEDESTRIAN WIND COMFORT ASSESSMENT

PROJECT #2307122

Completed: September 1, 2023

Updated: December 22, 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 150 Rutledge Road in Mississauga, Ontario. The objective of this assessment is to provide an evaluation of the potential wind impact of the proposed development in support of the upcoming Official Plan Amendment (OPA) and Zoning By-Law Amendment (ZBA) submission.

The project site is located at 150 Rutledge Road between Tannery Street and Ontario Court, surrounded by low-rise suburban neighbourhoods and commercial development, dense woods and some open fields in all directions. A few taller buildings (up to seven storeys) exist in the immediate vicinity of the site to the east (Image 1).

The project is a residential development that will consist of a 10-storey building with an outdoor courtyard planned on the south side. The building will have a stepped form, which is favourable for reducing wind impacts (Image 2).

In addition to sidewalks and properties near the project site, key areas of interest for this assessment include the main entrances to the building and the courtyard area at the rear of the building (Image 3).

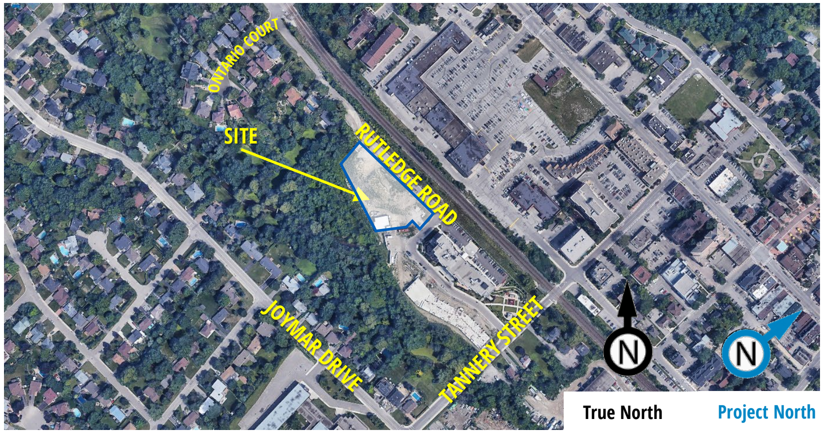

Image 1: Aerial view of the existing site and surroundings
Source: Google Maps

Image 2: Conceptual massing of the proposed project
(Information provided to RWDI in August 2023)

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1. INTRODUCTION

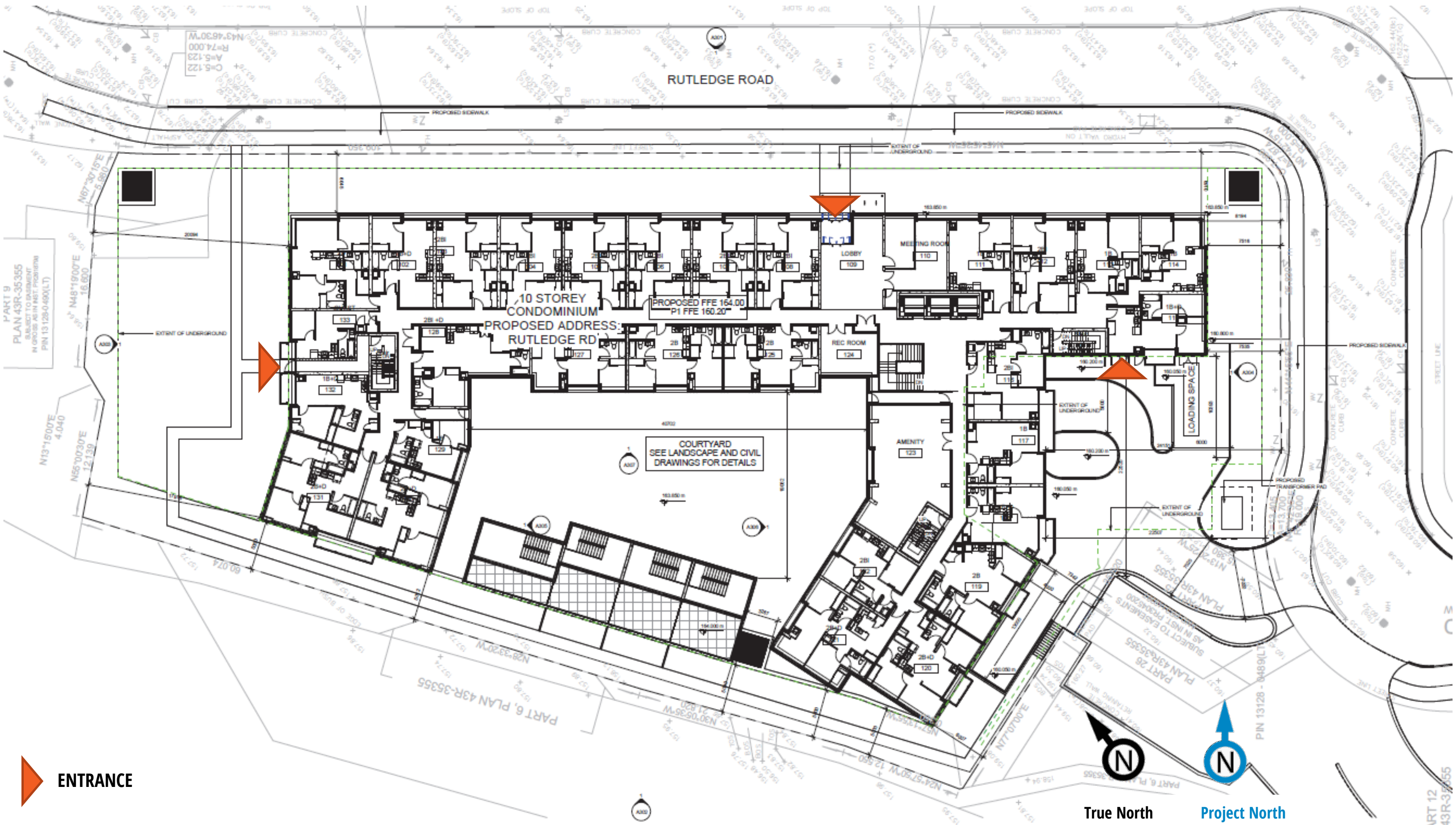


Image 3: Ground floor plan identifying key outdoor areas of interest (Information provided to RWDI in August 2023)

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 Toronto Pearson International Airport;
- The use of *Orbital Stack*, an in-house CFD tool;
- CFD simulations completed in September 2023 using computer models created from drawings of the proposed project received on August 3, 2023, and 3D model received on August 14, 2023;
- Qualitative and experience-based review of updated architectural plans received on December 21, 2023;
- RWDI's engineering judgment, experience, and expert knowledge of wind flows around buildings[1-3]; and,
- The City of Mississauga 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 flows in complex environments. For this analysis, CFD techniques were used to generate a virtual wind tunnel where flows around the site and its surroundings were simulated in full scale. The computational domain that covered the site and its surroundings was divided into millions of small cells where calculations were performed, yielding a prediction of wind conditions across the entire study domain. CFD excels as a tool for wind modelling, presenting early design advice, comparing different design and site scenarios, resolving complex flow physics, and helping diagnose problematic wind conditions.

While the computational modelling method used in the current assessment does not explicitly simulate the transient behaviour of turbulent wind, its effects were estimated based on other calculated quantities. RWDI has found this approach to be appropriate for the assessment of typical wind comfort conditions. Wind safety issues, which relate to transient, higher-speed gusts, are discussed qualitatively, based on the CFD predictions and our extensive wind-tunnel experience for similar projects.

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.

2.3 Simulation Model

CFD simulations were completed for two scenarios:

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

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 1.5 m above concerned levels, to the mean wind speed at a reference height. The data was then combined with meteorological records obtained from Toronto Pearson International Airport to determine the wind speeds and frequencies in the simulated areas.

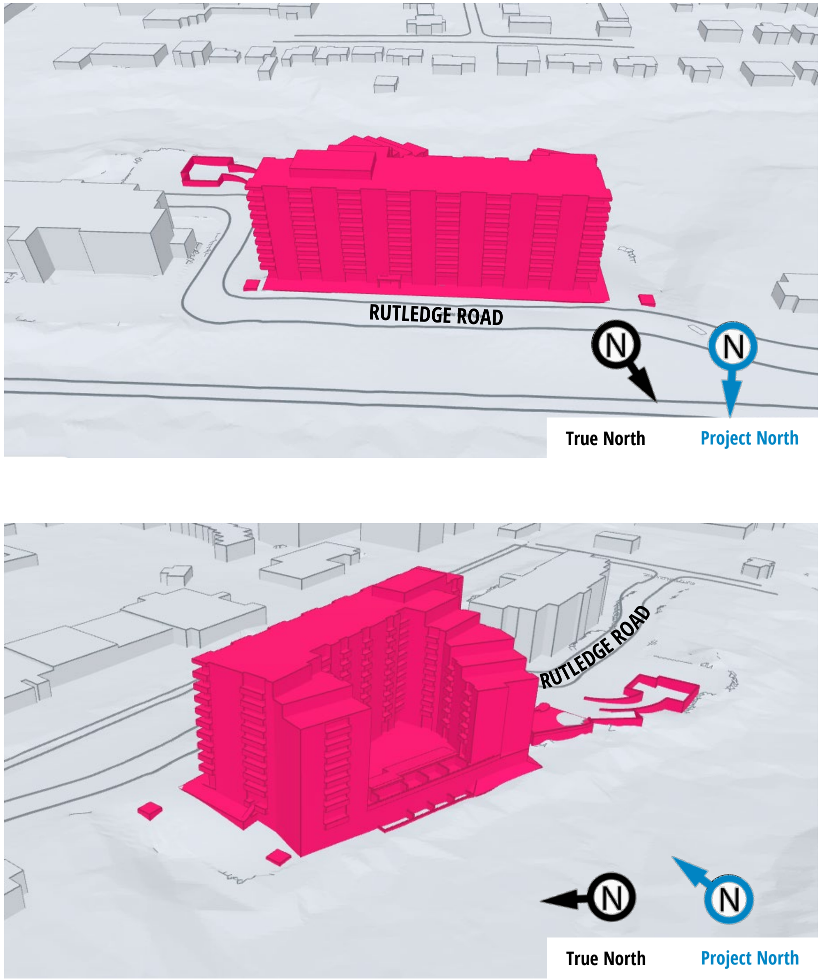


Image 4: Computer model of the proposed project

2. METHODOLOGY

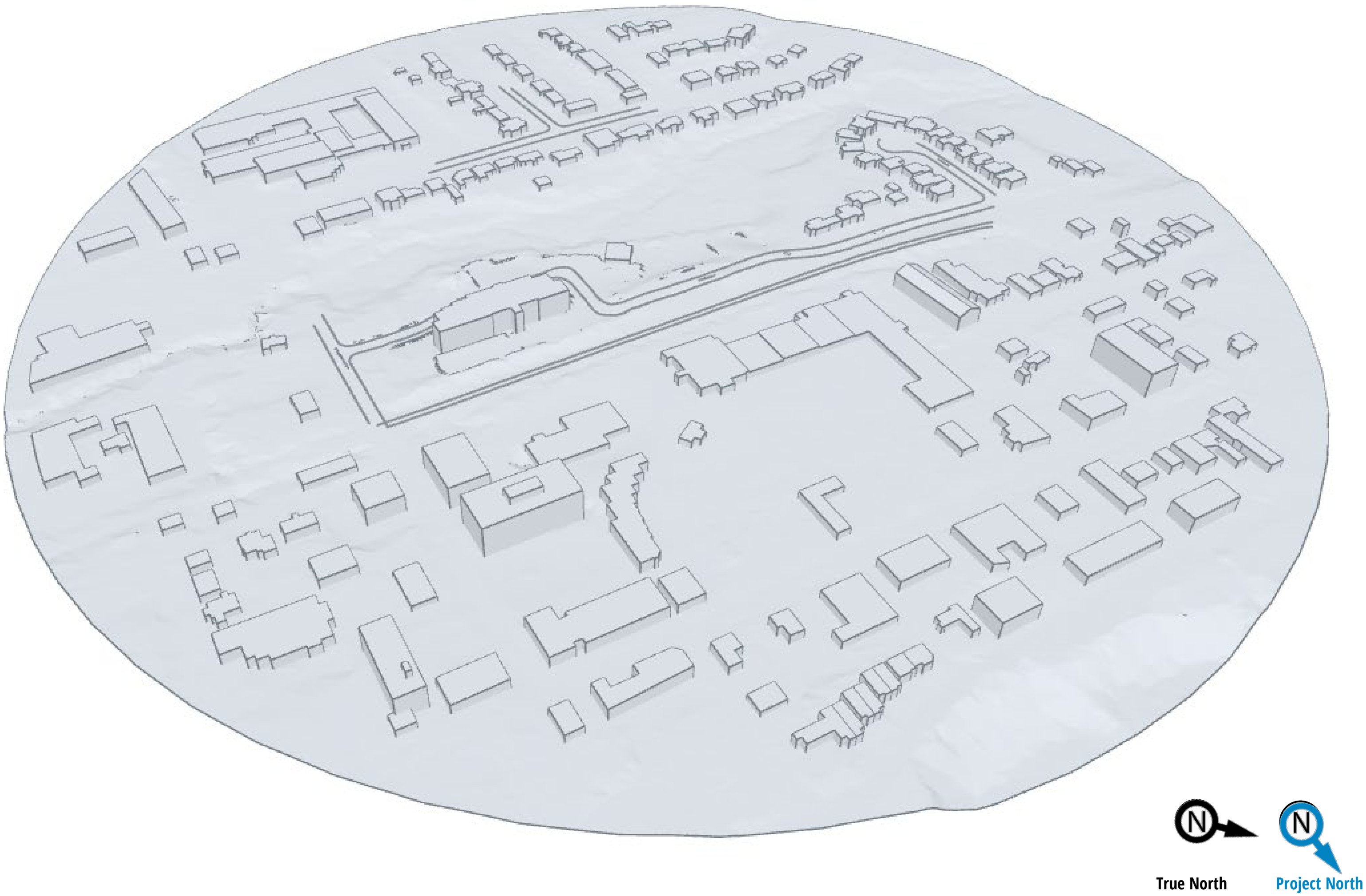


Image 5a: Computer model of the existing site and extended surroundings

2. METHODOLOGY

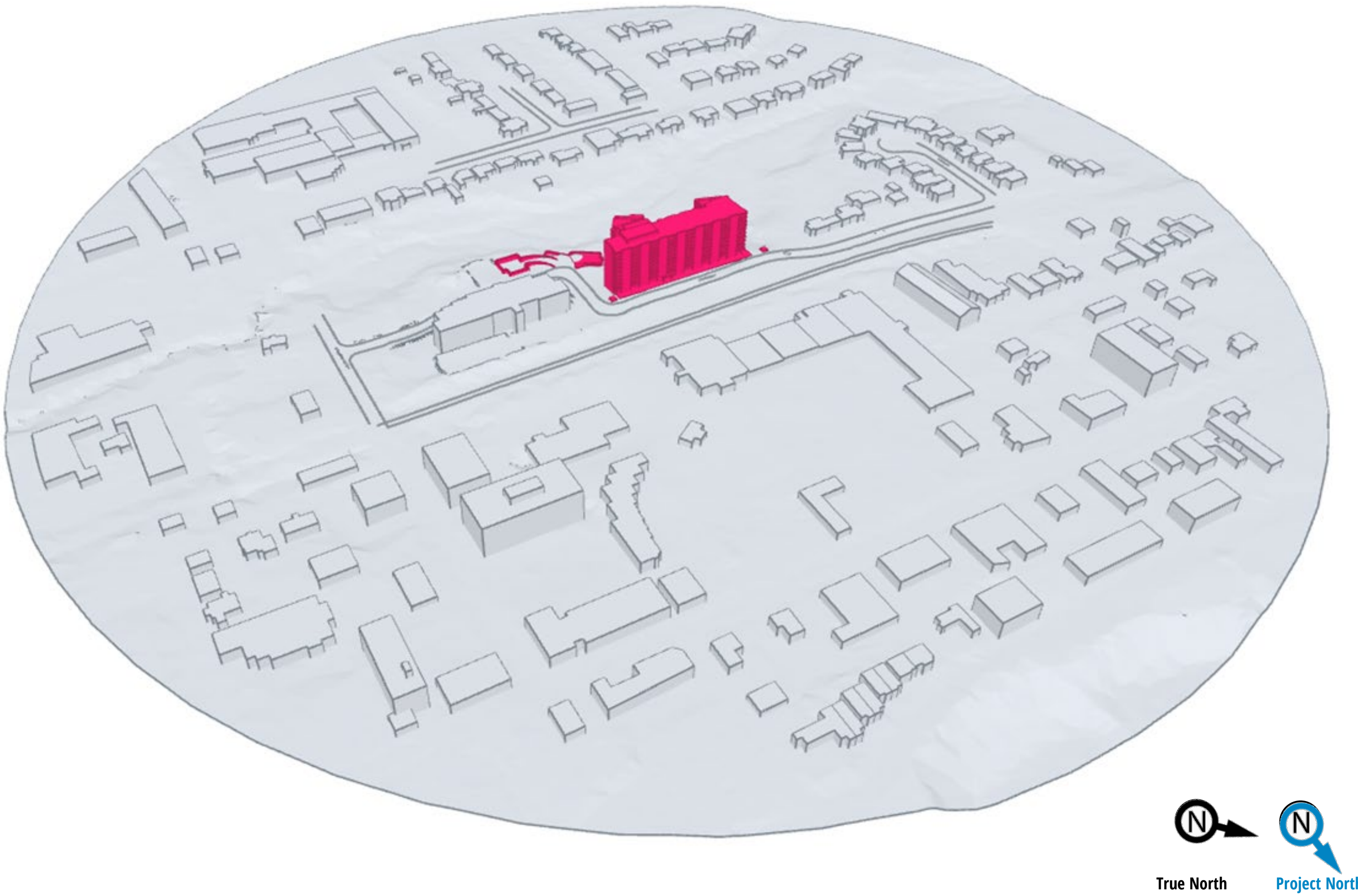


Image 5b: Computer model of the proposed project and extended surroundings

2.4 Meteorological Data

Long-term wind data recorded at Toronto Pearson International Airport between 1992 and 2022, 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 and winter, winds from the southwest through the north directions are predominant, with secondary frequent winds from the southeast quadrant in the summer and from the east in the winter.

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

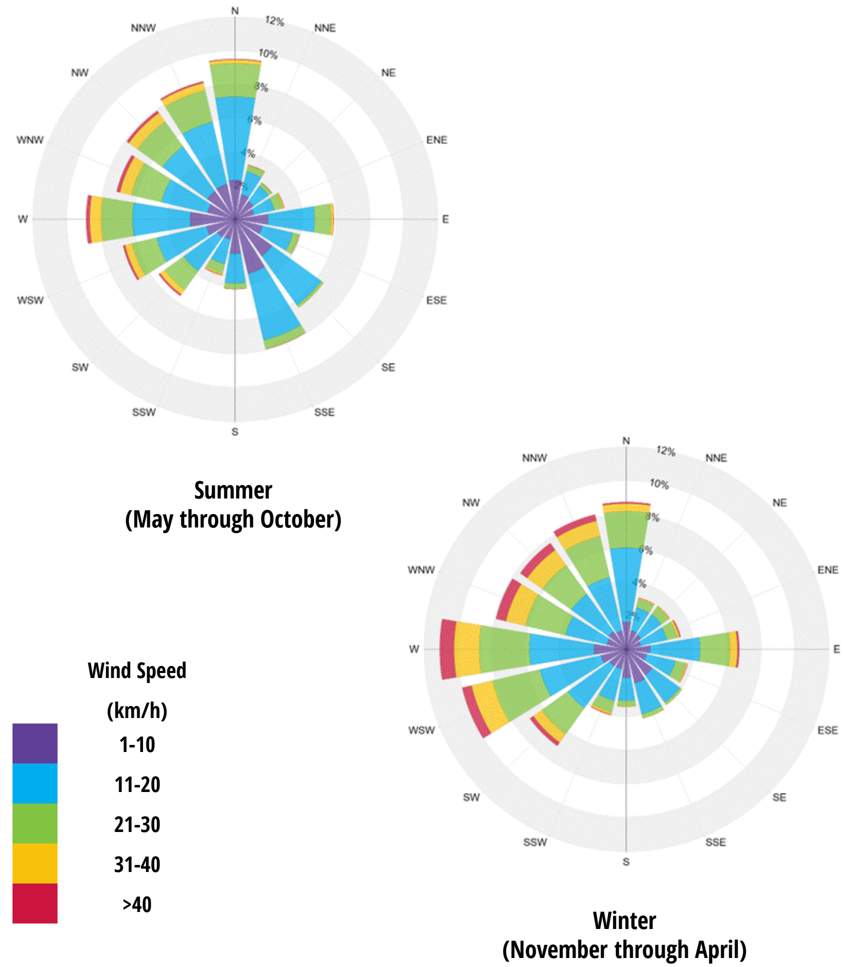


Image 6: Directional distribution of wind approaching Toronto Pearson International Airport (1992 to 2022)

3. WIND CRITERIA

The Mississauga pedestrian wind criteria, updated in February 2023, are specified in the Urban Design Terms of Reference, “Pedestrian Wind Comfort and Safety Studies”. The criteria are as follows:

3.1 Pedestrian Comfort Criteria

Wind comfort can be categorized by typical pedestrian activities:

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

Standing (≤ 15 km/h): Gentle breezes suitable for main building entrances and bus stops.

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

Uncomfortable (>20 km/h): Strong winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended.

Wind conditions are considered suitable for sitting, standing or walking if the associated mean 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 exceed the wind safety criterion.

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

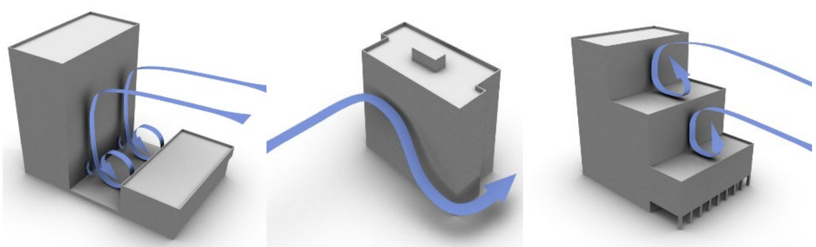
3.2 Pedestrian Safety Criterion

Pedestrian safety is associated with excessive gust 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. RESULTS AND DISCUSSION

4.1 Wind Flow around Buildings

Wind generally tends to flow over buildings of uniform height, without disruption. Buildings that are taller than their surroundings tend to 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*. Stepped 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.



Downwashing   Corner Acceleration   Stepped massing and low roofs

Image 7: General wind flow patterns

4.2 Presentation of Results

The results of the assessment are presented and discussed in detail in Sections 4.3 and 4.4. Images 8 and 9 are the predicted seasonal wind conditions at grade for the Existing and Proposed configurations, respectively. The graphical presentation is in the form of colour contours of wind speeds calculated based on the wind comfort criteria (Section 3.1), approximately 1.5 m above the concerned levels. The assessment against the safety criterion (Section 3.2) was conducted qualitatively based on the predicted wind conditions and our extensive experience with wind tunnel assessments. The discussion also includes recommendations for wind control, where necessary, to reduce the potential for high wind speeds for the design team's consideration.

Target Conditions

For the current development, wind speeds comfortable for walking 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 or standing 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.

4.3 Existing Scenario

The existing site is currently vacant and is immediately surrounded by low-rise suburban neighbourhoods and commercial development, dense woods and some open fields in all directions, except for a few taller buildings near the site to the east. Wind conditions at most areas in the existing scenario are considered comfortable for standing or walking in the summer (Image 8a) and generally comfortable for walking in the winter (Image 9a). Uncomfortable wind conditions do occur in the winter, typically near the corners of the mid-rise buildings and large open areas (like the existing site) where strong wind tends to accelerate.

These wind conditions are primarily driven by seasonally stronger winds and are the result of the site exposure to the prevailing westerly winds. Wind conditions at all areas near the project site are expected to meet the safety criterion.

4.4 Proposed Scenario

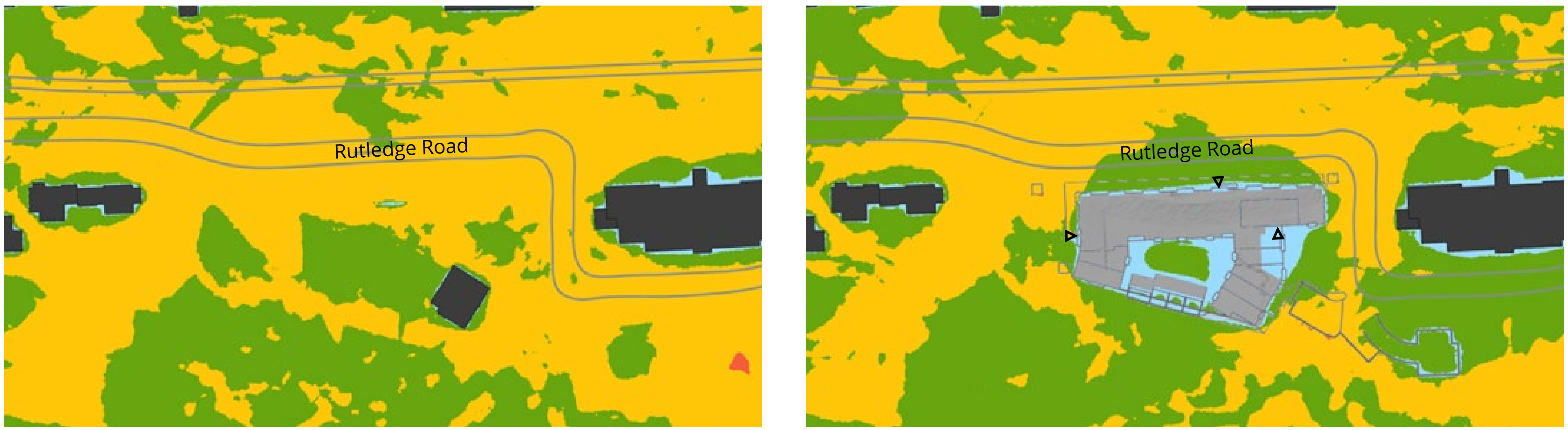
Project North is towards Rutledge Road and about 45-degrees off from True North. In the discussion that follows, references to wind directions are based on True North, while references to buildings features are based on Project North.

The proposed development at 10 storeys, will be taller than the buildings in the surrounding area. The project is expected to redirect winds around it; however, potential wind impacts would be moderated by the stepped massing, façade projections and orientation of the different facades of the proposed building. These details help create multiple disruptions for the wind flow that is redirected around the building. While the introduction of a relatively tall building in a low-rise context will result in an increase in wind speeds around it, these details also help reduce speeds in areas immediately around the building perimeter, and in some areas downwind of the building (east) relative to the predominant westerly winds.

With the proposed development in place, wind conditions in the immediate surroundings and around the building perimeter are expected to be comfortable for sitting or standing in the summer, with conditions remaining comfortable for standing or walking in the extended surroundings (Image 8b).

During the winter, wind speeds conducive to sitting or standing are anticipated along the building perimeter, with conditions comfortable for walking in most other areas on and around the site. Due to seasonally stronger winds, uncomfortable conditions are expected near the northwest building corner and in some areas in the extended surroundings similar to the existing scenario (Image 9b).

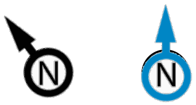
Wind conditions in the courtyard and near the main entrances are expected to be comfortable for sitting or standing throughout the year, which is considered appropriate for the intended use (Images 8b and 10b).



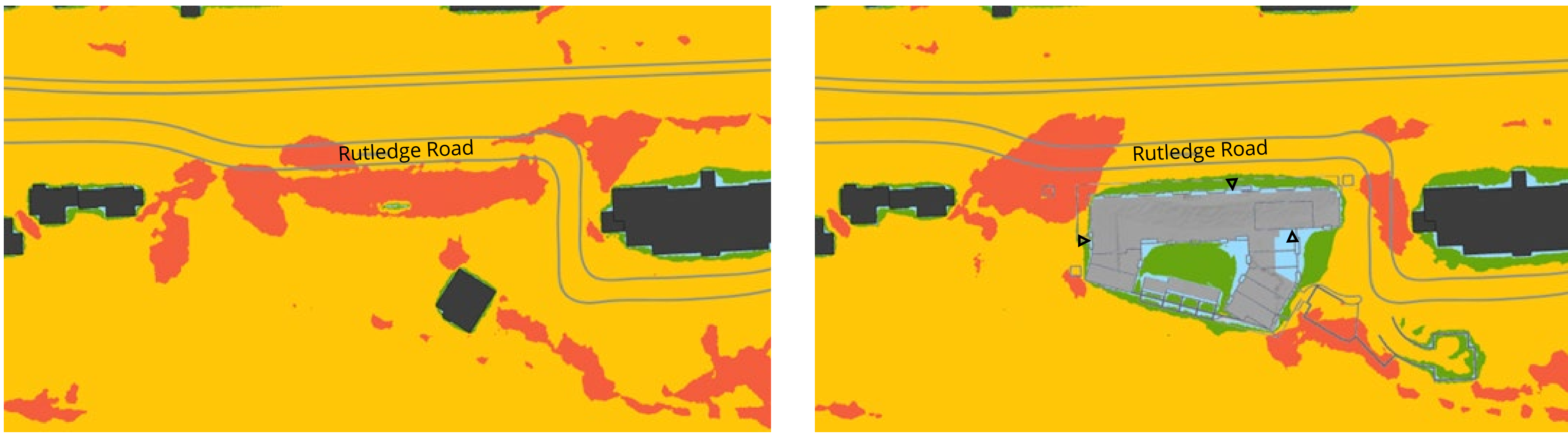
(a) EXISTING **(b) PROPOSED**

Image 8: Predicted wind conditions – GROUND LEVEL – SUMMER

COMFORT: SITTING | STANDING | WALKING | UNCOMFORTABLE



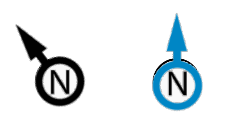
True North Project North



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

Image 9: Predicted wind conditions – GROUND LEVEL – WINTER

COMFORT: SITTING | STANDING | WALKING | UNCOMFORTABLE



True North Project North

4. RESULTS AND DISCUSSION

The pedestrian wind safety criterion is expected to be met at all areas assessed, however, due to the site exposure, wind gusts approaching speeds close to the criterion threshold are likely near the northwest corner of the proposed building on windy days during the winter months.

The uncomfortable wind conditions near the northwest building corner are driven by westerly winds intercepted by the buildings massing, and redirected down to grade level, these winds subsequently accelerate around exposed building corners (Images 10 and 11).

Following the initial CFD assessment based on design information provided to RWDI in August 2023, RWDI received updated architectural plans on December 21, 2023. The new drawings reflect the addition of a deep overhead horizontal feature wrapping around the northwest corner above the first floor (see Image 12). This proposed addition will help disrupt flows accelerating vertically and around that corner to and likely result in reduced wind speeds immediately around that corner.

To extend the wind control benefits across a larger area around the northwest corner, RWDI recommends the consideration of vertical wind control measures such as wind screens, and evergreen landscaping features on the west (narrower) side of the building and around the northwest corner to disturb the wind acceleration in the area. For these elements to be effective, a minimum height of 2 m and porosity of 20-30% are recommended. These features may be interspersed in the area and should be oriented perpendicular to the north façade of the building. Note that landscaping features are only effective when they are in full foliage. Thus, to extend the wind benefits of landscaping to winter, coniferous/marcescent species should be considered.

Some examples of wind control features are shown in Image 13. RWDI can help guide the placement of wind control features to achieve appropriate levels of wind comfort based on the programming of the various outdoor spaces. The effectiveness of wind control features can be confirmed though quantitative assessments at a later design stage.

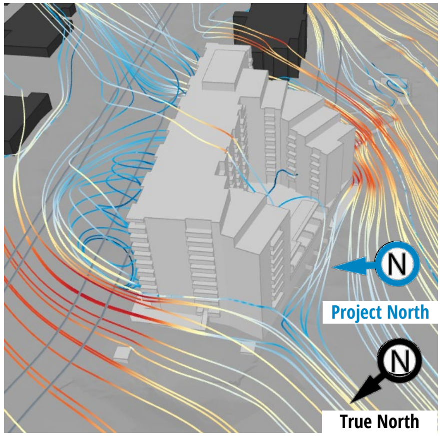


Image 10: Streamlines of winds approaching from W (270º)

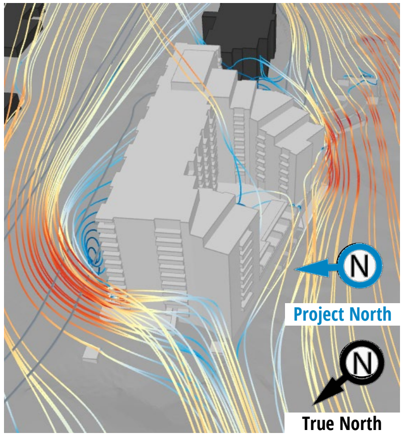
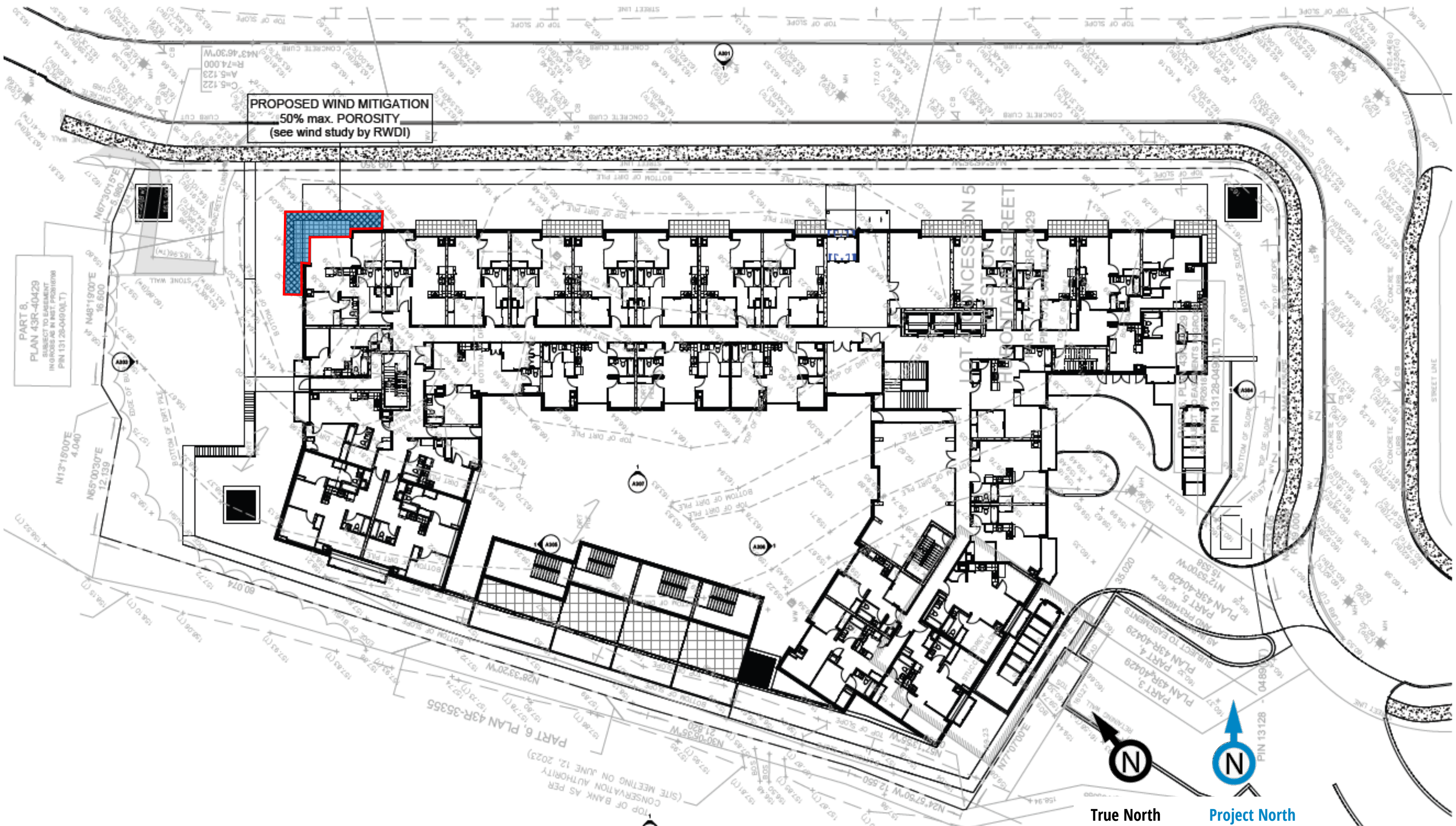


Image 11: Streamlines of winds approaching from WNW (292º)

4. RESULTS AND DISCUSSION



PROPOSED WIND CONTROL FEATURE

Image 12: Updated ground floor plan identifying wind control feature (Information provided to RWDI on December 21, 2023)

4. RESULTS AND DISCUSSION

Image 13: Design strategies for wind control at grade level

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed project at 150 Rutledge Road in Mississauga, 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 City of Mississauga wind criteria for pedestrian comfort and safety. Our findings are summarized as follows:

- In the existing configuration, wind conditions on and around the project site are expected to be appropriate for the intended pedestrian use at all areas assessed, apart from localized of uncomfortable conditions on and off-site in the winter. The pedestrian safety criterion is expected to be met at all areas assessed.
- The proposed building is taller than its surroundings, and therefore will redirect wind to ground level. However, some features in the massing form will help moderate wind impacts at grade level.
- Wind conditions at ground level, including the areas near the main entrances and courtyard, are expected to be appropriate for the intended usage.
- Potentially uncomfortable wind speeds are expected near the northwest building corner in the winter.
- The pedestrian wind safety criterion is expected to be met all areas assessed in the proposed configuration; however, wind gusts reaching speeds closer to the criterion threshold are expected to occur on windy days, mainly during the winter months.
- The project is not expected to have a notable influence on wind conditions on other properties.
- Following the initial assessment, RWDI received updated architectural plans, indicating the addition of a new overhead horizontal feature wrapping around the northwest corner above the first floor. This feature is expected to reduce corner accelerations of wind locally.
- Recommendations have been provided to extend wind mitigation impacts to a larger area around the northwest corner.
- Further testing can be conducted to quantify the impact of the proposed overhead feature, and any additional wind control features on wind conditions around the site.

6. DESIGN ASSUMPTIONS

The findings/recommendations in this report are based on the building geometry and architectural drawings communicated to RWDI between August and December 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)
A103 - Site Ground Plan	PDF	08/03/2023
Vic 2	Revit	08/14/2023
231221 Architectural	PDF	12/21/2023

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 Glen Schnarr & Associates Inc. ("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.