REPORT

RIVERFRONT COMMUNITY PHASE II- BLOCK A05

NIAGARA FALLS, ONTARIO

PEDESTRIAN WIND COMFORT ASSESSMENT

PROJECT #2206772
September 13, 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 Block A05 of Riverfront Community Phase II in Niagara Falls, Ontario. The objective of this assessment is to provide an evaluation of the potential wind conditions around the proposed development.

The project site (Image 1) seats on a currently undeveloped land to the east side of Dorchester Road between the existing Conrail Drain and railways. The study buildings are two 7-storey (31 m) tall senior care homes that are connected with a 1-storey structure. The study buildings are part of a masterplan that includes condo and retail buildings to the west and northeast of the site (Image 2). There is a one taller hotel building (12-storey) at the northwest corner of the site (Block A02 in Image 1) which RWDI has already conducted a separate wind tunnel study in July 2023 for its potential wind impact.

Main building entrances are identified in Image 3, as they are one of the key areas of interest beside nearby sidewalks/walkways and parking spaces.

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

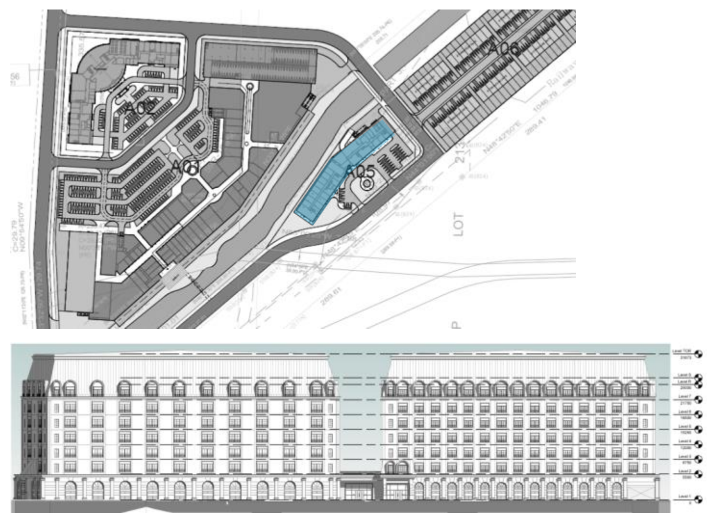


Image 2: Project master plan (top image), south elevation view (bottom image) (Courtesy of GR-GP)

1. INTRODUCTION

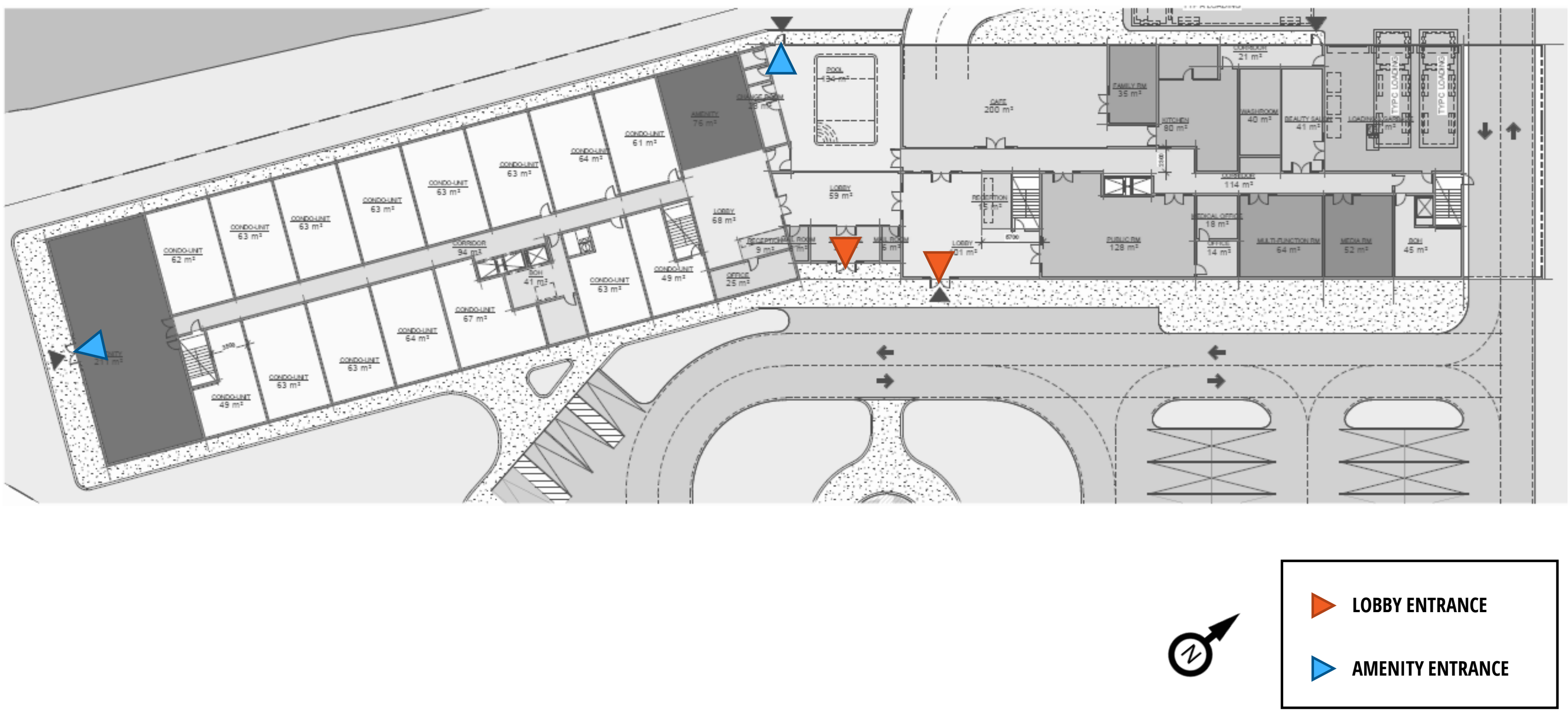


Image 3: Ground floor plan identifying building entrances (Courtesy of GR-GP)

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 Niagara Falls International Airport;
- 3D e-model of the proposed project received on August 30, 2023, and site plans received on September 1, 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 wind comfort and safety criteria for Niagara Region (dated July 2022),

Note that other wind related issues such as 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 boundary-layer wind tunnel or transient computational modelling.

2. METHODOLOGY

2.3 Simulation Model

CFD simulations were completed for the proposed scenario. The computer model of the proposed buildings is shown in Image 4. The Proposed configuration with the proximity model are shown in Image 5. The 3D model was 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 Niagara Falls International Airport to determine the wind speeds and frequencies in the simulated areas.

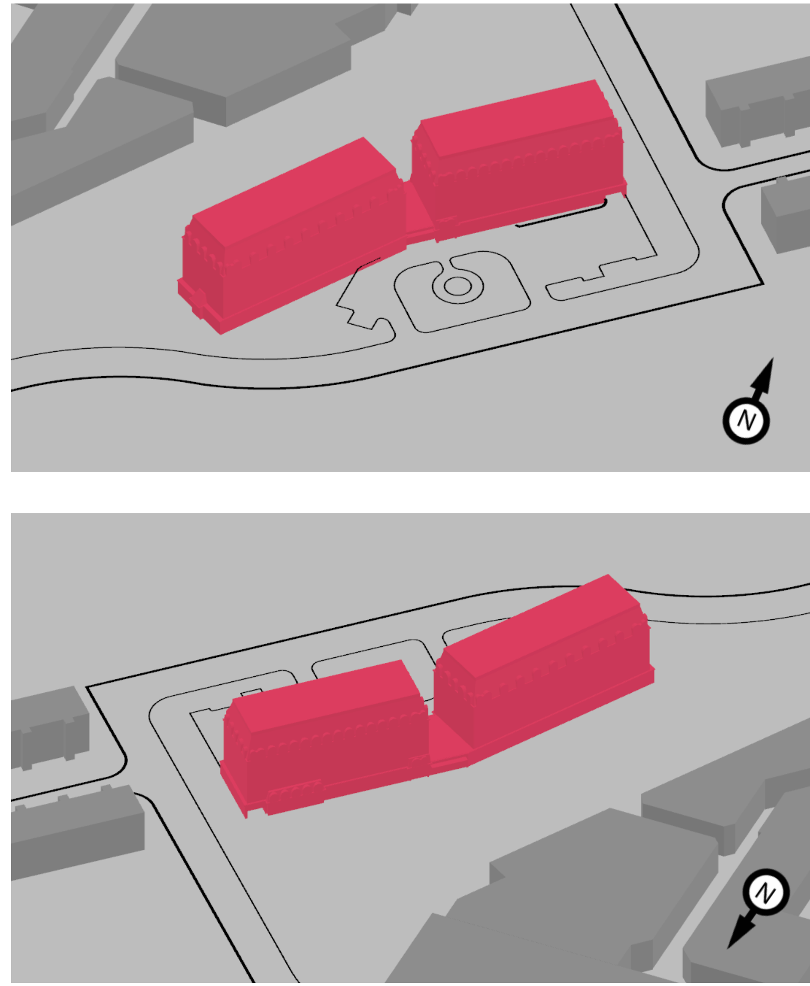


Image 4: Computer model of the proposed project

2. METHODOLOGY

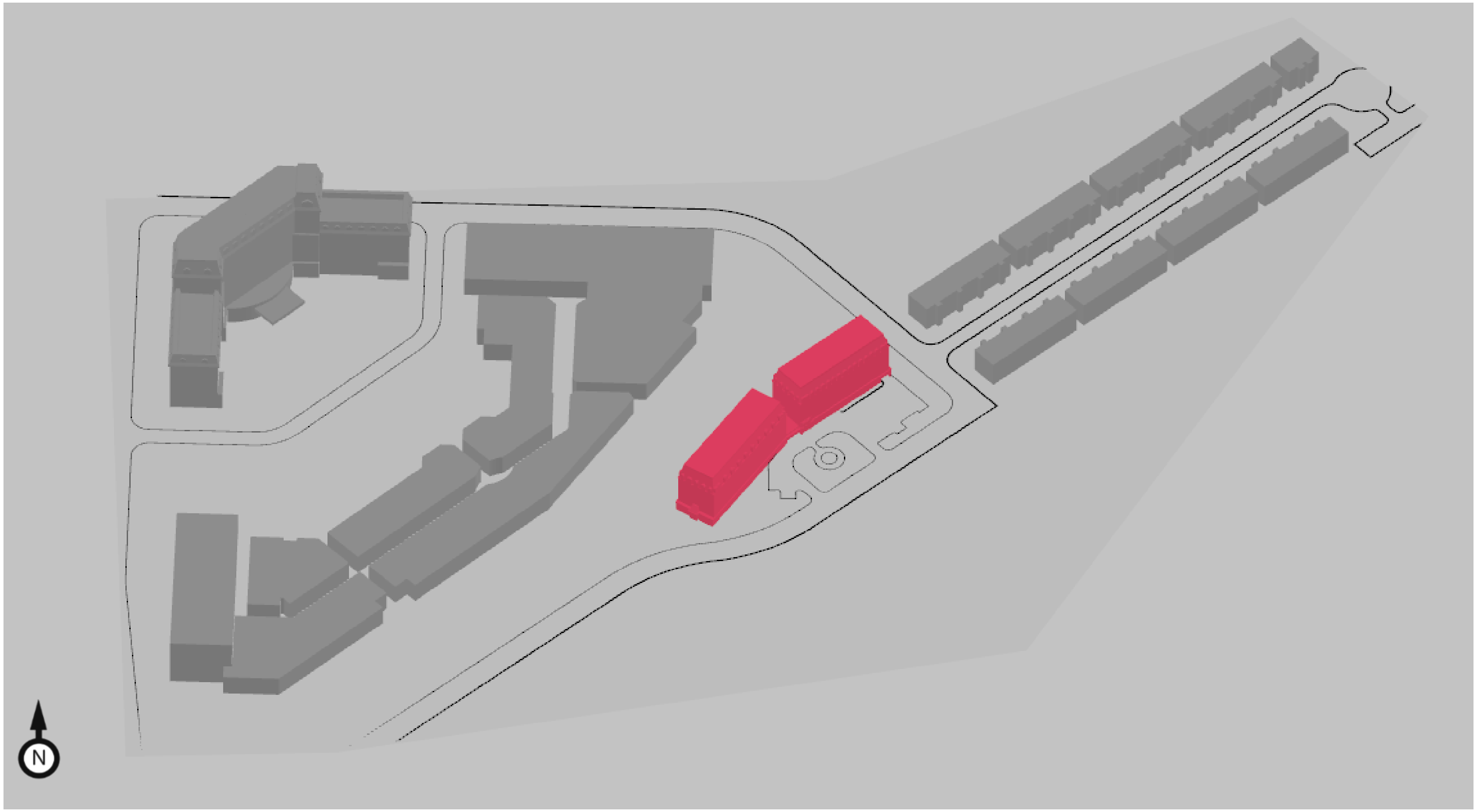


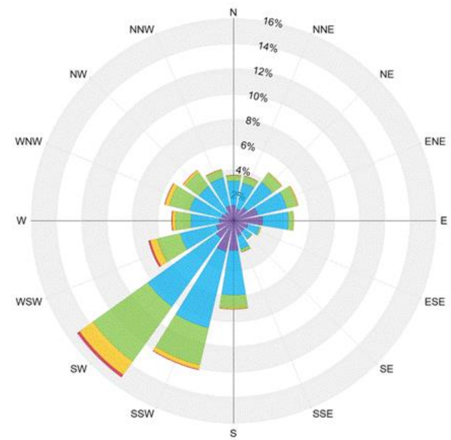
Image 5: Computer model of the proposed project and extended surroundings

2. METHODOLOGY

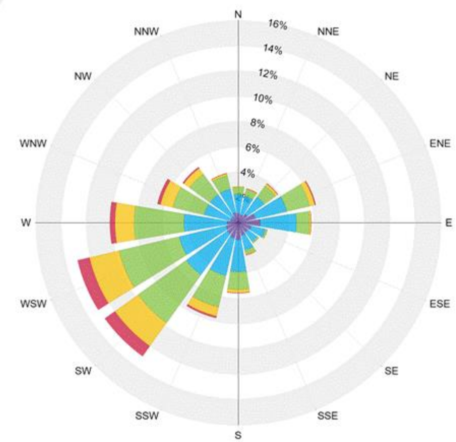
Long-term wind data recorded at Niagara Falls International Airport in NY between 1991 and 2021, inclusive, were analyzed for the summer (May to October) and winter (November to April) months. Image 6 graphically depicts the directional distributions of wind frequencies and speeds for these periods.

Winds from the southwest quadrant are predominant throughout the year as indicated by the wind roses, with secondary winds from the northeast and northwest quadrants. Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10 m) occur for 3.9% and 12.8% of the time during the summer and winter seasons, respectively, and they are primarily from the southwesterly directions.

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.



Summer
(May through October)



Winter
(November through April)

Wind Speed (km/h)	Probability (%) Summer	Probability (%) Winter
Calm	10.4	5.9
1-10	23.4	16.1
11-20	42.6	36.3
21-30	19.7	28.9
31-40	3.3	9.8
>40	0.6	3.0

Image 6: Directional distribution of winds approaching Niagara Falls International Airport, NY between 1991 and 2021

3. WIND CRITERIA

Based on pedestrian level wind study terms of reference guide for Niagara Region (dated July 2022), the public realm, streetscapes and public/private outdoor open spaces related to the existing and proposed buildings are to be comfortable for their intended use. The table below describes the minimum criteria for specific locations. The criteria deal with comfort and safety of pedestrians:

Comfort: Commonly experienced wind speeds have been categorized into ranges based on the activity level of a person that the winds would be conducive to. Lower wind speeds are desirable for passive activities and active pedestrians would be tolerant of higher wind speeds.

Safety: It is important to assess wind conditions in the pedestrian realm from a safety perspective as strong wind gusts can deter safe pedestrian use of outdoor spaces. Wind speeds associated with wind gusts are infrequent but deserve special attention due to their potential impact on pedestrian safety.

Comfort Category	Speed (km/h)	Description	Area of Application
Sitting	≤ 10 at least 80% of the time	Light breezes desired for outdoor seating areas where one can read a paper without having it blown away.	Park benches, restaurant and café seating, balconies, amenity terraces, children's areas, etc. intended for relaxed, and usually seated activities.
Standing	≤ 15 at least 80% of the time	Gentle breezes suitable for passive pedestrian activities where a breeze may be tolerated	Areas where seated activities are not expected but would be used for passive activities such as bus-stops, dog areas and main entrances.
Walking	≤ 20 at least 80% of the time	Relatively high speeds that can be tolerated during intentional walking, running and other active movements.	Sidewalks, parking lots, alleyways and areas where pedestrian activity is primarily for walking.
Uncomfortable	> 20 more than 20% of the time	Strong winds, considered a nuisance for most activities.	Not acceptable in areas with pedestrian access

Safety Criterion	Gust (km/h)	Description	Area of Application
Exceeded	> 90 At least 0.1 % of the time (9 hours) in a year)	Excessive gusts that can adversely affect one's balance and footing. Wind mitigation is typically required.	Not acceptable in any area of interest

4. RESULTS AND DISCUSSION

4.1 Presentation of Results

The results of the assessment are presented and discussed in detail in the following sections. 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 ground level. 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 includes recommendations for wind control to reduce the potential for high wind speeds for the design team's consideration.

4.2 Wind Flow around the Project

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. These effects can be further intensified with presence of another building in proximity (Wind Channelling). These flow patterns are illustrated in Image 7.

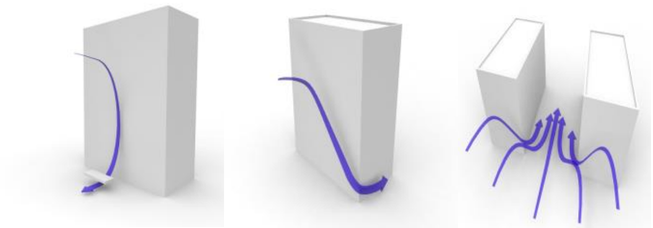


Image 7: General wind flow patterns

The project, at 7 storeys, is taller than the buildings that exist in the surrounding area. Thus, it is expected to redirect winds around it, creating higher-wind zones near the southwestern corners of the building (Image 8). However, potential wind impacts are expected to be moderate as the building would be aligned with the prevailing winds.

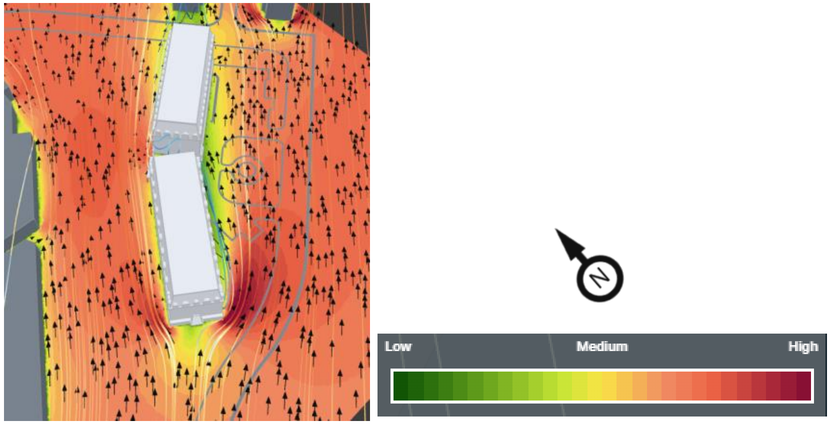


Image 8: Wind intensity and flow pattern in case of southwesterly winds

4. RESULTS AND DISCUSSION

Image 9: Predicted wind conditions - PROPOSED SCENARIO – Ground Level

4. RESULTS AND DISCUSSION

4.3 Existing Scenario

The existing site is undeveloped and surrounded by relatively dense vegetation. Based on the meteorological data and our experience from previous projects in the Niagara Falls region, during the summer, wind speeds on the existing project site, with the trees removed, are comfortable for standing. During the winter, when seasonally stronger winds occur, wind speeds are mostly comfortable for walking.

Wind conditions at all areas near the project site are expected to meet the safety criterion.

4.4 Proposed Scenario

The proposed project, owing to its moderate height and orientation relative to prevailing winds, is not expected to significantly alter wind conditions on-site (Images 9a and 9b). However, the southwest facade of the project is directly exposed to the predominant southwesterly winds and will redirect winds to the ground, which subsequently accelerate around the corners. As a result, wind speeds are expected to be increased at the above-mentioned areas, compared to the Existing scenario.

4.4.1 Walkways and Neighbouring Properties

The resultant wind speeds at most sidewalks, walkways and parking spaces and areas around the property are expected to continue to be comfortable for standing in the summer and walking in the winter (Images 9a and 9b). These conditions are appropriate for the intended active use. Higher wind speeds at the southwestern corners of the building are expected to be comfortable for walking during the summer and can be uncomfortable during the winter.

Wind safety criterion is expected to be met at all areas around the site.

To improve the wind conditions, landscaping and/or screens should be used to dissipate the energy of accelerating winds at the identified windy areas. Note that only coniferous and marcescent trees afford wind control benefits in the winter months when the highest wind speeds are expected to occur in the area. Some examples are illustrated in Image 10.

4.4.2 Main Entrances

Wind. conditions near the two Lobby entrances are expected to be comfortable for sitting or standing throughout the year; these wind speeds are suitable for the intended use. Wind speeds near the amenity entrances are expected to be comfortable for standing in summer but comfortable for walking during the winter, which are higher than desired. The design team may consider reducing the exposure of these entrances to prevailing winds by recessing entrances into building facades or adding deep screens and canopies to these entrances, if lower wind speeds are desired. Some examples are shown in the Image 11.

4. RESULTS AND DISCUSSION

Image 10: Landscaping / screens examples for wind control along walkways

Image 11: Design strategies for wind control at entrances

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed Block A05 of the Riverfront Community Phase II in Niagara Falls, 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:

- Existing wind conditions on-site are generally comfortable for standing during the summer and walking during the winter.
- The proposed buildings are taller than surroundings, and therefore will redirect wind to ground level. However, with the moderate height of the building and its favourable orientation, wind impacts are expected to be low and local.
- Wind gusts are expected to meet the safety criterion.
- Wind conditions at most of ground level areas are expected to be appropriate for the intended pedestrian usage around the site, including sidewalks, walkways, parking spaces and two lobby entrances.
- Uncomfortable wind speeds are expected near southwestern corners of the project during the winter.
- During the winter higher than desired wind speeds are also expected near amenity entrances.
- Conceptual wind control strategies have been discussed in the body of report applicable to each windy area. 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 listed below. 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)
RetireV4 20230828	DWG	08/30/2023
A05- Retirement Home 20230816	PDF	09/01/2023

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 GR (CAN) Investment Co. Ltd. ("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.

7. 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.