REPORT

DELTA – 1248 MAIN STREET EAST

HAMILTON, ON

PEDESTRIAN WIND COMFORT ASSESSMENT

PROJECT #2204667
SEPTEMBER 16, 2022

SUBMITTED TO

Delta Developments Joint Venture

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to conduct a pedestrian wind assessment for the proposed development at 1248 Main Street East in Hamilton, Ontario. The objective of this assessment is to provide an evaluation of the potential wind impact of the proposed development in support of the Site Plan Application to the City of Hamilton.

The project site is located on the south side of Main Street (Highway 8), between Wexford Avenue South and Graham Avenue South. The site is surrounded by low-rise single-storey houses in all directions with the escarpment less than 1 km to the south.

The project consists of three new 14-storey residential buildings, six townhouse buildings, as well as the existing three-storey retrofit residential building. In addition to sidewalks and properties near the project site, key areas of interest for this assessment include the main entrances to the buildings and plaza space in the areas between buildings (Image 3).

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

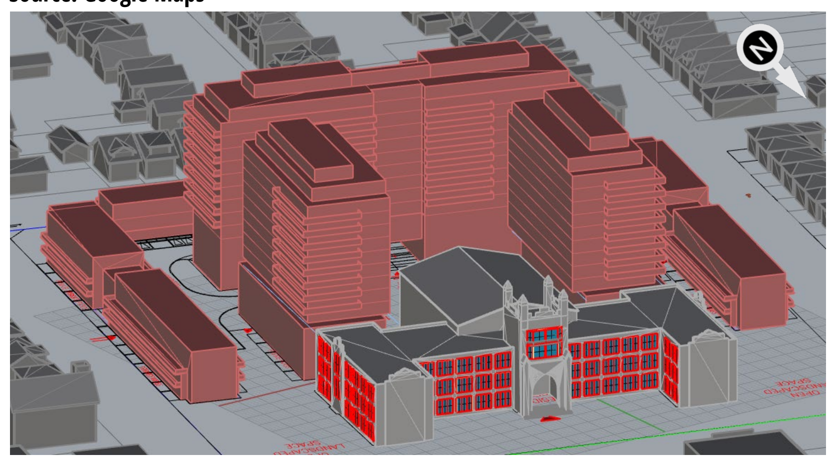


Image 2: Conceptual Massing/Rendering of the Proposed Project

1. INTRODUCTION

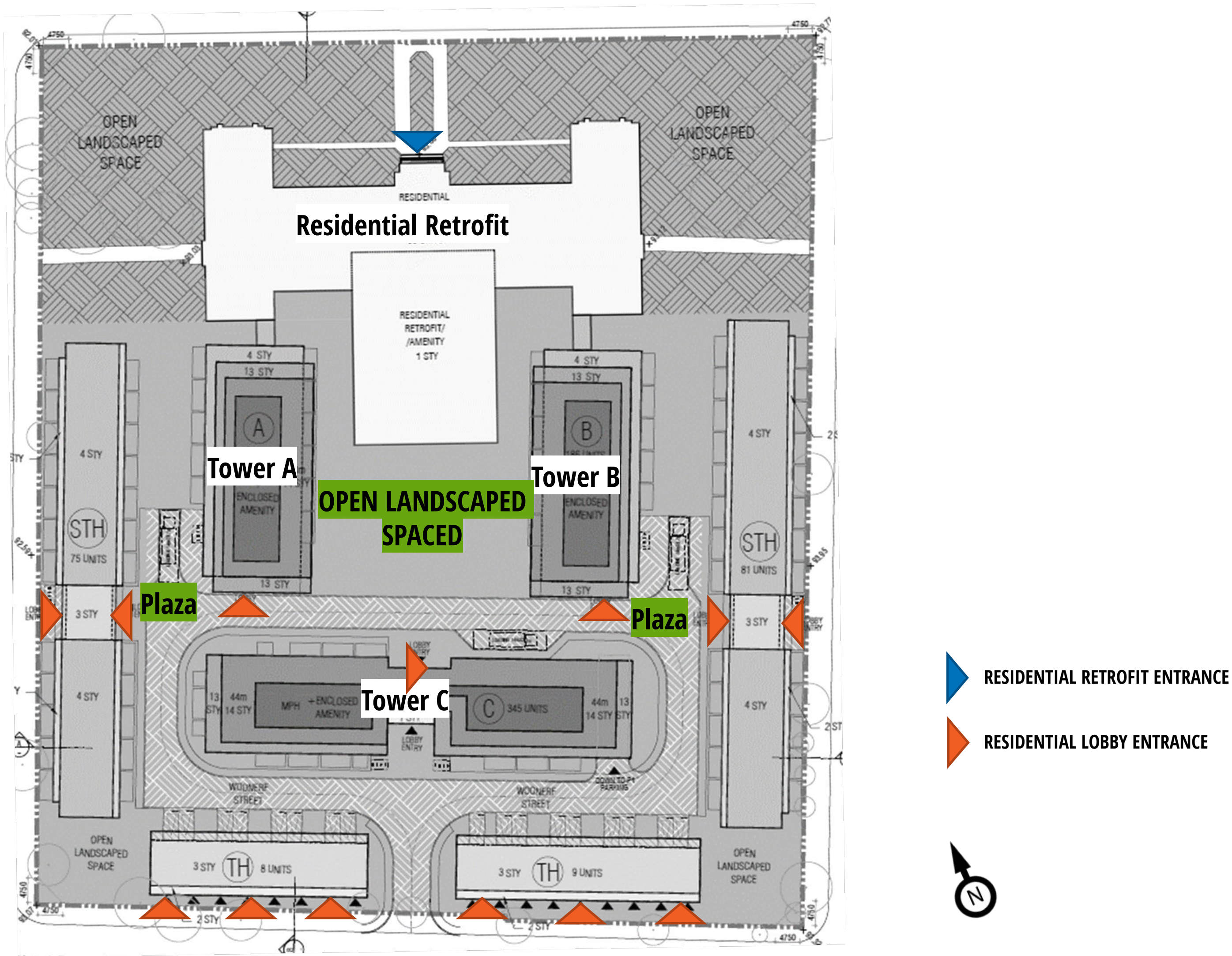


Image 3: Floor Plan identifying Key Outdoor Areas of Interest

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 Hamilton International Airport;
- CFD simulations completed using the e-model of the proposed project received on September 1, 2022;
- Updated floor plans received on September 7, 2022 with minor design changes relative to the design used for the CFD simulations;
- 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 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, 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 using Orbital Stack, an in-house CFD tool, for two scenarios:

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

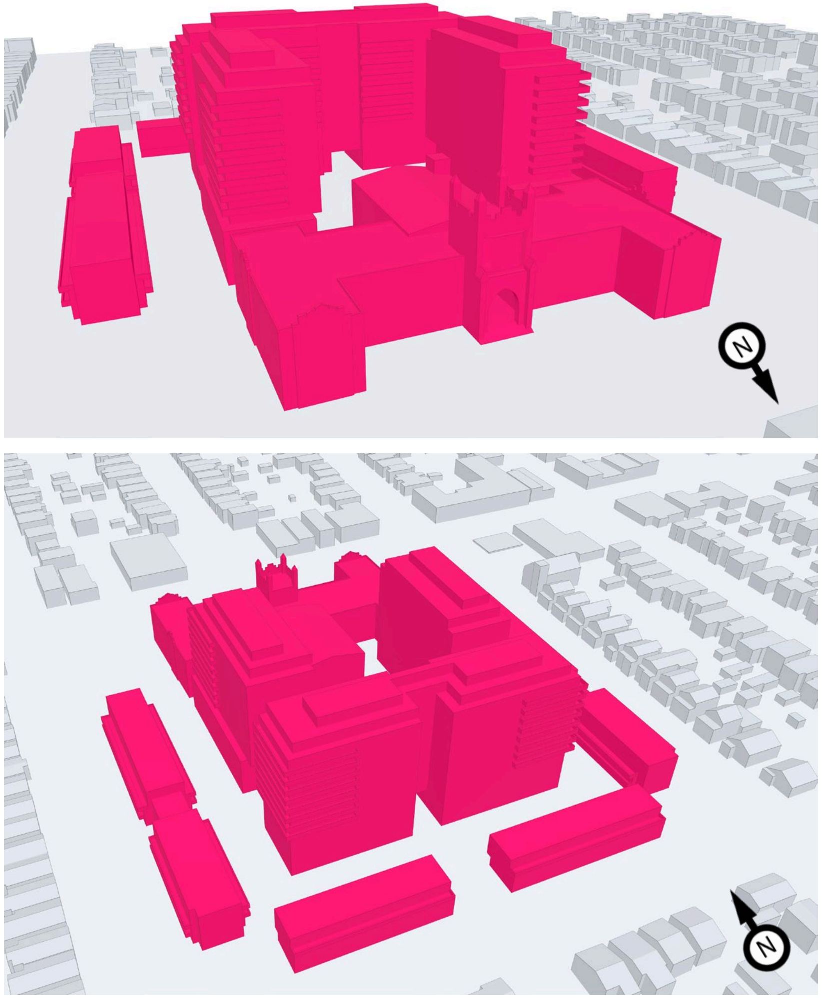


Image 4: Computer model of the proposed project

2. METHODOLOGY

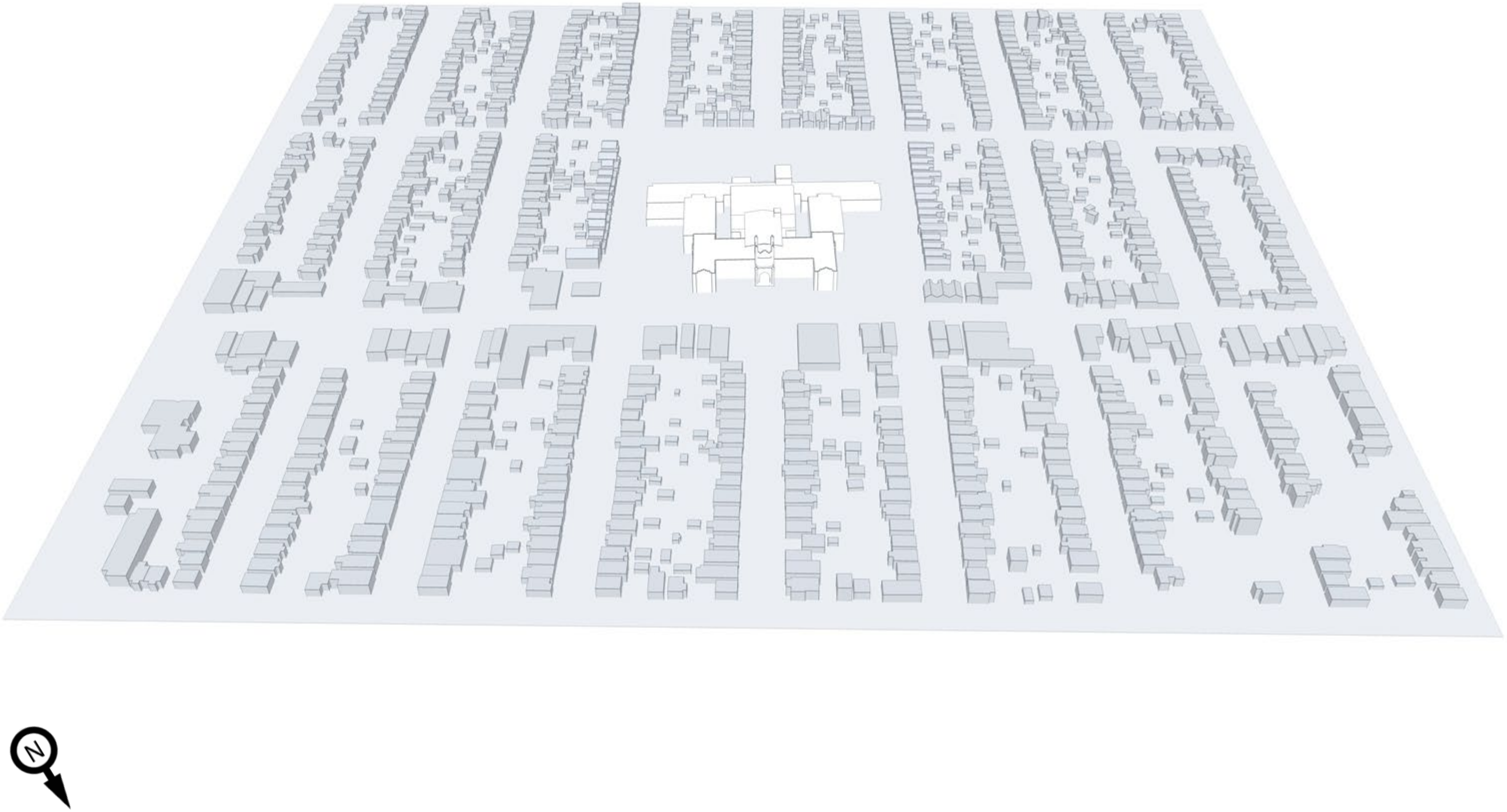


Image 5a: Computer model of the existing site and extended surroundings

2. METHODOLOGY

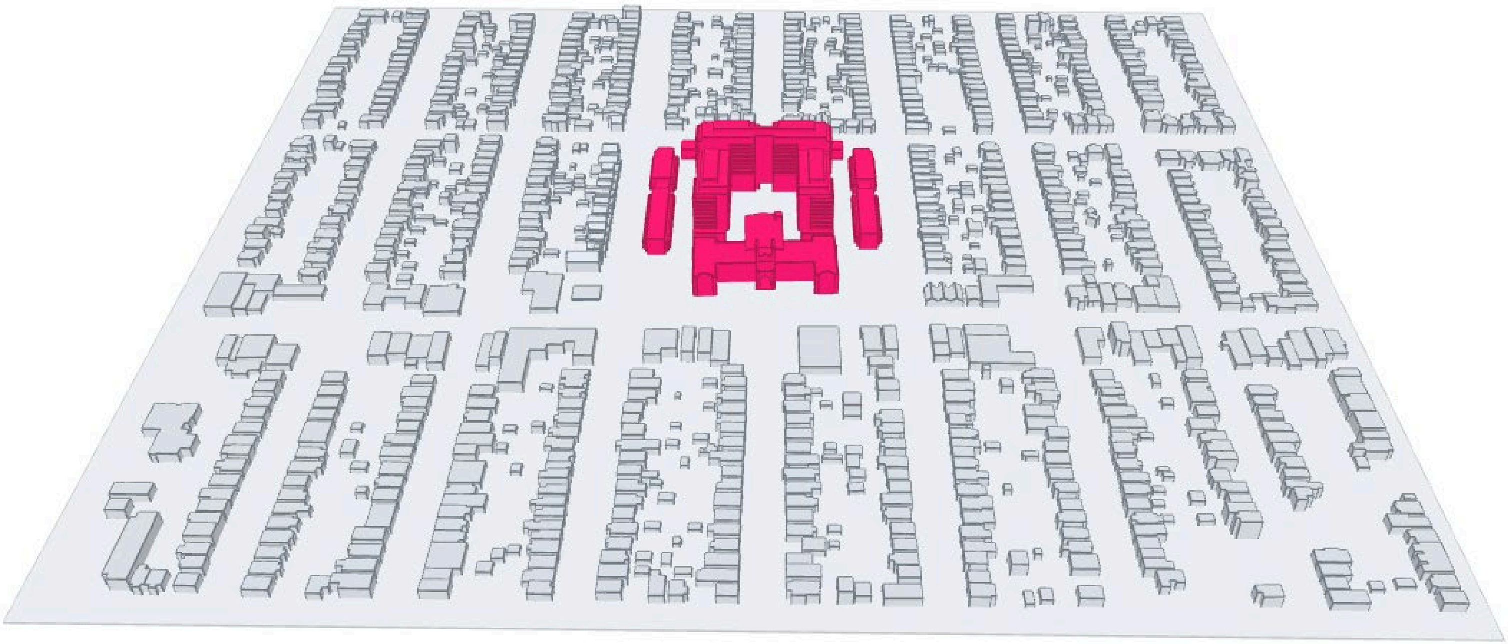


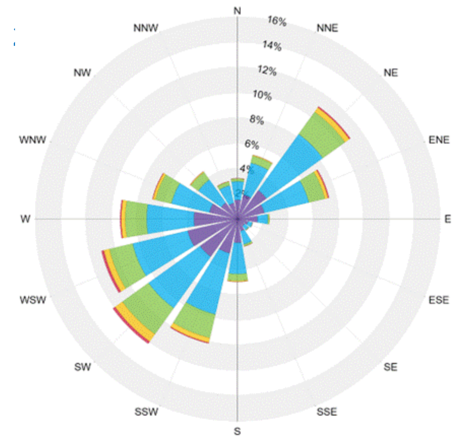
Image 5b: Computer model of the proposed site and extended surroundings

2. METHODOLOGY

Long-term wind data recorded at Hamilton International Airport between 1990 and 2020, 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.

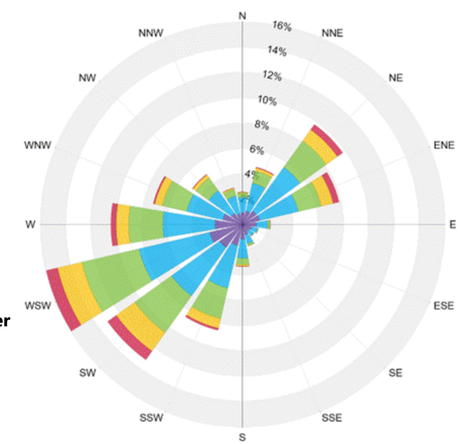
In the summer and winter seasons, winds from the southwest quadrant, west and northeast are predominant. Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10m) are more frequent in the winter (red and yellow bands in Image 6). These winds potentially 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.



Summer
(May through October)

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	3.8	2.2
1-10	33.7	21.8
11-20	43.2	39.5
21-30	15.5	23.9
31-40	3.0	9.1
>40	0.8	3.6



Winter
(November through April)

Image 6: Directional distribution of winds approaching Hamilton International Airport (1990 to 2020)

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 Presentation of Results

The results of the assessment are presented and discussed in detail in Sections 4.3 and 4.4. 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 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. A detailed discussion of the expected wind conditions with respect to the prescribed criteria and applicability of the results follows in Sections 4.3. and 4.4. The discussion includes recommendations for wind control 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 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 seated activities are anticipated, such as any seating areas in the outdoor plazas, especially during the summer when these areas are typically in use.

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 downward in a mechanism called *Downwashing*. These flows subsequently move around exposed building corners, causing a localized increase in wind activity due to *Corner Acceleration*. Wind also accelerates through the space between tall buildings due to *channeling* effect. Stepped massing, low roofs and canopies disrupt downwash and reduce the potential wind impact on the ground level. These flow patterns are illustrated in Image 7.

The project with the three residential buildings and 6 townhouses will be at 14 storeys and 4 storeys, respectively. The tall towers in the proposed development will create downwashing, corner acceleration and channeling wind impacts owing to their orientation and height compared to the low-rise surroundings. The shorter residential retrofit and townhouse buildings enclosing the group of towers is positive in that the arrangement will provide some wind control and limit the wind impact of the development to the site.

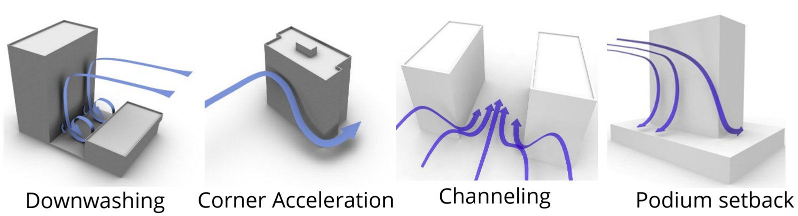


Image 7: General wind flow patterns

4. RESULTS AND DISCUSSION

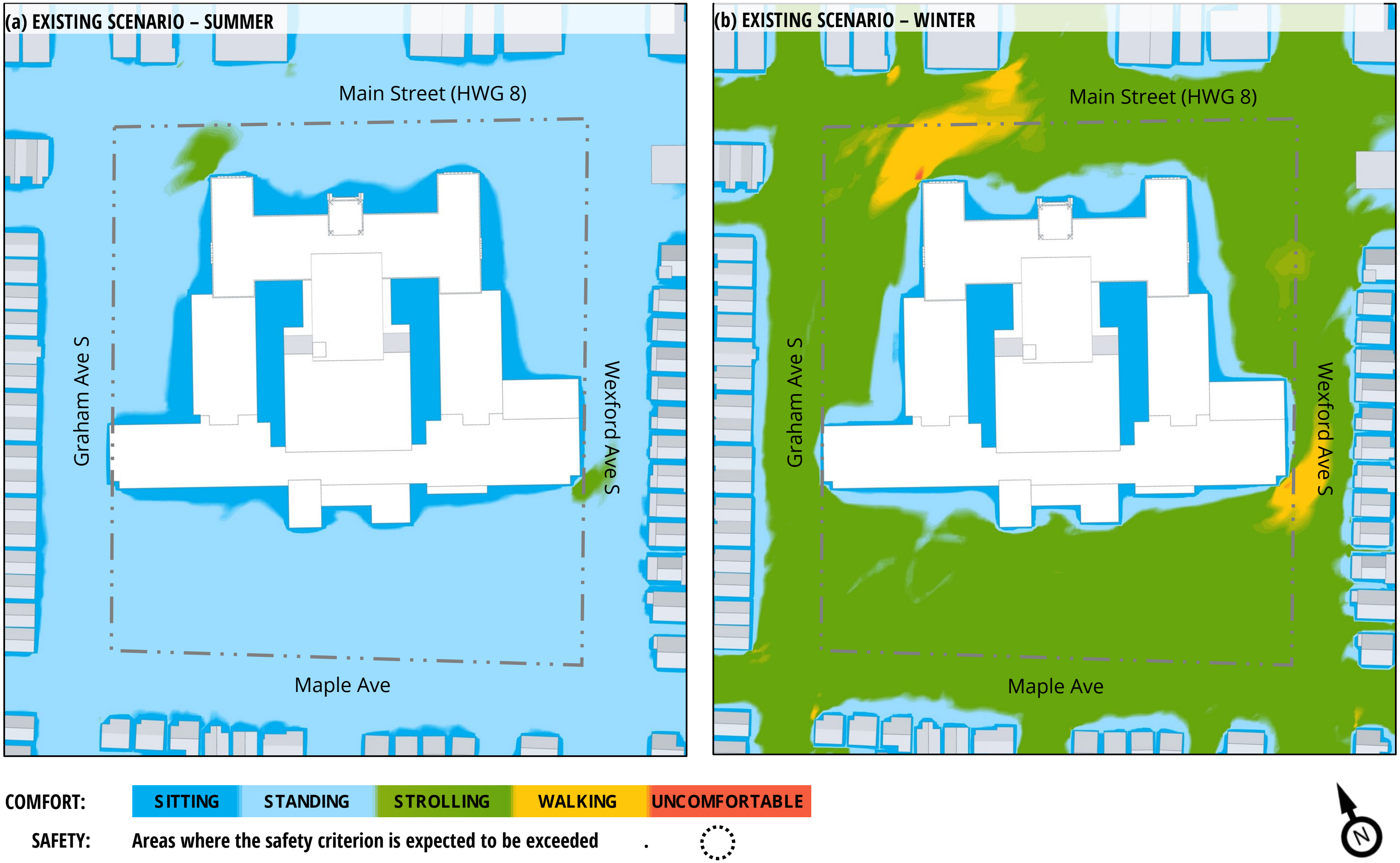


Image 8: Predicted wind conditions – GROUND LEVEL – EXISTING Scenario

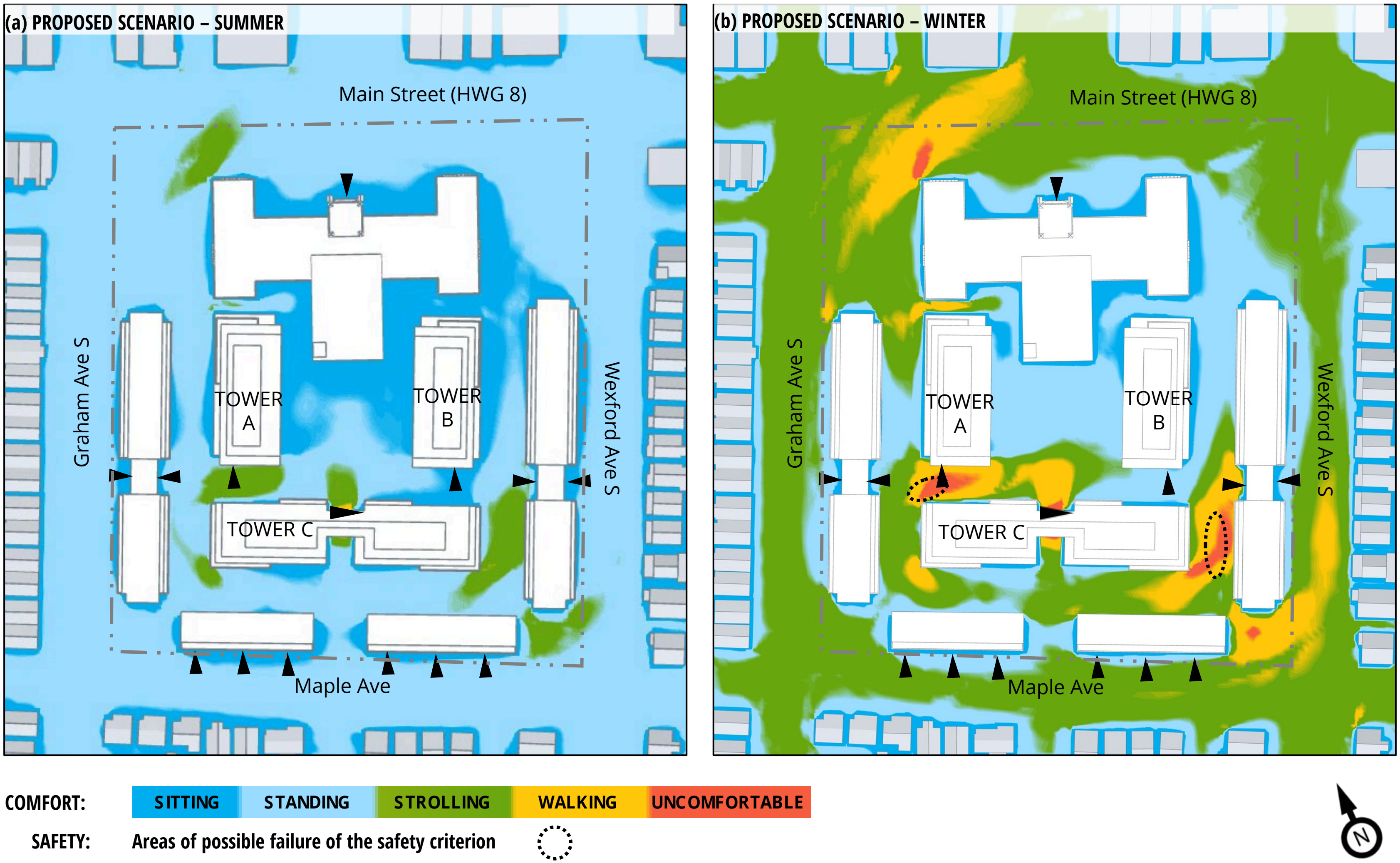


Image 9: Predicted wind conditions – GROUND LEVEL - PROPOSED Scenario

4. RESULTS AND DISCUSSION

4.3 Existing Scenario

Wind conditions at most areas in the existing scenario are comfortable for standing in the summer (light blue regions in Image 8a) and for strolling in the winter (green regions in Image 8b). Closer to the building perimeter wind speeds are lower and comfortable for sitting or standing in the summer and winter. Localized wind acceleration at the northwest and southeast corners of the existing building creates conditions comfortable for strolling during the summer and walking during the winter season (see green and yellow regions in Image 8a and 8b)

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

4.4 Proposed Scenario: Safety

Wind conditions at most areas around the project site will meet the safety criterion. The only exception being two areas near and around the northwest and southeast corners of Tower C. Due to localized downwashing, corner acceleration and channeling between the tall buildings these areas may be windier, requiring the addition of localized mitigation (see areas circled in Image 9b). These conditions can be confirmed, and mitigation options verified through further wind study, as the design develops.

4.5 Proposed Scenario: Comfort

4.5.1 Sidewalks and Neighbouring Properties

Although the introduction of tall buildings in a low-rise context will result in an increase in wind speeds, the impact of the project will be limited to the site ,and the project is not expected to worsen wind conditions on neighbouring properties. The resulting wind speeds at most sidewalks and areas outside the property will continue to be comfortable for standing or strolling in the summer, and walking in the winter, similar to the existing scenario (Images 9a and 9b). These conditions are appropriate for sidewalk use.

4.5.2 Site conditions

On the project site, during the summer season wind speeds comfortable for standing or strolling with slight increase in wind speeds during the winter. Uncomfortable conditions occur near the northwestern and southeastern corners of Tower C and occasionally near the northwest corner of the residential retrofit building (see red regions in Image 9b). These wind speeds may have the potential to exceed the wind safety criterion as indicated in Image 9b. The addition of landscaping on the site wind conditions would be improved. A mix of coniferous and deciduous landscaping around the corners of Tower C would help reduce winds during the winter months.

4.5.3 Open Landscaped Space and Plaza Areas

The open landscaped space proposed between Towers A and B is expected to be comfortable for sitting or standing during the summer (see blue regions in Image 9a) and comfortable for standing during the winter months (Image 9b).

Wind conditions in the outdoor plaza areas indicated in Image 2 are expected to be comfortable for standing or strolling during the summer. During the winter months the plaza spaces are shown to be comfortable for strolling or walking most of the time but may be occasionally uncomfortable on windy days (Images 9a and 9b).

The addition of landscaping will provide overall wind reductions across the site, especially during the summer months.

4.5.4 Main Entrances – Residential Retrofit, Townhouses, Towers A and B

The entrances for the residential retrofit building , townhouse buildings and Tower B are shown to be comfortable for sitting or standing during the summer and winter months, which is appropriate (see Images9a and 9b).

Slightly higher wind speeds comfortable for strolling in the summer and walking in the winter occur at the lobby entrance of Tower A due to prevailing winds channeling through the gap between Tower A and Tower C. The vestibule at this entrance is a positive design feature allowing pedestrians to wait or transition in a sheltered area during colder winter months or windy days. Recessing this entrance or adding vertical screens on either side would also help reduce wind speeds at this entrance (see examples in Image 10).

Image 10: Suggestions for wind control at the residential lobby entrance

4.5.5 Main Entrance – Tower C – Updated Design

RWDI received updated site and floor plans on September 7, 2022 following the completion of the computational assessment (CFD) for the design that was received on September 1, 2022. The site plans of the original and updated designs are shown in Images 11a and 11b, respectively.

The design updates include the elimination of the grade level underpass in the central portion of Tower C, and the addition of lobby entrances on the north and south side of the new facades. (see Image 11a). These architectural changes to Tower C will eliminate the wind accelerations through the previous underpass, thus improving conditions in these areas and new entrances.

Considering the minor changes in the updated design and the localized impact on wind conditions, the wind conditions discussed in sections 4.4 and 4.5 continue to be applicable.

4. RESULTS AND DISCUSSION

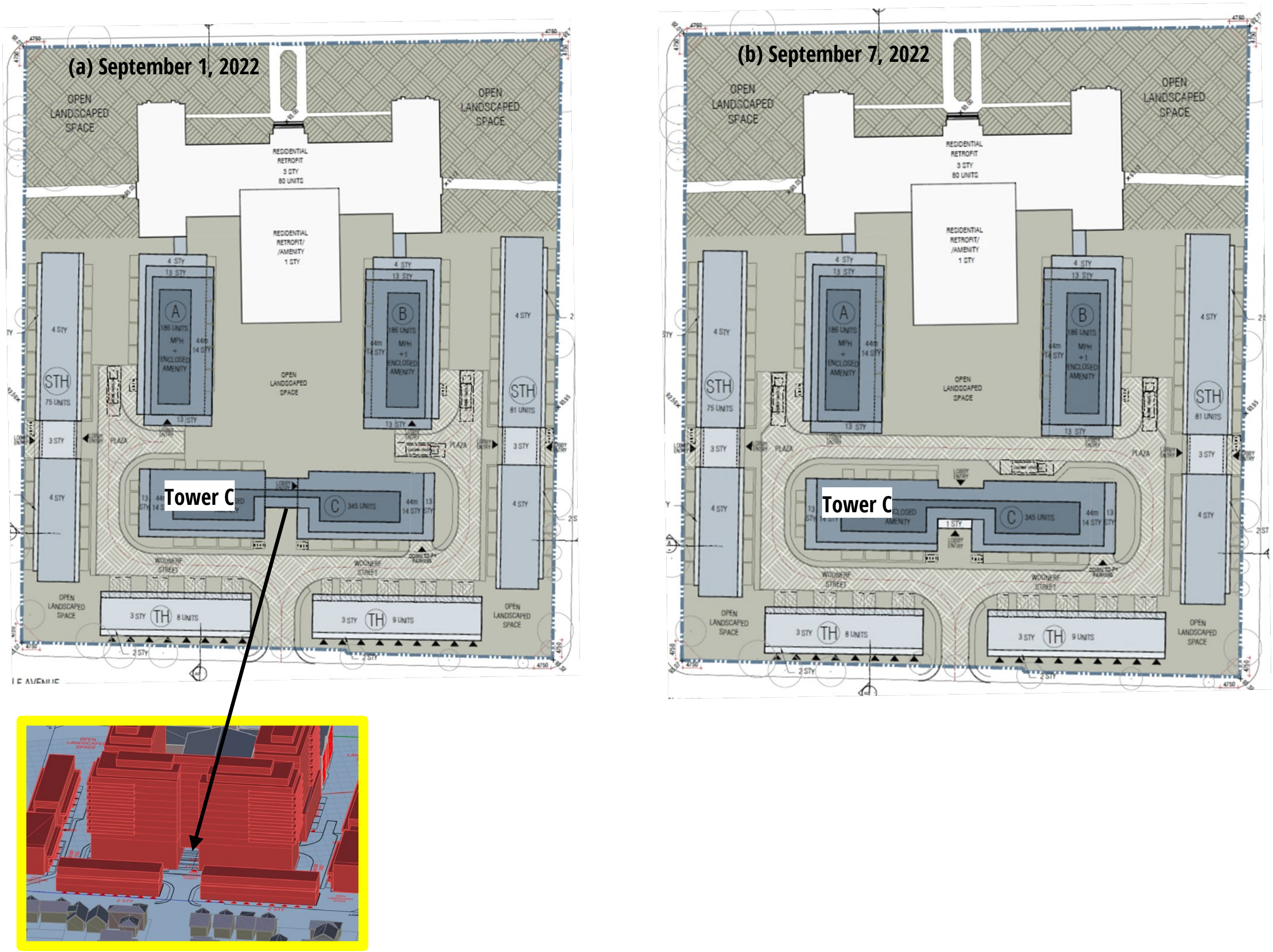


Image 11: Site plans received on (a) September 1, 2022 and (b) September 7, 2022

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed development at 1248 Main Street East in Hamilton, Ontario. Our assessment was based on computational modelling and simulation of wind conditions completed for the massing design received on September 1, 2022, analysis of the data in conjunction with the local wind climate data and the RWDI wind criteria for pedestrian comfort and safety, and a review of the updated plans of the proposed development received on September 7, 2022. Our findings are summarized as follows:

- The proposed buildings are taller than their surroundings, and therefore will redirect wind to ground level. However, as the proposed residential towers will be built alongside relatively shorter townhouse buildings, this will help limit the wind impact of the proposed development at grade around the project site.
- Wind conditions at grade level, including the majority of entrances, plaza areas and open landscaped spaces, will be appropriate for the intended usage.
- Slightly higher wind speeds comfortable for strolling in the summer and walking in the winter occur at the lobby entrance of Tower A. The vestibule at this entrance is a positive design feature. Recessing this entrance or adding vertical screens on either side would also help reduce wind speeds at this.
- Potentially uncomfortable or unsafe wind speeds occur around the northwest and southeast corners of the Tower C, and the northwest corner of the residential retrofit building.
- The addition of landscaping will provide overall wind reductions across the site, especially during the summer months.
- Wind control measures are suggested in the report for the areas associated with higher wind activity and can be verified through further wind study as the design develops.

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 1, 2022, and September 7, 2022, 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)
2022-sep-01-option d	DWG	09/01/2022
2022-sep-01-option d-1939 3D context model-rvt-1-{3D}	DWG	09/01/2022
2022-sep-01-option d-1939-21 Delta Secondary School - school model-rvt-1-{3D}	DWG	09/01/2022
1939.21 Delta Secondary School - Design	PDF	09/01/2022
1939.21.Delta.siteplan.concept.revision_D_gf PLAN	PDF	09/01/2022
1939.21.Delta.siteplan.concept.revision_D	PDF	09/01/2022
1939.21.Delta.GF plan.concept.revision_D	PDF	09/07/2022
1939.21.Delta.siteplan.concept.revision_D	PDF	09/07/2022
1939.21 Delta Secondary School -CAD	DWG	09/07/2022

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 Delta Developments Joint Venture ("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.