499 MOHAWK ROAD EAST

HAMILTON, ON

PEDESTRIAN WIND ASSESSMENT

PROJECT #2203345
JULY 14, 2022

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 499 Mohawk Road East in Hamilton, Ontario (Image 1). The objective of this assessment is to provide an evaluation of the potential wind impact of the proposed development in support of the application for Official Plan and Zoning By-law Amendment.

The project site is located at the northwest corner of the intersection of Mohawk Road East and Upper Sherman Avenue in Hamilton (Image 1). The site is currently occupied by a low, large commercial building and parking lots, and surrounded by low-rise suburban neighbourhoods in all directions. A few mid-rise buildings exist to the south, across Mohawk Road East, and there is an open green field to the immediate northeast of the project site, as shown in Image 1. The Niagara Escarpment is located approximately 2 km to the north and 3 km to the east, and Hamilton International Airport is 7 km to the southwest.

The project consists of 15 residential buildings, ranging from 3-storey townhouses along the west and north perimeters to 25-storey towers at the southeast corner of the site (Images 2 and 3). All the proposed high-rise buildings include significant podiums and tower setbacks, which are positive for wind control. The current assessment focuses on wind conditions at the ground level, including sidewalks, walkways, entrances and outdoor amenities.

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

1. INTRODUCTION

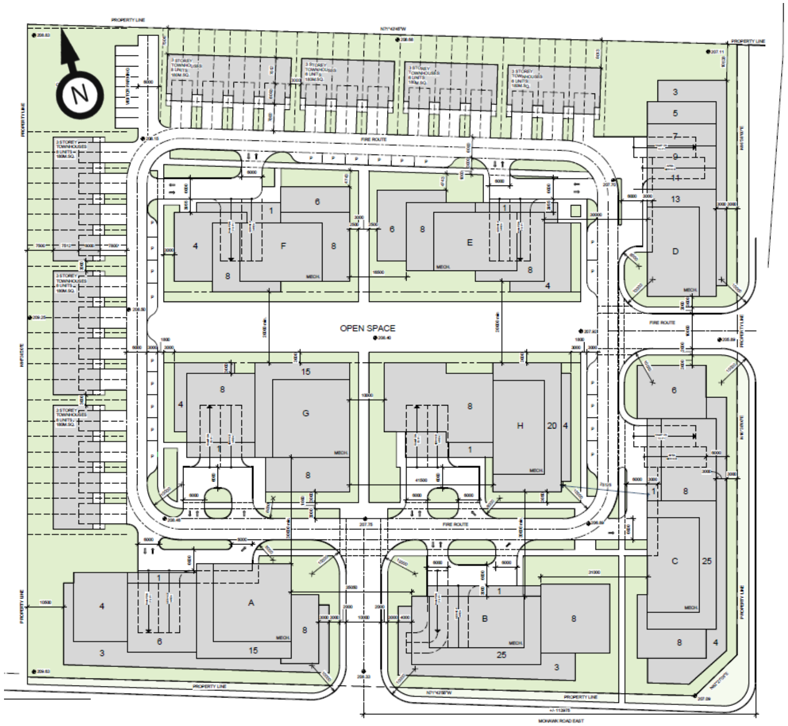


Image 2: Site Plan of the Proposed Buildings

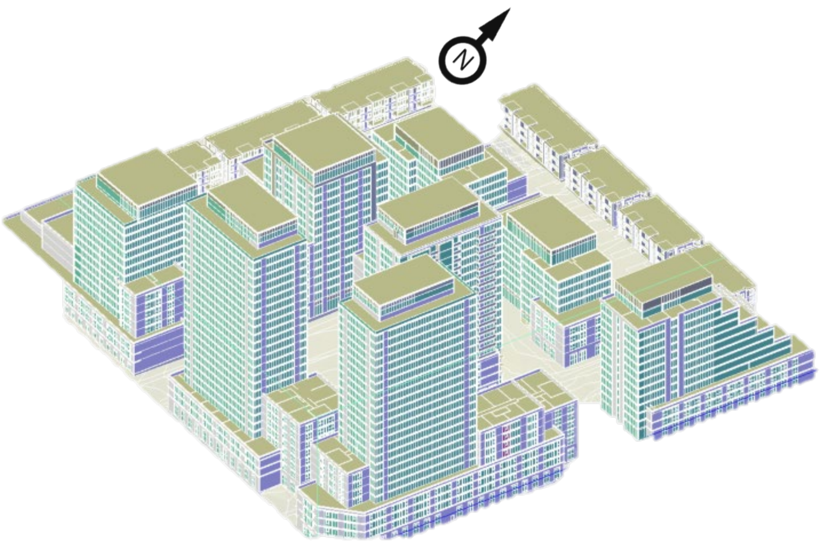


Image 3: 3D Model of the Project – View from Southeast

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 John C. Munro Hamilton International Airport;
- 3D model and site plan of the proposed project received on May 30, 2022;
- The use of *Orbital Stack*, an in-house CFD tool;
- The use of RWDI's proprietary tool WindEstimator[1] for estimating the potential wind conditions around generalized building forms;
- Wind tunnel studies completed by RWDI for similar projects in the Hamilton area;
- 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 behavior of wind and refine any conceptual mitigation measures, physical scale-model tests in a boundary-layer wind tunnel or more detailed transient computational modelling would be required.

2. METHODOLOGY

2.3 Simulation Model

Wind flows were simulated using Orbital Stack, an in-house computational fluid dynamics (CFD) tool, for the Existing and Proposed site buildings with the existing surroundings.

The computer models of the Existing and Proposed buildings are shown in Image 4, and the proposed project with the extended surroundings is shown in Image 5. For the purposes of this computational study, 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 speed profiles in the atmospheric boundary, approaching the modelled area were simulated for 16 directions (starting at 0°, at 22.5° increments around the compass). Wind data in the form of ratios of wind speeds at approximately 1.5m above concerned levels, to the mean wind speed at a reference height were obtained. The data was then combined with meteorological records obtained from Hamilton International Airport to determine the wind speeds and frequencies in the simulated areas.

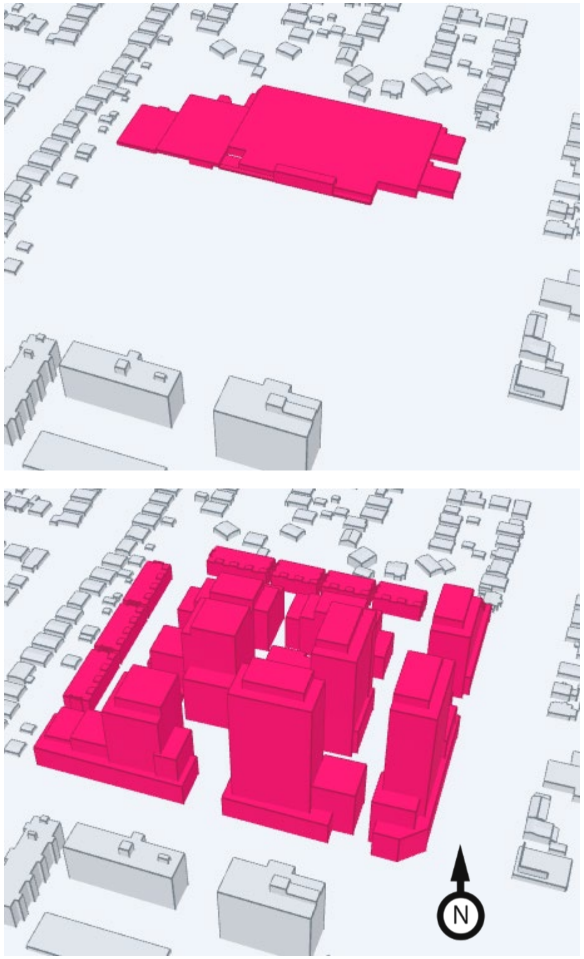


Image 4: Computer Models of the Existing and Proposed Buildings

2. METHODOLOGY

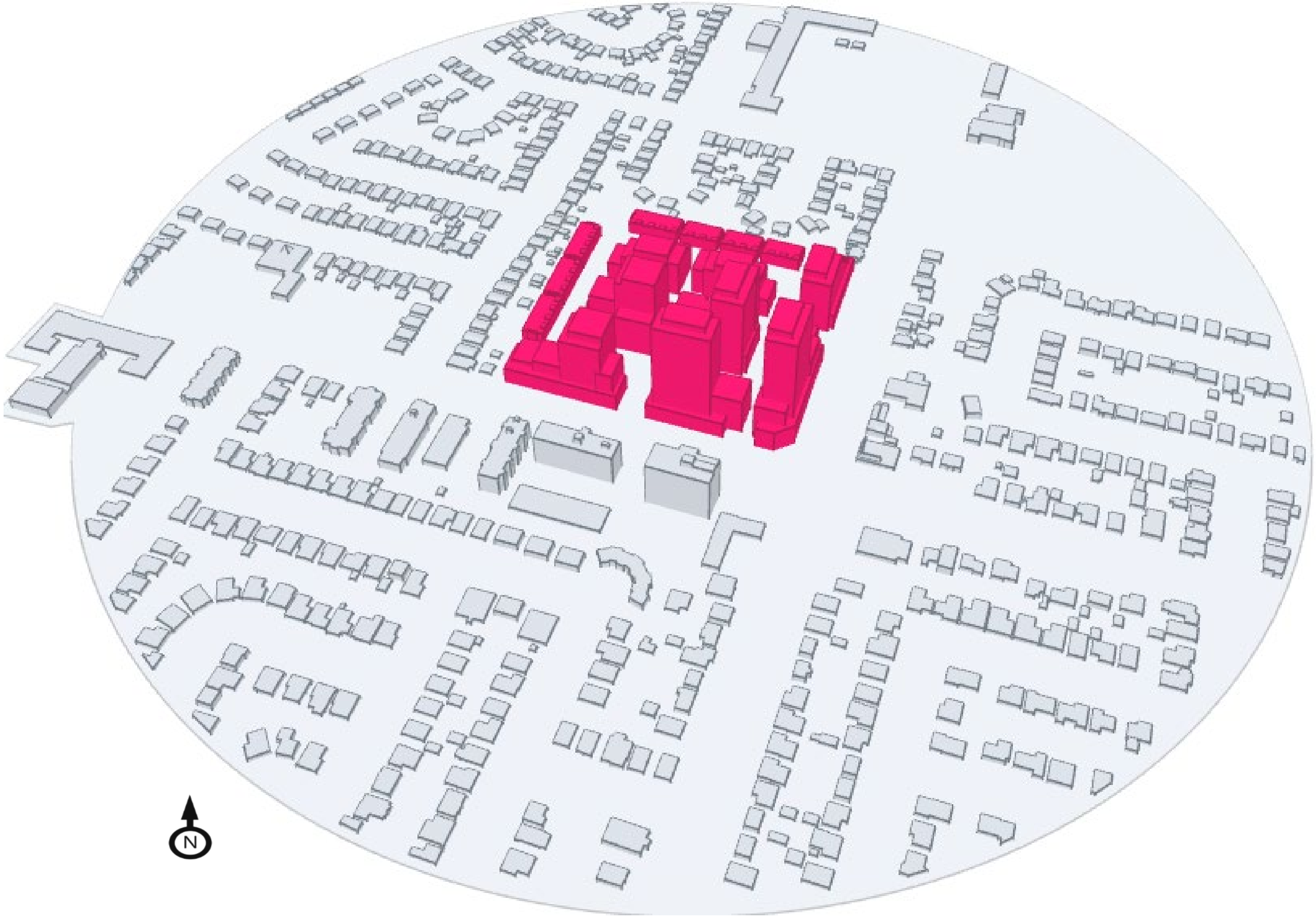


Image 5: Computer Model of the Proposed Project and Extended Surroundings

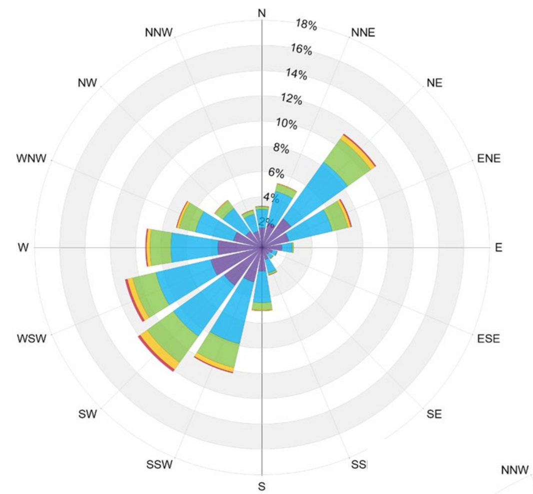
2.4 Meteorological Data

Long-term wind data recorded at John C. Muron Hamilton International Airport between 1992 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.

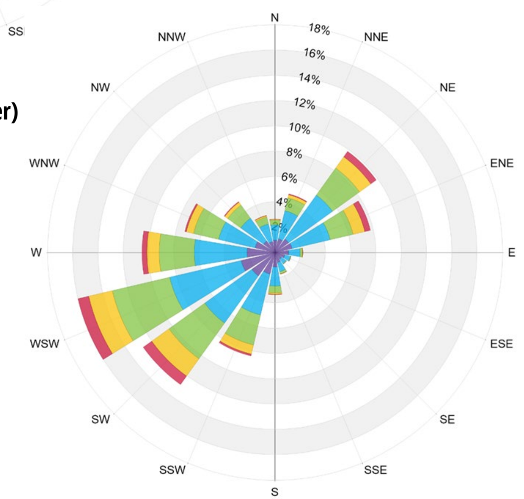
For both the summer and winter seasons, winds from the southwesterly and northeasterly directions are predominant, as shown in Image 6.

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)



Winter (November through April)

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	3.7	2.2
1-10	34.0	21.9
11-20	43.1	39.4
21-30	15.6	24.1
31-40	2.9	8.8
>40	0.7	3.5

Image 6: Directional Distribution of Wind Approaching Hamilton International Airport (1992 to 2021)

3. 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, building designers and the city planning community. The criteria are as follows:

3.1 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 (**> 90km/h**) occur more than **0.1%** of the time or 9 hours per year, the wind conditions are considered severe.

3.2 Pedestrian Comfort Criteria

Wind comfort is expressed in terms of typical pedestrian activities that the speeds would be conducive to:

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: The comfort category for walking is not met.

Wind conditions are considered suitable for sitting, standing, strolling 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 they exceed the wind safety criterion.

Note that these wind speeds are assessed at the pedestrian height (i.e., 1.5m 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.

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 building entrances and areas where people are expected to be engaged in passive activities. Calm wind speeds suitable for sitting are desired in areas where prolonged periods of passive activities are anticipated, such as outdoor amenities, seating areas etc., especially during the summer when these areas are typically in use.

4. RESULTS AND DISCUSSION

4.1 Wind Flow Around the Project

Wind generally tends to flow over buildings of uniform height, without disruption. Buildings that are taller than their surroundings 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*. Wind accelerations can also be caused by C*hannelling Effect* through the space between buildings. These flow patterns are illustrated in Image 7.

The proposed project, including buildings up to 25 storeys, will be taller than the existing surroundings. It is expected to redirect winds to the ground. However, potential wind impacts would be moderated by several positive design features, including the stepped massing for buildings along Mohawk Road East and Upper Sherman Avenue, low podiums and tower setbacks, as well as the low-rise townhouse along the north and west perimeters of the project.

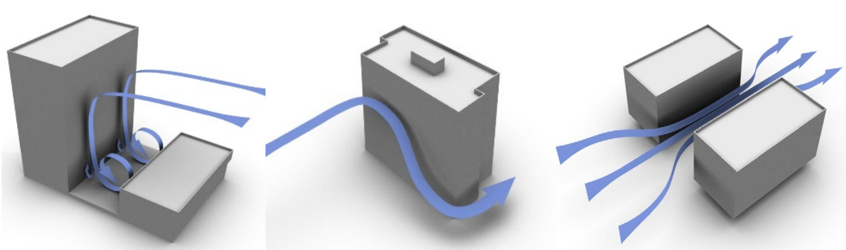


Image 7: General Wind Flow Patterns

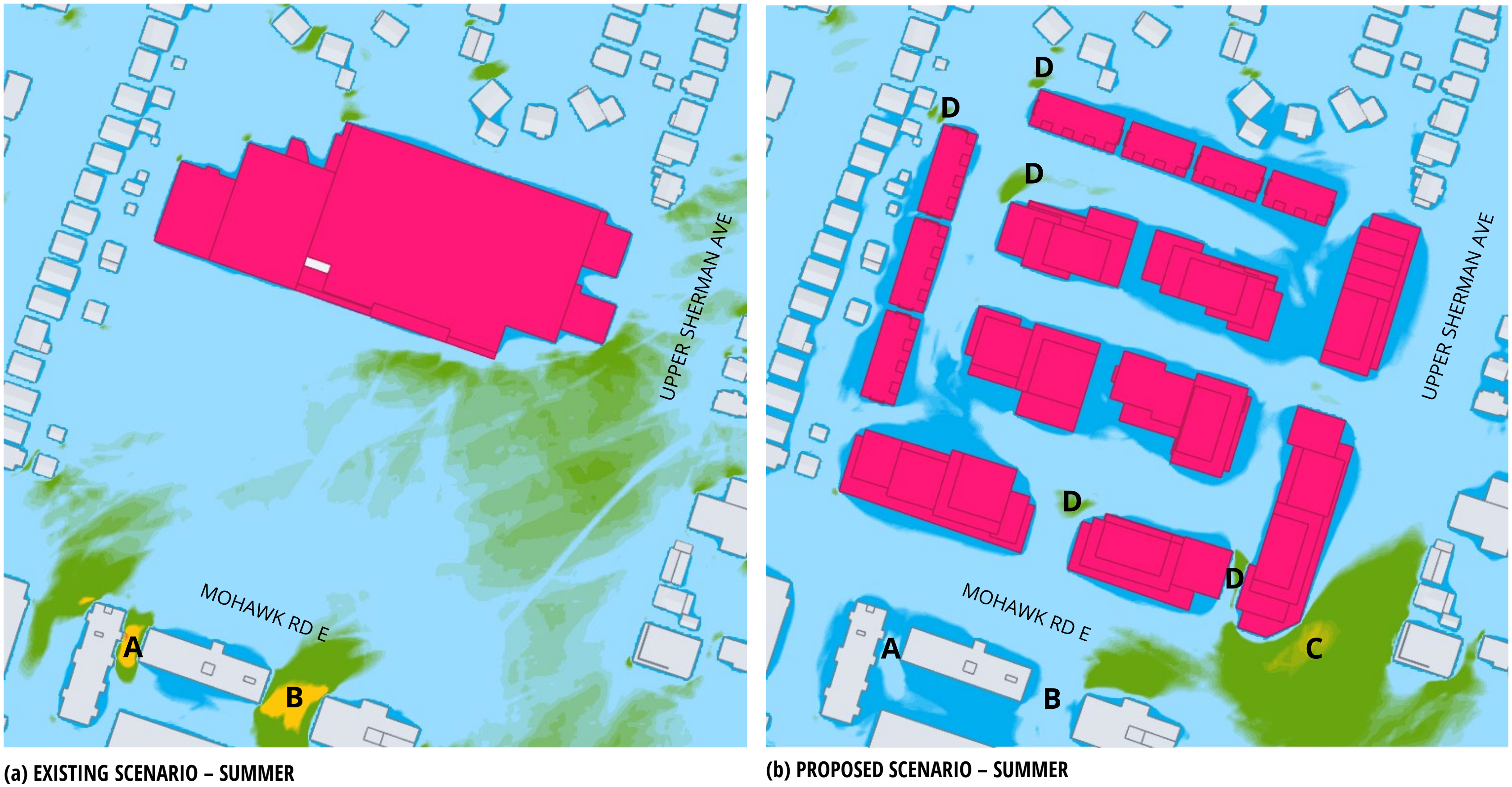
4.2 Simulation Results

The predicted wind comfort conditions for the Existing and Proposed configurations are presented in Images 8 and 9 for the summer and winter seasons, respectively. The results are presented as colour contours of wind speeds calculated based on the wind comfort criteria (Section 3.2). The contours represent wind speeds at a horizontal plane approximately 1.5 m above ground.

The assessment against the wind safety criterion (Section 3.1) was conducted, based on the predicted wind conditions and our wind-tunnel experience with similar developments. The areas where the criterion is expected to be exceeded are indicated in Image 9.

A detailed discussion of the expected wind conditions with respect to the prescribed criteria and applicability of the results is presented in Sections 4.3 through 4.5. The discussion includes recommendations for wind control to reduce the potential for high wind speeds for the design team's consideration.

4. RESULTS AND DISCUSSION



COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

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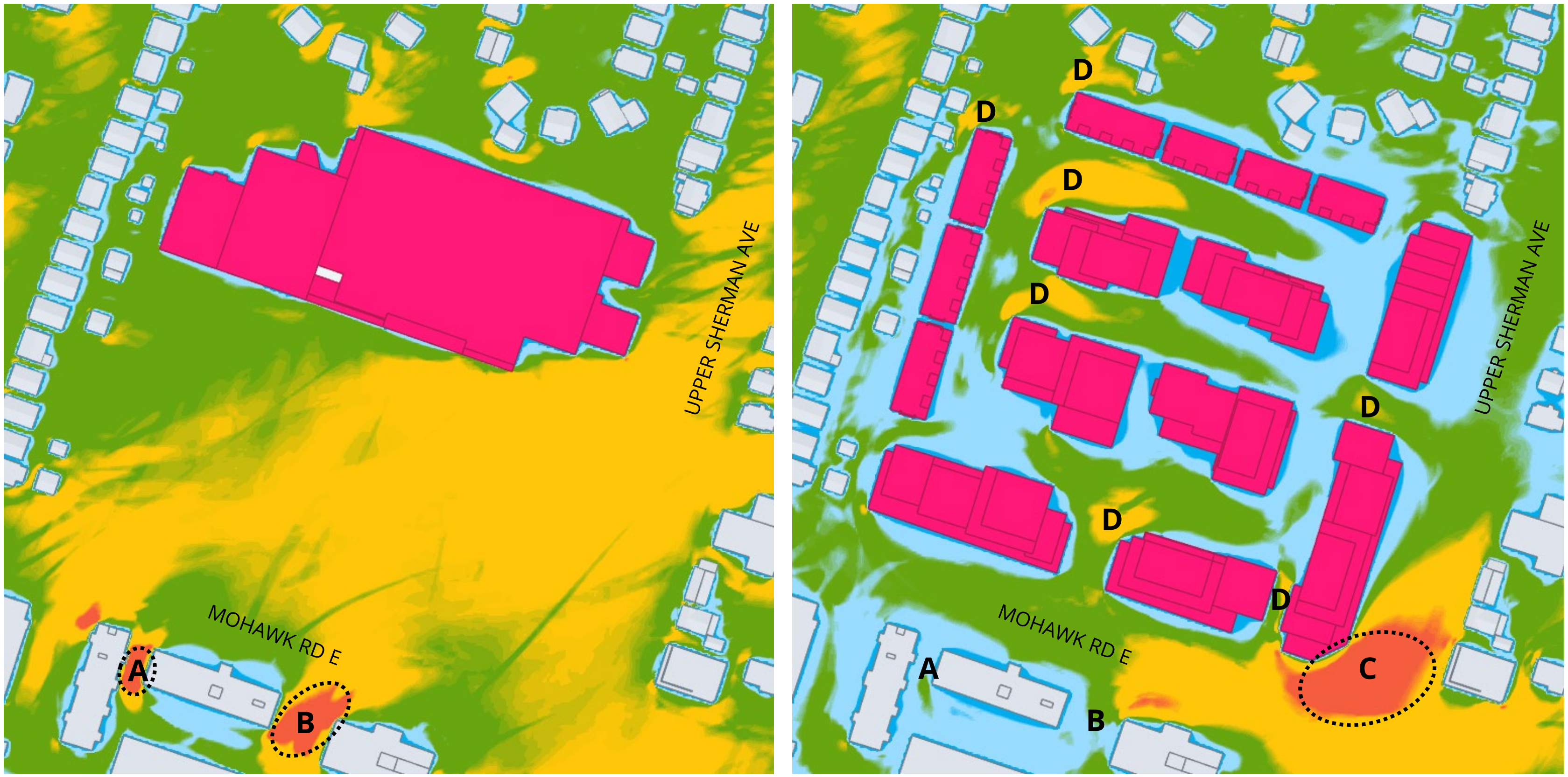
Image 8: Predicted Wind Conditions at Grade - SUMMER

4. RESULTS AND DISCUSSION



(a) EXISTING SCENARIO – WINTER

(b) PROPOSED SCENARIO – WINTER

COMFORT: SITTING | STANDING | STROLLING | WALKING | UNCOMFORTABLE

SAFETY: Areas where the safety criterion is expected to be exceeded

Image 9: Predicted Wind Conditions at Grade - WINTER

4.3 Existing Scenario

The existing building on the project site is low rise, like the neighbouring buildings and, therefore, will not redirect winds to create any notable impact. Wind conditions at most areas in the existing scenario are considered comfortable for standing or strolling in the summer (blue and green regions in Image 8a) and for strolling or walking in the winter (green and yellow regions in Image 9a).

Higher wind speeds are likely present between the existing mid-rise buildings to the south, across Mohawk Road East. These wind speeds may potentially exceed the comfortable and safety criteria in the winter (Locations A and B in Image 9a), due to the corner acceleration and channelling effect of the prevailing southwest and northeast winds.

4.4 Proposed Scenario: Safety

The proposed project is not expected to create any significant wind impact on and around the site, due to the stepped massing for buildings along the south and east perimeters, low podiums and tower setbacks, and the low height of townhouses along the other two sides, as demonstrated by the future wind conditions in Images 8b and 9b.

The only exception is at the southeast corner of the site (or the intersection of Mohawk Road East and Upper Sherman Avenue), where wind speeds may potentially exceed the safety limit (Location C in Image 9b). This is caused by the prevailing southwest and northeast winds being deflected down by the proposed 25-storey towers and accelerating around the building massing, as shown by the streamlines in Image 10.

As discussed previously, the stepped massing for the 25-storey towers at the intersection is a positive design feature for wind control. The chamfered podium corner for the Upper Sherman Avenue Tower is also positive in reducing the wind acceleration around the corner. If feasible, moving the tower further away from the intersection would be beneficial. Corner chamfering or other articulations may also be considered for the tower for additional wind reduction. Wind tunnel testing can be conducted at a later design stage to quantify these wind conditions and to determine the need and extend of wind mitigation.

In addition, on another positive note the existing wind speeds at Locations A and B are expected to decrease considerably, and the existing uncomfortable and unsafe conditions will be eliminated with the proposed project in place (Images 8 and 9).

4. RESULTS AND DISCUSSION

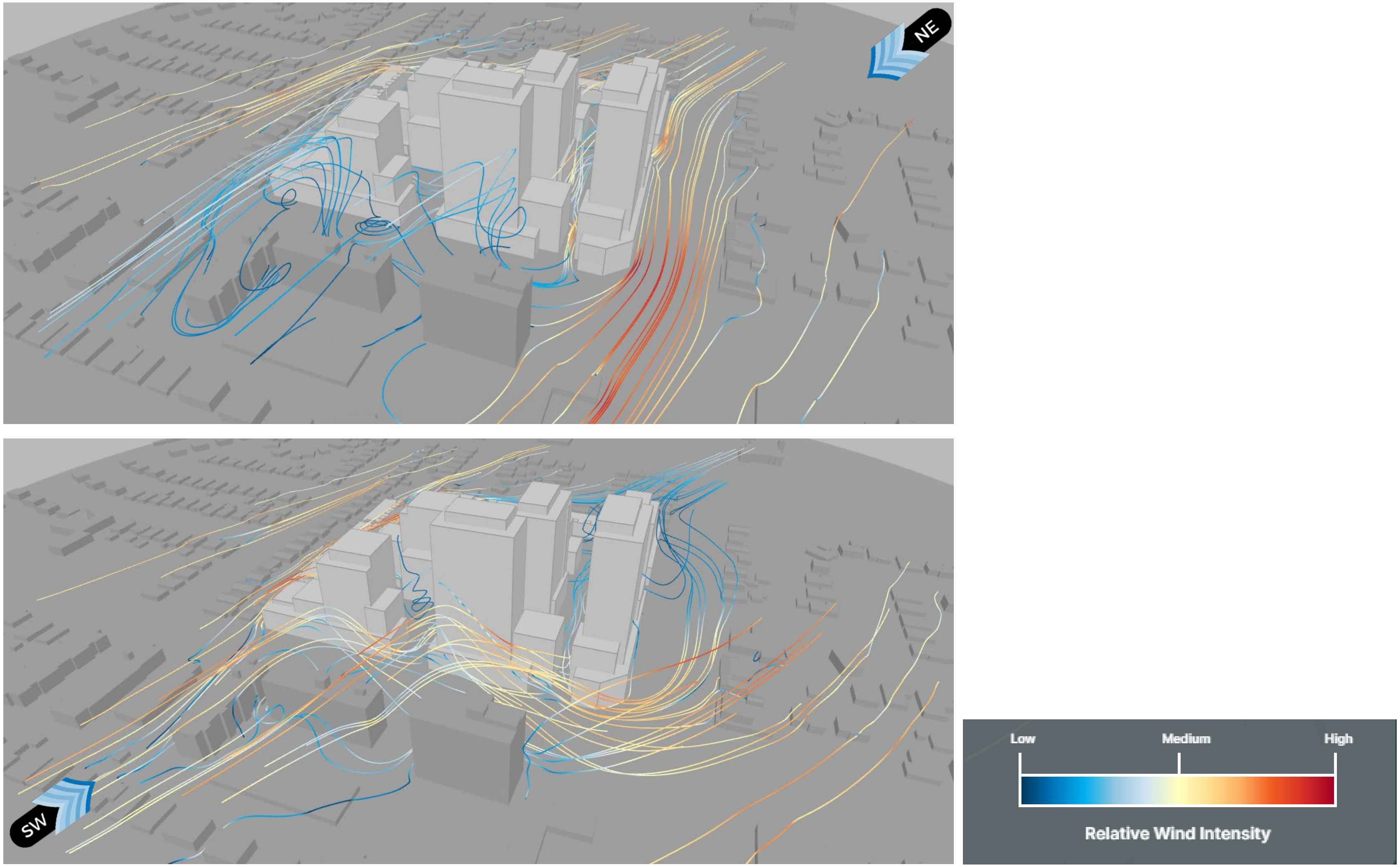


Image 10: Flow Patterns for the Prevailing Winds from the Northeast (upper) and Southwest (lower) Directions

4.5 Proposed Scenario: Comfort

4.5.1 Sidewalks Walkways and Neighbouring Properties

Except the above-mentioned intersection (Location C), the future wind speeds on the project site and surrounding areas are similar to, or slightly reduced from those that currently exist in the area and they are comfortable for the use of walkways and sidewalks in general.

Note that the wind mitigation measures discussed in Section 4.4 for Location C would also improve the wind comfort on sidewalks in the area.

4.5.2 Building Entrances

The location of building entrances is not identified in the current master plan. From the predicted wind conditions shown in Images 8b and 9b, low or moderate wind speeds are expected throughout the core of the development. There are many areas immediately around the proposed buildings where wind speeds are comfortable for sitting or standing throughout the year (dark blue and light blue regions) and suitable for main entrances.

As a general guideline, entrances should be placed away from building corners where wind speeds tend to higher in general (Locations C and D in Images 8b and 9b). If feasible, main entrances should be recessed from building façades and/or protected by screens, planters and canopies.

4.5.3 Outdoor Amenities

Low wind speeds comfortable for sitting or standing are desired for outdoor amenity spaces during the summer months when these areas are typically in use. This criterion is met in most areas around the proposed buildings as shown by the blue regions in Image 8b.

Amenity spaces should be placed away from the exposed building corners (Locations C and D in Image 8b), or wind control solutions will need to be developed.

Higher wind speeds in the winter (Image 9b) are acceptable as outdoor amenities will likely not be occupied frequently in the cold months.

Landscaping, which was not included in the current CFD simulations, will lower wind speeds around it. Coniferous species afford wind control benefits in the winter months as well.

5. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed project at 499 Mohawk Road East in Hamilton, Ontario. Our assessment was based on the local wind climate, the current design of the proposed development, the existing surrounding buildings, and computational modelling and simulation of wind conditions. Our findings are summarized as follows:

- The proposed buildings are taller than the existing surroundings and, therefore, will redirect wind to ground level. However, several positive features in the massing design, such as low podiums and tower setbacks, will help moderate wind impacts to a large extent.
- Low or moderate wind speeds are predicted throughout the core of the development. Wind conditions at ground level are expected to be appropriate for the intended usage. General comments and design guidelines for wind control are provided for main entrances and outdoor amenities, where needed.
- Potentially, uncomfortable and unsafe wind speeds may occur at the southeast corner of the site in the winter. The existing uncomfortable and unsafe wind conditions between the mid-rise buildings to the south of the site will be improved considerably by the proposed development.
- Wind-tunnel testing can be conducted at a later design stage to quantify these wind conditions and, if necessary, to develop wind control solutions.

6. STATEMENT OF LIMITATIONS

Design Assumptions

The findings/recommendations in this report are based on the building geometry and architectural drawings communicated to RWDI on May 30, 2022. 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)
499 Mohawk - 3D Massing Export - May-30-2022	dwg	05/30/2022
499 Mohawk - Site Plan - May.30.2022	pdf	05/30/2022

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.

Limitations

This report was prepared by Rowan Williams Davies & Irwin Inc. for 499 Mohawk Road E. JV ("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.