# 306 KING STREET WEST

HAMILTON, ON

## PEDESTRIAN WIND CFD ASSESSMENT

GNOBI # 390024

JANUARY 26, 2025


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# 1.0 INTRODUCTION

This pedestrian level wind CFD assessment report presents an analysis of the wind conditions around the proposed 306 King Street West development in Hamilton, ON. The purpose of this study is to evaluate the potential wind effects on pedestrians and outdoor spaces within and around the site and was completed as part of the Design Review Panel application.

The analysis considered a range of factors that can influence wind patterns, including wind direction and speed, and the height and configuration of nearby buildings. The results of the analysis provide insight into the expected wind conditions at the site and allow for an assessment of the potential impact of wind on pedestrian comfort and safety.

The proposed development 14-storeys tall (**Image 2**). The area surrounding the site is primarily characterized by low-rise commercial and residential buildings in all directions, except in the southeast quadrant, where several mid to high-rise buildings are located within the downtown core of the city (**Image 1**). Focal points of pedestrian activity that require careful attention include building entryways such as the main entrance along King Street W. and adjacent sidewalks.

Physical modelling or wind tunnel testing in an atmospheric boundary layer wind tunnel is recommended at an appropriate stage of the design to confirm the predicted wind conditions and efficacy of suggested wind mitigation concepts.

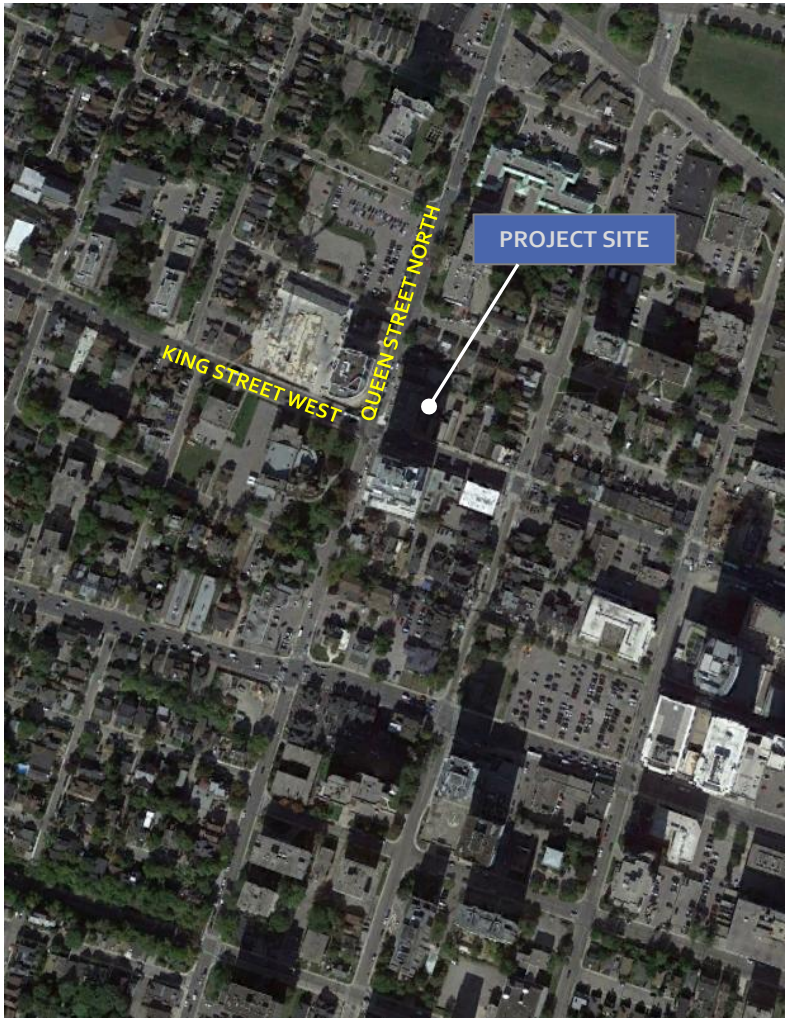


**Image 1:** Aerial View of the Proposed Site, Source: Google Earth™

# 2.0 PROJECT AND SITE CONTEXT

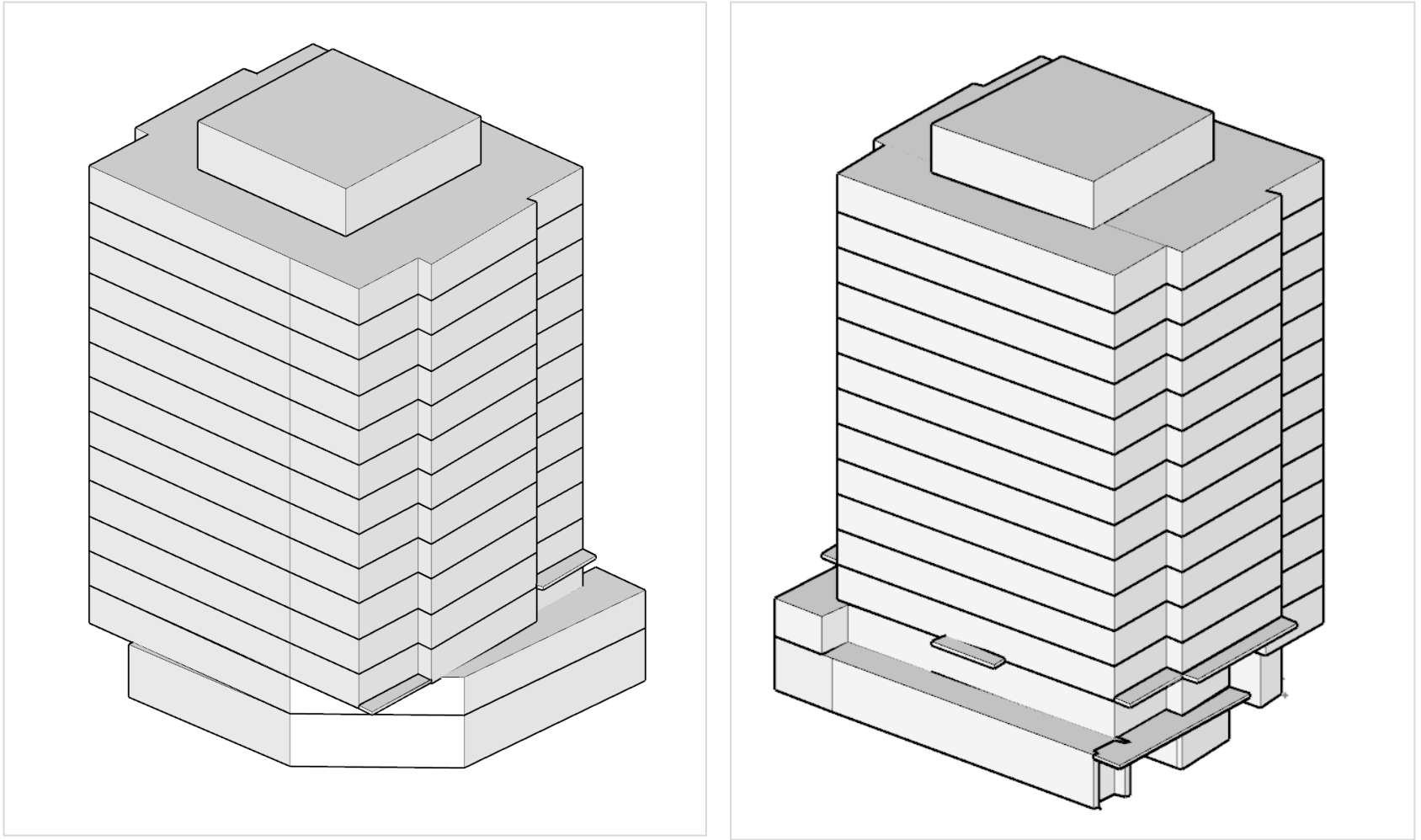

**Image 2:** Simplified Massing / Rendering of the Proposed Project

# 3.0 METHODOLOGY

## 3.1 Study Approach

The study approach involves an assessment of the proposed building design in relation to local wind patterns and the surrounding environment. The assessment utilizes advanced computational fluid dynamics (CFD) modelling, supported by engineering expertise and a deep understanding of wind behavior in urban settings. Insights from previous successful projects with similar characteristics also contribute to the analysis.

The CFD analysis simulates the mean wind speed profile of the atmospheric boundary layer approaching the site for 12 prevailing wind directions. Mean wind speed ratios at a height of approximately 1.5 meters above local grade are then integrated with hourly wind speed measurements from a reference meteorological station. This process enables the prediction of wind speed conditions throughout the site.

The predicted wind speeds are then compared against established thresholds and frequencies to determine their suitability for various pedestrian activities, including sitting, outdoor dining, standing, and walking.

The study evaluates both existing conditions (**Image 3**) and the proposed design configuration within the context of the surrounding environment (**Image 4**).

The CFD analysis serves as a qualitative assessment of the mean wind speed conditions both on and around the project. It forms the basis for providing preliminary feedback on potential strategies to mitigate wind effects and improve the wind conditions, as necessary.

Overall, the methodology ensures a thorough and informed evaluation of pedestrian wind comfort, utilizing cutting-edge tools and our expertise in urban wind dynamics.

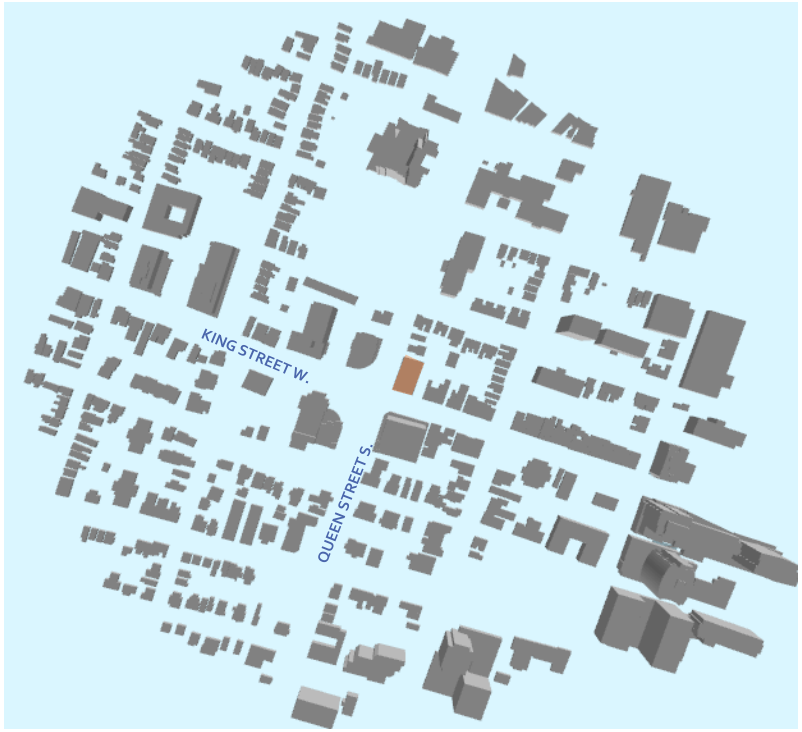


**Image 3:** Model of the Existing Site and Surrounding Context

# 3.0 METHODOLOGY

## 3.1 Study Approach Cont'd


**Image 4:** Model of the Proposed Project and Surrounding Context

# 3.0 METHODOLOGY

## 3.2 Meteorological Data

The local wind climate at the proposed site was evaluated using hourly wind data collected at John C. Munro Hamilton International Airport, situated at a height of 10 meters above ground level, as a point of reference. The wind roses in **Image 5** below presents the cumulative probability distribution of wind speeds for the summer (May to October) and winter (November to April) months.

Analysis of the data reveals that winter months are characterized by a higher frequency of strong winds than the summer months. Specifically, wind speeds greater than 20km/hr occur 18% of the time compared to 35% in the winter.

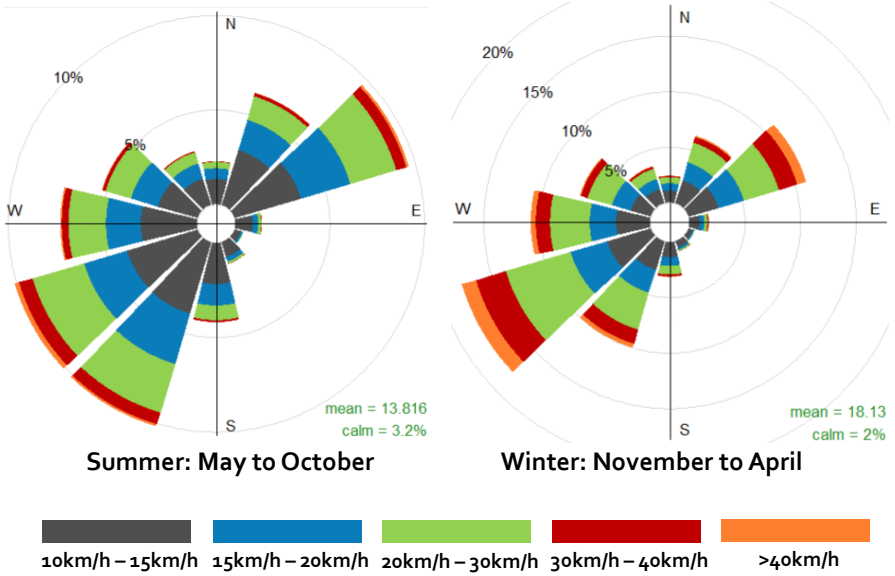


**Image 5:** Wind Data from John C. Munro Hamilton International Airport (1991 – 2022)

# 3.0 METHODOLOGY

## 3.3 Wind Criteria

The pedestrian wind criteria used in the current study are specified in the draft pedestrian level wind Terms of Reference for the City of Hamilton, ON. The wind criteria are an essential component of building design in urban areas. They are established guidelines that determine the maximum allowable wind speed and frequency of occurrence that pedestrians can safely and comfortably tolerate for various passive or active activities such as sitting, standing, strolling or walking. The criteria are generally based on a combination of scientific data, engineering principles, and human experience. They take into consideration factors such as the intended use of the pedestrian spaces on and around the project.

The wind criteria referenced include two primary categories:

**1. Pedestrian Wind Safety / Hazard**

Pedestrian safety is correlated with gust wind speeds that exceed the threshold (90 km/h) capable of negatively impacting a pedestrian's stability and balance. When wind speeds capable of destabilizing an individual, at around 90 km/h, occur more than 0.1% of the time or for a duration of 9 hours per year, the wind conditions can be classified as hazardous.

| Sitting | Standing | Strolling | Walking | Uncomfortable |
|---|---|---|---|---|
| ≤ 10 km/h | ≤ 14 km/h | ≤ 17 | ≤ 20 km/h | > 20 km/h |

**2. Pedestrian Wind Comfort**

**Sitting (≤ 10 km/h):** Tranquil breezes desired for passive pedestrian activities such as outdoor dinning or seating areas.

**Standing (≤ 14 km/h):** Suitable for areas where pedestrians are apt to linger such as main building entrances, drop-off areas, parks and bus stops.

**Strolling (≤ 17 km/h):** Moderate winds that are suitable for leisure walking.

**Walking (≤ 20 km/h):** Relatively high speeds but are considered suitable for active pedestrian activities such as walking, running or cycling.

**Uncomfortable (>20km/h):** wind speeds exceeding 20km/h more than 20% of the time.

To determine suitable wind conditions for pedestrian activities such as sitting, standing, strolling or walking, it is recommended that the associated mean wind speeds be expected for at least 80% of the time (approximately five and half out of seven days). In areas where winds surpass the 20km/h limit for over 20% of the time or surpass the wind safety threshold, wind control measures are typically required to ensure the safety and comfort of individuals.

# 4.0 RESULTS AND DISCUSSION

## 4.1 Existing Wind Conditions

The area surrounding the site is primarily characterized by low-rise commercial and residential buildings in all directions, except in the southeast quadrant, where several mid to high-rise buildings are located within the downtown core of the city.

**Images 6A** and **6B** visually represent the current wind conditions at the site and surrounding areas, based on the findings of the qualitative CFD analysis. As shown in the images, the existing wind conditions on and around the site are generally comfortable for standing or better throughout most of the year. However, localized areas along King Street and Queen Street show conditions suitable for strolling or walking.

Due to the occurrence of seasonally stronger prevailing winds, uncomfortable wind speeds are observed at the southeast corner of Queen and King Streets, as depicted in **Image 6B**.

Additionally, the recommended pedestrian wind safety criterion is predicted to be met across all areas of the site, except near the southeast corner of King and Queen Streets, where potential exceedance of the safety criterion is likely.

## 4.2 Wind flow Patterns around the Proposed Project

In general, winds tend to flow smoothly over buildings of uniform height. However, taller buildings disrupt this smooth flow by intercepting and redirecting the wind around them, a phenomenon known as downwashing. Additionally, as wind flows around the corners of these buildings, it can cause localized increases in wind speed, known as corner acceleration.

Another common wind flow pattern in urban environments is wind tunneling or channeling, which occurs when two tall buildings are positioned side by side, causing the prevailing winds to accelerate through the gap between them. Factors influencing this phenomenon include the size of the gap and the alignment of the buildings with one or more prevailing wind directions at the project site.

Narrower gaps tend to create stronger wind tunnel effects, while larger distances reduce the potential for channeling. These wind flow mechanisms are often the main factors contributing to uncomfortable and potentially hazardous wind conditions around buildings.

The current CFD assessment for the proposed project considers wind tunneling/channeling, downwashing, corner acceleration, and other typical wind patterns found in urban settings.

# 4.0 RESULTS AND DISCUSSION

## 4.3 Proposed Wind Conditions

The area surrounding the site is primarily characterized by low-rise commercial and residential buildings in all directions, except in the southeast quadrant, where several mid to high-rise buildings are located within the downtown core of the city.

As shown in **Images 7A** and **7B**, the CFD simulation provides valuable insights into the anticipated wind conditions around the site. The results indicate that the proposed project will have minimal adverse effects on existing wind patterns in the surrounding areas and may improve wind speeds in some localized areas due to its sheltering effect for winds approaching from one or more prevailing directions.

**Wind Conditions and Comfort Levels:**

- **Year-Round Condition**s: Wind speeds on nearby sidewalks are predicted to be suitable for strolling, standing, or better in most areas throughout the year, aligning with desired comfort criteria. Localized areas along King and Queen Streets are expected to remain comfortable for walking during the summer months.
- **Winter Conditions:** Seasonally stronger prevailing winds during winter are expected to result in more areas along King and Queen Streets, as well as the alley west of the adjacent Hampton Inn Hotel on Queen Street North, being suitable for walking.

**Southeast Corner and Entrance Conditions:**

- **Southeast Corner (King & Queen Streets):** The existing uncomfortable wind conditions near the southeast corner of King and Queen Streets are expected to improve slightly with the addition of the proposed building due to its sheltering effect. However, some areas of uncomfortable wind speeds are likely to persist.
- **Main Entrance:** The main entrance, located on the southwest corner along King and Queen Streets, is designed to include a vestibule—a positive design feature that provides a sheltered area for pedestrians on particularly windy days. Wind speeds at the main entrance are predicted to be comfortable for standing or better year-round, which is appropriate for a building entrance where pedestrians may linger.

**Wind Safety and Mitigation Recommendations:**

- **Wind Improvement Strategies:** If calmer conditions suitable for strolling are desired, particularly near the northwest corner of the project along Queen Street North where conditions suitable for walking are predicted, the design team may consider adding a canopy at the northwest corner.
- **Pedestrian Wind Safety:** The analysis predicts that the wind safety criterion will be met across most of the site, except for a localized area near the southeast corner of King and Queen Streets, where a potential exceedance of the criterion exists (these are pre-existing and not due to the addition of the project).
- **Further Testing:** Wind tunnel testing is recommended as the design progresses to confirm predicted wind conditions and assess the effectiveness of the suggested wind mitigation measures.

# 4.0 RESULTS AND DISCUSSION

## 4.4 CFD Simulation Results – Existing and Proposed Wind Conditions

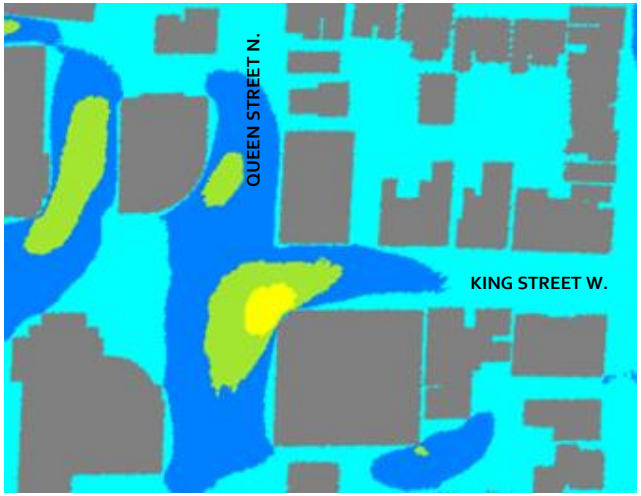


**Image 6A:** Existing – Summer (May to October, 6am to 11pm)

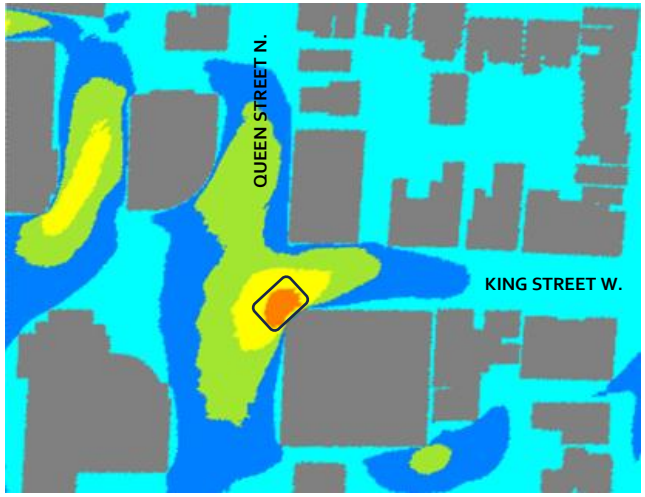


**Image 6B:** Existing – Winter (November to April, 6am to 11pm)

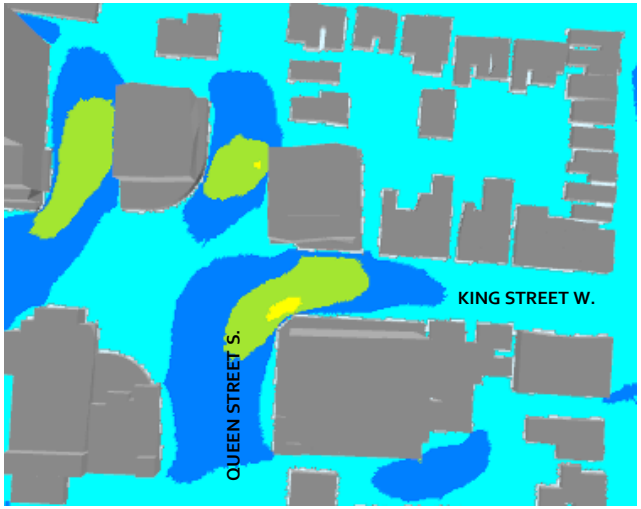


**Image 7A:** Proposed – Summer (May to October, 6am to 11pm)

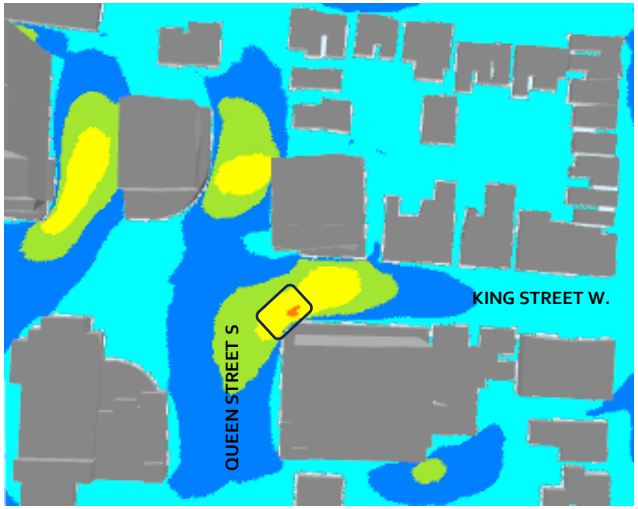


**Image 7B:** Proposed – Winter (November to April, 6am to 11pm)

N

LEGEND:

- Sitting ≤ 10 km/h
- Standing ≤ 14 km/h
- Strolling ≤ 17 km/h
- Walking ≤ 20 km/h
- Uncomfortable > 20 km/h
- Potential Safety Exceedance (24Hrs)

# 5.0 CONCLUSION

Gnobi Consulting Inc. was contracted to complete a qualitative pedestrian level wind CFD assessment for the proposed 306 King Street west development in in Hamilton, ON. The assessment utilized state-of-the-art CFD modeling techniques, a thorough analysis of the local wind climate, the proposed design, existing surrounding buildings, and our expertise in wind tunnel testing of similar structures, combined with our engineering judgment and knowledge of wind behavior in the built environment.

The current qualitative CFD wind study analyzed the existing and proposed wind conditions around the project site, considering key wind flow mechanisms such as downwashing, corner acceleration, and channeling. Under current conditions, wind speeds are generally comfortable for standing or better throughout the year. However, localized areas along King and Queen Streets exhibit conditions suitable for walking or strolling, and the southeast corner of King and Queen Streets experiences uncomfortable wind speeds during the winter months.

With the proposed project in place, the CFD analysis predicts minimal adverse effects on the surrounding wind patterns. The project is expected to slightly improve wind conditions at certain locations due to its sheltering effect for winds from one or more prevailing directions. Most areas near the site are predicted to meet the desired comfort standards (i.e., comfortable for strolling or better), with localized sidewalks along King and Queen Streets to be comfortable for walking during the summer. During the winter, seasonally stronger prevailing winds are predicted to expand areas suitable for walking along King and Queen Streets.

To achieve calmer conditions suitable for strolling, particularly near the northwest corner of the project along Queen Street North, where walking conditions are expected, the design team may consider wind mitigation measures such as adding a canopy at the northwest corner.

The main entrance, located at the southwest corner of King and Queen Streets, benefits from a vestibule, a positive design feature providing pedestrians with a sheltered area during windy conditions. Wind conditions at the entrance are anticipated to remain comfortable for standing or better year-round, which is appropriate for pedestrian use.

With the addition of the proposed development, the recommended annual wind safety criterion is predicted to be met across most of the site. However, a localized area near the southeast corner of King and Queen Streets, where pre-existing exceedances of the criterion occur, may see little change and is expected to persist.

As the design progresses toward site plan approval, wind tunnel testing is recommended to confirm the predicted wind conditions and validate the effectiveness of the recommended wind mitigation concepts.

# 6.0 REFERENCES


Isyumov, N. and Davenport, A.G., (1977) "The Ground Level Wind Environment in Built-up Areas", Proc. Of 4th Int. Conference on Wind Effects on Buildings and Structures, London, England, Sept. 1975, Cambridge University Press, 1977.

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# 7.0 STUDY APPLICABILITY

The assessment presented in this report pertains to the proposed development at 306 King Street West, Hamilton, ON, and is predicated on the coordination set of architectural drawings received from Bousfields Inc. January 16, 2025. Should there be any substantial modifications to the design, Gnobi Consulting Inc. is available to evaluate their potential impact on the pedestrian wind conditions discussed in this report. ***It is incumbent upon others to initiate this process by contacting Gnobi Consulting Inc.***