705 KINGSTON ROAD

PICKERING, ON

PEDESTRIAN LEVEL WIND CFD ASSESSMENT

GNOBI # 010023

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1.0 INTRODUCTION

This pedestrian-level wind CFD assessment report evaluates wind conditions around the proposed 705 Kingston Road development in Pickering, ON. The study aims to assess potential wind impacts on pedestrians and outdoor spaces within and around the site, conducted as part of the Zoning By-law Amendment application for the redevelopment.

The analysis considers factors such as wind direction, speed, and the height and configuration of nearby buildings. The findings offer insights into expected wind conditions at the site and assess potential impacts on pedestrian comfort and safety.

The proposed development features five mixed-use residential towers ranging from 28 to 35 storeys (approximately 101.82m to 122.77m) in height. The surrounding area is primarily characterized by medium- to low-rise commercial and residential buildings. Key areas of pedestrian activity requiring attention include building entrances, outdoor amenities, parking lots, and adjacent sidewalks.

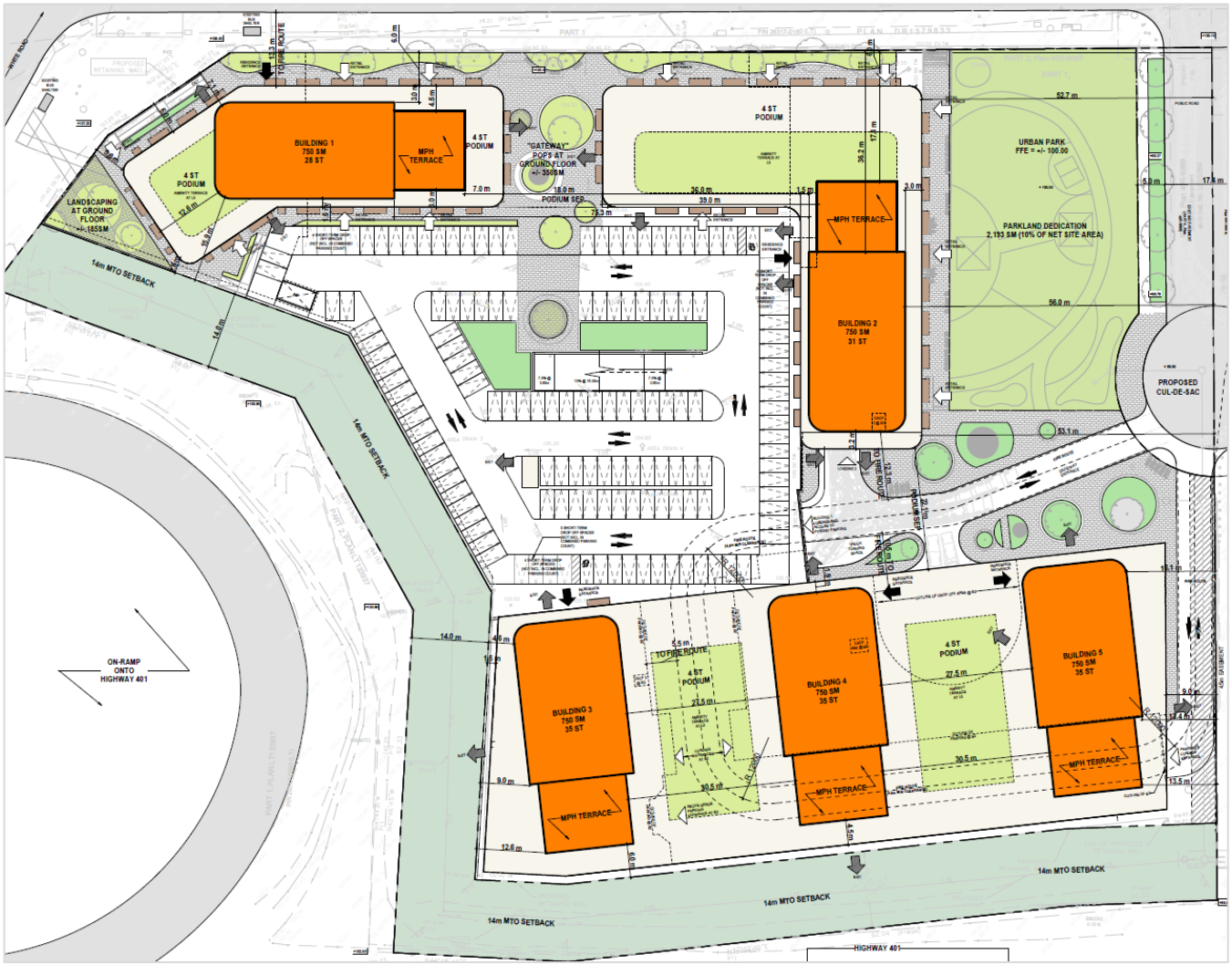
Images 2 and **3** below depict essential visual representations of the proposed project, site plan and ground floor plan. The main entrances to the development are highlighted in **Images 2** and **3**.

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

2.0 PROJECT AND SITE CONTEXT

Image 2: Renderings of the Proposed Project, Courtesy: BDP Quadrangle Inc.

2.0 PROJECT AND SITE CONTEXT



Main Residential Entrances

Image 3: Proposed Site Plan, Courtesy: BDP Quadrangle Inc.

2.0 PROJECT AND SITE CONTEXT

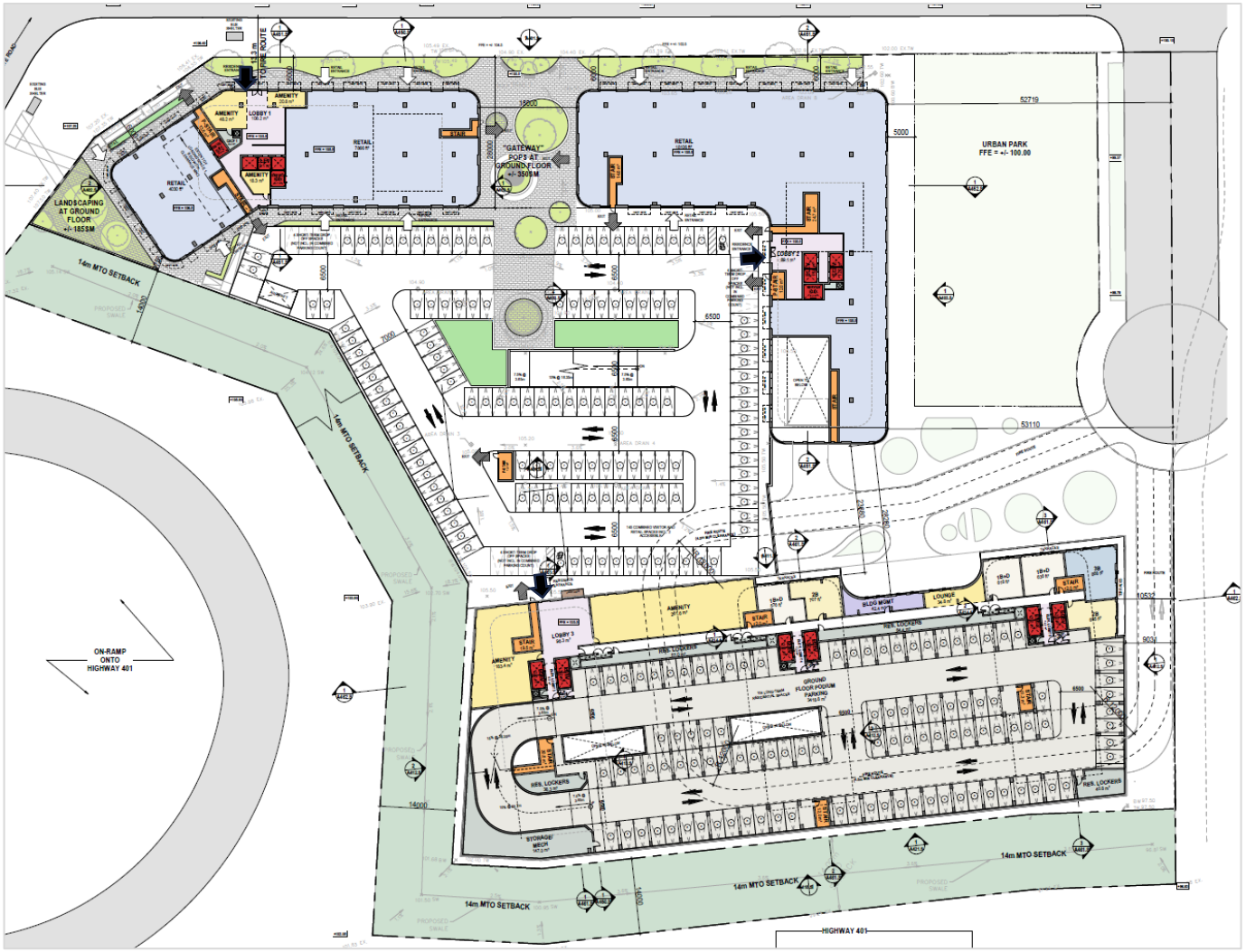


Image 4: Proposed Ground Floor Plan, Courtesy: BDP Quadrangle Inc.

3.0 METHODOLOGY

3.1 Study Approach

The study approach involves a thorough 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, incorporating at least 16 wind directions at 22.5° intervals. 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 5**) and the proposed design configuration within the context of the surrounding environment (**Image 6**).

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.

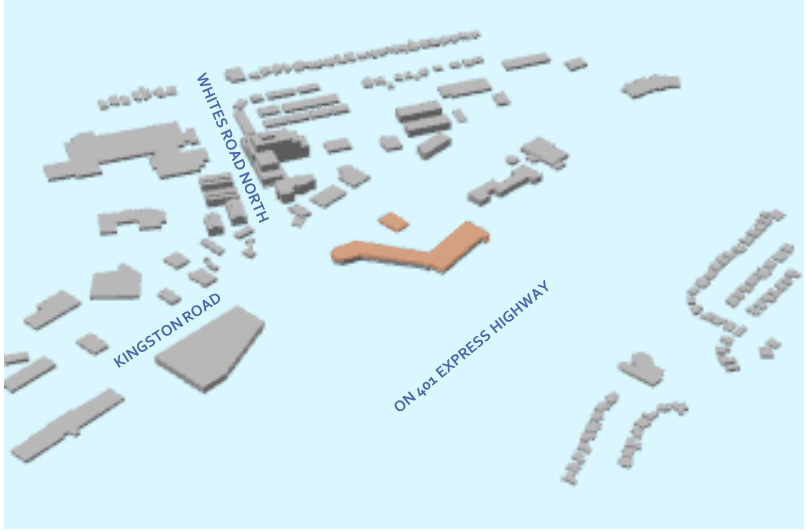


Image 5: Model of the Existing Site and Surrounding Context

3.0 METHODOLOGY

3.1 Study Approach Cont'd

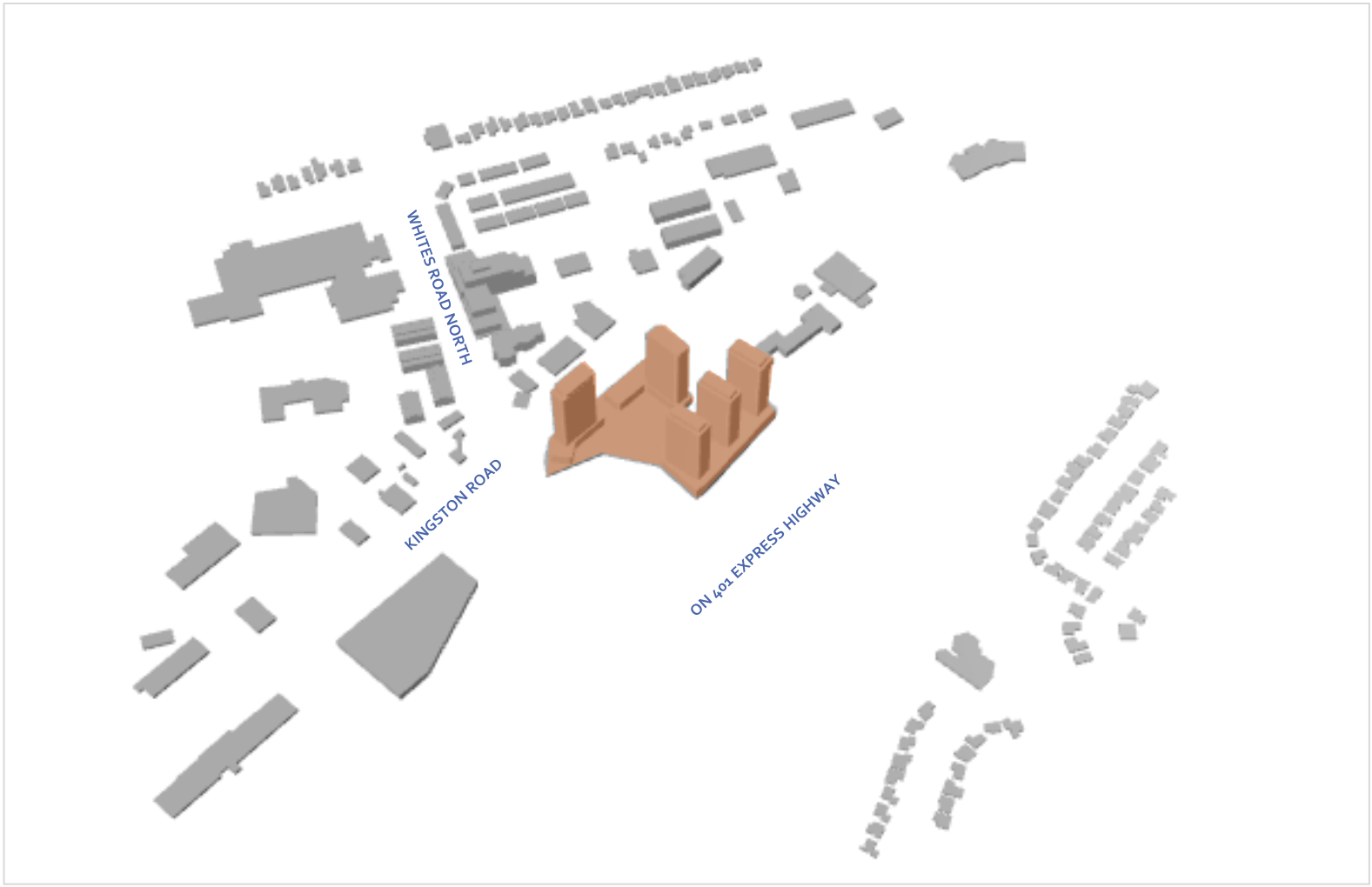


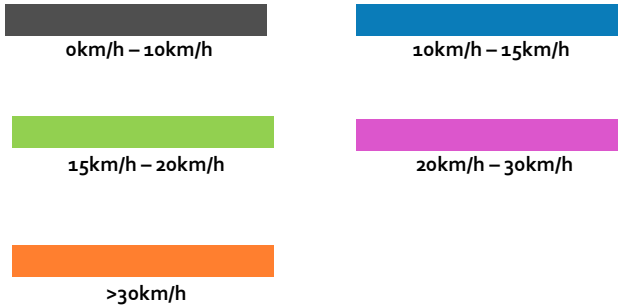
Image 6: Model of the Proposed Project and Surrounding Context

3.0 METHODOLOGY

3.2 Meteorological Data

The local wind climate at the proposed site was evaluated using hourly wind data collected at Toronto Pearson International Airport, situated at a height of 10 meters above ground level, as a point of reference. The wind roses in **Image 7** below presents the cumulative probability distribution of wind speeds for the spring (March to May), summer (June to August), fall (September to November) and winter (December to February) months.

Analysis of the data reveals that spring and winter months are characterized by a higher frequency of strong winds than the summer and fall months and the strong winds occur primarily from the northwest and southwest quadrants.



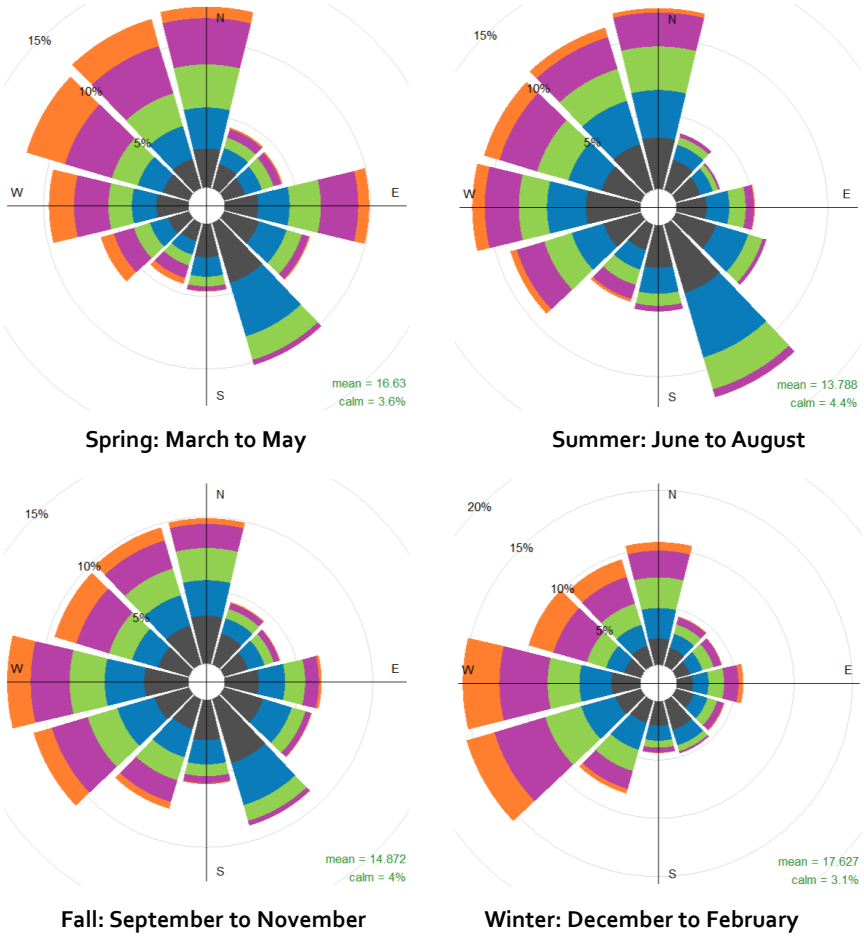


Image 7: Wind Data from Toronto Pearson International Airport (1992 – 2022)

3.0 METHODOLOGY

3.3 Wind Criteria

The pedestrian wind criteria used in the current study are specified in the pedestrian level wind Terms of Reference of most cities in southern Ontario and are applicable in the city of Pickering, 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.

2. Pedestrian Wind Comfort

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

Standing (≤ 15 km/h): Suitable for areas where pedestrians are apt to linger such as main building entrances, drop-off areas, parks and bus stops.

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.

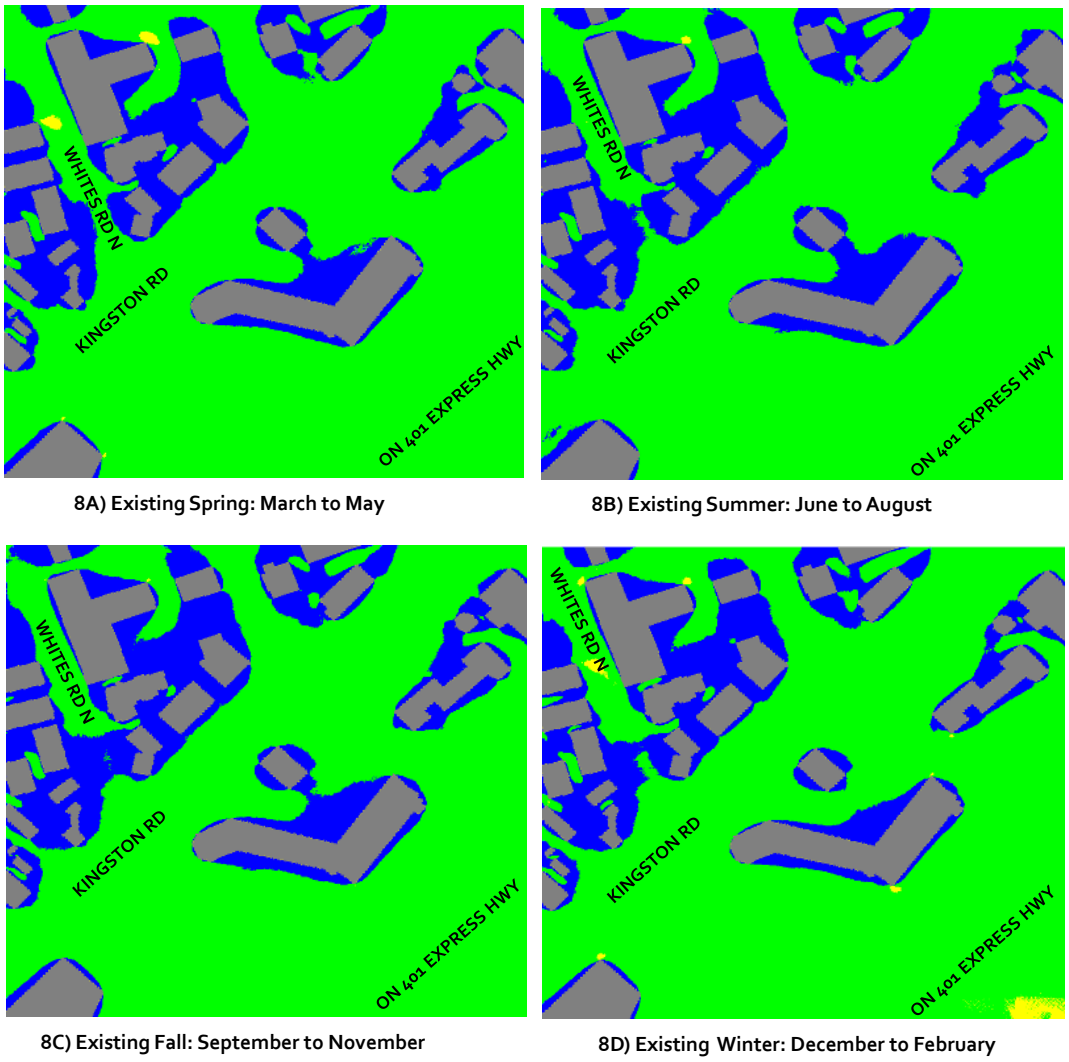
4.0 RESULTS AND DISCUSSION

4.1 Existing Wind Conditions

The proposed site is primarily surrounded by a combination of medium to low-rise commercial and residential buildings in all directions, as a result, the impact of downwashing and subsequent corner-accelerating winds at the site is expected to be minimal.

Images 8A to **8D** visually represent the current wind conditions at the site and surrounding areas, based on the findings of the CFD analysis. As depicted in the images, the existing wind conditions generally provide a comfortable environment for standing or better throughout the year, which is deemed appropriate.

Furthermore, the prediction indicates that the pedestrian wind hazard/safety criterion is met in all areas on and around the existing site. This suggests that wind conditions are unlikely to pose any danger to pedestrians.



8A) Existing Spring: March to May

8B) Existing Summer: June to August

8C) Existing Fall: September to November

8D) Existing Winter: December to February

Image 8: Existing Wind Conditions (6am to 11pm, Spring, Summer, Fall & Winter)

4.0 RESULTS AND DISCUSSION

4.2 Proposed Design and Anticipated Wind Flows

The proposed project incorporates several positive design features that are deemed advantageous for favorable wind speeds and should be preserved in the final design. These features include the following:

1. The strategic placement of the main residential entrances away from exposed building corners, which are prone to higher wind speeds.
2. The rounded corners of the towers also contribute to favourable wind speeds by making the building more aerodynamic and to some extent reducing the potential for downwashing winds.
3. The incorporation of building setbacks and steps, which contribute to the overall design and wind mitigation measures.

By retaining these design elements, the project can capitalize on their benefits in terms of wind speed management.

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.

4.3 Proposed Wind Conditions

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

As shown in **Images 9A** through **9D**, the CFD simulation provides valuable insights into the anticipated wind conditions around the site. The results suggest that the project will have a minimal impact on existing wind patterns in the surrounding areas. Throughout the year, wind speeds on nearby sidewalks are expected to be suitable for standing or walking, aligning with the desired comfort criteria.

Wind conditions in the above-grade parking area between the towers are predicted to be generally comfortable for standing, which is appropriate for the space. Additionally, the wind speeds at the main residential entrance and retail entrances are expected to remain comfortable for their intended use year-round.

4.0 RESULTS AND DISCUSSION

4.3 Proposed Wind Conditions (Grade Level)

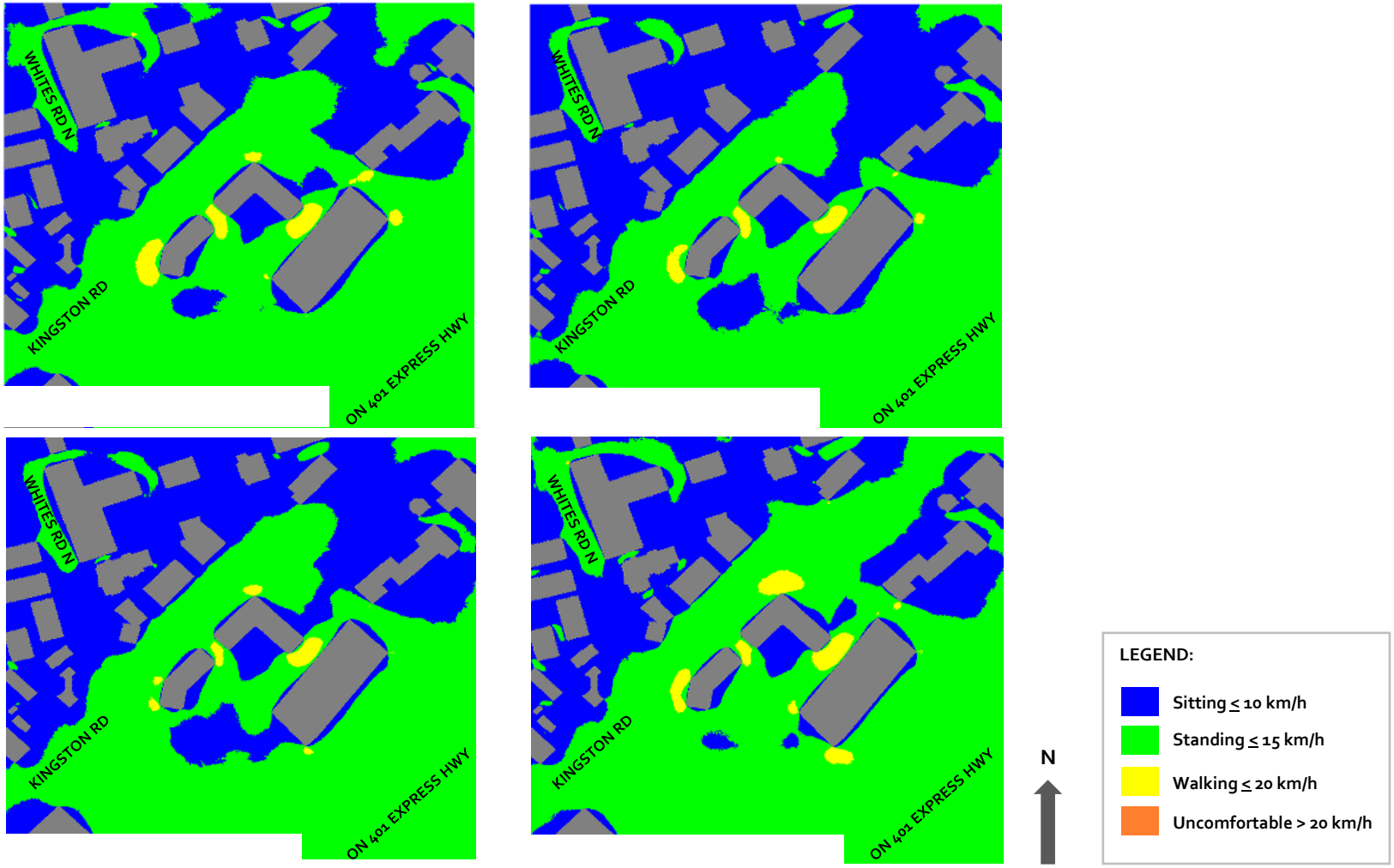


Image 9: Proposed Wind Conditions (6am to 11pm, Spring, Summer, Fall & Winter)

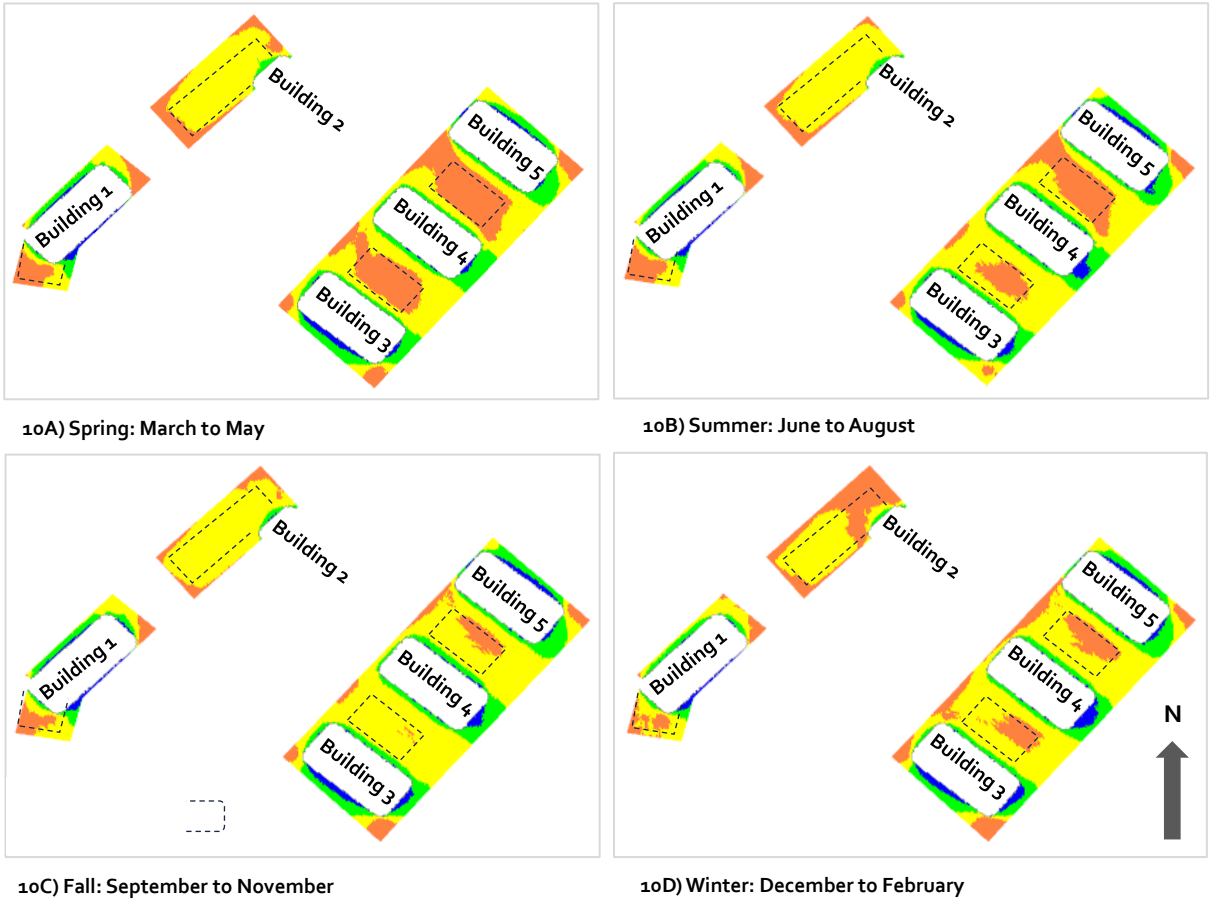
4.0 RESULTS AND DISCUSSION

4.3 Proposed Wind Conditions

Several above-grade amenity areas are planned throughout the development, as shown in Image 10. Ideally, wind conditions at these locations should be comfortable for sitting or standing, given that pedestrians are likely to spend time there. However, as depicted in **Image 10**, wind speeds on the podium are generally more suitable for walking in most areas and uncomfortable in some localized areas on Building 1 and between Buildings 3, 4 and 5 during the summer when the area will be most frequently used.

In addition, the annual wind safety criterion may be exceeded at localized areas of the podium where uncomfortable wind speeds are anticipated.

To enhance comfort in these amenity areas, hardscape wind control measures—such as trellises, canopies, taller parapets, guardrails, and localized wind screens—can be implemented to create more sheltered and pleasant spaces for pedestrians.



10A) Spring: March to May

10B) Summer: June to August

10C) Fall: September to November

10D) Winter: December to February

Image 10: Proposed Wind Conditions – Above Grade Level (6am to 11pm, Spring, Summer, Fall & Winter)

5.0 CONCLUSION

Gnobi Consulting Inc. was contracted to conduct a pedestrian-level wind CFD assessment for the proposed development at 705 Kingston Road in Pickering, 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 report provides a comprehensive analysis of the wind conditions around the proposed project site. Positive design features, such as positioning the main residential entrances away from building corners (which are more susceptible to strong winds), tower setbacks, and the aerodynamic design of the towers, demonstrate a proactive approach to managing wind speeds and enhancing pedestrian comfort.

Based on the CFD simulation results shown in **Images 9A** through **9D**, wind speeds on surrounding sidewalks are expected to be comfortable and suitable for pedestrian activities throughout the year. Additionally, wind conditions at the main residential and retail entrances, as well as in the above-grade parking area, are predicted to provide a comfortable environment year-round.

For the proposed above-grade amenity areas, **Images 10A** through **10D** show variations in wind conditions that may be higher than desired for spaces where pedestrians are likely to linger. However, adding localized hardscape features, such as trellises, canopies, taller parapets/guardrails (at least 2.5 meters tall), and wind screens, can improve wind speeds in these areas to more comfortable levels.

Overall, the recommended pedestrian wind safety criteria are expected to be met at all grade-level areas of the site throughout the year, ensuring pedestrian safety and comfort, except for localized areas on the podium where uncomfortable wind speeds are anticipated. As the design progresses toward site plan approval, wind tunnel testing can be conducted to confirm the predicted wind conditions and validate the effectiveness of the recommended wind mitigation strategies.

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.

Stathopoulos, T., Wu, H., (1995) "Generic models for pedestrian-level winds in built-up regions" *Journal of Wind Engineering and Industrial Aerodynamics 41/44.*

Durgin, F.H. (1997) "Pedestrian level wind criteria using the equivalent average" *Journal of Wind Engineering and Industrial Aerodynamics 66.*

Blocken, B., and J. Carmeliet (2004) " Pedestrian Wind Environment around buildings: Literature Review and Practical Examples" *Journal of Thermal Environment and Building Science, 28(2)*

Cochran, L. (2004) "Design Features to Change and/or Ameliorate Pedestrian Wind Conditions" ASCE Structures Conference 2004.

Irwin, P.A. (2004) "Overview of ASCE Report on Outdoor Comfort Around Buildings: Assessment and Methods of Control" ASCE Structures Conference 2004.

7.0 STUDY APPLICABILITY

The assessment presented in this report pertains to the proposed development at 705 Kingston Road in Pickering, ON., and is predicated on the coordination set of architectural drawings by BDP Quadrangle Inc. and 3D SketchUp model received September 26, 2024. ***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***.