1900 APPLEBY LINE

BURLINGTON, ONTARIO

PEDESTRIAN WIND ASSESSMENT

PROJECT #2104103
MAY 26, 2021

SUBMITTED TO

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by LJM Developments to conduct a qualitative assessment of the pedestrian wind conditions expected around the proposed project at 1900 Appleby Line in Burlington, Ontario. This effort is intended to inform good design and has been conducted in support of Rezoning Application for the project.

The proposed site is located at the south corner of the intersection of Appleby Line and Ironstone Dr (Image 1). The site is surrounding by low-rise commercial and residential buildings, except three relatively tall buildings along Ironstone Drive to the north. Lake Ontario is around 5 km to the southeast.

The project consists of three phases and will encompass three buildings with primarily residential units and some commercial/retail. Phase One will consist of an 18-storey building, and Phase Two and Three will consist of two 16-storey buildings, as shown in Images 2 and 3. Pedestrian areas of interest include sidewalks, walkways, building entrances, privately-owned publicly accessible spaces (POPS), and the Level 3 outdoor amenity terrace of Phase One tower.

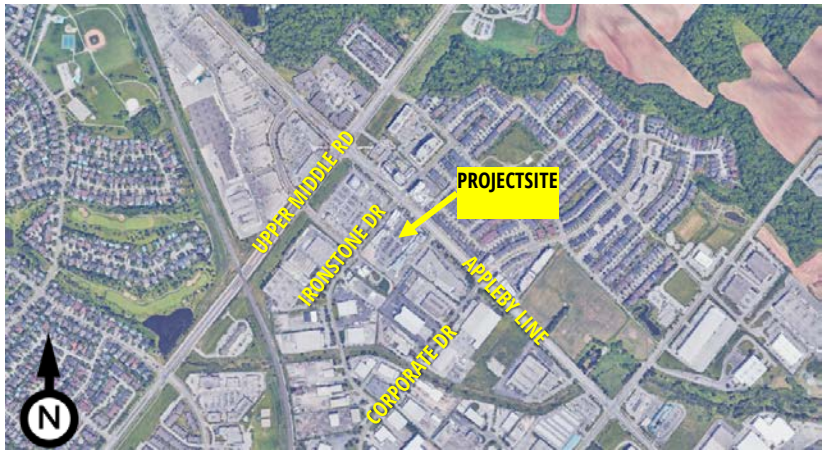


Image 1: Aerial View of the Existing Site and Surroundings (Credit: Google Maps)



Image 2: Project Rendering – North View

1. INTRODUCTION



Image 3a: Project Rendering – West View



Image 3b: Project Rendering – South View

1. INTRODUCTION

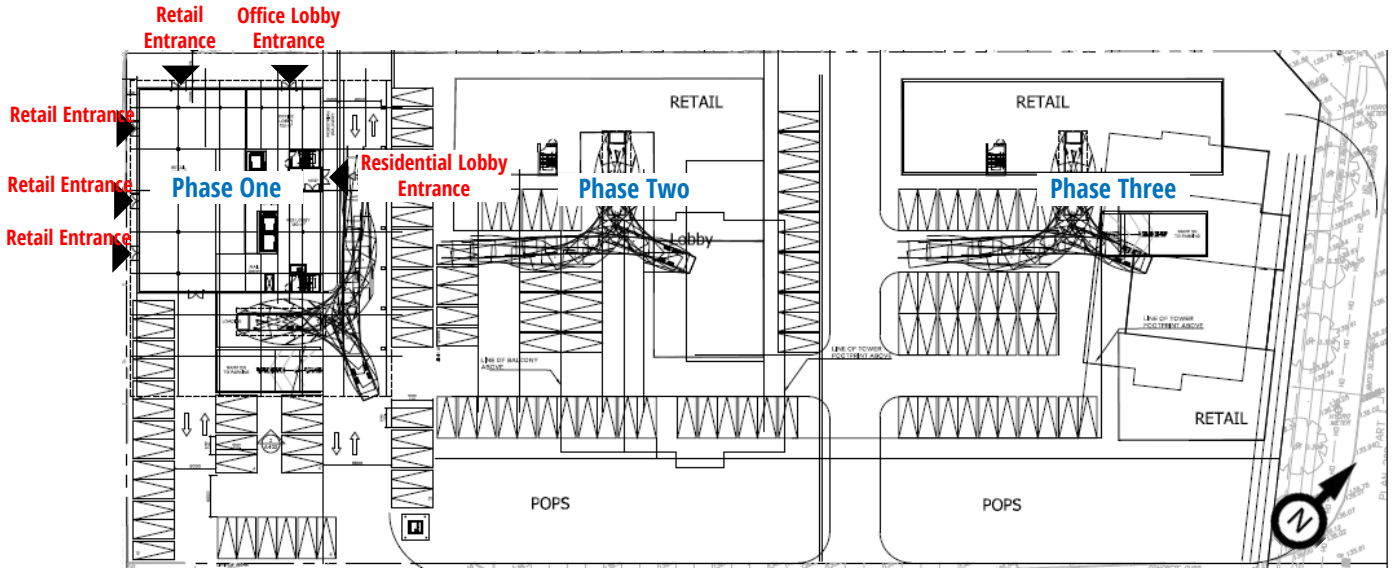


Image 3c: Ground Floor Plan

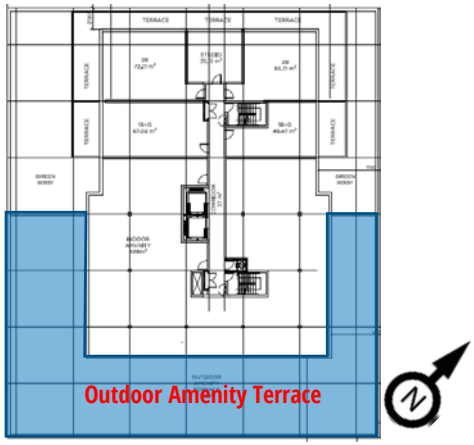


Image 3d: Level 3 Outdoor Amenity Terrace of Phase One Tower

2. METHODOLOGY

Predicting wind speeds and occurrence frequencies is complex. It involves the combined assessment of building geometry, orientation, position and height of surrounding buildings, upstream terrain and the local wind climate.

Over the years, RWDI has conducted thousands of wind-tunnel model studies on pedestrian wind conditions around buildings, yielding a broad knowledge base. In some situations, this knowledge and experience, together with literature, allow for a reliable, consistent and efficient desktop estimation of pedestrian wind conditions without wind-tunnel testing. This approach provides a screening-level estimation of potential wind conditions and offers conceptual wind control measures for improved wind comfort, where necessary.

In order to quantify and confirm the predicted conditions or refine any of the suggested conceptual wind control measures, physical scale model tests in a boundary-layer wind tunnel would be required.

Note that other microclimate issues such as those relating to cladding and structural wind loads, door operability, building air quality, noise, vibration, etc. are not part of the scope of this assessment.

RWDI's assessment is based on the following:

- Design drawings and renderings received by RWID on May 4 and 14, 2021;
- A review of the regional long-term meteorological data from Hamilton International Airport;
- Use of RWDI's proprietary software (*WindEstimator*[1]) for providing a screening-level numerical estimation of potential wind conditions around generalized building forms;
- Wind-tunnel studies and desktop assessments undertaken by RWDI for projects in the Burlington area;
- RWDI's engineering judgement and knowledge of wind flows around buildings[2, 3]; and,
- The wind comfort and safety criteria specified in the Pedestrian Level Wind Study Guidelines and Terms of Reference published in March 2020 by the City of Burlington.

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.

3. METEOROLOGICAL DATA

Meteorological data from Hamilton International Airport for the period from 1990 to 2019 were used as a reference for wind conditions in the project area as specified in the Pedestrian Level Wind Study Guidelines and Terms of Reference published by the City of Burlington. The distributions of wind frequency and directionality for the summer (May through October) and winter (November through April) seasons are shown in the wind roses in Image 4.

When all winds are considered, winds from the southwest and northeast are predominant throughout the year. Strong winds of a speed greater than 30 km/h measured at the airport (red and yellow bands) occur more often in the winter than in the summer season. These strong winds potentially could be the source of uncomfortable or severe wind conditions, depending on the site exposure and development design.

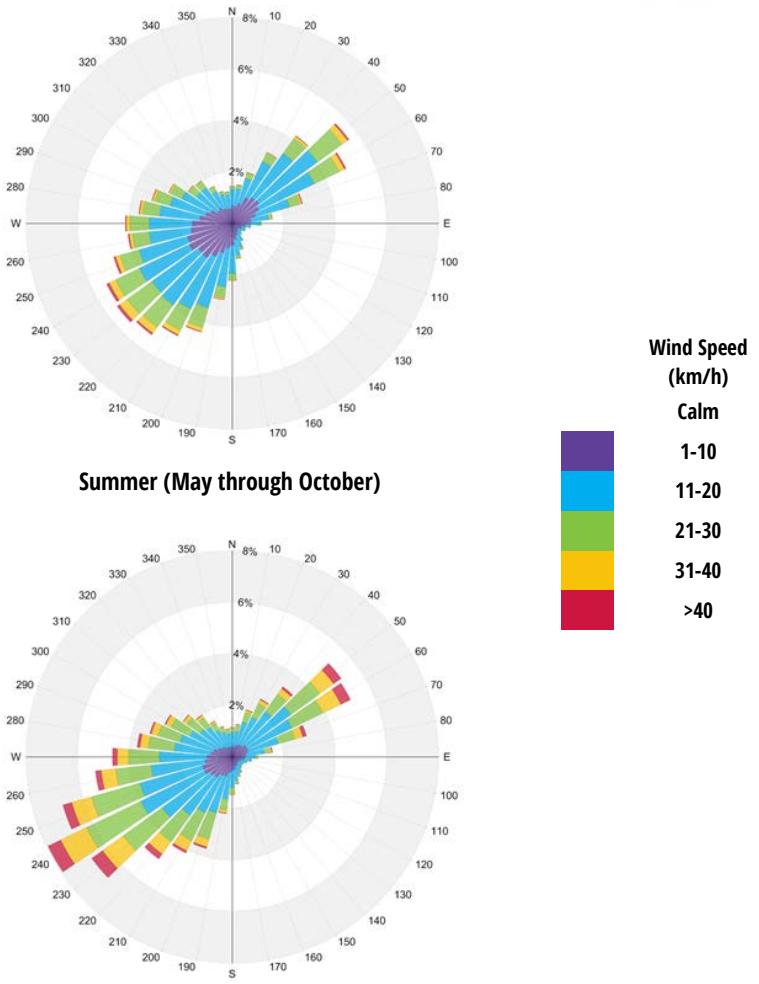


Image 4: Directional Distribution of Winds Approaching Hamilton International Airport (1990 to 2019)

4. WIND CRITERIA

The wind comfort and safety criteria specified in the Pedestrian Level Wind Study Guidelines and Terms of Reference published in March 2020 by the City of Burlington are used in this study. The criteria are presented herein.

The comfort assessment considers hours between 06:00 and 23:00 and is based on Gust Equivalent Mean speeds, which is a calculated mean speed that accounts for the effect of gust as well. The comfort categorization is based on a minimum compliance with the GEM speed criteria for 80% of the time (four out of five days) in each season. Hours between are considered in the assessment.

The safety assessment considers all hours of the day and the criterion is based on an annual exceedance of 9 hours or 0.1% of the time annually.

Note that these wind speeds are assessed at the pedestrian height (i.e., 1.5 m above grade or the concerned floor level), typically lower than those recorded in the airport (10 m height and open terrain).

For the current development, wind speeds comfortable for fast walking or leisurely walking are appropriate for sidewalks; lower wind speeds comfortable for standing are required for building entrances and bus-stops where pedestrians may linger, and calm wind speeds suitable for sitting are desired in areas where passive activities are anticipated, such as the retail patio.

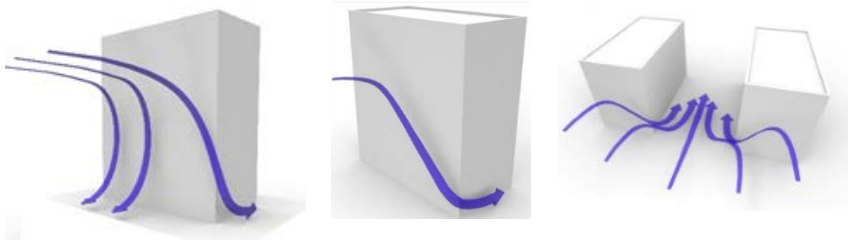
Comfort Category	GEM Wind Speed (km/h)	Description
Sitting	≤ 10	Calm or light breezes •Appropriate for dedicated seating areas such as cafés, patios, and outdoor amenity areas
Standing	≤ 14	Gentle breezes •Appropriate for main building entrances, bus stops, and other places where pedestrians may linger
Leisurely Walking	≤ 17	Moderate winds •Appropriate for shopping and strolling along retail streets and parks
Fast Walking	≤ 20	Relative higher speed winds •Appropriate for areas where pedestrians are walking, running, or cycling without lingering
Uncomfortable	> 20	Strong winds •Inappropriate due to nuisance for all pedestrian activities •Wind mitigation measures required
Safety Criterion	**Gust Speed (km/h)**	**Description**
Exceeded	> 90	•Excessive gust speeds •Adverse effect on pedestrian's balance and footing •Wind mitigation is required

5. RESULTS AND DISCUSSION

5.1 Wind Flow Around Buildings

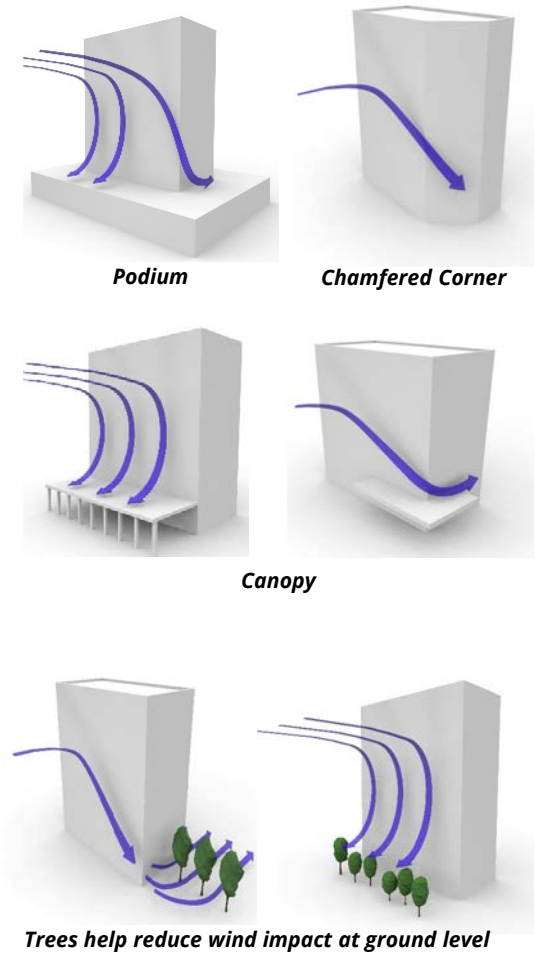
Tall buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level (Downwashing). These winds subsequently move around exposed building corners, causing a localized increase in wind activity due to Corner Acceleration, and in the gap between buildings (Channelling Effect), causing increased wind activity at grade. Image 5 shows illustrations of these flows. If these building / wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and *uncomfortable* conditions.

Design details such as low podium, chamfered corner, deep canopies close to ground level, wind screens / tall trees with dense underplanting, etc. (Image 6) can help reduce wind speeds. The choice and effectiveness of these measures would depend on the exposure and orientation of the site with respect to the prevailing wind directions and the size and massing of the proposed buildings.



Downwashing ***Corner Acceleration*** ***Channelling Effect***

Image 5: Generalized Wind Flows



Podium ***Chamfered Corner***

Canopy

Trees help reduce wind impact at ground level

Image 6: Examples of Common Wind Control Measures

5. RESULTS AND DISCUSSION

5.2 Existing Scenario

The existing site is currently occupied by two low-rise commercial buildings and a parking lot, and surrounded by low-rise commercial and suburban neighborhoods, except three relatively tall buildings along Ironstone Drive to the north. As such, wind conditions on the sidewalks around the site are considered to be comfortable for sitting or standing in the summer and for standing or leisurely walking in the winter.

Although the existing buildings along Ironstone Drive are relatively tall, they are located north of the project site, where winds are not predominant throughout the year. Wind conditions exceeding the safety criterion are not expected on or around the project site.

5.3 Proposed Scenario: Wind Flow

As shown in Image 4, the prevailing winds are from the southwest and northeast directions for both the summer and winter seasons. The proposed towers are 18 and 16 storeys, which are taller than the existing surroundings in the prevailing wind directions. They will deflect winds down to the grade level, causing increased wind activity around tower corners and nearby sidewalks.

The resultant wind conditions are predicted in Images 7a and 7b for the summer and winter seasons, respectively, together with the corresponding wind roses. The following sections provide a discussion of the potential wind conditions around the project.

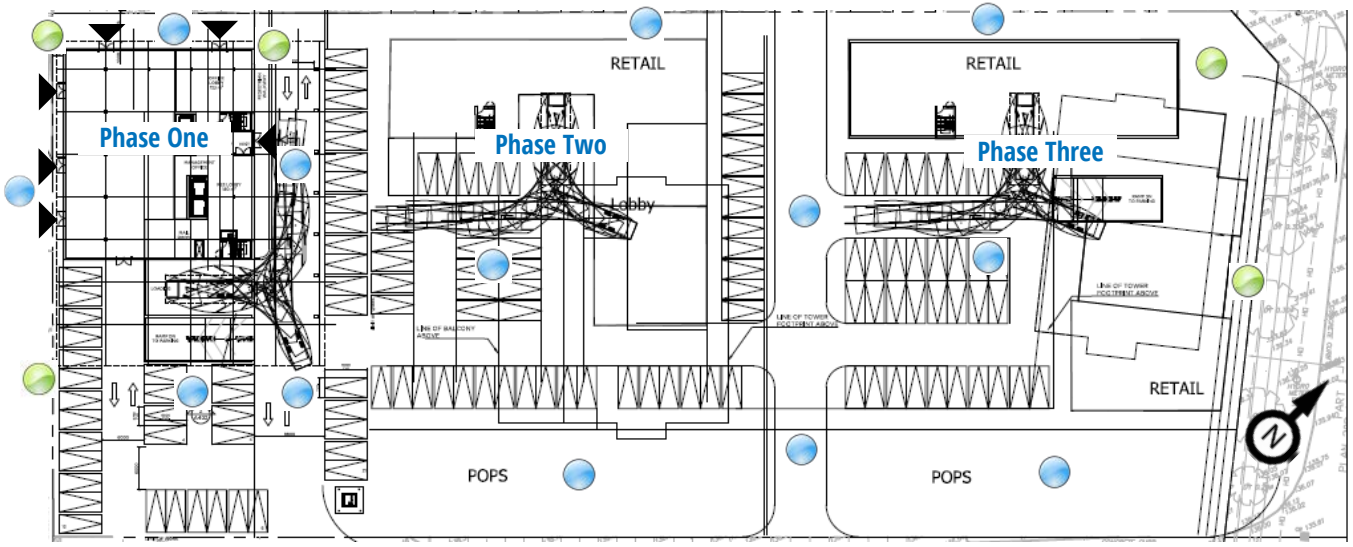


Image 7a: Ground Floor – Predicted Wind Conditions - Summer

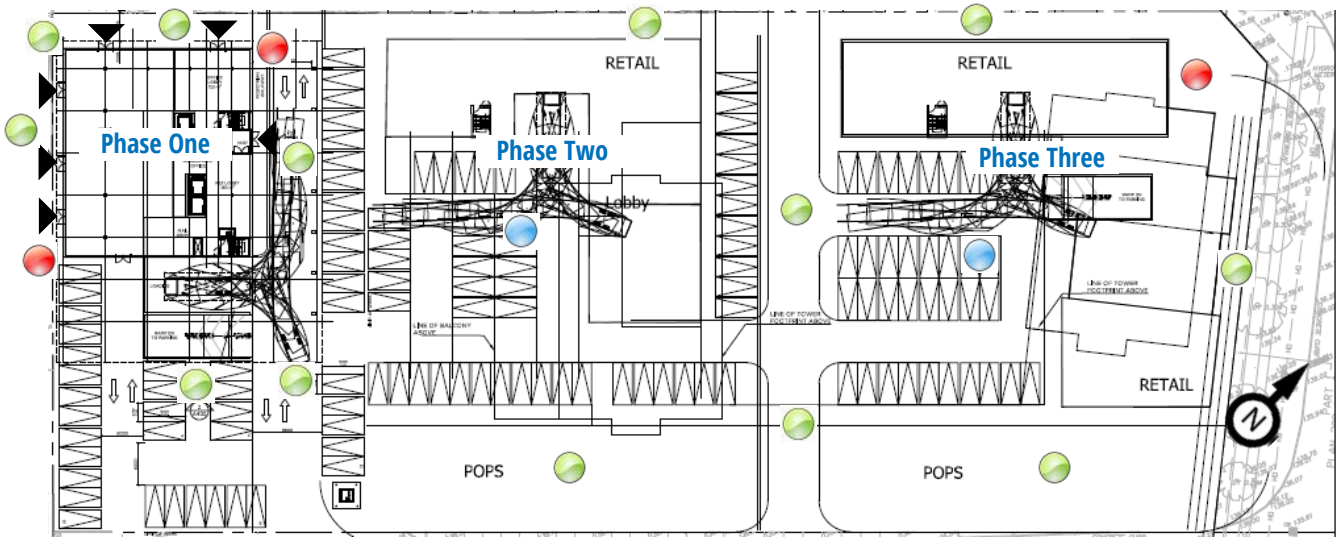
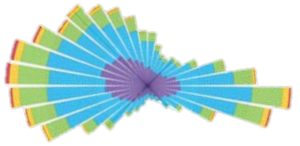
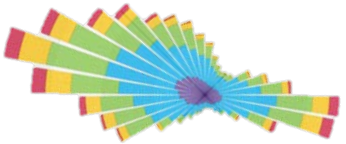


Image 7b: Ground Floor – Predicted Wind Conditions - Winter



Summer (May through October)



Winter (November through April)

COMFORT CATEGORIES

- Sitting / Standing
- Leisurely Walking / Fast Walking
- Potentially Uncomfortable or exceeding the Safety Criterion

5.3.1 Phase One

The proposed 3-storey podium and undercuts around the Phase One tower is a positive design feature, it is expected to reduce the impact of winds downwashing off the building façade onto the ground level.

Entrances

The main residential lobby entrance is located between Phase One and Phase Two buildings (Image 8). The 16-storey Phase Two building is located northeast of the 18-storey Phase One building, reducing the wind exposure of the Phase One main entrance to the prevailing northeasterly winds; however, the southwesterly winds are anticipated to accelerate around the north building corner (C1 in image 8), and then channel between the two buildings. The closed vestibule at the main entrance will serve as conditioned areas for people to wait or transition between the indoor and outdoor on windy days.

The retail and office lobby entrances on the northwest and southwest sides would be more exposed to the southwesterly winds and downwashing flows (Image 8) due to the low surroundings; however, these entrances are located in the middle portion of the façade, far enough from the corners that wind impact at the entrance may be moderate.

Suitable wind conditions are expected for all the Phase One entrances in the summer (Figure 7a); however, slightly higher than desired wind speeds are predicted for the entrances during the winter (Figure 7b). Higher wind speeds in the winter season may be acceptable as people are less likely to linger outside the entrance in the cold.

Sidewalks and Walkways

Suitable wind conditions (standing or leisurely walking in Image 7a) are expected on all sidewalks and walkways in the summer, and on most pedestrian areas during the winter (leisurely walking or fast walking in Image 7b). The north and south tower corners (C1 and C2 in Image 8) are exceptions, where wind conditions may become uncomfortable or potentially unsafe in the winter. Wind tunnel testing is recommended at a later design stage to quantify these wind conditions and to develop and verify the effectiveness of wind control solutions.

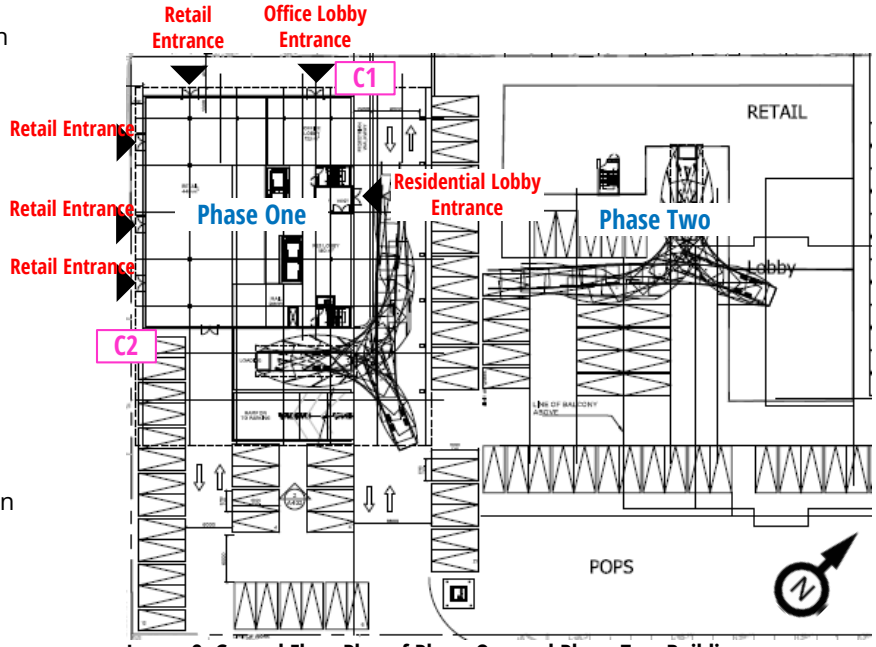


Image 8: Ground Floor Plan of Phase One and Phase Two Buildings

5.3.1 Phase One (continued)

The potential wind control strategies of the windy corner C1 may be a combination of canopy and landscaping / wind screens placed around the northwest office lobby entrance, as shown in Image 9. If lower wind speeds are desired at the windy corner C2, a wind screen extending out the southwest building façade at grade level can be considered, as indicated in Image 9. Examples of these mitigation options are shown in Image 10.

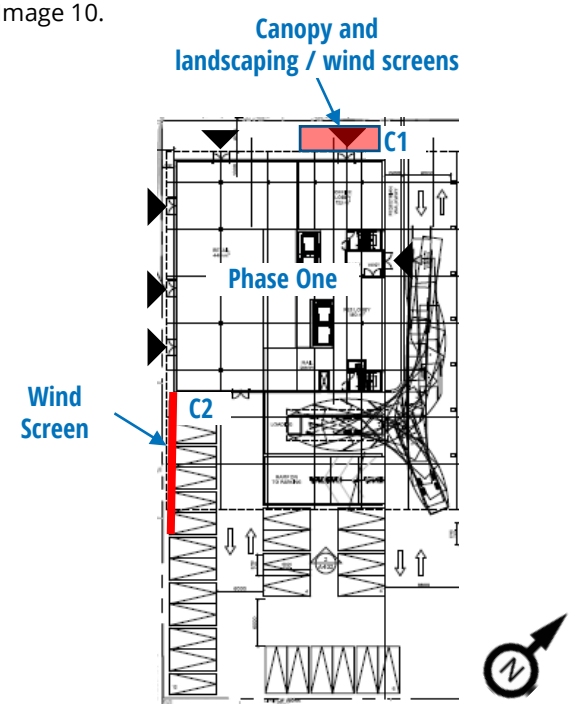


Image 9: Wind Control Strategies for Phase One

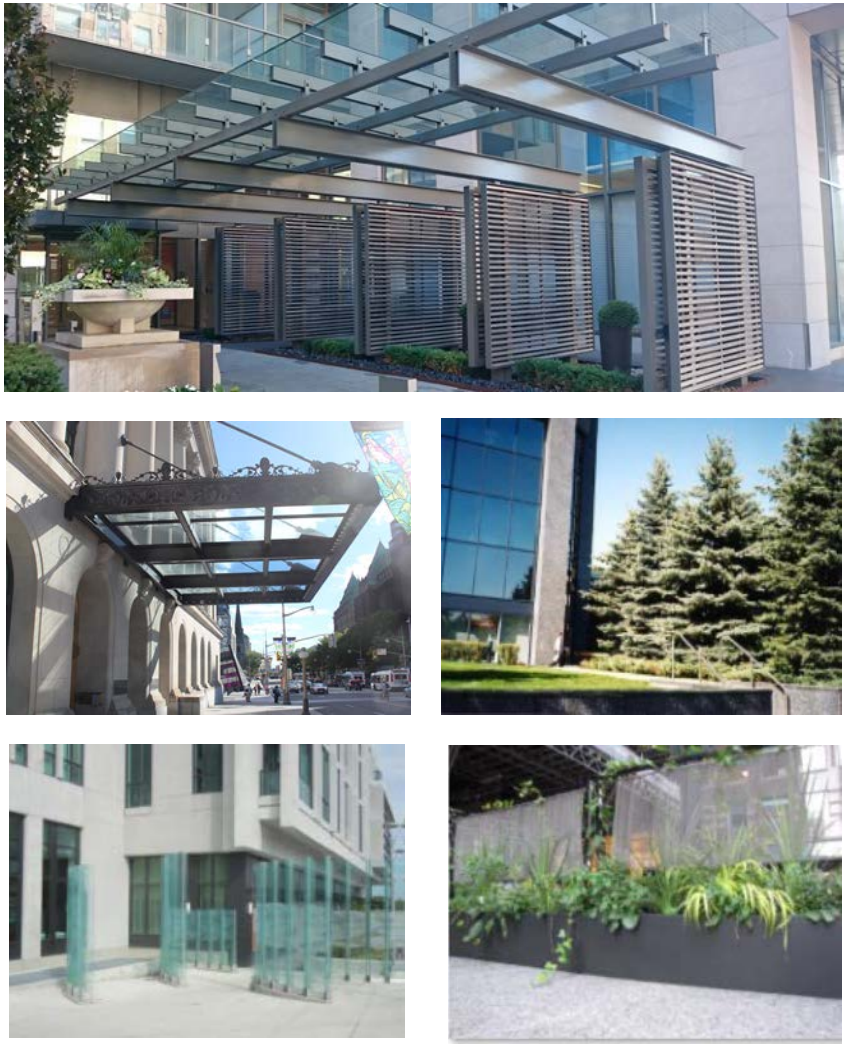


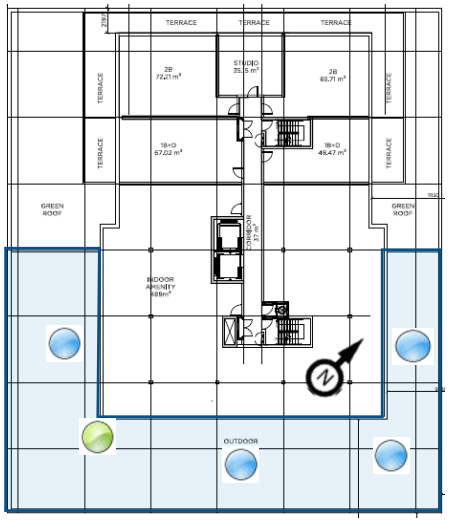
Image 10: Examples of Canopy, Landscaping and Wind Screens

5.3.1 Phase One (continued)

Level 3 Podium – Outdoor Amenity Terrace

Wind conditions at the outdoor amenity terrace on the Level 3 podium are expected to be suitable for passive activities in the summer at most areas, as shown in Image 11, except the south corner where wind speeds are anticipated to be slightly higher than desired due to the corner acceleration effect (*see Corner Acceleration in Image 5*). The tall and waving guardrail is a positive design that provides protection for the amenity area (Image 3b).

A corner canopy / trellis, planters or wind screens placed at the south corner can be used for wind control. Examples of these mitigation strategies are shown in Image 12. High wind activity on podium terraces during the winter is not a concern due to reduced usage during cold months. It is recommended that the wind impact of the project be quantified through a wind tunnel study at a later design stage so as to confirm the frequency of high wind activity and thereby the need and level of wind mitigation efforts.



COMFORT CATEGORIES

- Sitting / Standing
- Leisurely Walking / Fast Walking
- Potentially Uncomfortable or exceeding the Safety Criterion

Image 11: Level 3 Outdoor Amenity Terrace of Phase One Tower - Summer



Image 12: Wind Control Strategies for Outdoor Amenity Terraces

5.3.2 Phase Two and Three

Wind conditions at most areas at ground level around the Phase Two and Three buildings, including sidewalks and privately-owned publicly accessible spaces (POPS), are predicted to be comfortable for sitting or standing in the summer (Image 7a), and for mostly fast walking in the winter (Image 7b). These conditions are appropriate for the intended pedestrian use.

The highest wind speeds are expected at the north corner of the Phase Three building, where wind conditions may become uncomfortable or potentially unsafe in the winter (Image 7b).

It is recommended to position entrances away from the building corners for both Phase Two and Three buildings, in order to avoid the corner acceleration winds.

Wind tunnel testing is recommended at a later design stage to quantify these wind conditions and to develop and verify the effectiveness of wind control solutions.

6. SUMMARY

RWDI was retained to provide an assessment of the potential pedestrian level wind impact of the proposed project at 1900 Appleby Line in Burlington, Ontario. Our assessment was based on the Burlington Guidelines and Terms of Reference for Pedestrian Level Wind Study, the local wind climate, the current design of the proposed development, the existing surrounding buildings, our experience with wind tunnel testing of similar buildings, and screening-level modelling.

Our findings are summarized as follows:

- The proposed development includes several positive design features, such as low podium and undercuts around the proposed Phase One building, and favorable location and vestibule for the main entrance.
- Suitable wind conditions are expected at all pedestrian areas in the summer, including main entrances and sidewalks, as well as most outdoor amenity spaces.
- In the winter, elevated wind speeds around building corners may become uncomfortable or potentially unsafe. Higher-than-desired wind speeds are also anticipated at the south tower corner on the Level 3 outdoor amenity space of Phase One in the summer.
- Conceptual wind control measures are provided in the report and will be reviewed with the design team. It is recommended to quantify the level and frequency of high wind activity through wind tunnel testing at a later design stage, and to develop and refine wind control solutions.

7. APPLICABILITY OF RESULTS

The assessment presented in this report is for the proposed project at 1900 Appleby Line based on the information listed in the table below. In the event of any significant changes to the design, construction or operation of the building or addition of surroundings in the future, RWDI could provide an assessment of their impact on the pedestrian wind conditions discussed in this report. It is the responsibility of others to contact RWDI to initiate this process.

File Name	File Type	Date Received (mm/dd/yyyy)
2021.04.30 - Architectural Concept	PDF	05/04/2021
2021.04.30 - Model Views	PDF	05/14/2021