REPORT

PLAINS ROAD & FAIRVIEW STREET MASTERPLAN

BURLINGTON, ONTARIO

PEDESTRIAN LEVEL WIND ASSESSMENT

PROJECT # 2004217
MAY 5, 2021

SUBMITTED TO

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Molinaro Group to conduct a qualitative assessment of the pedestrian wind conditions expected around the proposed Plains Road and Fairview Street Masterplan in Burlington, Ontario (Image 1).

The project site is located at the intersection of Plains Road East and Fairview Street (Image 1). It is currently occupied by a low-rise building, parking lots and a vacant land. The site is immediately surrounded by roads, low-rise structures and vacant lands. Away from the immediate surroundings, there are treed lands to the southwest through northwest and buildings of low height in all other directions.

The proposed master plan consists of two parcels (see Image 2 on the next page):

- Phase 1: Two 35 and 30-storey towers on a 2-storey podium and connected by a bridge at the second floor; and
- Phase 2: Two 30 and 22-storey towers on a 2-storey podium and connected by a bridge at the second floor.

Pedestrian areas of interest include public sidewalks and walkways, building entrances and above grade amenity spaces.



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

1. INTRODUCTION



Image 2: Site plan

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 qualitative screening-level estimation of potential wind conditions and offers conceptual wind control measures for improved wind comfort, where necessary.

RWDI's wind assessment is based on the following:

- Design drawings received by RWDI on January 21 and February 12 and April 20, 2021;
- Use of RWDI's proprietary software (*WindEstimator*[1]) for providing a screening-level numerical estimation of potential wind conditions around generalized building forms;
- A review of the long-term meteorological data for the Burlington area;
- Burlington pedestrian wind criteria;
- Wind-tunnel studies and desktop assessments undertaken by RWDI for projects in Burlington and around the world; and,
- RWDI's engineering judgement and knowledge of wind flows around buildings[2, 3].

Note that other wind issues, such as those related to cladding and structural wind loads, door operability, snow loading, etc., are not considered in the scope of this assessment.

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 recorded between 1990 and 2019 were used as reference for wind conditions around the current project. 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 3.

When all winds are considered (regardless of speeds), winds are frequent from the southwest and northeast quadrants for both seasons, as indicated by the wind roses in Image 3.

Strong winds of a mean speed greater than 30 km/h measured at the airport at an anemometer height of 10 m occur more often in the winter than in the summer (red and yellow bands in Image 3). They are also from the southwest and northeast quadrants.

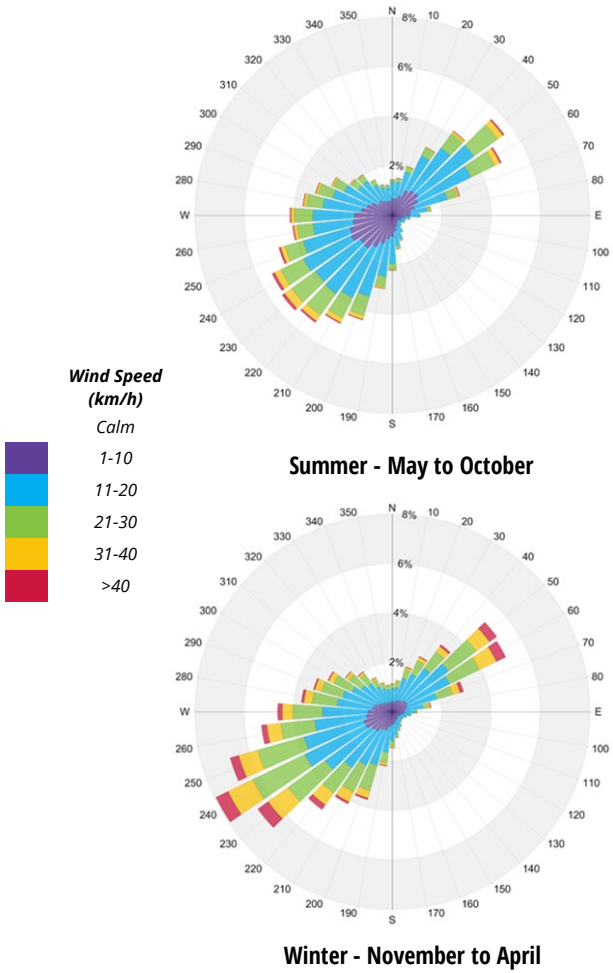


Image 3: Directional distribution of winds approaching Hamilton International Airport (1990–2019)

4. WIND CRITERIA

The Burlington pedestrian wind criteria, developed in March 2020, are specified in the Guidelines and Terms of Reference, "Pedestrian Level Wind Study". The table to the right defines the criteria for both wind comfort and safety.

These criteria for wind forces represent average wind tolerance. They are sometimes subjective as 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.

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 and walkways; lower wind speeds comfortable for standing are required for main entrances where pedestrians may linger, and calm wind speeds suitable for sitting are desired in areas where passive activities are anticipated, such as the above-grade amenities, especially during the summer when these areas are typically in use.

Comfort Category	GEM Speed (km/h)	Description
Sitting	≤ 10	Calm or light breezes • Appropriate for dedicated seating areas such as cafes, 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

Notes:

(1) GEM is defined as the maximum mean wind speed or gust speed divided by 1.85 (whichever is larger). Gust speed can be directly measured in a wind tunnel or represented by mean wind speed + 3*RMS (Root Mean Square) wind speed.

(2) GEM speeds listed above are based on a seasonal exceedance of 20% of the time between 06:00 and 23:00. The criterion has been met if the wind speeds occur at least four out of five days.

Safety Criterion	Gust Speed (km/h)	Description
Exceeded	> 90	• Excessive gust speeds • Adverse effect on pedestrian's balance and footing • Wind mitigation is required

Notes:

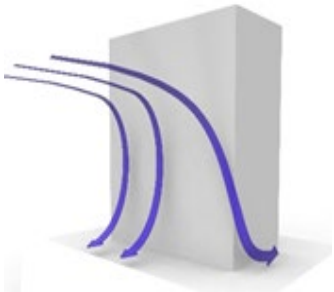
(1) Based on an annual exceedance of 9 hours or 0.1% of the time for 24 hours a day.

(2) Gust speed can be directly measured in a wind tunnel or represented by mean wind speed + 3*RMS wind speed.

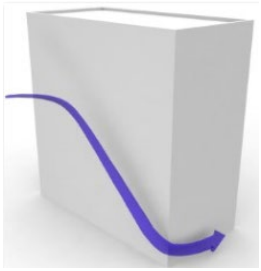
5. RESULTS AND DISCUSSION

5.1 Wind Flow around Buildings

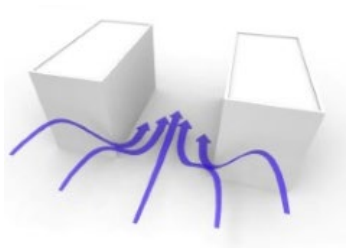
Tall buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level (Downwashing, Image 4a). These winds subsequently move around exposed building corners (Corner Acceleration, Image 4b), and along the gap between buildings (Channelling Effect, Image 4c), causing increased wind activity at grade. If these building / wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and uncomfortable conditions.



a) Downwashing Flow



b) Corner Acceleration



c) Channelling Effect

Image 4: Generalized wind flows

5.2 Existing Conditions

The existing buildings on and around the project site are low and surrounded by roads, low-rise buildings and vacant lands in all directions. As such, wind conditions on and around the site are considered to be comfortable for sitting or standing in the summer and for leisurely/fast walking in the winter.

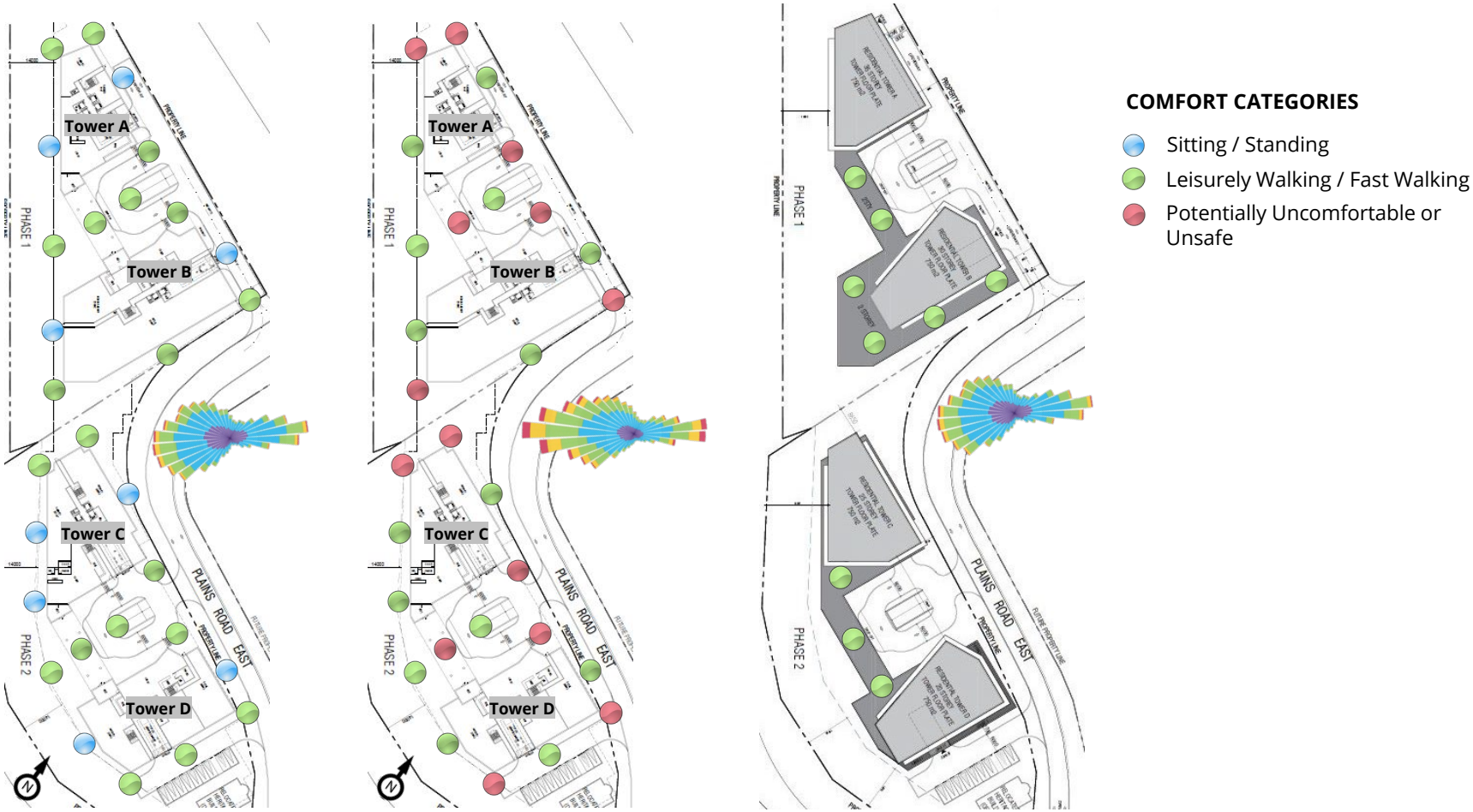
Wind conditions exceeding the safety criterion are not expected on and around the site.

5.3 Proposed Wind Conditions

As shown in Image 3, the prevailing winds are from the southwest and northeast directions for both the summer and winter seasons. All the proposed towers are significantly taller than the existing surroundings in the prevailing wind directions. Thus, they will deflect winds down to the grade level, causing increased wind activity around tower corners and along the public sidewalks and walkways, the orientation of the towers will also result in channelling flows (Image 4).

The predicted wind conditions are shown in Images 5a-5c for the summer and winter seasons, respectively, together with the corresponding wind roses. The following sections provide a detailed discussion of the potential wind conditions around the project.

5.3 Proposed Wind Conditions



(a) (b) (c)

Image 5: Predicted wind conditions: (a) Ground Level during the summer, (b) Ground level during the winter and (c) Level 3 during the summer

5.3.1 Pedestrian Wind Comfort

The 2-storey podium of Tower B is a positive design feature which helps with deflecting the downwashing winds. However, winds downwashed off the tall façades of Tower A, Tower C and Tower D will cause high wind activity on the ground level due to the redirection of winds and their subsequent acceleration around the corners and throughout the grade. Moreover, the predominant winds will channel between the two towers, especially under the 1-storey bridges and create high wind conditions.

The main entrances to the towers (A1, A2, B1 and B2 in Image 6) are located under the connecting bridges, and will be exposed to the northeast or southwest winds flowing between the towers and under the bridges. Thus, wind conditions at these entrances are predicted to be comfortable for leisurely/fast walking in the summer and uncomfortable during the winter (Images 5a and 5b). Note that the secondary entrances and the retail entries are not identified in the drawings.

Considering the seasonal variations of the winds, the conditions along the nearby sidewalks, walkways and drop-off areas are expected to be comfortable for leisurely/fast walking in the summer and uncomfortable during the winter. Lower wind speeds are predicted along the north and south façades at areas away from the corners.

The channelling of winds between the two towers of each phase will also result in high wind speeds throughout the Level 3 outdoor amenities. Wind conditions at these areas are expected to be higher than those comfortable for the anticipated passive patron use in the summer (Image 5c). It should be noted that the higher wind speeds on these amenities in the winter may not be a concern due to the limited use of these areas during the colder months.

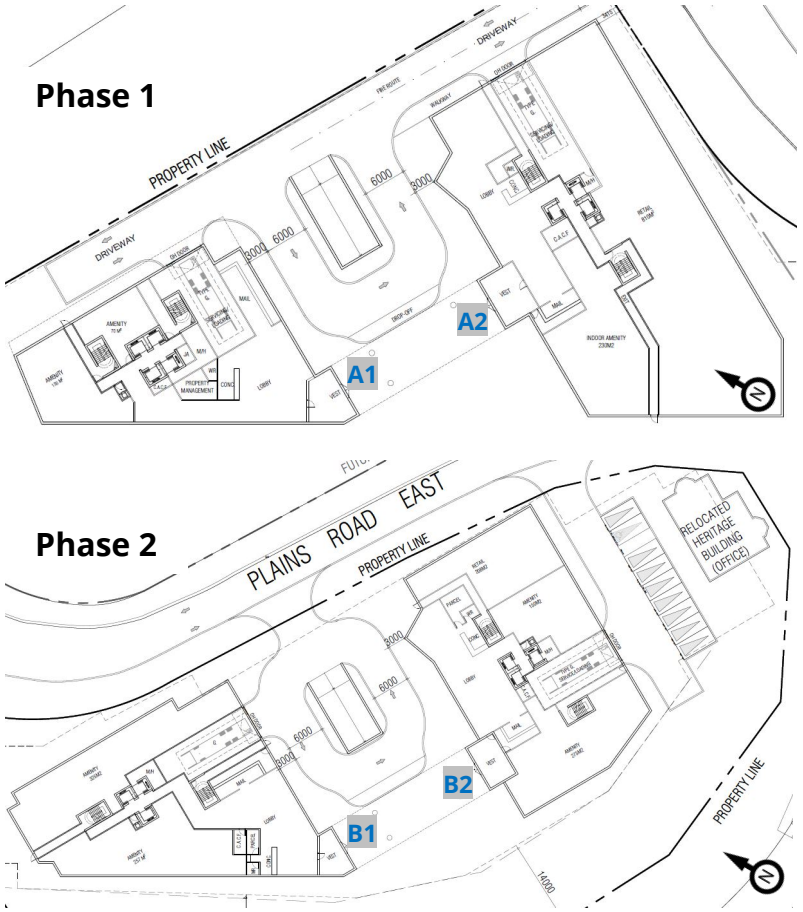


Image 6: Roof plans of Phase 1 and Phase 2

5.3.2 Pedestrian Wind Safety

Areas where the pedestrian wind safety criterion may be exceeded are identified in Image 5b. These locations primarily include areas near the building corners, under the bridges and on the Level 3 amenity in the winter season.

5.3.3 Wind Mitigation Strategies

To improve the wind impact of the proposed project, several large scale and small scale wind control measures can be considered. The large scale solutions include:

(1) Stepped low podium structures for all the towers, with significant tower setbacks on all sides;

(2) Chamfered or curved corner designs rather than sharp corners;

(3) A connecting podium instead of the 1-story bridges to hinder the channelling flow; and,

(4) Large recession at the grade level and implementation of wide canopies wrapping around the corners and also colonnade features.

Regarding the height of the towers relative to the surroundings, additional small scale wind control solutions should also be considered. This may include, recessed doorways, implementation of tall coniferous landscaping/porous wind screens near the high-wind areas, tall parapets along the perimeters of the amenity terraces and extensive use of landscaping elements and trellises near the specified seating and gathering areas in the amenities.

Examples of various types of mitigation options are provided in Image 7. RWDI is working with the design team to determine the most suitable options prior to verification in the wind tunnel.

5. RESULTS AND DISCUSSION



Image 7a: Wind control measures applicable to the predicted windy areas on the grade level



Image 7b: Wind control measures applicable to the predicted windy areas on the Level 3 amenity

6. SUMMARY

RWDI was retained by Molinaro Group to provide an assessment of the potential pedestrian wind conditions on and around the proposed Plains Road and Fairview Street Masterplan 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 of wind flows around buildings.

Our findings are summarized as follows:

- The proposed masterplan includes several positive design features such as stepped podiums connecting towers of each parcel, and favorable locations for main building entrances.
- During the summer season, appropriate wind conditions are predicted along the sidewalks and walkways, however, winds higher than those desired are expected near the entrances, drop-off areas and Level 3 amenity terraces. With the proper mitigation in place these areas will be improved.
- During the winter, elevated wind speeds around tower corners and in the opening between the towers may become uncomfortable or potentially unsafe. With the proper mitigation in the form of soft and hard landscaping wind conditions can be improved.
- Conceptual wind control measures are provided in the report and will be reviewed with the design team and validated through wind tunnel testing at a later design stage to quantify the level and frequency of high wind activity, and to develop and refine wind control solutions.

7. APPLICABILITY OF RESULTS

The assessment presented in this report is for the proposed Plains Road and Fairview Street Masterplan based on the information received by RWDI on January 21, February 12, and April 20, 2021, 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)
1572.17.Jan.19.2021.design set	PDF	01/21/2021
1572.17.Jan.19.2021.Plains Rd.Floor Plans	DWG	01/21/2021
Plains Rd Lots A+B - feb.05.2021 (1)	SKP	02/12/2021
Plain Rd_Plans_apr.20.21	PDF	04/20/2021