REPORT

GEORGIAN COURT REDEVELOPMENT

BURLINGTON, ON

PEDESTRIAN WIND ASSESSMENT

PROJECT #1700618

JULY 19, 2017

PREPARED FOR

bcIMC Realty Corporation
c/o Realstar Management

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INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Urban Strategies Inc. to assess the wind comfort conditions for the proposed masterplan for the redevelopment of Georgian Court Estates in Burlington, ON (**Image 1**). This qualitative assessment is based on the following:

- a review of the regional long-term meteorological data from a nearby airport and weather stations;
- design drawings and documents received by RWDI on June 9 and July 7, 2017;
- wind-tunnel studies undertaken by RWDI for similar projects in the area and around the world;
- our engineering judgment, experience and expert knowledge of wind flows around buildings[1-3]; and,
- use of software developed by RWDI (WindEstimator[2]) for estimating the potential wind conditions around generalized building forms.

This qualitative approach provides a screening-level estimation of potential wind conditions for re-zoning applications. Conceptual wind control measures to improve wind comfort are recommended, where necessary. In order to quantify these conditions or refine any conceptual wind control measures, physical scale-model tests in a boundary-layer wind tunnel would be required.

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



Image 1: Aerial view of the site and surroundings (photo credit: Google™ Earth)

1. 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.
2. 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.
3. 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.

SITE & BUILDING INFORMATION

As shown in **Image 1**, the proposed development is located on the east side of King Rd, between Surrey Ln and Marley Rd. The existing buildings on the site include multiple two-storey townhouses. They are surrounded by towers of 16 storeys to the north and low-rise houses in the remaining directions.
Note that, in the current project, true north differs from project north, as shown in **Image 2**. In our discussions, building and street orientations refer to project north and wind directions are based on true north.

The proposed master plan consists of 10 parcels as well as green parks and walkways (**Image 2**). The new buildings will be three storeys on the west portion and along the south perimeter of the site (**Image 3**) and the rest are four to 11 storeys with three towers of 16, 19 and 20 storeys on the central northern portion of the plan.

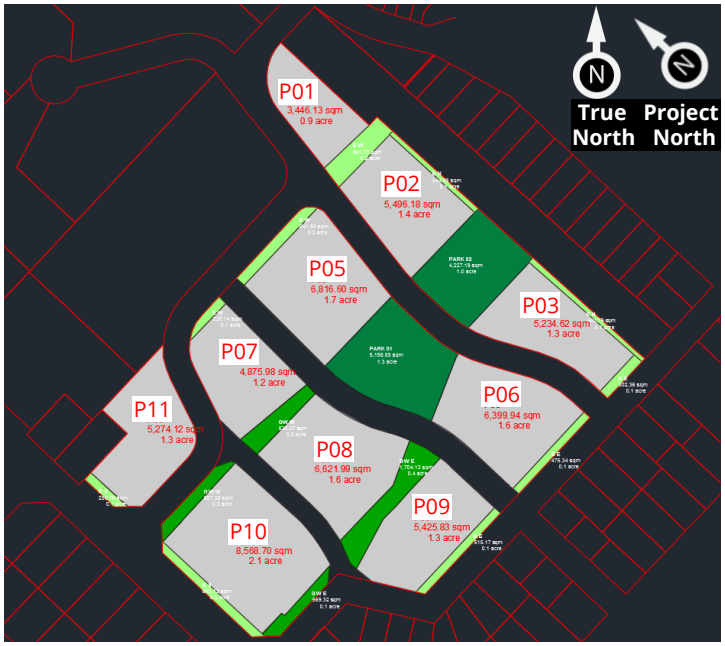


Image 2: Master plan – 10 parcels and multiple green spaces

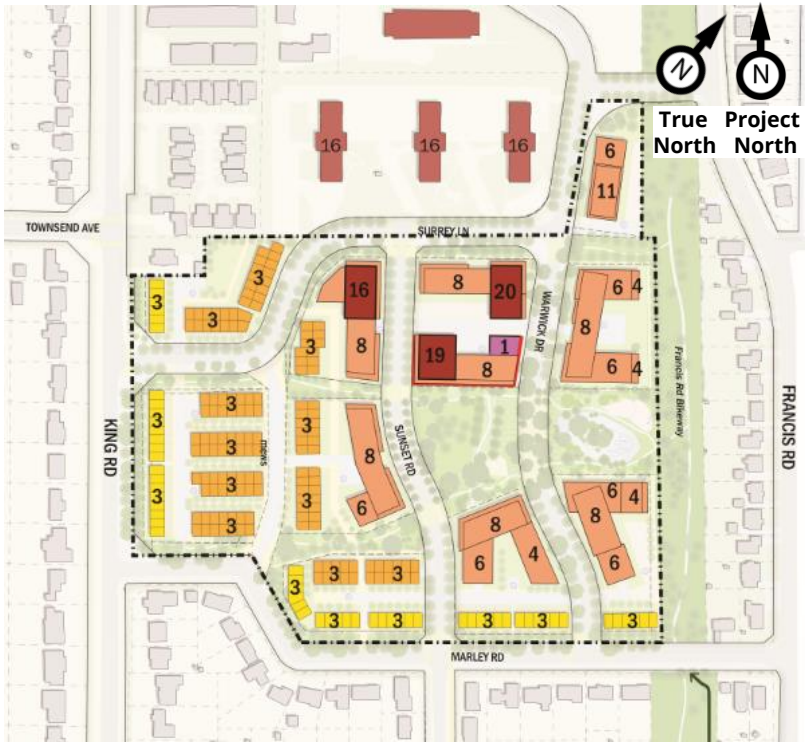


Image 3: Master plan – Building layout

LOCAL WIND CLIMATE

Wind statistics recorded at Hamilton International Airport between 1975 and 2015, inclusive, were analyzed for the summer (May through September) and winter (October through April) seasons. The seasonal data is presented in the form of wind roses in **Image 4**, where the sectors show the frequency of winds blowing from different directions. It can be noted that winds in the area are predominantly from the southwesterly and northeasterly directions throughout the year.

Strong winds of speeds greater than 30 km/h (yellow and red bands in **Image 4**) occur more often in the winter (13.8% of the time) than in the summer (3.9%), and they are primarily from the southwesterly and northeasterly directions.

Wind records from major airports are typically measured in open fields for a long term and with high quality. They are often used as a reference of wind climate for building projects in the surrounding area.

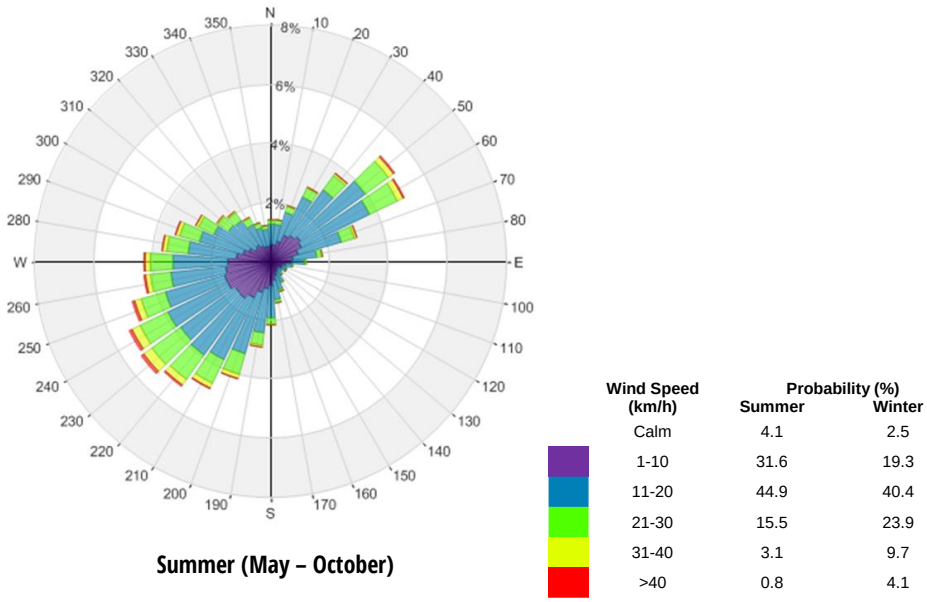
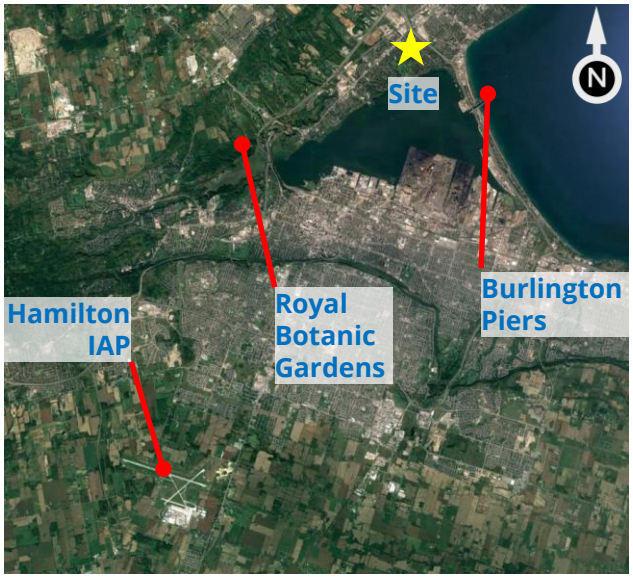


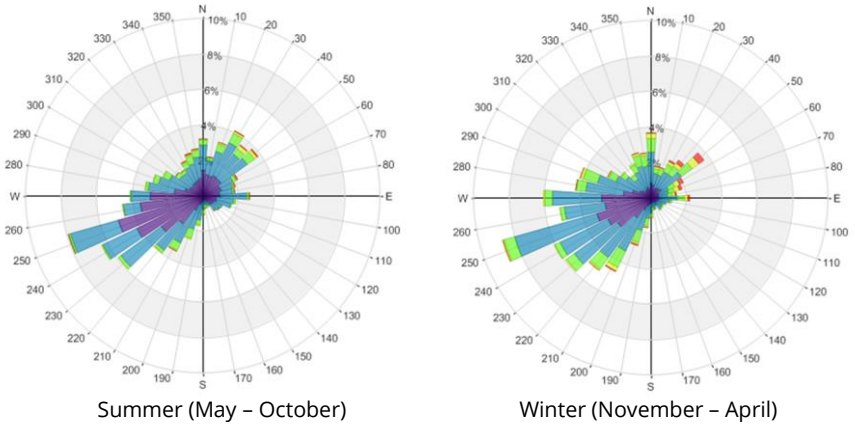
Image 4: Distribution of winds approaching Hamilton International Airport (1975–2015)

LOCAL WIND CLIMATE

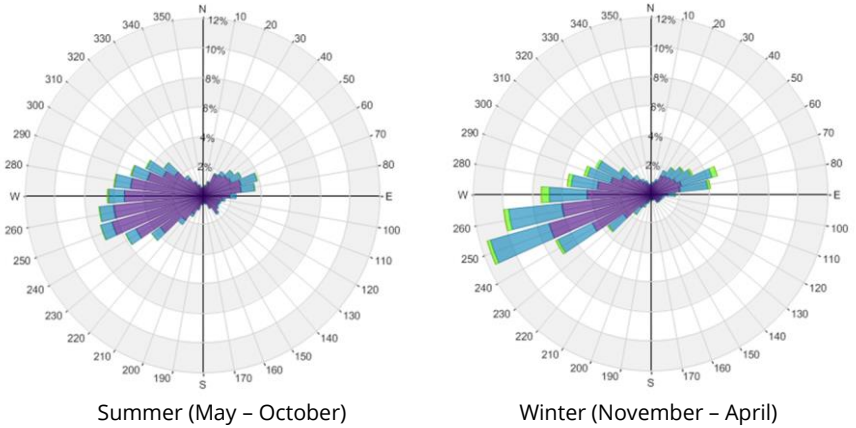
Wind data from two nearby met stations (Burlington Piers and Royal Botanic Gardens) are also analyzed to confirm the local wind directionality. As shown in **Image 5**, winds in these two stations are also from the southwesterly and northeasterly directions in general. Their speeds are lower than those measured at the airport, probably due to more surrounding obstacles, lower measurement heights, local topography and/or other reasons.



(photo credit: Google™ Earth)



Burlington Piers (2008-2015)



Royal Botanic Gardens (2000-2014)

Image 5: Distribution of winds approaching Burlington Piers and Royal Botanic Gardens

PEDESTRIAN 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 as well as by the building design and city planning community. The criteria are as follows:

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.

Wind conditions are considered suitable for sitting, standing, strolling or walking if the associate mean wind speeds are expected for at least four out of five days (80% of the time). An **Uncomfortable** designation means that the criterion for walking is not satisfied.

Safety is also considered by the criteria and is associated with excessive gust wind speeds that can adversely affect a pedestrian's balance and footing. If winds sufficient to affect a person's balance (90 km/h) occur more than 0.1% of the time or 9 hours per year, the wind conditions are considered severe. Wind control measures are typically required at locations where winds are rated as uncomfortable or they exceed the wind safety criterion.

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.

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

For the current development, wind speeds comfortable for walking or strolling are appropriate for sidewalks and walkways. Lower wind speeds comfortable for standing are required for major building entrances and plazas, where pedestrians may linger. Low wind speeds comfortable for sitting are desired for outdoor amenity spaces at and above grade in the summer, when these spaces are typically in use.

Background

Predicting wind speeds and occurrence frequencies is complicated. It involves the assessment of geometry, orientation, position and height of buildings in the master plan, 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. This knowledge has been incorporated into RWDI's proprietary software that allows, in many situations, for a qualitative, screening-level numerical estimation of pedestrian wind conditions without wind tunnel testing.

Tall buildings tend to intercept stronger winds at higher elevations and redirect them to the ground level. Such a Downwashing Flow (**Image 6a**) is the main cause for increased wind activity around tall buildings at the pedestrian level. When two buildings are situated side by side, wind flows tend to accelerate through the space between the buildings due to the Channelling Effect (**6b**). Oblique winds also cause wind accelerations around the downwind building corner (**Image 6c**). If these building/wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and uncomfortable conditions.

Podium structures under towers are beneficial for wind control, as they reduce the direct impact of any downwashing winds from the towers to the grade (**Image 6d**). Stepping the windward façade (**6e**) is also a positive design strategy that can be used for wind control. However, increased wind activity will be created on the podium terraces.

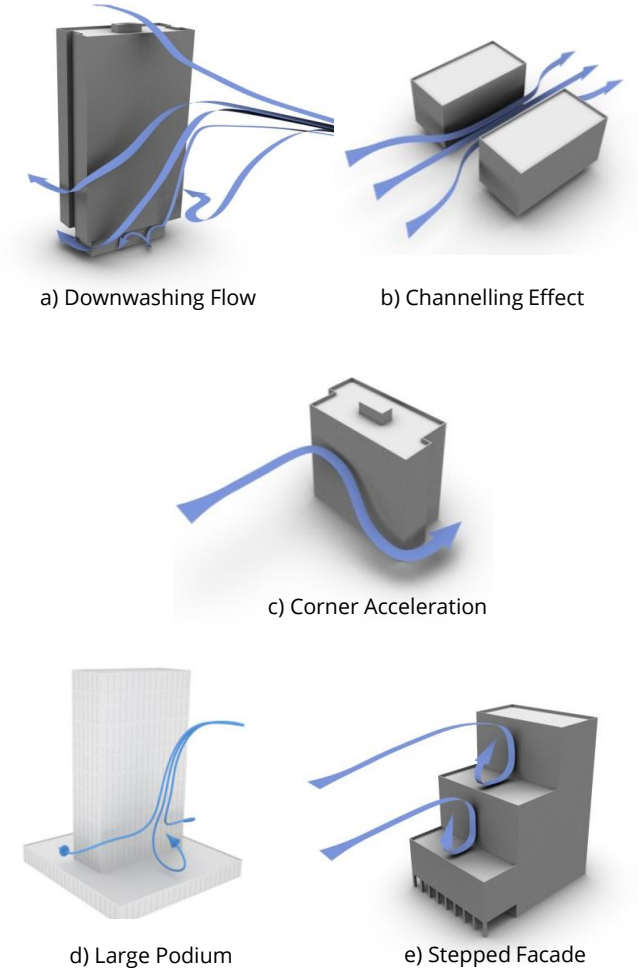


Image 6: Typical wind flow patterns

Existing Wind Conditions

The development site is an area surrounded by Lake Ontario, Hamilton Harbour and Niagara Escarpment (left photo in **Image 7**), with the prevailing winds from the southwest (valley) and northeast (lake) directions. Dense low-rise buildings and landscaping (including coniferous trees) exist on the site and in the immediate surrounding areas (right photo in **Image 7**).

As a result, the existing wind conditions on and around the site are expected to be comfortable for standing in the summer and for strolling or walking in the winter. The higher wind speeds in the winter are due to the seasonal climate and reduced protection offered by existing trees on and around the site.

Higher wind speeds may exist along Surrey Ln, next to the existing high-rise buildings (highlighted in the right photo in **Image 7**). These three existing buildings are 16 storeys and they deflect the prevailing winds down to the grade, causing wind flow accelerations along the street. The resultant wind conditions may become uncomfortable from time to time in the winter. These wind conditions are considered appropriate in general.

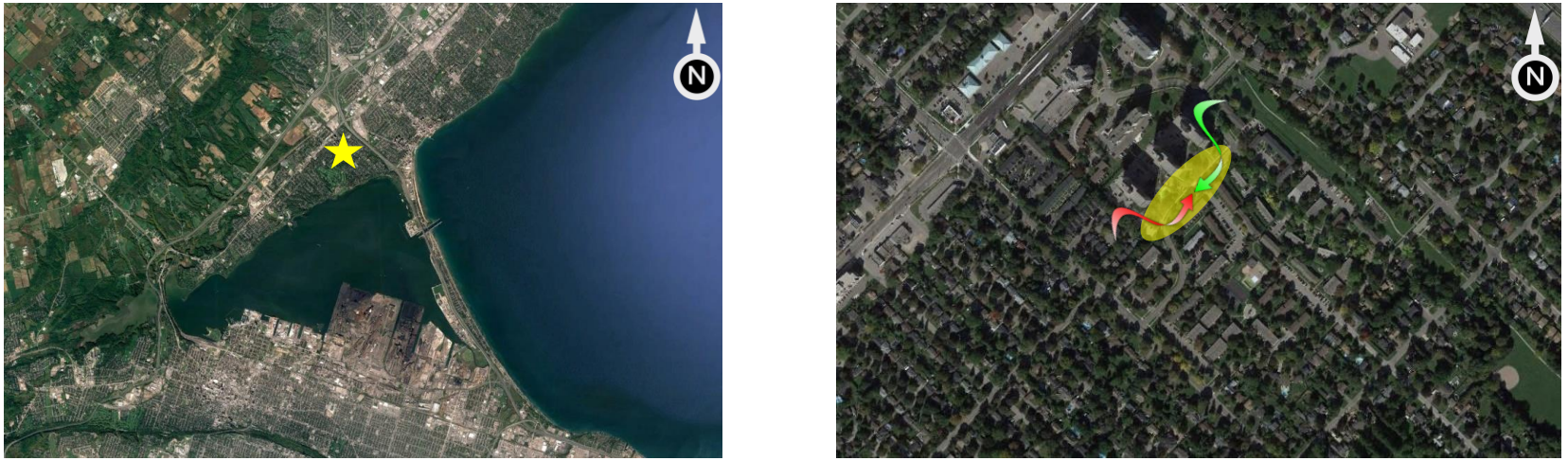


Image 7: Local topography (left) and immediate surroundings (right) (photo credit: Google™ Earth)

Positive Features for Wind Control

The following discussions on potential wind conditions around the proposed master plan focus on the positive features and challenges for the site. Details are provided for select buildings and parcels, based on the updated drawings and our experience with similar projects. Wind-tunnel studies should be conducted to quantify the wind conditions as the design progresses.

The proposed master plan includes several positive design features for wind control and they should be retained or enhanced in the final design. For instance,

- The lowest buildings (three storeys) are located along the south and west perimeters of the site, and the buildings along the east perimeter are stepped from four storeys at the edge to eight storeys (**Image 3**). As a result, the existing wind conditions in the surrounding areas will not be negatively affected by the proposed development;
- The three proposed towers (16, 19 and 20 storeys) are located at the central northern portion of the proposed development, with existing tall buildings to the north. This reduces the direct wind exposure of the proposed towers (**Image 8**).
- These towers are staggered to provide wind protection to each other for the prevailing southwesterly and northeasterly winds. The lower buildings attached to these towers form podiums that will further reduce the wind impact at the ground level (**Image 6d**);
- Taller buildings in Parcels 2, 3 and 5 through 8 (**Images 2** and **3**) are arranged in C or L shapes in plan, creating semi-enclosed areas where reduced wind activity is anticipated;
- The proposed open green space is expected to be sheltered by the long, eight-storey building to the west (circled in **Image 8**) from the most frequent southwesterly directions. The existing and proposed landscaping will further reduce the wind activity in the space; and
- Extensive landscaping, including mature coniferous trees exist on and around the development site. It is our understanding that a large portion will be preserved and additional landscaping has been proposed throughout the site.

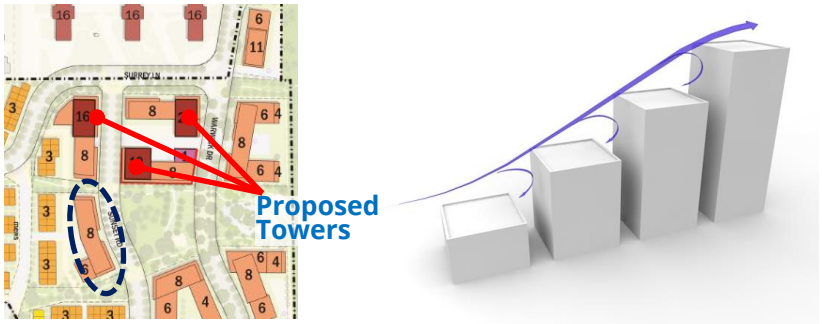


Image 8: Towers at the central west of the site, with dense surroundings

Site and Building Challenges

The site is close to the lake and valley where the prevailing winds come from. The surrounding buildings are low-rise houses in most wind directions. The wind flow phenomena described in **Image 6** (e.g., downwashing flow, channelling effect and corner acceleration) can occur with several buildings on the site. As shown in **Image 9**,

- Two main streets (Surrey Ln and Marley Rd), the large open green space and two green walkways (circled in blue in **Image 9**) are aligned with the prevailing winds, resulting in increased wind activity;
- The proposed towers along Surrey Ln (16 and 20 storeys) have their wider facades facing the prevailing winds. Together with the existing towers across the street, they may cause channelling flows along the street for both prevailing wind directions (red and green arrows in **Image 9**);
- The three proposed towers have significant podiums on one or two sides and they have a 3 m stepback on public-facing frontages, whereas there are no stepbacks internal to the block; and,
- Increased wind activity may occur around the exposed tower facades (see purple dots in **Image 9**) due to the corner acceleration and channeling effect (**Images 6b and 6c**).

Based on above discussions on local wind climate, positive design features and challenges, the potential wind conditions on and around the development are predicted in Image 10 on the next page.

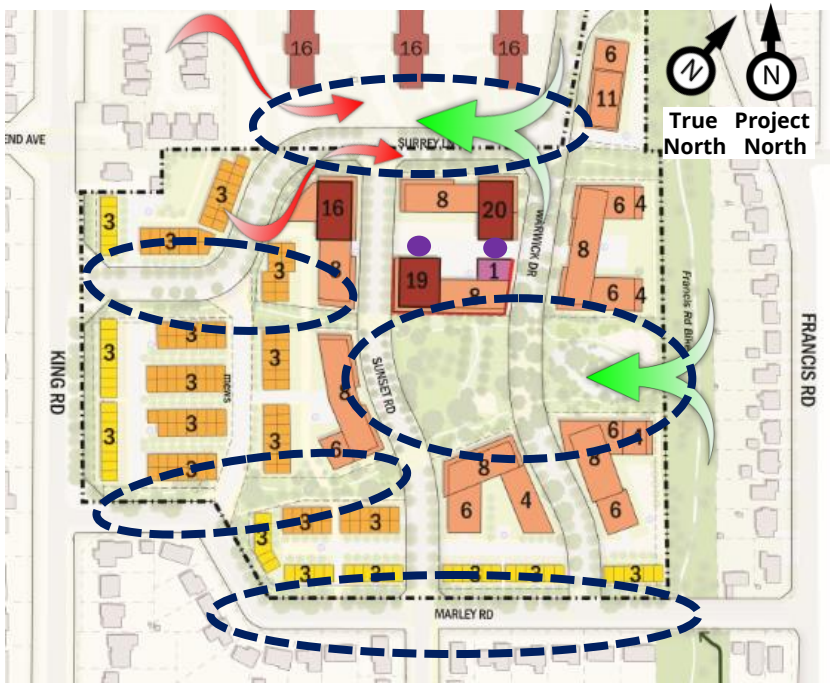


Image 9: Alignment with and exposure to prevailing winds

Predicted Wind Conditions

In **Image 10**, red dots present potentially windy locations on the site, primarily during the winter season which may require wind mitigation measures. Summer conditions in these areas are expected to meet the wind comfort and safety criteria.

Yellow dots represent moderate areas where wind conditions are generally suitable for pedestrian walking or strolling, but not for sitting or standing.

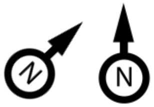
The green dots in **Image 10** indicate more sheltered areas where calm conditions comfortable for sitting can readily be achieved in the summer with or without wind control measures.



Windy (Winter only)

Moderate

Calm



True North

Project North

Image 10: Predicted wind conditions on proposed development

Building Massing and Layout

As discussed previously, the proposed master plan includes several positive features for wind control. Due to the local wind climate and the height of the proposed towers relative to the low surroundings, elevated wind conditions may be expected in the winter. Higher-than-desired wind speeds may also occur during the summer in outdoor amenities. This section presents our recommendations for building massing and layout, plus architectural and landscaping details for improving wind conditions to appropriate levels.

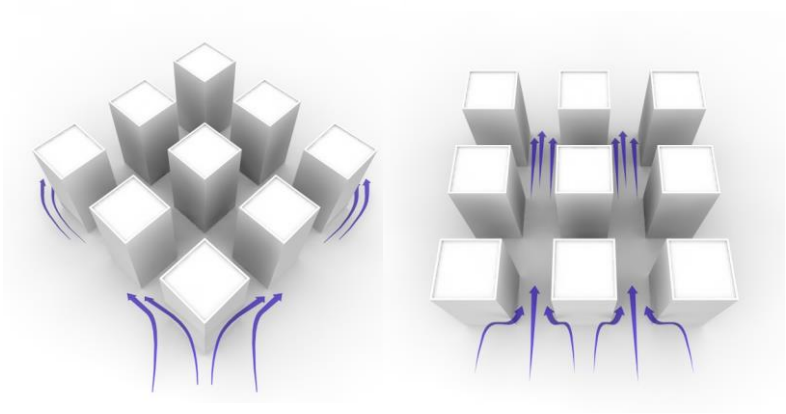


Image 11: Main streets angled (left) and aligned (right) with prevailing winds

To improve the pedestrian wind conditions, we recommend that:

- Main streets, especially those near high-rise buildings, should not be aligned with the prevailing southwesterly and northeasterly winds (**Images 6b and 11**), if feasible;
- Reducing the widths of the tower facades that are exposed to the prevailing winds (or rotating the proposed towers along Surrey Ln by 90 degrees); and,
- Providing larger podiums or tower stepbacks along public streets (**Image 6d**), if feasible, to reduce the wind impact on sidewalks and other public areas.

Building Entrances

Building entrances are not identified in the current design drawings. Low wind speeds are desired for the main entrance areas, where pedestrians may linger. As general guidelines,

- Main entrances should be placed away from building corners where high wind activity is typically expected;
- For the entrances facing the prevailing winds, winds downwashing off the towers may be an issue. Canopies should be installed for protection from wind, rain and snow; and
- Additional wind control measures may include entrance recessing, arcades as well as wind screens and planters on both sides of the entrances.

Image 12 below provides photo examples of wind control measures for building entrances.



Image 12: Wind control examples for building entrances

Green Parks and Walkways

The large open green parks are sheltered by the proposed buildings to the west, but exposed to winds from the other end; the two green walkways are aligned with the prevailing winds; and the proposed towers may also deflect winds onto these green areas. As a result, high wind speeds may occur in these areas, where passive pedestrian activities are expected despite considerable existing proposed landscaping in the area.

We recommend additional wind protection be considered along the east end of the parks, including a row of coniferous trees and hardscaping (e.g., screens, fences, trellises, etc.). Another effective wind control strategy is to include under plantings to stop wind accelerations under tree canopies.

Image 13 provides landscaping examples for consideration.



Image 13: Examples of landscaping for wind control

Roof and Podium Amenity

Potentially, there could be many above-grade terraces and green areas for the development. Rooftop areas are typically windy due to their elevation and exposure. The most common wind control measures are tall guardrails and parapets.

While podiums and setbacks are positive measures for reducing the wind impact at ground level, increased wind speeds are expected for podium terraces. The actual speeds vary with the exposure, locations, sizes and elevations of these areas.

In the event that undesirable conditions occur, taller guardrails, windscreens, privacy fences and landscaping may be incorporated to provide sheltering for amenity users. Podium terraces may also be affected by vertical winds that are deflected down by the building elements above. Therefore, wind control measures may also include overhead protection provided by trellises and canopies.

Image 14 provides a few examples of wind control features.

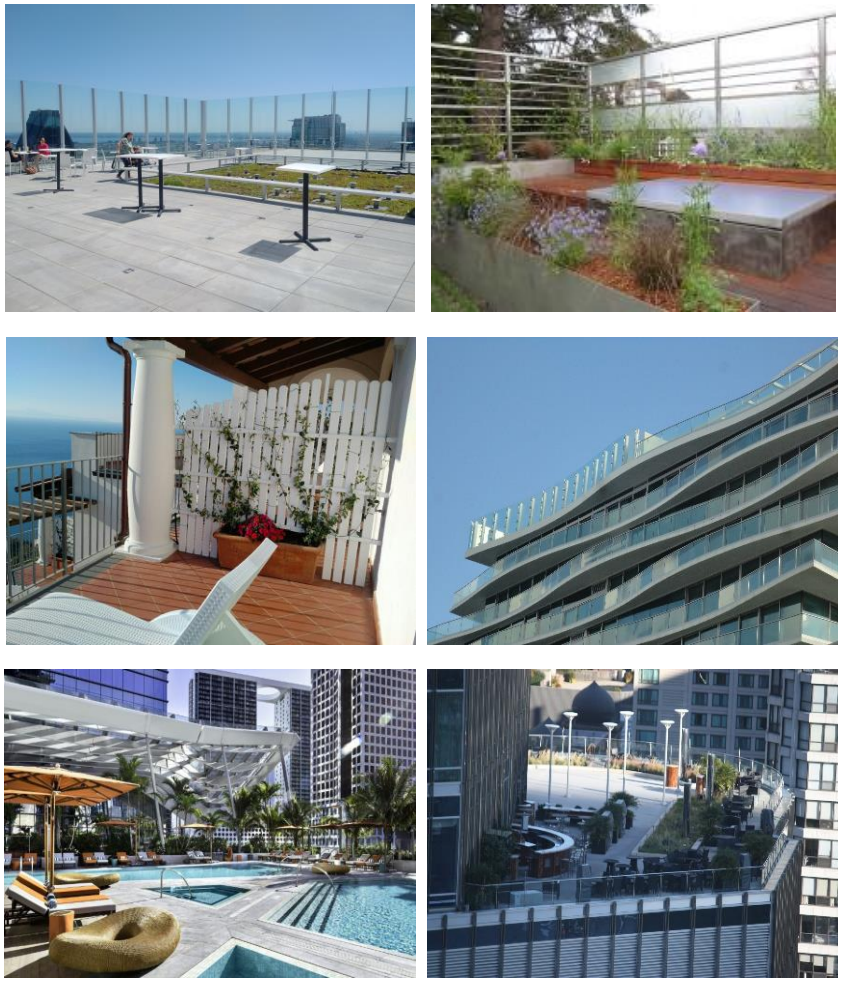


Image 14: Examples of wind control features for above-ground amenity areas

SUMMARY

Pedestrian wind conditions are assessed for the proposed Georgian Court Redevelopment in Burlington, ON. This qualitative assessment is based on the local wind climate, current master plan, existing surroundings and our knowledge and experience with wind flow around buildings.

The proposed development includes several positive design features for wind control. As a result, the existing wind conditions in the surrounding areas will not be altered significantly. On the development site, suitable wind conditions are predicted for most sidewalks and the proposed green spaces throughout the year.

Due to the local wind climate, elevated wind conditions are anticipated around the proposed towers during the winter season. Other potential areas with undesirable wind conditions may include exposed building entrances, green spaces and above-ground amenities.

Wind control concepts are provided to improve these wind conditions, ranging from street orientation and building massing to small scale mitigation measures such as landscaping, screens and canopies. Photo examples are provided in the report for consideration.

Wind tunnel tests should be conducted at a later design stage to quantify these wind conditions and to develop wind control solutions.