Tivoli Condominiums

Hamilton, Ontario

Pedestrian Wind Assessment

RWDI # 1401113
November 7, 2014

SUBMITTED TO

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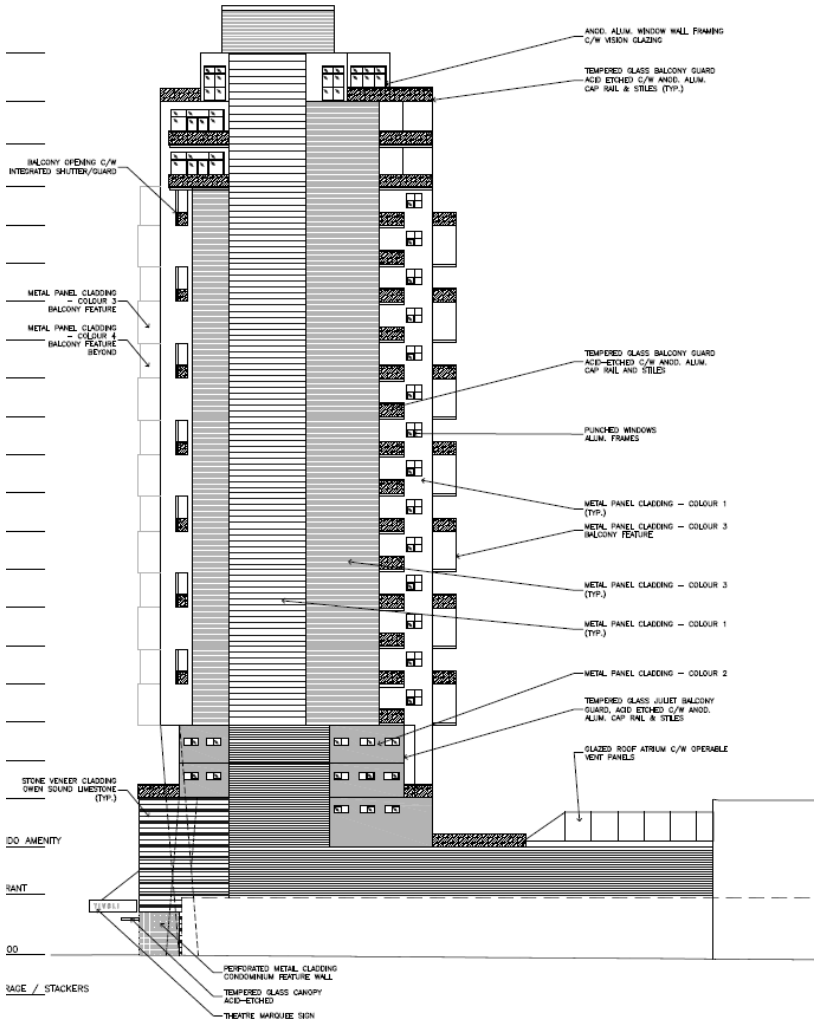


1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by 1150735 Ontario Ltd. to assess the wind comfort conditions on and around the proposed Tivoli Condominiums at 108 James Street North in Hamilton, ON.

The objective of this assessment was to provide a qualitative evaluation of pedestrian wind comfort and safety conditions around the proposed development as required by the City of Hamilton. Conceptual mitigation measures to improve wind comfort have been recommended, where necessary, to improve wind conditions.

This qualitative assessment is based on the following:

- a review of long-term meteorological data for the Hamilton region;
- design drawings received by RWDI on March 24, 2014 and updated elevations on October 31, 2014;
- our engineering judgment and knowledge of wind flows around buildings;
- Our previous experience with wind tunnel model studies[1,2], including projects in the Hamilton area; and
- use of software developed by RWDI (Windestimator[3]) for estimating the potential wind conditions around generalized building forms.

This qualitative approach provides a screening-level estimation of potential wind conditions. To quantify these conditions or refine any conceptual mitigation measures, physical scale model tests would typically be required.

Other wind issues, such as those related to door pressures, stack effect, exhaust re-entrainment, snowdrifting, wind loading, etc., are not considered in the scope of the current assessment.

Image 1 - Aerial Photograph of Existing Site and Surroundings
(*Courtesy of Google earth™*)

1. 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.
2. 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. 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. BUILDING AND SITE INFORMATION

The proposed development site is located on the east side of James Street North, between a three-storey office building to the north, a one-storey retail building to the south and the two-storey Tivoli Theatre to the east (see Image 1 on the previous page). The Ground Floor Plan of the development is shown in Image 2.

The main entrances to the proposed development are all located along James Street North, on the west side of the development. The development consists of commercial spaces at the first three floors, and condominium units above from the 4th to 22nd floors. Typical floor plans are shown in Image 3, with an approximate floor plate footprint of 22 m by 22 m.

Beyond the immediate surroundings, there are low-rise residential and commercial buildings, roadways and parking lots in all directions. Hamilton downtown is located to the south and southwest, with dense high-rise buildings. Farther away from the site, the Niagara Escarpment is approximately 1.5 km to the south, Hamilton Harbour 2.5 km to the north and Lake Ontario 7 km to the northeast.

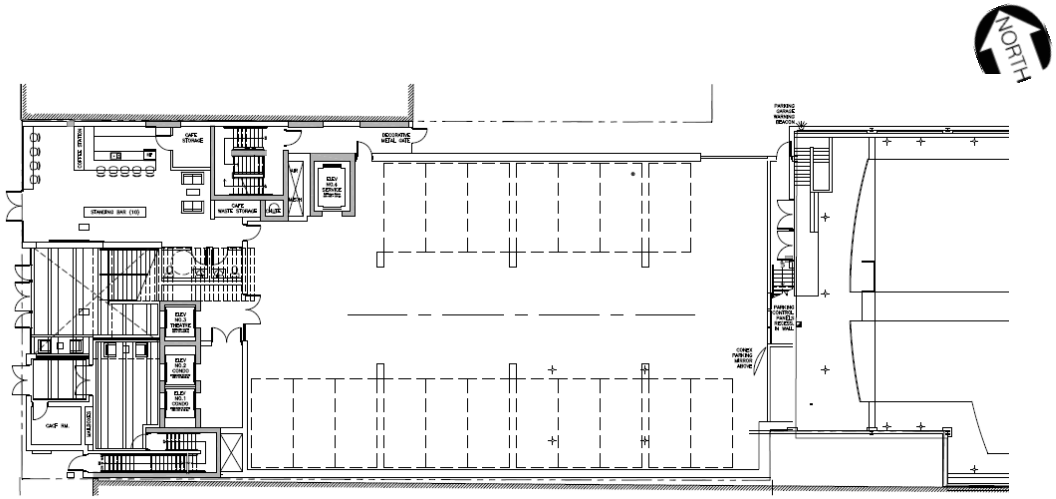


Image 2 – Ground Floor Plan

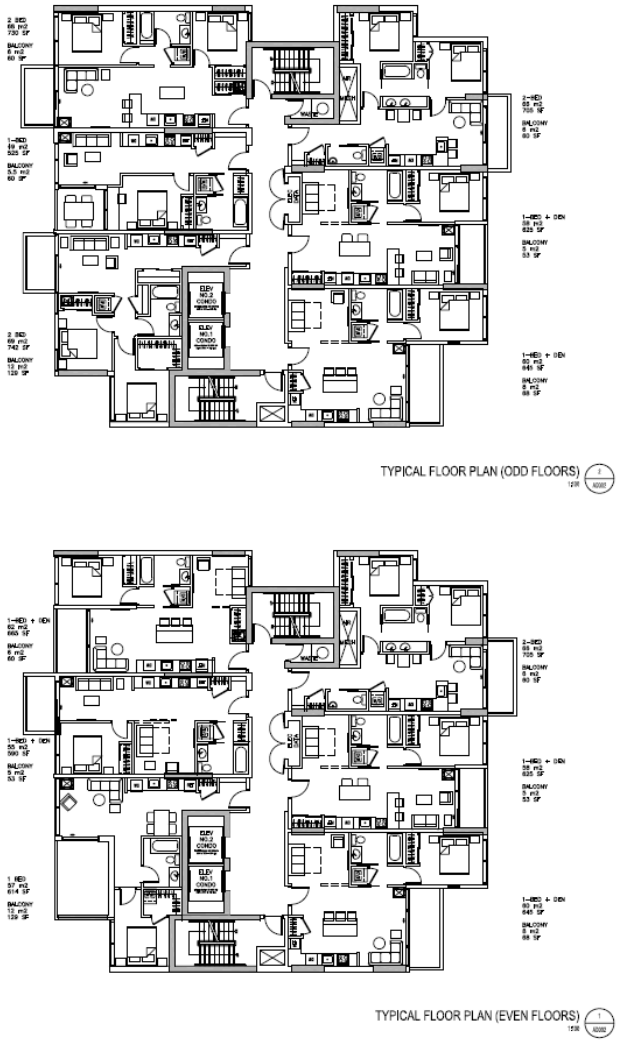


Image 3 - Typical Floor Plans

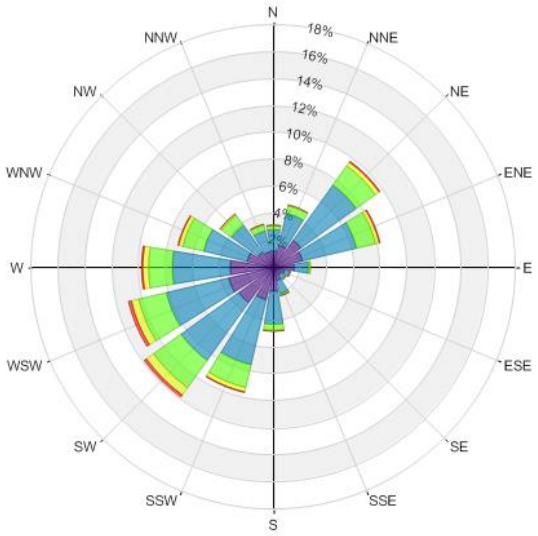
3. METEOROLOGICAL DATA

Meteorological data from Hamilton International Airport between 1970 and 2011 were used as reference for wind conditions in the area (see Image 4).

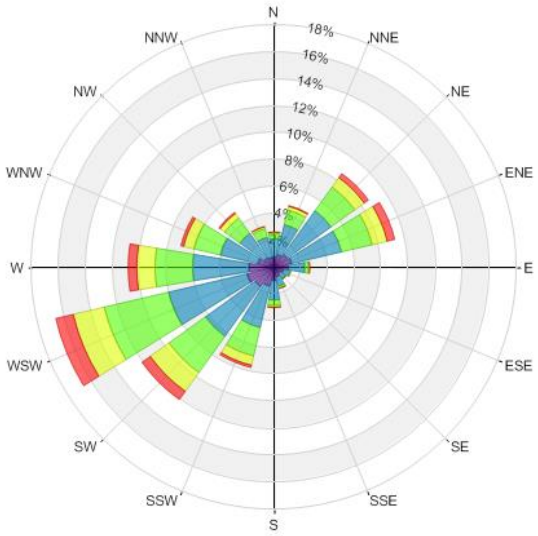
The distributions of wind frequency and directionality for summer (May through October) and winter (November through April) seasons are shown in the wind roses in Image 4. Winds from the south-southwest through west-northwest, northeast and east-northeast directions are predominant in the summer when all winds are considered. The right wind rose shows the winter data, indicating the predominance of winds from the southwest, west-southwest, west, northeast and east-northeast during this season.

Strong winds of a mean speed greater than 30 km/h measured at the airport occur for 4.1% and 14.3% of the time during the summer and winter seasons, respectively. The southwesterly and northwesterly winds are prevalent for both seasons, as demonstrated by the yellow and red bands in the wind roses. Winds from these directions potentially could be the source of uncomfortable or even severe wind conditions, depending upon the site exposure or development design.

Wind approaching from the southwest, west and northeast were considered most important for this assessment; however, winds from all directions were considered in the numerical assessment of wind conditions at the site.



Summer Winds



Winter Winds

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	4.3	2.8
1-10	30.4	18.4
11-20	45.2	40.2
21-30	16.0	24.2
31-40	3.3	10.0
>40	0.8	4.3

Image 4 - Directional Distribution (%) of Winds (Blowing From)
Hamilton International Airport (1970 to 2011)

4. EXPLANATION OF 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, including the City of Hamilton, and by the building design and city planning communities.

Sitting: Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away.

Standing: Gentle breezes suitable for main building entrances and bus stops.

Strolling: Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park.

Walking: 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 or walking if the 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 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. Comparisons of wind speeds for different building configurations are the most objective way in assessing local pedestrian wind conditions.

5. PEDESTRIAN WIND CONDITIONS

5.1 Background

Generally, wind conditions suitable for walking or strolling are appropriate for sidewalks, and lower wind speeds comfortable for standing are preferred for primary building entrances. For amenity spaces, wind conditions comfortable for sitting or standing would be appropriate in the summer when these areas will typically be in use.

The proposed building will be taller than its immediate surroundings. Tall buildings tend to intercept the stronger winds at higher elevations and redirect these flows down to grade. Such a Downwashing Flow (see Image 5a) is often the main cause for accelerated winds at street level.

An effective measure to reduce the direct impact of the downwashing flow is to include a large podium around the tower (see Image 5b). The existing buildings abutting the proposed Tivoli development to the north, east and south will act as a podium for wind control.

The inclusion of recessed 4th and 5th floors is a also positive feature for wind reduction, as the recessed space would form another podium on the east and west sides of the tower, reducing any direct wind impact on the ground level (see Image 6).

Alternated floor plans and notched tower corners (see Image 3 on the previous page) are also positive in reducing the potential wind downwashing from the tower.

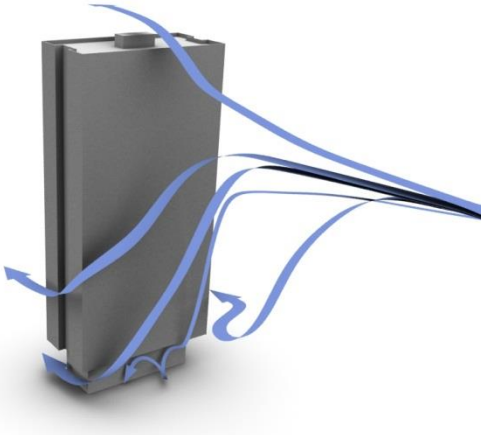


Image 5a - Downwashing Flow

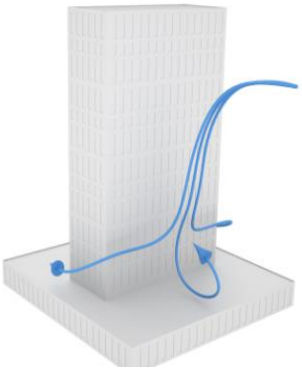


Image 5b - Large Podium for Pedestrian Wind Control

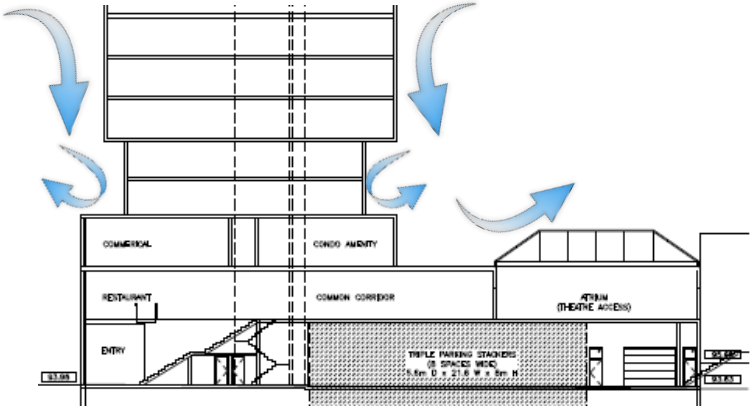


Image 6 - Recessed Lower Floors for Pedestrian Wind Control

5.2 Wind Conditions at Grade

Pedestrian areas at grade that may potentially be affected by the proposed development include building entrances (Locations A1, A2 and A3 in Image 7a), an outdoor seating area (Location B in Image 7b) and sidewalks along James Street North (Locations C and C1 in Image 7b). These areas are sheltered by the existing and proposed buildings from the northeasterly winds, but the southwest and west winds may be intercepted by the proposed Tivoli tower and downwash into these areas. The downwashing of prevailing southwest and west winds along the west façade of the Tivoli development will increase wind speeds in front of the proposed building.

The resultant wind comfort conditions may be higher than desired for building entrances (A1, A2 and A3 in Image 7a) in the winter and for the outdoor seating area (B in Image 7b) in the summer. However, these increased winds along the west side of the development will not exceed the safety criterion throughout the year.

The proposed lobby for the commercial entrance A2 and the vestibule for the residential entrance A3 are positive design features that will provide indoor waiting areas on cold and windy days.

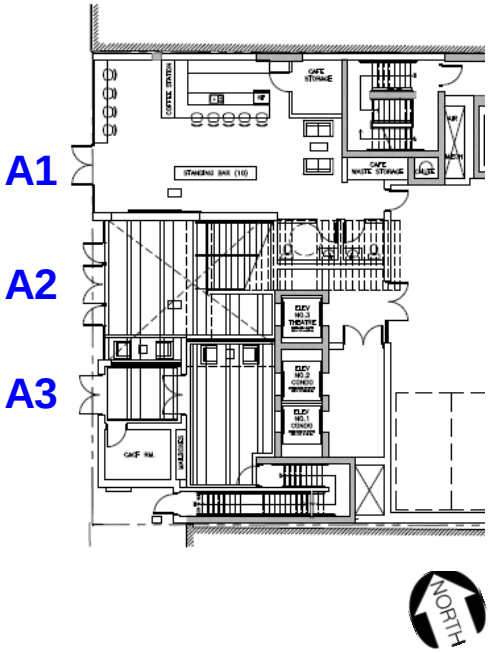


Image 7a - Entrance Locations

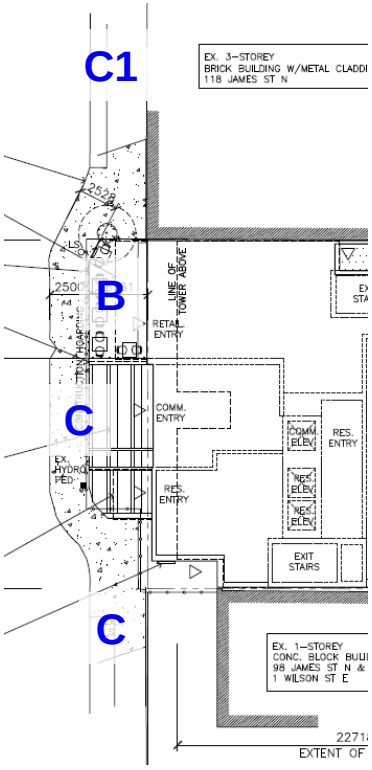


Image 7b – Seating and Sidewalks

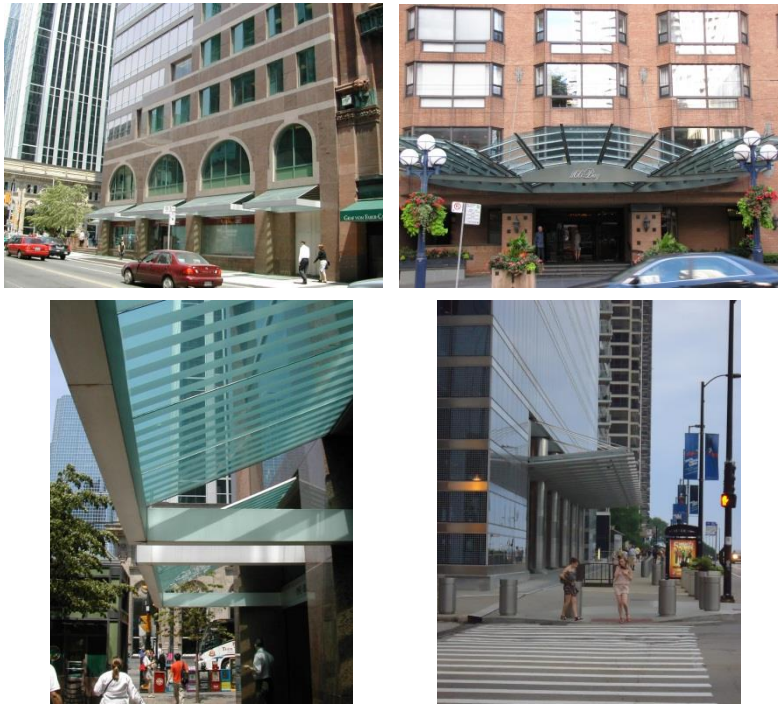


Image 8 - Examples of Large Entrance Canopies

Large entrance canopies should be considered along the west façade of the proposed building to protect these areas from downwashing winds and improve the wind conditions around the entrances. Examples of entrance canopies are provided in Image 8 on the previous page.

For the outdoor seating area (Location B in Image 7b) in front of the retail entrance (Location A1 in Image 7a), low wind speeds comfortable for sitting are recommended during the summer. However higher-than-desired wind activity is anticipated due to downwashing flows off the tower and wind accelerations along the sidewalk. Therefore, wind mitigation measures should include both horizontal elements above the seating area (e.g., canopies, trellises and umbrellas) and vertical elements on the south and west sides of the area (e.g., screens and landscaping as shown – see Image 9 for examples).

Image 9 – Mitigation Examples for Seating Area

After construction of the proposed tower, wind speeds along the James Street sidewalk north of the tower (Location C1 in Image 7b) will increase slightly due to the southwesterly winds downwashing off of the tower. However, the resultant wind conditions are expected to be suitable for walking or better throughout the year, which meets the intended comfort criterion.

The entrances to the existing buildings in this area are all recessed from the building façade (see Image 10) thereby providing some wind protection and suitable wind conditions are expected at these entrances.

Image 10 - Recessed Entrances to Existing Buildings
(Photo *Courtesy of Google earth*™)

5.3 Wind Conditions at On-site Amenity Areas

The roof spaces at the 3rd and 4th floors (Locations D1 and D2, respectively, in Image 11) may be used as outdoor amenity spaces in the future. Due to their exposure to horizontal winds over the existing surroundings and vertical winds downwashing off of the proposed tower, wind speeds in these areas are predicted to be higher than desired for passive pedestrian activities such as sitting in the summer, when these areas will typically be in highest use. Higher wind speeds in the winter may be tolerable due to reduced usage.

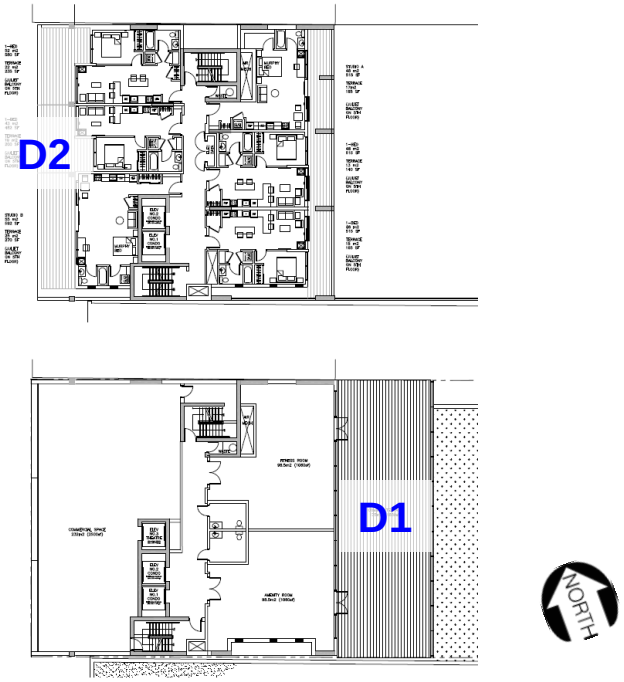


Image 11 – Potential Amenity Spaces at Third (lower image) and Fourth Floors (upper image)

To create better summer wind conditions in these areas, mitigation measures should be included in the building design. They may take the form of tall parapets/screens, landscaping and overhead trellises. Image 12 includes mitigation examples for outdoor amenity spaces.

Image 12 – Mitigation Examples for Above-grade Amenity

6. SUMMARY

The proposed 22-storey development consists of several positive design features for wind control. Based on the current design information and local wind climate, it is our opinion that the resultant wind conditions will meet the wind safety criterion in all pedestrian areas throughout the year, and the proposed development will not negatively affect wind conditions in the surrounding areas.

Higher-than-desired wind speeds may be experienced along the west side of the proposed development at the entrances and the outdoor seating area along James Street North, and the outdoor amenity areas at the 3rd and 4th floors. Wind mitigation measures have been recommended and described through photographic examples to improve these wind conditions to appropriate levels.

A more detailed assessment of the wind conditions on and around the development involving scale model wind tunnel tests is not warranted provided the wind mitigation recommended herein, particularly along the west side of the development, are implemented.

7. APPLICABILITY OF RESULTS

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 design considered in this report. It is the responsibility of others to contact RWDI to initiate this process.