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Date: September 5, 2024

Re: Pedestrian Wind Assessment
1 Dunbar Road North
Waterloo, Ontario
SLR Project #241.031009.00001

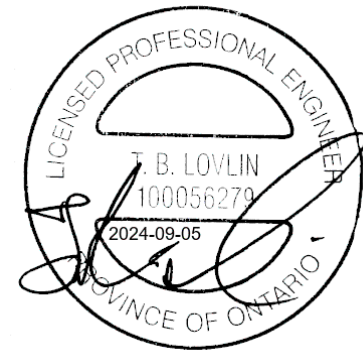


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1.0 Introduction

SLR Consulting (Canada) Ltd. (SLR) was retained by 2744668 Ontario Inc. to conduct a pedestrian wind assessment for the proposed development at 1 Dunbar Road North in Waterloo, Ontario. This report is in support of the Site Plan Approval (SPA) application for the development.

1.1 Existing Development

The proposed development is located along the north side of Erb Street West, bounded by Roslin Avenue North to the west and Dunbar Road North to the east. The site is currently occupied by seven vacated single-detached residences. Figure 1 provides an aerial view of the immediate study area.

Immediately surrounding the site are low-rise residential buildings in all directions. Beyond the immediate surroundings, there are mid-rise residential buildings to the west; empty lots and parking lots to the northwest; a low-rise recreational centre to the north; high-rise residential developments to the northeast; and low-rise residential buildings in all other directions.

Typically, developments with Site Plan Application (SPA) approval within a 500 m radius are included as existing surroundings. For the current assessment, with guidance from the project planner, the following developments were included as existing surroundings: 202-218 Erb Street West (50 Westmount) and Westmount Place Phase 2.



Figure 1: Aerial view of existing site & surroundings

*Credit: Esri, Maxar, Earthstar Geographics, and the GIS User Community
(Image Date June 24, 2022)*

1.2 Proposed Development

The proposed development is a 10-storey apartment building that is approximately 32 m in height (Figure 2).

The main entrance is located on the east facade along Dunbar Road North, while the secondary entrance is located on the north facade, near the parking spaces. There are four exits, three of which are located on the south facade along Erb Street West, and one exit is on the west facade along Roslin Avenue North, as shown in Figure 3a.

There is an outdoor amenity space on the building's rooftop, as shown in Figure 3b.

1.3 Areas of Interest

Areas of interest for pedestrian wind conditions include those areas which pedestrians are expected to use on a frequent basis. Typically, these include sidewalks, main entrances, transit stops, plazas and parks. On-site areas of interest are shown in Figures 3a and 3b.

In addition, three transit stops are located within the project vicinity:

- At the southwest corner of Erb Street West and Roslin Avenue North (right across the street from the site),
- At the northwest corner of Erb Street West and Roslin Avenue North (to the west of the site), and,
- Along the north side of Erb Street West (to the east of the site, between Dunbar Road North and Avondale Avenue North).



Figure 2: 3D model of the proposed development

Credit: 360 Pacifica Capital Corporation

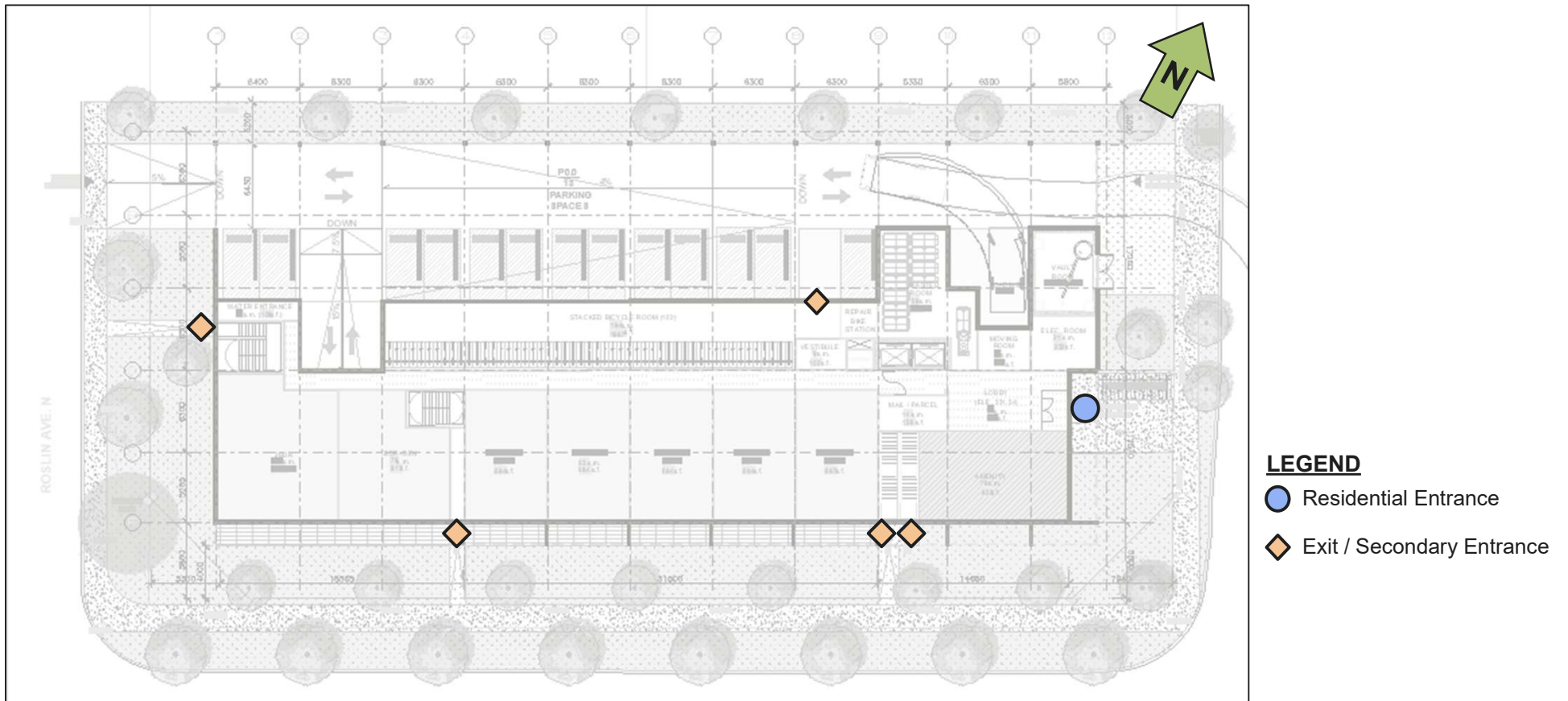


Figure 3a: Areas of interest - grade
 Credit: 360 Pacifica Capital Corporation

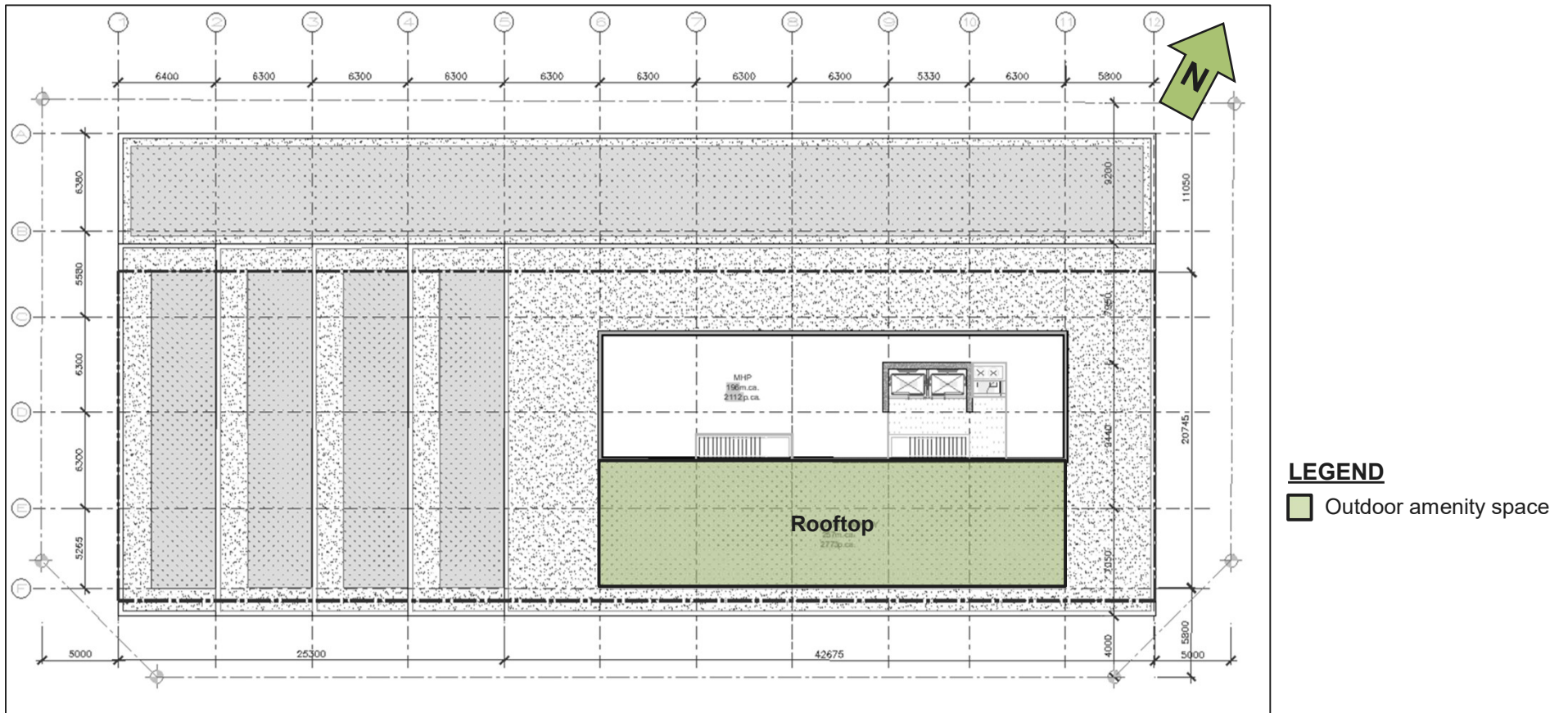


Figure 3b: Areas of interest – above-grade
Credit: 360 Pacifica Capital Corporation

2.0 Approach

A qualitative assessment was conducted using computational fluid dynamics (CFD). As with any approach, there are some limitations with this analysis technique, specifically in the ability to simulate the turbulence of the wind. Nonetheless, a qualitative CFD analysis is a useful tool to identify potential wind issues, as it employs a comparable analysis methodology to that used in quantitative wind tunnel testing.

2.1 Methodology

Wind comfort conditions were predicted on and around the development site to identify potentially problematic windy areas. Floor plans and elevations of the proposed development were provided by 360 Pacifica Capital Corporation between July 23, 2024, and August 15, 2024. The model included surrounding buildings within 500 m of the study site centre. The simulations were performed using CFD software by Meteodyn Inc.

The 3D space throughout the modelled area is filled with a three-dimensional grid. The CFD virtual wind tunnel calculates wind speed at each one of the 3D grid points. The upstream “roughness” for each test direction is adjusted to reflect the upwind conditions encountered around the site. Wind flows for 16 compass directions were simulated. Although wind speeds are calculated throughout the modelled area, wind comfort conditions were only plotted for a smaller area immediately surrounding the proposed development.

SLR assessed two configurations, for comparison, as follows:

- **Existing Configuration:** Existing site with existing and SPA-approved or under-construction surroundings, as directed by the design team.
- **Proposed Configuration:** Proposed development with existing and SPA-approved or under-construction surroundings, as directed by the design team.

A view of the 3D model used in the wind comfort analysis for each configuration is shown in Figures 4a and 4b.

The CFD-predicted wind speeds for all test directions and grid points were combined with historical wind climate data for the region to predict the occurrence of wind speeds in the pedestrian realm, and to compare against wind criteria for comfort and safety. This analysis was conducted for the Existing Configuration and Proposed Configuration. The analysis of wind conditions is undertaken for two seasons: Summer (May to October) and Winter (November to April).

Results are presented through discussion of the wind conditions along major streets and the areas of interest. The comfort criteria are based on predictions of localized wind forces combined with frequency of occurrence. Climate issues that influence a person’s overall “thermal” comfort, (e.g., temperature, humidity, wind chill, exposure to sun or shade) are not considered in the comfort rating.

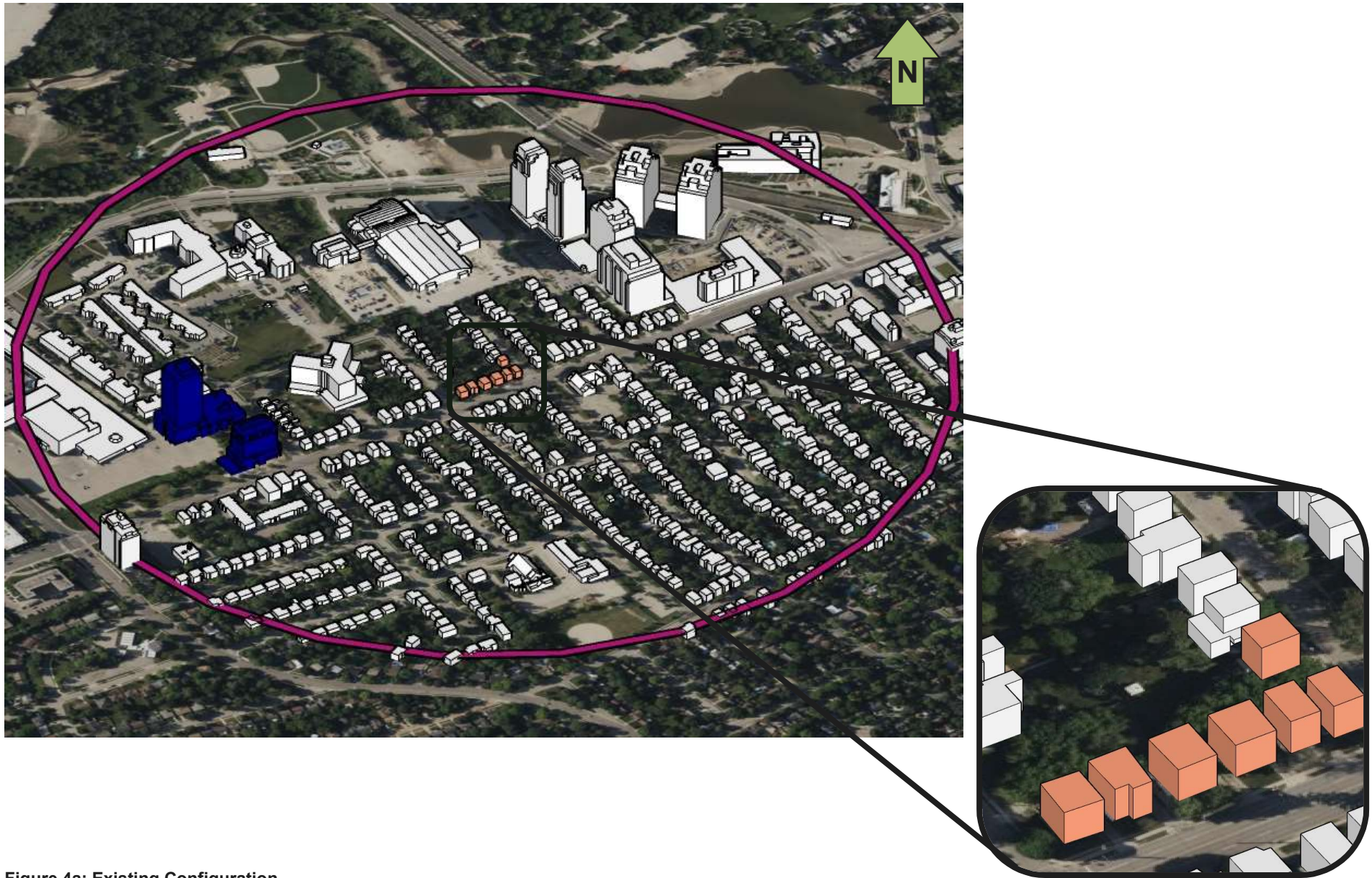


Figure 4a: Existing Configuration

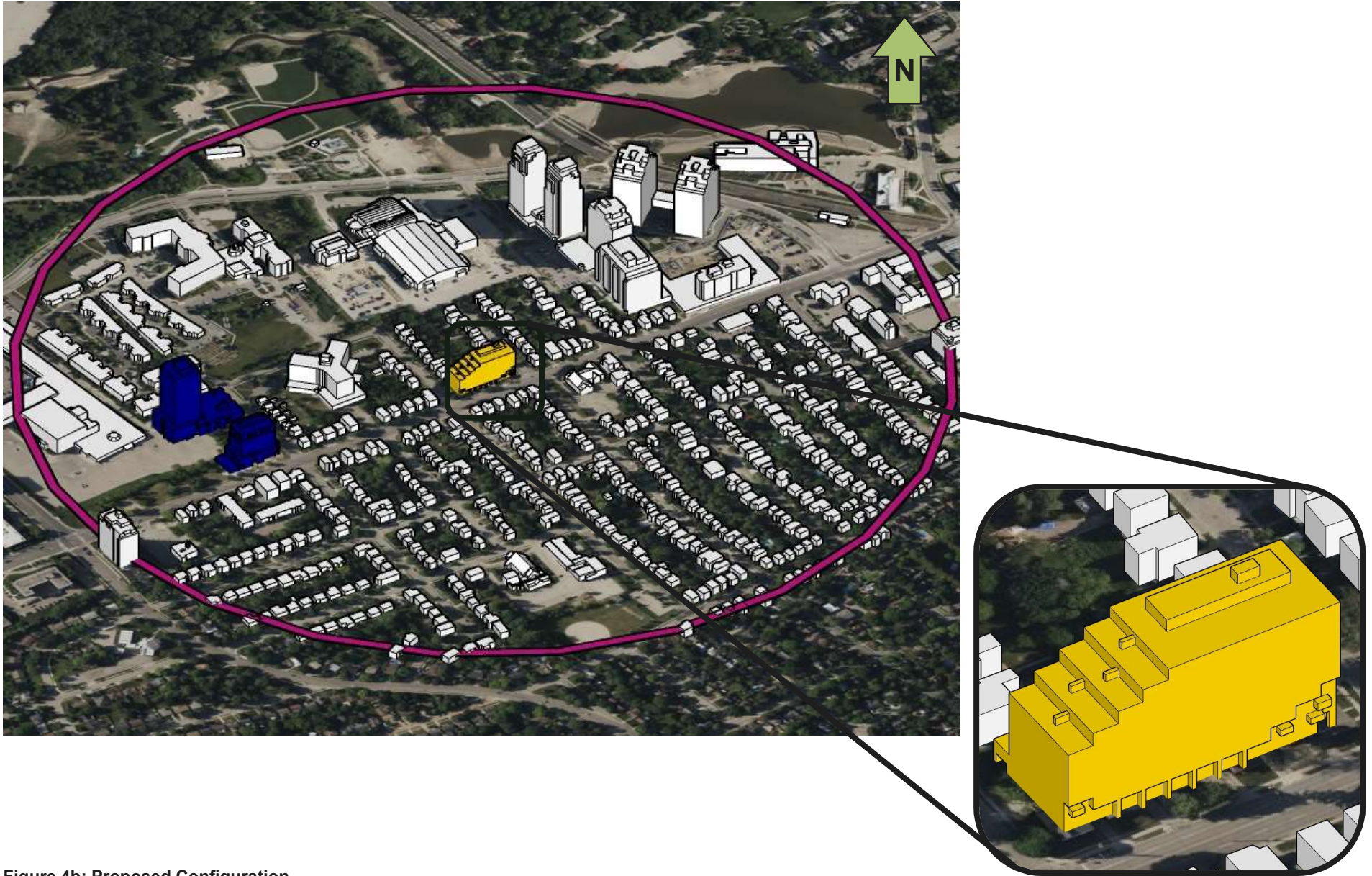


Figure 4b: Proposed Configuration

2.2 Wind Climate

Wind data recorded at Waterloo International Airport for the period of 1993 to 2020 were obtained and analyzed to create a wind climate model for the region. Annual and seasonal wind distribution diagrams (“wind roses”) are shown in Figure 5. These diagrams illustrate the percentage of time wind blows from the 16 main compass directions. Of main interest are the longest peaks that identify the most frequently occurring wind directions. The annual wind rose indicates that winds approaching from the southwest through northwest and east directions are most prevalent. The seasonal wind roses readily show how the prevalent winds shift throughout the year.

The directions from which stronger winds (e.g., > 30 km/h) approach are also of interest as they have the highest potential of creating problematic wind conditions, depending upon site exposure and the building configurations. The wind roses in Figure 5 also identify the directional frequency of these stronger winds, as indicated in the figure’s legend colour key. On an annual basis, strong winds occur from the northwesterly and westerly sectors, as well as from the east. All wind speeds and directions were included in the wind climate model.

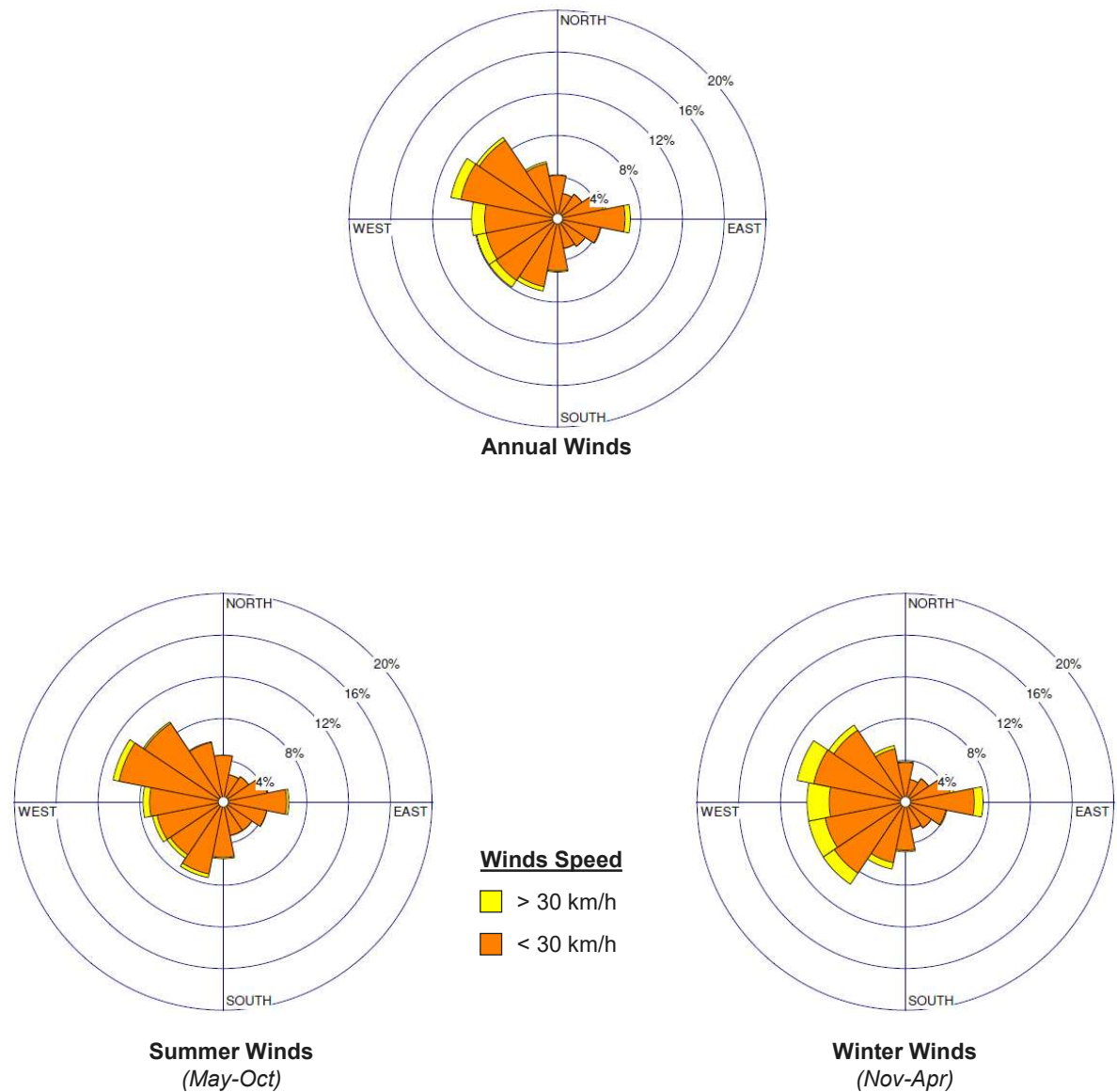


Figure 5: Wind roses for Waterloo International Airport (1993-2020)

3.0 Pedestrian Wind Criteria

Wind comfort conditions are discussed in terms of being acceptable for certain pedestrian activities and are based on predicted wind force and the expected frequency of occurrence. Wind chill, clothing, humidity and exposure to direct sun, for example, all affect a person's thermal comfort; however, these influences are not considered in the wind comfort criteria.

The criteria utilized for this analysis are provided by the City of Waterloo, in the document Terms of Reference: Wind Study (June 30, 2023). The comfort criteria, which are based on certain predicted hourly gust-equivalent mean (GEM) wind speeds being exceeded 20% of the time, are summarized in Table 1. By allowing for a 20% exceedance, it assumes wind speeds will be comfortable for the corresponding activity at least four out of five days. The comfort criteria consider only daytime hours, between 6:00 am and 11:00 pm. GEM is defined as the maximum of either mean wind speed or gust wind speed divided by 1.85.

The criterion for wind safety in the table is based on hourly gust wind speeds that are exceeded nine hours per year (approximately 0.1% of the time). When more than one event is predicted annually, wind mitigation measures are then advised. The wind safety criterion is shown in Table 2.

Table 1: Wind Comfort Criteria

Comfort Category	GEM Wind Speed Exceeded 20% of the time	Description of Wind Comfort
Sitting	≤ 10 km/h	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away.
Standing	≤ 15 km/h	Gentle breezes suitable for main building entrances and bus stops.
Walking	≤ 20 km/h	Moderate breezes that can be tolerated if one's objective is to walk, run or cycle without lingering.
Uncomfortable	> 20 km/h	Strong winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended.

Table 2: Wind Safety Criterion

Safety Criterion	Gust Wind Speed Exceeded Once Per Year (0.1%)	Description of Wind Effects
Exceeded	> 90 km/h	Excessive gust speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is typically required.

4.0 Results

Figures 6a through 9b present graphical images of the wind comfort conditions for the summer and winter months around the existing site and the proposed development. The predicted wind conditions are shown at 1.5 m above the respective grade, to exhibit the height at which pedestrians experience wind conditions. The “comfort zones” shown are based on an integration of wind speed and frequency for all 16 wind directions tested with the seasonal wind climate model. The presence of mature trees can lead to wind comfort levels that are marginally more comfortable than shown, during seasons when foliage is present. Appendix A presents the wind safety conditions on an annual basis.

There are generally accepted wind comfort levels that are desired for various pedestrian uses. However, in some regions, certain conditions may be difficult to achieve, especially during the windy months of the year (typically winter), due to the overall climate. For sidewalks, walkways and pathways, wind speeds suitable for walking are desirable year-round but may not be feasible in the winter. For main entrances and transit stops, wind conditions conducive to standing are preferred throughout the year. For on-site amenity areas, such as outdoor patios at or above grade, wind conditions suitable for sitting are desirable during the summer and shoulder seasons, with stronger wind flows, conducive to walking, tolerated in the winter, as such areas may not be used during the colder months of the year.

4.1 Building Entrances & Walkways

Existing on-site wind conditions are generally expected to be comfortable for sitting in the summer (Figure 6a) and sitting or standing in the winter (Figure 7a).

In the Proposed Configuration, with the addition of the proposed development, on-site wind conditions are generally expected to be suitable for walking or better year-round on the site (Figures 7b and 8b), which is considered appropriate. Wind conditions at the main and secondary entrances, as well as the exits, are anticipated to be comfortable for sitting or standing year-round (Figures 8a and 8b), which is considered appropriate. It should be noted that having the entrances recessed behind the main facade is a positive design feature, as it shelters the entrances from prevailing winds. This feature should be retained in the final design.

4.2 Surrounding Sidewalks & Transit Stops

Wind conditions on the sidewalks surrounding the site are expected to be generally comfortable for sitting or standing year-round for the Existing Configuration (Figures 6a and 7a). In the Proposed Configuration, wind conditions comfortable for sitting or standing are anticipated in the summer, while in the winter wind conditions are expected to be conducive to walking (Figures 6b and 7b). These wind conditions are considered appropriate.

In both the Existing and Proposed Configurations, wind conditions at the nearby transit stops are predicted to be comfortable for sitting in the summer (Figures 6a and 7a) and sitting or standing in the winter (Figures 6b and 7b), which is also considered appropriate.

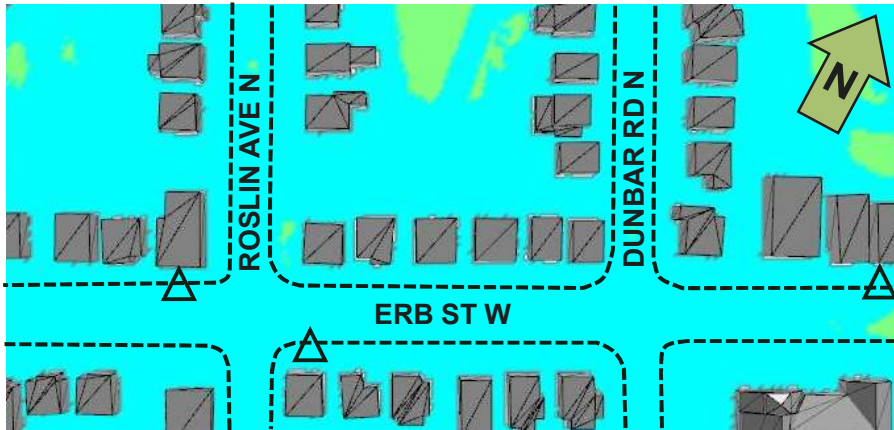


Figure 6a: Existing Configuration – Pedestrian Wind Comfort Summer – On-site & Surrounding Areas

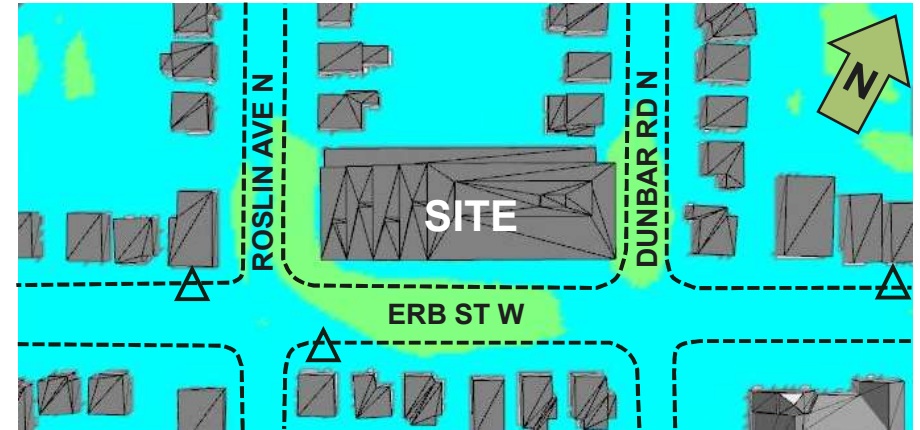


Figure 6b: Proposed Configuration – Pedestrian Wind Comfort Summer – On-site & Surrounding Areas

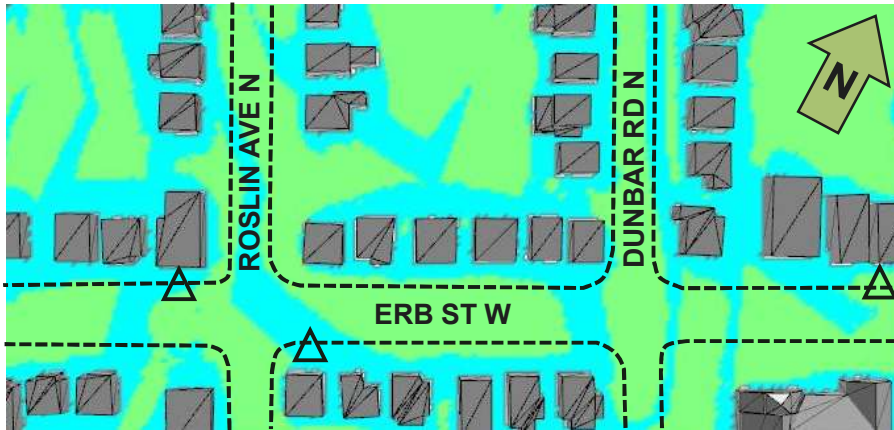


**Figure 7a: Existing Configuration – Pedestrian Wind Comfort
Winter – On-site & Surrounding Areas**

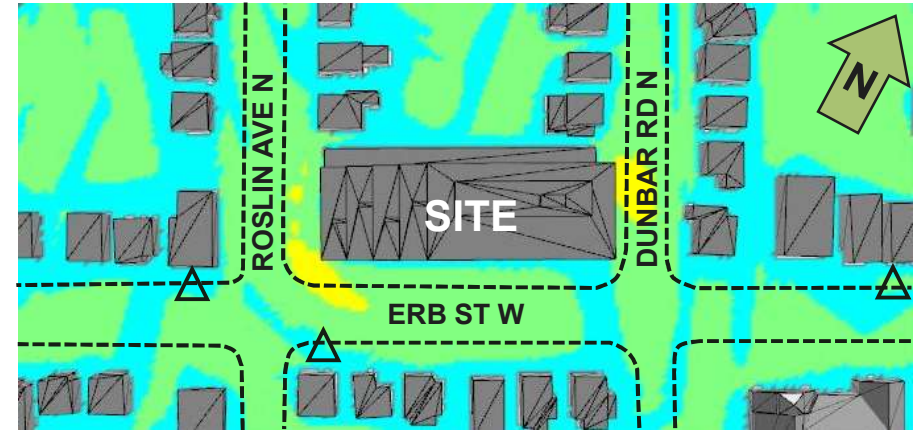
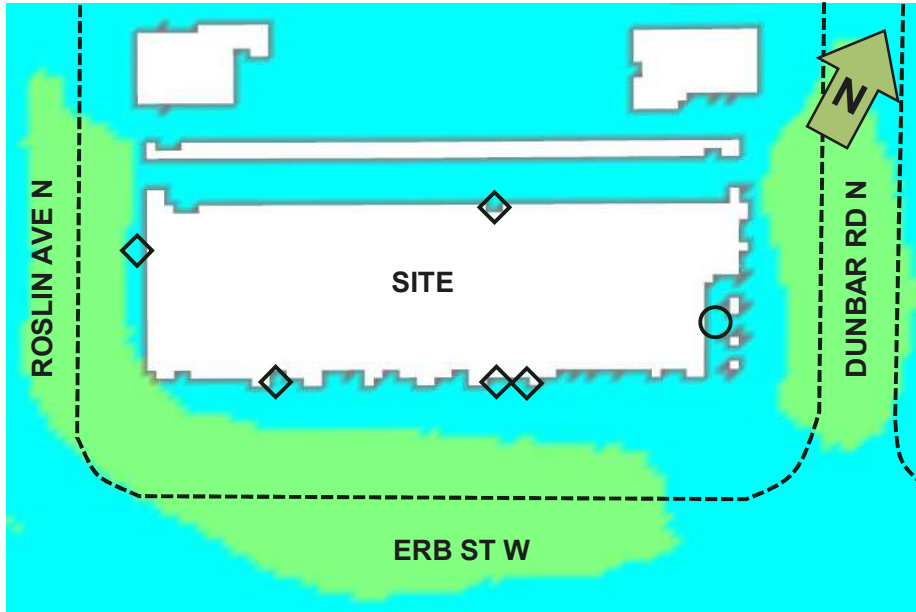
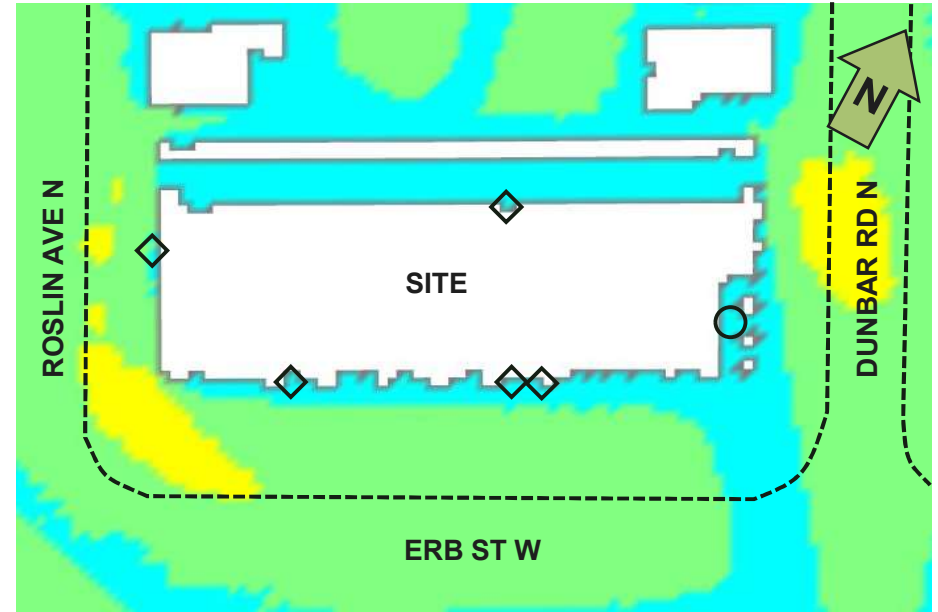


**Figure 7b: Proposed Configuration – Pedestrian Wind Comfort
Winter – On-site & Surrounding Areas**



- | | |
|---------------|---------------------------|
| Sitting | Residential Entrance |
| Standing | Exit / Secondary Entrance |
| Walking | |
| Uncomfortable | |

**Figure 8a: Proposed Configuration – Pedestrian Wind Comfort
Summer – Building Entrances & Walkways**



- | | |
|---------------|---------------------------|
| Sitting | Residential Entrance |
| Standing | Exit / Secondary Entrance |
| Walking | |
| Uncomfortable | |

**Figure 8b: Proposed Configuration – Pedestrian Wind Comfort
Winter – Building Entrances & Walkways**

4.3 Rooftop Amenity Terrace

In the summer, wind conditions on the rooftop amenity terrace are expected to be mostly suitable for standing, with stronger wind flows conducive to walking expected around the perimeter (Figure 9a). These wind conditions are considered windier than desired for passive use.

During the winter, wind speeds conducive to walking or uncomfortable are expected throughout the terrace (Figure 9b). This may not be of concern, as the terrace is anticipated to be used infrequently during the colder months.

It should be noted that the terrace includes 1 m guardrails along the east and west perimeter, with a 1 m tall planter box running along the south perimeter (Figure 10). While these features provide local shelter to patrons engaged in seated activities, these features have a negligible influence on overall wind comfort. Hence, the wind conditions shown in Figures 9a and 9b.

If improved wind conditions are desired in the summer, we suggest the design team increase the guardrail height to a minimum of 2.2 m, to provide local wind protection for residents.

4.4 Wind Safety

The wind safety criterion is expected to be met on an annual basis in all areas for the Existing Configuration and in all grade and above-grade areas for the Proposed Configuration (Appendix A).

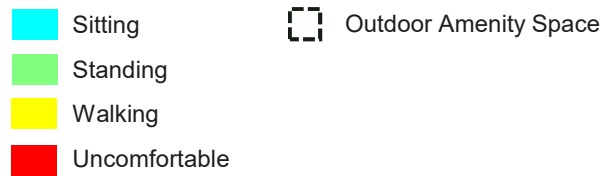
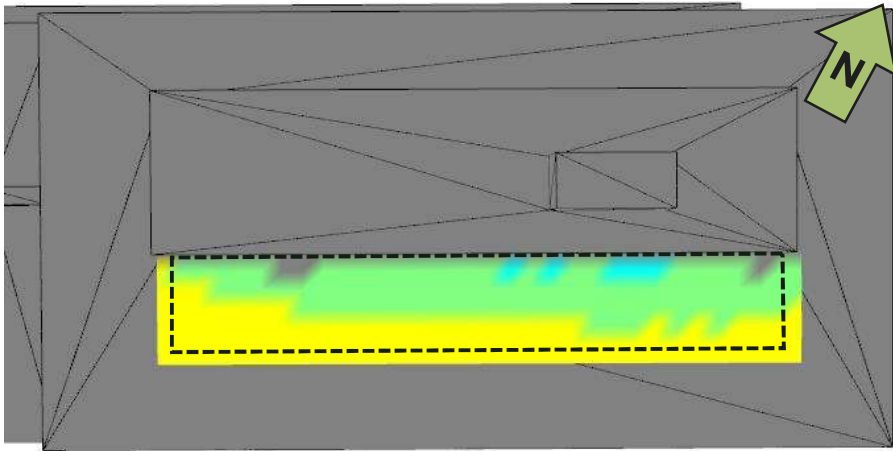


**Figure 9a: Proposed Configuration – Pedestrian Wind Comfort
Summer – Amenity Terraces**

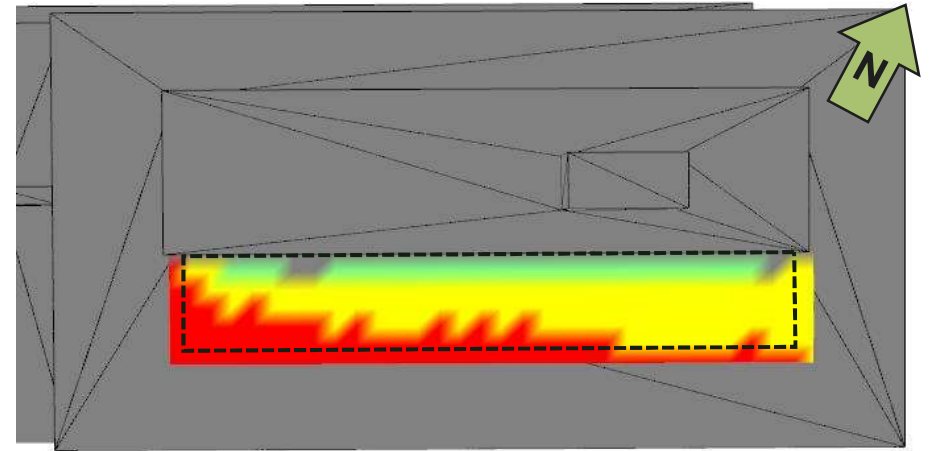


**Figure 9b: Proposed Configuration – Pedestrian Wind Comfort
Winter – Amenity Terraces**



Figure 10: Rendering of the rooftop terrace illustrating wind control features
 Credit: ACDF Architecture

5.0 Conclusion & Recommendations

The pedestrian wind conditions predicted for the proposed development at 1 Dunbar Road North in Waterloo have been assessed through qualitative CFD modelling techniques. Based on the results of our assessment, the following conclusions have been reached:

- The wind safety criterion is expected to be met at all areas assessed in both the Existing Configuration and Proposed Configuration.
- Existing wind conditions on and around the site are expected to be suitable for the intended use year-round.
- With the addition of the proposed development, wind conditions on-site including the main and secondary building entrances and exits are predicted to be appropriate for the intended use throughout the year.
- On the sidewalk surrounding the proposed development, as well as at the nearby transit stops, wind conditions are expected to be suitable for the intended use year-round.
- During the summer months, wind conditions on the rooftop outdoor amenity terrace are expected to be suitable for passive use (e.g., lounging). Suggestions are provided.

6.0 Statement of Limitations

This report has been prepared by SLR Consulting (Canada) Ltd. (SLR) for 2744668 Ontario Inc. (Client) in accordance with the scope of work and all other terms and conditions of the agreement between such parties. SLR acknowledges and agrees that the Client may provide this report to government agencies, interest holders, and/or Indigenous communities as part of project planning or regulatory approval processes. Copying or distribution of this report, in whole or in part, for any other purpose other than as aforementioned is not permitted without the prior written consent of SLR.

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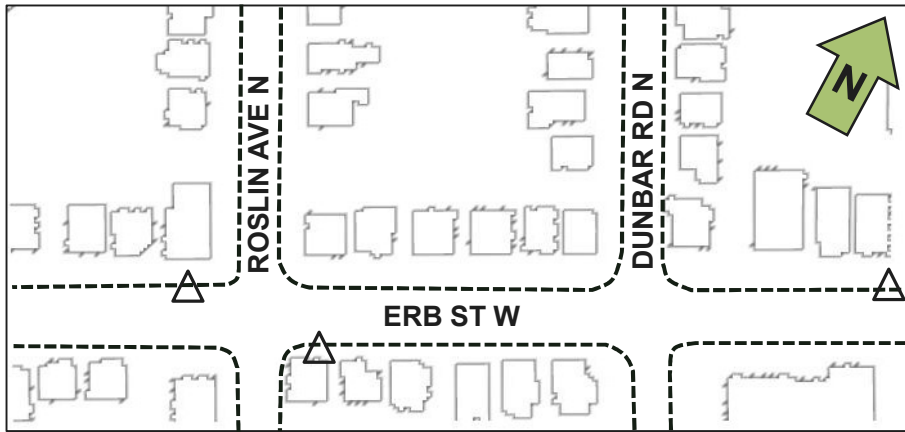
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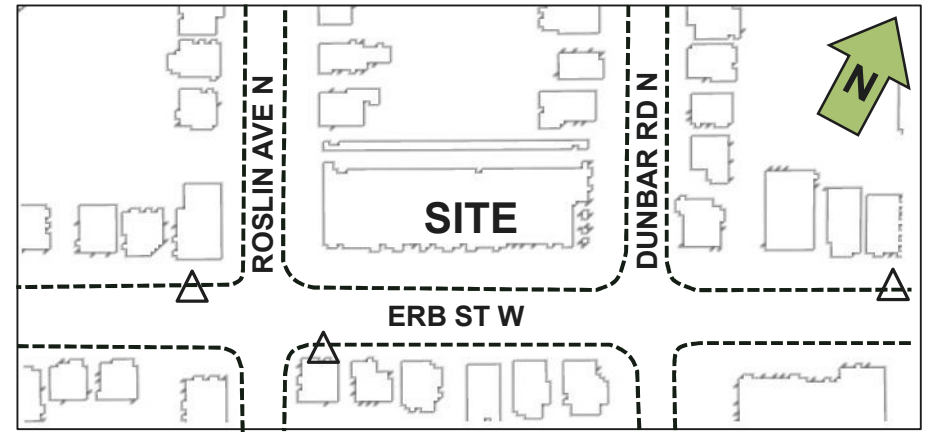
Appendix A

Pedestrian Wind Safety Analysis Annual



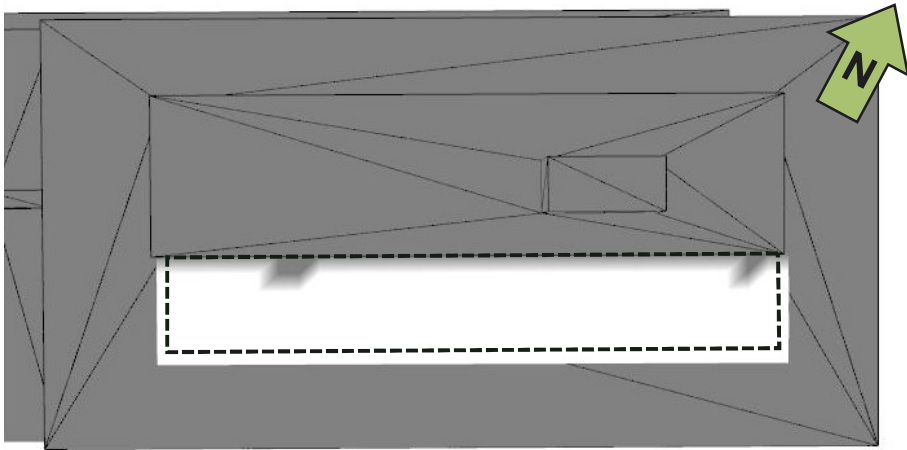
Exceeded Safety Criterion
 Transit Stop

Figure A1a: Existing Configuration – Wind Safety
 Annual – On-site & Surrounding Areas



Exceeded Safety Criterion
 Transit Stop

Figure A1b: Proposed Configuration – Wind Safety
 Annual – On-site & Surrounding Areas



- Exceeded Safety Criterion
- Outdoor Amenity Space

Figure A2: Proposed Configuration – Wind Safety
Annual – Amenity Terraces