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Date: March 14, 2024

Re: Pedestrian Wind Assessment
170 Northfield Drive West
Waterloo, ON
SLR Project #241.030968.00001

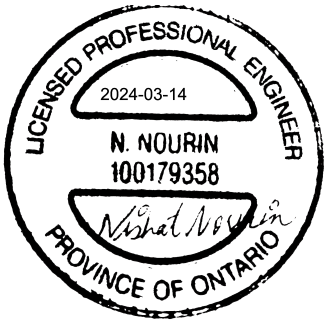


Credit: Turner Fleischer Architects Inc.

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1.0 Introduction

SLR Consulting (Canada) Ltd. (SLR) was retained by Forgestone Capital Management L.P to conduct a pedestrian wind assessment for the proposed development at 170 Northfield Drive West in Waterloo, Ontario. This report is in support of the combined Official Planning Approval (OPA) and Zoning Bylaw Amendment (ZBA) application for the City of Waterloo for the development.

1.1 Existing Site

The proposed development is located on the north side of Northfield Drive West, between Weber Street North and the Conestoga Parkway. The site is currently occupied by two low-rise commercial buildings and a large parking lot. **Figure 1** provides an aerial view of the immediate study area.

Immediately surrounding the site are low-rise commercial developments and parking lots in all directions. Beyond the immediate surroundings are low-rise commercial buildings to the north, east, and south, with low-rise residential developments to the southwest and west.

Typically, developments with Site Plan Approval (SPA) within a 500 radius are included as existing surroundings. For this assessment, no such developments were found within 500 m radius.



Figure 1: Aerial view of existing site & surroundings
Credit: Bing Maps, 2024

1.2 Proposed Development

The proposed development will include three phases:

- Phase 1: Parcels A through E consisting of eight mixed-use towers ranging in height from 25 to 40 storeys, with a Privately Owned Publicly Accessible Space (POPS) at the west end.
- Phase 2: Parcels I through L consisting of four low-rise commercial and industrial buildings.
- Phase 3: Parcels F through H consisting of six mixed-use residential towers ranging in height from 25 to 35 storeys and a POPS on the east end.

Note, Parcels A through H are atop a six-storey podium. **Figure 2** shows the south elevation of the overall proposed development. **Figure 3a** illustrates the overall site plan with all buildings and towers.

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. The main and secondary entrances, as well as grade level amenity spaces are shown in **Figure 3b**. In addition, outdoor amenity terraces are located at Level 7.

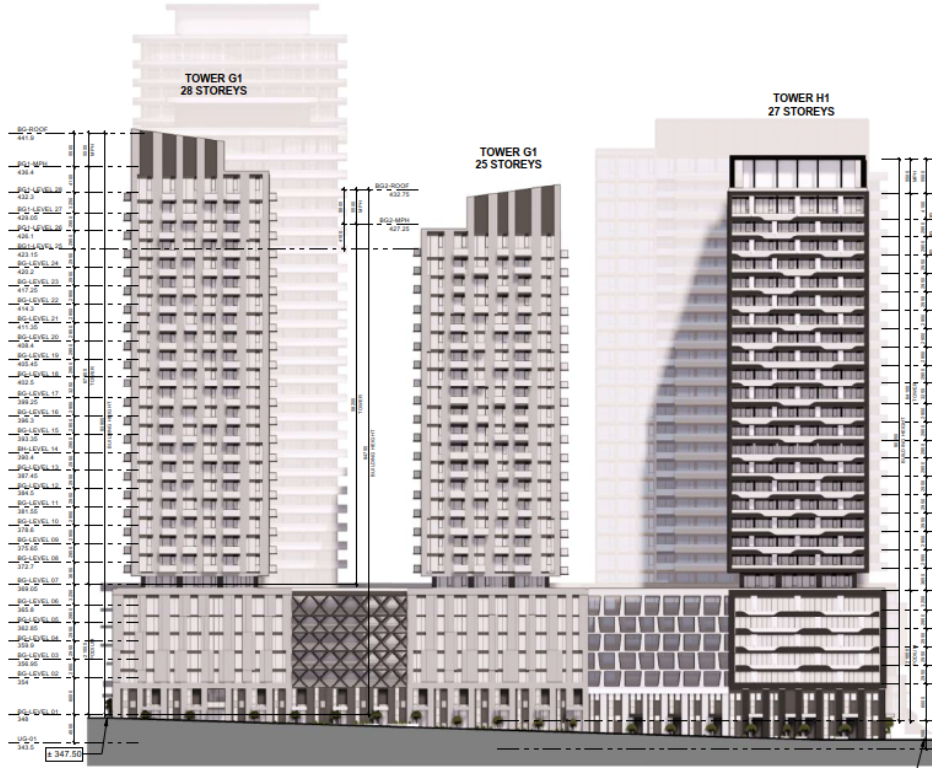


Figure 2: South Elevation of the proposed development
Credit: Turner Fleischer Architects Inc.

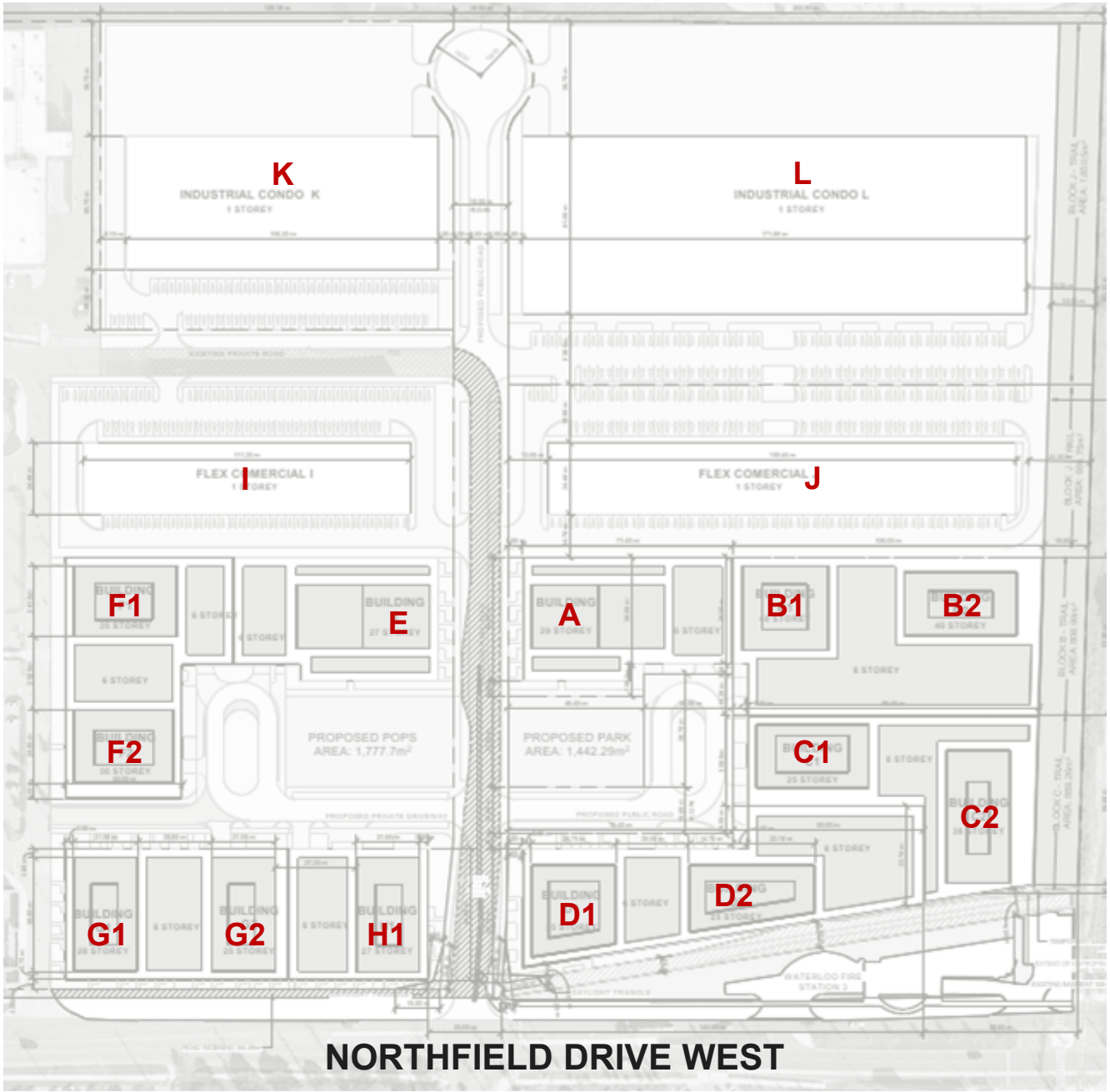


Figure 3a: Overall Site Plan

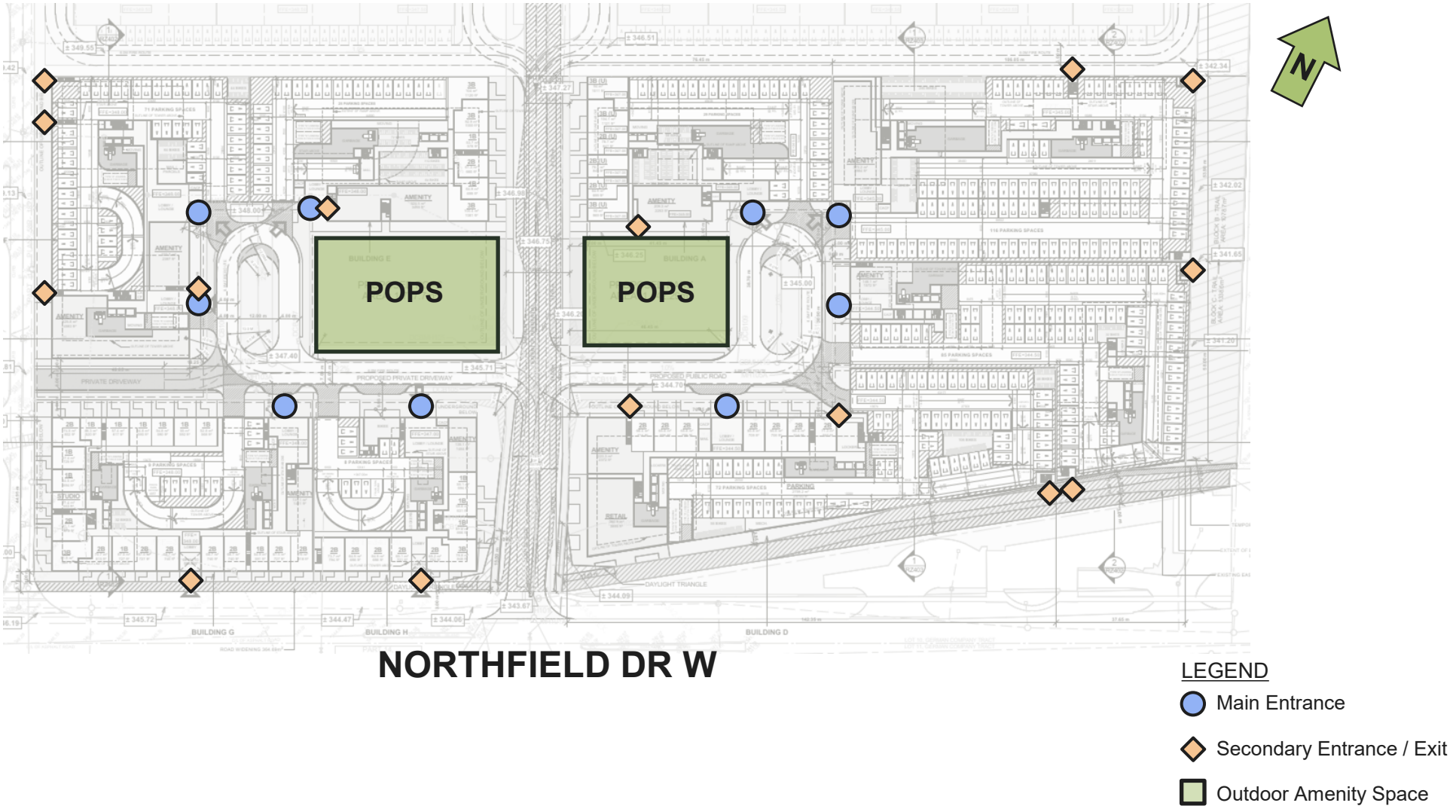


Figure 3b: Areas of Interest – Grade level floor plan

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. A 3D model of the proposed development, as well as floor plans and elevations, were provided by Turner Fleischer Architects Inc. on January 24, 2024. A view of the 3D model used in the computer wind comfort analysis is shown in **Figure 4.** This model included surrounding buildings within 500 m from the study site centre. The simulations were performed using CFD software by Meteodyn Inc.

The 3D space throughout the modeled 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 modeled 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 surroundings.
- **Proposed Configuration:** Proposed development with existing surroundings.

A view of the two configurations are shown in **Figures 4a** and 4**b.**

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 The analysis of wind conditions is undertaken for two seasons: Winter (November to April) and Summer (May to October).

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

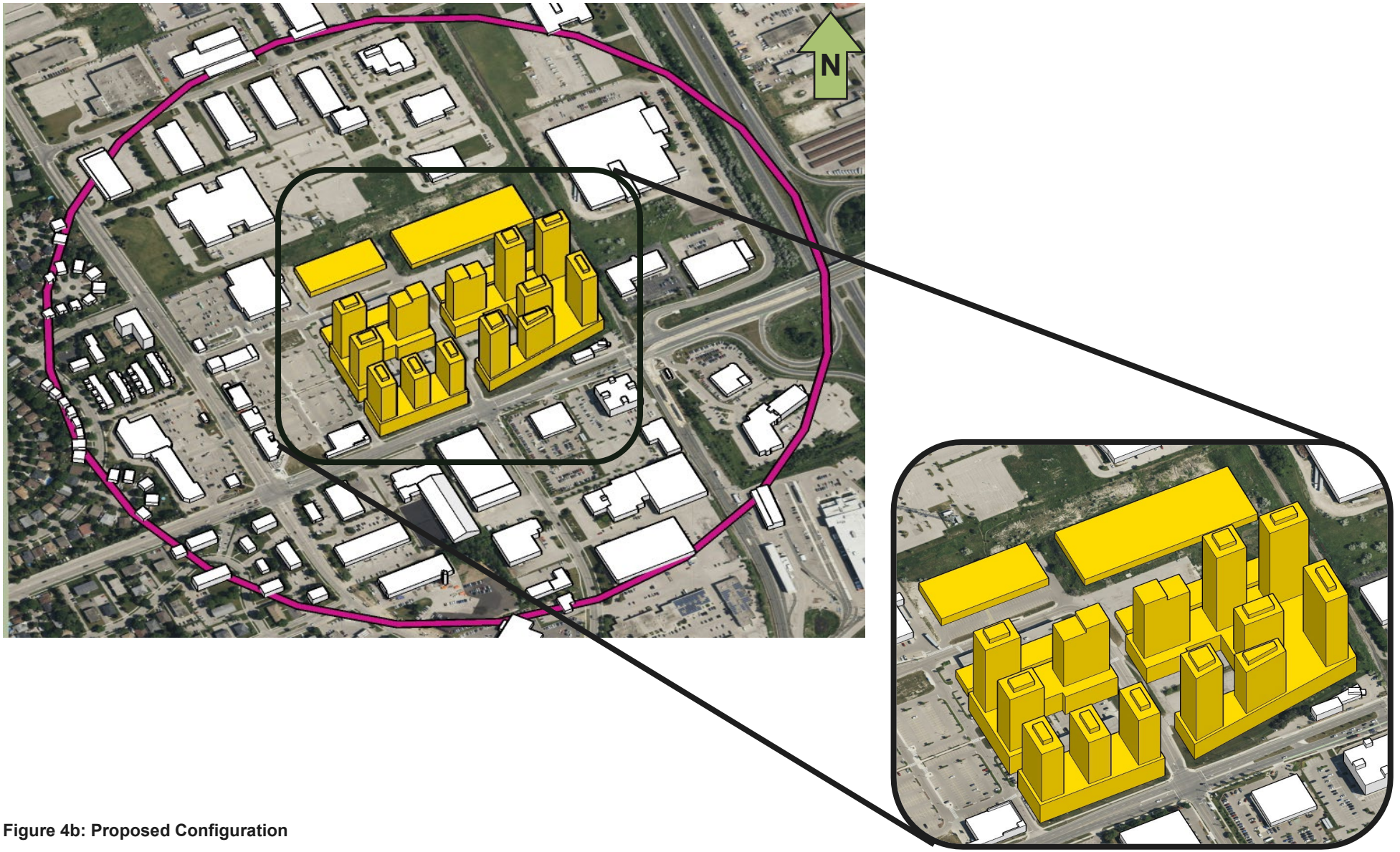


Figure 4b: Proposed Configuration

2.2 Wind Climate

Wind data recorded at Waterloo Region International Airport in Breslau, Ontario, for the period of 1993 to 2020 were obtained and analysed 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 wind 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.

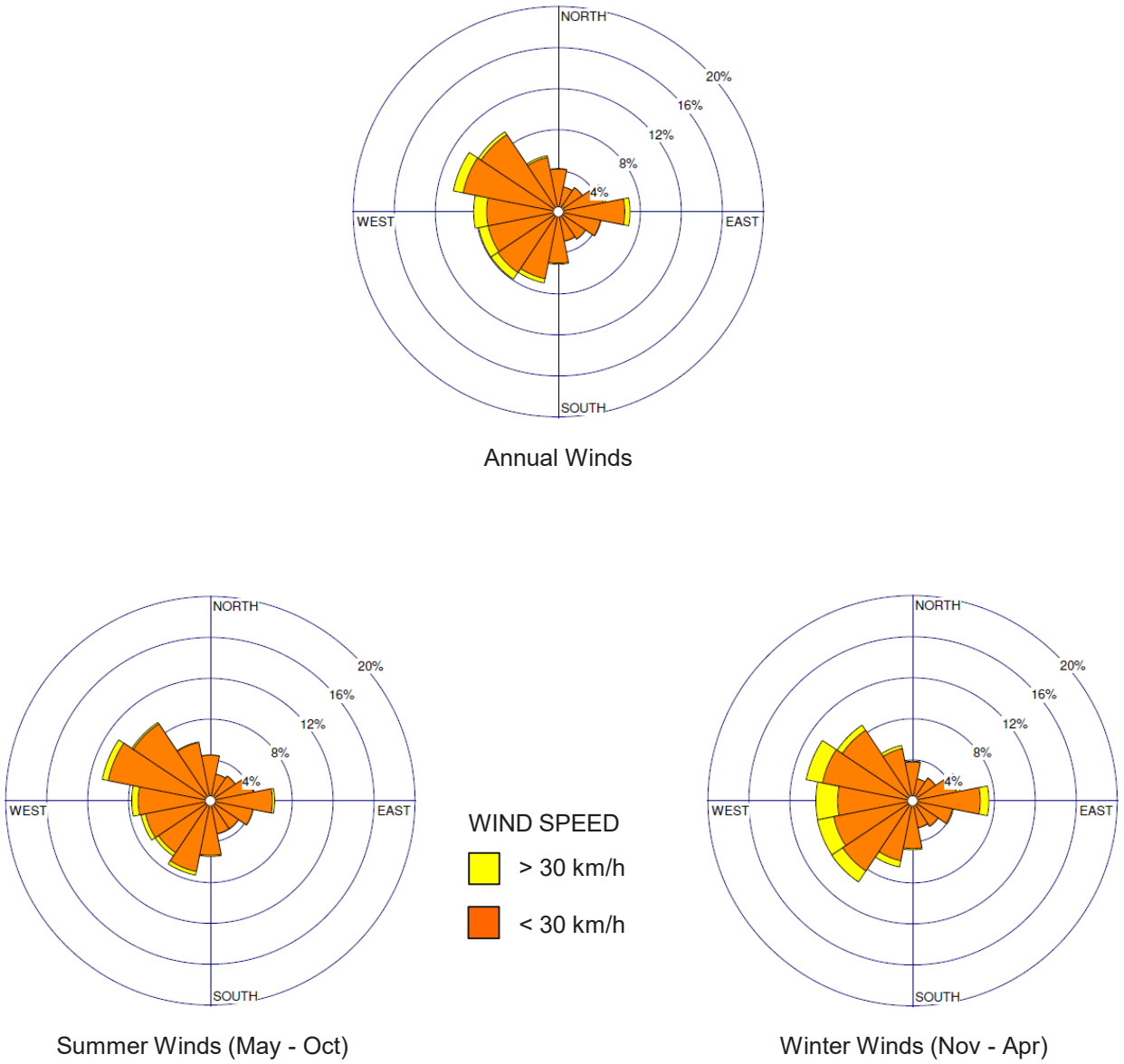


Figure 5: Wind Roses for Waterloo Region International Airport (1993 – 2020)

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 is provided by the City of Waterloo, in the Terms of Reference – Wind Study (June 30, 2023). The comfort criteria, which is 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 6:00am and 11:00pm. GEM is defined as the maximum mean wind speed, or the 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 7a through **8b** present graphical images of the wind comfort conditions for the summer and winter months around the proposed development. These typically represent the seasonal extremes of best and worst case.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 climates these may be difficult to achieve in the winter due to the overall climate. For sidewalks, walkways and pathways, wind comfort suitable for walking are desirable year-round but may not be feasible in the winter. For main entrances, transit stops, and public amenity spaces such as parks and playgrounds, wind conditions conducive to standing are preferred throughout the year. For on-site amenity areas, wind conditions suitable for sitting or standing are desirable during the summer, with stronger wind flows, conducive to walking, tolerated in the winter. The most stringent category of sitting is desirable during the summer for dedicated seating areas, such as patios, where calmer wind is expected for the comfort of patrons.

4.1 Building Entrances & Walkways

Existing wind conditions on the site are expected to be comfortable for sitting or standing year-round (**Figures 6a** and **7a**).

In the Proposed Configuration, wind conditions on-site are generally predicted to remain comfortable for sitting or standing throughout the year (**Figures 6b** and **7b**). The exceptions are near a few building corners and between Buildings A and E, where wind conditions conducive to walking are expected during the winter season (**Figure 7b**).

Wind conditions at the main entrances and secondary entrances are generally predicted to be comfortable for sitting or standing year-round, which is considered suitable for the intended use (**Figures 8a** and **8b**).

4.2 Outdoor Amenity Spaces

In the proposed POPS to the south of Building E and in the proposed POPS to the south of Building A, wind conditions are expected to be comfortable for sitting or standing throughout the year, which is considered suitable for the intended use (**Figures 8a and 8b**).

On the numerous outdoor amenity terraces at Level 7, wind conditions are predicted to be comfortable for standing or walking in the summer (**Figure 9a**). During the winter season, wind conditions are predicted to be comfortable for walking, with uncomfortable wind conditions anticipated in a few areas (**Figure 9b**). To improve wind conditions on these terraces, we recommend including vertical screens minimum 2.2 m tall along the edges of each terrace. Additional wind control measures, in the form of vertical partitions and/or wind screens, as well as trellises or pergolas near seating areas will be beneficial to enhance overall wind comfort conditions. Such details can be determined during SPA for each individual block.

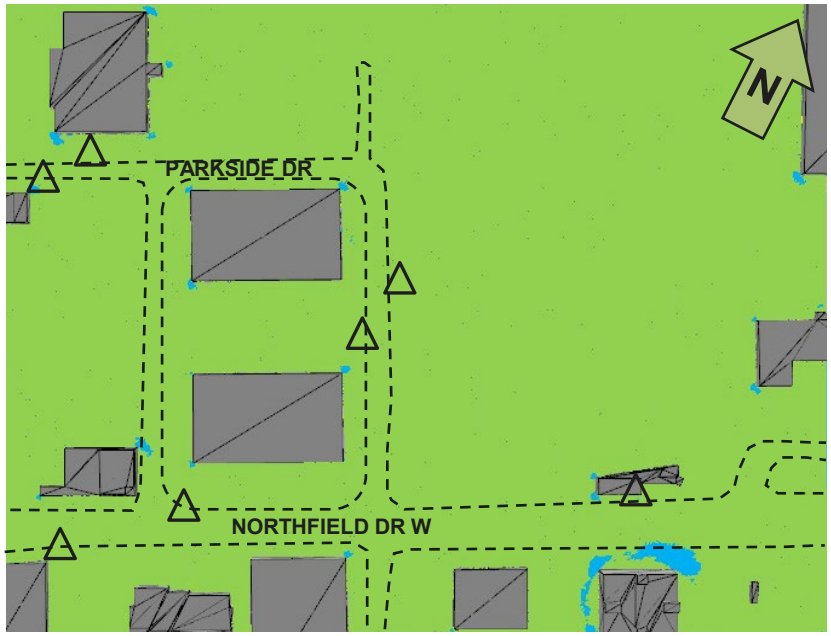


Figure 6a: Existing Configuration – Pedestrian Wind Comfort Summer – On-site & Surrounding Areas

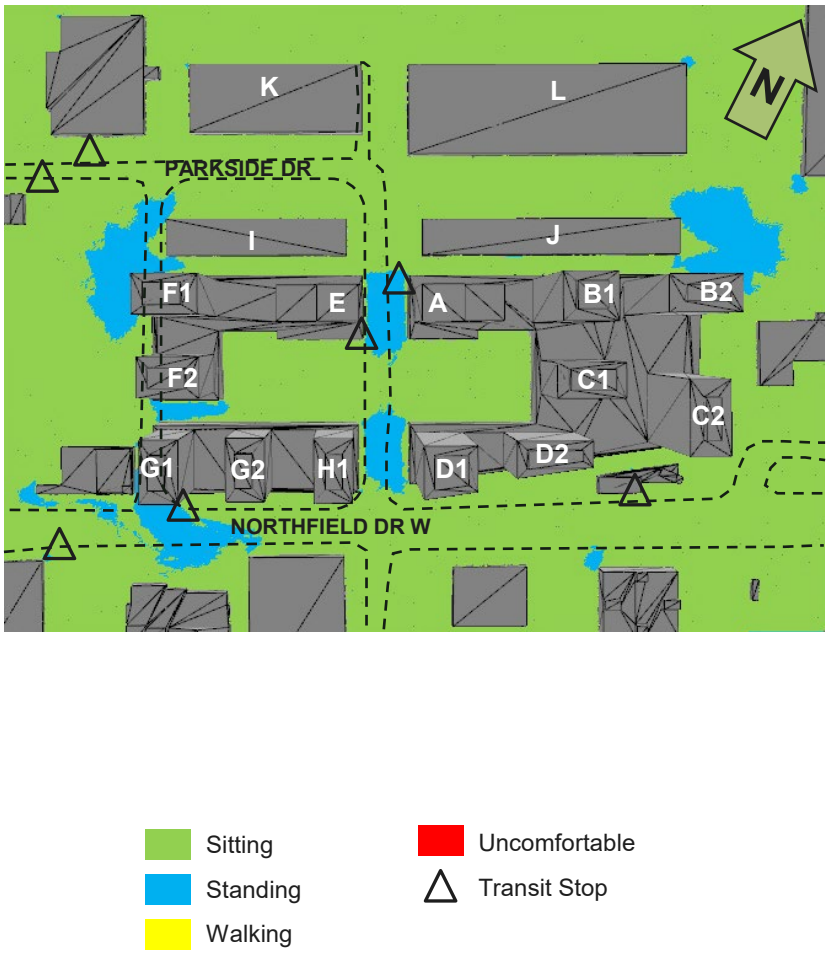


Figure 6b: Proposed Configuration – Pedestrian Wind Comfort Summer – On-site & Surrounding Areas

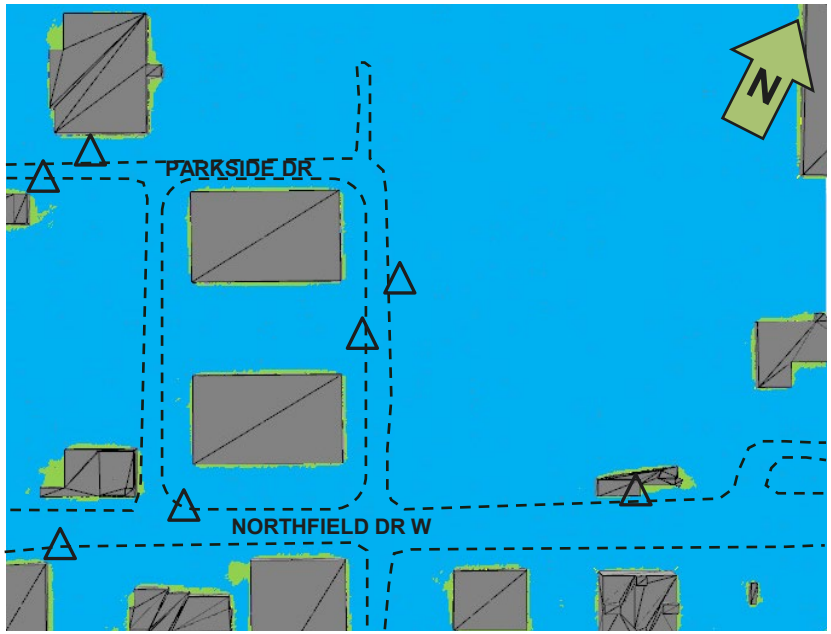


Figure 7a: Existing Configuration – Pedestrian Wind Comfort Winter – On-site & Surrounding Areas

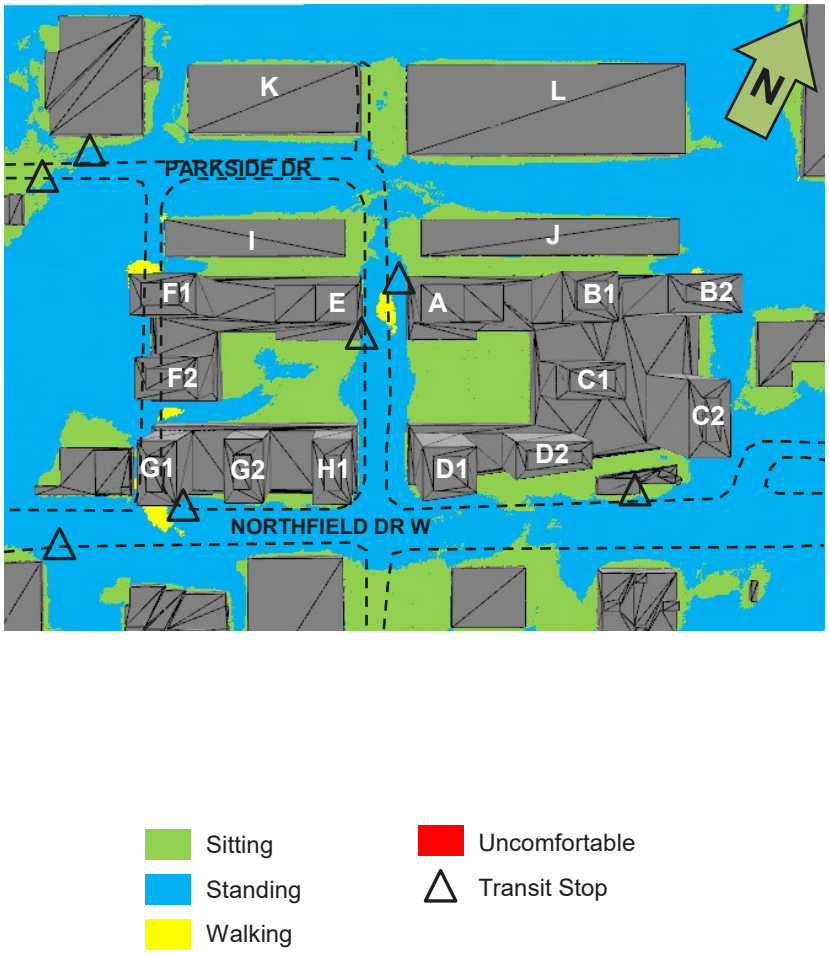
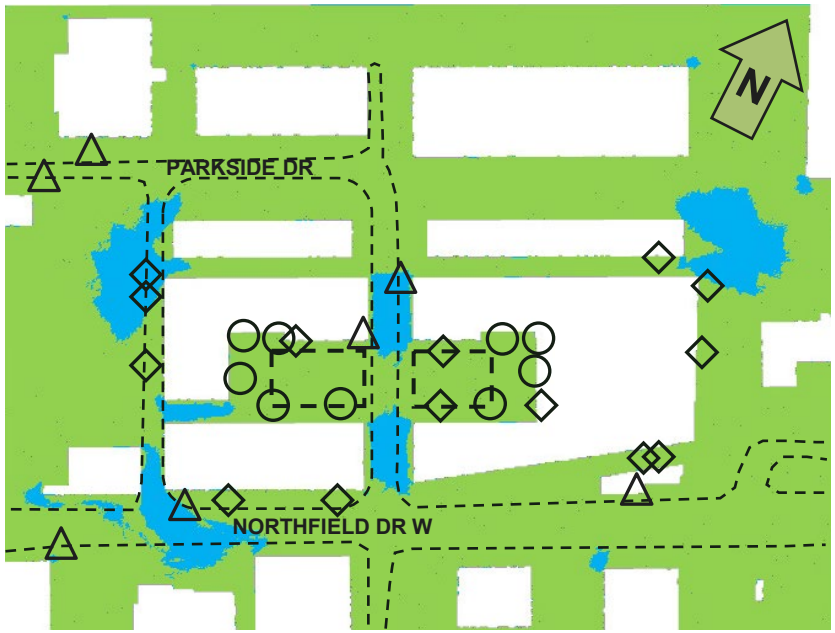
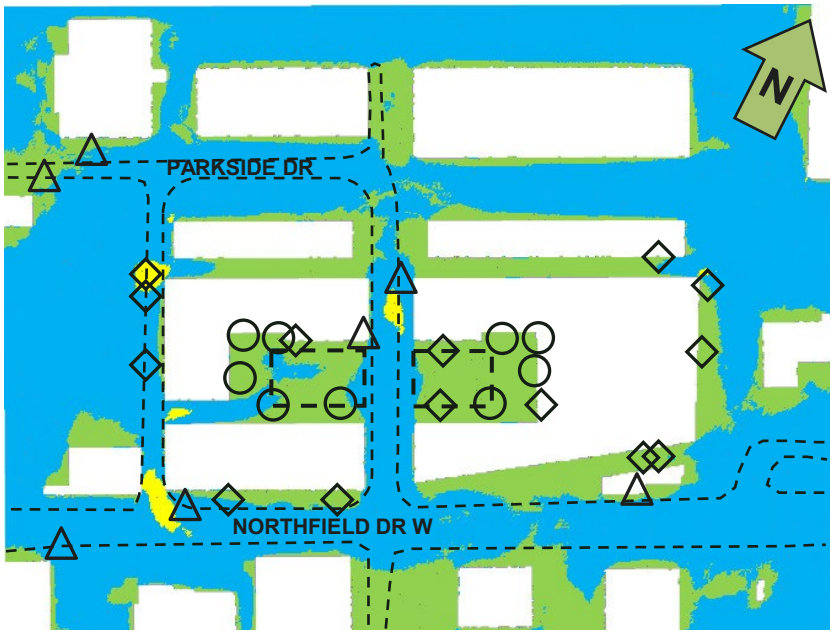


Figure 7b: Proposed Configuration – Pedestrian Wind Comfort Winter – On-site & Surrounding Areas



Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Amenity Space
Main Entrance
Secondary Entrance / Exit

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



Sitting
Standing
Leisurely Walking
Fast Walking
Uncomfortable
Amenity Space
Main Entrance
Secondary Entrance / Exit

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



Figure 9a: Proposed Configuration – Pedestrian Wind Comfort Summer – Amenity Terraces at Level 7

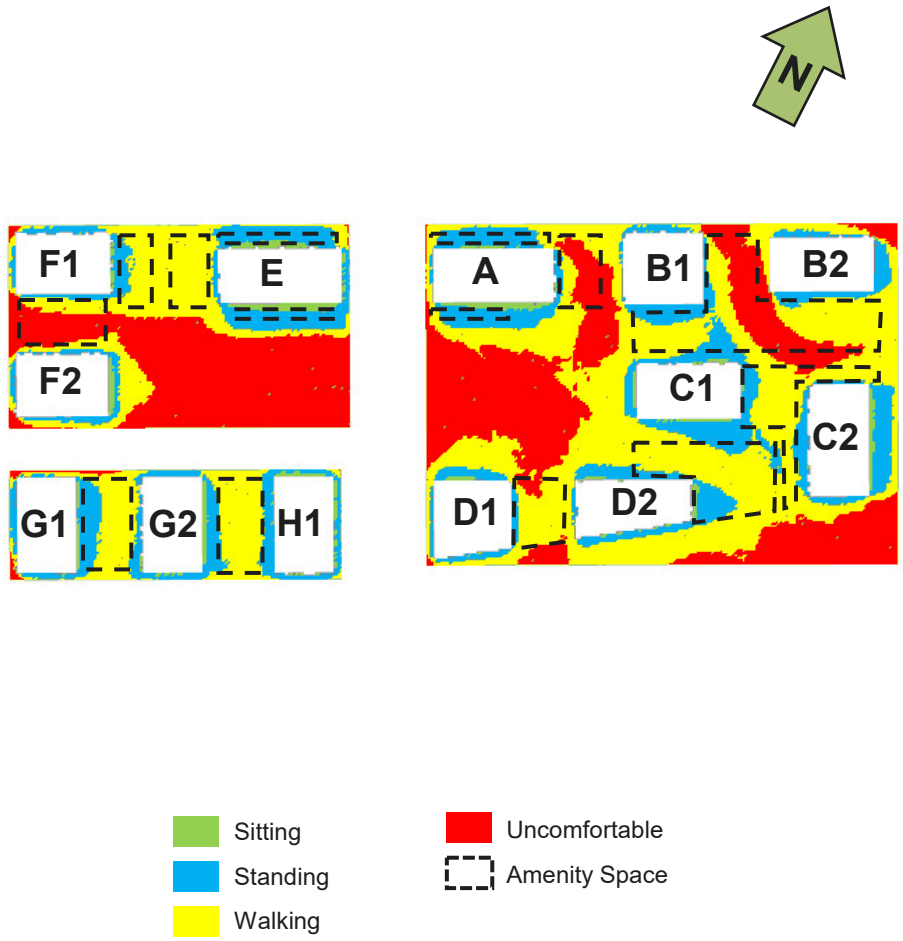


Figure 9b: Proposed Configuration – Pedestrian Wind Comfort Winter – Amenity Terraces at Level 7

4.3 Surrounding Sidewalks

In the Existing Configuration, wind conditions along the sidewalks of Northfield Drive West and Parkside Drive are expected to be suitable for sitting or standing throughout the year. At the nearby transit stops, wind conditions are expected to be comfortable for sitting or standing year-round (**Figures 6a** and **7a**).

With the proposed development in place, wind conditions are predicted to be suitable for walking or better throughout the year on the surrounding sidewalks. At the nearby transit stops, wind conditions are expected to remain suitable for sitting or standing year-round (**Figures 6b** and **7b**).

These wind conditions are satisfactory for the anticipated use.

4.4 Wind Safety

In the Existing Configuration, the wind safety criterion is expected to be met in all areas on-site and surrounding the site on an annual basis (**Appendix A**).

In the Proposed Configuration, the wind safety criterion was met in most areas at grade, with the exception of the northeast, northwest and southwest corners of the podium, and at the northwest corner of Building I. In these areas, the wind safety criterion is exceeded on an annual basis (**Figure A1b**). To improve wind conditions, we recommend increasing tower step-backs for Towers F1 and F2 at the northwest and southwest corners, respectively. In addition, we recommend including canopies minimum 3 m deep, wrapping around these corners and at the northwest corner of Building I.

On the terraces at Level 7, the wind safety criterion is expected to be exceeded in several areas on an annual basis (**Figure A2** in **Appendix A**). The wind control measures recommended in **Section 4.2** will be beneficial to eliminate the safety concerns.

5.0 Conclusion & Recommendations

The pedestrian wind conditions predicted for the proposed development at 170 Northfield Drive West in Waterloo, Ontario have been assessed through CFD modeling techniques. Based on the results of our assessment, the following conclusions have been reached:

- The wind safety criterion is met in all areas on-site and surrounding the development in the Existing Configuration. In the Proposed Configuration, the wind safety criterion is exceeded at a few building corners on grade, as well as on some of the Level 7 terraces. Wind control measures are recommended for these areas.
- Wind conditions on the site, including the entrances and in the outdoor amenity spaces at grade, are generally expected to be suitable for the intended use year-round.
- Wind comfort conditions on the proposed terraces at Level 7 are expected to be windier than desired. Wind control measures are recommended.
- On the sidewalks surrounding the proposed development, wind conditions are suitable for the intended use.

6.0 Statement of Limitations

This report has been prepared by SLR Consulting (Canada) Ltd. (SLR) for Forgestone Capital Management L.P. (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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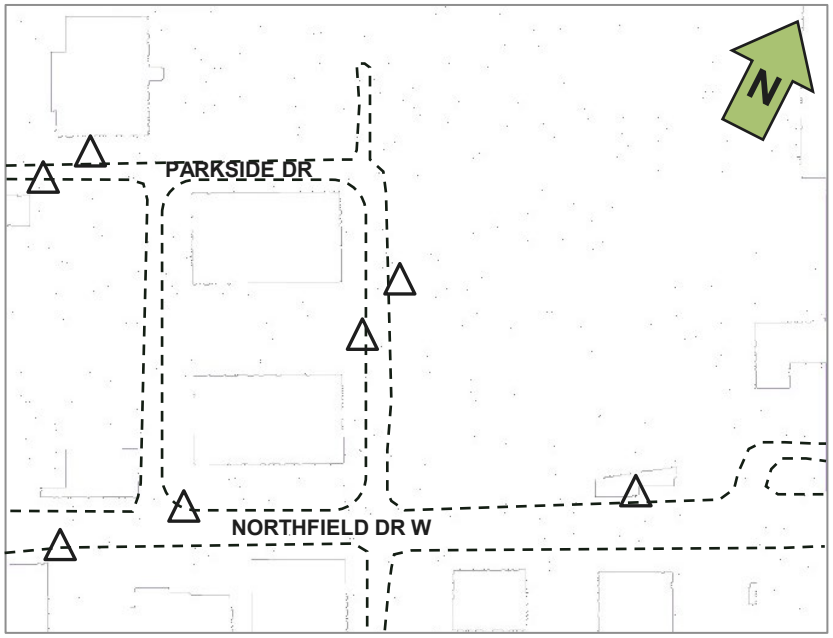
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Appendix A

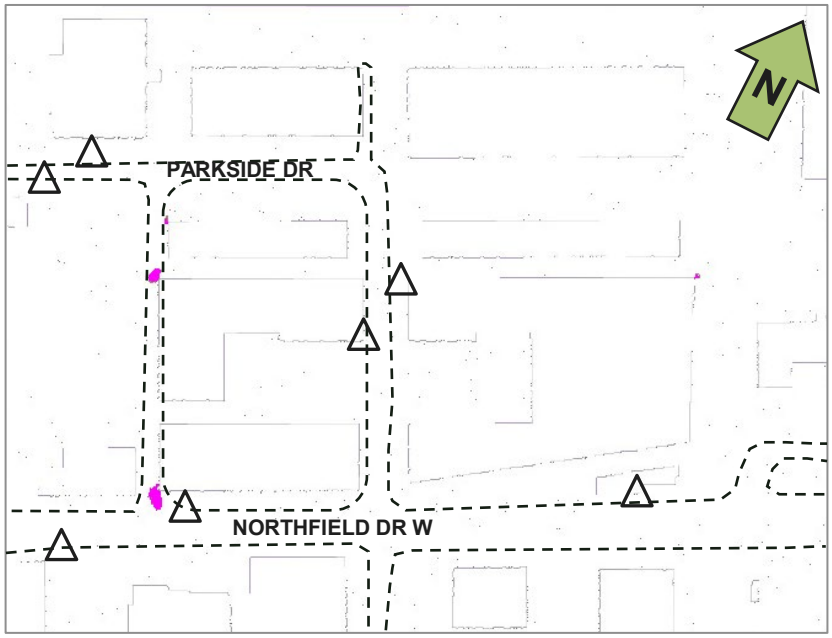
Pedestrian Wind Safety Analysis
Annual



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

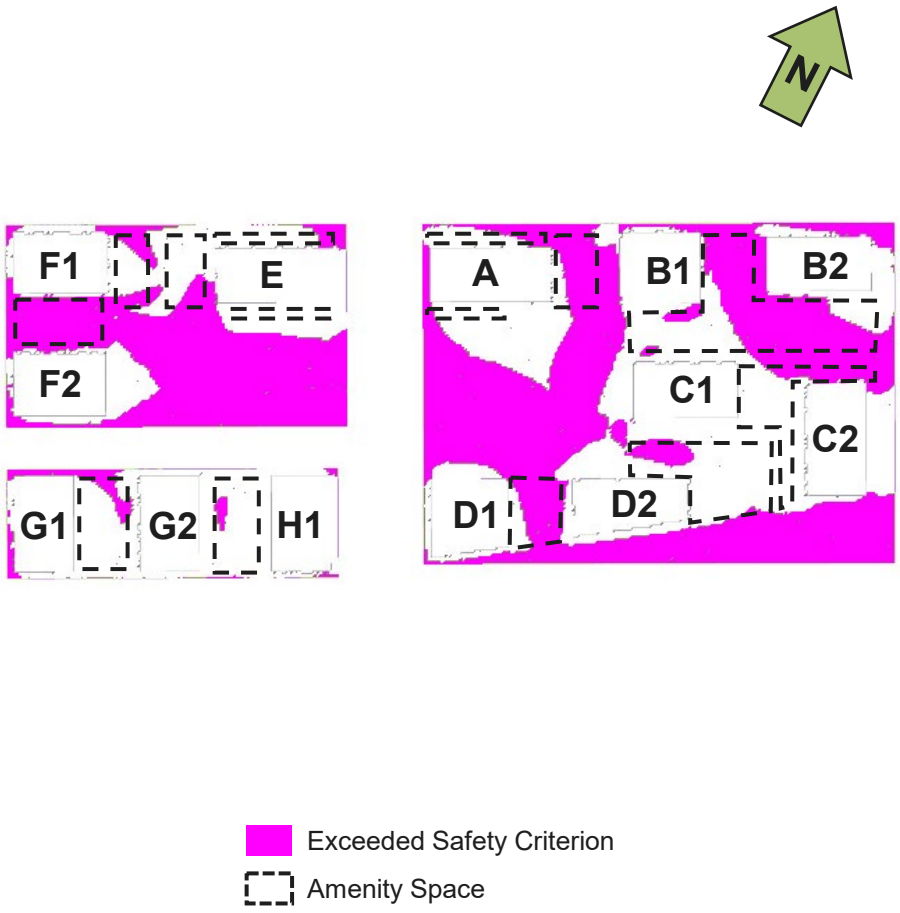


Figure A2: Proposed Configuration– Wind Safety Annual – Amenity Terraces at Level 7