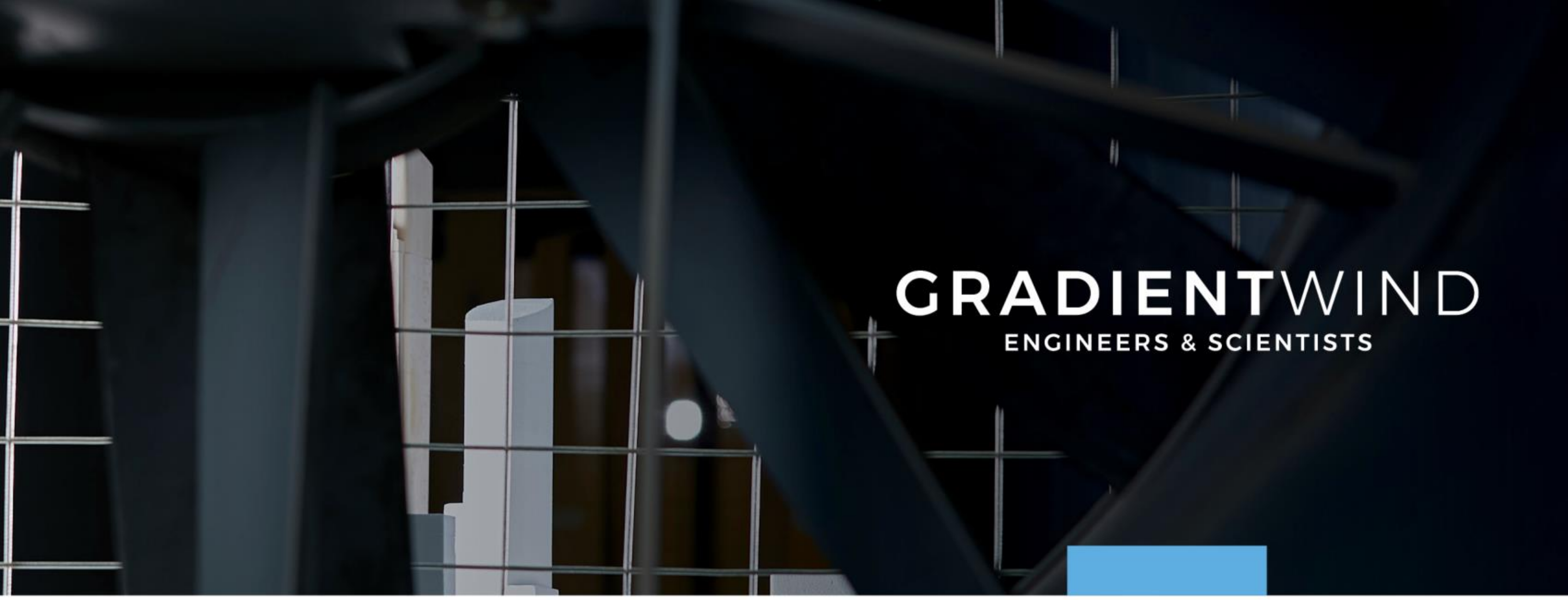
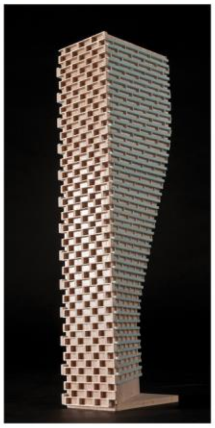


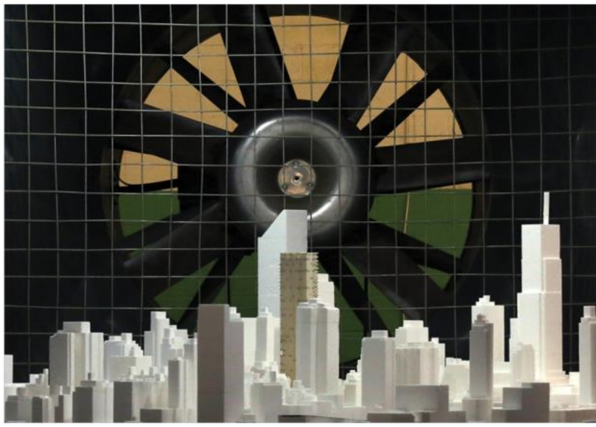
GRADIENTWIND
ENGINEERS & SCIENTISTS

PEDESTRIAN LEVEL WIND STUDY

1824 Bank Street
Ottawa, Ontario

Report: 24-150-PLW





October 11, 2024

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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Official Plan Amendment (OPA) and Zoning By-Law Amendment (ZBLA) application submission requirements for the proposed mixed-use residential development located at 1824 Bank Street in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within this study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

The study involves simulation of wind speeds for selected wind directions in a three-dimensional (3D) computer model using the computational fluid dynamics (CFD) technique, combined with meteorological data integration, to assess pedestrian wind comfort and safety within and surrounding the subject site according to City of Ottawa wind comfort and safety criteria. The results and recommendations derived from these considerations are detailed in the main body of the report (Section 5), illustrated in Figures 3A-9, and summarized as follows:

1) While the introduction of the proposed development is predicted to produce generally windier conditions at grade, most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for their intended pedestrian uses throughout the year. Specifically, conditions over nearby sidewalks, neighbouring existing surface parking lots, the proposed public road and drop-off areas, and most areas along the proposed drive aisle and walkways are considered acceptable. Conditions in the vicinity of the building access points serving the proposed development are considered acceptable.

    a. Isolated regions of conditions that may occasionally be considered uncomfortable for walking are situated over the drive aisle and neighbouring walkways between Buildings 3 and 4 and over the walkways between Buildings 2 and 3.

b. Mitigation strategies that may be considered by the design team may include targeted placement of isolated clusters of vertical wind barriers, in combination with the targeted placement of canopies that extend from select building facades above grade to deflect downwash flows.

c. Furthermore, it is recommended to implement a typical transit shelter for the transit stop located to the south of Building 2 to provide pedestrians with a means to protect themselves from the elements, including during periods of strong wind activity.

d. Wind conditions within the POPS and central open space at grade are predicted to be suitable for standing, or better, during the typical use period (May to October, inclusive). If the windier areas within these spaces will not include designated seating or lounging areas, the noted conditions may be considered as acceptable. Notably, within the open space, a calmer region suitable for sitting is located to the east along the proposed public road where seating may be strategically placed to be comfortable during the typical use period. Additionally, large portions of the POPS fronting Bank Street are predicted to be suitable for sitting during the typical use period. Depending on programming, the noted conditions may be considered acceptable. If required by programming, comfort levels at designated seating areas within the windier regions may be improved by implementing targeted landscaping elements around sensitive areas such as tall wind screens and coniferous plantings in dense arrangements, in combination with strategically placed seating with high-back benches and other local wind mitigation.

2) Regarding the exterior amenity areas serving Building 1 at the ground level and at the Mezzanine Level, conditions are predicted to be suitable for sitting during the typical use period (May to October, inclusive) and are considered acceptable. Conditions during the same period within the MPH Level amenity terrace serving Building 4, which was modelled with 1.8-m-tall wind screens along its full perimeter, are predicted to be suitable for sitting, which is considered acceptable.

3) Regarding the amenity terraces serving Buildings 1-3 at the MPH Level, conditions during the typical use period are predicted to be suitable for a mix of sitting and standing. The noted amenity terraces were modelled with 1.8-m-tall wind screens along their full perimeters.

a. Mitigation inboard of the terrace perimeters and targeted around sensitive areas is recommended, in combination with the noted perimeter wind screens.

b. The extent of mitigation measures is dependent on the programming of the terraces. It is recommended that a mitigation strategy be developed in collaboration with the building and landscape architects as the design of the proposed development progresses through the Site Plan Control application stage and this work is expected to support the future Site Plan Control application.

4) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events, (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by BentallGreenOak (Canada) LP on behalf of Sun Life Assurance Company of Canada to undertake a pedestrian level wind (PLW) study to satisfy Official Plan Amendment (OPA) and Zoning By-Law Amendment (ZBLA) application submission requirements for the proposed mixed-use residential development located at 1824 Bank Street in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Our mandate within the current study is to investigate pedestrian wind conditions within and surrounding the subject site, and to identify areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, where required.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, City of Ottawa wind comfort and safety criteria, architectural drawings prepared by Hobin Architecture Incorporated, surrounding street layouts and existing and approved future building massing information obtained from the City of Ottawa, as well as recent satellite imagery.

2. TERMS OF REFERENCE

The subject site is located at 1824 Bank Street in Ottawa, situated at the northwest corner of the intersection of Bank Street and Walkley Road, bordered by a commercial plaza and surface parking to the north, Bank Street to the east, Walkley Road to the south, and low-rise residential buildings to the west.

The proposed development comprises four buildings: Building 1 (24-storey tower atop a 4-storey podium) located at the southwest corner of the subject site fronting Walkley Road; Building 2 (39-storey tower atop a 5-storey podium) located at the southeast corner fronting Walkley Road and Bank Street; Building 3 (33-storey tower atop a 4-storey podium) located along the east perimeter fronting Bank Street; and Building 4 (33-storey tower atop a 4-storey podium) located along the north elevation. The four proposed buildings are positioned around a central open green space along the west elevation. A crescent-shaped private drive aisle extends around the north, east, and south perimeter of the green space extending from a proposed public street extending north from Walkley Road along the west elevation of the subject site. The public street connects the private drive aisle and the underground parking entrances of Buildings 1 and 4 to Walkley Road. An additional private drive aisle extends east along the north elevation of

Building 3 to connect the subject site to Bank Street. Drop-off areas are located along the private drive aisle along the central open space and building entrances. Privately-Owned Publicly Accessible Spaces (POPS) are located to the east of Building 2 fronting the intersection of Bank Street and Walkley Road, at the southwest corner of the subject site, and at the northeast corner of the subject site.

Building 1 includes an underground parking entrance along the west elevation. The ground floor is programmed for residential use and includes a lobby at the northeast corner, a loading bay and garbage room along the east elevation, and an amenity terrace to the west which is accessible through indoor amenities along the west elevation. The mezzanine includes an indoor amenity with balconies along the north elevation and along the east elevation, storage at the southeast corner, and bicycle storage along the south and west elevations.

The ground floor of Building 2 comprises a residential lobby and indoor amenities along the north elevation, a loading bay and a bicycle lobby along the west elevation, and additional amenity area fronting Bank Street along the east elevation. Shared building support spaces are located along the south elevation. The mezzanine includes additional indoor amenity space at the northwest corner and bicycle storage along the south elevation.

The ground floor of Building 3 is programmed for mixed-use and includes a residential lobby at the southwest corner, indoor amenities along the south and west elevations, a garbage room and loading bay along the north elevation, and commercial space fronting Bank Street along the east elevation. The mezzanine includes indoor amenities along the west and north elevations and storage to the south.

Building 4 includes a parking entrance along the west elevation. The ground floor includes a residential lobby and loading bay along the south elevation, amenity space to the west, and residential units to the north.

Buildings 1-4 include amenity terraces at their respective mechanical penthouse (MPH) levels. Canopies extend over the MPH Level amenity terraces from the adjoining MPHs as well as from the four podia above the ground level residential primary access points.

The near-field surroundings (defined as an area within 200 metres (m) of the subject site) comprise low-rise commercial buildings with surface parking to the north clockwise to the east-northeast and to the south-southeast, low-rise residential buildings to the southwest clockwise to the north-northwest and from the east clockwise to the southeast, and mid-rise residential buildings to the south. The far-field surroundings (defined as an area beyond the near-field but within a 2-kilometre (km) radius of the subject site) are characterized by suburban massing from the southwest clockwise to the south-south east and a mix of green spaces and suburban massing in the remaining directions, with isolated mid- and high-rise buildings to the west, along Bank Street to the north-northwest, and to the northeast, east, and southeast.

Site plans for the proposed and existing massing scenarios are illustrated in Figures 1A and 1B, while Figures 2A-2H illustrate the computational models used to conduct the study. The existing massing scenario includes the existing massing and any developments which have been approved by the City of Ottawa.

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level wind conditions at key areas within and surrounding the development site; (ii) identify areas where wind conditions may interfere with the intended uses of outdoor spaces; and (iii) recommend suitable mitigation measures, where required.

4. METHODOLOGY

The approach followed to quantify pedestrian wind conditions over the site is based on CFD simulations of wind speeds across the subject site within a virtual environment, meteorological analysis of the Ottawa area wind climate, and synthesis of computational data with City of Ottawa wind comfort and safety criteria[1]. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

[1] City of Ottawa Terms of References: Wind Analysis
https://documents.ottawa.ca/sites/documents/files/wind_analysis_tor_en.pdf

4.1 Computer-Based Context Modelling

A computer based PLW study was performed to determine the influence of the wind environment on pedestrian comfort over the proposed development site. Pedestrian comfort predictions, based on the mechanical effects of wind, were determined by combining measured wind speed data from CFD simulations with statistical weather data obtained from Ottawa Macdonald-Cartier International Airport. The general concept and approach to CFD modelling is to represent building and topographic details in the immediate vicinity of the subject site on the surrounding model, and to create suitable atmospheric wind profiles at the model boundary. The wind profiles are designed to have similar mean and turbulent wind properties consistent with actual site exposures.

An industry standard practice is to omit trees, vegetation, and other existing and planned landscape elements from the model due to the difficulty of providing accurate seasonal representation of vegetation. The omission of trees and other landscaping elements produces slightly stronger wind speeds.

4.2 Wind Speed Measurements

The PLW analysis was performed by simulating wind flows and gathering velocity data over a CFD model of the site for 16 wind directions. The CFD simulation model was centered on the proposed development, complete with surrounding massing within a radius of 530 m. The process was performed for two context massing scenarios, as noted in Section 2.

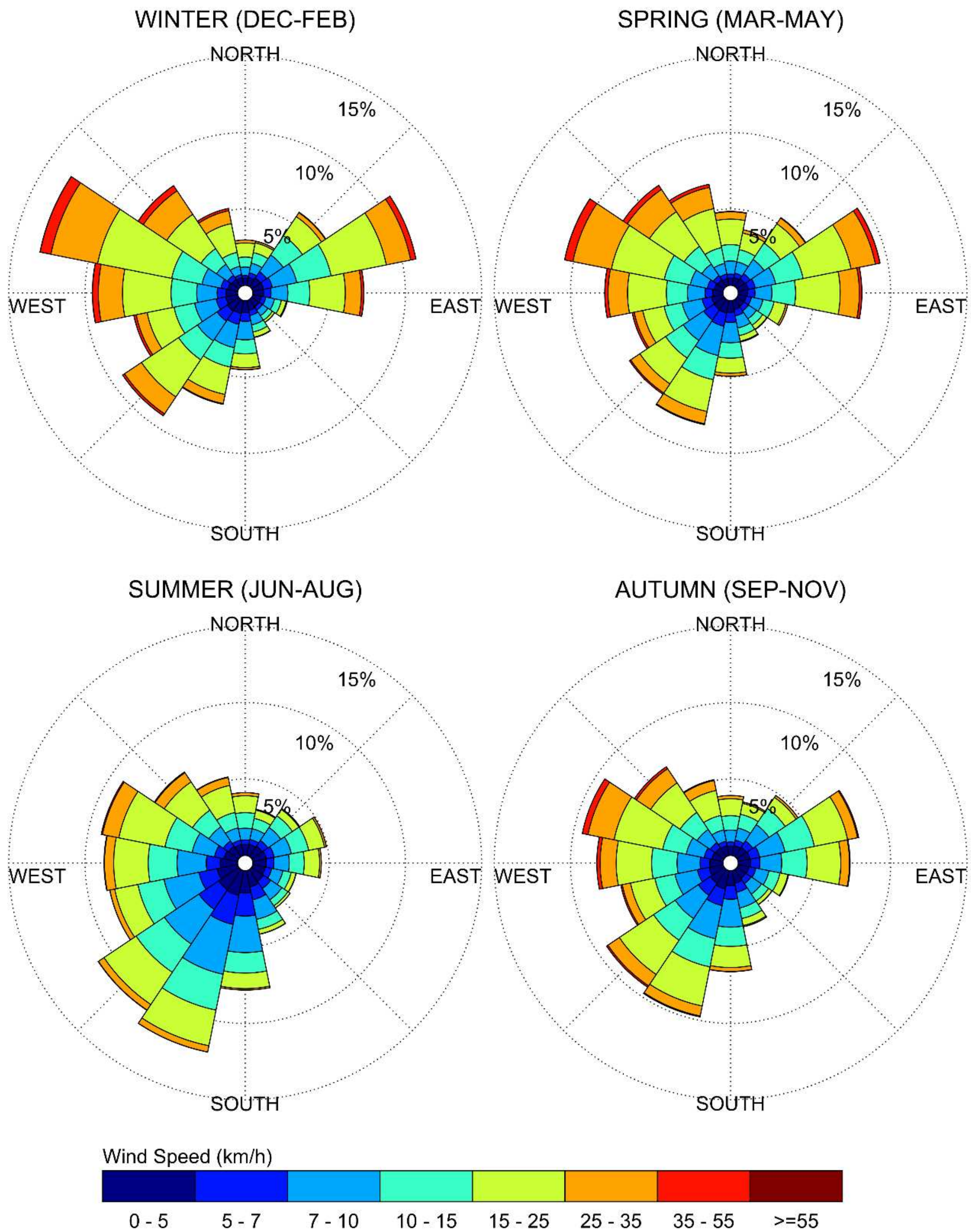
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the amenity terraces serving the proposed development were referenced to the wind speed at gradient height to generate mean and peak velocity ratios, which were used to calculate full-scale values. Gradient height represents the theoretical depth of the boundary layer of the earth’s atmosphere, above which the mean wind speed remains constant. Further details of the wind flow simulation technique are presented in Appendix A.

4.3 Historical Wind Speed and Direction Data

A statistical model for winds in Ottawa was developed from approximately 40 years of hourly meteorological wind data recorded at Ottawa Macdonald-Cartier International Airport and obtained from Environment and Climate Change Canada. Wind speed and direction data were analyzed during the appropriate hours of pedestrian usage (that is, between 06:00 and 23:00) and divided into four distinct seasons, as stipulated in the wind criteria. Specifically, the spring season is defined as March through May, the summer season is defined as June through August, the autumn season is defined as September through November, and the winter season is defined as December through February, inclusive.

The statistical model of the Ottawa area wind climate, which indicates the directional character of local winds on a seasonal basis, is illustrated on the following page. The plots illustrate seasonal distribution of measured wind speeds and directions in kilometers per hour (km/h). Probabilities of occurrence of different wind speeds are represented as stacked polar bars in sixteen azimuth divisions. The radial direction represents the percentage of time for various wind speed ranges per wind direction during the measurement period. The prominent wind speeds and directions can be identified by the longer length of the bars. For Ottawa, the most common winds occur for westerly wind directions, followed by those from the east, while the most common wind speeds are below 36 km/h. The directional prominence and relative magnitude of wind speed changes somewhat from season to season.

SEASONAL DISTRIBUTION OF WIND
OTTAWA MACDONALD-CARTIER INTERNATIONAL AIRPORT



Notes:

1. Radial distances indicate percentage of time of wind events.
2. Wind speeds are mean hourly in km/h, measured at 10 m above the ground.

4.4 Pedestrian Wind Comfort and Safety Criteria – City of Ottawa

Pedestrian wind comfort and safety criteria are based on the mechanical effects of wind without consideration of other meteorological conditions (that is, temperature and relative humidity). The comfort criteria assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Five pedestrian comfort classes based on 20% non-exceedance mean wind speed ranges are used to assess pedestrian comfort: (1) Sitting; (2) Standing; (3) Strolling; (4) Walking; and (5) Uncomfortable. The gust speeds, and equivalent mean speeds, are selected based on the Beaufort scale, which describes the effects of forces produced by varying wind speed levels on objects. Wind conditions suitable for sitting are represented by the colour blue, standing by green, strolling by yellow, and walking by orange; uncomfortable conditions are represented by the colour magenta. Specifically, the comfort classes, associated wind speed ranges, and limiting criteria are summarized as follows:

PEDESTRIAN WIND COMFORT CLASS DEFINITIONS

Wind Comfort Class	Mean Speed (km/h)	Description
SITTING	≤ 10	Mean wind speeds no greater than 10 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 16 km/h.
STANDING	≤ 14	Mean wind speeds no greater than 14 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 22 km/h.
STROLLING	≤ 17	Mean wind speeds no greater than 17 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 27 km/h.
WALKING	≤ 20	Mean wind speeds no greater than 20 km/h occurring at least 80% of the time. The equivalent gust wind speed is approximately 32 km/h.
UNCOMFORTABLE	> 20	Uncomfortable conditions are characterized by predicted values that fall below the 80% target for walking. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this criterion.

Regarding wind safety, the pedestrian safety wind speed criterion is based on the approximate threshold that would cause a vulnerable member of the population to fall. A 0.1% exceedance gust wind speed of 90 km/h is classified as dangerous. From calculations of stability, it can be shown that gust wind speeds of 90 km/h would be the approximate threshold wind speed that would cause an average elderly person in good health to fall. Notably, pedestrians tend to be more sensitive to wind gusts than to steady winds for lower wind speed ranges. For strong winds approaching dangerous levels, this effect is less important because the mean wind can also create problems for pedestrians.

Experience and research on people's perception of mechanical wind effects has shown that if the wind speed levels are exceeded for more than 20% of the time, the activity level would be judged to be uncomfortable by most people. For instance, if a mean wind speed of 10 km/h (equivalent gust wind speed of approximately 16 km/h) were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting. Similarly, if mean wind speed of 20 km/h (equivalent gust wind speed of approximately 32 km/h) at a location were exceeded for more than 20% of the time, walking or less vigorous activities would be considered uncomfortable. As these criteria are based on subjective reactions of a population to wind forces, their application is partly based on experience and judgment.

Once the pedestrian wind speed predictions have been established throughout the subject site, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for discrete regions within and surrounding the subject site. This step involves comparing the predicted comfort classes to the target comfort classes, which are dictated by the location type for each region (that is, a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their typical windiest target comfort classes are summarized on the following page. Depending on the programming of a space, the desired comfort class may differ from this table.

TARGET PEDESTRIAN WIND COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Target Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Walking
Public Sidewalk / Bicycle Path	Walking
Outdoor Amenity Space	Sitting / Standing
Café / Patio / Bench / Garden	Sitting / Standing
Transit Stop (Without Shelter)	Standing
Transit Stop (With Shelter)	Walking
Public Park / Plaza	Sitting / Standing
Garage / Service Entrance	Walking
Parking Lot	Walking
Vehicular Drop-Off Zone	Walking

5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-6B, which illustrate wind conditions at grade level for the proposed and existing massing scenarios, and by Figures 8A-D, which illustrate conditions over the amenity terraces serving the proposed development. Conditions are presented as continuous contours of wind comfort throughout the subject site and correspond to the comfort classes presented in Section 4.4.

Wind comfort conditions are also reported for the typical use period, which is defined as May to October, inclusive. Figures 7 and 9 illustrate wind comfort conditions during this period at grade level and within the noted amenity terraces serving the proposed development, respectively, consistent with the comfort classes illustrated in Section 4.4.

The details of these conditions are summarized in the following pages for each area of interest.

5.1 Wind Comfort Conditions – Grade Level

The mostly suburban environs of the subject site and the limited built-up massing in the vicinity of the proposed development exposes the subject site to prevailing winds from multiple directions, particularly prevailing winds from the east and east-northeast as well as winds from the southwest clockwise to the northwest. These salient winds are predicted to downwash towards grade over the façades of the podia and towers serving the proposed development, accelerate around the exposed northwest corner of Building 3 and the northeast corner of Building 2, and accelerate between Buildings 2 and 3 and between Buildings 3 and 4.

As illustrated in Figures 3A, 5A, and 6A, following the main text, regions of conditions that may occasionally be considered uncomfortable for walking during the colder months are situated between Buildings 2 and 3 and between Buildings 3 and 4. These conditions are predicted to impact isolated sections of the walkways between the buildings and the private drive aisle connecting to Bank Street. Between Buildings 2 and 3, conditions are predicted to be suitable for walking at least 74%, 78%, and 71% of the time during the spring, autumn, and winter seasons, respectively, representing exceedances of 6%, 2%, and 9% of the walking comfort threshold. Between Buildings 3 and 4, conditions are predicted to be suitable for walking at least 69%, 76%, and 72% of the time during the spring, autumn, and winter seasons, respectively, representing exceedances of 11%, 4%, and 8% of the walking comfort threshold.

Possible mitigation measures that may be considered by the design team may include targeted placement of isolated clusters of vertical wind barriers, in combination with the targeted placement of canopies that extend from select building facades above grade to deflect downwash flows.

Public Sidewalks and Transit Stops along Bank Street: As illustrated in Figures 3A-6A, following the introduction of the proposed development, wind comfort conditions over the nearby public sidewalks along Bank Street are predicted to be suitable for standing, or better, during the summer months, becoming suitable for a mix of sitting, standing and strolling in the spring, autumn, and winter. Conditions over the nearby southbound transit stop, which is served by a typical transit shelter, are predicted to be suitable for sitting throughout the year, while conditions over the nearby northbound stop are predicted to be suitable for standing throughout the year. The noted conditions are considered acceptable.

Conditions over the nearby sidewalks along Bank Street under existing massing, as illustrated in Figures 3B-6B, are predicted to be suitable for mostly sitting during the summer, a mix of sitting and standing in autumn, and standing in the spring and winter. Wind conditions over the noted nearby transit stops along Bank Street under the existing massing are predicted to be suitable for sitting during the summer and autumn, becoming suitable for standing, or better, during the spring and autumn. While the introduction of the proposed development produces slightly windier conditions in comparison to existing conditions, wind conditions along Bank Street with the proposed development are nevertheless considered acceptable.

Public Sidewalks and Transit Stops along Walkley Road: Following the introduction of the proposed development, wind conditions over the nearby sidewalks along Walkley Road are predicted to be suitable for mostly sitting and standing during the summer (Figure 4A), becoming suitable for a mix of mostly standing and strolling throughout the remainder of the year with conditions suitable for walking predicted to the southwest and southeast of Building 1 (Figures 3A, 5A, and 6A). The noted conditions are considered acceptable for public sidewalks.

Following the introduction of the proposed development, wind conditions over the nearby westbound transit stop along Walkley Road to the immediate south of Building 2 are predicted to be suitable for standing during the summer and autumn (Figures 4A and 5A), becoming suitable for strolling during the spring and winter (Figures 3A and 6A). It is recommended to implement a typical transit shelter to provide pedestrians with a means to protect themselves from the elements, including during periods of strong wind activity.

As illustrated in Figures 3B-6B, under the existing massing, conditions over the nearby sidewalks along Walkley Road are predicted to be suitable for standing, or better, throughout the year, while conditions over the noted transit stop are predicted to be suitable for sitting during the summer and standing throughout the remainder of the year.

Westvalley Private and Glenhaven Private: Wind conditions over the nearby areas along Westvalley Private and Glenhaven Private are predicted to be suitable for standing, or better, throughout the year, and to be mostly unchanged following the introduction of the proposed development, as illustrated in Figures 3A-6B. The noted conditions are considered acceptable.

Neighbouring Existing Surface Parking Lots: Following the introduction of the proposed development, wind conditions over the nearby areas of the neighbouring existing commercial surface parking lots are predicted to be suitable for standing, or better, during the summer (Figure 4A) and strolling, or better, throughout the remainder of the year (Figure 3A, 5A, and 6A), which is considered acceptable.

As illustrated in Figures 3B-6B, conditions over the noted areas under the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, during the three remaining seasons. While conditions over the nearby surface parking lots are predicted to be windier following the introduction of the proposed development, conditions with the proposed development are nevertheless considered acceptable over the noted areas.

POPS: As illustrated in Figure 7, wind comfort conditions within the POPS to the east of Buildings 2 and 4 are predicted to be suitable for a mix of sitting and standing during the typical use period, while conditions within the POPS at the southwest corner of the subject site are predicted to be suitable for standing during the same period. Notably, large areas of the POPS fronting Bank Street are predicted to be suitable for sitting during the typical use period. Depending on programming, the noted conditions may be considered acceptable.

If designated seating or lounging areas are desired for the windier areas for the POPS, comfort levels within the windier regions of the POPS may be improved by implementing targeted landscaping elements around sensitive areas. These could include elements such as tall wind screens and coniferous plantings in dense arrangements, in combination with strategically placed seating with high-back benches and other local wind mitigation.

Open Space: During the typical use period, wind comfort conditions within the central open space are predicted to be suitable for mostly standing, as illustrated in Figure 7. Depending on programming, the noted conditions may be considered acceptable. Notably, a calmer region suitable for sitting is located to the east along the proposed public road where seating may be strategically placed to be comfortable during the typical use period.

If designated seating or lounging areas are desired for the windier areas for the open space, comfort levels may be improved by implementing targeted landscaping elements around sensitive areas. These could include elements such as tall wind screens and coniferous plantings in dense arrangements, in combination with strategically placed seating with high-back benches and other local wind mitigation.

Proposed Public Road, Drop-off Areas, Private Drive Aisles, and Walkways within the Subject Site: Wind comfort conditions over the proposed public road and its adjoining sidewalk along the west perimeter of the subject site are predicted to be suitable for a mix of sitting and standing during the summer (Figure 4A) and a mix of sitting, standing, and strolling during the spring, autumn, and winter (Figures 3A, 5A, and 6A). The noted conditions are considered acceptable.

Conditions over the private drive aisle along the central open space and the drop-off areas serving the proposed development are predicted to be suitable for a mix of sitting and standing during the summer, a mix of sitting, standing, and strolling during autumn, and a mix of standing, strolling, and walking during the spring and winter. Conditions over the proposed drive aisle and walkways between Buildings 1 and 2 are predicted to suitable for walking, or better, throughout the year. The noted conditions are considered acceptable.

Conditions over most of the remaining walkways serving the proposed development are predicted to be suitable for mostly strolling, or better, during the summer months and walking, or better, throughout the colder seasons.

As noted above, windier conditions are located between Buildings 2 and 3 and between Buildings 3 and 4, where conditions are predicted to occasionally be considered uncomfortable for walking, affecting isolated sections of the walkways between these buildings. These conditions are attributed to the acceleration of prevailing winds that accelerate around the northwest corner of Building 3 and the northeast corner of Building 2, and channelling effects between Buildings 2 and 3 and Buildings 3 and 4.

Building Access Points: Owing to the protection of the building façades and the implementation of overhead canopies, wind conditions in the vicinity of the primary building access points serving the proposed development are predicted to be suitable for standing, or better, throughout the year, which is considered acceptable. Conditions in the vicinity of the secondary building points serving the proposed development are predicted to be suitable for mostly strolling, or better, throughout the year. The noted conditions are considered acceptable.

5.2 Wind Comfort Conditions – Common Amenity Terraces

Building 1, Grade-Level and Mezzanine Level Exterior Amenities: Wind comfort conditions during the typical use period within the grade-level amenity terrace and the amenity balconies serving Building 1 at the Mezzanine Level are predicted to be suitable for sitting. The noted conditions are considered acceptable.

Building 4, MPH Level Terrace: Conditions during the typical use period within the MPH Level common amenity terrace serving Building 4, which was modelled with 1.8-m-tall wind screens along the full terrace perimeter, are predicted to be suitable for sitting. The noted conditions are considered acceptable.

Buildings 1-3, MPH Level Terraces: The MPH Level amenity terraces serving Buildings 1-3 were similarly modelled with 1.8-m-tall wind screens along their full perimeters. Conditions within the amenity terraces serving Buildings 1-3 are predicted to be suitable for a mix of sitting and standing during the typical use period. Where conditions are suitable for standing, they are also suitable for sitting at least 71%, 75%, and 73% of the time during the same period within the MPH Level terraces serving Buildings 1, 2, and 3, respectively, where the target is 80% to achieve the sitting comfort class.

In combination with the noted tall wind screens along the full terrace perimeters, mitigation inboard of the terrace perimeters and targeted around sensitive areas is recommended. Inboard mitigation could take the form of wind screens, canopies, or other common landscape elements.

The extent of mitigation measures is dependent on the programming of the terraces. It is recommended that a mitigation strategy be developed in collaboration with the building and landscape architects as the design of the proposed development progresses through the Site Plan Control application stage and this work is expected to support the future Site Plan Control application.

5.3 Wind Safety

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no pedestrian areas within or surrounding the subject site are expected to experience conditions that could be considered dangerous, as defined in Section 4.4.

5.4 Applicability of Results

Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the subject site. Future changes (that is, construction or demolition) of these surroundings may cause changes to the wind effects in two ways, namely: (i) changes beyond the immediate vicinity of the subject site would alter the wind profile approaching the subject site; and (ii) development in proximity to the subject site would cause changes to local flow patterns.

6. CONCLUSIONS AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 and illustrated in Figures 3A-9. Based on computer simulations using the CFD technique, meteorological data analysis of the Ottawa wind climate, City of Ottawa wind comfort and safety criteria, and experience with numerous similar developments, the study concludes the following:

1) While the introduction of the proposed development is predicted to produce generally windier conditions at grade, most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for their intended pedestrian uses throughout the year. Specifically, conditions over nearby sidewalks, neighbouring existing surface parking lots, the proposed public road and drop-off areas, and most areas of the proposed drive aisle and walkways are considered acceptable. Conditions in the vicinity of the building access points serving the proposed development are considered acceptable.

    a. Isolated regions of conditions that may occasionally be considered uncomfortable for walking are situated over the drive aisle and neighbouring walkways between Buildings 3 and 4 and over the walkways between Buildings 2 and 3.

b. Mitigation strategies that may be considered by the design team may include targeted placement of isolated clusters of vertical wind barriers, in combination with the targeted placement of canopies that extend from select building facades above grade to deflect downwash flows.

c. Furthermore, it is recommended to implement a typical transit shelter for the transit stop located to the south of Building 2 to provide pedestrians with a means to protect themselves from the elements, including during periods of strong wind activity.

d. Wind conditions within the POPS and central open space at grade are predicted to be suitable for standing, or better, during the typical use period (May to October, inclusive). If the windier areas within these spaces will not include designated seating or lounging areas, the noted conditions may be considered as acceptable. Notably, within the open space, a calmer region suitable for sitting is located to the east along the proposed public road where seating may be strategically placed to be comfortable during the typical use period. Additionally, large portions of the POPS fronting Bank Street are predicted to be suitable for sitting during the typical use period. Depending on programming, the noted conditions may be considered acceptable. If required by programming, comfort levels at designated seating areas within the windier regions may be improved by implementing targeted landscaping elements around sensitive areas such as tall wind screens and coniferous plantings in dense arrangements, in combination with strategically placed seating with high-back benches and other local wind mitigation.

2) Regarding the exterior amenity areas serving Building 1 at the ground level and at the Mezzanine Level, conditions are predicted to be suitable for sitting during the typical use period (May to October, inclusive) and are considered acceptable. Conditions during the same period within the MPH Level amenity terrace serving Building 4, which was modelled with 1.8-m-tall wind screens along its full perimeter, are predicted to be suitable for sitting, which is considered acceptable.

3) Regarding the amenity terraces serving Buildings 1-3 at the MPH Level, conditions during the typical use period are predicted to be suitable for a mix of sitting and standing. The noted amenity terraces were modelled with 1.8-m-tall wind screens along their full perimeters.

a. Mitigation inboard of the terrace perimeters and targeted around sensitive areas is recommended, in combination with the noted perimeter wind screens.

b. The extent of mitigation measures is dependent on the programming of the terraces. It is recommended that a mitigation strategy be developed in collaboration with the building and landscape architects as the design of the proposed development progresses through the Site Plan Control application stage and this work is expected to support the future Site Plan Control application.

4) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events, (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is the main concern. However, these events are generally short-lived and infrequent and there is often sufficient warning for pedestrians to take appropriate cover.

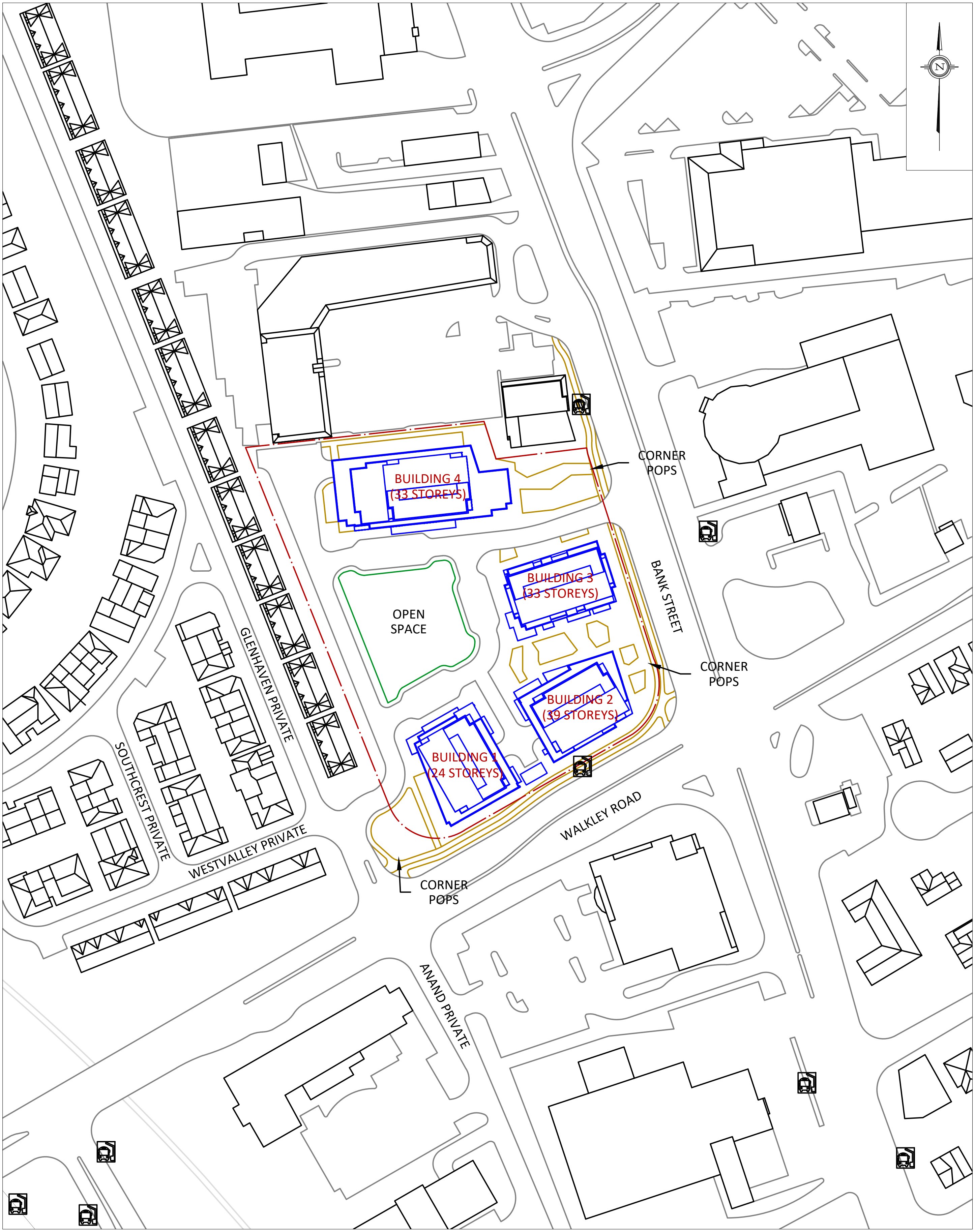
5) The pedestrian wind comfort and safety results provided in the present study will be used to inform the programming and detailed design of the proposed development through the Site Plan Control application stage. Appropriate mitigation measures to address the isolated windier conditions at grade and within the amenity terraces serving Buildings 1-3 may be detailed and implemented in collaboration with the building and landscape architects as the design of the proposed development progresses through the Site Plan Control application stage.

Sincerely,

Gradient Wind Engineering Inc.

Justin Denne, M.ASc.
Junior Wind Scientist

David Huitema, M.Eng, P.Eng.
CFD Lead Engineer



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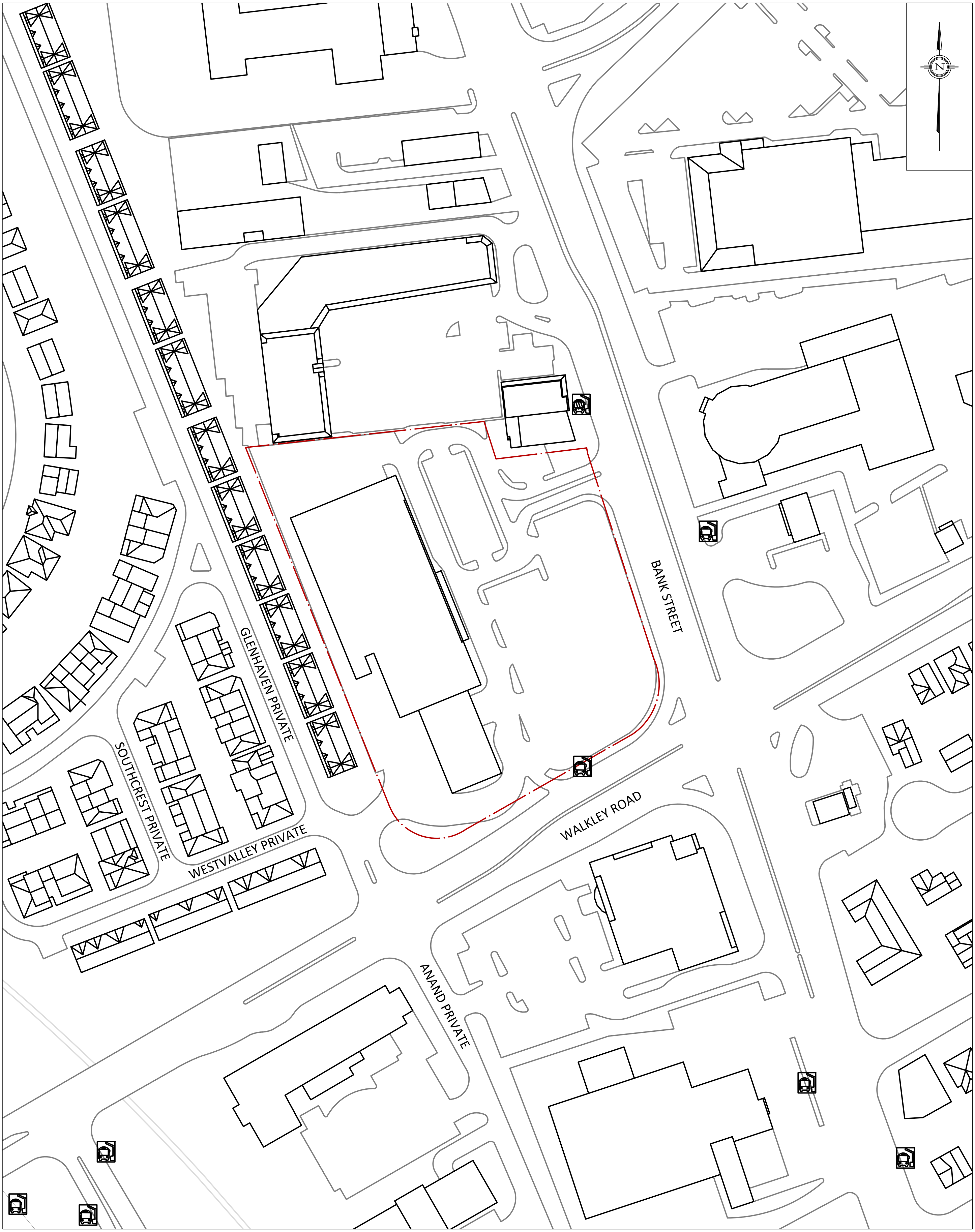
PROJECT	1824 BANK STREET, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2000	DRAWING NO.	24-150-PLW-1A
DATE	OCTOBER 11, 2024	DRAWN BY	S.K.

DESCRIPTION

FIGURE 1A:
PROPOSED SITE PLAN AND SURROUNDING CONTEXT



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PROJECT	1824 BANK STREET, OTTAWA PEDESTRIAN LEVEL WIND STUDY
SCALE	1:2000
DRAWING NO.	24-150-PLW-1B
DATE	OCTOBER 11, 2024
DRAWN BY	S.K.
DESCRIPTION	FIGURE 1B: EXISTING SITE PLAN AND SURROUNDING CONTEXT

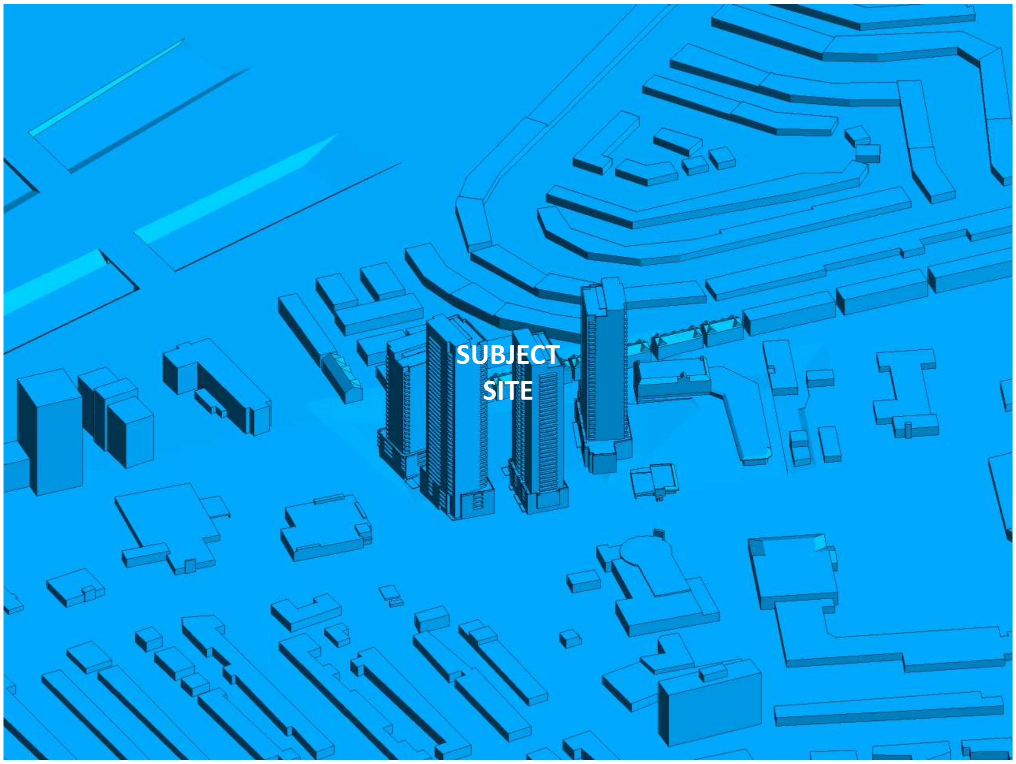


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, EAST PERSPECTIVE

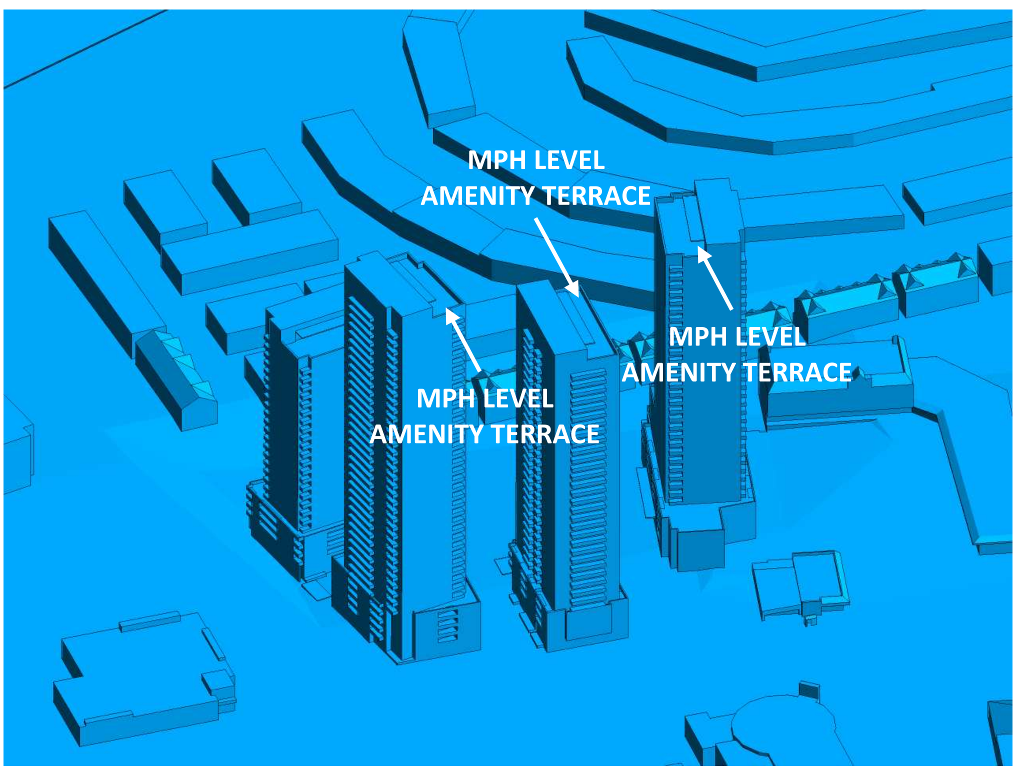


FIGURE 2B: CLOSE UP OF FIGURE 2A

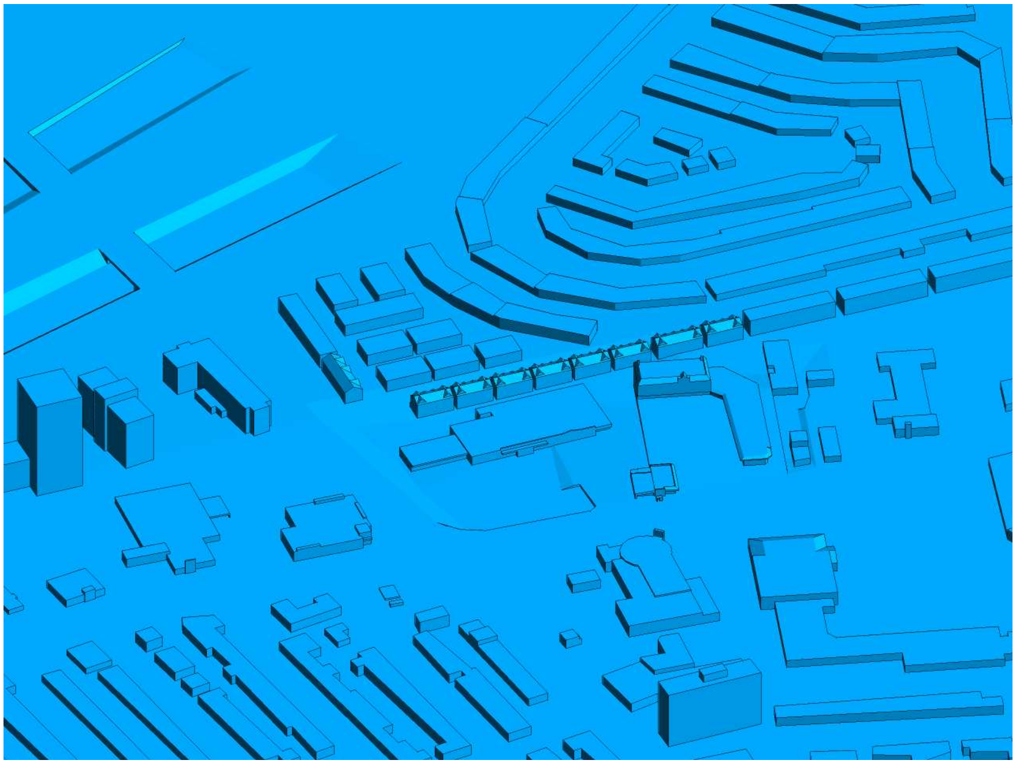


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, EAST PERSPECTIVE

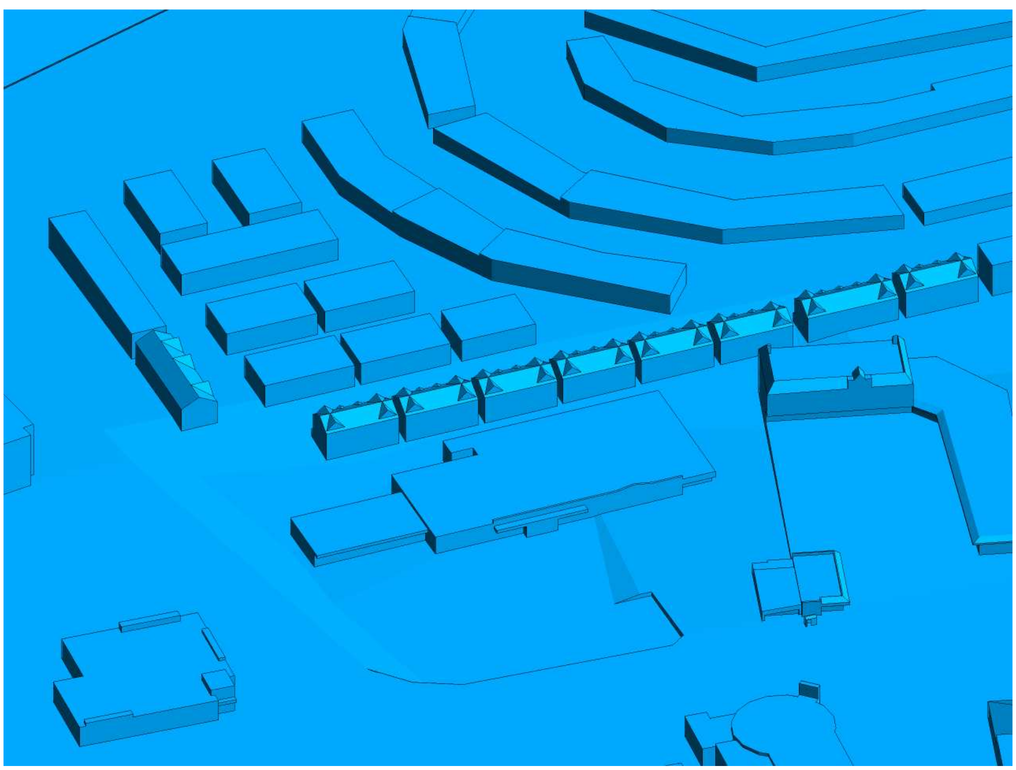


FIGURE 2D: CLOSE UP OF FIGURE 2C

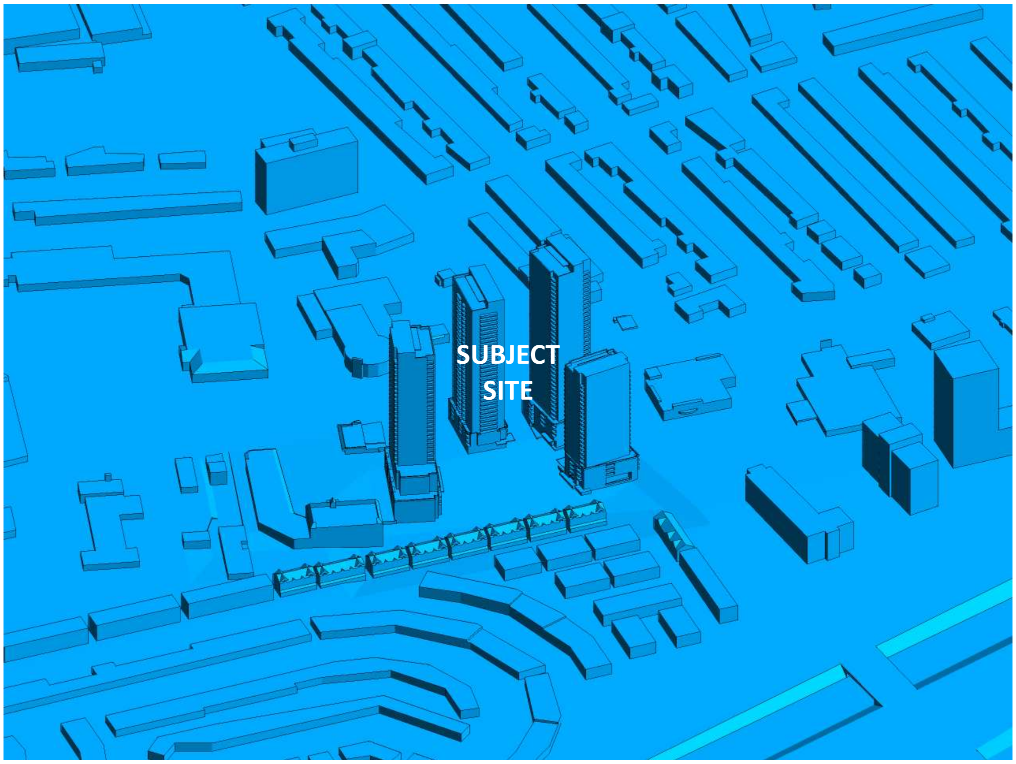


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, WEST PERSPECTIVE

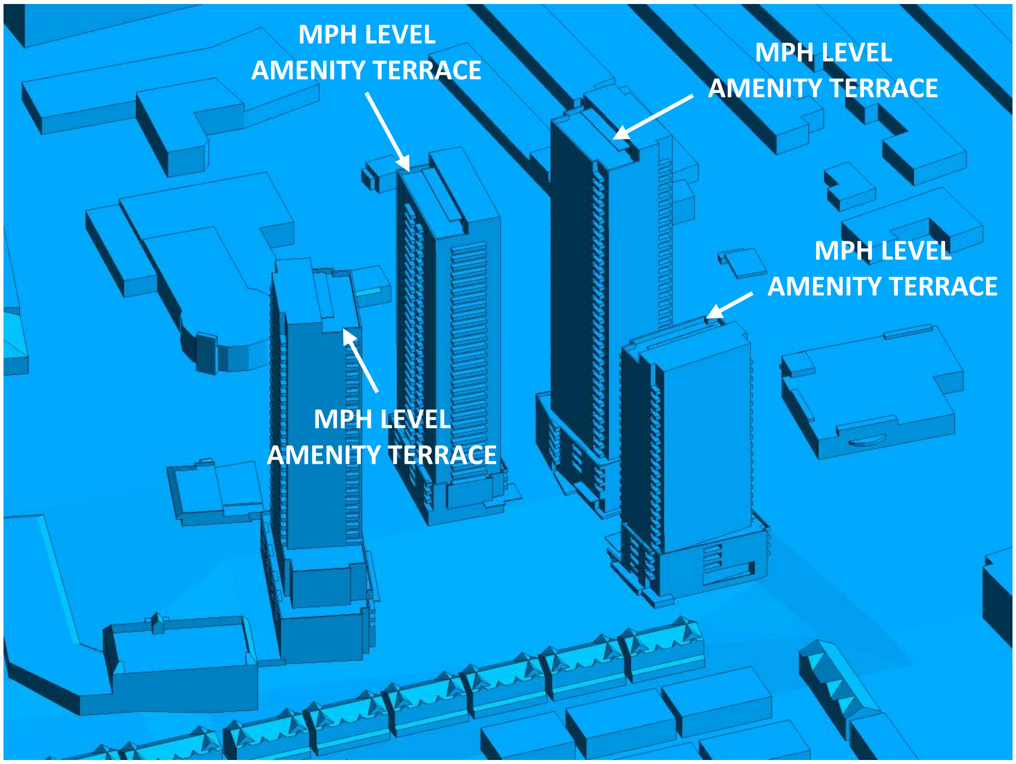


FIGURE 2F: CLOSE UP OF FIGURE 2E

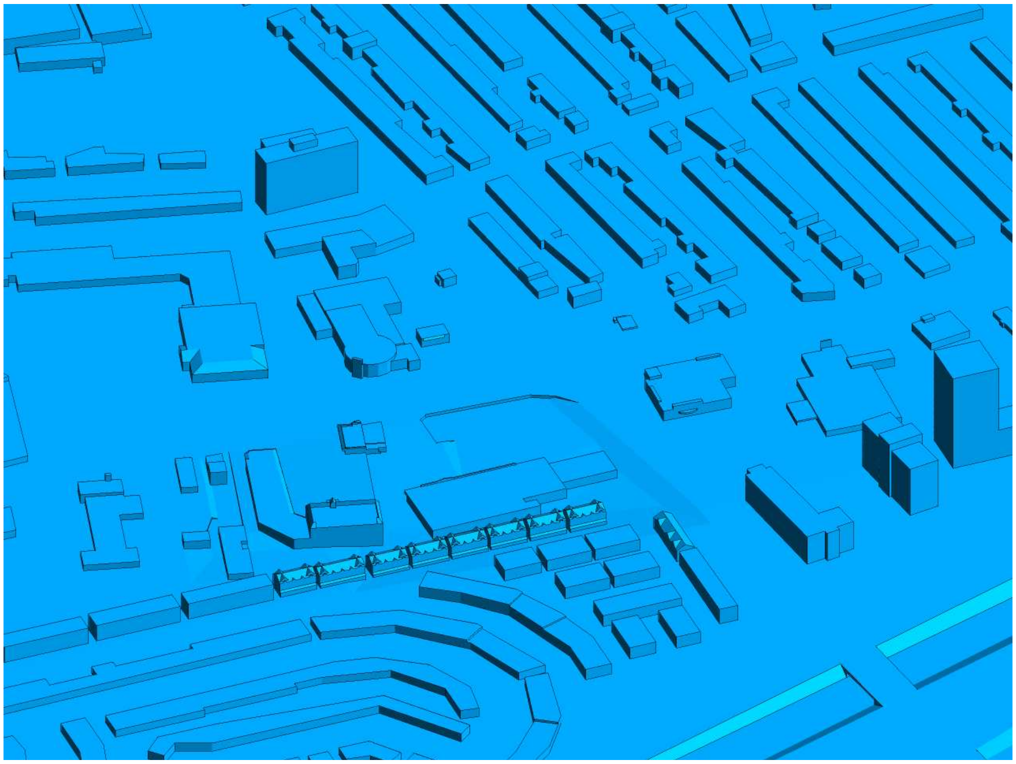


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, WEST PERSPECTIVE

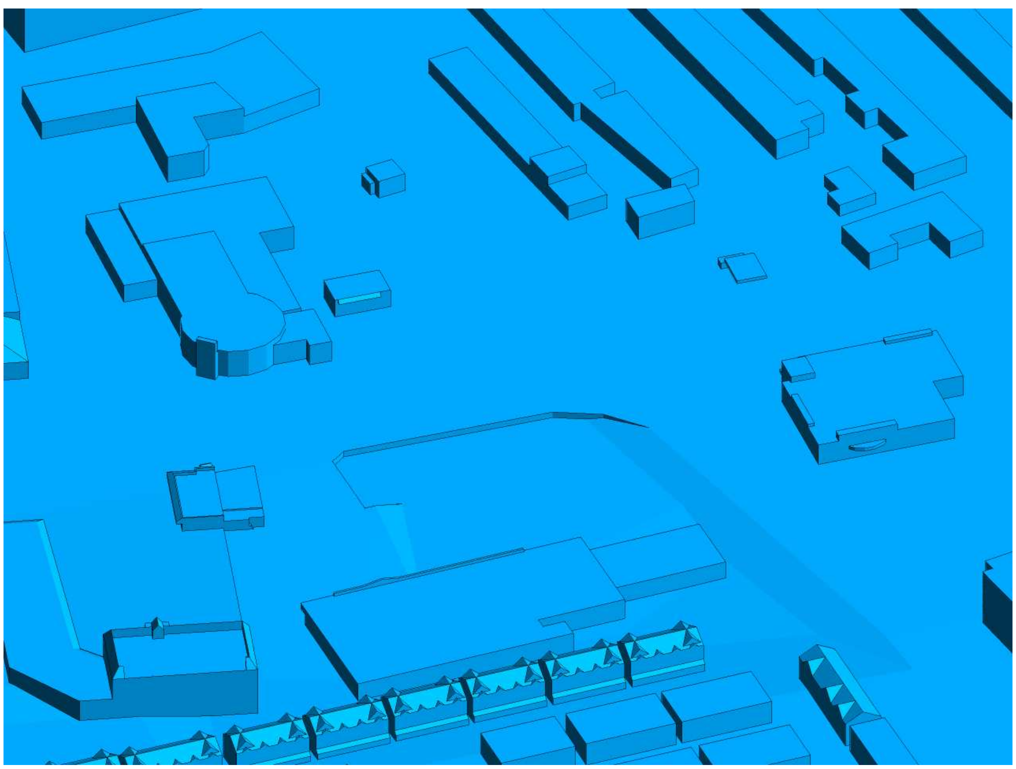


FIGURE 2H: CLOSE UP OF FIGURE 2G

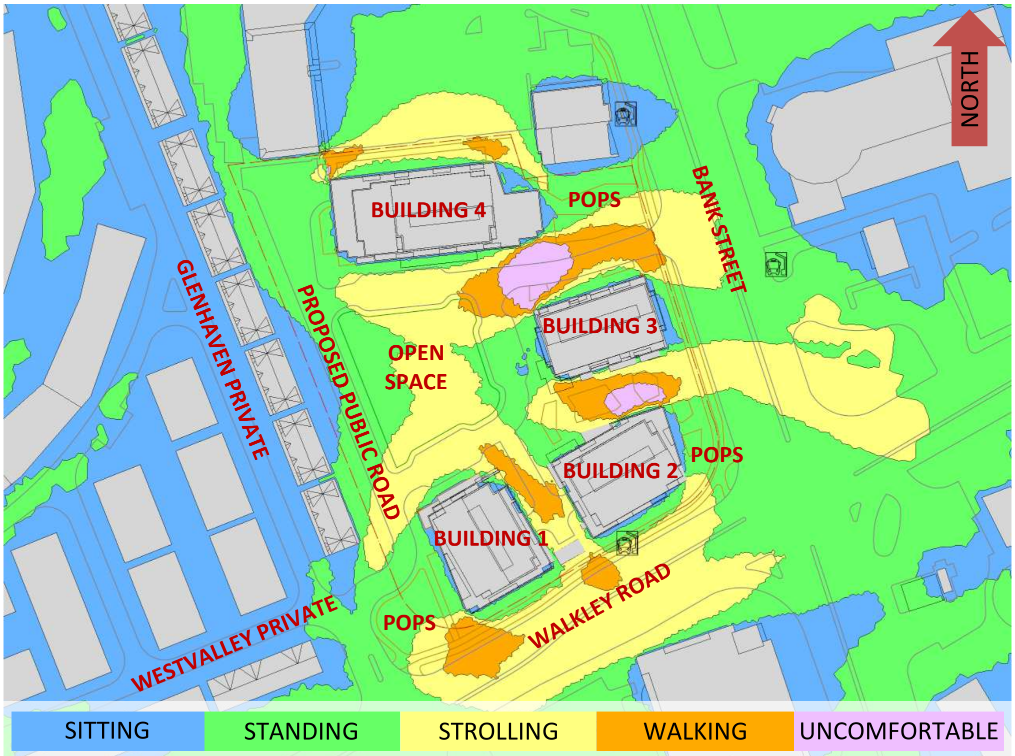


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

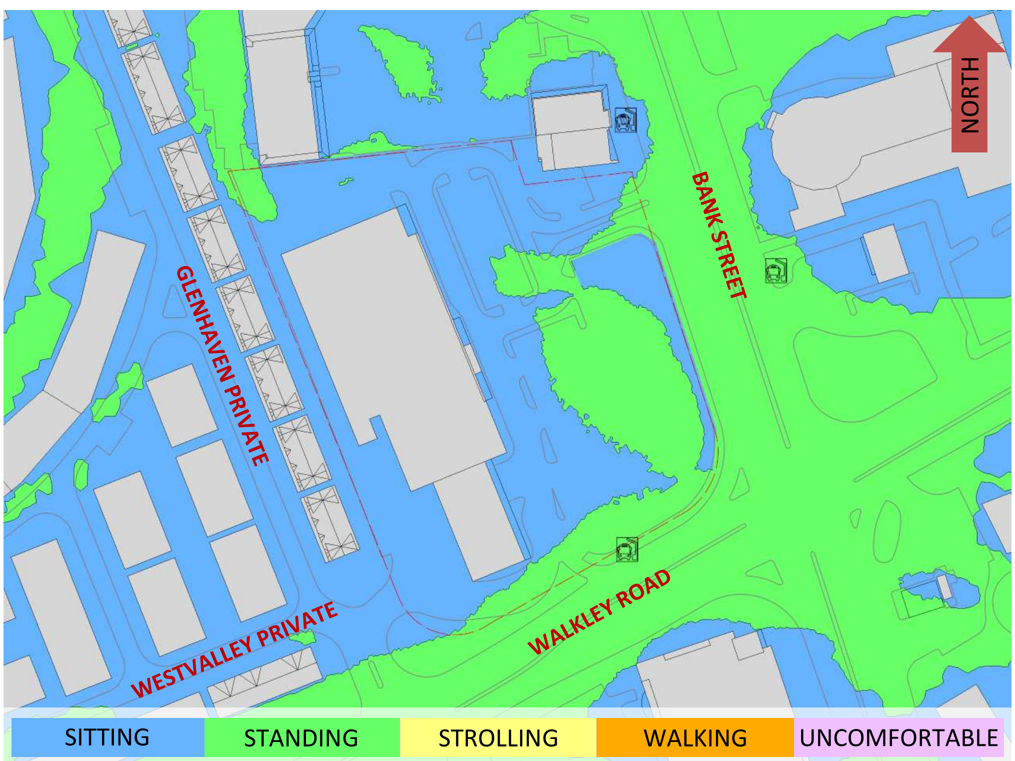


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

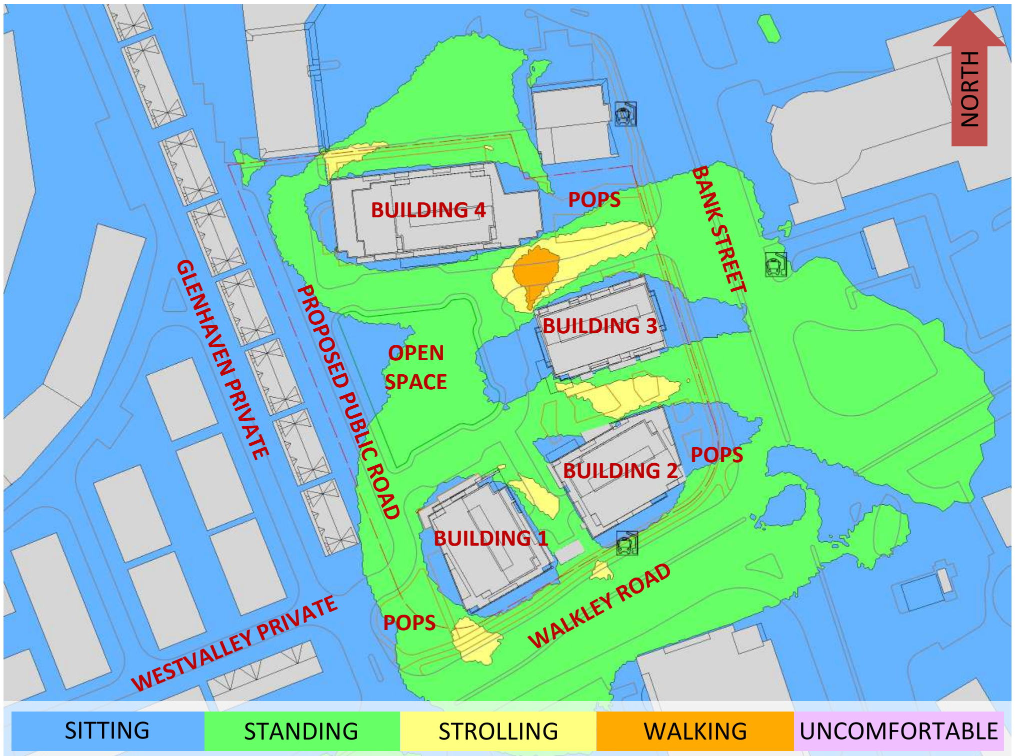


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

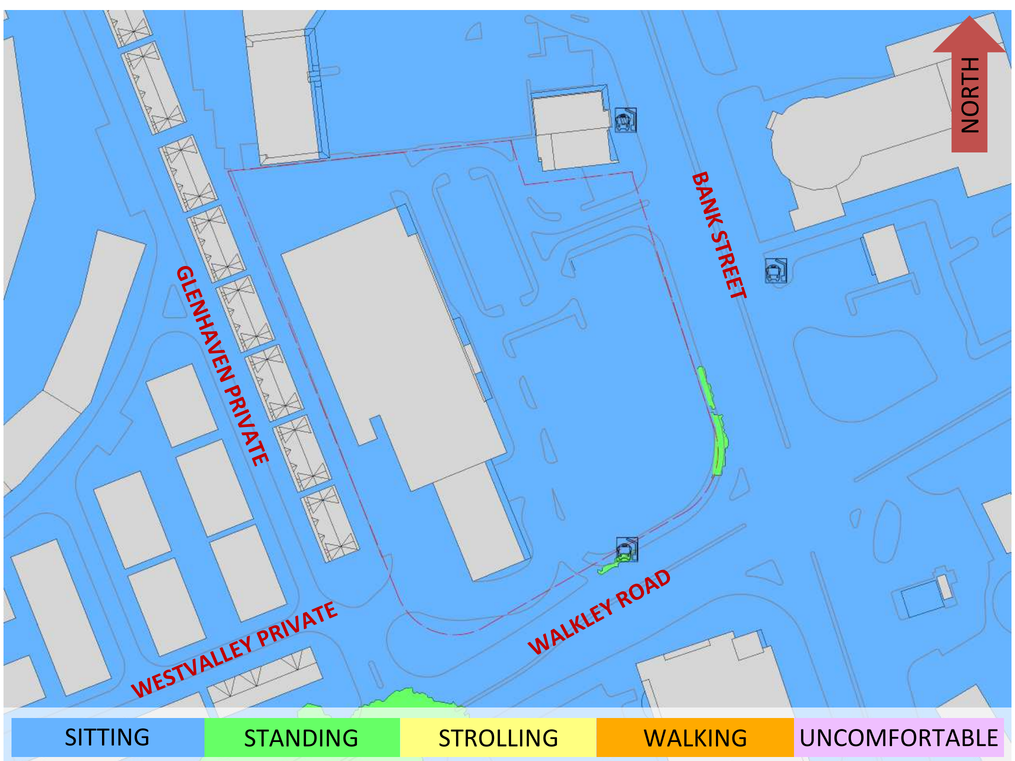


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

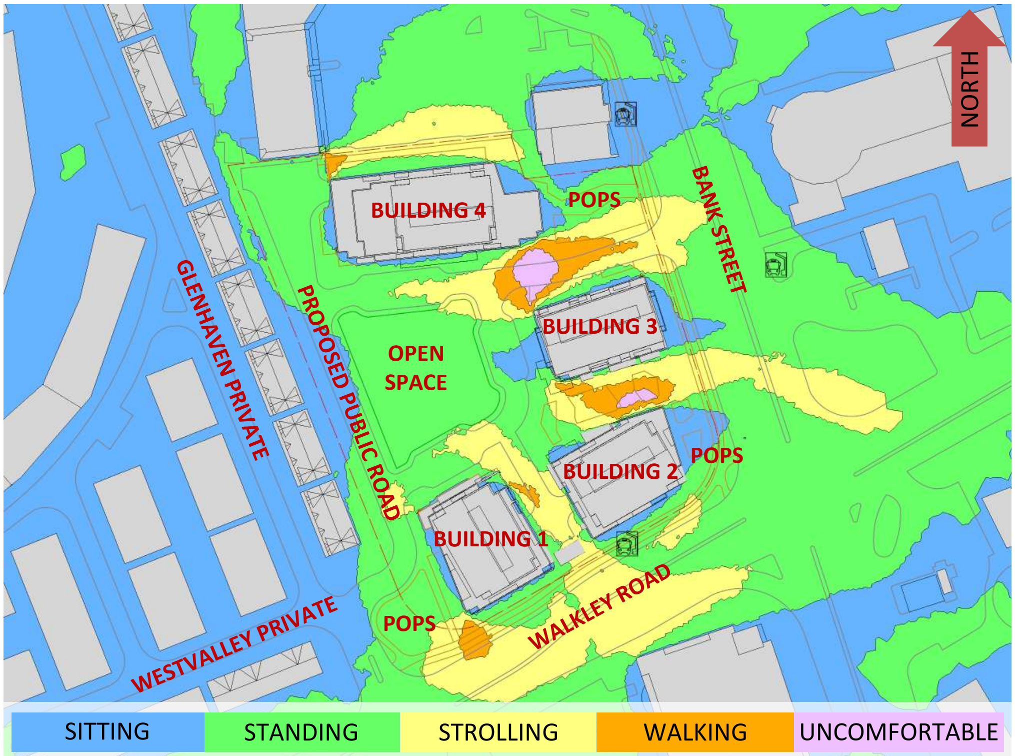


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

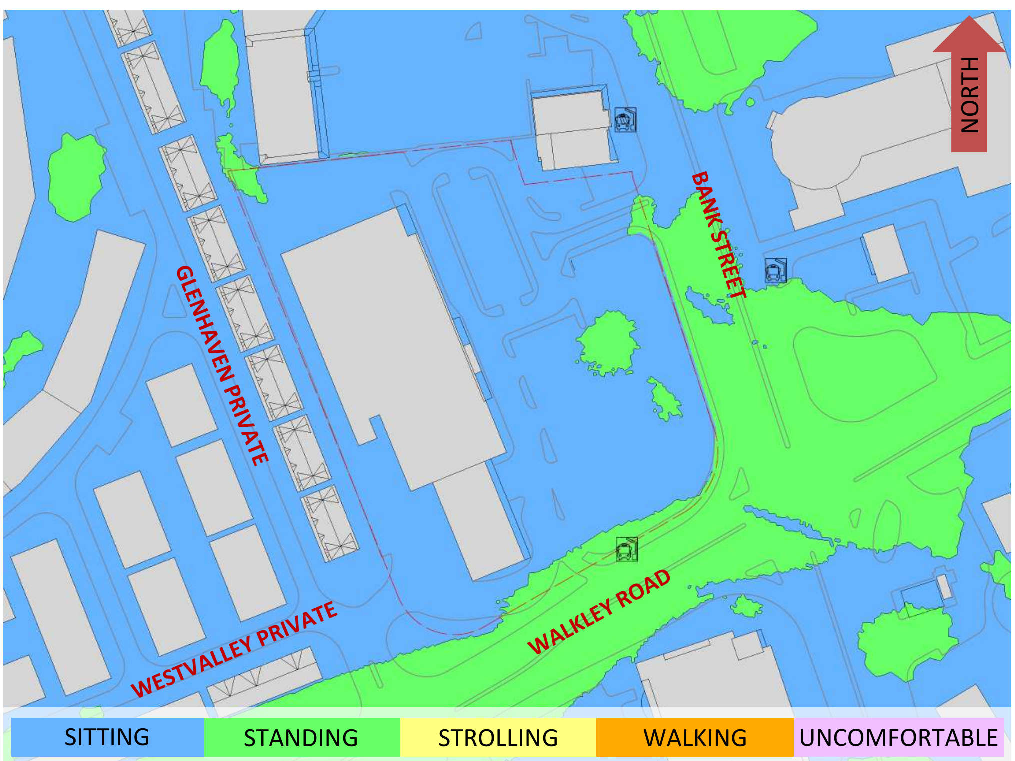


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

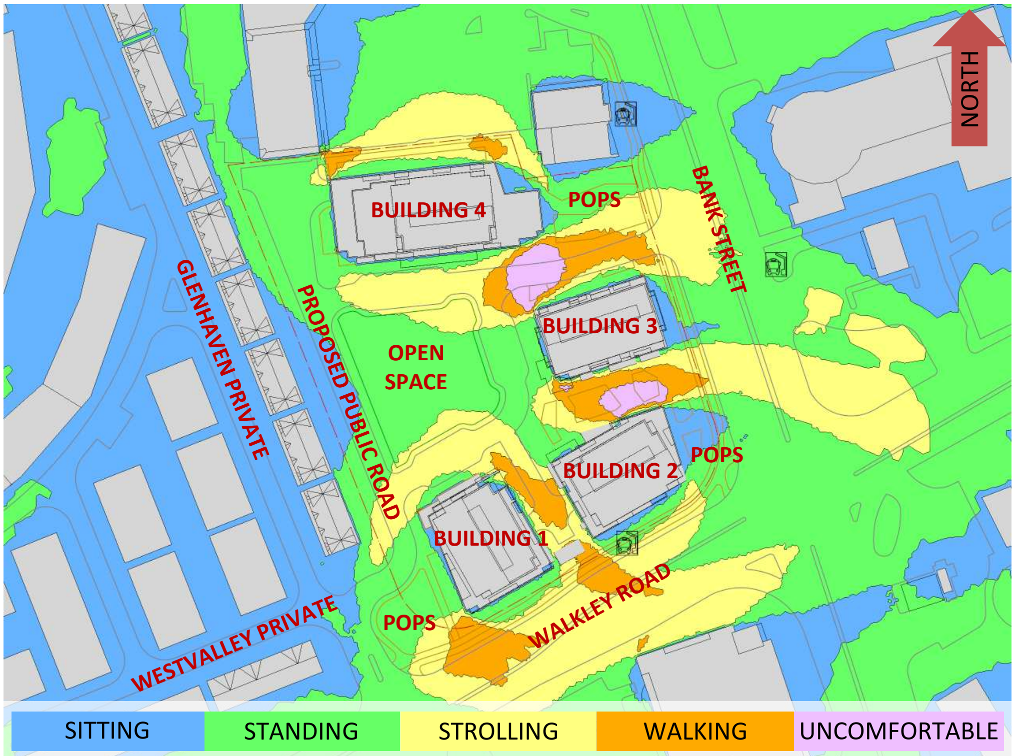


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

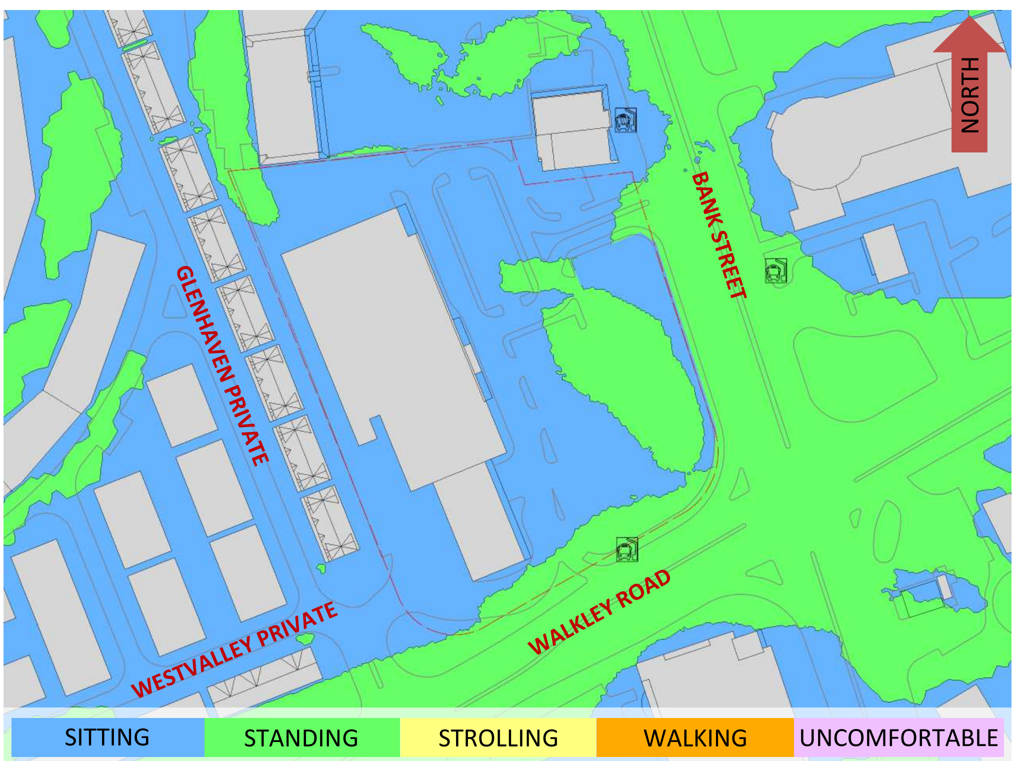


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

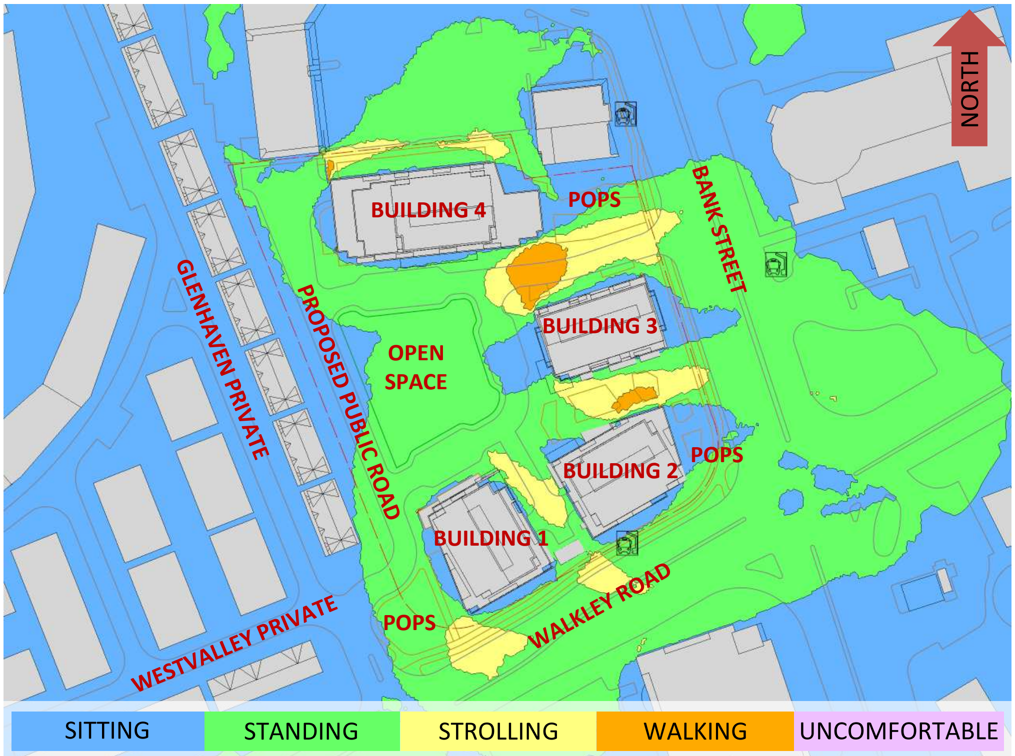


FIGURE 7: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

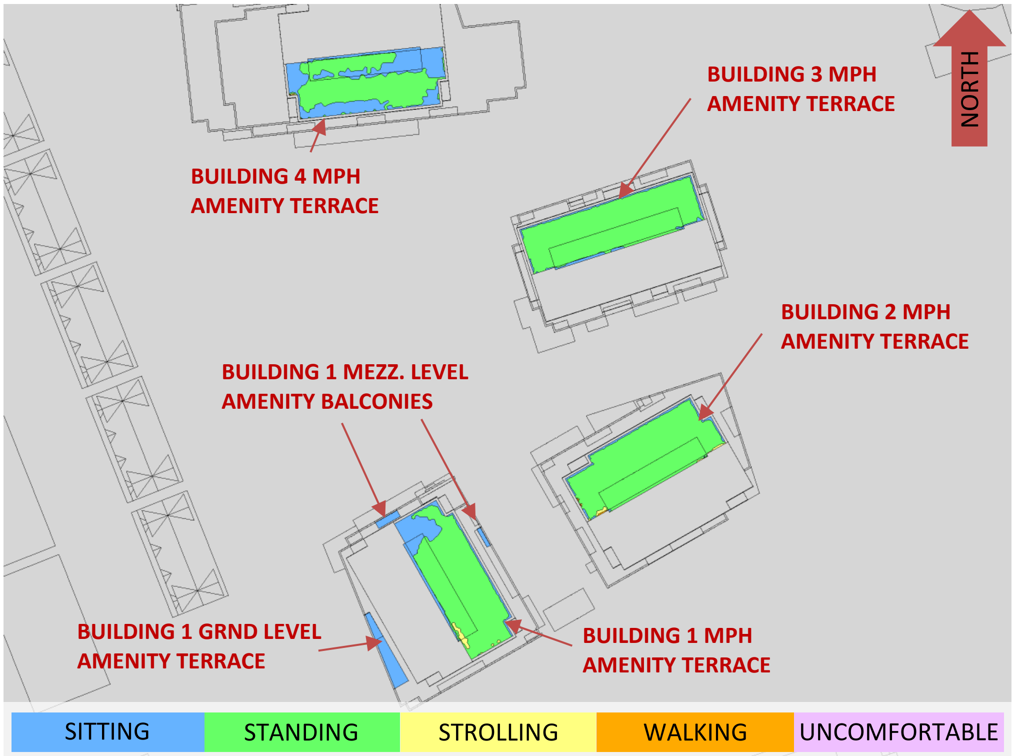


FIGURE 8A: SPRING – WIND COMFORT, COMMON AMENITY TERRACES

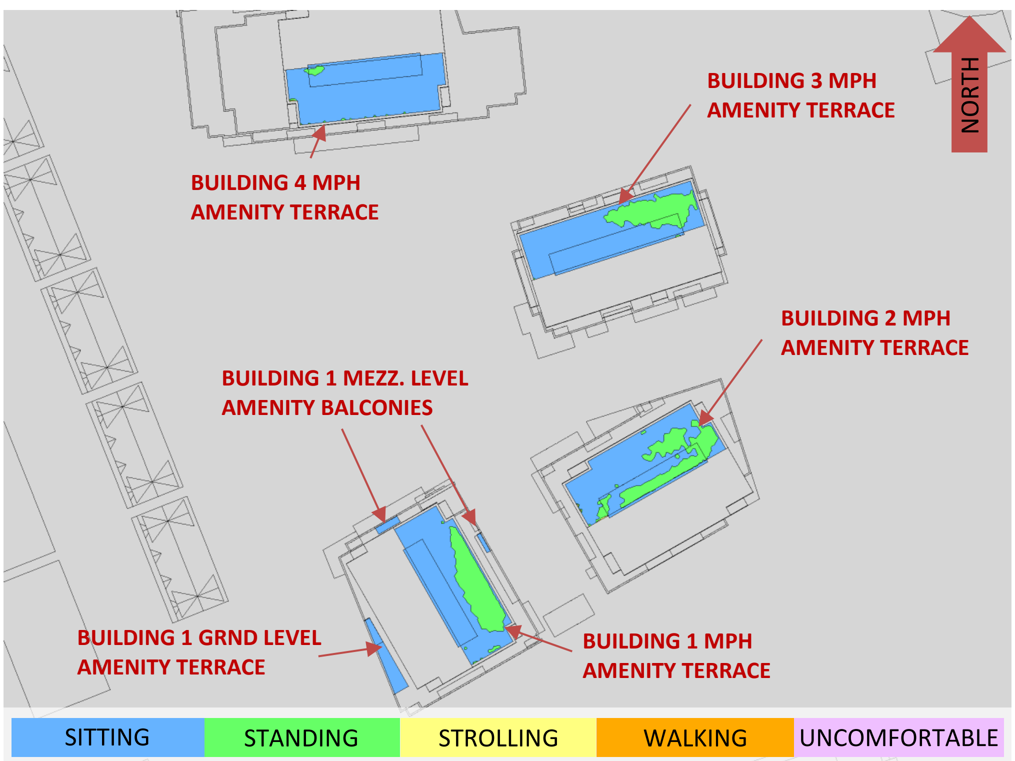


FIGURE 8B: SUMMER – WIND COMFORT, COMMON AMENITY TERRACES

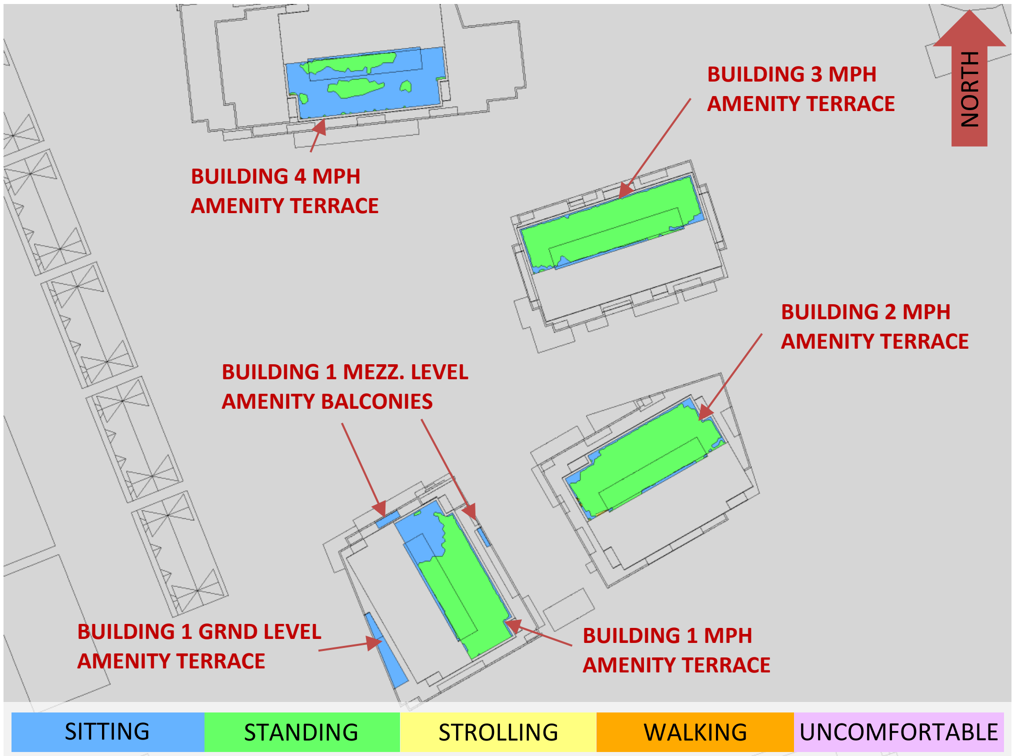


FIGURE 8C: AUTUMN – WIND COMFORT, COMMON AMENITY TERRACES

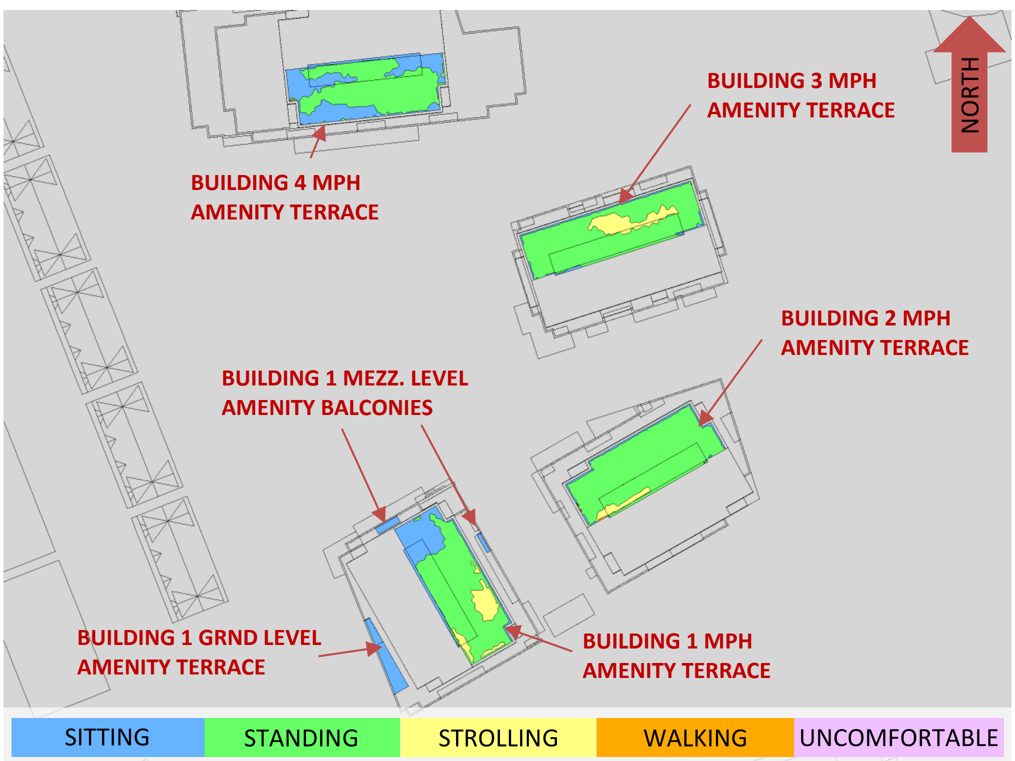


FIGURE 8D: WINTER – WIND COMFORT, COMMON AMENITY TERRACES

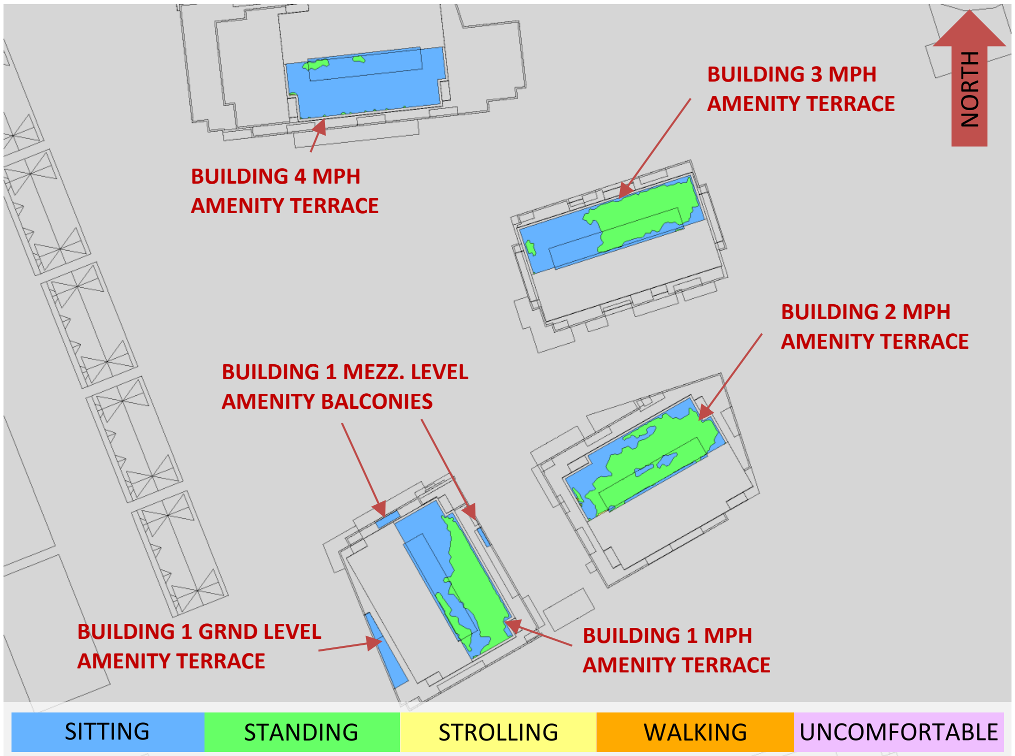
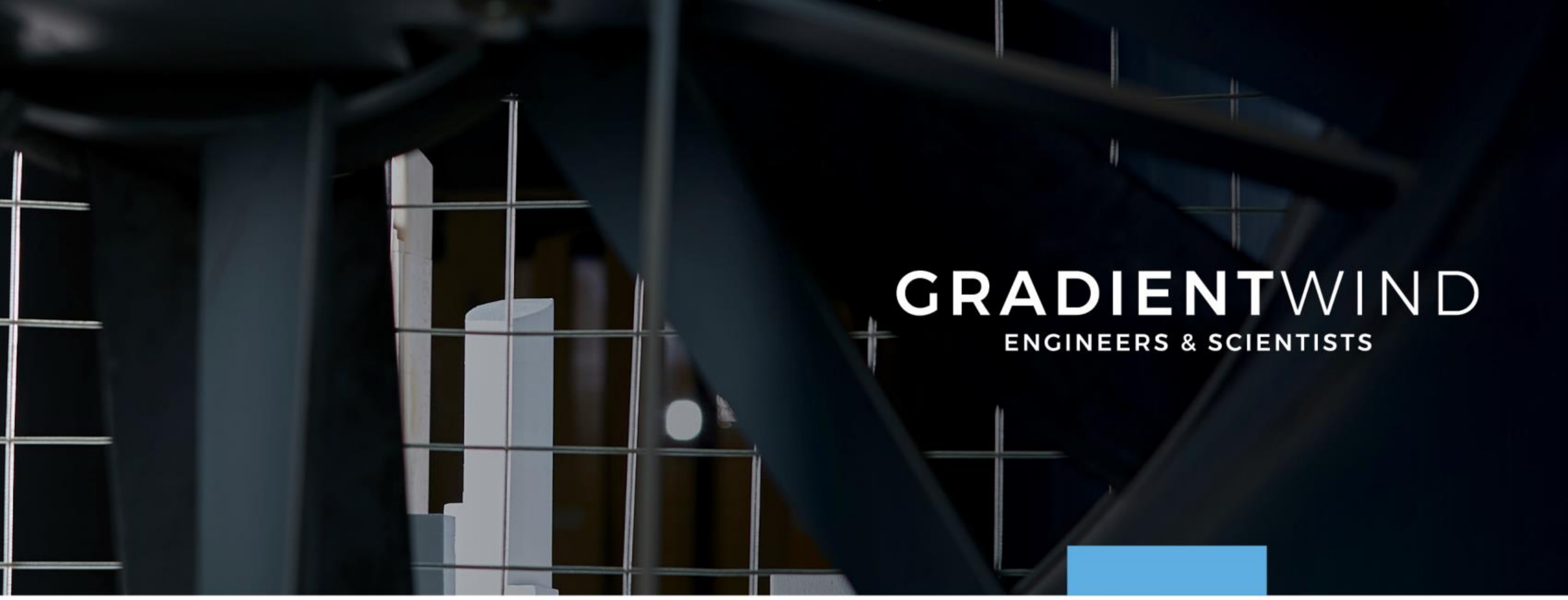
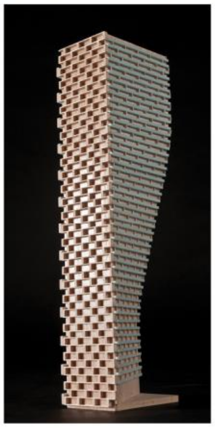
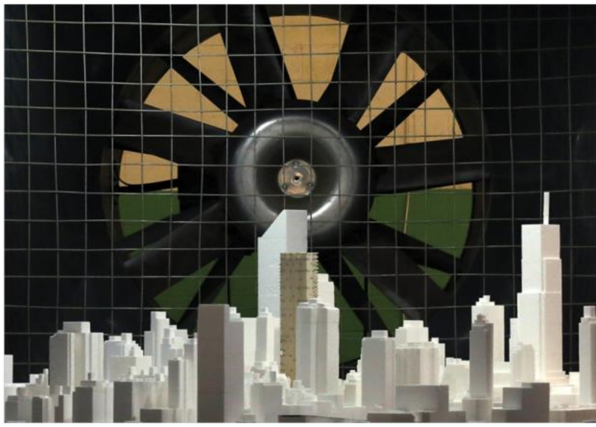


FIGURE 9: TYPICAL USE PERIOD – COMMON AMENITY TERRACES







APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

The atmospheric boundary layer (ABL) is defined by the velocity and turbulence profiles according to industry standard practices. The mean wind profile can be represented, to a good approximation, by a power law relation, Equation (1), giving height above ground versus wind speed (1), (2).

$$U = U_g \left(\frac{Z}{Z_g}\right)^{\alpha} \qquad \text{Equation (1)}$$

where, $\boldsymbol{U}$ = mean wind speed, $\boldsymbol{U_g}$ = gradient wind speed, $\boldsymbol{Z}$ = height above ground, $\boldsymbol{Z_g}$ = depth of the boundary layer (gradient height), and α is the power law exponent.

For the model, U_g is set to 6.5 metres per second (m/s), which approximately corresponds to the 60% mean wind speed for Ottawa based on historical climate data and statistical analyses. When the results are normalized by this velocity, they are relatively insensitive to the selection of gradient wind speed.

Z_g is set to 540 m. The selection of gradient height is relatively unimportant, so long as it exceeds the building heights surrounding the subject site. The value has been selected to correspond to our physical wind tunnel reference value.

α is determined based on the upstream exposure of the far-field surroundings (that is, the area that it not captured within the simulation model).

Table 1 presents the values of α used in this study, while Table 2 presents several reference values of α. When the upstream exposure of the far-field surroundings is a mixture of multiple types of terrain, the α values are a weighted average with terrain that is closer to the subject site given greater weight.

TABLE 1: UPSTREAM EXPOSURE (ALPHA VALUE) VS TRUE WIND DIRECTION

Wind Direction (Degrees True)	Alpha Value (α)
0	0.24
22.5	0.24
45	0.24
67.5	0.24
90	0.23
112.5	0.23
135	0.24
157.5	0.23
180	0.22
202.5	0.22
225	0.23
247.5	0.23
270	0.23
292.5	0.23
315	0.24
337.5	0.25

TABLE 2: DEFINITION OF UPSTREAM EXPOSURE (ALPHA VALUE)

Upstream Exposure Type	Alpha Value (α)
Open Water	0.14-0.15
Open Field	0.16-0.19
Light Suburban	0.21-0.24
Heavy Suburban	0.24-0.27
Light Urban	0.28-0.30
Heavy Urban	0.31-0.33

The turbulence model in the computational fluid dynamics (CFD) simulations is a two-equation shear-stress transport (SST) model, and thus the ABL turbulence profile requires that two parameters be defined at the inlet of the domain. The turbulence profile is defined following the recommendations of the Architectural Institute of Japan for flat terrain (3).

$$I(Z) = \begin{cases} 0.1\left(\frac{Z}{Z_g}\right)^{-\alpha-0.05}, & Z > 10\text{ m} \\ 0.1\left(\frac{10}{Z_g}\right)^{-\alpha-0.05}, & Z \leq 10\text{ m} \end{cases}$$ Equation (2)

$$L_t(Z) = \begin{cases} 100\text{ m}\sqrt{\frac{Z}{30}}, & Z > 30\text{ m} \\ 100\text{ m}, & Z \leq 30\text{ m} \end{cases}$$ Equation (3)

where, ***I*** = turbulence intensity, L_t = turbulence length scale, ***Z*** = height above ground, and **α** is the power law exponent used for the velocity profile in Equation (1).

Boundary conditions on all other domain boundaries are defined as follows: the ground is a no-slip surface; the side walls of the domain have a symmetry boundary condition; the top of the domain has a specified shear, which maintains a constant wind speed at gradient height; and the outlet has a static pressure boundary condition.

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[2] S. A. Hsu, E. A. Meindl and D. B. Gilhousen, "Determining the Power-Law Wind Profile Exponent under Near-neutral Stability Conditions at Sea," vol. 33, no. 6, 1994.

[3] Y. Tamura, H. Kawai, Y. Uematsu, K. Kondo and T. Okhuma, "Revision of AIJ Recommendations for Wind Loads on Buildings," in *The International Wind Engineering Symposium, IWES 2003*, Taiwan, 2003.