

**PEDESTRIAN LEVEL
WIND STUDY**

1500 Merivale Road
Ottawa, Ontario

Report: 21-166-PLW



June 3, 2021

PREPARED FOR
Claridge Homes
210 Gladstone Avenue
Ottawa, ON K2P 0Y6

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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy a Zoning By-law Amendment (ZBLA) submission for the proposed development located at 1500 Merivale Road in Ottawa (hereinafter referred to as “subject site” or “proposed development”). Our mandate within this study is to investigate pedestrian wind comfort and safety within and surrounding the subject site, and to identify any areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, as 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-6B, and summarized as follows:

- 1) All grade-level areas within and surrounding the subject site are predicted to be acceptable for the intended pedestrian uses throughout the year. Specifically, wind conditions over surrounding sidewalks, building access points, transit stops, and nearby parking lots are considered acceptable for the intended pedestrian uses throughout the year. One exception is as follows:
 - a. Over the proposed public park, wind conditions are predicted to be suitable for a mix of sitting and standing during the typical use period, defined as May to October, inclusive. During this period, most of the park is predicted to be suitable for sitting at least 75% of the time, which may be considered satisfactory.
- 2) The rooftop amenity terraces serving Phases 2, 5, 6, and 7 are predicted to experience conditions suitable for the intended uses without mitigation.
- 3) To extend sitting conditions over the full amenity terrace serving Phase 1, it is recommended that 1.5-m-tall barriers, typically glazed, be installed around the perimeter of the terrace.
- 4) Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no pedestrian areas within and surrounding the subject site were found to experience conditions that could be considered dangerous.



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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Claridge Homes to undertake a pedestrian level wind (PLW) study to satisfy a Zoning By-law Amendment (ZBLA) submission for the proposed development located at 1500 Merivale Road in Ottawa (hereinafter referred to as “subject site” or “proposed development”). Our mandate within this study is to investigate pedestrian wind comfort and safety within and surrounding the subject site, and to identify any areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered, as 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 provided by EVOQ Architecture in May 2021, 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 1500 Merivale Road on an irregular portion of a parcel of land bounded by Baseline Road to the north, Clyde Avenue to the west, and Merivale Road to the southeast. Throughout this report, Baseline Road is referred to as the north elevation.

The proposed development comprises five buildings subdivided into 11 phases, a park, and several green spaces and pedestrian

walkways throughout the site. At the southwest of the site, there is an 11-storey building subdivided into Phase 10 at the west and Phase 11 at the east. Phases 10 and 11 include entrances at the west elevation, fronting Clyde Avenue, and at the northeast corner. Phase 10 rises with a roughly constant planform up to Level 9, while Phase 11 rises to Level 10, where the building steps back from the west elevation and rises with a roughly square planform to Level 11.



*Rendering of Proposed Development, West Perspective
(Courtesy of EVOQ Architects)*

To the north of Phase 10, there is a 9-storey building (hereinafter referred to as “Phase 9”). Phase 9 includes entrances at the west elevation, fronting Clyde Avenue, and at the southwest corner. Phase 9 maintains a constant planform up to Level 9.

At the northwest of the site, there is a 10-storey building subdivided into Phases 6, 7, and 8 from north to south. The southwest of Phase 8 is connected to the east of Phase 9 by a pedestrian bridge above grade. Phases 6, 7, and 8 include entrances at the north elevation, fronting Baseline Road, and along the east elevation. There are two passageways which pass through Phases 6 and 7 at grade. Phase 6 includes an amenity terrace on the roof at Level 9, while Phase 7 includes an amenity terrace on the roof at Level 8. Phases 7 and 8 rise 9 storeys, while Phase 6 rises 10 storeys above grade.

Along the east elevation of the site, there is an 11-storey building subdivided into Phases 2, 3, 4, and 5. Phases 2, 3, 4, and 5 include entrances at the north elevation, fronting Baseline Road, at the south elevation, fronting Merivale Road, and along the west elevation. There is a passageway which passes through Phases 3 and 4 at grade. Phase 5 includes an amenity terrace at Level 8, while Phase 2 includes an amenity terrace at Level 10. The Phase 2 amenity terrace is planned to be a recreational zone and includes tennis courts.

At the south end of the subject site, to the west of Phase 2, there is a 10-storey building (hereinafter referred to as “Phase 1”). Phase 1 includes entrances at the south elevation, fronting Merivale Avenue, and at the southeast corner. At Level 10, the building pulls back from the east elevation to accommodate an amenity terrace.

At grade, there are several pedestrian walkways and green spaces throughout the site. Of particular importance, there is a public park between Phases 1, 2, 3, 7, and 8. Additionally, there is a recreational zone at grade to the west of Phase 6. Access to underground parking is provided via a laneway along the north of the public park, accessed from Merivale Road.

The near-field surroundings (defined as an area within 200 meters (m) of the subject site) are characterized by mostly low-rise commercial and suburban buildings in all directions. Additionally, there is a 12-storey development approximately 180 m to the northwest of the subject site. 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 mostly suburban low- and mid-rise massing for all directions. Additionally, the



open exposure of the Central Experimental Farm lies between the north-northeast clockwise to the northwest approximately 1 km from the subject site. Further, the massing along Clyde Avenue to the south-southeast is predominantly low-rise commercial massing. Highway 417 runs southwest to northeast approximately 1.7 km to the northwest of the subject site.

Key areas under consideration include surrounding sidewalks, walkways, bus stops, and building access points. The site plan for the proposed massing scenario is illustrated in Figure 1, while Figures 2A-2D illustrate the computational model used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian wind comfort and safety 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 criteria¹. 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/default/files/torwindanalysis_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 more conservative (i.e., windier) wind speed values.

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 12 wind directions. The CFD simulation model was centered on the study building, complete with surrounding massing within a diameter of approximately 650 m.

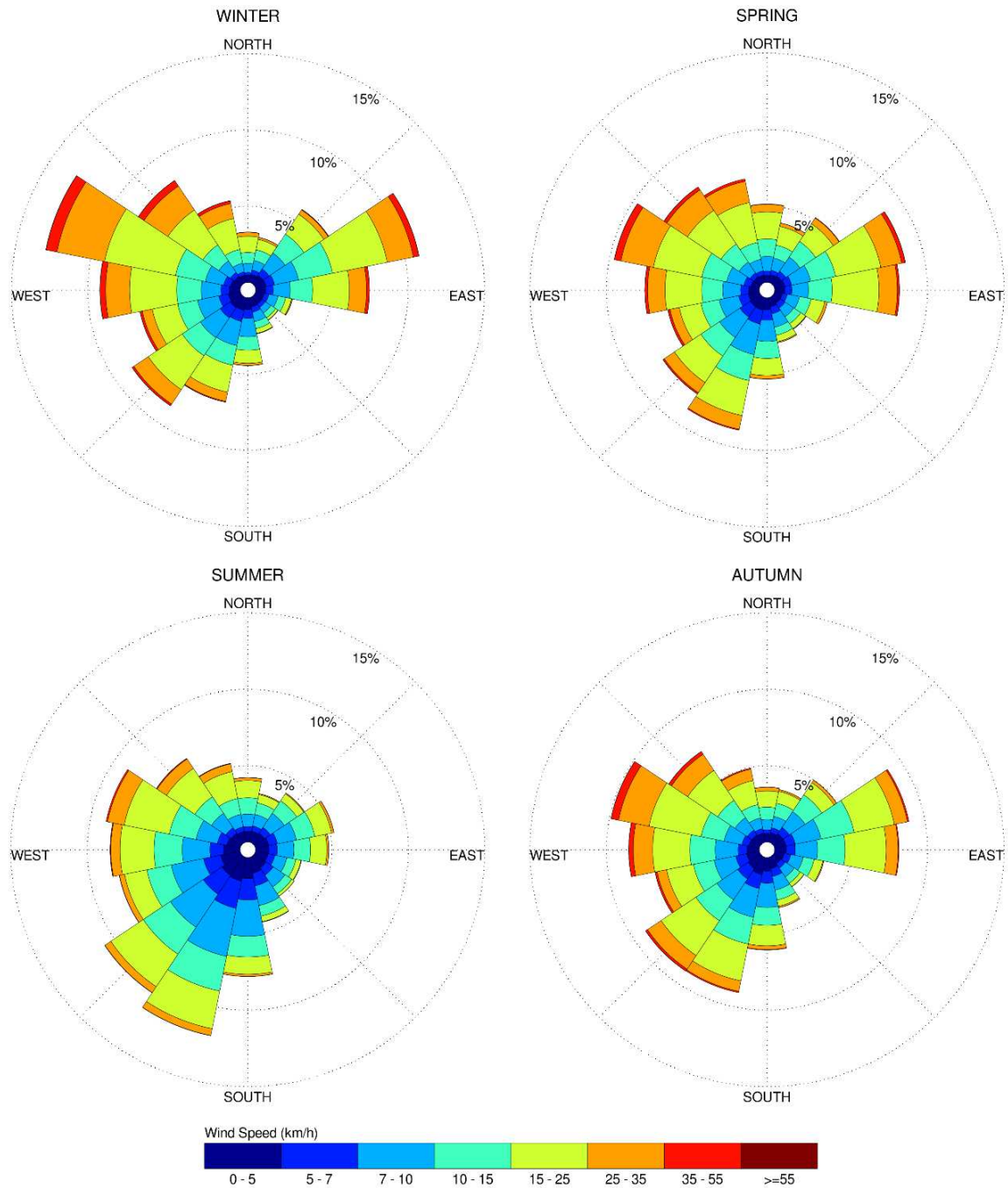
Mean and peak wind speed data obtained over the subject site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the elevated amenity terraces were referenced to the wind 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 Meteorological Data Analysis

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 for each month of the year to determine the statistically prominent wind directions and corresponding speeds, and to characterize similarities between monthly weather patterns.

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 preferred 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 preference 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 Comfort and Safety Criteria – City of Ottawa

Pedestrian comfort and safety criteria are based on the mechanical effects of wind without consideration of other meteorological conditions (i.e., 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 are based on 20% non-exceedance mean wind speed ranges, which include (1) Sitting; (2) Standing; (3) Strolling; (4) Walking; and (5) Uncomfortable. More specifically, the comfort classes and associated mean wind speed ranges are summarized as follows:

- 1) **Sitting:** 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.
- 2) **Standing:** 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.
- 3) **Strolling:** 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.
- 4) **Walking:** 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.
- 5) **Uncomfortable:** 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.

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. The gust speeds, and equivalent mean speeds, are selected based on 'The Beaufort Scale', presented on the following page, which describes the effects of forces produced by varying wind speed levels on objects. Gust speeds are included because 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.

THE BEAUFORT SCALE

Number	Description	Wind Speed (km/h)		Description
		Mean	Gust	
2	Light Breeze	6-11	9-17	Wind felt on faces
3	Gentle Breeze	12-19	18-29	Leaves and small twigs in constant motion; wind extends light flags
4	Moderate Breeze	20-28	30-42	Wind raises dust and loose paper; small branches are moved
5	Fresh Breeze	29-38	43-57	Small trees in leaf begin to sway
6	Strong Breeze	39-49	58-74	Large branches in motion; Whistling heard in electrical wires; umbrellas used with difficulty
7	Moderate Gale	50-61	75-92	Whole trees in motion; inconvenient walking against wind
8	Gale	62-74	93-111	Breaks twigs off trees; generally impedes progress

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 were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting. Similarly, if a mean wind speed of 20 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 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 desired comfort classes, which are dictated by the location type for each region (i.e., a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their desired comfort classes are summarized on the following page.

DESIRED PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Desired Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Standing / Strolling / Walking
Primary Public Sidewalk	Strolling / Walking
Secondary Public Sidewalk / Bicycle Path	Walking
Outdoor Amenity Space	Sitting / Standing / Strolling
Café / Patio / Bench / Garden	Sitting
Transit Stop	Sitting / Standing
Public Park / Plaza	Standing / Strolling
Garage / Service Entrance	Walking
Parking Lot	Strolling / Walking
Vehicular Drop-Off Zone	Standing / Strolling / Walking

5. RESULTS AND DISCUSSION

The following discussion of predicted pedestrian wind conditions is accompanied by Figures 3A-3D, which illustrate seasonal wind conditions at grade level for the proposed massing scenario, and Figures 4A-4D, which illustrate seasonal wind conditions over the rooftop amenity terraces and recreational areas serving the proposed development. Wind conditions are presented as continuous contours of wind comfort within and surrounding the subject site.

The colour contours indicate various wind comfort classes predicted for certain regions, which correspond to the City of Ottawa wind comfort criteria in Section 4.4. Wind conditions comfortable for sitting or more sedentary activities are represented by the colour green, standing are represented by yellow, strolling by orange, and walking by blue. Uncomfortable conditions are represented by magenta.

Figures 5A and 5B illustrate wind comfort and the percentage of time grade level areas are predicted to be suitable for sitting during the typical use period, defined as May to October, inclusive. Figure 5A represents wind comfort based on the definitions in Section 4.4, while Figure 5B represents sitting percentages. Regarding the amenity terraces and recreational areas, Figures 6A and 6B illustrate wind

comfort conditions and the percentage of time the noted roof areas are predicted to be suitable for sitting during the typical use period.

5.1 Wind Comfort Conditions – Grade Level

Sidewalks, Transit Stops, and Building Entrances along Merivale Road: Following the introduction of the proposed development, the sidewalks along Merivale Road, inclusive of transit stops, in the vicinity of the proposed development are predicted to be suitable for mostly sitting during the summer season, becoming suitable for a mix of sitting and standing throughout the remainder of the year. Owing to the protection of the building façades, conditions in the vicinity of building entrances serving the proposed development are predicted to be suitable for sitting throughout the year, while conditions in the vicinity of nearby existing building entrances along Merivale Road are predicted to be suitable for sitting during the summer and autumn seasons, becoming suitable for a mix of sitting and standing during the spring and winter seasons. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Sidewalks and Building Entrances along Clyde Avenue: Following the introduction of the proposed development, the sidewalks along Clyde Avenue, inclusive of transit stops, in the vicinity of the proposed development are predicted to be suitable for mostly sitting during the summer season, becoming suitable for a mix of sitting and standing throughout the remainder of the year. Owing to the protection of the building façades, conditions in the vicinity of building entrances are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Sidewalks and Building Entrances along Baseline Road: Following the introduction of the proposed development, the sidewalks along Baseline Road, inclusive of transit stops, in the vicinity of the proposed development are predicted to be suitable for mostly sitting during the summer season, with standing conditions predicted within the northwest corner of Phase 6. During the three colder seasons, conditions are predicted to be suitable for a mix of sitting and standing, with strolling conditions predicted near the northeast corner of Phase 5 during the spring and winter seasons. Owing to the protection of the building façades, conditions in the vicinity of building entrances are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.



Walkway and Green Space along East Elevation of Subject Site: Conditions over the walkway and green spaces along the east elevation of the subject site are predicted to be suitable for mostly sitting throughout the year. Within the grade-level passageway that extends through Phases 3 and 4, conditions are predicted to be suitable for sitting during the summer season, becoming suitable for mostly standing throughout the remainder of the year. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Walkways, Bicycle Paths, and Green Spaces along West Elevation of Phases 6, 7, and 8: Conditions over the walkways, bicycle paths, and green spaces, which include the grade-level recreational zone, along the west elevation of Phases 6, 7, and 8, are predicted to be suitable for sitting during the summer and autumn seasons, becoming suitable for a mix of sitting and standing during the spring and winter seasons. Within the grade-level passageways that extend through Phases 6 and 7, conditions are predicted to be suitable for a mix of sitting and standing during the summer and autumn seasons, becoming suitable for a mix of standing and strolling during the spring and winter seasons. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Walkway, Green Space, and Building Entrances Between Phases 9 and 10: Conditions over the walkway and green space between Phases 9 and 10 are predicted to be suitable for a mix of sitting and standing during the summer and autumn seasons, becoming suitable for strolling, or better, during the spring and winter seasons. The windiest conditions in this area occur near the northeast corner of Phase 10. Within the grade-level passageway between Phases 8 and 9, conditions are predicted to be suitable for sitting during the spring, summer, and autumn seasons, becoming suitable for a mix of sitting and standing during the winter season. Owing to the protection of the building façades, conditions in the vicinity of building entrances are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.



Walkways, Green Spaces, and Building Entrances Between Phases 3-4 and Phases 6-7: Conditions over the walkways and green spaces between Phases 3-4 and Phases 6-7 are predicted to be suitable for a mix of sitting and standing during the summer and autumn seasons, becoming suitable for mostly standing during the spring and winter seasons, with some isolated strolling conditions. Owing to the protection of the building façades, conditions in the vicinity of building entrances are predicted to be suitable for sitting during the summer and autumn seasons, becoming suitable for a mix of sitting and standing during the spring and winter seasons. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Walkways, Green Spaces, and Building Entrances Between Phases 1 and 2: Conditions over the walkways and green spaces between Phases 1 and 2 are predicted to be suitable for sitting during the summer season, becoming suitable for a mix of sitting and standing throughout the remainder of the year. Owing to the protection of the building façades, conditions in the vicinity of building entrances are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Walkways, Public Park, and Building Entrances Between Phase 1 and Phases 7-8: Conditions over the walkways between Phase 1 and Phases 7-8 are predicted to be suitable for a mix of sitting and standing during the summer season, becoming suitable for mostly standing throughout the remainder of the year. Owing to the protection of the building façades, conditions in the vicinity of building entrances are predicted to be suitable for sitting throughout the year. The noted conditions are considered acceptable according to the City of Ottawa wind criteria.

Over the proposed public park, conditions are predicted to be suitable for a mix of sitting and standing during the typical use period, as illustrated in Figure 5A, becoming suitable for mostly standing during the remaining colder months of the year. Additionally, most of the park is predicted to be suitable for sitting at least 75% of the time, as illustrated in Figure 5B. The noted conditions may be considered satisfactory.

5.2 Wind Comfort Conditions – Common Amenity Terraces

Amenity Terrace, Phase 1: The rooftop amenity terrace serving Phase 1 is predicted to be suitable for a mix of sitting and standing during the typical use period. To extend the sitting conditions over the full terrace, it is recommended that a 1.5-m-tall wind barrier, typically glazed, be installed around the perimeter of the terrace.

Amenity Terrace, Phase 2: The amenity terrace serving Phase 2, which includes tennis courts and is intended as a recreational area, is predicted to be suitable for a mix of sitting and standing during the typical use period with the standing conditions located towards the south half of the terrace. The noted conditions are considered acceptable based on the programming of the space.

Amenity Terrace, Phase 5: The amenity terrace serving Phase 5 is predicted to be suitable for sitting throughout the year, which is considered acceptable according to the City of Ottawa wind criteria.

Amenity Terrace, Phase 6: The amenity terrace serving Phase 6 is predicted to be mostly suitable for sitting during the typical use period. There is a small region which is predicted to be suitable for standing during the typical use period. However, since this region is predicted to be suitable for sitting at least 75% of the time during the typical use period, conditions may be considered satisfactory.

Amenity Terrace, Phase 7: The amenity terrace serving Phase 7 is predicted to be suitable for sitting throughout the year, which is considered acceptable according to the City of Ottawa wind criteria.

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 surrounding the subject site at grade level or on the common amenity terraces were found to experience conditions that could be considered dangerous, as defined in Section 4.4.

5.4 Applicability of Results

Wind conditions over surrounding sidewalks beyond the subject site, as well as at nearby primary building entrances, are predicted to be acceptable for their intended pedestrian uses during each seasonal period upon the introduction of the proposed development. Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the subject site. Future changes (i.e., 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 site would alter the wind profile approaching the site; and (ii) development in proximity to the site would cause changes to local flow patterns. In general, development in suburban and urban centers generally creates reduction in the mean wind speeds and localized increases in the gustiness of the wind.

Regarding primary and secondary building access points, wind conditions predicted in this study are only applicable to pedestrian comfort and safety. As such, the results should not be construed to indicate wind loading on doors and associated hardware.

6. CONCLUSIONS AND RECOMMENDATIONS

A complete summary of the predicted wind conditions is provided in Section 5 and illustrated in Figures 3A-6B. 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 in Ottawa, the study concludes the following:

- 1) All grade-level areas within and surrounding the subject site are predicted to be acceptable for the intended pedestrian uses throughout the year. Specifically, wind conditions over surrounding sidewalks, building access points, transit stops, and nearby parking lots are considered acceptable for the intended pedestrian uses throughout the year. One exception is as follows:
 - a. Over the proposed public park, wind conditions are predicted to be suitable for a mix of sitting and standing during the typical use period, defined as May to October, inclusive. During this period, most of the park is predicted to be suitable for sitting at least 75% of the time, which may be considered satisfactory.



- 2) The rooftop amenity terraces serving Phases 2, 5, 6, and 7 are predicted to experience conditions suitable for the intended uses without mitigation.
- 3) To extend sitting conditions over the full amenity terrace serving Phase 1, it is recommended that 1.5-m-tall barriers, typically glazed, be installed around the perimeter of the terrace.
- 4) Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no pedestrian areas within and surrounding the subject site were found to experience conditions that could be considered dangerous.

Sincerely,

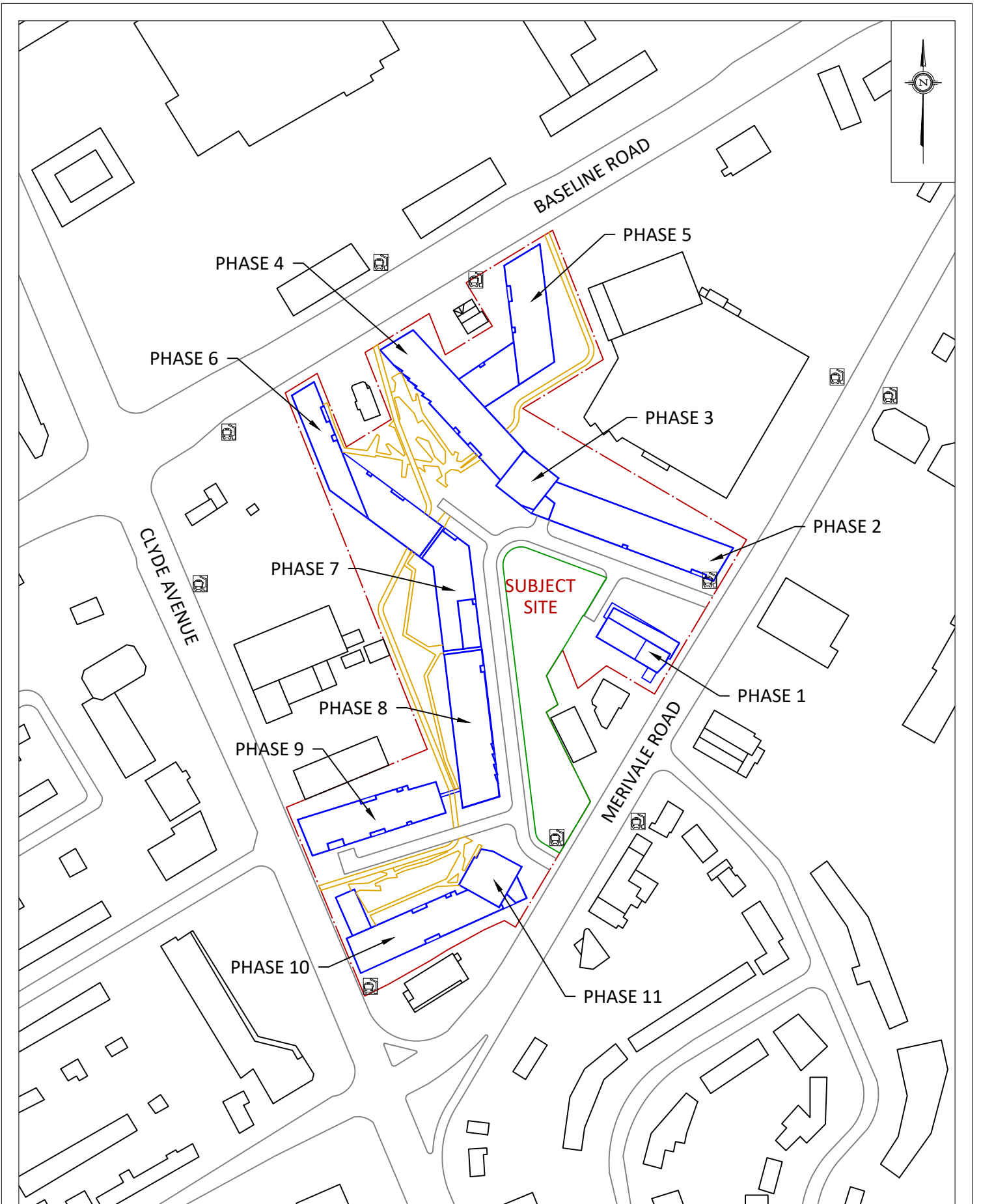
Gradient Wind Engineering Inc.



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GRADIENTWIND ENGINEERS & SCIENTISTS 127 WALGREEN ROAD, OTTAWA, ON 613 836 0934 • GRADIENTWIND.COM	PROJECT	1500 MERIVALE ROAD, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION
	SCALE	1:3000	DRAWING NO.	21-166-PLW-1
	DATE	JUNE 3, 2021	DRAWN BY	O.R.

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT

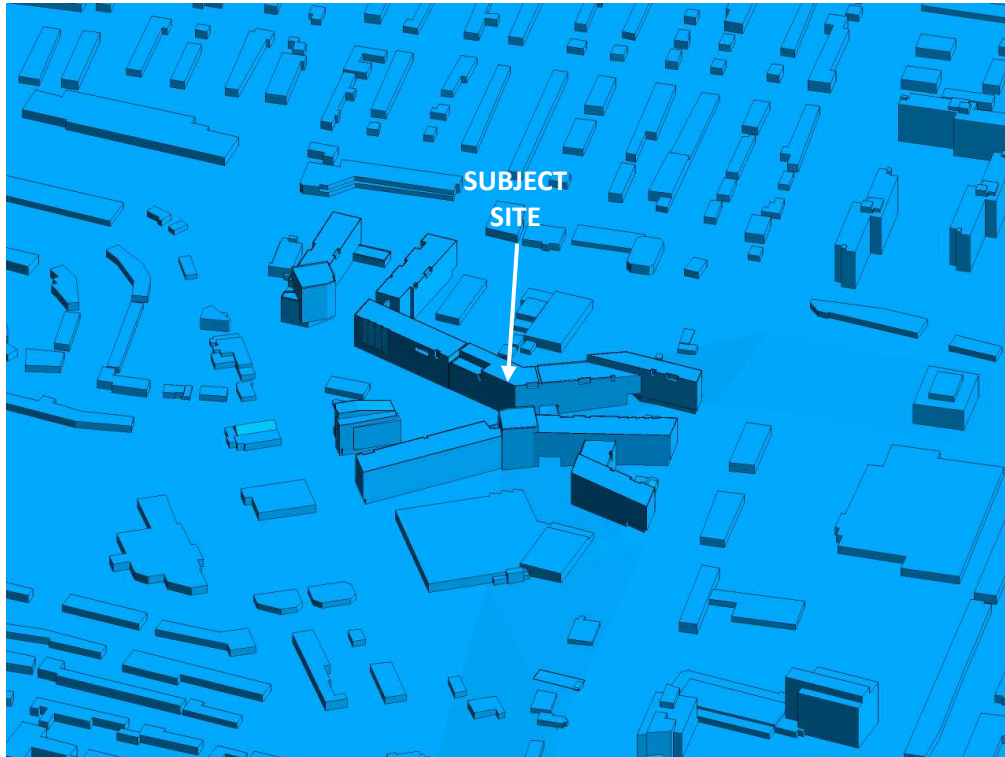


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTHEAST PERSPECTIVE

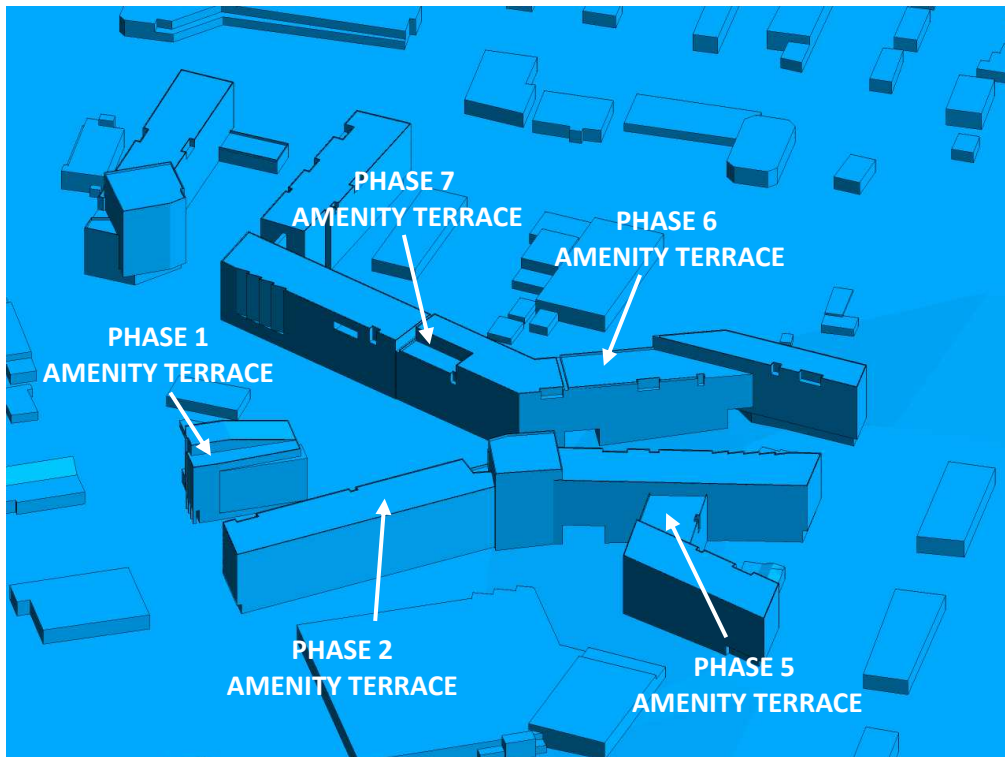


FIGURE 2B: CLOSE UP OF FIGURE 2A

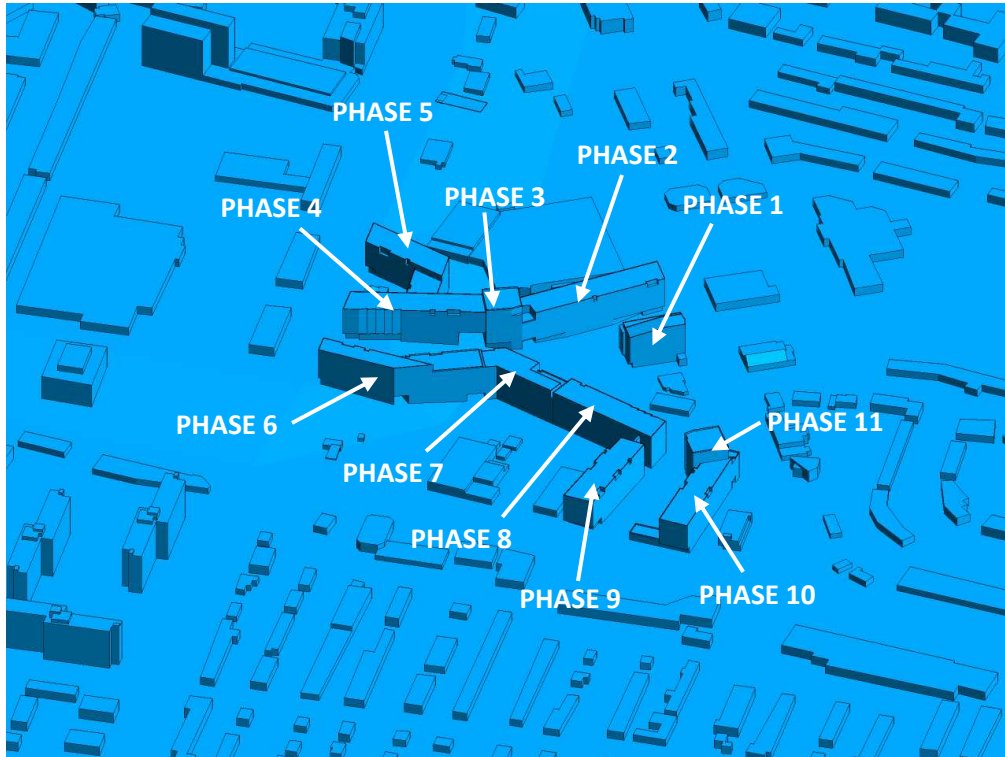


FIGURE 2C: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTHWEST PERSPECTIVE

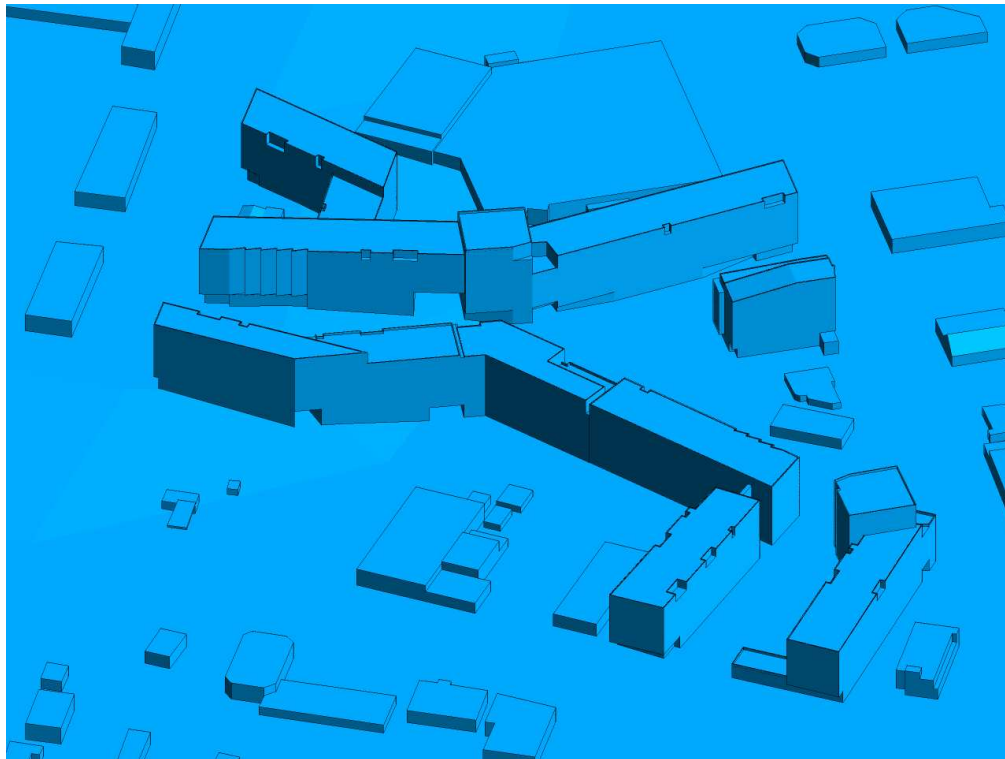


FIGURE 2D: CLOSE UP OF FIGURE 2E



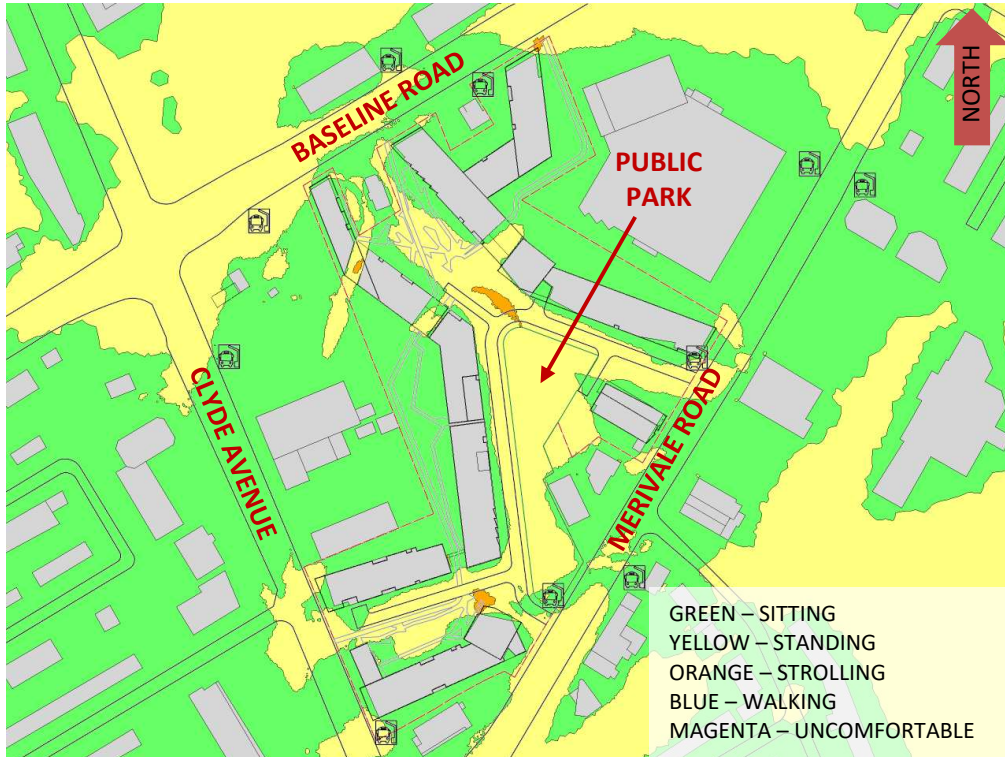


FIGURE 3A: SPRING – PROPOSED MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL

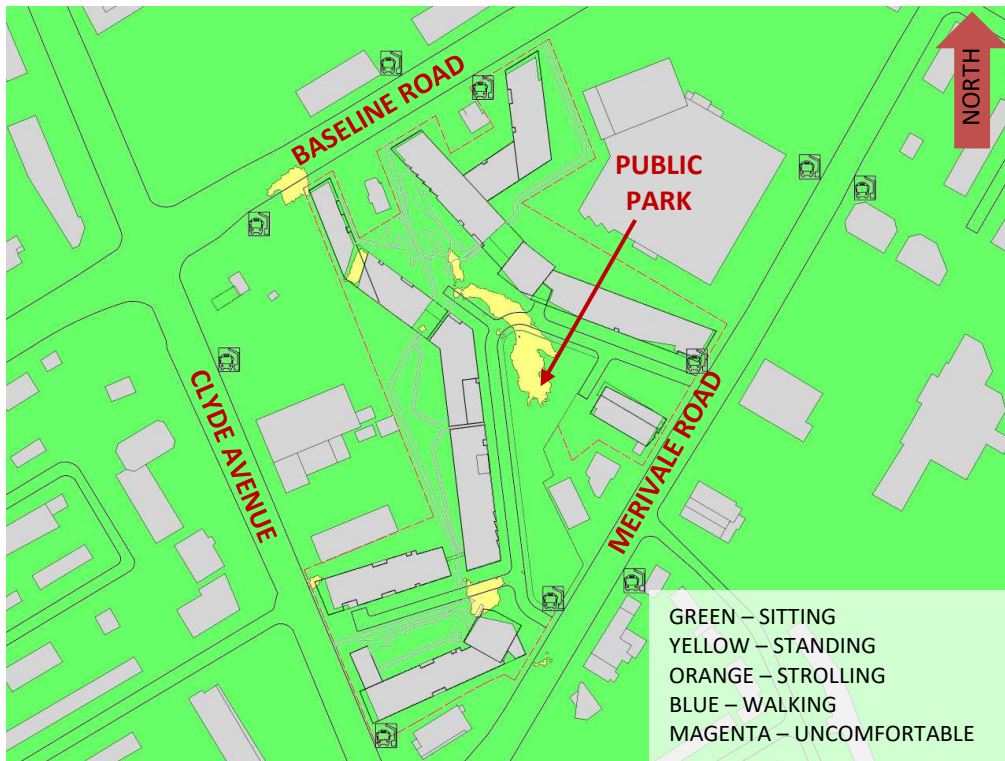


FIGURE 3B: SUMMER – PROPOSED MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL



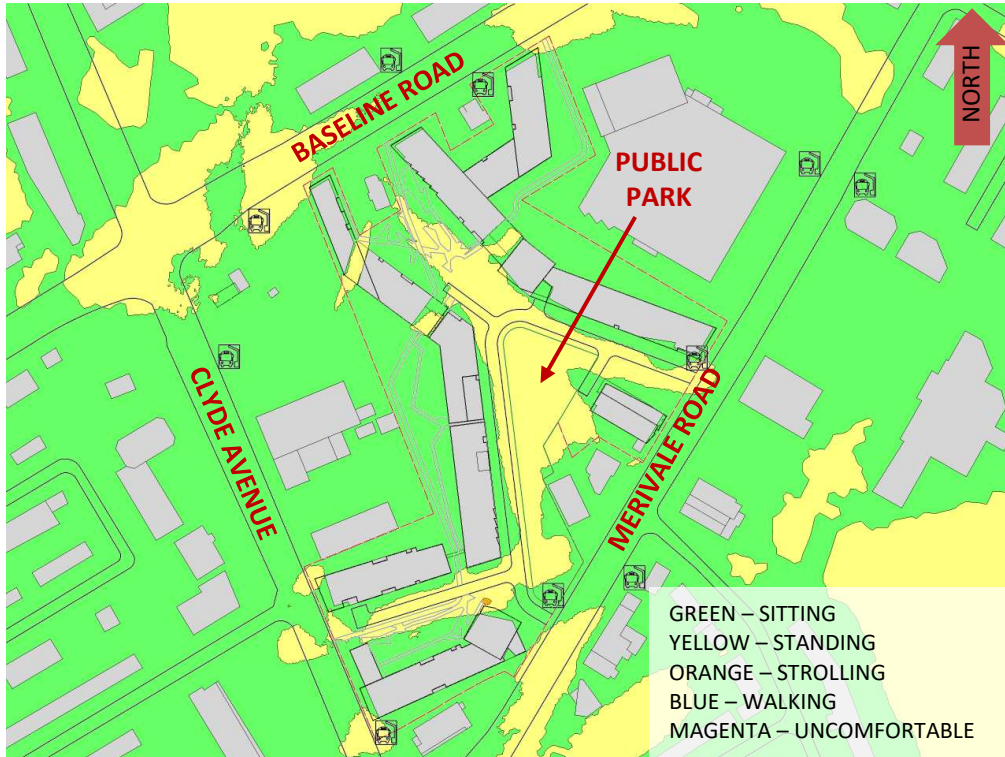


FIGURE 3C: AUTUMN – PROPOSED MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL

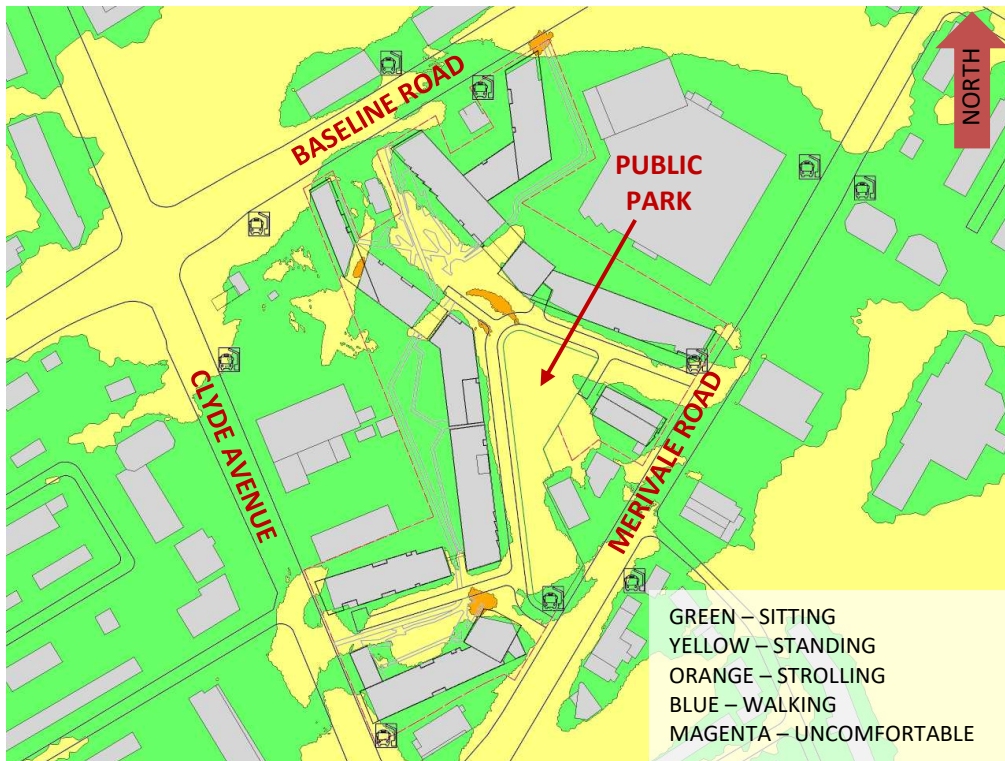


FIGURE 3D: WINTER – PROPOSED MASSING – WIND COMFORT CONDITIONS, GRADE LEVEL



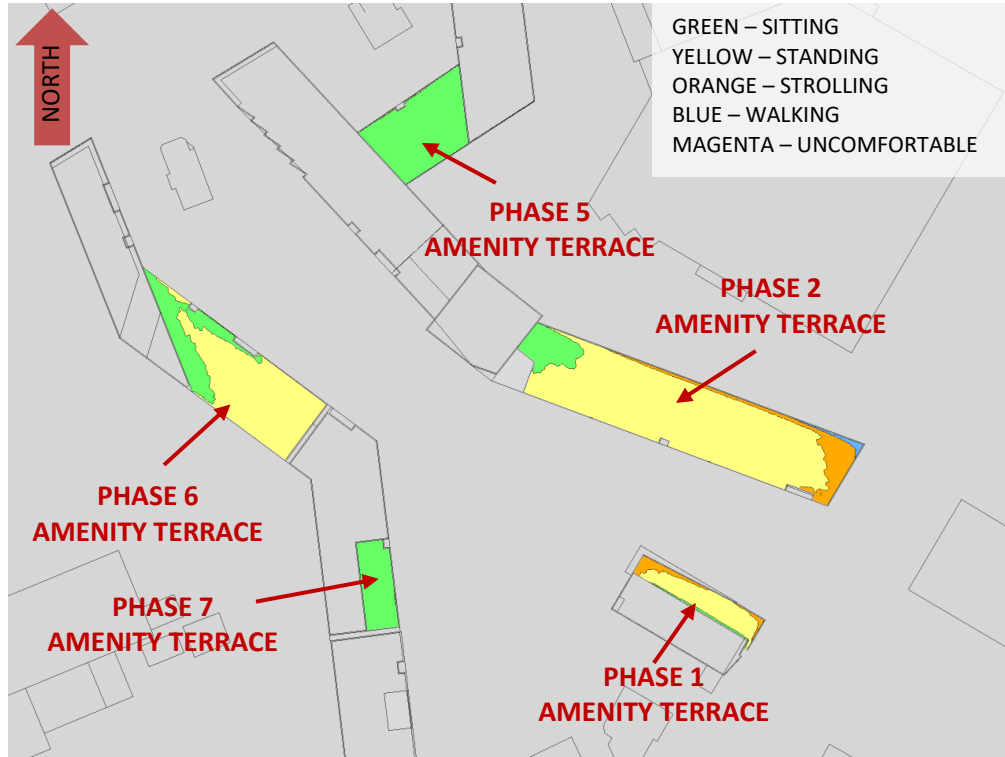


FIGURE 4A: SPRING – WIND COMFORT, ELEVATED AMENITY TERRACES

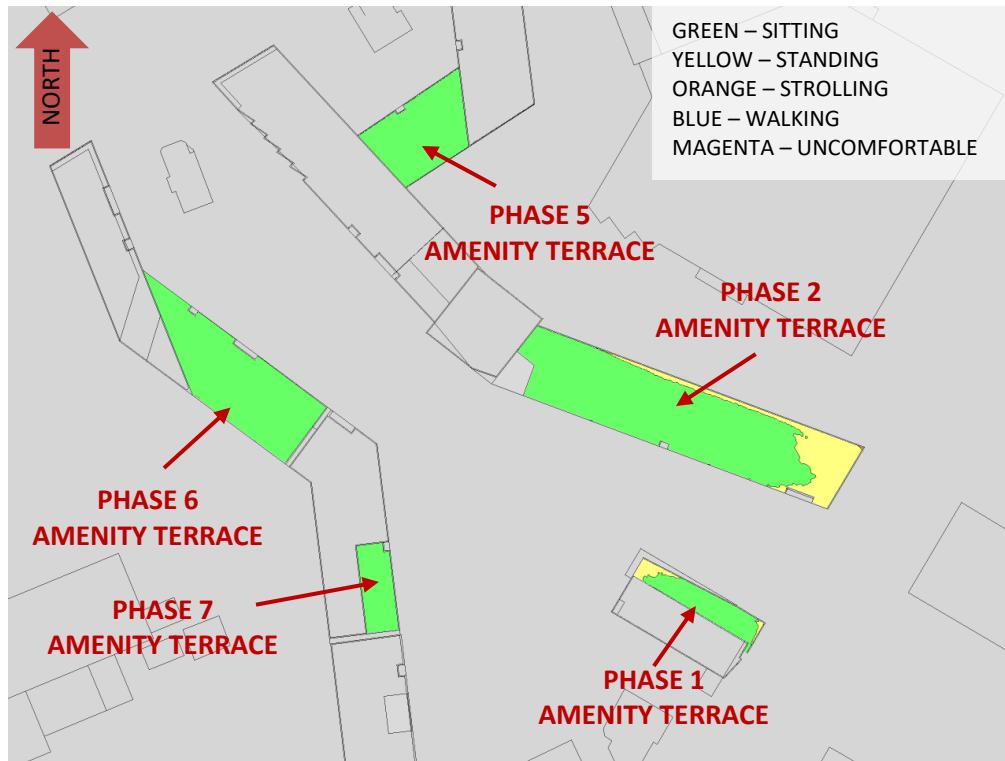


FIGURE 4B: SUMMER – WIND COMFORT, ELEVATED AMENITY TERRACES



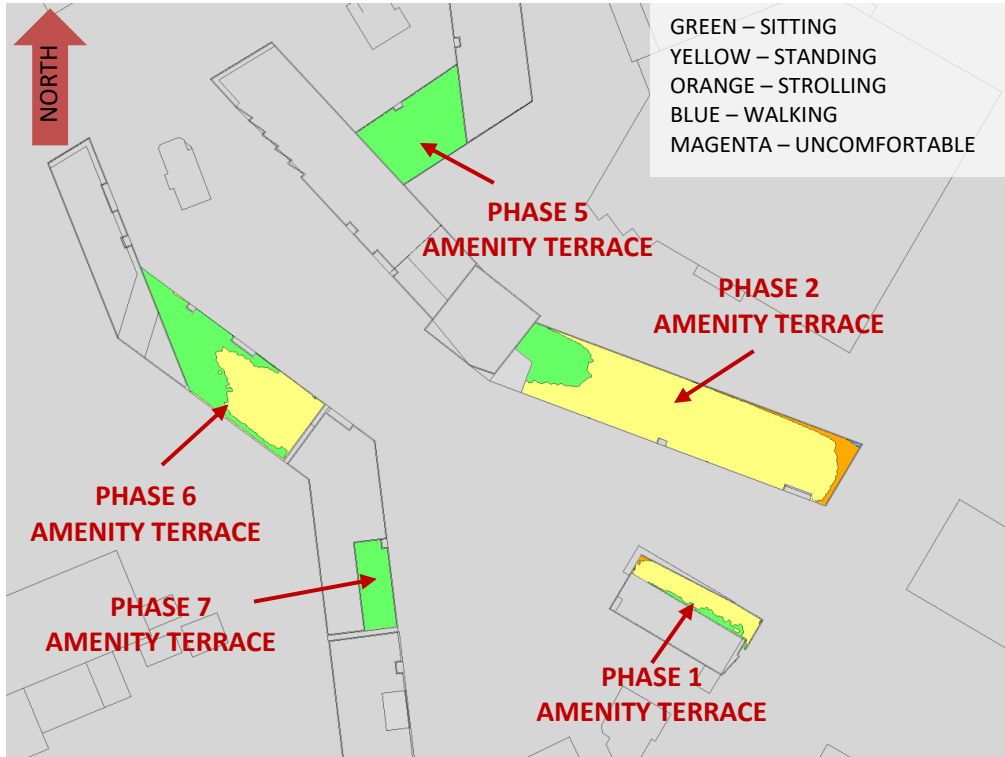


FIGURE 4C: AUTUMN – WIND COMFORT, ELEVATED AMENITY TERRACES

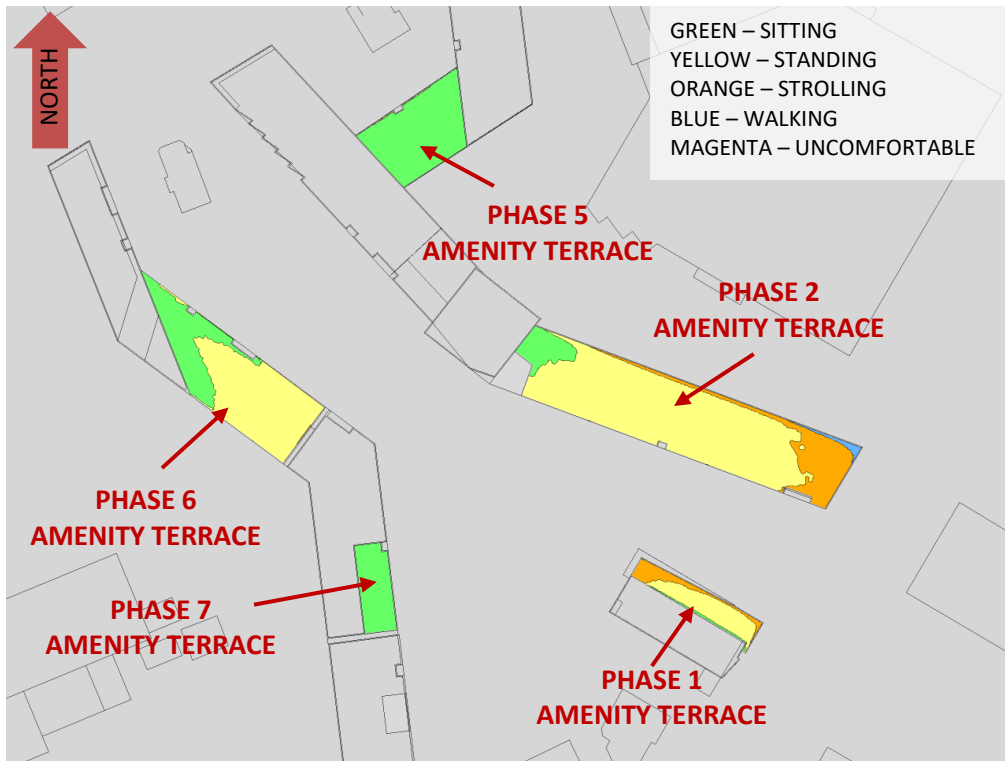


FIGURE 4D: WINTER – WIND COMFORT, ELEVATED AMENITY TERRACES

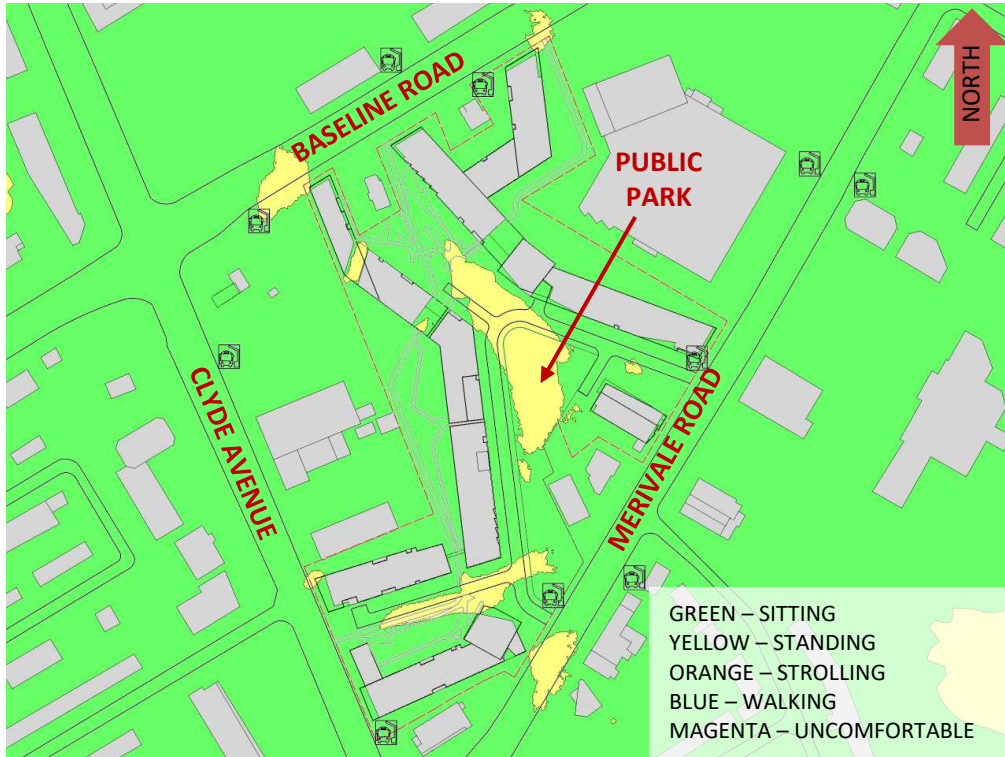


FIGURE 5A: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL



FIGURE 5B: TYPICAL USE PERIOD – % OF TIME SUITABLE FOR SITTING, GRADE LEVEL



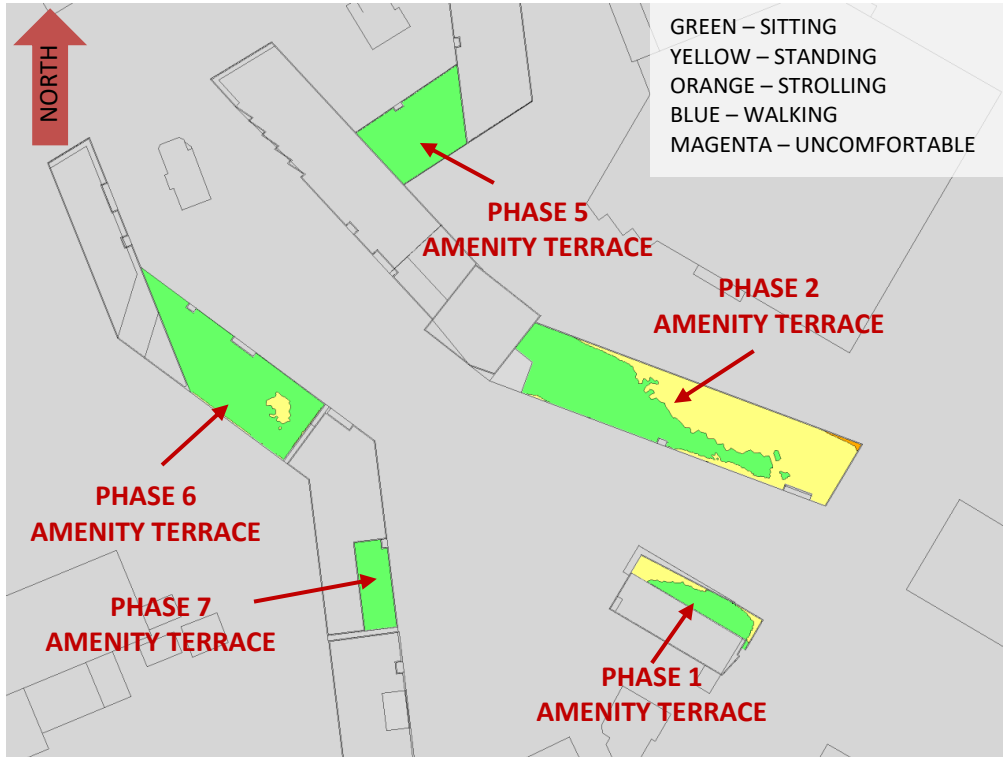


FIGURE 6A: TYPICAL USE PERIOD – WIND COMFORT, ELEVATED AMENITY TERRACES

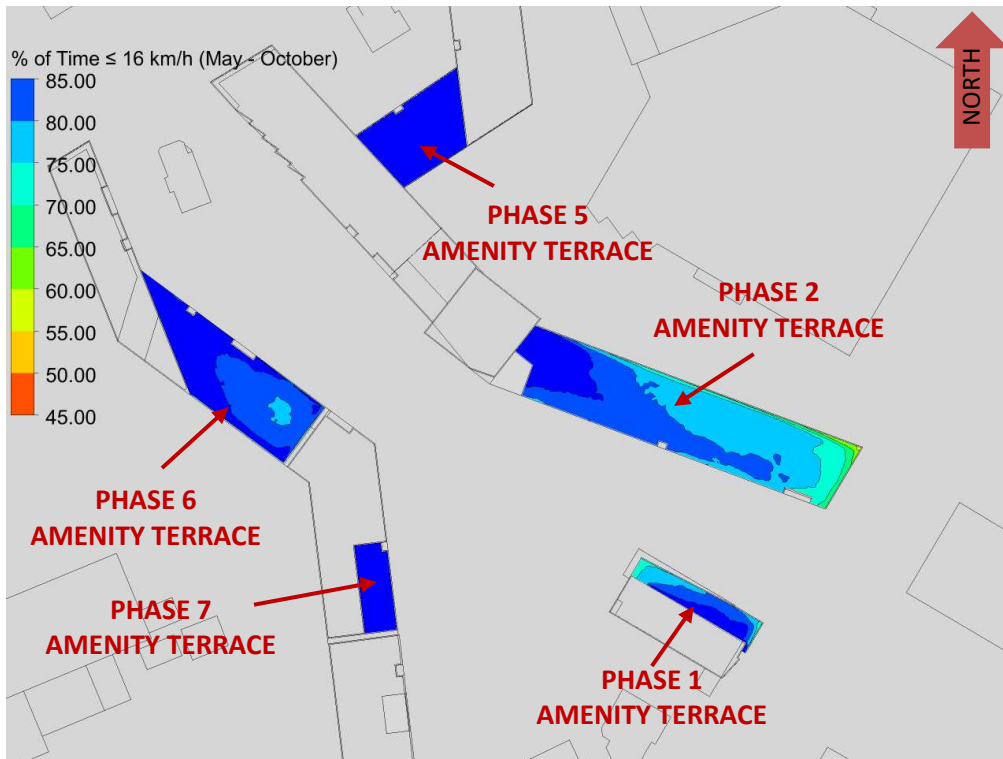


FIGURE 6B: TYPICAL USE PERIOD – % OF TIME SUITABLE FOR SITTING, AMENITY TERRACES



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APPENDIX A

SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER

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].

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

where, U = mean wind speed, U_g = gradient wind speed, Z = height above ground, 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 (i.e., 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
49	0.21
74	0.24
103	0.24
167	0.24
197	0.24
217	0.24
237	0.24
262	0.24
282	0.24
302	0.24
324	0.24

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].

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

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

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.

REFERENCES

- [1] P. Arya, "Chapter 10: Near-neutral Boundary Layers," in *Introduction to Micrometeorology*, San Diego, California, Academic Press, 2001.
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- [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.