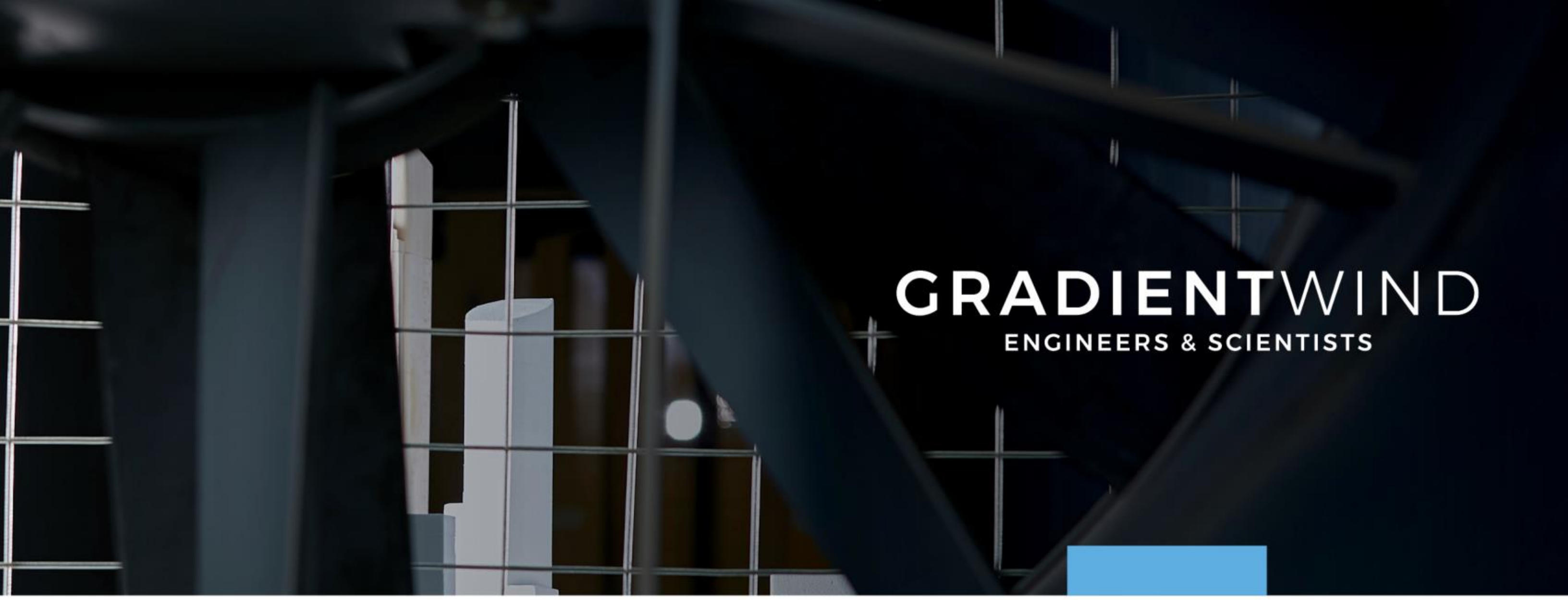
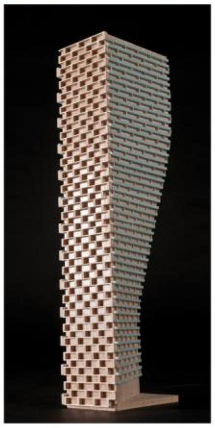


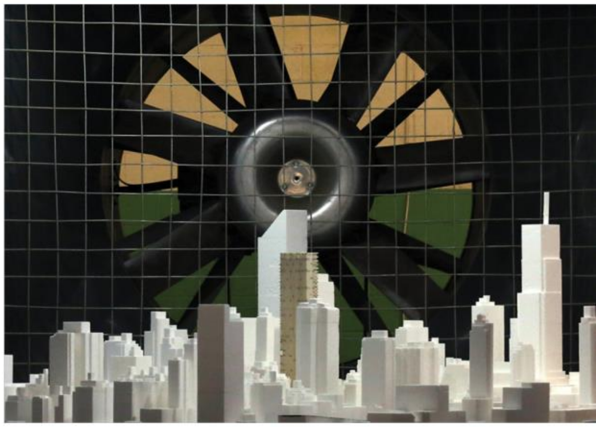
GRADIENTWIND
ENGINEERS & SCIENTISTS

PEDESTRIAN LEVEL WIND STUDY

90 Woodridge Crescent
Ottawa, Ontario

Report: 17-005-PLW





March 7, 2022

PREPARED FOR
Ferguslea Properties Limited
98 Woodridge Crescent
Ottawa, ON K2B 7S9

PREPARED BY
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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy concurrent Official Plan Amendment and Zoning By-law Amendment application requirements for the proposed residential development located at 90 Woodridge Crescent in Ottawa, Ontario (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 areas where wind conditions may interfere with certain pedestrian activities so that mitigation measures may be considered.

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-7B, and summarized as follows:

1) While the introduction of the proposed development is predicted to produce generally windy conditions at grade, most areas within and surrounding the subject site are predicted to receive conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, wind conditions over surrounding sidewalks, transit stops, surface parking, and building access points are considered acceptable for the intended pedestrian uses throughout the year. Exceptions are as follows:

    a. Prominent westerly and northwesterly winds are predicted to downwash over the broad face of the 80 Woodridge building and accelerate around its southwest corner, producing windy conditions along the south elevation. Conditions over the Multi-Use Path along the south elevation are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing, strolling, and walking during the autumn, and suitable for a mix of strolling and walking during the spring and winter. During the winter, there is a region which may occasionally be considered uncomfortable. Importantly, the uncomfortable conditions are mostly to the north of the Multi-Use Path. Specifically, conditions in this region are predicted to be comfortable for walking at least 77% of the winter, where the target is 80%. Because the exceedance is only 3%, conditions are expected to be suitable for walking following the introduction of landscaping features such as tall wind barriers, topographical depressions or berms, or dense arrangements of coniferous plantings.

b. Conditions over the outdoor amenity along the south elevation of 70 Woodridge are predicted to be suitable for a mix of sitting and standing during the typical use period of late spring through early autumn, becoming suitable for a mix of standing, strolling, and walking during the colder months.

c. Prominent northwesterly winds are predicted to accelerate around the northeast corner of 80 Woodridge at grade, creating windy conditions. Overall, conditions over the outdoor amenity space along the east elevation of 80 Woodridge are predicted to be suitable for standing during the typical use period, becoming suitable for walking, or better, during the colder months. Additionally, strong northwesterly winds are predicted to produce a small region where conditions will exceed 90 km/hr for an average of 0.13% of the time on an annual basis (11 hours annually), where the target is less than 0.1% (8 hours). This small exceedance is expected to be improved following the introduction of landscaping features such as tall wind barriers, topographical depressions or berms, or dense arrangements of coniferous plantings. Regarding the overall comfort levels, while conditions will be improved somewhat with the introduction of landscaping features, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

d. Conditions over the splash pad at the northwest corner of the subject site are predicted to be suitable for a mix of strolling and standing during the typical use period, becoming suitable for a mix of strolling and walking during the colder months.

e. While conditions for the aforementioned areas will be improved somewhat with the introduction of landscaping features such as tall wind barriers, topographical depressions or berms, or dense arrangements of coniferous plantings, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels. Mitigation strategies will be developed in collaboration with the design team as the design progresses and confirmed via wind tunnel testing of a scale model in preparation of the future Site Plan Control application submission.

2) 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, as defined in Section 4.4. The sole exception is the area along the east elevation of 80 Woodridge mentioned above. Mitigation strategies will be developed in collaboration with the design team as the design progresses and confirmed via wind tunnel testing of a scale model in preparation of the future Site Plan Control application submission to ensure the safety criterion is satisfied.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Ferguslea Properties Limited to undertake a pedestrian level wind (PLW) study to satisfy concurrent Official Plan Amendment and Zoning By-law Amendment application requirements for the proposed residential development located at 90 Woodridge Crescent in Ottawa, Ontario (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 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 Brisbin Brook Beynon Architects, in January 2022, 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 on the east half of 90 Woodridge Crescent on an irregular parcel of land on the south elevation of Woodridge Crescent, approximately 120 metres (m) to the west of the Bayshore Shopping Centre. The subject site is bounded by Woodridge Crescent to the north, the OC Transpo Transitway to the south, the existing development at 90 Woodridge Crescent to the west, and the proposed development at 100 Bayshore Drive to the east. The proposed development comprises two residential buildings: a 40-storey building at the northeast corner of the subject site (hereinafter referred to as '70 Woodridge') and a 37-storey building at the southwest corner of the subject site (hereinafter referred to as '80 Woodridge'). Throughout this report, the Woodridge Crescent elevation is considered project north.

Above two levels of shared below-grade parking, the two buildings each include a two-storey podium, above which the buildings setback from all elevations. Each building includes a tower which is segmented into two rectangular floorplates rotated at a small angle from each other and connected in the centre. The 70 Woodridge tower rises with a constant planform to Level 38, where the floorplate steps back from the south elevation and the tower rises with a rectangular planform to Level 40. Similarly, the 80 Woodridge tower rises with a constant planform to Level 31 where the floorplate steps back from the west elevation and the tower rises with a rectangular planform to Level 37. At grade, 70 Woodridge is served by an outdoor amenity along its south elevation and 80 Woodridge is served by an outdoor amenity along its east elevation. Additionally, a splash pad is provided to the east of 70 Woodridge and to the north of 80 Woodridge, and a Multi-Use Path is located along the south elevation of the subject site. Access to underground parking is provided by a ramp at the west elevation of the subject site to the north of 80 Woodridge.

The near-field surroundings (defined as an area within 200 m of the subject site) include low-rise buildings from the west-northwest clockwise to the northeast (Accora Village), Bayshore Shopping Centre from the northeast clockwise to the east, and mostly open land and roadways from the east clockwise to the west. Additionally, the existing building at 90 Woodridge Crescent (12 storeys) lies to the immediate west, a future residential development comprising two towers of 27 and 30 storeys is proposed at 100 Bayshore Drive to the immediate east of the subject site, and the Bayshore Transit Station is located to the immediate east-southeast of the subject site with modifications underway for the Stage 2 Ottawa Light Rail Transit West Extension of the Confederation Line. 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 a mix of low-rise buildings and the open exposure of Ottawa River from the west-northwest clockwise to the north-northeast, by a mix of low- and mid-rise buildings from the north-northeast clockwise to the east-northeast, by mostly farmland from the east-southeast clockwise to the west-southwest, and by mostly low-rise suburban massing for the remaining compass directions. Notably, the Ottawa River is located approximately 1 km to the north-northwest.

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 changes which have been approved by the City of Ottawa. Specifically, a ZBLA application for the development at 100 Bayshore Drive has been approved, followed by a Site Plan Control application submission[1].

[1] City of Ottawa Application Number D07-12-21-0057

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level 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 study 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[2]. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

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 study 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.

[2] City of Ottawa Terms of References: Wind Analysis
https://documents.ottawa.ca/sites/default/files/torwindanalysis_en.pdf

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 radius of 540 m.

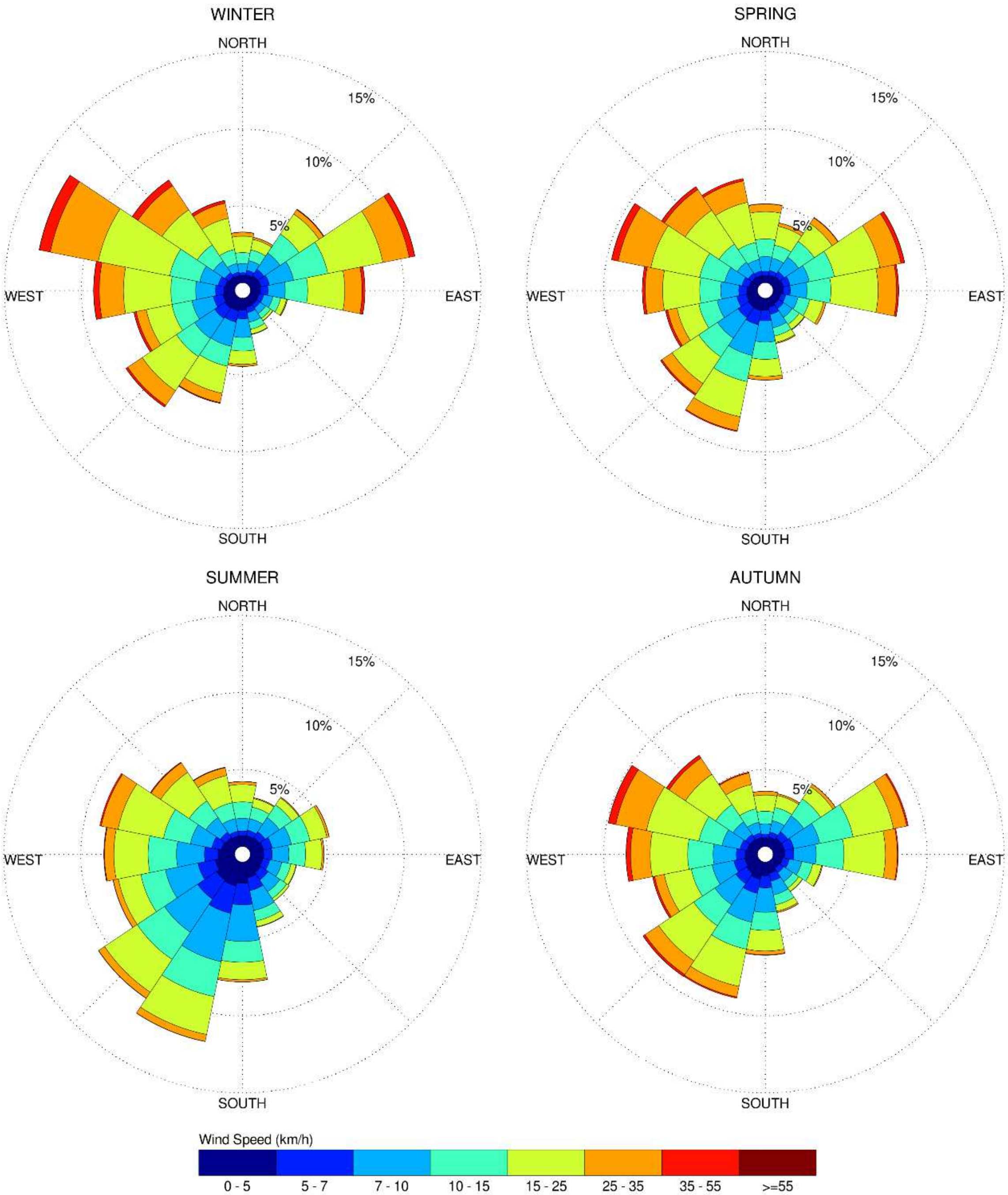
Mean and peak wind speed data obtained over the study site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade were referenced to the wind speed at gradient height to generate 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 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, 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	Gust Wind Speed (km/h)	Description
2	Light Breeze	9-17	Wind felt on faces
3	Gentle Breeze	18-29	Leaves and small twigs in constant motion; wind extends light flags
4	Moderate Breeze	30-42	Wind raises dust and loose paper; small branches are moved
5	Fresh Breeze	43-57	Small trees in leaf begin to sway
6	Strong Breeze	58-74	Large branches in motion; Whistling heard in electrical wires; umbrellas used with difficulty
7	Moderate Gale	75-92	Whole trees in motion; inconvenient walking against wind
8	Gale	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 (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 acceptable 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 typical windiest acceptable comfort classes are summarized on the following page. Depending on the programming of a space, the acceptable comfort class may differ from this table.

ACCEPTABLE PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

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

5. RESULTS AND DISCUSSION

The following discussion of the predicted pedestrian wind conditions for the subject site is accompanied by Figures 3A-6B, illustrating wind conditions at grade level for the proposed and existing massing scenarios. Conditions are presented as continuous contours of wind comfort within and surrounding the subject site and correspond to the various comfort classes noted in Section 4.4. 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.

Wind conditions at grade level are also reported for the typical use period, which is defined as May to October, inclusive. Figures 7A and 7B illustrate wind comfort conditions during this period for the proposed and existing massing scenarios, respectively, consistent with the comfort classes 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

Sidewalks and Bus Stops along Woodridge Crescent: Following the introduction of the proposed development, the nearby public sidewalk areas along Woodridge Crescent are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for a mix of sitting, standing, and strolling during the remaining seasons. Conditions in the vicinity of the nearby bus stops along Woodridge Crescent are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year. The noted conditions are considered acceptable according to the comfort guidelines in Section 4.4.

Conditions over the sidewalks along Woodridge Crescent with the existing massing are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, during the remaining three seasons. In the vicinity of the nearby bus stops on Woodridge Crescent, conditions are predicted to be suitable for standing, or better, during the summer and suitable for strolling, or better, throughout the remaining seasons. Notably, the introduction of the proposed development is predicted to improve comfort levels at the northeast corner of the subject site, in comparison to existing conditions.

Sidewalk along West Elevation: Following the introduction of the proposed development, conditions over the sidewalk along the west elevation of the subject site are predicted to be suitable for a mix of sitting, standing, and strolling during the summer, becoming suitable for walking, or better, throughout the remainder of the year. The noted conditions are considered acceptable according to the comfort guidelines in Section 4.4.

Conditions over the sidewalk prior to the introduction of the proposed development are predicted to be suitable for a mix of sitting and standing during the summer and autumn, becoming suitable for a mix of standing and strolling during the spring and winter. While the introduction of the proposed development results in windier conditions, in comparison to existing conditions, wind conditions with the proposed development are considered acceptable.

Multi-Use Path along South Elevation: Prominent westerly and northwesterly winds are predicted to downwash over the broad face of the 80 Woodridge Tower and accelerate around the southwest corner, producing windy conditions along the south elevation. Conditions over the Multi-Use Path along the south elevation are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing, strolling, and walking during the autumn, and suitable for a mix of strolling and walking during the spring and winter. During the winter, there is a region which may occasionally be considered uncomfortable. Importantly, the uncomfortable conditions are mostly to the north of the Multi-Use Path. Specifically, conditions in this region are predicted to be comfortable for walking at least 77% of the winter, where the target is 80%. Because the exceedance is only 3%, conditions are expected to be suitable for walking following the introduction of landscaping features such as tall wind barriers, topographical depressions or berms, or dense arrangements of coniferous plantings. Mitigation strategies will be developed in collaboration with the design team as the design progresses and confirmed via wind tunnel testing of a scale model in preparation of the future Site Plan Control application submission.

Walkway along East Elevation: Following the introduction of the proposed development, conditions over the walkway between 70 Woodridge and the development at 100 Bayshore Drive are predicted to be suitable for a mix of standing and strolling during the summer and autumn, becoming suitable for a mix of standing, strolling, and walking during the spring and winter. The noted conditions are considered acceptable according to the comfort guidelines in Section 4.4.

Conditions over the walkway prior to the introduction of the proposed development are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing and strolling during the autumn, and suitable for a mix of standing, strolling, and walking during the spring and winter, with the walking conditions during the spring and winter located near the northwest corner of 100 Bayshore Drive. While the introduction of the proposed development results in windier conditions, in comparison to existing conditions, wind conditions with the proposed development are considered acceptable.

Walkways within Subject Site: Conditions over the walkways within the subject site, are predicted to be mostly suitable for standing during the summer, becoming suitable for a mix of standing and strolling during the autumn, and suitable for a mix of standing, strolling, and walking during the spring and winter. The noted conditions are considered acceptable according to the comfort guidelines in Section 4.4.

Building Access Points Serving 70 Woodridge: Conditions in the vicinity of building entrances serving the north and south elevations of 70 Woodridge are predicted to be suitable for sitting throughout the year. In the vicinity of building entrances serving the west elevation, conditions are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year. In the vicinity of building entrances serving the east elevation, conditions are predicted to be suitable for standing, or better, during the summer and autumn, becoming suitable for strolling, or better, during the spring and winter. Since primary entrances are not planned for the east elevation, the noted conditions are considered acceptable according to the comfort guidelines in Section 4.4.

Building Access Points Serving 80 Woodridge: Conditions in the vicinity of building entrances serving the north, east, and west elevations of 80 Woodridge are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year. In the vicinity of building entrances serving the south elevation, conditions are predicted to be suitable for standing, or better, during the summer, becoming suitable for strolling, or better, throughout the remainder of the year. Since primary entrances are not planned for the south elevation, the noted conditions are considered acceptable according to the comfort guidelines in Section 4.4.

Surface Parking and Drop-off Area at Northwest Corner: Conditions over the surface parking lot and drop-off area at the northwest corner of the subject site are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing and strolling in the autumn, and suitable for strolling during the spring and winter. The noted conditions are considered acceptable according to the comfort guidelines in Section 4.4.

Outdoor Amenity along South Elevation of 70 Woodridge: While the proposed 70 Woodridge will provide protection from direct northerly winds over the outdoor amenity along the south elevation of 70 Woodridge, westerly winds are predicted to accelerate around the southwest corner, occasionally producing windy conditions. Overall, conditions over the outdoor amenity along the south elevation are predicted to be suitable for a mix of sitting and standing during the typical use period of late spring through early autumn, becoming suitable for a mix of standing, strolling, and walking during the colder months. While conditions will be improved somewhat with the introduction of landscaping features such as tall wind barriers, topographical depressions or berms, or dense arrangements of coniferous plantings, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels. Mitigation strategies will be developed in collaboration with the design team as the design progresses and confirmed via wind tunnel testing of a scale model in preparation of the future Site Plan Control application submission.

Outdoor Amenity along East Elevation of 80 Woodridge: Prominent northwesterly winds are predicted to accelerate around the northeast corner of 80 Woodridge at grade, creating windy conditions. Overall, conditions over the outdoor amenity space along the east elevation of 80 Woodridge are predicted to be suitable for standing during the typical use period, becoming suitable for walking, or better, during the colder months. Additionally, strong northwesterly winds are predicted to produce a small region where conditions will exceed 90 km/hr for an average of 0.13% of the time on an annual basis (11 hours annually), where the target is less than 0.1% (8 hours). While conditions in this region may occasionally be considered dangerous according to the criteria in Section 4.4, the small exceedance is expected to be improved following the introduction of landscaping features such as tall wind barriers, topographical depressions or berms, or dense arrangements of coniferous plantings. Regarding the overall comfort levels, while conditions will be improved somewhat with the introduction of landscaping features, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels. Mitigation strategies will be developed in collaboration with the design team as the design progresses and confirmed via wind tunnel testing of a scale model in preparation of the future Site Plan Control application submission.

Splash Pad: Prominent northwesterly winds are predicted to accelerate around the surrounding massing over the splash pad at the northwest corner of the subject site. Specifically, conditions over the splash pad are predicted to be suitable for a mix of strolling and standing during the typical use period, becoming suitable for a mix of strolling and walking during the colder months. While conditions will be improved somewhat with the introduction of landscaping features such as tall wind barriers, topographical depressions or berms, or dense arrangements of coniferous plantings, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels. Mitigation strategies will be developed in collaboration with the design team as the design progresses and confirmed via wind tunnel testing of a scale model in preparation of the future Site Plan Control application submission.

5.2 Wind Safety

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, as defined in Section 4.4. The sole exception is the area along the east elevation of 80 Woodridge described in Section 5.1. While wind speeds greater than 90 km/h are predicted to occur in this area for up to 0.13% of the time annually (11 hours), where the threshold is 0.1% (8 hours), the small exceedance is expected to be improved following the introduction of landscaping features. Mitigation strategies will be developed in collaboration with the design team as the design progresses and confirmed via wind tunnel testing of a scale model in preparation of the future Site Plan Control application to ensure the safety criterion is satisfied.

5.3 Applicability of Results

Wind conditions over surrounding sidewalks beyond the subject site, as well as at nearby primary building entrances, will be acceptable for their intended pedestrian uses during each seasonal period upon the introduction of the subject site. Pedestrian wind comfort and safety have been quantified for the specific configuration of existing and foreseeable construction around the study 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.

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-7B. 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 windy conditions at grade, most areas within and surrounding the subject site are predicted to receive conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, wind conditions over surrounding sidewalks, transit stops, surface parking, and building access points are considered acceptable for the intended pedestrian uses throughout the year. Exceptions are as follows:

    a. Prominent westerly and northwesterly winds are predicted to downwash over the broad face of the 80 Woodridge building and accelerate around its southwest corner, producing windy conditions along the south elevation. Conditions over the Multi-Use Path along the south elevation are predicted to be suitable for standing during the summer, becoming suitable for a mix of standing, strolling, and walking during the autumn, and suitable for a mix of strolling and walking during the spring and winter. During the winter, there is a region which may occasionally be considered uncomfortable. Importantly, the uncomfortable conditions are mostly to the north of the Multi-Use Path. Specifically, conditions in this region are predicted to be comfortable for walking at least 77% of the winter, where the target is 80%. Because the exceedance is only 3%, conditions are expected to be suitable for walking following the introduction of landscaping features such as tall wind barriers, topographical depressions or berms, or dense arrangements of coniferous plantings.

    b. Conditions over the outdoor amenity along the south elevation of 70 Woodridge are predicted to be suitable for a mix of sitting and standing during the typical use period of late spring through early autumn, becoming suitable for a mix of standing, strolling, and walking during the colder months.

c. Prominent northwesterly winds are predicted to accelerate around the northeast corner of 80 Woodridge at grade, creating windy conditions. Overall, conditions over the outdoor amenity space along the east elevation of 80 Woodridge are predicted to be suitable for standing during the typical use period, becoming suitable for walking, or better, during the colder months. Additionally, strong northwesterly winds are predicted to produce a small region where conditions will exceed 90 km/hr for an average of 0.13% of the time on an annual basis (11 hours annually), where the target is less than 0.1% (8 hours). This small exceedance is expected to be improved following the introduction of landscaping features such as tall wind barriers, topographical depressions or berms, or dense arrangements of coniferous plantings. Regarding the overall comfort levels, while conditions will be improved somewhat with the introduction of landscaping features, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels.

d. Conditions over the splash pad at the northwest corner of the subject site are predicted to be suitable for a mix of strolling and standing during the typical use period, becoming suitable for a mix of strolling and walking during the colder months.

e. While conditions for the above areas will be improved somewhat with the introduction of landscaping features such as tall wind barriers, topographical depressions or berms, or dense arrangements of coniferous plantings, further investigation is required to determine an appropriate strategy to improve wind conditions to comfortable levels. Mitigation strategies will be developed in collaboration with the design team as the design progresses and confirmed via wind tunnel testing of a scale model in preparation of the future Site Plan Control application submission.

2) 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, as defined in Section 4.4. The sole exception is the area along the east elevation of 80 Woodridge described in Section 5.1. While wind speeds greater than 90 km/h are predicted to occur in this area for up to 0.13% of the time annually (11 hours), where the threshold is 0.1% (8 hours), the small exceedance is expected to be improved following the introduction of landscaping features. Mitigation strategies will be developed in collaboration with the design team as the design progresses and confirmed via wind tunnel testing of a scale model in preparation of the future Site Plan Control application submission to ensure the safety criterion is satisfied.

Sincerely,

Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
S. R. HALL
100197168
Mar. 7, 2022
PROVINCE OF ONTARIO

David Huitema, M.Eng.
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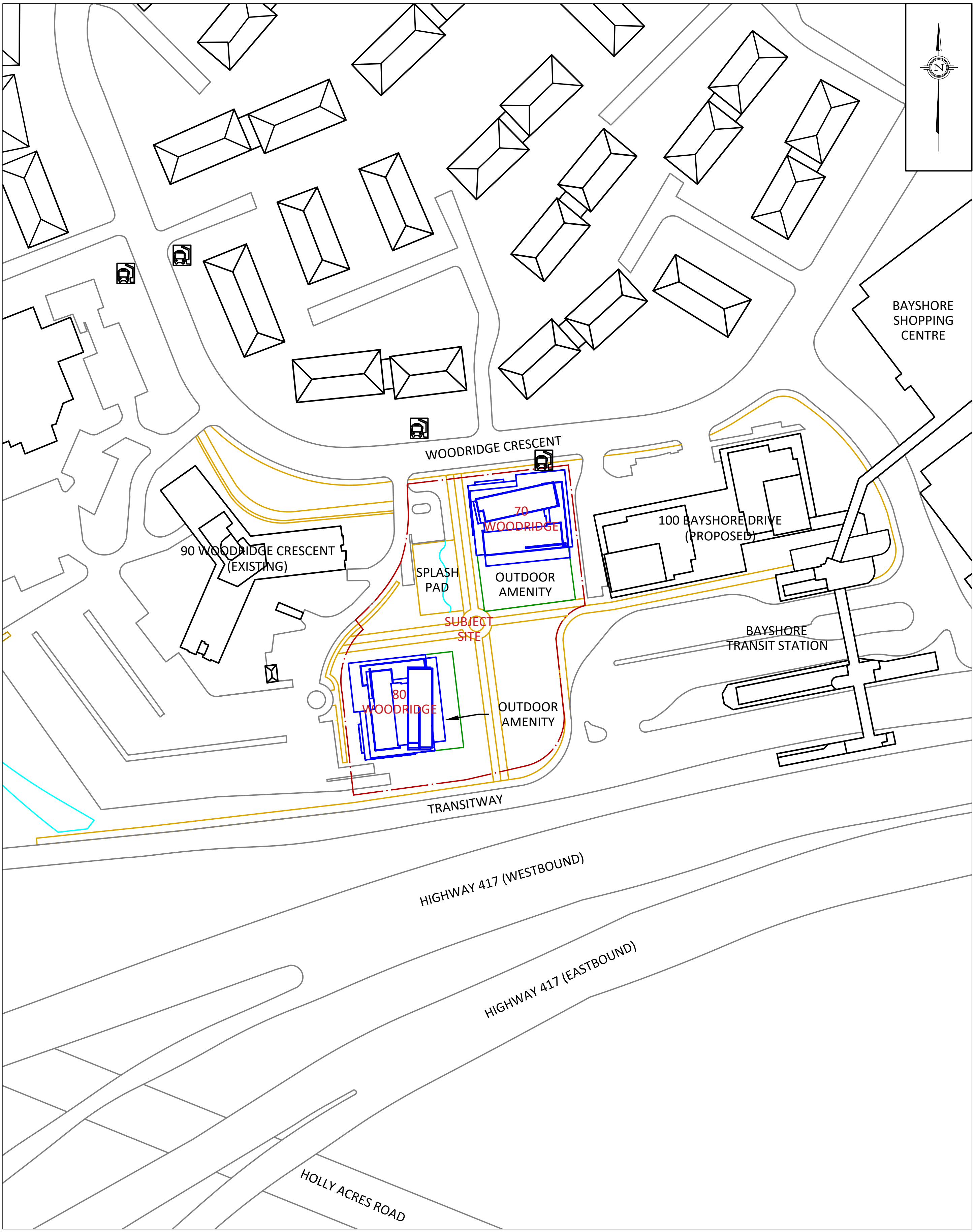

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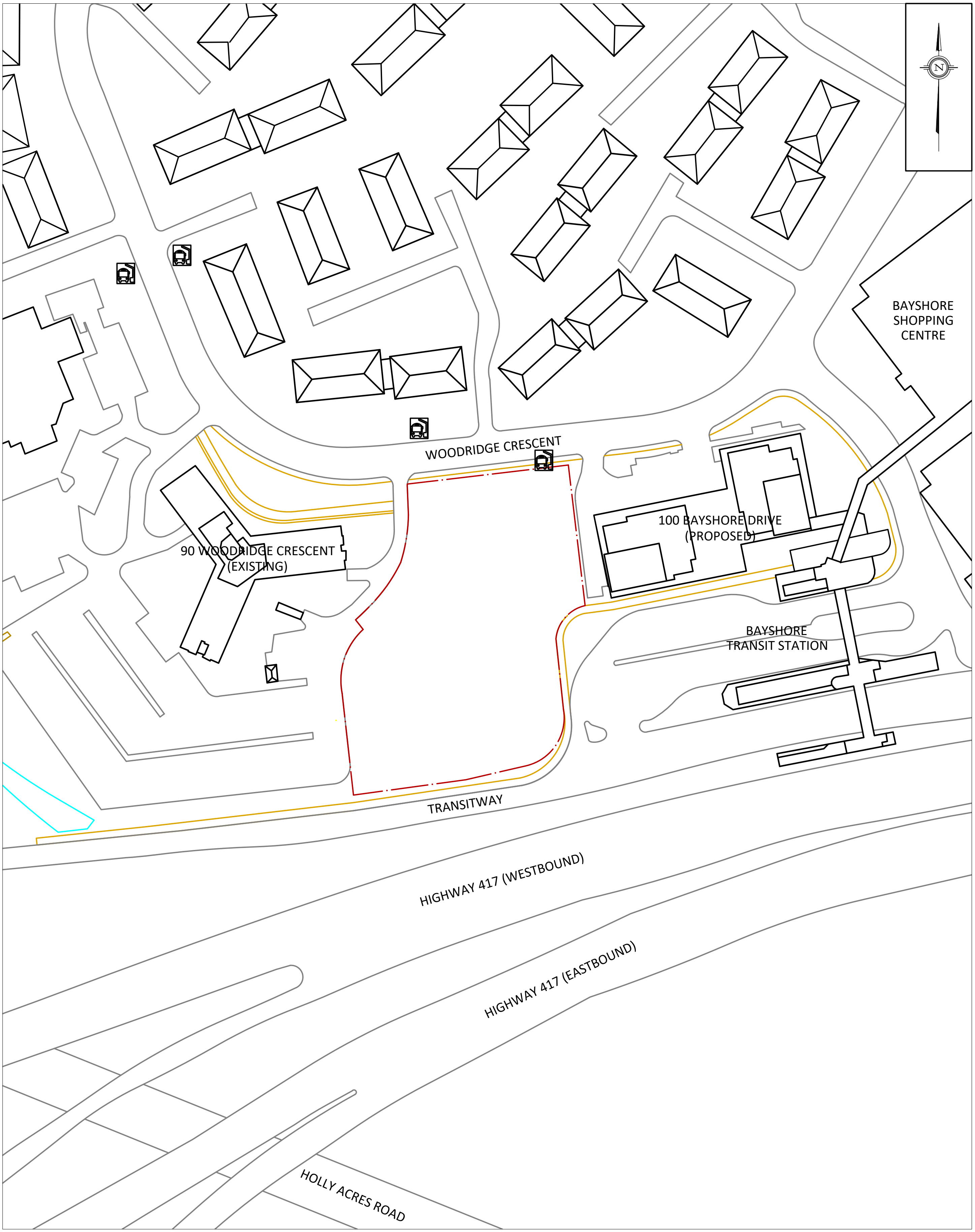
PROJECT	90 WOODRIDGE CRESCENT, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:1500	DRAWING NO.	17-005-PLW-1A
DATE	FEBRUARY 15, 2022	DRAWN BY	S.K.

DESCRIPTION

FIGURE 1A:
PROPOSED SITE PLAN AND SURROUNDING CONTEXT



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PROJECT	90 WOODRIDGE CRESCENT, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION
SCALE	1:1500	DRAWING NO. 17-005-PLW-1B	FIGURE 1B: EXISTING SITE PLAN AND SURROUNDING CONTEXT
DATE	FEBRUARY 15, 2022	DRAWN BY S.K.	

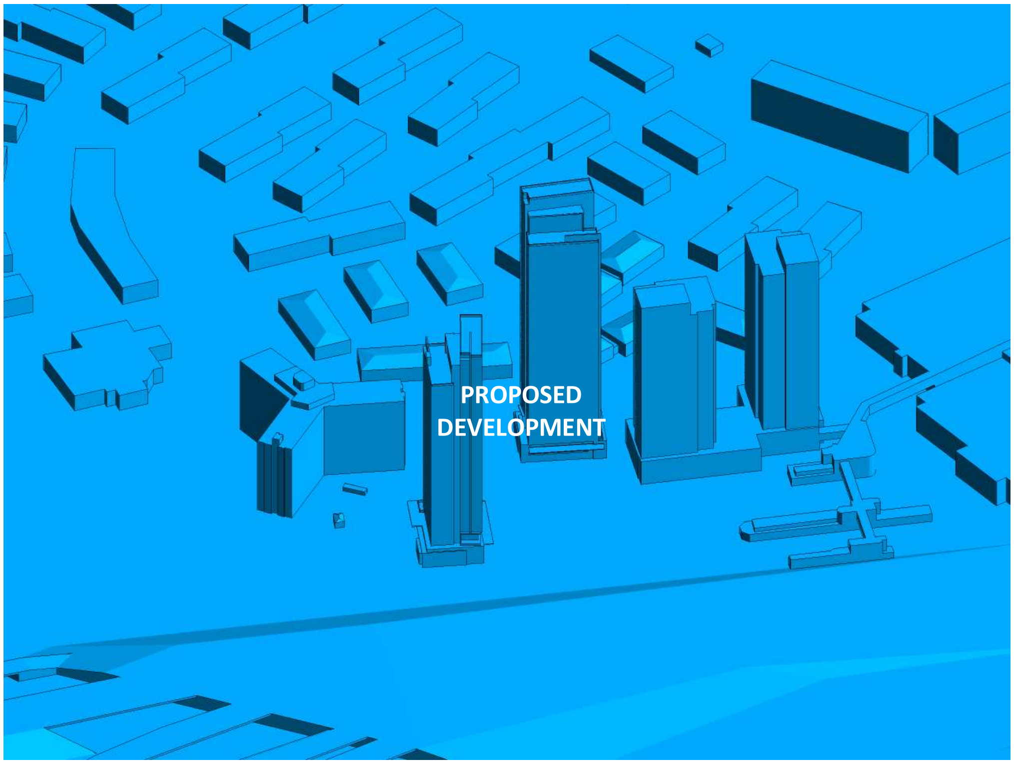


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, SOUTH PERSPECTIVE

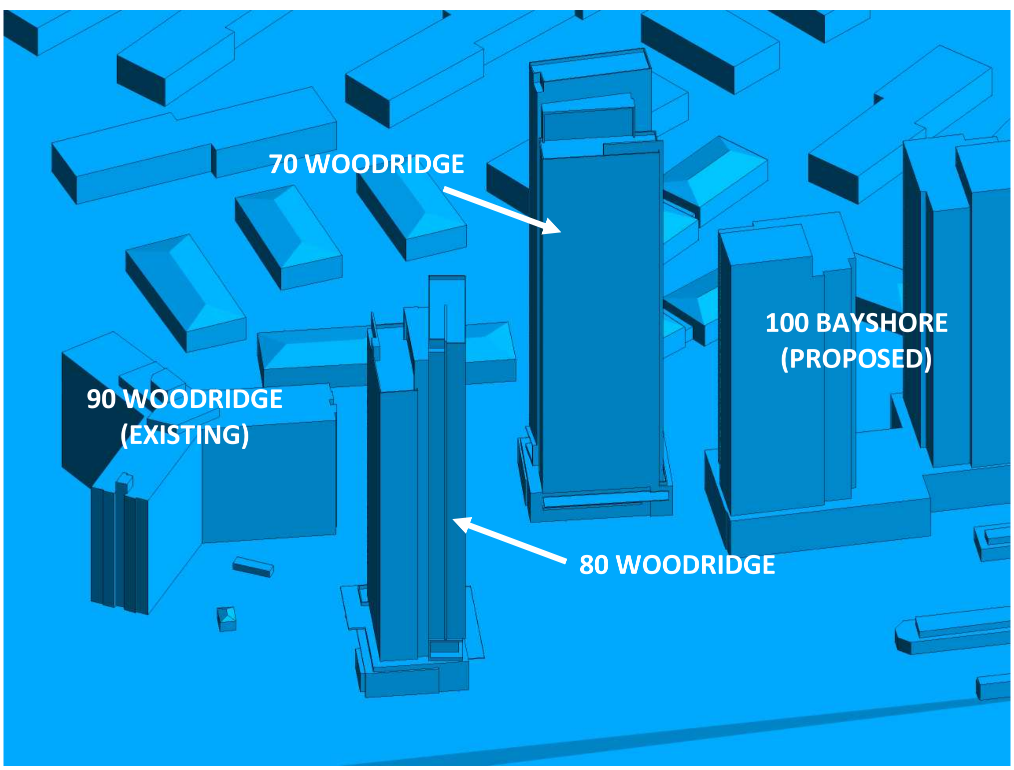


FIGURE 2B: CLOSE UP OF FIGURE 2A

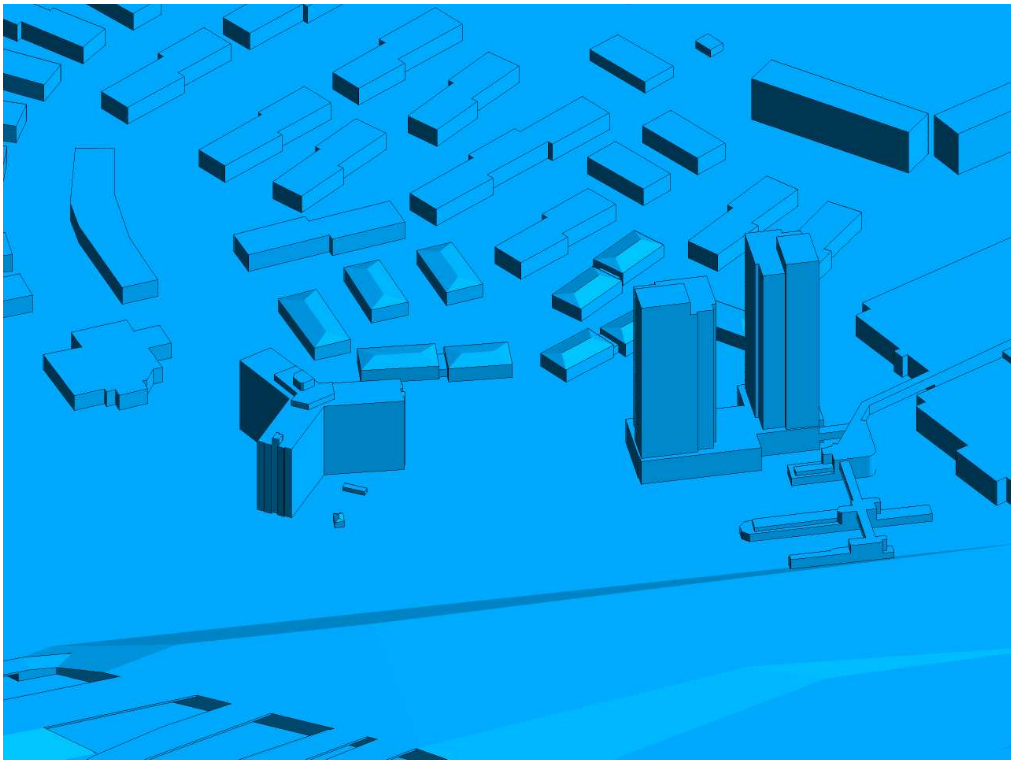


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, SOUTH PERSPECTIVE

FIGURE 2D: CLOSE UP OF FIGURE 2C

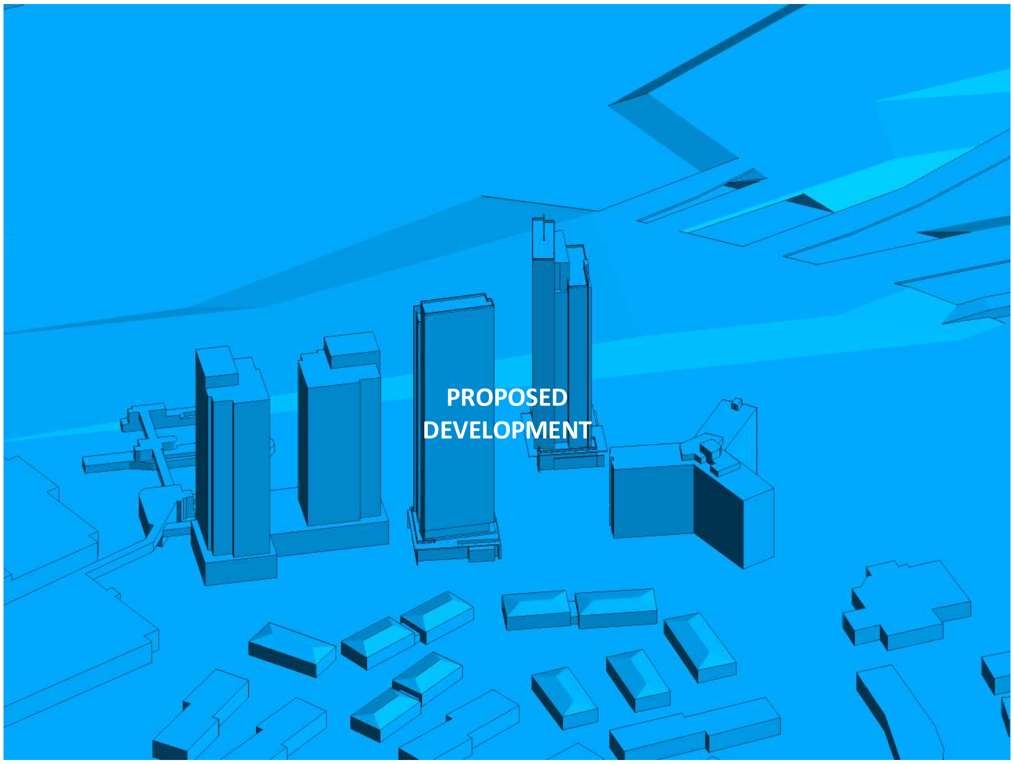


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, NORTH PERSPECTIVE

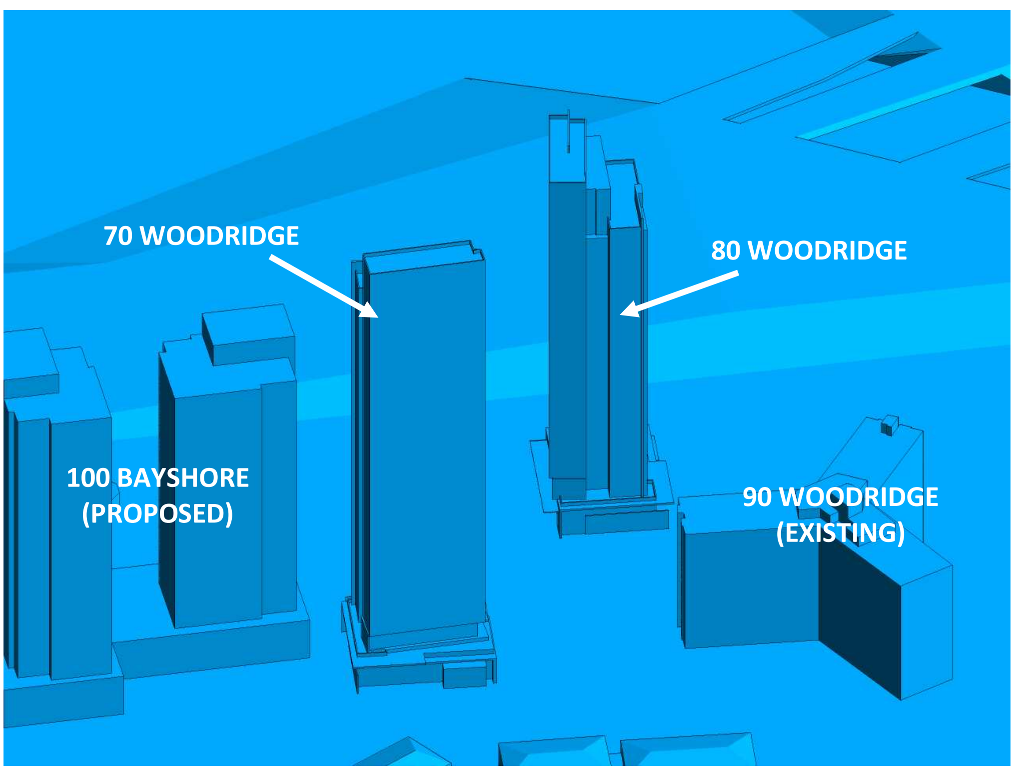


FIGURE 2F: CLOSE UP OF FIGURE 2E

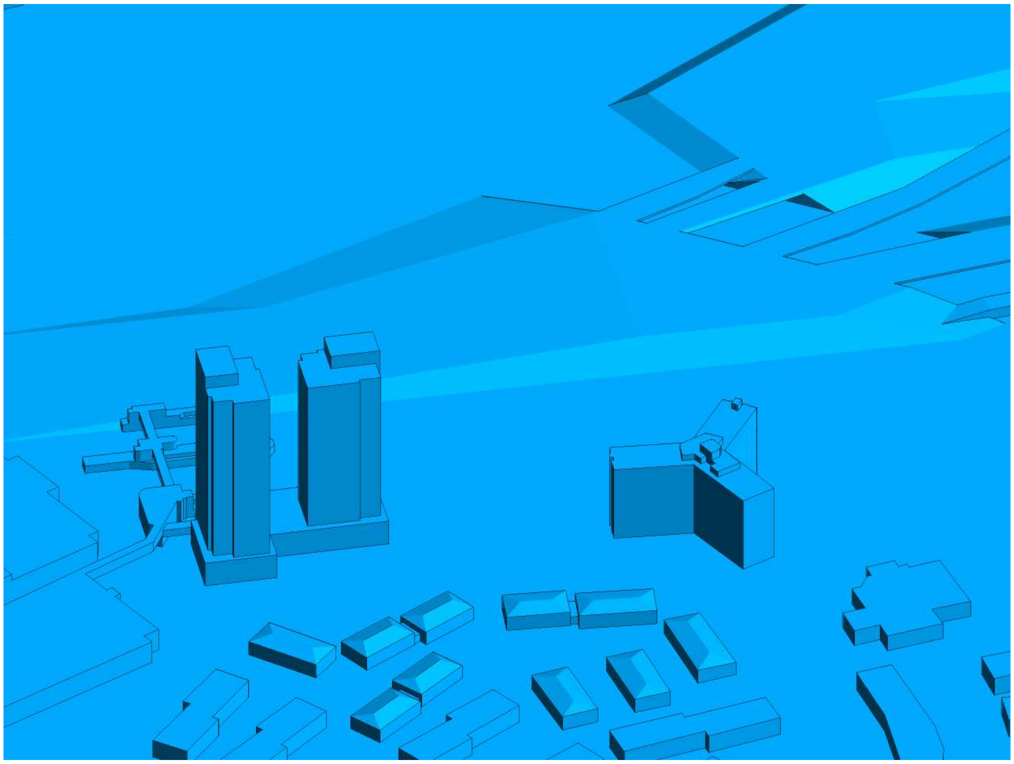


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, NORTH PERSPECTIVE

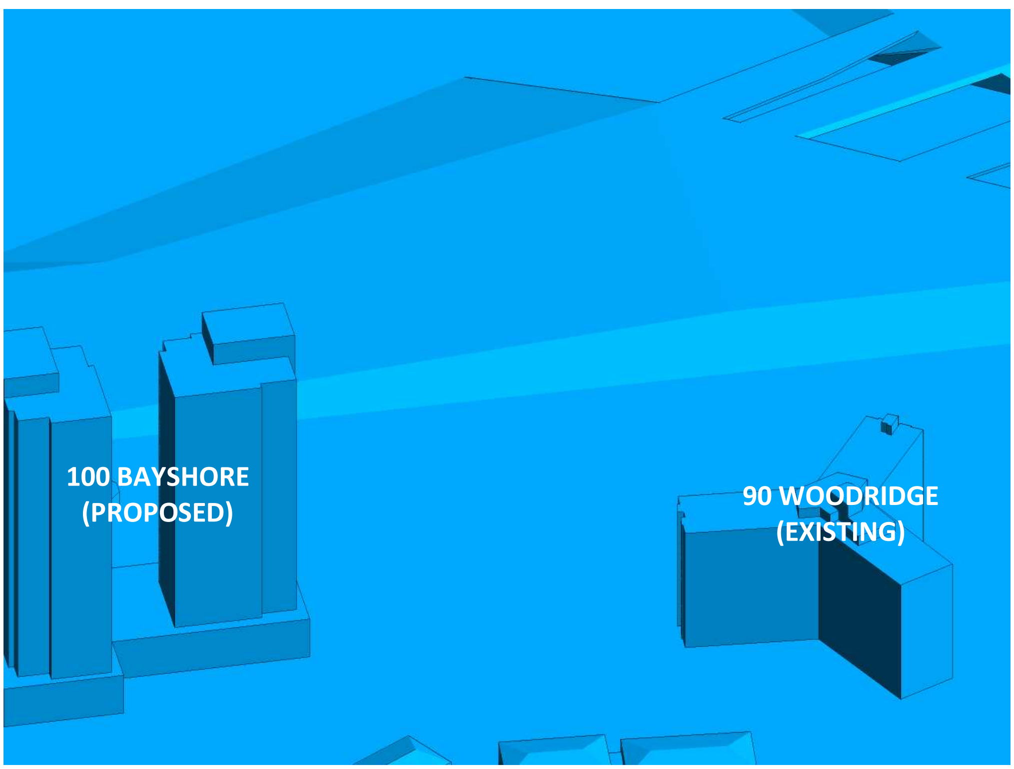


FIGURE 2H: CLOSE UP OF FIGURE 2G

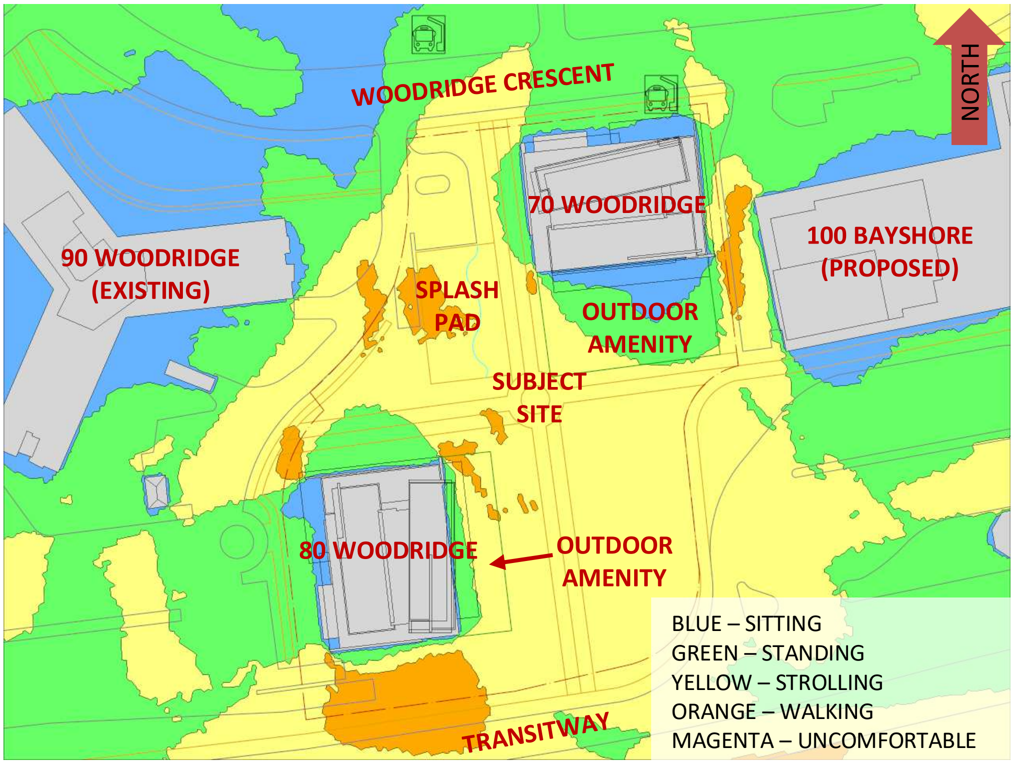


FIGURE 3A: SPRING – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

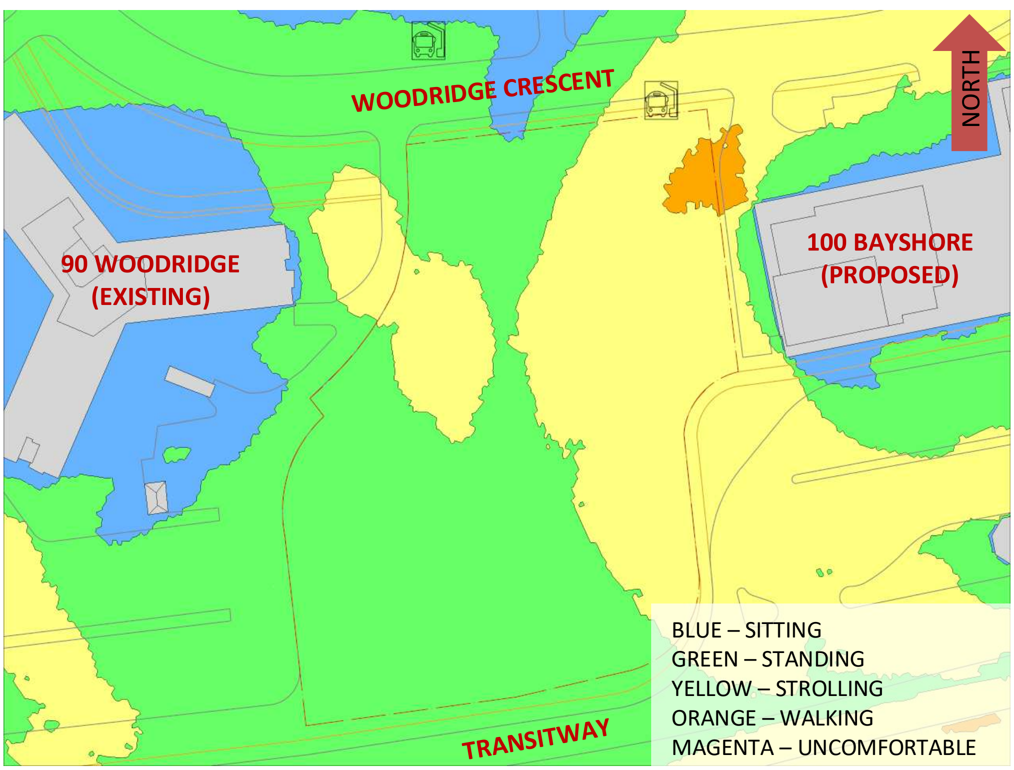


FIGURE 3B: SPRING – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

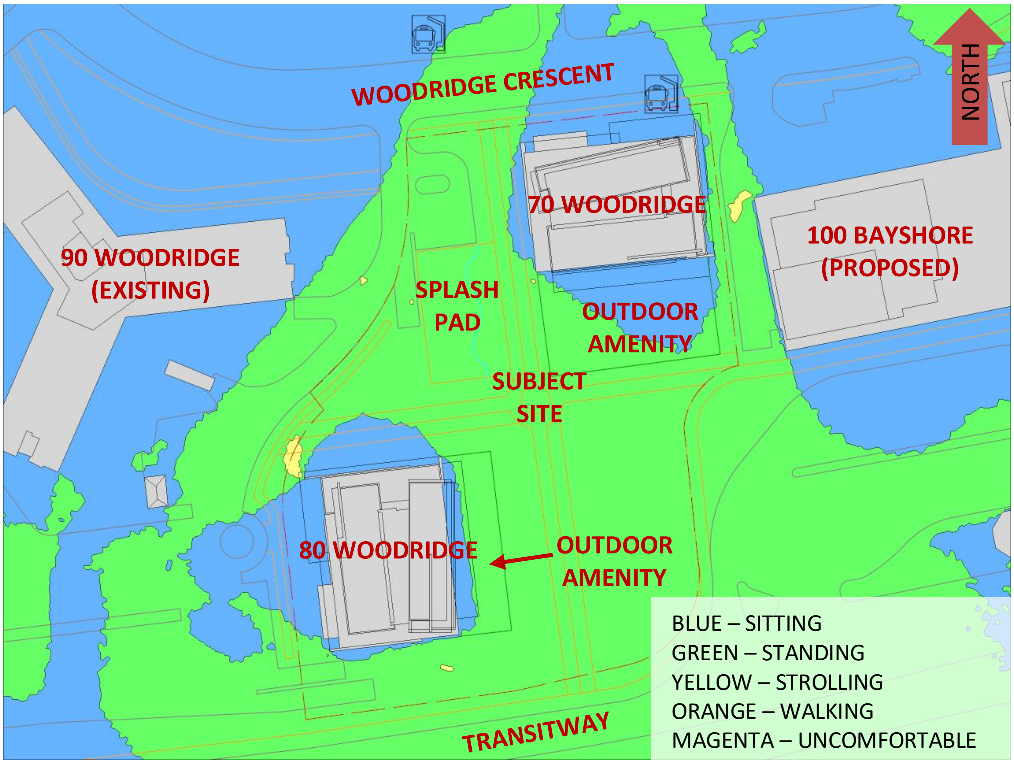


FIGURE 4A: SUMMER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

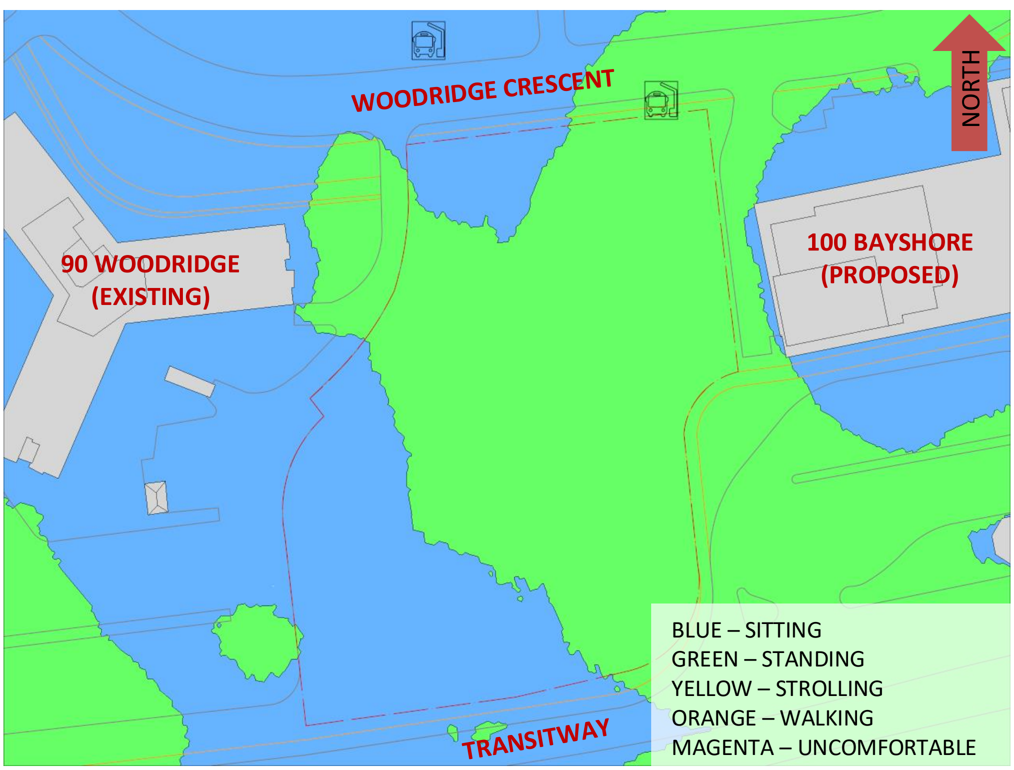


FIGURE 4B: SUMMER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

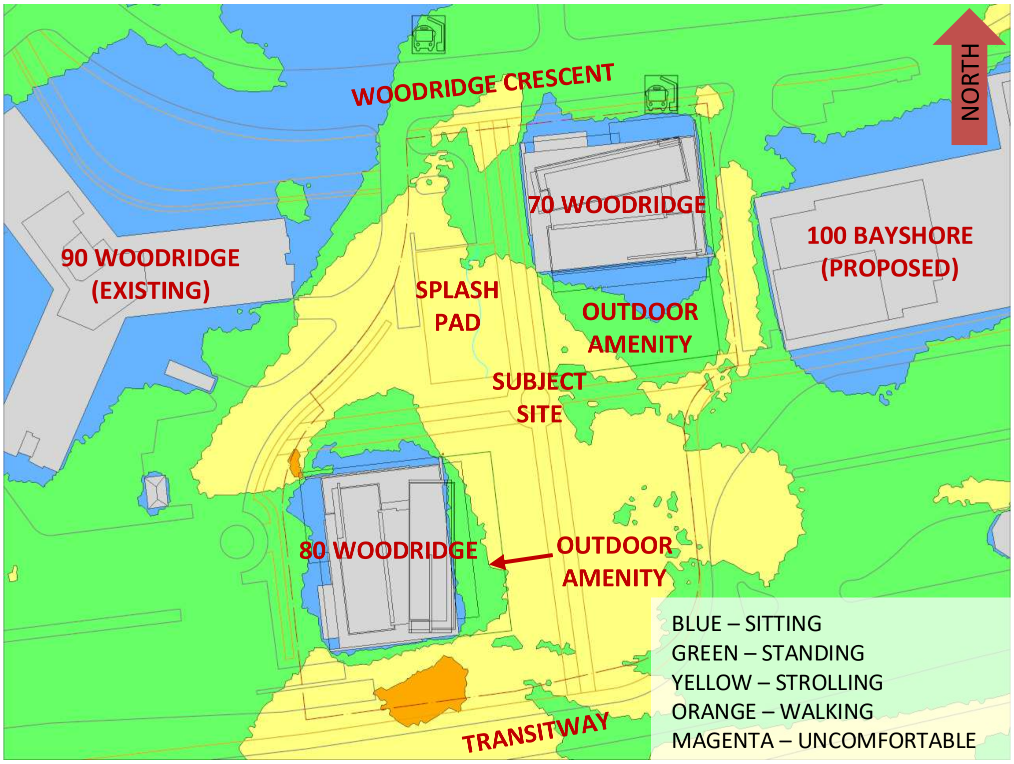


FIGURE 5A: AUTUMN – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

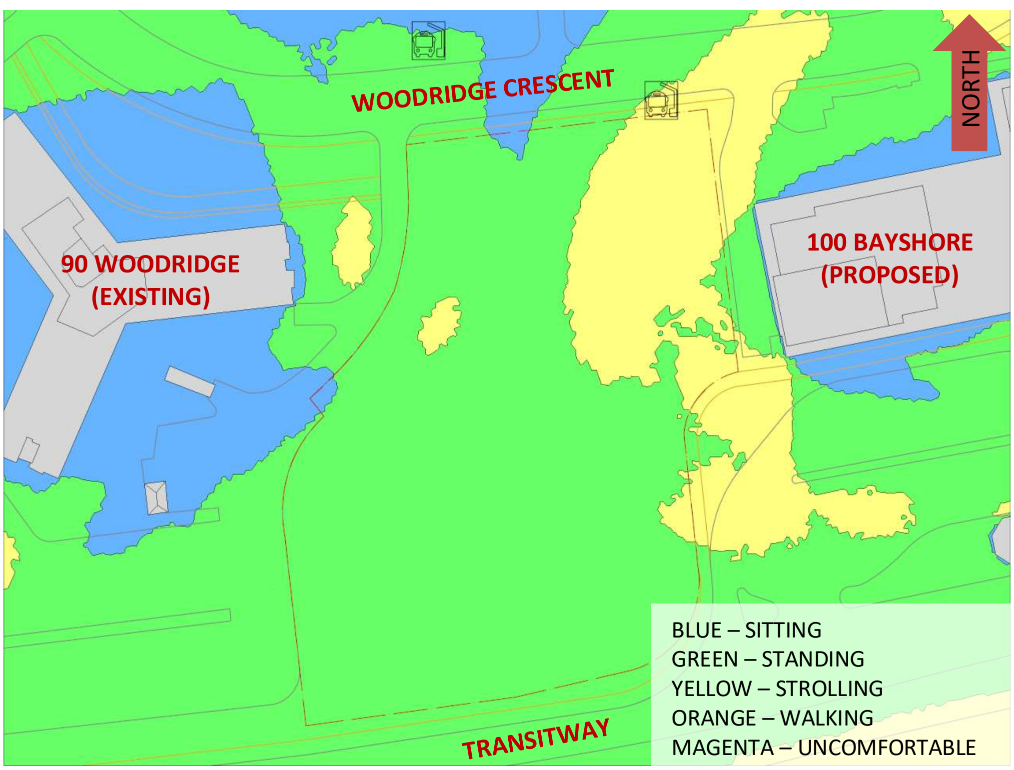


FIGURE 5B: AUTUMN – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

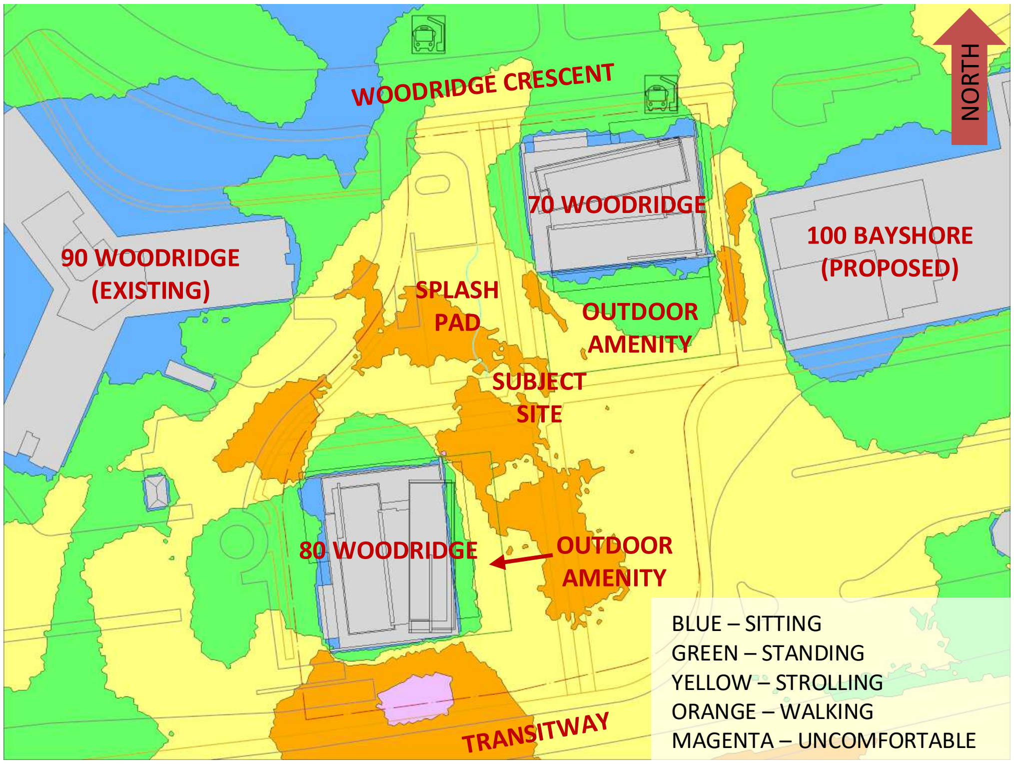


FIGURE 6A: WINTER – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

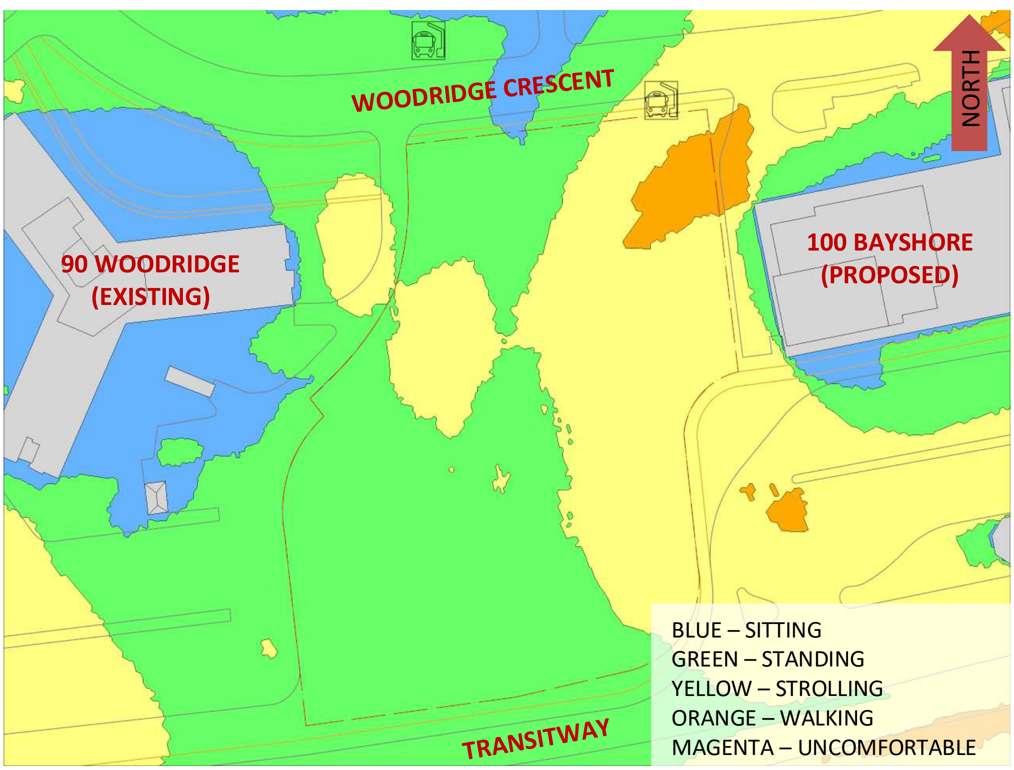


FIGURE 6B: WINTER – WIND COMFORT, GRADE LEVEL– EXISTING MASSING

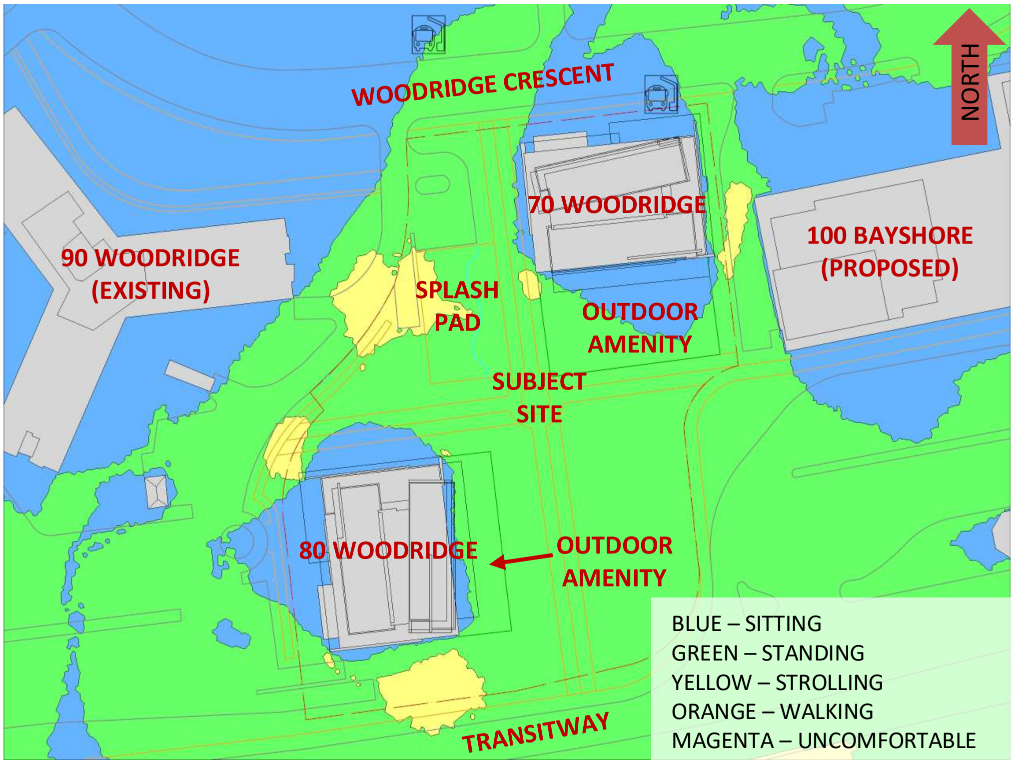


FIGURE 7A: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL – PROPOSED MASSING

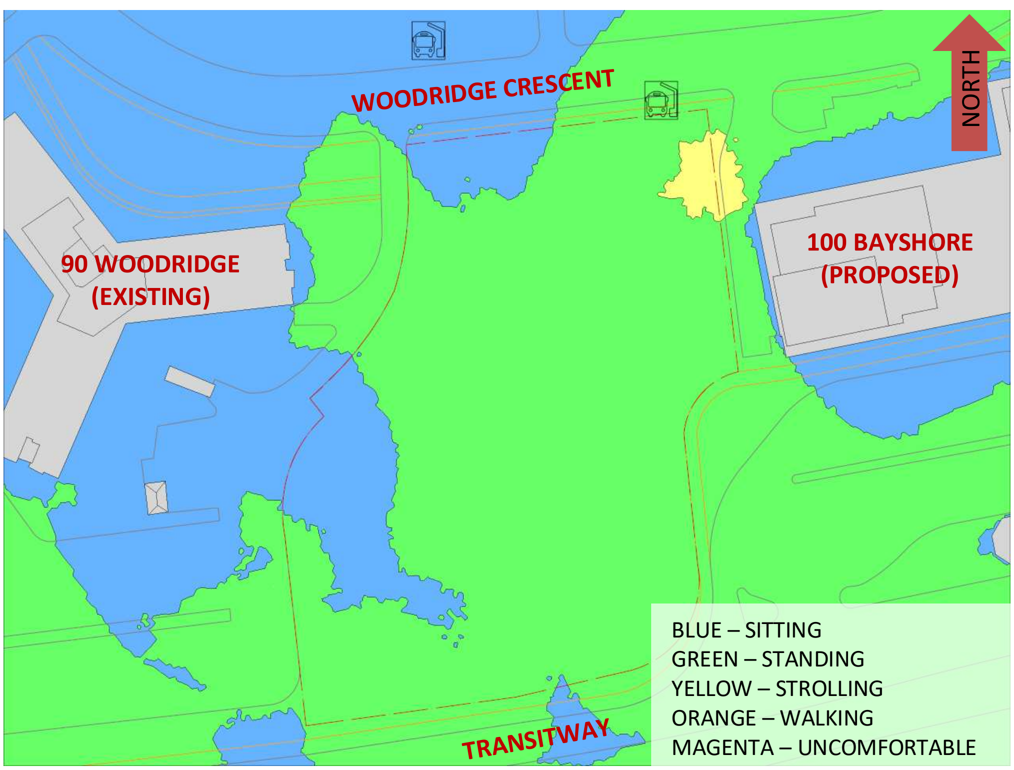
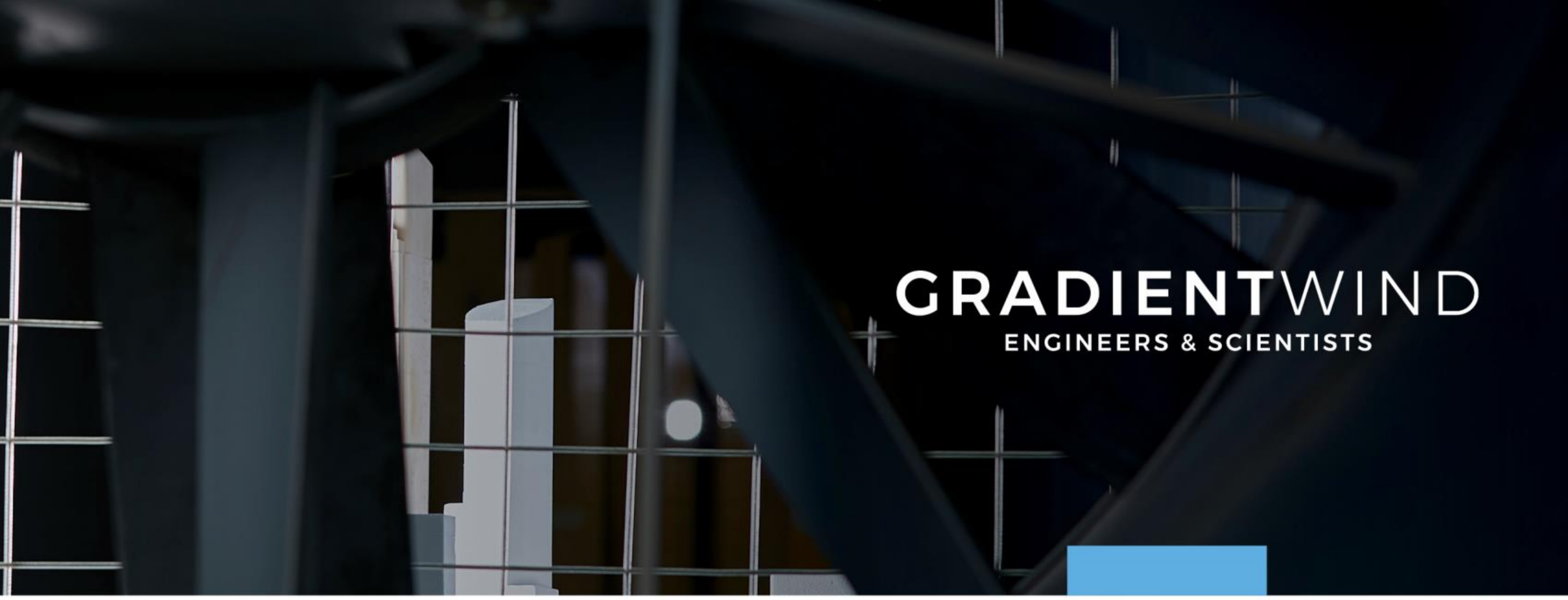
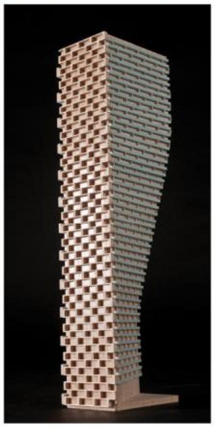
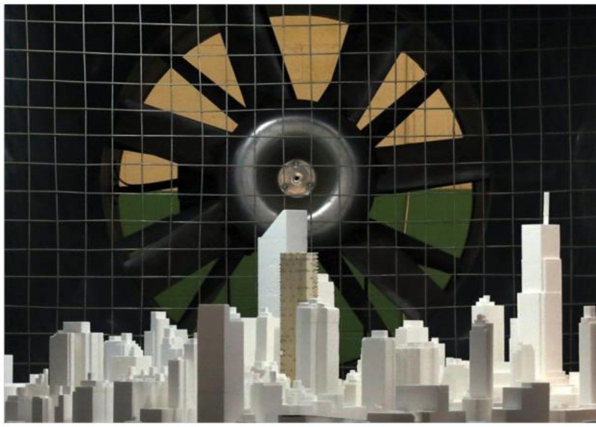


FIGURE 7B: TYPICAL USE PERIOD – WIND COMFORT, GRADE LEVEL– EXISTING MASSING







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 (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	0.20
49	0.25
74	0.24
103	0.24
167	0.21
197	0.20
217	0.20
237	0.19
262	0.21
282	0.23
302	0.20
324	0.17

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).

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

$$L_t(Z) = \begin{cases} 100\text{ m}\sqrt{\dfrac{Z}{30}}, & Z > 30\text{ m} \\ 100\text{ m}, & Z \leq 30\text{ m} \end{cases}$$ 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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[1] P. Arya, "Chapter 10: Near-neutral Boundary Layers," in *Introduction to Micrometeorology*, San Diego, California, Academic Press, 2001.

[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 Engieering Symposium, IWES 2003*, Taiwan, 2003.