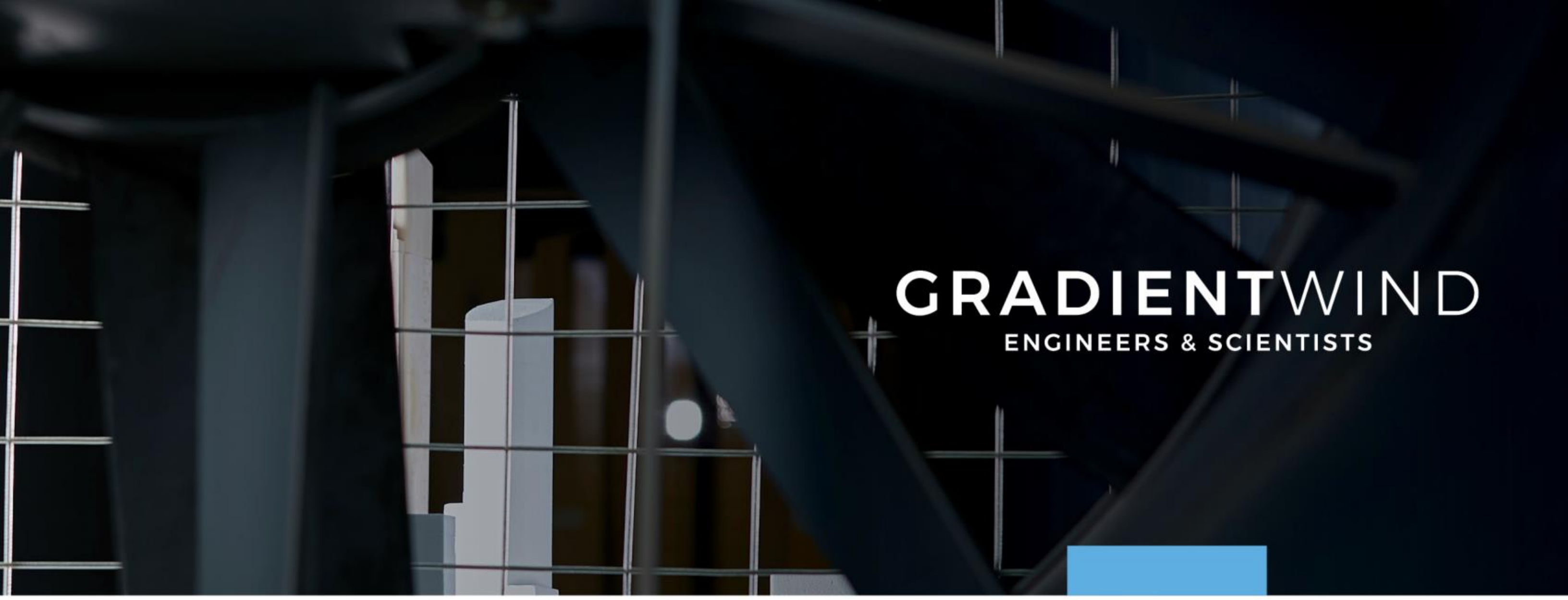
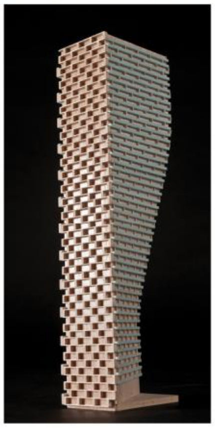


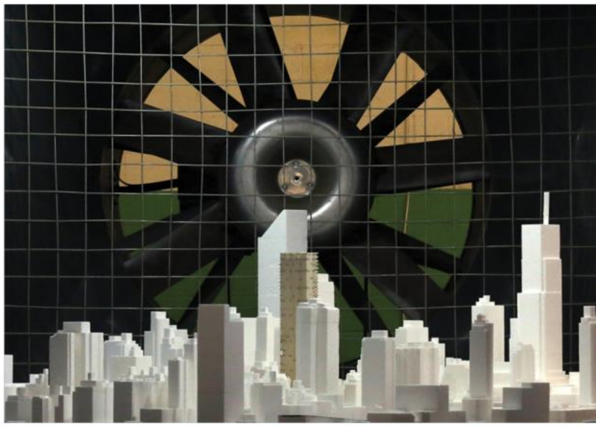
GRADIENTWIND
ENGINEERS & SCIENTISTS

PEDESTRIAN LEVEL WIND STUDY

Lansdowne 2.0
Ottawa, Ontario

Report: 23-053-PLW-2024





November 6, 2024

PREPARED FOR
City of Ottawa
110 Laurier Avenue West
Ottawa, ON K1P 1J1

PREPARED BY
Justin Denne, M.ASc., Junior Wind Scientist
David Huitema, M.Eng., P.Eng., CFD Lead Engineer

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
GRADIENTWIND.COM

EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Site Plan Control application requirements for the second redevelopment phase of Lansdowne Park, known as Lansdowne 2.0, 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 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-7B, and summarized as follows:

1) Most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions in the vicinity of the building access points serving the proposed development and over most grade-level public sidewalks and walkways, surface parking, walkways, the East Court, the Great Lawn, Aberdeen Square, the South Court, the stadium field, the proposed patios and terraces serving the new Event Centre, and the walking and bike pathways to the east and south within Lansdowne Park are considerable acceptable.

2) Following the introduction of the proposed development, conditions over the existing patios along Exhibition Way are predicted to be suitable for a mix of sitting and standing during the summer and strolling during the remainder of the year, with conditions during the typical use period (May to October, inclusive) over the patios predicted to be suitable for sitting close to the building façades and standing elsewhere.

   a. Notably, landscaping elements that could not be implemented in the simulation model (such as trees, wooden barriers, or fences) are expected to improve pedestrian comfort around seating areas within the noted patios, including during the colder seasons.

3) During the spring and winter seasons, an isolated area over the future walkway to the east of Tower 2 that connects Exhibition Way and the Aberdeen Pavilion to the new Event Centre is predicted to receive windier conditions that may occasionally be considered uncomfortable for walking, exceeding the walking comfort criteria for approximately 1% and 2% of the time during the spring and winter seasons.

   a. It is recommended that these conditions be confirmed and further developed at the future Site Plan Control application for the commercial/retail block, and that an appropriate mitigation strategy, if required, be developed as the design of the commercial/retail block component of the Lansdowne 2.0 development progresses and evolves.

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 the City of Ottawa to undertake a pedestrian level wind (PLW) study to satisfy Site Plan Control application requirements for the second phase of redevelopment of Lansdowne Park, known as Lansdowne 2.0, in Ottawa, Ontario (hereinafter referred to as "subject site" or "proposed development"). Previous PLW studies were performed in 2023 at the Zoning By-Law Amendment (ZBLA) application stage considering the previous designs of the Lansdowne 2.0 development[1,2]. Our mandate within the current study is to investigate pedestrian wind conditions within and surrounding the subject site under the approved ZBLA massing scheme, and to identify areas where 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 BBB Architects in October 2024, 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 bordered by Exhibition Way to the north, the South Court and the Great Lawn to the east, the existing stadium field and the south side stands to the south, and the Rideau at Lansdowne condo development and the existing commercial building at 979 Bank Street to the west. The proposed development comprises the redevelopment of the north side stands (NSS), a new re-designed Event Centre, and two new residential towers, Towers 1 and 2, which both rise to 40-storeys at the west and east, respectively, above a shared podium along the north elevation of the site. A public promenade is situated to the south of the two towers, which provides access to the main concourse of the NSS and is accessed from the grade-level via an outdoor staircase and passageway between Towers 1 and 2. A new Event Centre is situated to the east of the stadium field, with an elevated pathway along the west elevation of the Event Centre connecting the NSS to the south side stands.

[1] Gradient Wind Engineering Inc., '*Lansdowne 2.0 – Pedestrian Level Wind Study*', [June 15, 2023]
[2] Gradient Wind Engineering Inc., '*Lansdowne 2.0 – Pedestrian Level Wind Study*', [Sept 13, 2023]

The near-field surroundings, defined as an area within 200-metres (m) of the subject site include the TD Place field to the south and southeast followed by the existing south side stands, the Rideau at Lansdowne high-rise condo development to the south-southwest and a commercial mid-rise building to the immediate west-southwest followed by a mix of mostly low- and mid-rise massing from the southwest clockwise to the west, low-rise commercial buildings from the west clockwise to the north-northeast, and the Aberdeen Pavilion and Lansdowne Park from the northeast clockwise to the south-southwest. Beyond Lansdowne Park, the Rideau Canal is situated from the south clockwise to the northeast. 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 low-rise massing with clusters of taller mid- and high-rise buildings in all directions, and the southern extent of the urban massing of the downtown core from the north-northeast clockwise to the north. Notably, Carleton University is situated approximately 1.3 km to the southwest and Dow's Lake, the Dominion Arboretum, and the Fletcher Wildlife Garden are located at the west-southwest extent of the far-field.

A site plan for the proposed massing scenario is illustrated in Figure 1A, while the existing massing scenario is illustrated in Figure 1B. Figures 2A-2H illustrate the computational models used to conduct the study. The existing massing scenario includes the existing massing and any future developments 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 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[3]. 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 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 study building, complete with surrounding massing within a radius of 640 m. The process was performed for two context massing scenarios, as noted in Section 2.

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

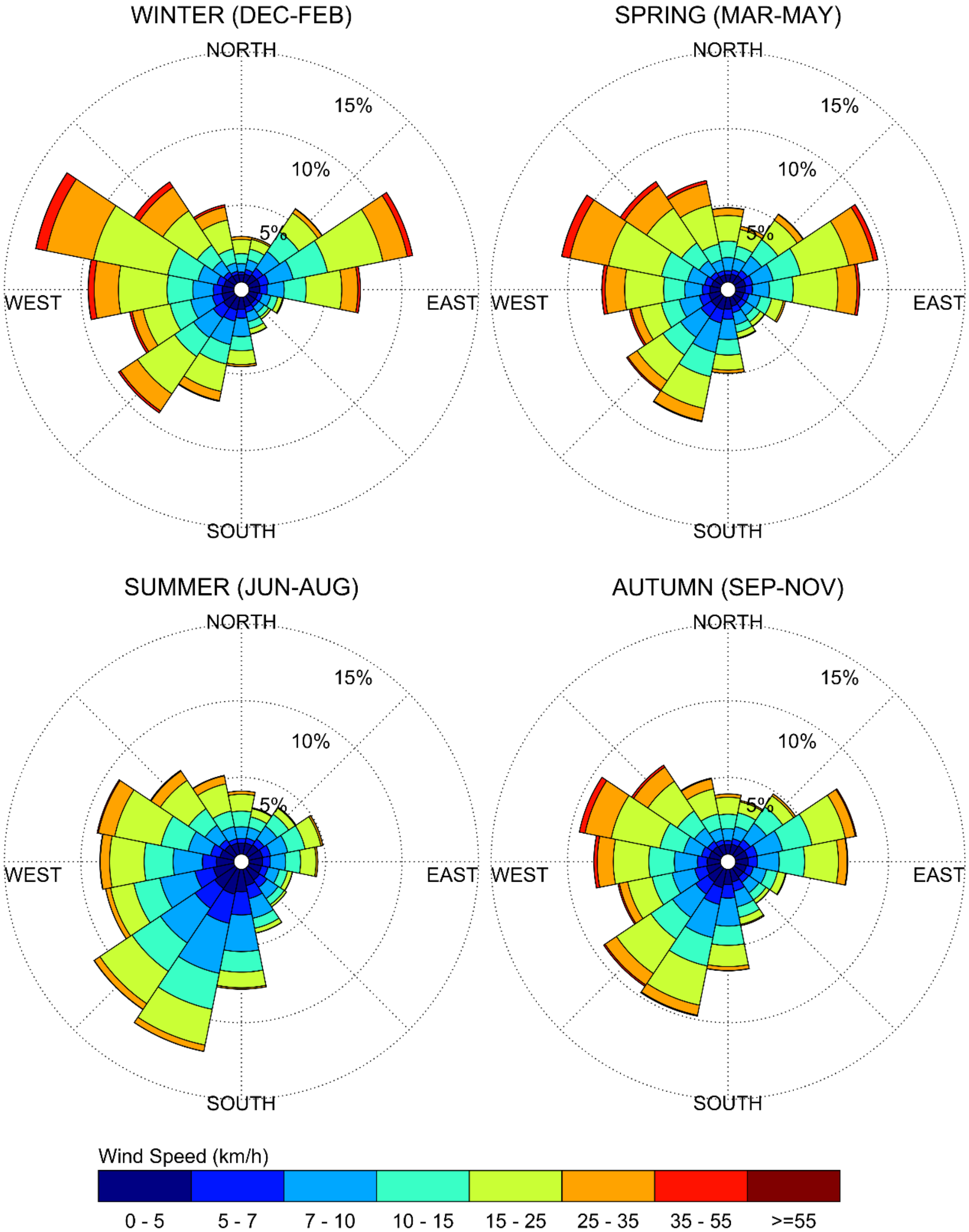
Mean and peak wind speed data obtained over the study site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade were referenced to the wind speed at gradient height to generate 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 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-7B, illustrating wind conditions at grade level for the proposed and existing massing scenarios. Conditions are presented as continuous contours of wind comfort throughout the subject site and correspond to the comfort classes presented 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 along Frank Clair Lane: Wind comfort conditions along Frank Clair Lane under the existing massing are predicted to be suitable for mostly sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year, with strolling conditions predicted beneath the scoreboard located to the west of the stadium field.

Following the introduction of the proposed development, wind conditions along Frank Clair Lane are predicted to be suitable for standing, or better, during the summer, becoming suitable for strolling, or better, throughout the remaining three seasons. The windiest conditions are located along the parking and pedestrian ramps at the west elevation of the NSS, and near the scoreboard during the winter. The noted conditions are considered acceptable for public sidewalks and walkways. While the introduction of the proposed development is predicted to produce slightly windier conditions along Frank Clair Lane in comparison to existing conditions, wind conditions with the proposed development are nevertheless considered acceptable for the intended pedestrian uses.

West Elevation of the Stadium Field: Following the introduction of the proposed development, wind conditions to the west of the stadium field are predicted to suitable for a mix of sitting and standing throughout the year. Conditions over the noted area with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the three colder seasons.

Sidewalks and Existing Patios along Exhibition Way: Conditions along Exhibition Way with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, during the three colder seasons, while conditions over the existing restaurant patios along Exhibition Way are predicted to be suitable for mostly sitting during the summer and autumn, and standing, or better, during the spring and winter. Following the introduction of the proposed development, conditions over the public sidewalks along Exhibition Way are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, during the autumn, and suitable for a mix of mostly standing and strolling during the spring and winter. The noted conditions are considered acceptable for public sidewalks.

Following the introduction of the proposed development, during the summer season when pedestrian usage of public and private seating areas is expected to be the most frequent and when pedestrians may linger in the area, wind conditions over the existing restaurant patios along Exhibition Way are predicted to be suitable for a mix of sitting and standing. Conditions over this area are predicted to be suitable for a mix of sitting, standing, and strolling during the remainder of the year, with the strolling conditions located at the southeast corner of the patio areas along Exhibition Way and over areas adjoining the public sidewalk. Landscaping elements that could not be implemented into the wind model (such as trees and wooden barriers or fences), as described in Section 4.1, are expected to somewhat improve pedestrian comfort over the noted patios or seating areas during the typical use period (May to October, inclusive).

Sidewalks along Paul Askin Way: Conditions over the nearby public sidewalks along Paul Askin Way with the existing massing are predicted to be mostly suitable sitting during all four seasons. Following the introduction of the proposed development, conditions over the public sidewalks along Paul Askin Way are predicted to be suitable for sitting during the summer, becoming suitable for a mix of mostly sitting and standing during the remaining seasons. While the introduction of the proposed development is predicted to produce windier conditions along Paul Askin Way in comparison to existing conditions, wind conditions with the proposed development are nevertheless considered acceptable for the intended pedestrian uses.

Aberdeen Square: Wind conditions over Aberdeen Square with the existing massing are predicted to be suitable for mostly sitting throughout the year. Following the introduction of the proposed development, conditions within Aberdeen Square are predicted to be suitable for sitting during the summer, autumn, and typical use period, and suitable for mostly sitting during the spring and winter seasons with an isolated area of standing conditions. The noted conditions are considered acceptable.

South Court: Under the existing massing, wind conditions over the South Court are predicted to be suitable for sitting during the summer and autumn, and suitable for a mix of sitting and standing during the spring and winter. Following the introduction of the proposed development, wind conditions over the South Court are predicted to be suitable for mostly sitting during the summer and autumn, becoming suitable for a mix of mostly sitting and standing during the spring and winter. Notably, during the typical use period, conditions within the South Court are predicted to be suitable for mostly sitting, which may be considered acceptable for the designated seating areas within the space.

East Court: Prior to the introduction of the proposed development, wind conditions over the East Court are predicted to be calm and suitable for mostly sitting during the summer, autumn, and winter seasons, becoming suitable for mostly sitting with standing conditions to the south during the spring. These conditions remain mostly unchanged following the introduction of the proposed development and are considered acceptable.

Walkway North of the New Event Centre: Wind conditions over the future walkway to the east of Tower 2 that connects the Aberdeen Pavilion to the proposed Event Centre are predicted to be mixed between standing and strolling during the summer months, and mixed between mostly walking, strolling, and standing during the spring, autumn, and winter. The windiest conditions are located to the immediate east of Tower 2, where conditions are predicted to occasionally be considered uncomfortable for walking during the spring and winter months over an isolated portion of the pedestrian walkway. Conditions over this area are predicted to be suitable for walking for approximately 79% of the time during the spring season and 78% of the time during the winter season, representing marginal exceedances of 1% and 2% of the walking comfort threshold, respectively.

It is recommended that these conditions be confirmed and further developed at the future Site Plan Control application for the commercial/retail block, and that an appropriate mitigation strategy, if required, be developed as the design of the commercial/retail block component of Lansdowne 2.0 develops.

New Event Centre Public Areas: Wind conditions over the new pedestrian areas to the north, east, and south of the proposed Event Centre are predicted to be suitable for mostly standing, or better, throughout the year, with conditions predicted to be suitable for sitting during the typical use period over the east and south terraces serving the proposed Event Centre, which is considered acceptable. Conditions over the patio along the west elevation of the proposed Event Centre that overlooks the stadium field are predicted to be mostly suitable for sitting throughout the year, which is considered acceptable.

Great Lawn: Prior to and following the introduction of the proposed development, conditions during the summer over the Great Lawn are predicted to be suitable for sitting, becoming suitable for a mix of sitting and standing during the autumn and suitable for mostly standing during the spring and winter. Wind conditions with the proposed development remain mostly similar to those under the existing massing throughout the year, including during the primary-use seasons of spring, summer, and autumn. Given these comparable conditions and that the Great Lawn has limited seating areas, conditions over the Great Lawn with the proposed development are considered acceptable.

Nearby Lansdowne Park Pathways to the South and East of the New Event Centre: Prior to the introduction of the proposed development, wind conditions over the nearby existing pathways within Lansdowne Park to the south and east of the new Event Centre and Great Lawn are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for mostly standing, or better, throughout the remainder of the year. Conditions following the introduction of the proposed development over these areas are predicted to remain similar to existing wind conditions, and the noted conditions are considered acceptable for public pathways and bicycle paths.

Stadium Field: Prior to and following the introduction of the proposed development, wind conditions over the stadium field are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the spring, autumn, and winter. During the typical use period, conditions over the field are predicted to be suitable for mostly sitting.

Building Access Points: Owing to the protection of the building façades, conditions in the vicinity of the primary building access points serving the new Event Centre and the new NSS are predicted to be suitable for standing, or better, throughout the year, while conditions in the vicinity of the secondary building access points serving these buildings are predicted to be suitable for strolling, or better, throughout the year. The noted conditions are considered acceptable.

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 or surrounding the subject site are expected to experience conditions that could be considered dangerous, as defined in Section 4.4.

5.3 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-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) Most grade-level areas within and surrounding the subject site are predicted to experience conditions that are considered acceptable for the intended pedestrian uses throughout the year. Specifically, conditions in the vicinity of the building access points serving the proposed development and over most grade-level public sidewalks and walkways, surface parking, walkways, the East Court, the Great Lawn, Aberdeen Square, the South Court, the stadium field, the proposed patios and terraces serving the new Event Centre, and the walking and bike pathways to the east and south within Lansdowne Park are considerable acceptable.

2) Following the introduction of the proposed development, conditions over the existing patios along Exhibition Way are predicted to be suitable for a mix of sitting and standing during the summer and strolling during the remainder of the year, with conditions during the typical use period (May to October, inclusive) over the patios predicted to be suitable for sitting close to the building façades and standing elsewhere.

    a. Notably, landscaping elements that could not be implemented in the simulation model (such as trees, wooden barriers, or fences) are expected to improve pedestrian comfort around seating areas within the noted patios, including during the colder seasons.

3) During the spring and winter seasons, an isolated area over the future walkway to the east of Tower 2 that connects Exhibition Way and the Aberdeen Pavilion to the new Event Centre is predicted to receive windier conditions that may occasionally be considered uncomfortable for walking, exceeding the walking comfort criteria for approximately 1% and 2% of the time during the spring and winter seasons.

a. It is recommended that these conditions be confirmed and further developed at the future Site Plan Control application for the commercial/retail block, and that an appropriate mitigation strategy, if required, be developed as the design of the commercial/retail block component of the Lansdowne 2.0 development progresses and evolves.

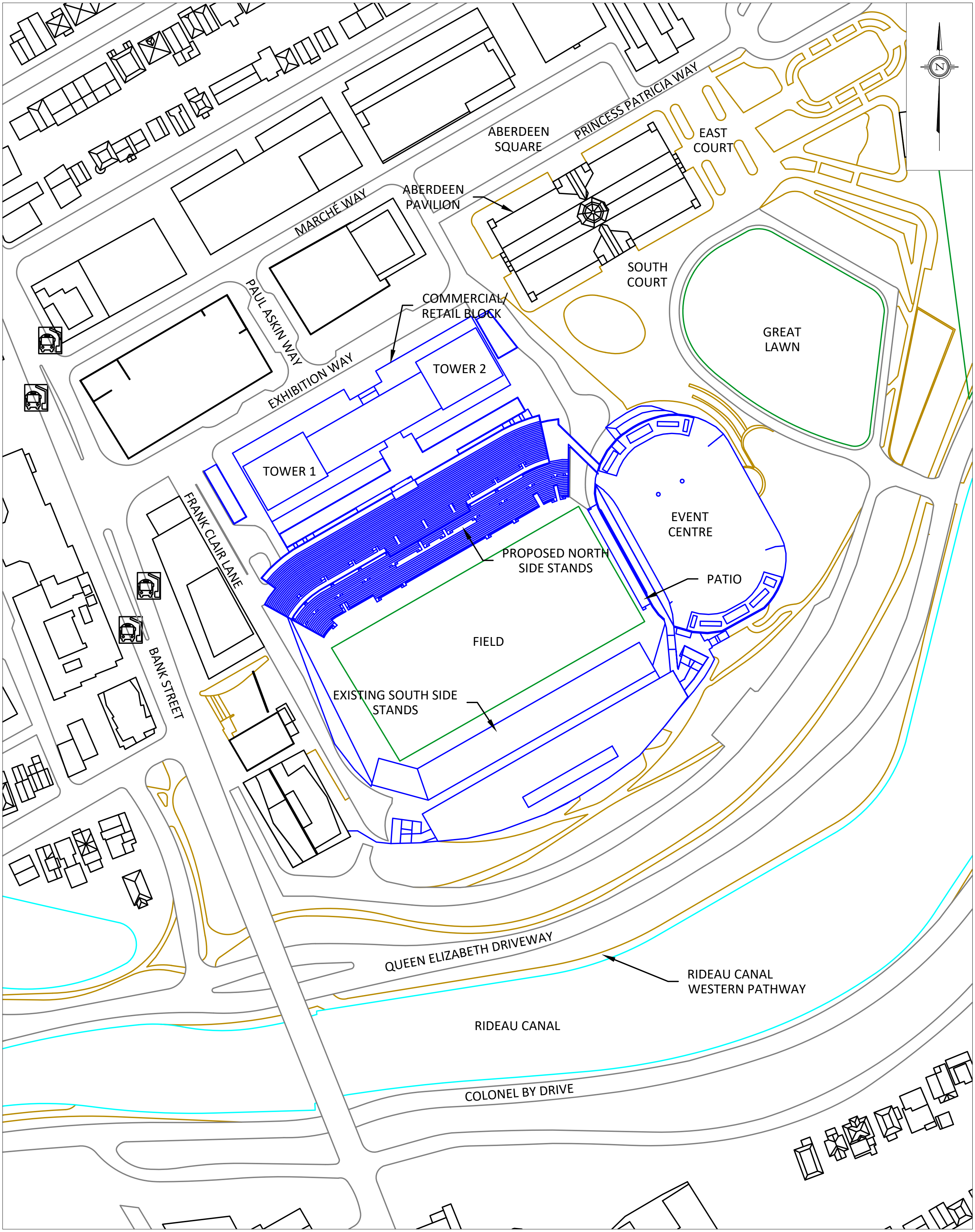
4) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events, (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is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

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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ENGINEERS & SCIENTISTS
127 WALGREEN ROAD, OTTAWA, ON
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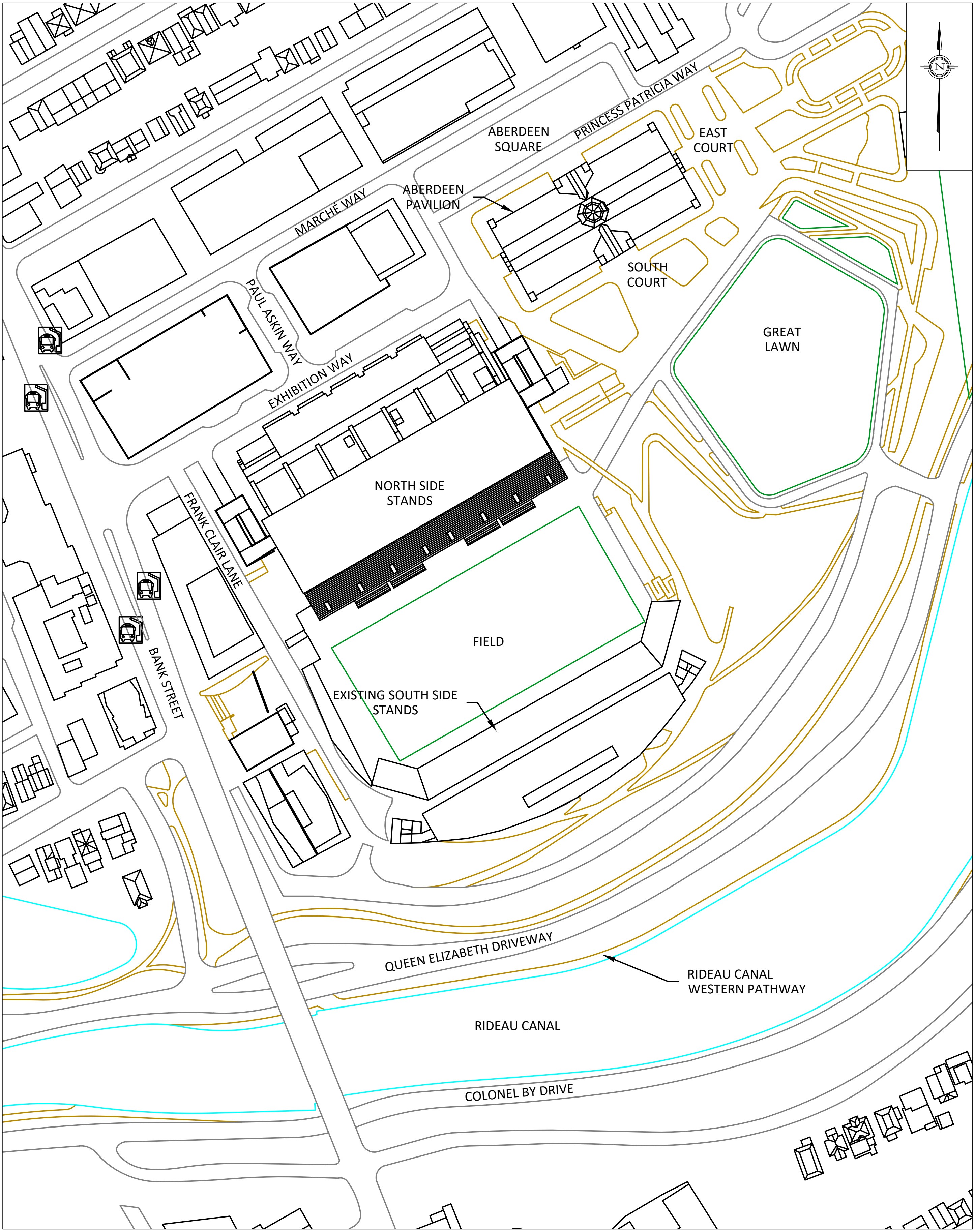
PROJECT: LANSDOWNE 2.0, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 1A: PROPOSED SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:2500	DRAWING NO. 23-053-PLW-1A	
DATE: NOVEMBER 6, 2024	DRAWN BY: NMP	



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PROJECT	LANSDOWNE 2.0, OTTAWA PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:2500	DRAWING NO.	23-053-PLW-1B
DATE	NOVEMBER 6, 2024	DRAWN BY	NMP

DESCRIPTION

FIGURE 1B:
EXISTING SITE PLAN AND SURROUNDING CONTEXT

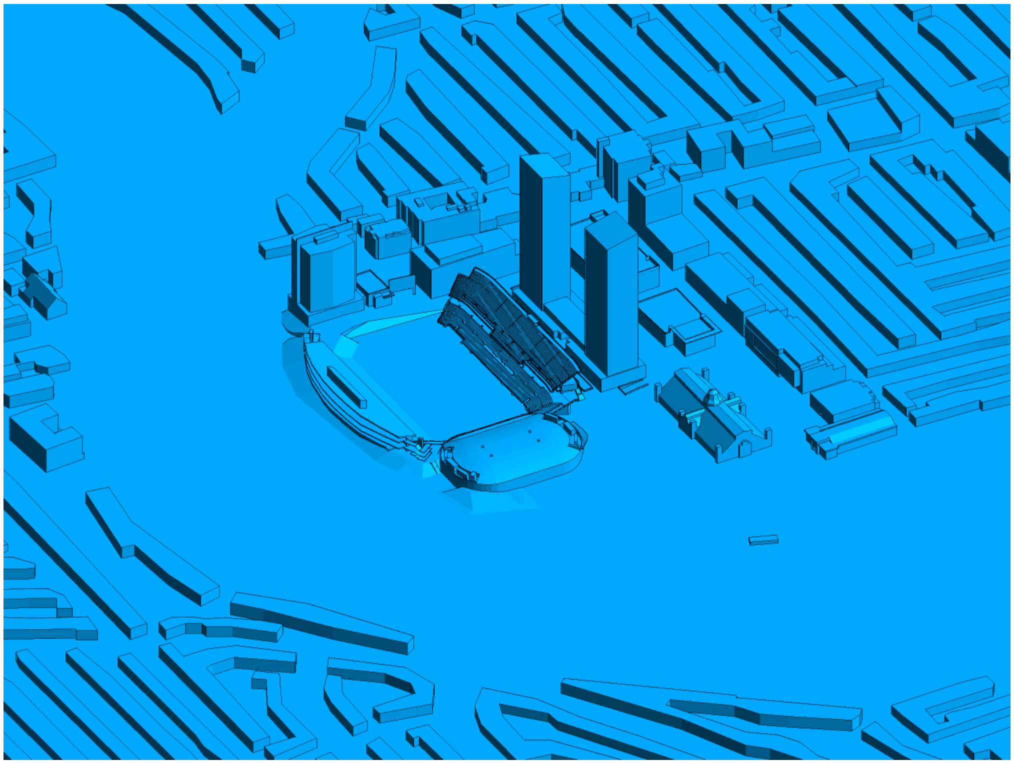


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, EAST VIEW

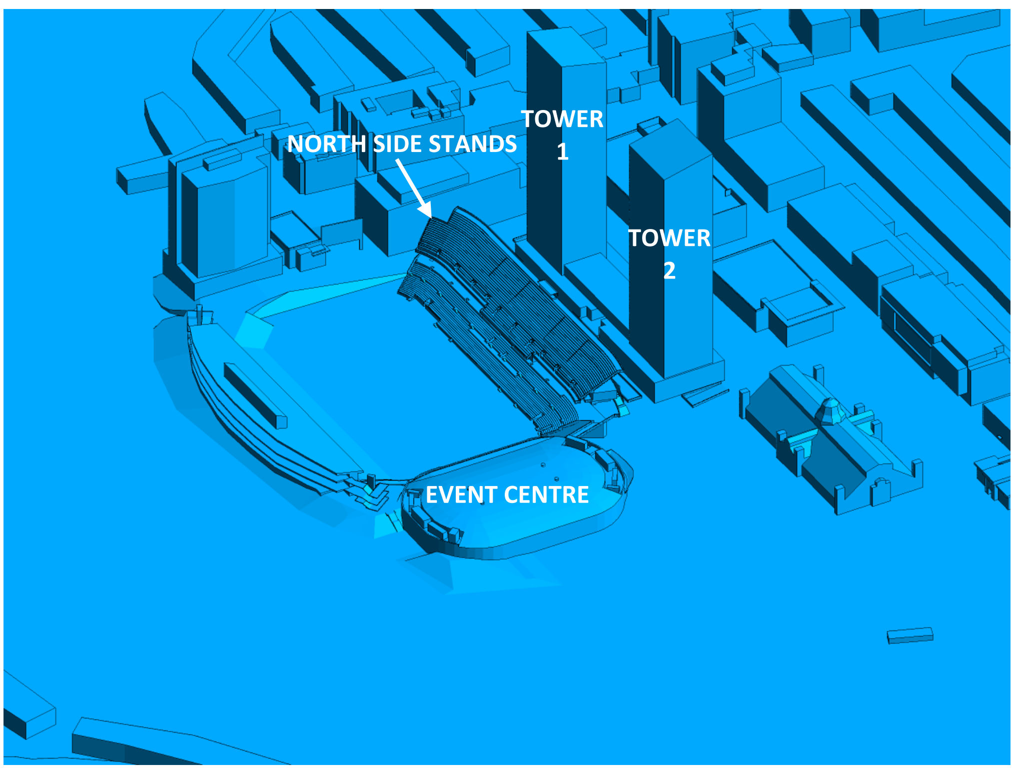


FIGURE 2B: CLOSE UP OF FIGURE 2A

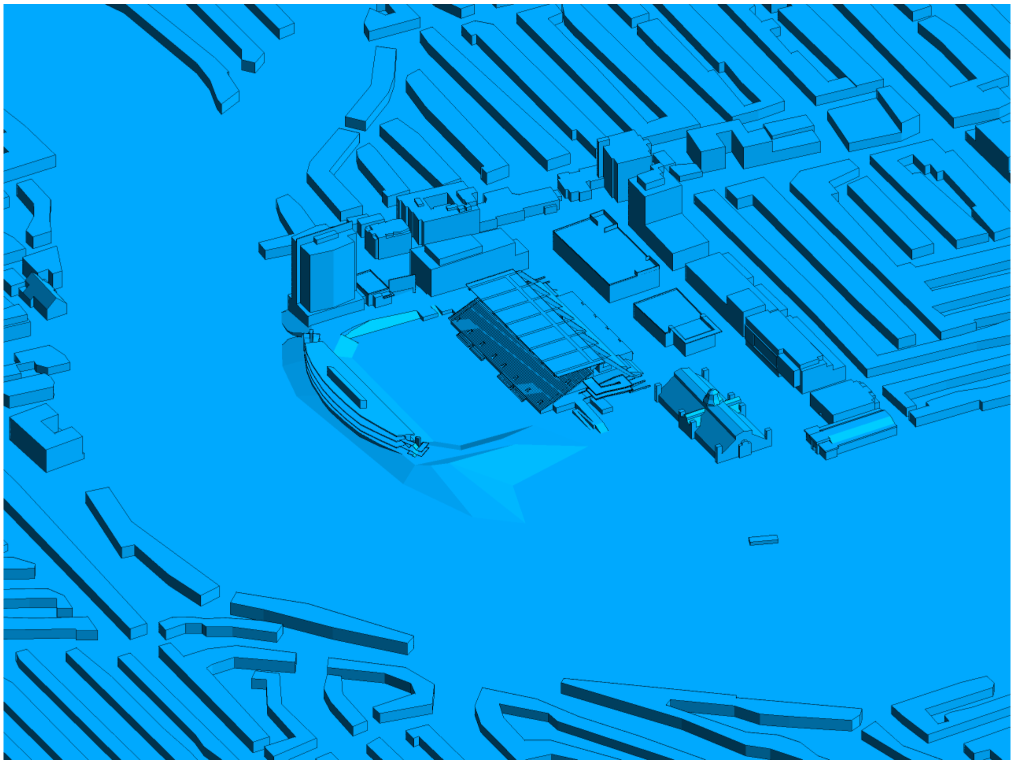


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, EAST VIEW

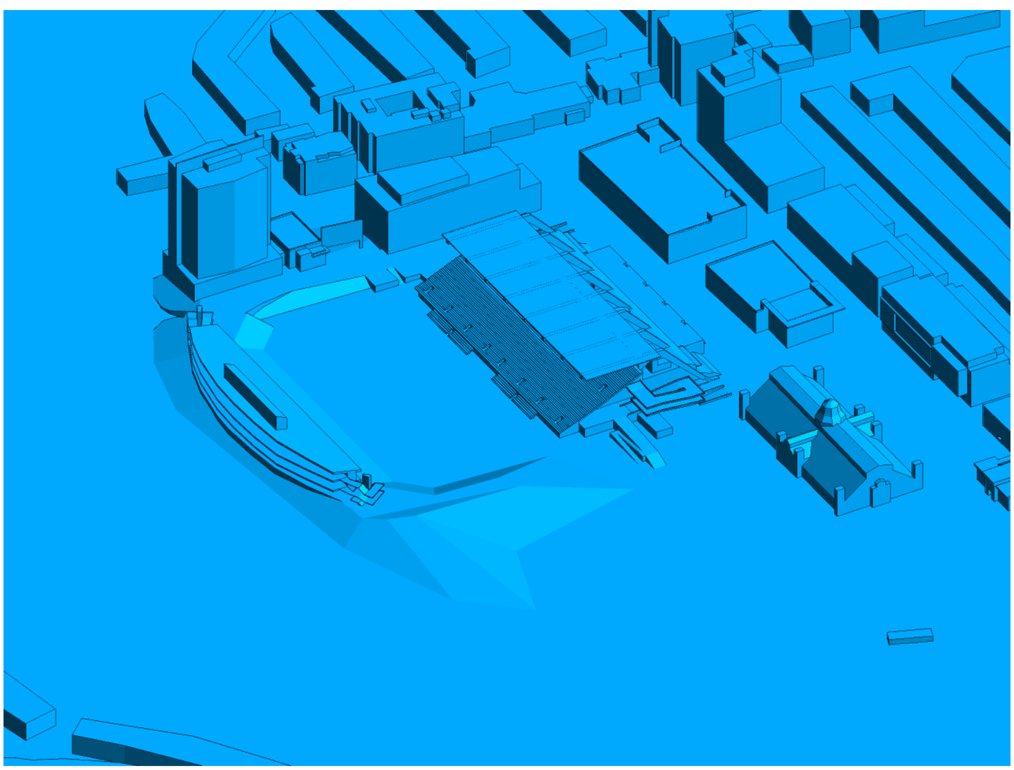


FIGURE 2D: CLOSE UP OF FIGURE 2C

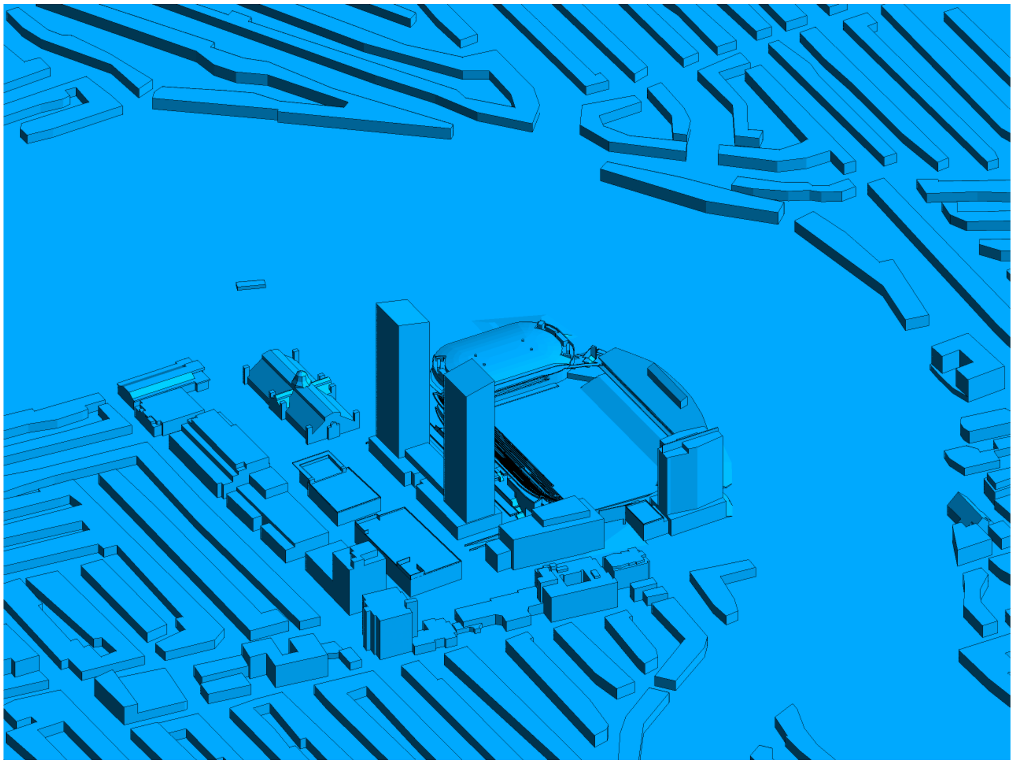


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, WEST VIEW

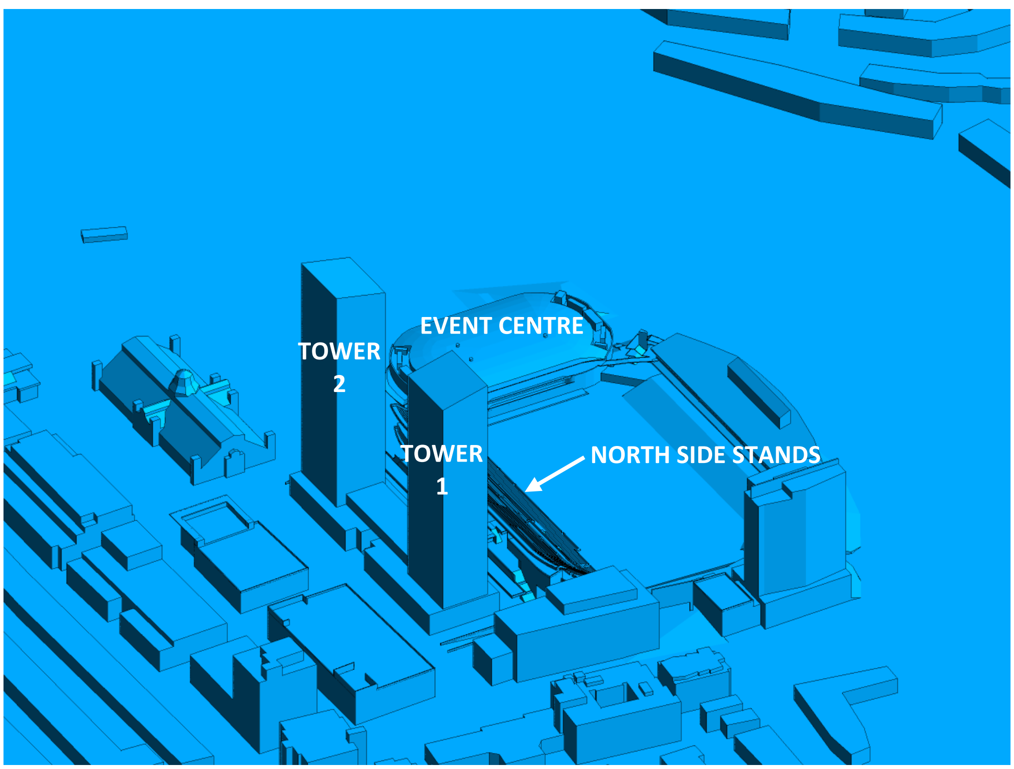


FIGURE 2F: CLOSE UP OF FIGURE 2E

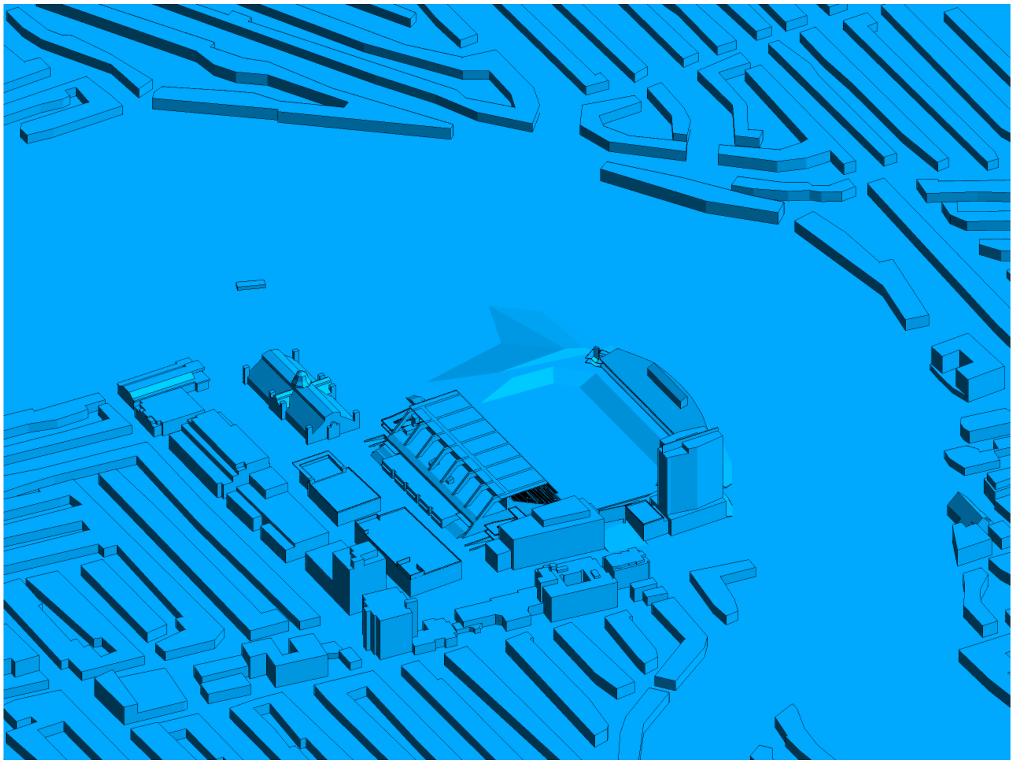


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, WEST PERSPECTIVE

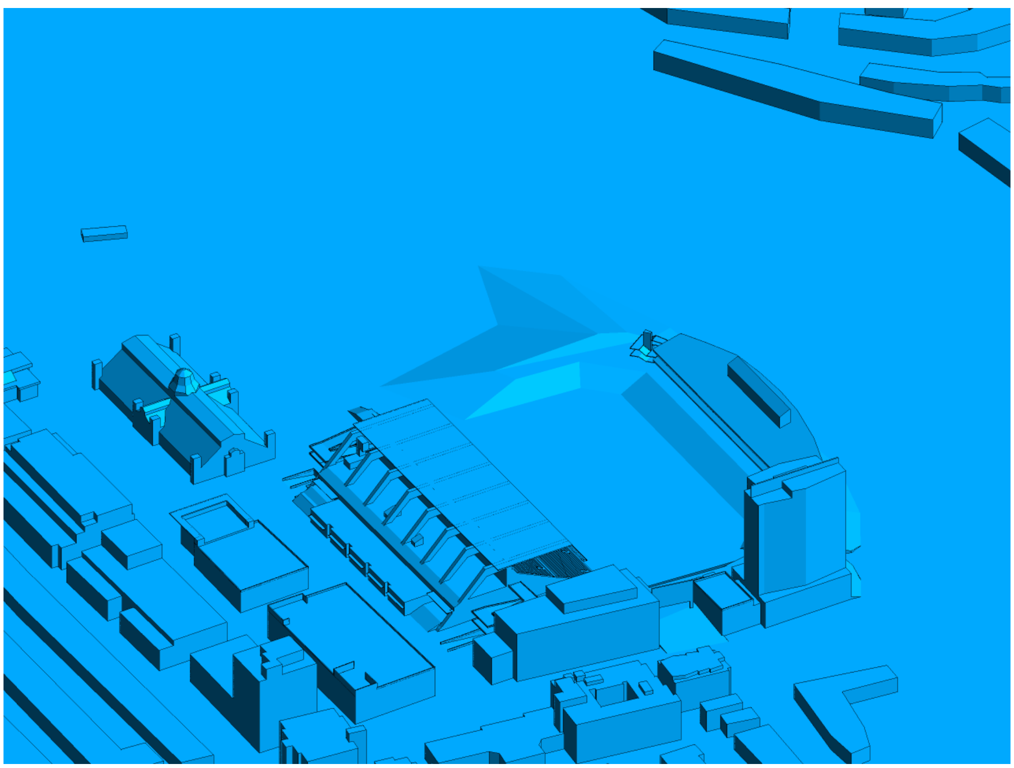


FIGURE 2H: CLOSE UP OF FIGURE 2G

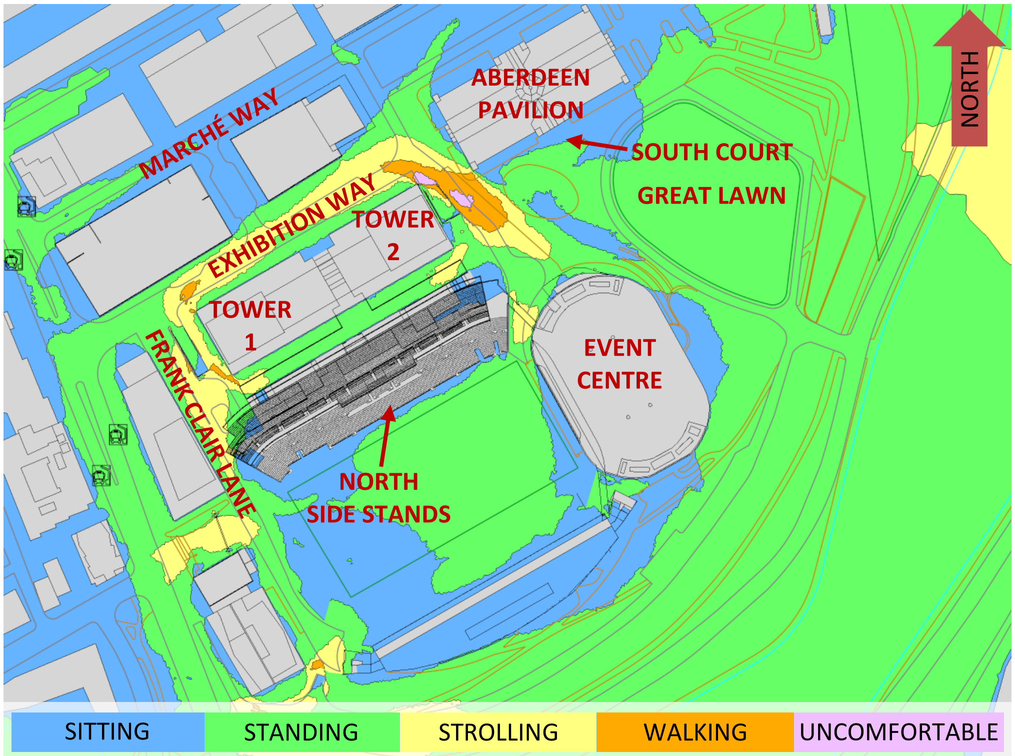


FIGURE 3A: SPRING – WIND COMFORT, PROPOSED

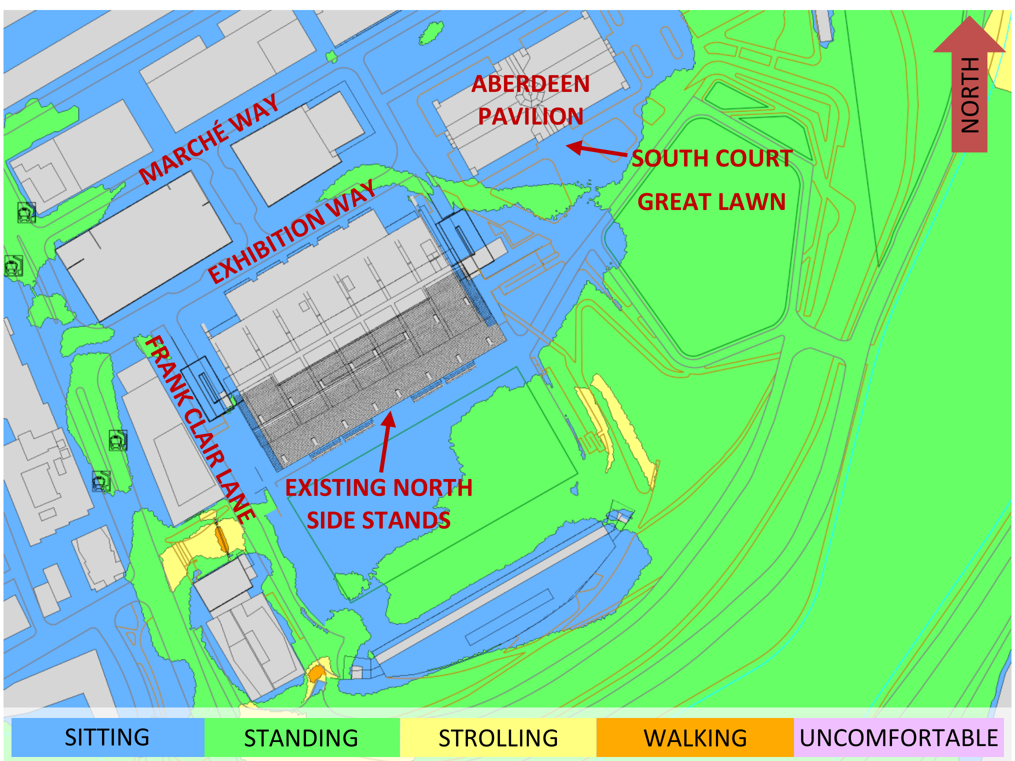


FIGURE 3B: SPRING – WIND COMFORT, EXISTING

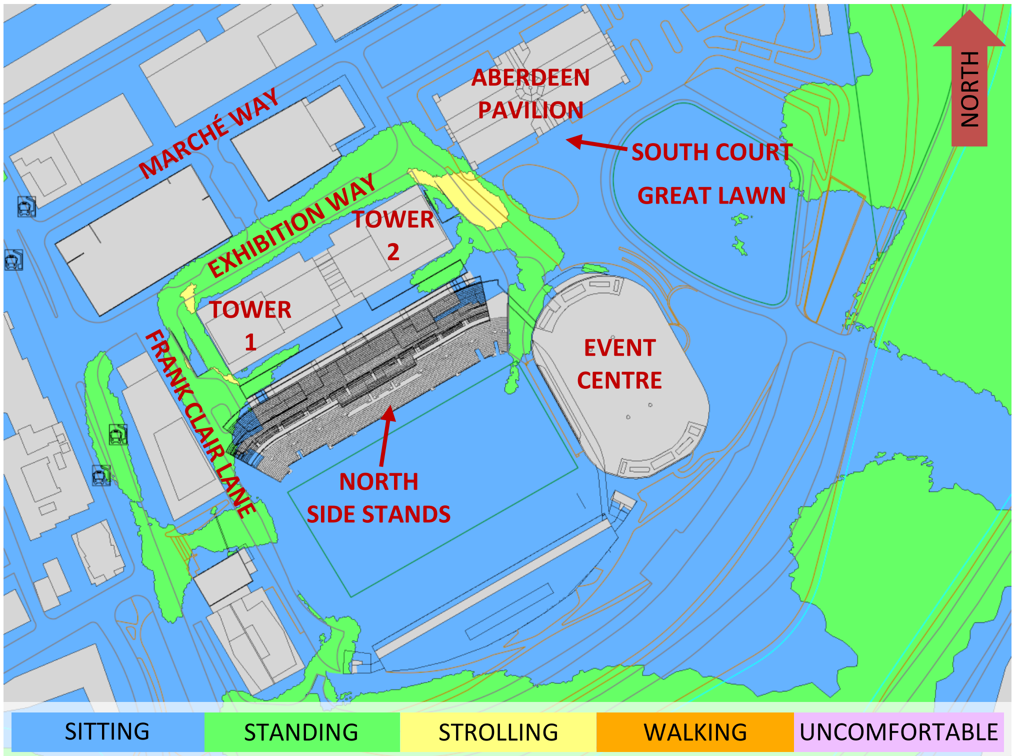


FIGURE 4A: SUMMER – WIND COMFORT, PROPOSED

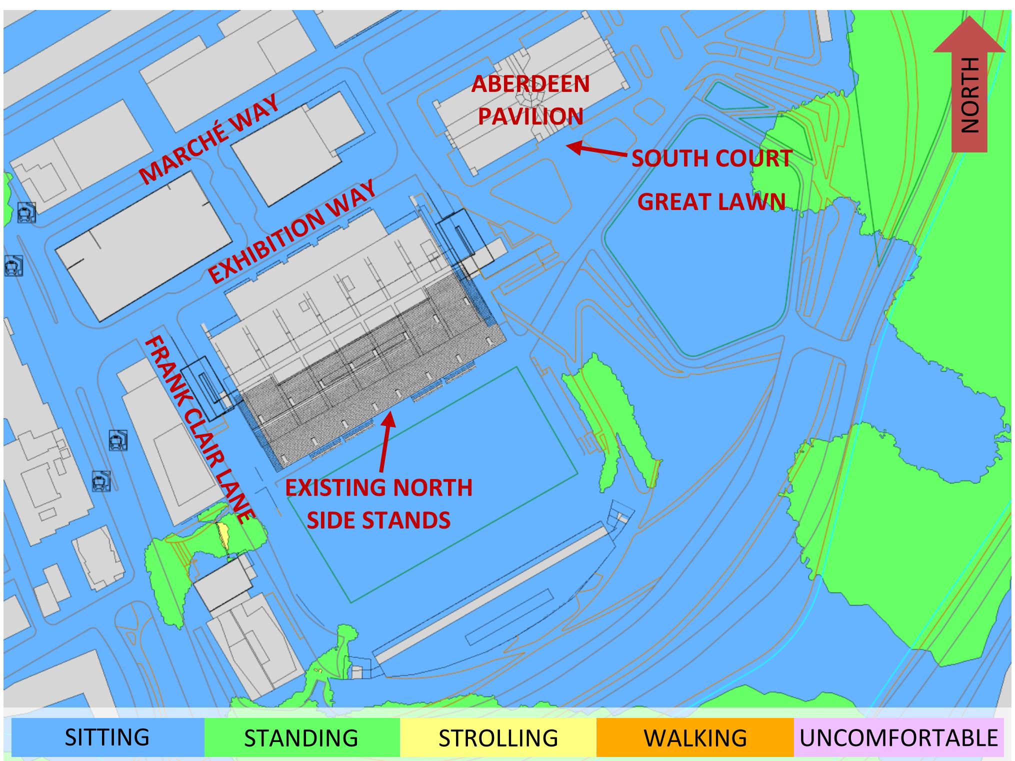


FIGURE 4B: SUMMER – WIND COMFORT, EXISTING

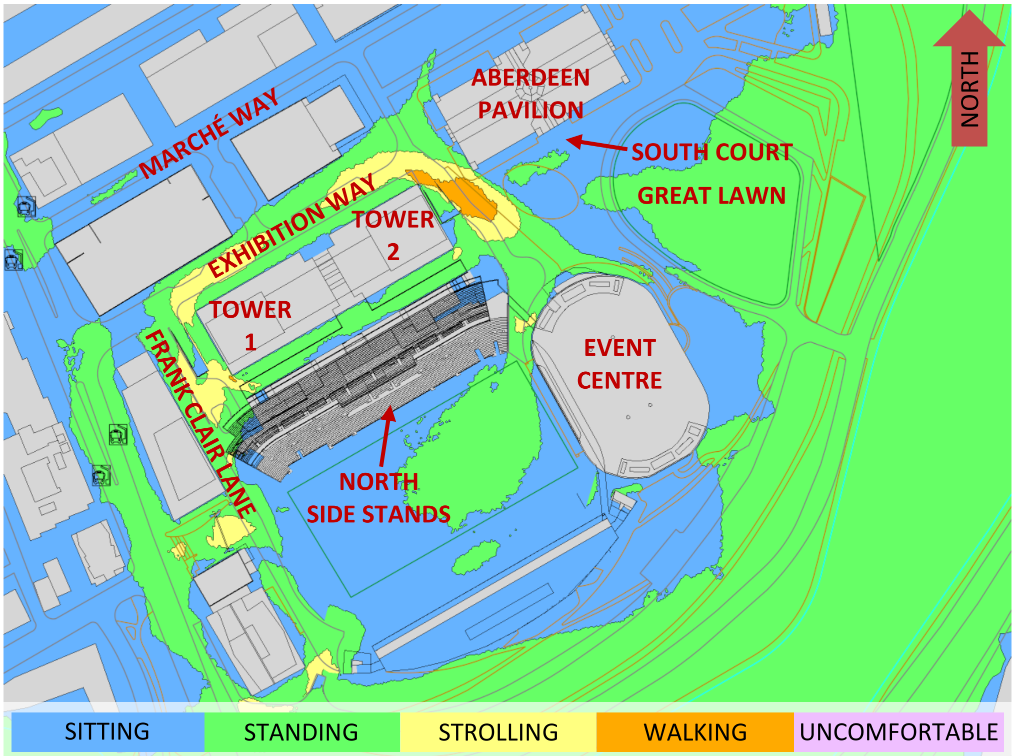


FIGURE 5A: AUTUMN – WIND COMFORT, PROPOSED

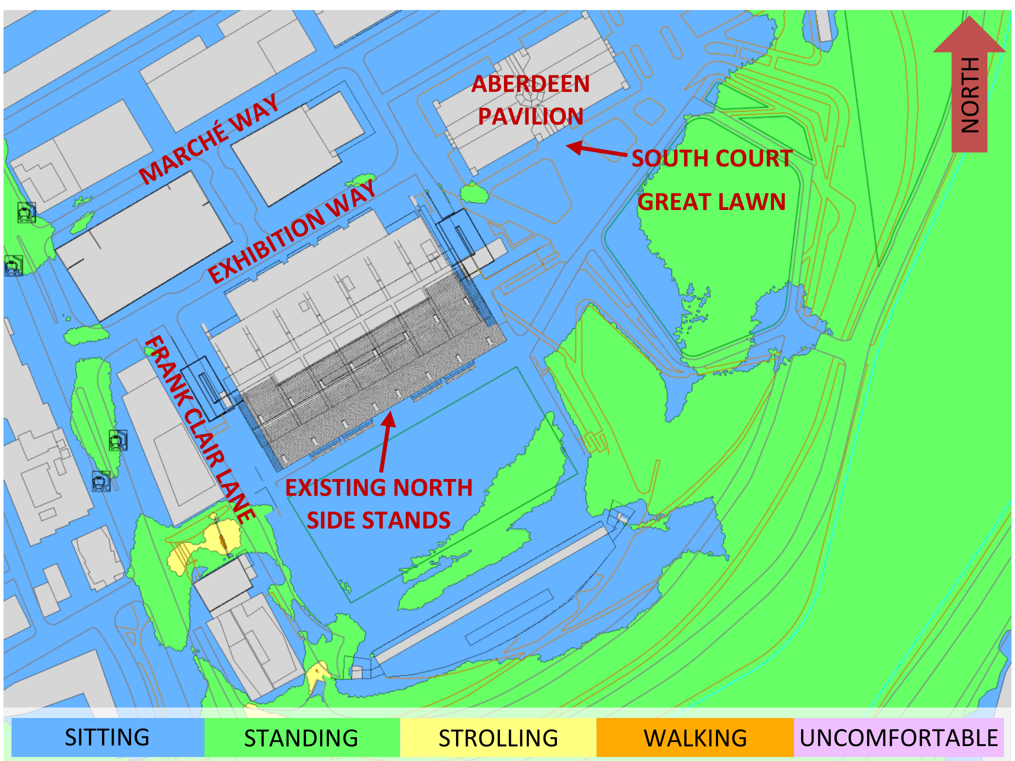


FIGURE 5B: AUTUMN – WIND COMFORT, EXISTING

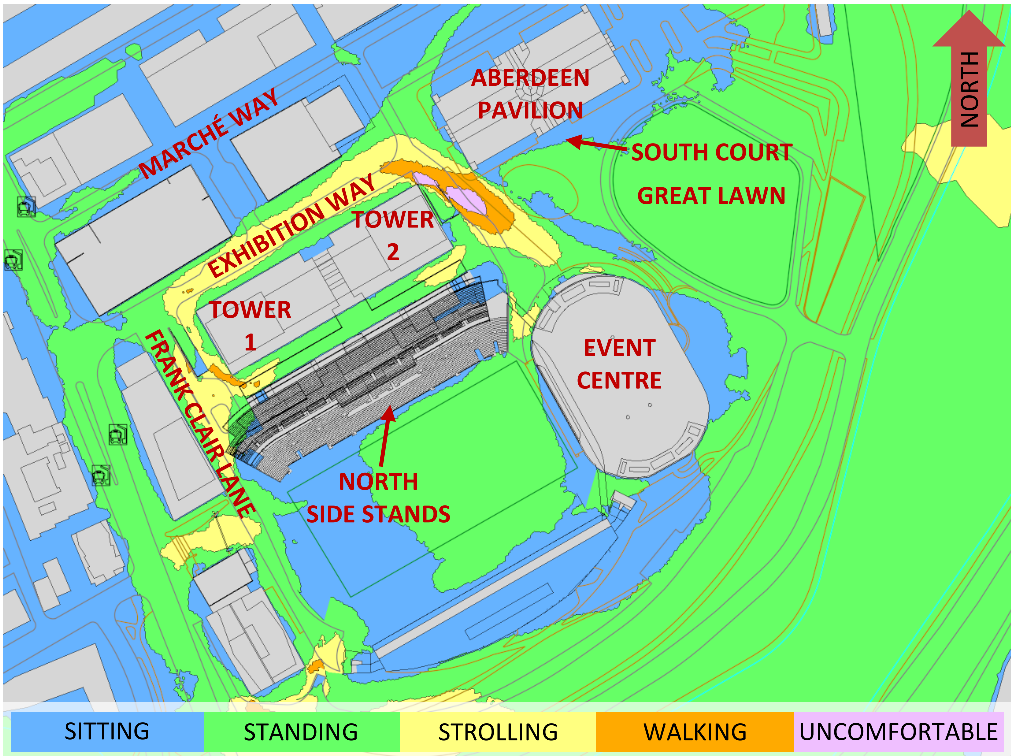


FIGURE 6A: WINTER – WIND COMFORT, PROPOSED

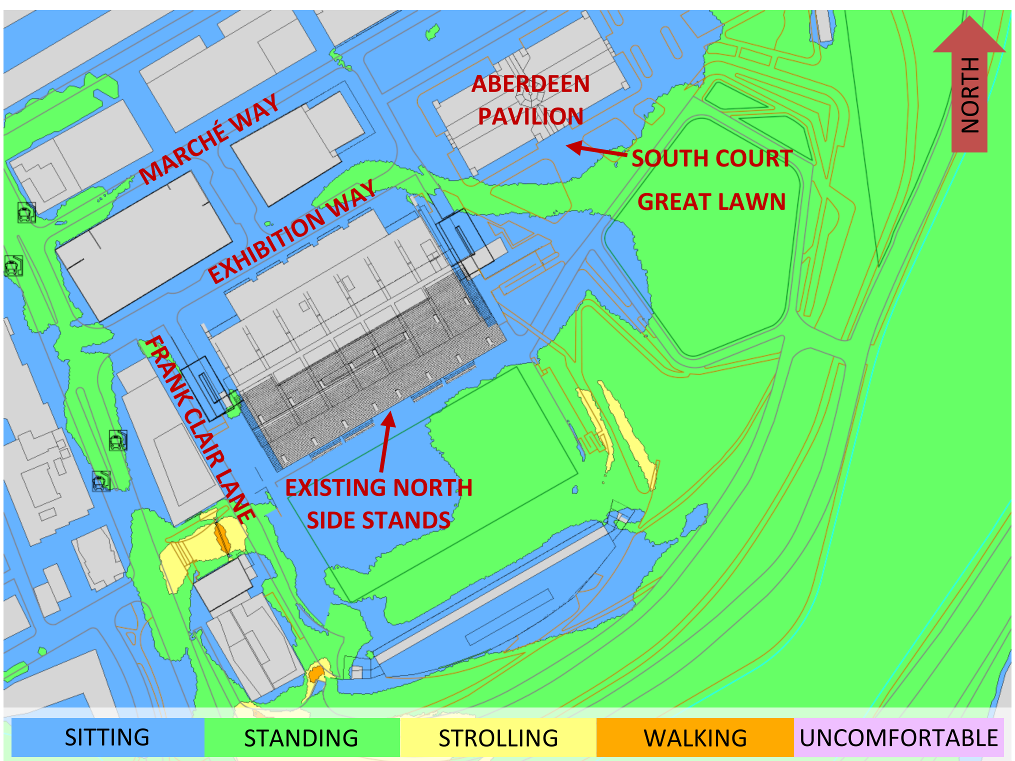


FIGURE 6B: WINTER – WIND COMFORT, EXISTING

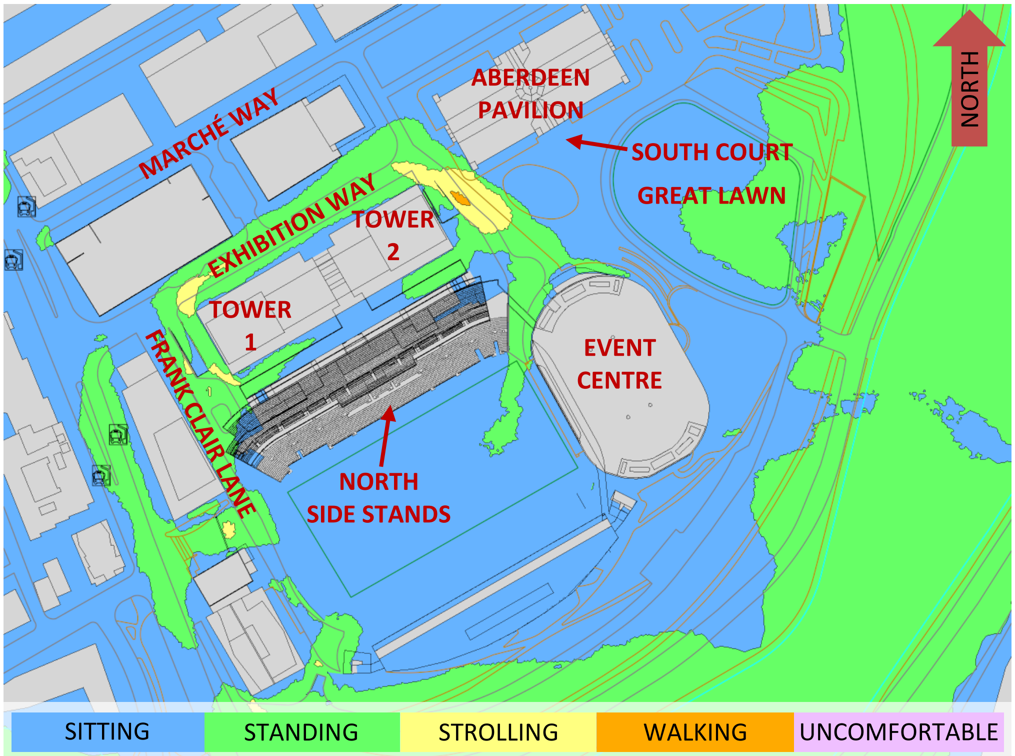


FIGURE 7A: TYPICAL USE PERIOD – WIND COMFORT, PROPOSED

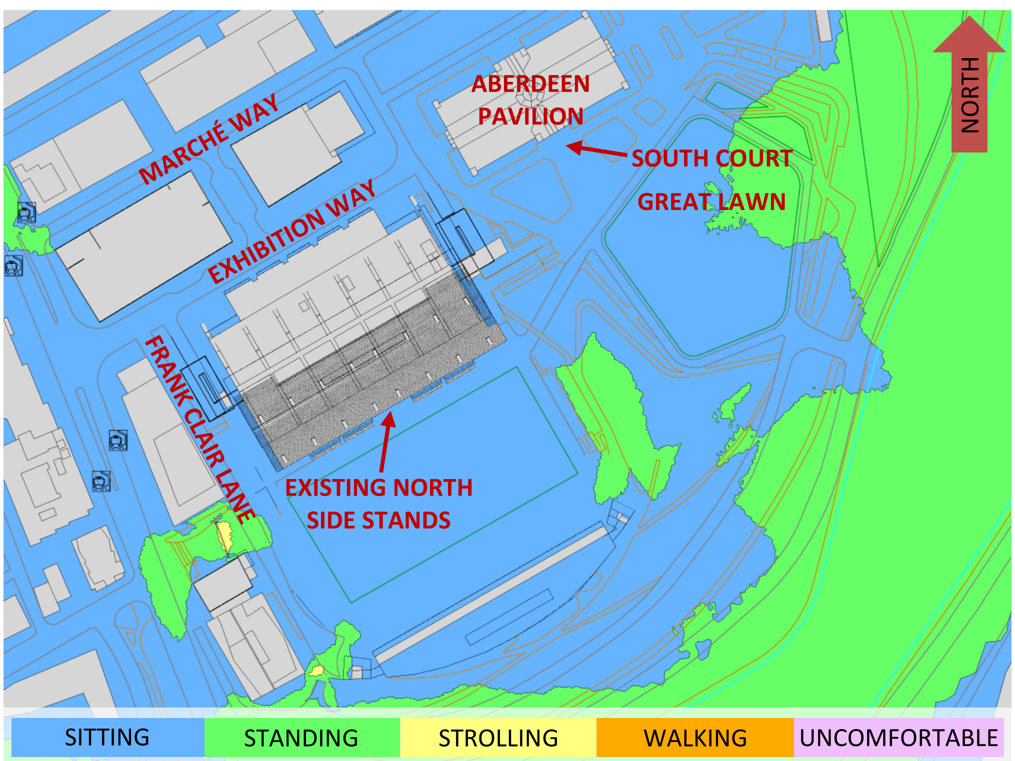
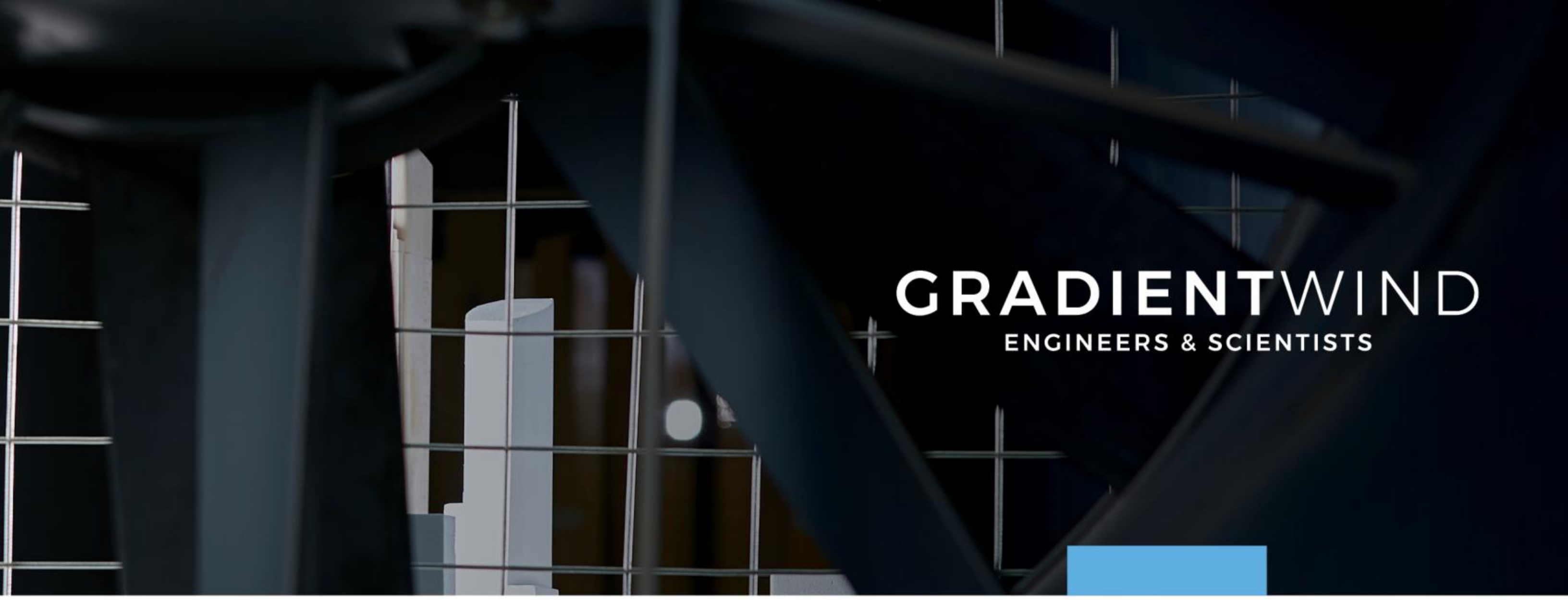
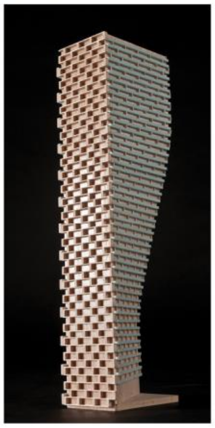
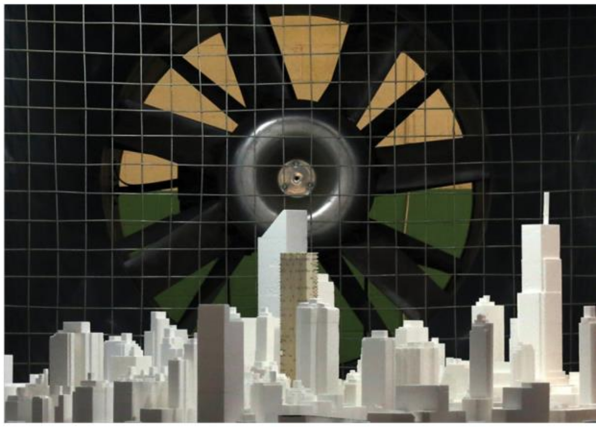


FIGURE 7B: TYPICAL USE PERIOD – WIND COMFORT, EXISTING







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, $\boldsymbol{U}$ = 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, 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	0.27
22.5	0.25
45	0.24
67.5	0.24
90	0.24
112.5	0.24
135	0.24
157.5	0.24
180	0.24
202.5	0.24
225	0.23
247.5	0.23
270	0.25
292.5	0.25
315	0.27
337.5	0.28

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).

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

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

where, ***I*** = turbulence intensity, $\boldsymbol{L_t}$ = 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.