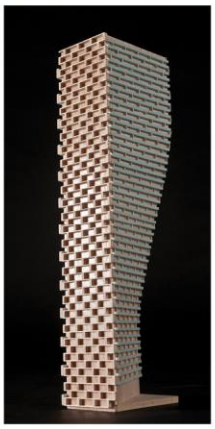
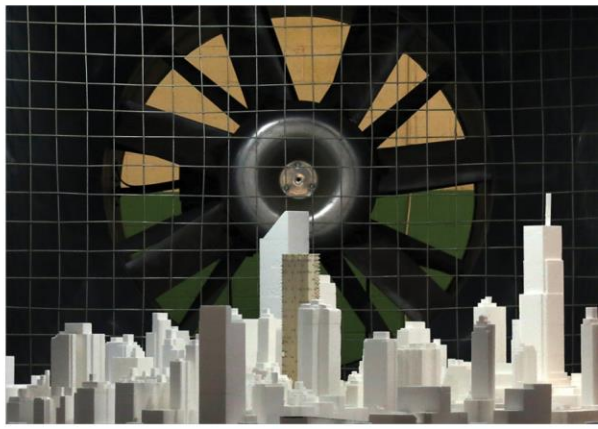
GRADIENTWIND
ENGINEERS & SCIENTISTS

PEDESTRIAN LEVEL WIND STUDY

Lansdowne 2.0
Ottawa, Ontario

Report: 23-053-PLW Two Tower Design





September 13, 2023

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City of Ottawa
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EXECUTIVE SUMMARY

This report describes a pedestrian level wind (PLW) study undertaken to satisfy Zoning By-law Amendment 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-11D, and summarized as follows:

1) Wind conditions in the vicinity of the building access points serving the proposed development and over all grade-level public sidewalks, surface parking, walkways, drop-off areas, the East Court, the Great Lawn, and the walking and bike pathways within Lansdowne Park within and surrounding the subject site are considerable acceptable for the intended pedestrian uses throughout the year.

2) Following the introduction of the proposed development, conditions over Aberdeen Square are predicted to be suitable for sitting during the spring, summer, and autumn, becoming suitable for a mix of sitting and standing during the winter. Conditions over the stadium field and the South Court are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the three colder months, while conditions over the existing patios along Exhibition Way are predicted to be suitable for a mix of sitting and standing during the summer and autumn, becoming suitable for standing during the spring and winter with conditions suitable for sitting along the building façades and strolling at the southeast corner of the patios.

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 South Court and over the existing patios along Exhibition Way during the colder seasons.

3) Wind conditions over the potential patio spaces along the north elevation of the proposed development are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year, while conditions over the seating areas along the walkway to the new Event Centre along the east elevation of Tower 2 are predicted to be suitable for standing, or better, during the spring, summer, and autumn, and strolling, or better, during the winter.

a. Targeted wind barriers, which could take the form of wind screens, clusters of coniferous plantings in dense arrangements, or a combination of both options, in combination with canopies above designated seating areas may be implemented to extend sitting conditions over the noted walkway seating areas, as well as over the potential patio spaces if these areas are included by the future retail tenants.

4) Areas to the north and at the southeast corner of the new Event Centre are predicted to be suitable for mostly sitting during the summer and autumn, becoming suitable for a mix of sitting and standing during the spring and winter. Conditions over the public promenade are predicted to be suitable for suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, throughout the colder months with a region of conditions suitable for walking to the south of Tower 1 during the winter.

a. The noted conditions within the public promenade and to the north and southeast of the new Event Centre may be considered acceptable depending on programming. Specifically, if the windier areas within these spaces will not accommodate seating or more sedentary activities, then the noted conditions would be considered acceptable.

b. If required by programming, comfort levels around seating areas within the noted windier areas may be improved with the implementation of targeted wind barriers around sensitive areas, which could take the form of wind screens, clusters of coniferous

plantings in dense arrangements, or a combination of both options, in combination with taller perimeter guards in place of standard height guards along perimeters of the promenade.

c. The extent of the mitigation measures is dependent on the programming of the noted areas. If required by programming, an appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the development progresses. This work is expected to support the future Site Plan Control application.

5) 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.

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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 Zoning By-Law Amendment (ZBLA) 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"). A PLW study considering the previous three-tower design of the Lansdowne 2.0 development was performed in June of 2022[1]. 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.

Our work is based on industry standard computer simulations using the computational fluid dynamics (CFD) technique and data analysis procedures, City of Ottawa wind comfort and safety criteria, architectural drawings prepared by Hobin Architecture in August 2023, 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

As a result of comments received through public consultant efforts, and City Staff review, as well as an internal evaluation of the development program, the proposed development has been amended as detailed below.

The proposed concept, as outlined in the June 2023 submission, has been revised to remove the third residential tower located closest to the Aberdeen Pavilion, resulting in a two-tower concept of 40 and 25 storeys in height. In addition to the removal of one residential tower, the proposed floorplate sizes of the remaining two towers have been reduced from approximately 900 square metres to approximately 800 square metres.

These two major revisions to the plan have resulted in a decrease in residential unit yield from 1,200 units to approximately 770 units (distributed between the two towers and potential residential podium). The revised design has also allowed for additional tower separation, with an opportunity to now provide

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

spacing between towers ranging from 40 to 60 metres, exceeding the distance required in the Zoning By-law and the Urban Design Guidelines for High Rise Buildings. Associated parking for the residential towers has also been reduced from the June 2023 proposal by almost half, decreasing from 739 spaces to 386 spaces. Of the 386 spaces proposed, approximately 35 spaces are allocated to non-residential uses. The remaining parking spaces will be allocated to the two residential towers. No visitor or commercial parking will be provided in the proposed new parking garage, as the existing 1,089 paid underground spaces (including the 230 nested Whole Foods / LCBO spaces) are expected to accommodate those vehicles. A bicycle parking count ratio of one space per unit continues to be proposed.

The retail podium is proposed to be developed as a two-storey built form, consistent with the June 2023 submission. As in the previous submission, the residential portion of the podium will be stepped back from the edge of the retail podium, providing a terrace for the residents of the building. The revised design also results in the podium decreasing in size from approximately 10,003 square metres to approximately 4,611 square metres. This decrease is a result of the removal of the music hall and one upper-level of retail space, which has been replaced by residential amenity area on the second floor of the podium. The reduction in the retail space still allows for an active ground floor that contributes to the year-round activation of Lansdowne.

The removal of the third residential tower adjacent to Aberdeen Pavilion has created an opportunity for the introduction of a new public realm space approximately 1,858 square metres in size. This new public realm space provides an opportunity for activation between the Aberdeen Pavilion and the new Event Centre. Key elements of the proposal such as the ceremonial stairs and raised promenade, as well as views to protected heritage assets are retained in the revised design.

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 rise to 40- and 25-storeys at the west and east, respectively, above a shared four-storey podium along the north elevation of the site. A public promenade is situated to the south of the two towers at Level 2 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. Access to underground parking and loading areas is provided at the east and west elevations of the proposed development. The NSS includes a potential roof over the upper seating levels.

Above an underground parking level, the ground floor of Towers 1 and 2 comprises retail frontage along Exhibition Way, with shared building support spaces along the rear elevation adjoining covered bike parking and loading areas. The residential lobby for Tower 1 is situated to the west, while the residential lobby serving Tower 2 is situated to the east. A ramp down to a truck parking facility is situated to the east of Tower 2. The second level of Towers 1 and 2 comprises commercial space and a residential amenity, respectively, and an outdoor amenity space is situated to the south of Tower 2 at this level. At Level 3, Towers 1 and 2 step back from their north and south elevations, and Levels 3 and 4 of both towers comprises residential units. An outdoor amenity is situated atop the podium between the two towers at Level 5, and the two towers rise above the shared podium with rectangular planforms. Levels 5 and 6 of Tower 1 comprise indoor amenities, while the remaining levels of Tower 1 and Levels 5-25 of Tower 2 comprise residential occupancy. Towers 1 and 2 step back from the west and east elevations at Level 5 and each tower is topped with a mechanical penthouse (MPH).

Level 1 of the NSS includes building operations areas, team spaces, a lower concourse to the west, viewing patios, and an office space to the north. Level 2 of the NSS comprises the main concourse. The NSS stands further include an upper concourse with fan decks overlooking the field, and two upper fan decks to the east and west that overlook the field.

The lower level of the proposed Event Centre comprises building operation and mechanical spaces, building support spaces, and team areas. The main level comprises the concourse level, while the second level includes a sports bar, media spaces, the Loge Club, Stageview Club, and other club spaces and suites.

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[2]. The following sections describe the analysis procedures, including a discussion of the noted pedestrian wind criteria.

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

4.1 Computer-Based Context Modelling

A computer based PLW study was performed to determine the influence of the wind environment on pedestrian comfort over the proposed development site. Pedestrian comfort predictions, based on the mechanical effects of wind, were determined by combining measured wind speed data from CFD simulations with statistical weather data obtained from Ottawa Macdonald-Cartier International Airport. The general concept and approach to CFD modelling is to represent building and topographic details in the immediate vicinity of the 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 12 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.

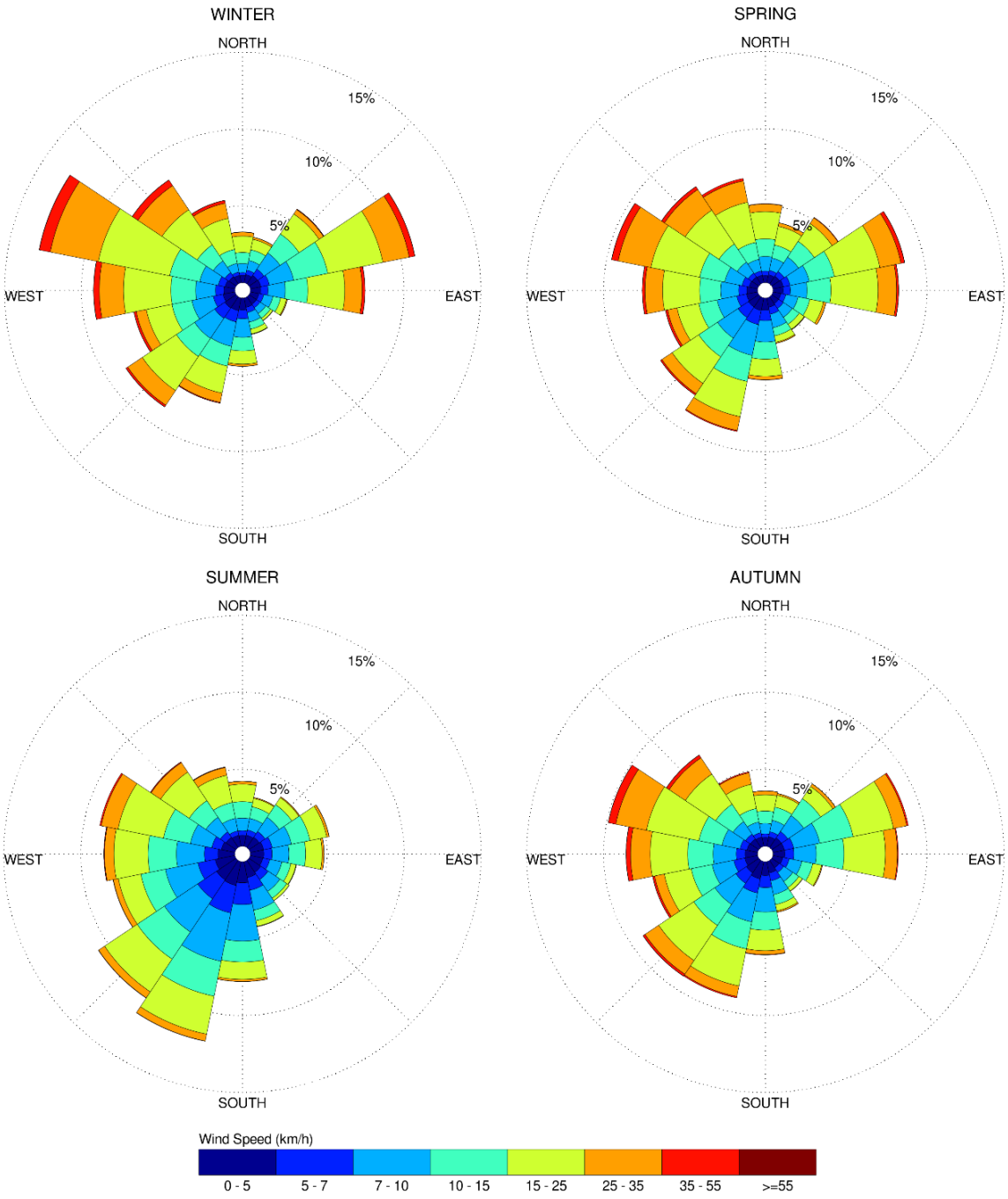
Mean and peak wind speed data obtained over the study site for each wind direction were interpolated to 36 wind directions at 10° intervals, representing the full compass azimuth. Measured wind speeds approximately 1.5 m above local grade and the public promenade were referenced to the wind speed at 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 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 COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	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-10C, illustrating wind conditions at grade level for the proposed and existing massing scenarios, and by Figures 11A-11D, which illustrate wind conditions over the public promenade. 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 – Grade Level

Sidewalks along Frank Clair Lane: Following the introduction of the proposed development, wind comfort conditions over the nearby sidewalks along Frank Clair Lane are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, throughout the remainder of the year. The windiest conditions are located along the parking and pedestrian ramps at the west elevation, and near the scoreboard during the winter. The noted conditions are considered acceptable for public sidewalks and walkways.

Conditions along Frank Clair Lane with 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 during the spring and winter predicted beneath the scoreboard. While the introduction of the proposed development is predicted to produce 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 at the west elevation of the field are predicted to suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the spring, autumn, and winter. Conditions over the noted area with the existing massing are predicted to be suitable for sitting during the summer, becoming suitable for sitting to the south and standing to the northwest during the three colder seasons.

Sidewalks, Drop-Off Areas, and Existing Patios along Exhibition Way: Following the introduction of the proposed development, conditions over the public sidewalks and drop-off areas along Exhibition Way are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for mostly standing during the autumn, and suitable for a mix of standing and strolling during the spring and winter. The noted conditions are considered acceptable for public sidewalks and drop-off areas.

Wind conditions over the existing restaurant patios along Exhibition way with the proposed massing are predicted to be suitable for a mix of sitting and standing during the summer and autumn. During the spring and winter, conditions over the noted patios are predicted to be suitable for mostly standing with conditions suitable for sitting along the building façades and conditions suitable for strolling at the southeast corner of the patio areas along Exhibition Way. Notably, 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, conditions with the proposed development over the noted areas are mostly suitable for sitting, with limited standing conditions along Exhibition Way that are mostly located over the adjoining sidewalks and roadway. Additionally, the noted moderately windier conditions suitable for strolling during the spring and winter are mostly limited to over the nearby roadways and public sidewalks. 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.

Conditions along Exhibition Way with the existing massing are predicted to be mostly suitable for sitting during the spring, summer, and autumn, becoming suitable for standing, or better, during the winter season, while conditions over the noted existing patios are predicted to be suitable for sitting throughout the year.

Potential Patio Spaces: Wind conditions over the potential patio spaces along the north elevation of the proposed development are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year. If these patio spaces are included by the future retail tenants of the Lansdowne 2.0 development, comfort levels may be improved with the implementation of targeted wind barriers around seating areas, which could take the form of wind screens, clusters of coniferous plantings in dense arrangements, or a combination of both options, in combination with canopies above designated seating areas.

Sidewalks along Paul Askin Way: 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 sitting and standing during the remaining seasons. The noted conditions are considered acceptable.

Conditions over the sidewalks along Paul Askin Way with the existing massing are predicted to be mostly suitable for sitting throughout the year. 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: Following the introduction of the proposed development, wind comfort conditions within Aberdeen Square are predicted to be suitable for sitting during the spring, summer, and autumn, becoming suitable for a mix of sitting and standing and during the winter. Wind conditions over Aberdeen Square with the existing massing are predicted to be suitable for sitting throughout the year.

South Court: Following the introduction of the proposed development, wind conditions over the South Court are predicted to be suitable for mostly sitting during the summer, becoming suitable for a mix of mostly sitting and standing throughout the remainder of the year. With the existing massing, wind conditions over the South Court are predicted to be suitable for sitting during the summer, suitable for sitting during the autumn with standing conditions to the east of the South Court, and suitable for standing to the east and west and sitting elsewhere within the court during the spring and winter. Notably, landscaping elements that could not be implemented in the simulation model (that is, dense plantings and trees), as described in Section 4.1, are expected to improve pedestrian comfort around seating areas within the South Court during the colder seasons.

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 throughout the year. 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 proposed walkway to the east of Tower 2 that connects the Aberdeen Pavilion to the proposed Event Centre are predicted to be suitable for a mix of sitting and standing during the spring, summer, and autumn, becoming suitable for a mix of sitting, standing, and strolling during the winter. The noted conditions are considered acceptable for public walkways and pathways.

Wind conditions over the seating areas along the noted walkways are predicted to be suitable for mostly sitting during the summer, becoming suitable for standing, or better, during the spring and autumn, and strolling, or better, during the winter. If required by programming, sitting conditions may be extended over the noted areas by implementing targeted wind barriers in the form of wind screens and coniferous plantings around designated seating areas.

New Event Centre Public Areas: Wind conditions to the north and at the southeast corner of the proposed Event Centre are predicted to be suitable for mostly sitting during the summer and autumn, becoming suitable for a mix of sitting and standing during the spring and winter. Where conditions are suitable for standing, they are also suitable for sitting for at least 75% of the time during the spring and at least 70% of the time during the winter, where the target is 80% to achieve the sitting comfort class.

Depending on the programming of these areas, conditions within the noted areas may be considered acceptable. Specifically, if the windier areas within the noted spaces will not accommodate seating or more sedentary activities, then the conditions would be considered acceptable. If required by programming, comfort levels may be improved with the implementation of targeted wind barriers around sensitive areas, which could take the form of wind screens, clusters of coniferous trees in dense arrangements, or a combination of both options.

Great Lawn: 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. Conditions are predicted to be suitable for mostly standing during the spring and winter. Prior to the introduction of the proposed development, wind conditions over the Great Lawn are predicted to be suitable for sitting during the summer, becoming suitable for standing to the east and sitting to the west during the spring, autumn, and winter. While the introduction of the proposed development produces windier conditions over the Great Lawn, wind conditions with the proposed development remain mostly similar to those under the existing massing during the primary use seasons of spring, summer, and autumn, and furthermore, the Great Lawn has limited seating areas. As such, 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 comfort conditions over the nearby existing pathways within Lansdowne Park to the south and east of the new Event Centre are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, throughout the remainder of the year. Wind conditions following the introduction of the proposed development are predicted to be similar over the noted pathways. The noted conditions are considered acceptable for public pathways and bicycle paths.

Stadium Field: Under the existing massing, wind conditions over the stadium field are predicted to be suitable for sitting during the summer and autumn. During the spring, the east end of the field is predicted to have conditions suitable for standing, while the remainder of the field is suitable for sitting, and during the winter season when the use of the field is limited, the standing conditions extend to the middle of the field. With the proposed development, conditions over the field are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing during the three colder seasons. The majority of the field is predicted to be suitable for standing during the spring and winter, with sitting conditions predicted at the west end of the field and over the eastern portion of the east end zone.

Laneway, Bike Storage, and Loading Areas to the South of Towers 1 and 2: Wind conditions over the covered bike storage and loading areas beneath the public promenade and over the laneway along the west elevation of Tower 1 are predicted suitable for standing, or better, during the summer, becoming suitable for strolling, or better, during the remainder of the year. The noted conditions are considered acceptable.

Public Promenade and Ceremonial Stair: As illustrated in Figures 11A-11D, wind comfort conditions over the ceremonial stair and passageway leading to the public promenade are predicted to be suitable for sitting during the summer, becoming suitable for standing, or better, during the spring, autumn, and winter. The noted conditions are considered acceptable for public walkways.

Conditions over the public promenade during the summer are predicted to are predicted to be suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, during the spring, autumn, and winter, with an area of conditions suitable for walking during the winter to the west of the public promenade.

The noted conditions within the public promenade may be considered acceptable depending on programming. Specifically, if the windier areas of the promenade will not accommodate seating or more sedentary activities, then the noted conditions would be considered acceptable. If required by programming, comfort levels around sensitive areas may be improved by implementing taller perimeter guards in place of standard height guards along the perimeters of the promenade, in combination with wind barriers or canopies located around sensitive areas.

The extent of the mitigation measures is dependent on the programming of the promenade. If required by programming, an appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the development progresses. This work is expected to support the future Site Plan Control application.

Building Access Points: Owing to the protection of the building façades, conditions in the vicinity of the building access points serving the proposed development are predicted to be suitable for standing, 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-11D. 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) Wind conditions in the vicinity of the building access points serving the proposed development and over all grade-level public sidewalks, surface parking, walkways, drop-off areas, the East Court, the Great Lawn, and the walking and bike pathways within Lansdowne Park within and surrounding the subject site are considerable acceptable for the intended pedestrian uses throughout the year.

2) Following the introduction of the proposed development, conditions over Aberdeen Square are predicted to be suitable for sitting during the spring, summer, and autumn, becoming suitable for a mix of sitting and standing during the winter. Conditions over the stadium field and the South Court are predicted to be suitable for sitting during the summer, becoming suitable for a mix of sitting and standing throughout the three colder months, while conditions over the existing patios along Exhibition Way are predicted to be suitable for a mix of sitting and standing during the summer and autumn, becoming suitable for standing during the spring and winter with conditions suitable for sitting along the building façades and strolling at the southeast corner of the patios.

    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 South Court and over the existing patios along Exhibition Way during the colder seasons.

3) Wind conditions over the potential patio spaces along the north elevation of the proposed development are predicted to be suitable for sitting during the summer, becoming suitable for standing throughout the remainder of the year, while conditions over the seating areas along the walkway to the new Event Centre along the east elevation of Tower 2 are predicted to be suitable for standing, or better, during the spring, summer, and autumn, and strolling, or better, during the winter.

a. Targeted wind barriers, which could take the form of wind screens, clusters of coniferous plantings in dense arrangements, or a combination of both options, in combination with canopies above designated seating areas may be implemented to extend sitting conditions over the noted walkway seating areas, as well as over the potential patio spaces if these areas are included by the future retail tenants.

4) Areas to the north and at the southeast corner of the new Event Centre are predicted to be suitable for mostly sitting during the summer and autumn, becoming suitable for a mix of sitting and standing during the spring and winter. Conditions over the public promenade are predicted to be suitable for suitable for a mix of sitting and standing during the summer, becoming suitable for strolling, or better, throughout the colder months with a region of conditions suitable for walking to the south of Tower 1 during the winter.

a. The noted conditions within the public promenade and to the north and southeast of the new Event Centre may be considered acceptable depending on programming. Specifically, if the windier areas within these spaces will not accommodate seating or more sedentary activities, then the noted conditions would be considered acceptable.

b. If required by programming, comfort levels around seating areas within the noted windier areas may be improved with the implementation of targeted wind barriers around sensitive areas, which could take the form of wind screens, clusters of coniferous plantings in dense arrangements, or a combination of both options, in combination with taller perimeter guards in place of standard height guards along perimeters of the promenade.

c. The extent of the mitigation measures is dependent on the programming of the noted areas. If required by programming, an appropriate mitigation strategy will be developed in collaboration with the building and landscape architects as the design of the development progresses. This work is expected to support the future Site Plan Control application.

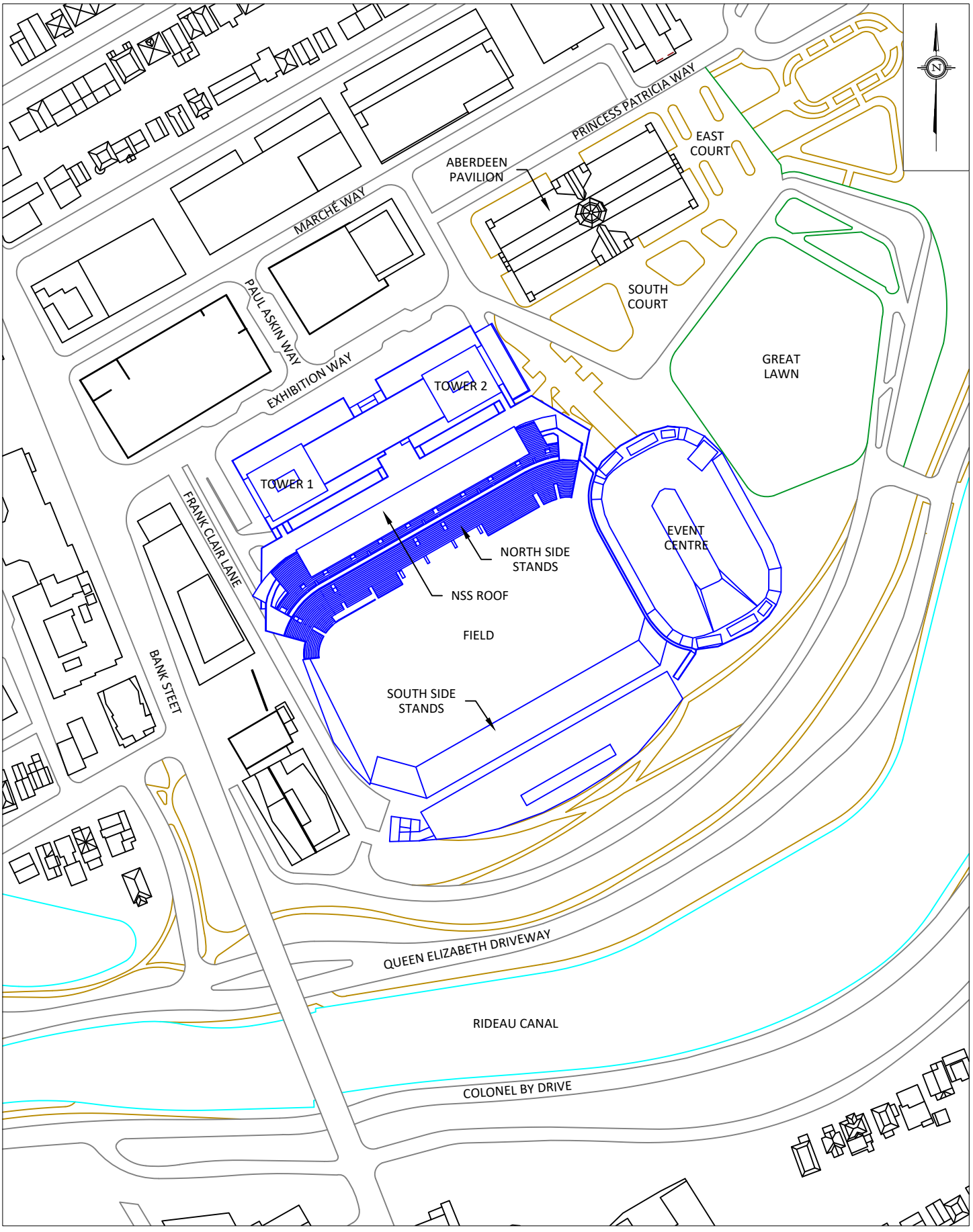
5) The foregoing statements and conclusions apply to common weather systems, during which no dangerous wind conditions, as defined in Section 4.4, are expected anywhere over the subject site. During extreme weather events, (for example, thunderstorms, tornadoes, and downbursts), pedestrian safety is 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.

David Huitema, M.Eng.
Wind Scientist

Justin Ferraro, P.Eng.
Principal



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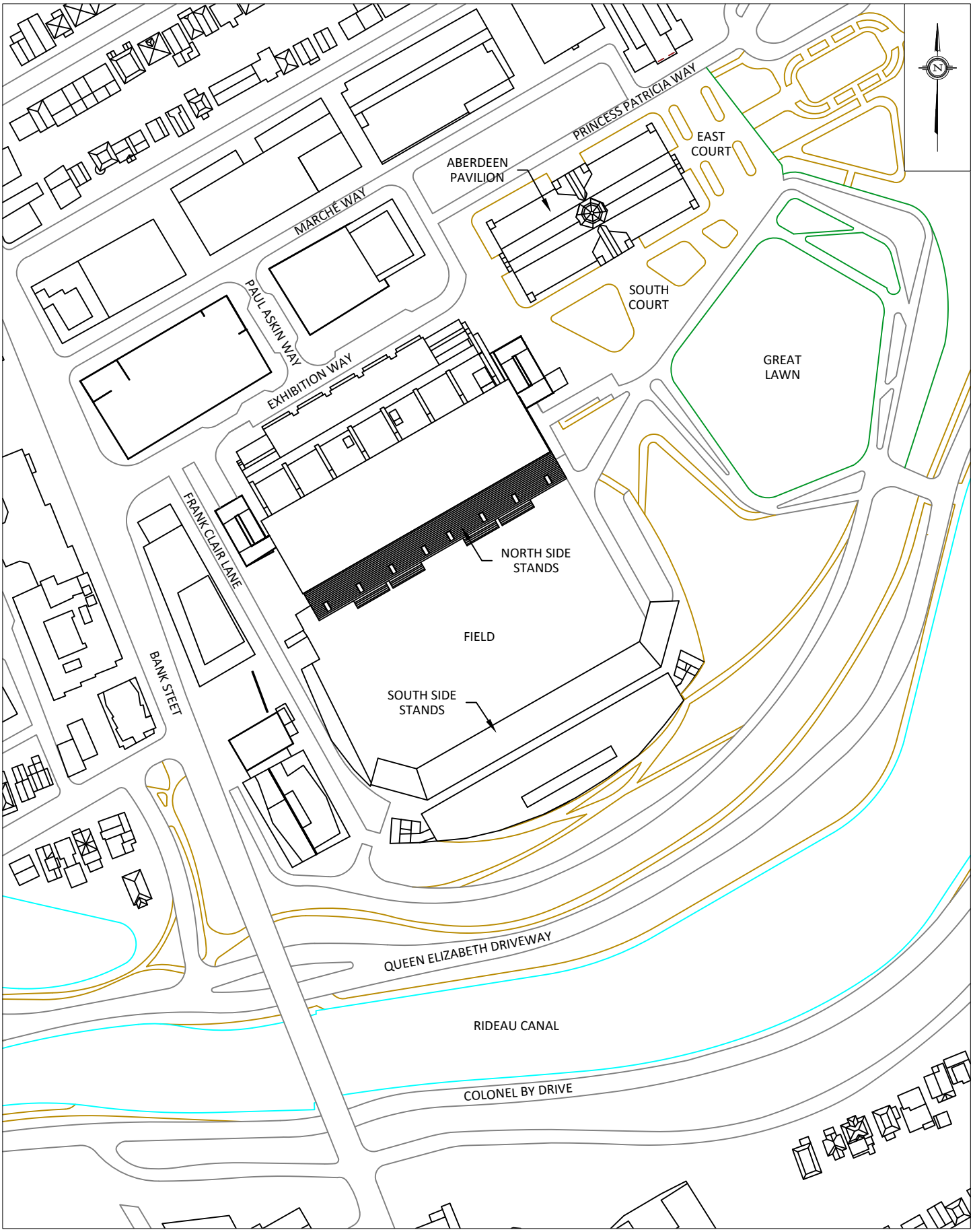
PROJECT	LANSDOWNE 2.0, OTTAWA PEDESTRIAN LEVEL WIND STUDY
SCALE	1:2000
DRAWING NO.	23-053-PLW-1A
DATE	AUGUST 31, 2023
DRAWN BY	T.K.

DESCRIPTION

FIGURE 1A:
PROPOSED SITE PLAN AND SURROUNDING CONTEXT
WITH NORTH SIDE STANDS ROOF



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PROJECT	LANSDOWNE 2.0, OTTAWA PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION
SCALE	1:2000	DRAWING NO.	23-053-PLW-1B
DATE	AUGUST 31, 2023	DRAWN BY	T.K.

FIGURE 1B:
EXISTING SITE PLAN AND SURROUNDING CONTEXT

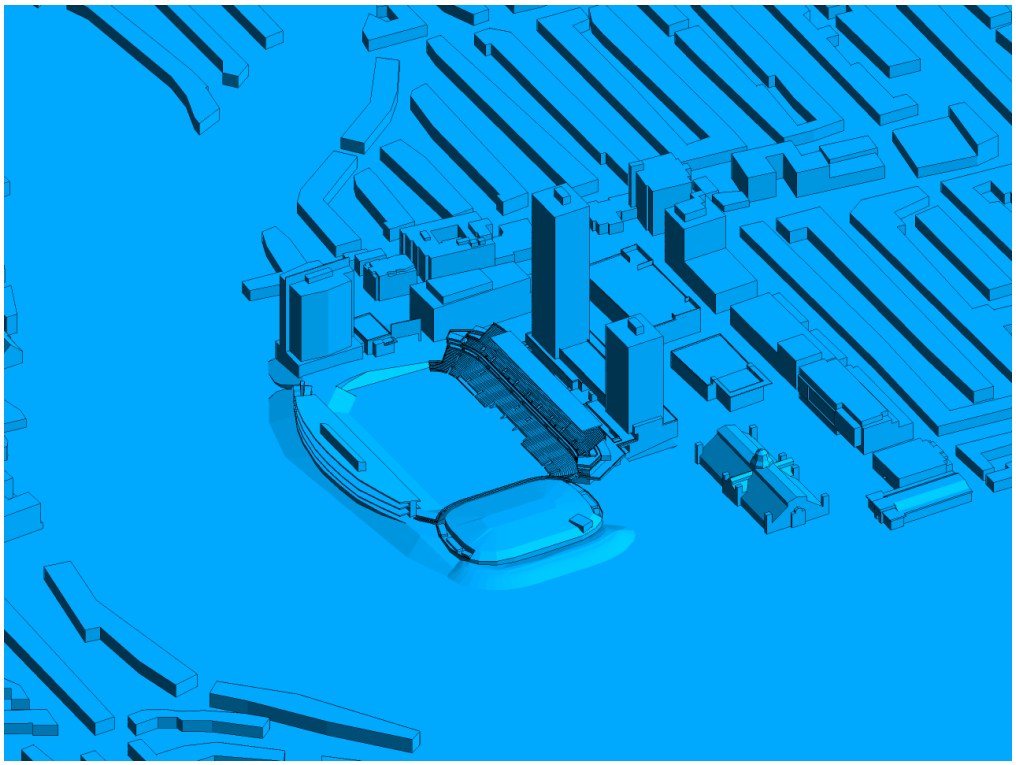


FIGURE 2A: COMPUTATIONAL MODEL, PROPOSED MASSING, EAST VIEW

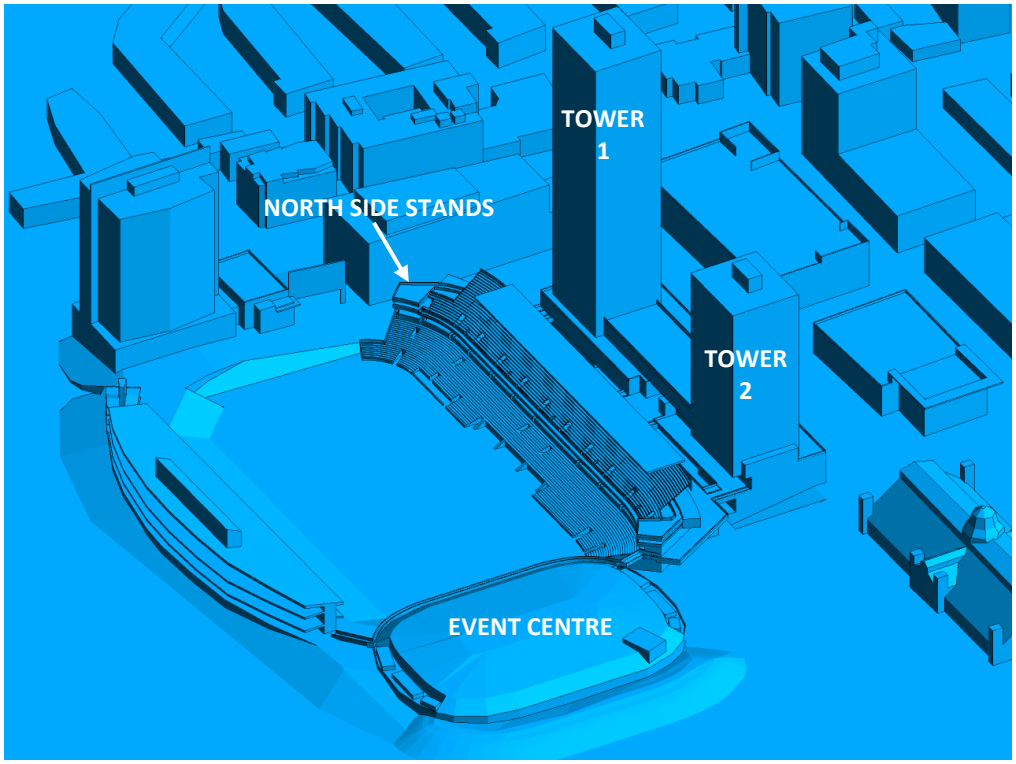


FIGURE 2B: CLOSE UP OF FIGURE 2A

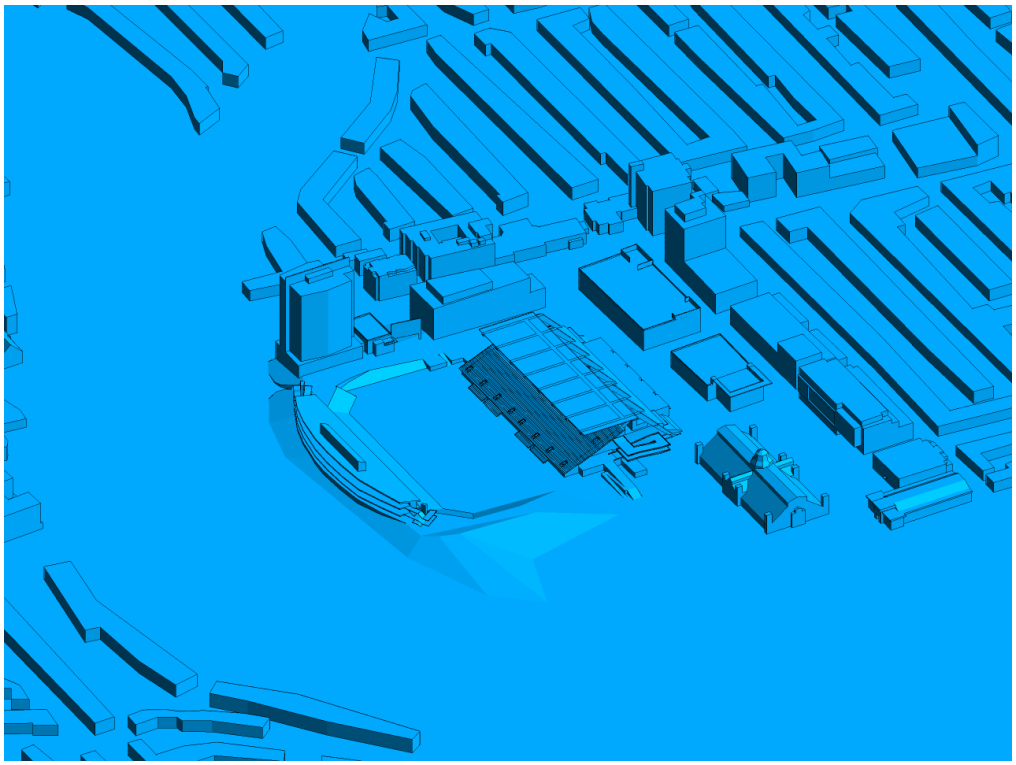


FIGURE 2C: COMPUTATIONAL MODEL, EXISTING MASSING, EAST VIEW

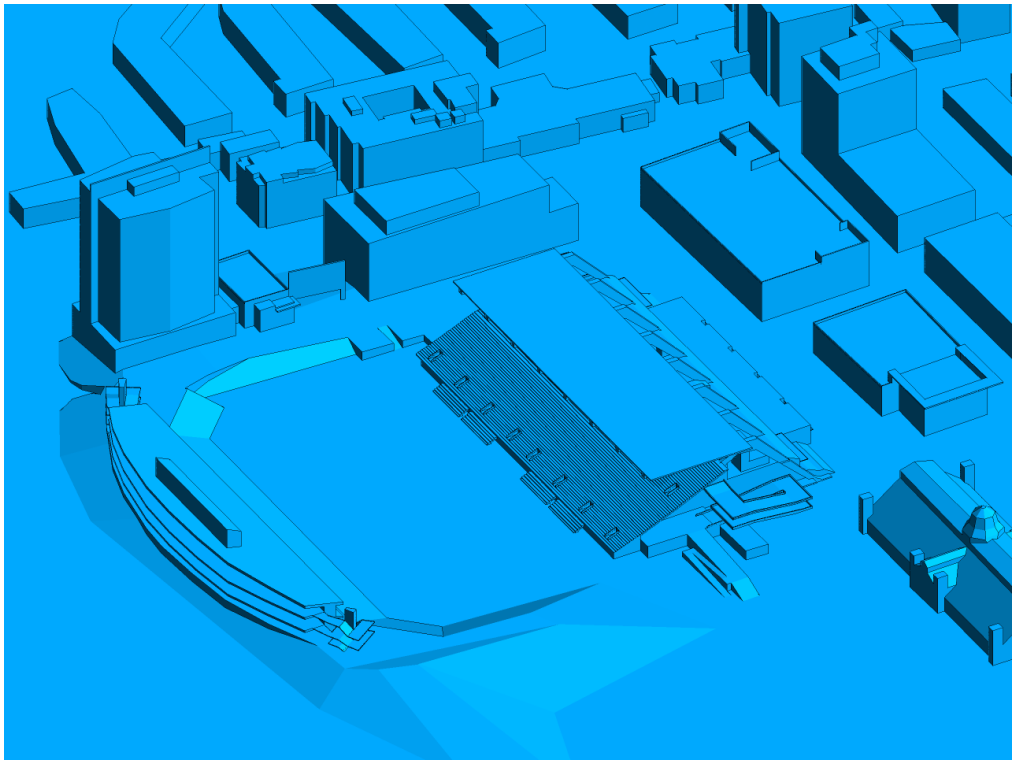


FIGURE 2D: CLOSE UP OF FIGURE 2C

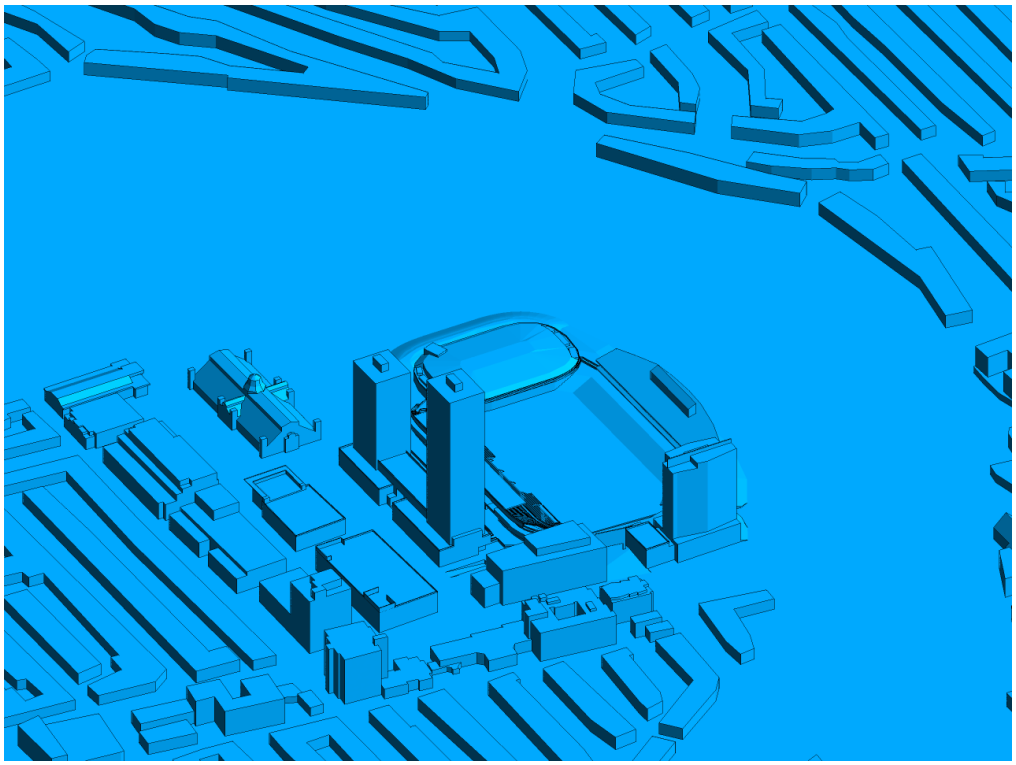


FIGURE 2E: COMPUTATIONAL MODEL, PROPOSED MASSING, WEST VIEW

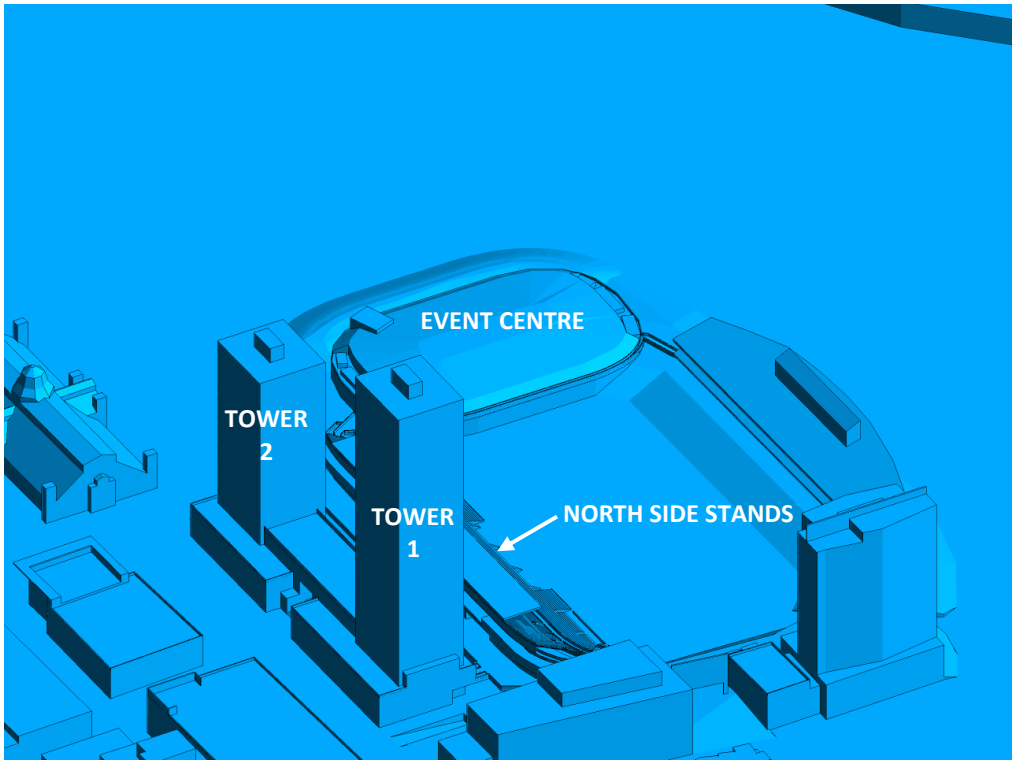


FIGURE 2F: CLOSE UP OF FIGURE 2E

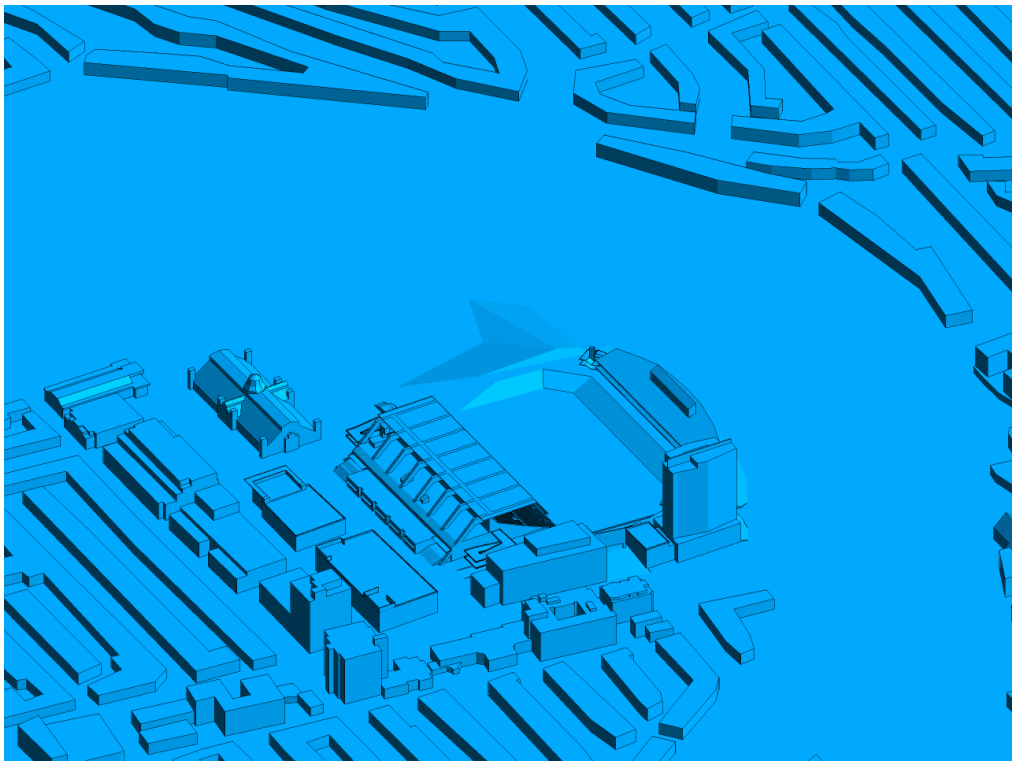


FIGURE 2G: COMPUTATIONAL MODEL, EXISTING MASSING, WEST PERSPECTIVE

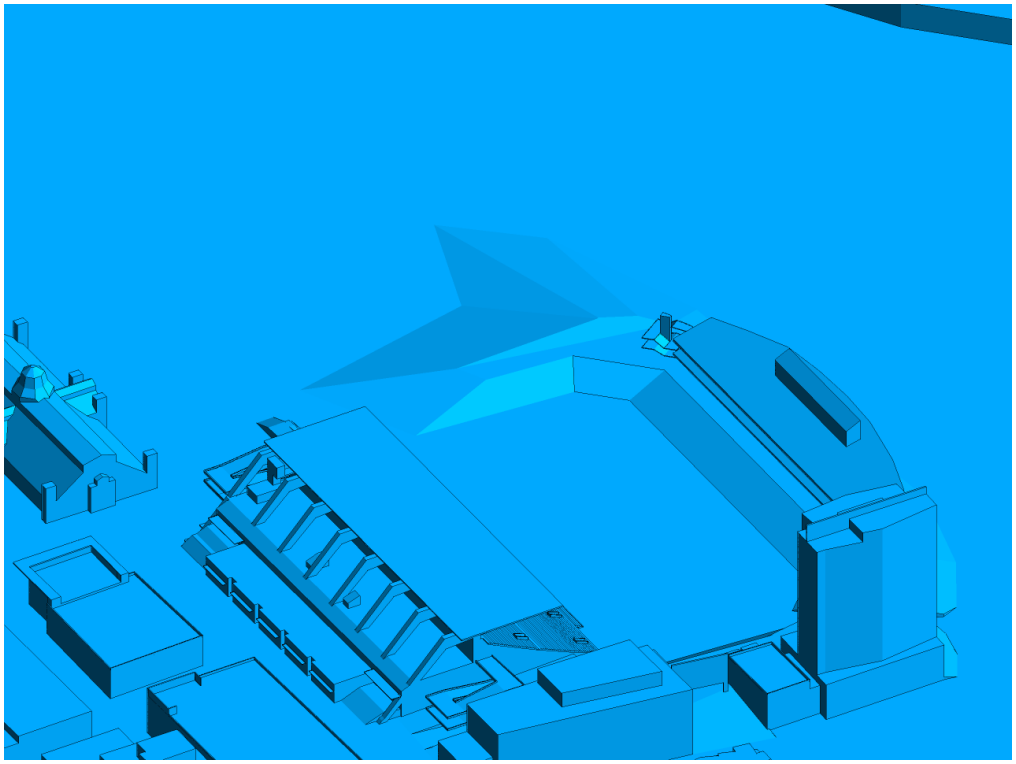


FIGURE 2H: CLOSE UP OF FIGURE 2G

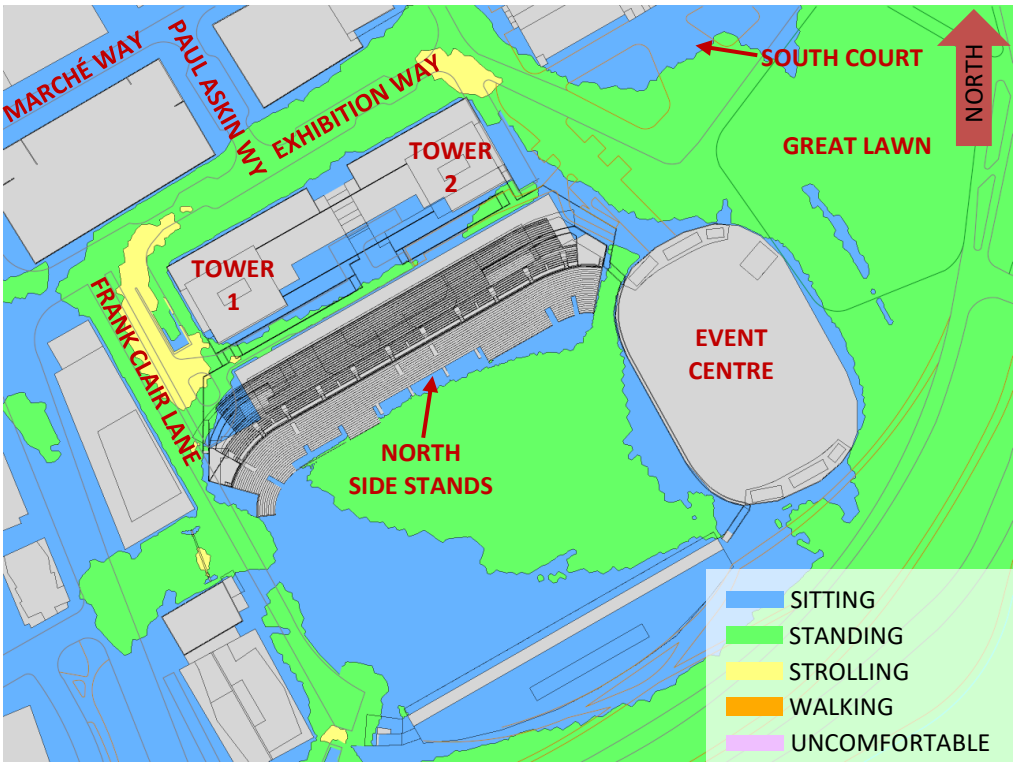


FIGURE 3A: SPRING – WIND COMFORT, TD PLACE – PROPOSED

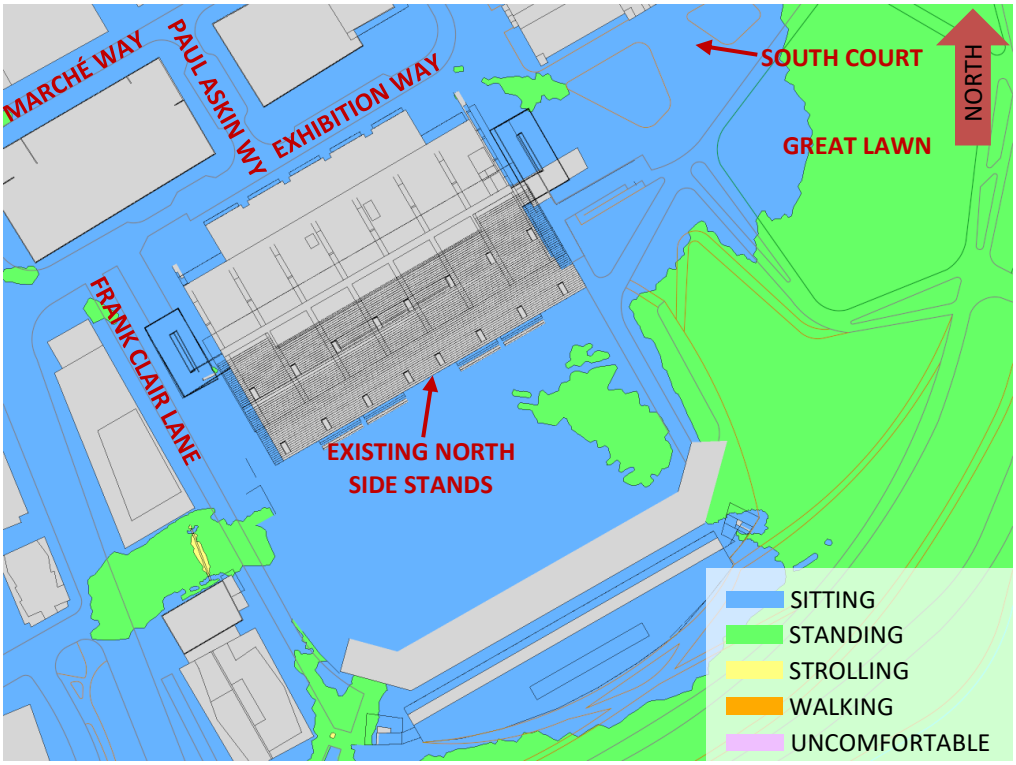


FIGURE 3B: SPRING – WIND COMFORT, TD PLACE – EXISTING

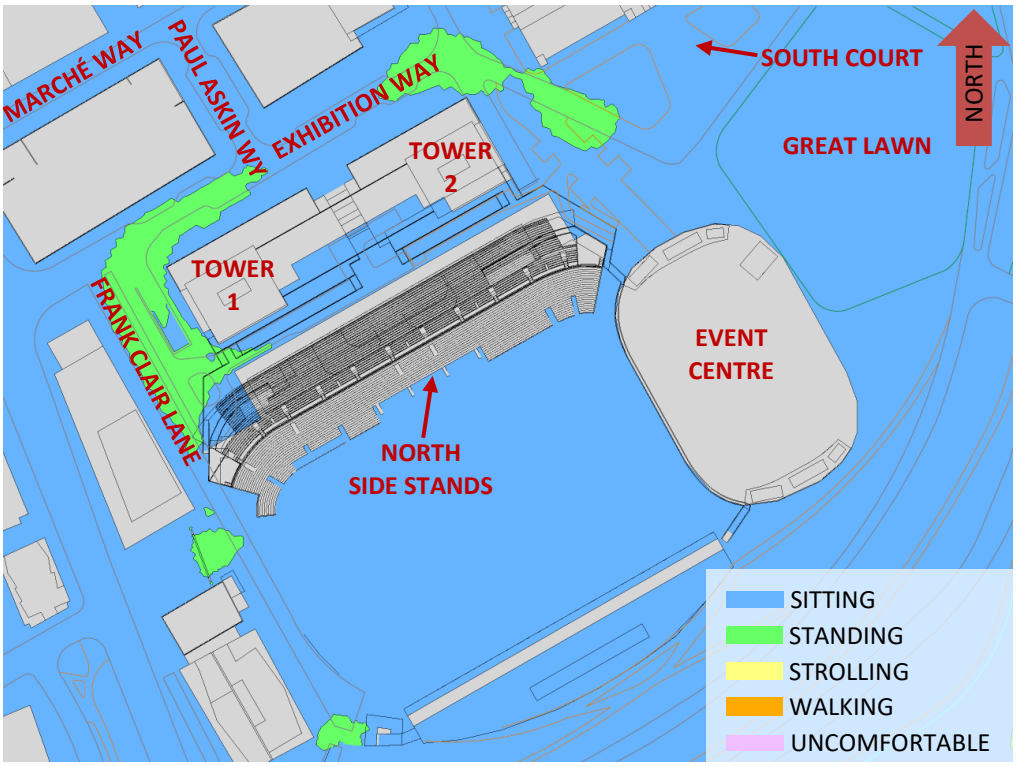


FIGURE 4A: SUMMER – WIND COMFORT, TD PLACE – PROPOSED

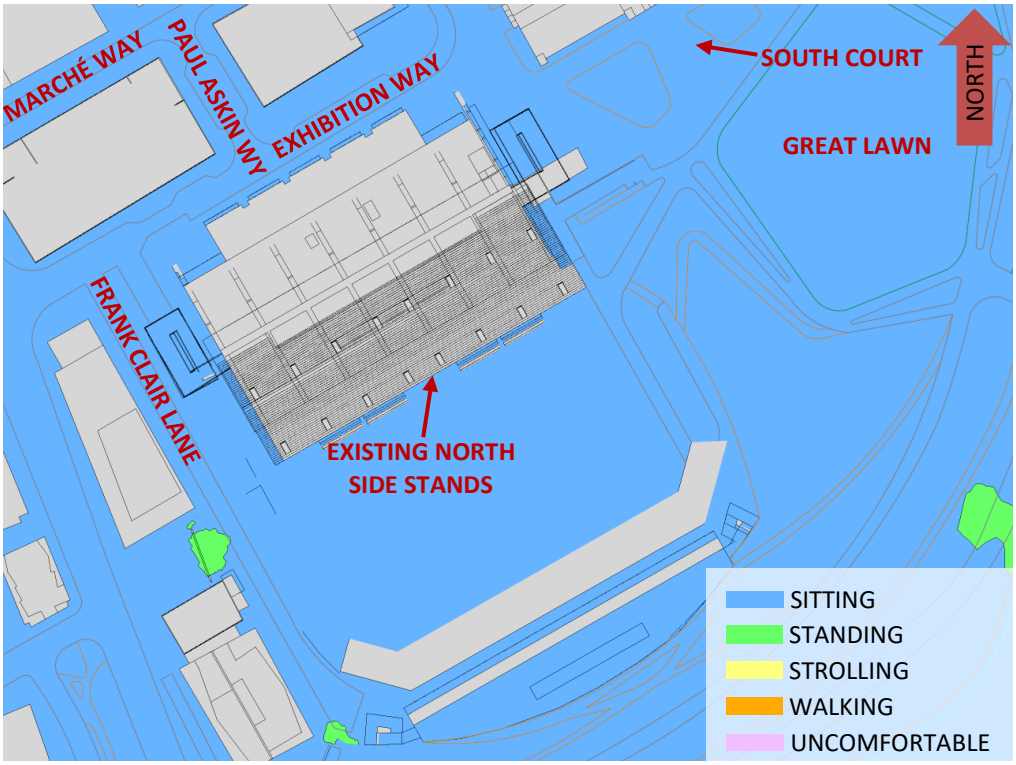


FIGURE 4B: SUMMER – WIND COMFORT, TD PLACE – EXISTING

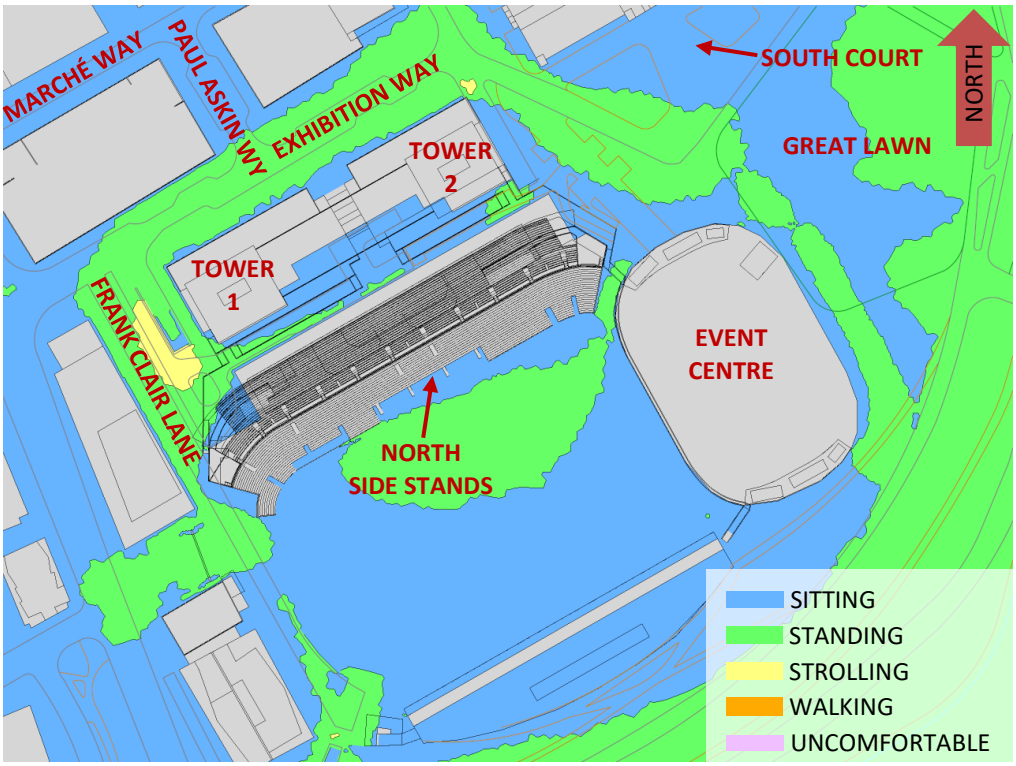


FIGURE 5A: AUTUMN – WIND COMFORT, TD PLACE – PROPOSED

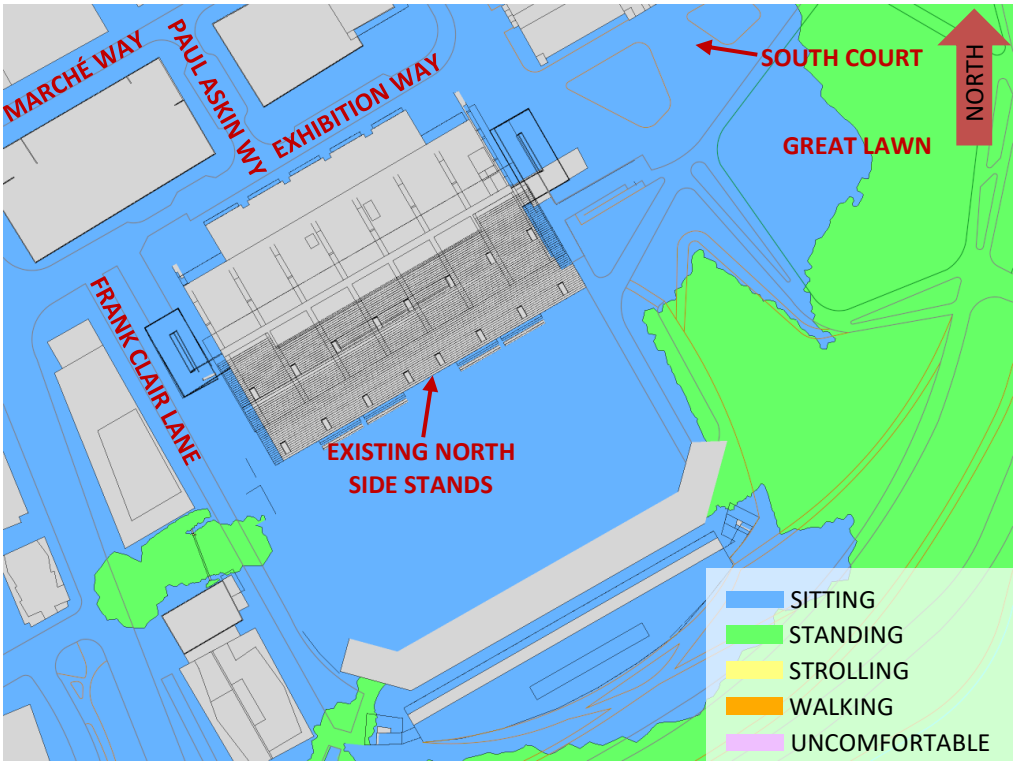


FIGURE 5B: AUTUMN – WIND COMFORT, TD PLACE – EXISTING

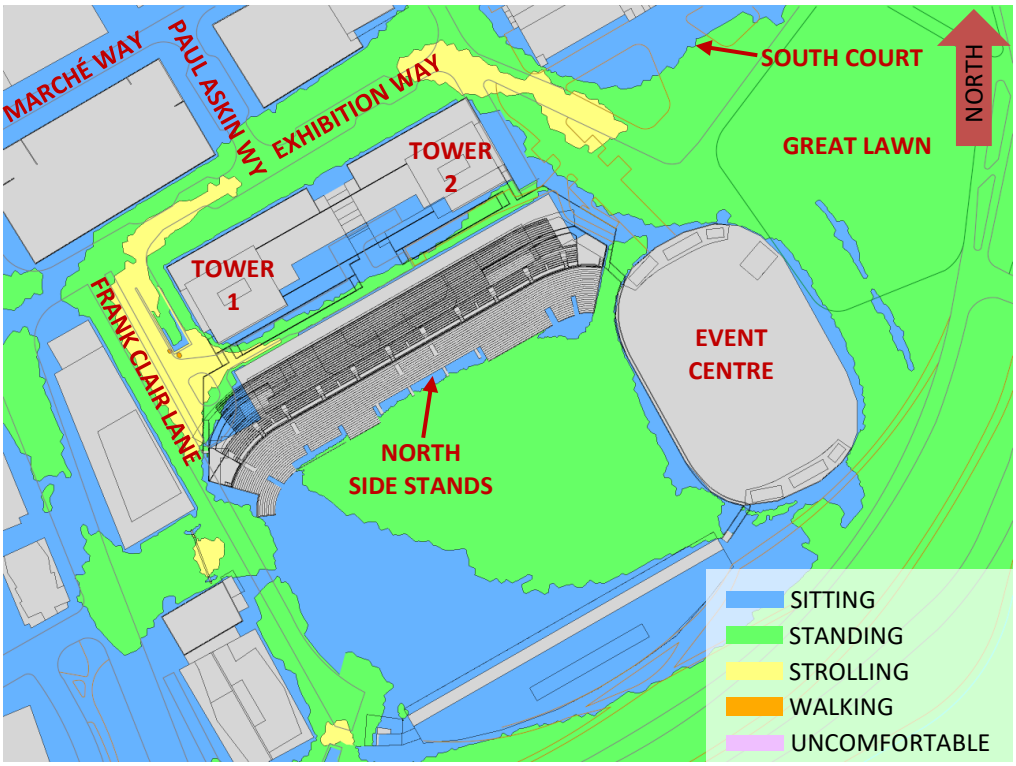


FIGURE 6A: WINTER – WIND COMFORT, TD PLACE – PROPOSED

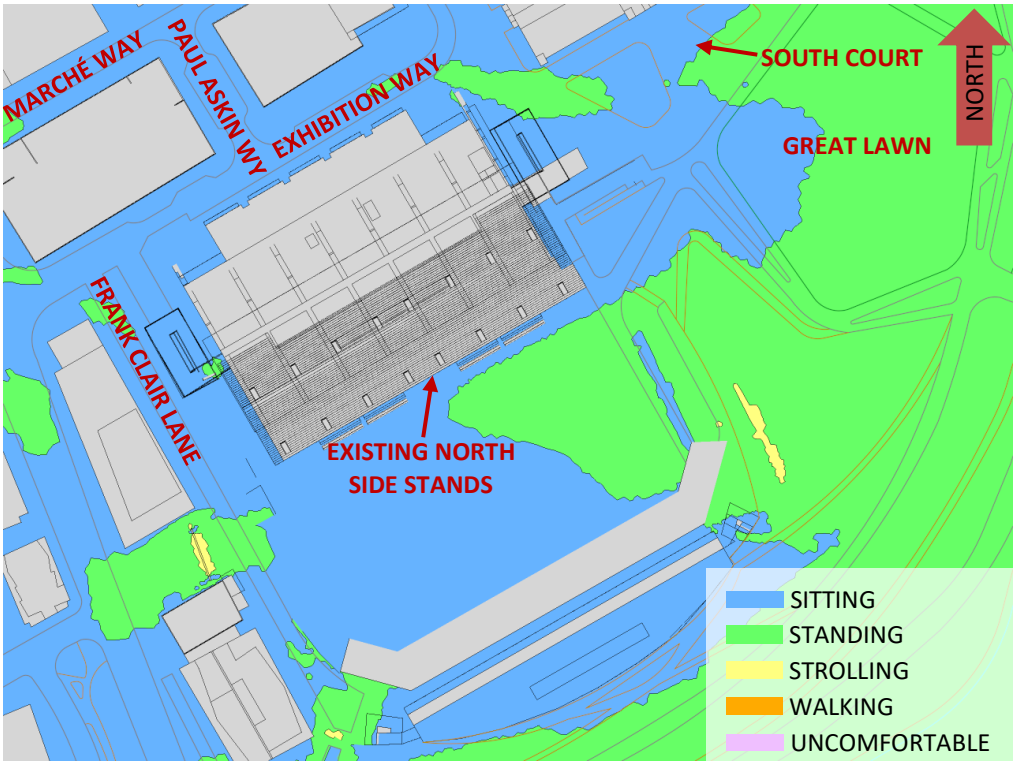


FIGURE 6B: WINTER – WIND COMFORT, TD PLACE – EXISTING

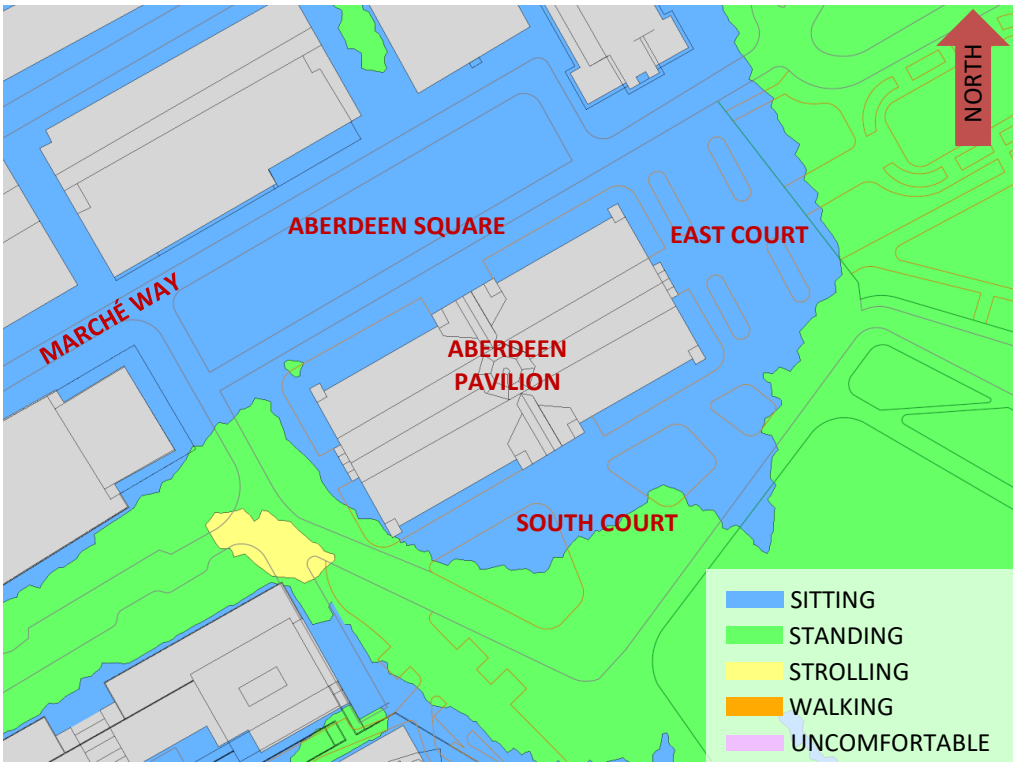


FIGURE 7A: SPRING – WIND COMFORT, ABERDEEN PAVILION – PROPOSED

FIGURE 7B: SPRING – WIND COMFORT, ABERDEEN PAVILION – EXISTING

FIGURE 8A: SUMMER – WIND COMFORT, ABERDEEN PAVILION – PROPOSED

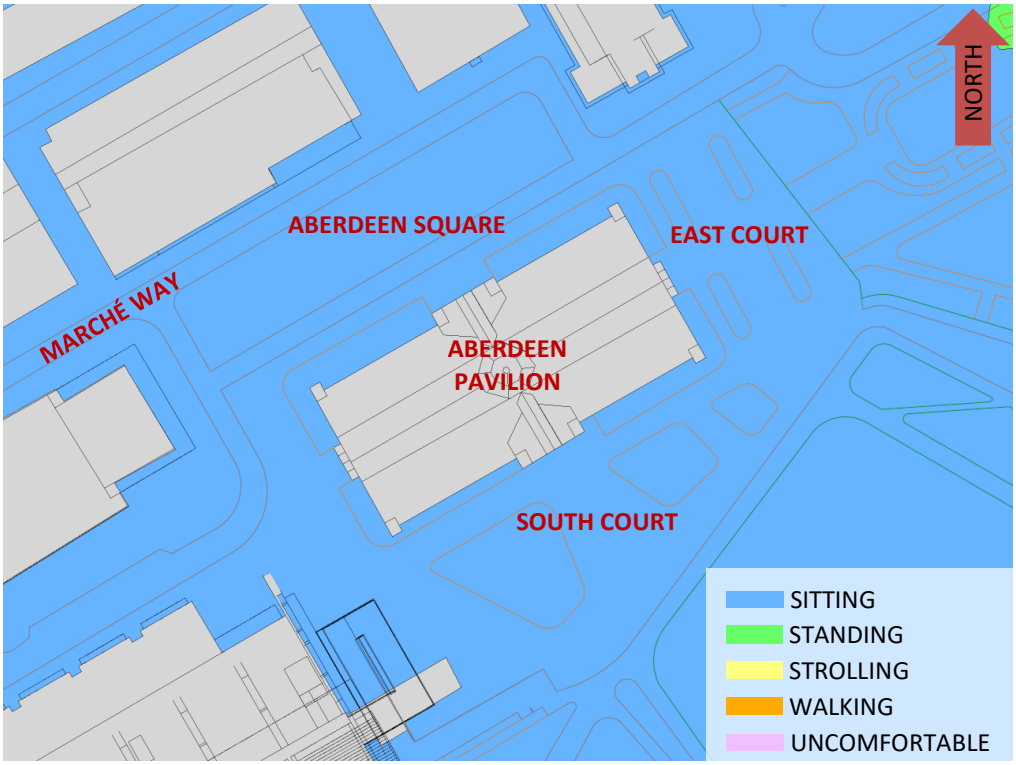


FIGURE 8B: SUMMER – WIND COMFORT, ABERDEEN PAVILION – EXISTING

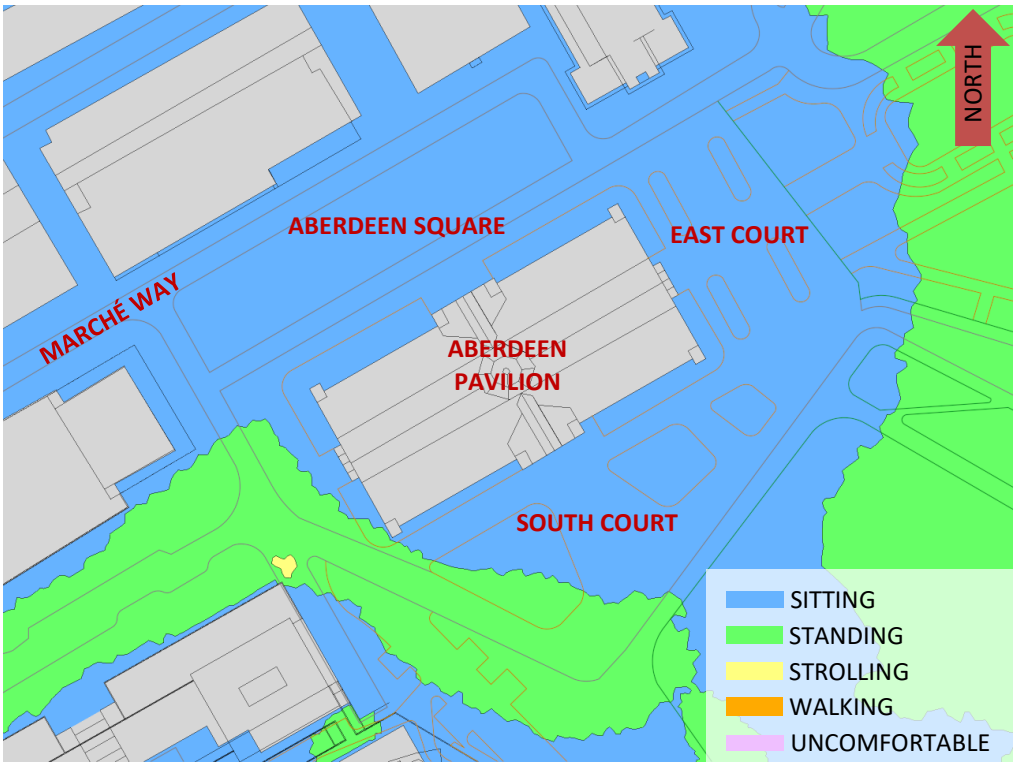


FIGURE 9A: AUTUMN – WIND COMFORT, ABERDEEN PAVILION – PROPOSED

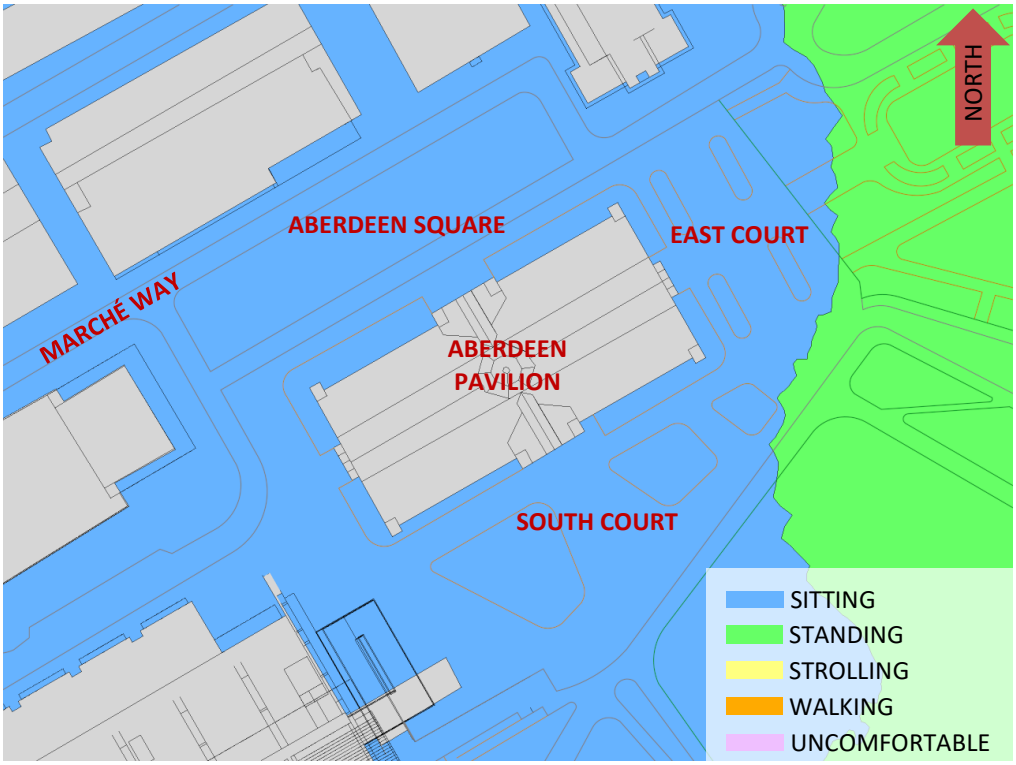


FIGURE 9B: AUTUMN – WIND COMFORT, ABERDEEN PAVILION – EXISTING

FIGURE 10A: WINTER – WIND COMFORT, ABERDEEN PAVILION – PROPOSED

FIGURE 10B: WINTER – WIND COMFORT, ABERDEEN PAVILION – EXISTING

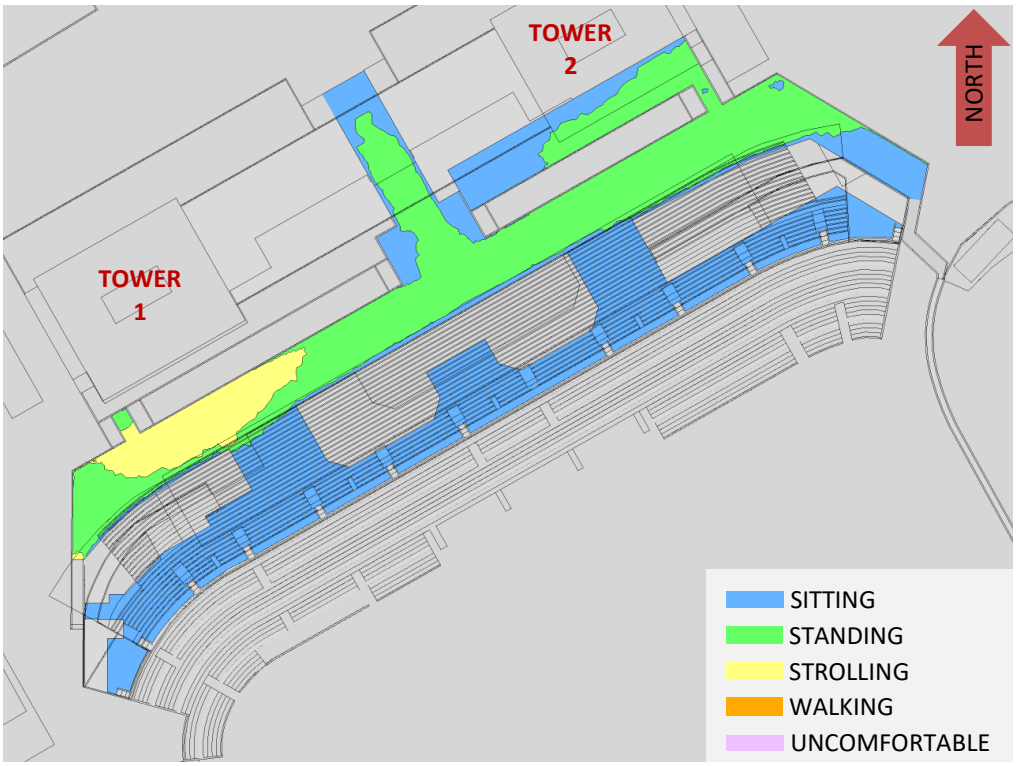


FIGURE 11A: SPRING – WIND COMFORT, PUBLIC PROMENADE

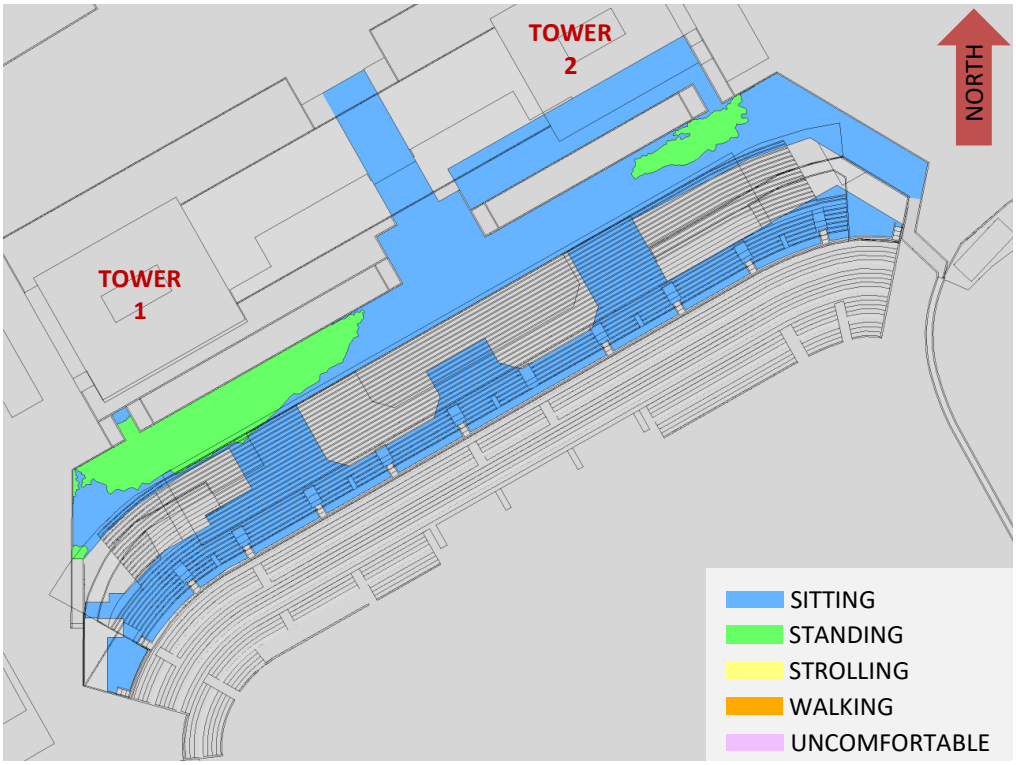


FIGURE 11B: SUMMER – WIND COMFORT, PUBLIC PROMENADE

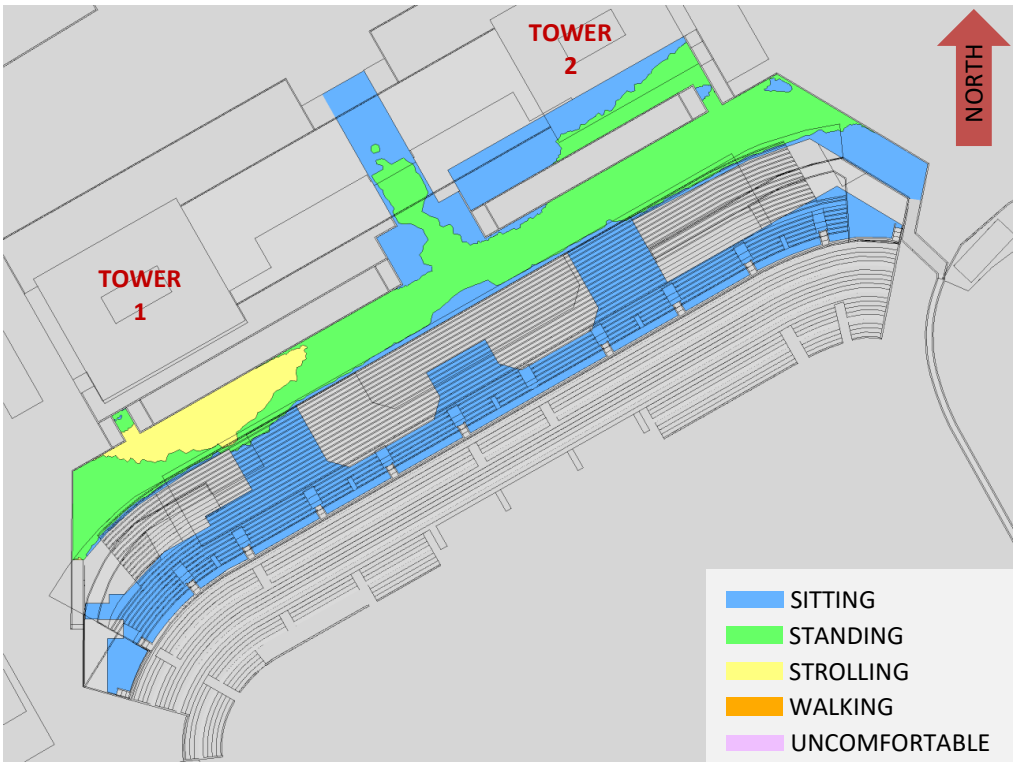
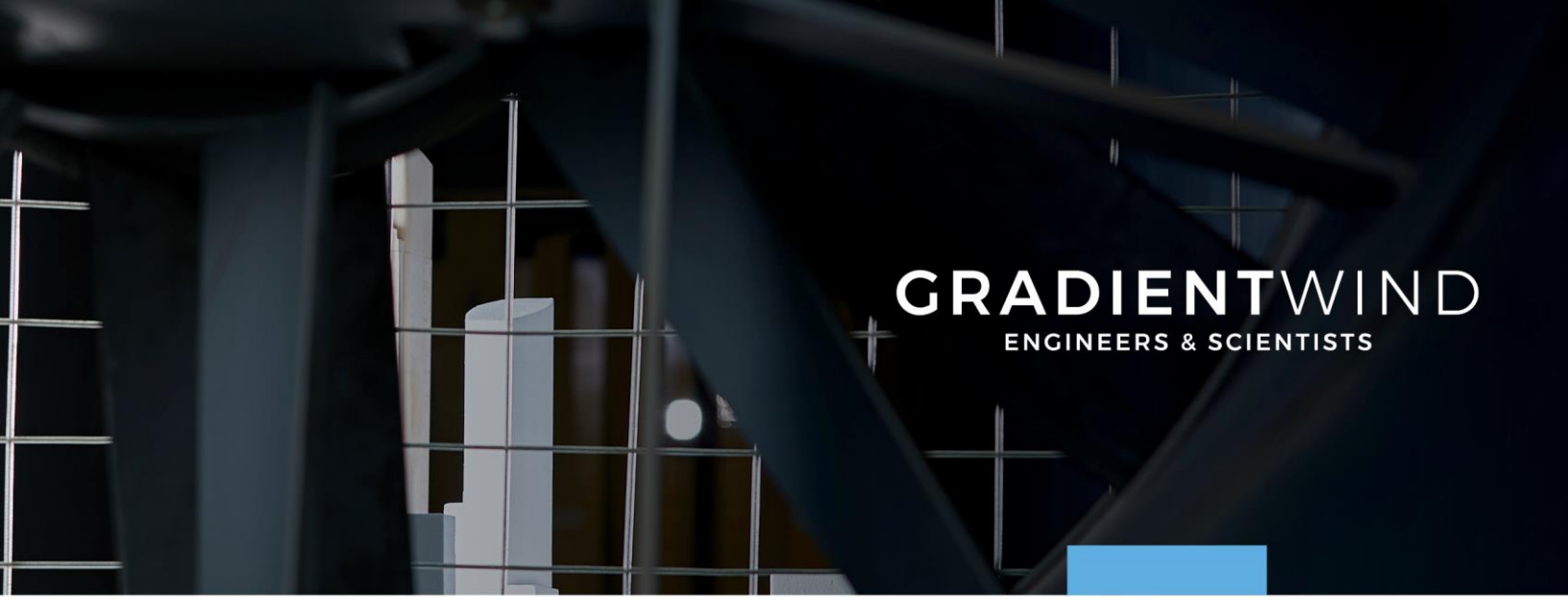
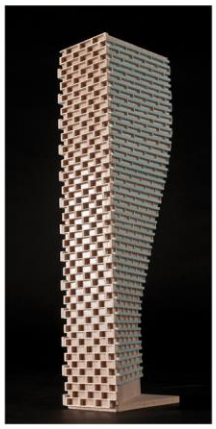
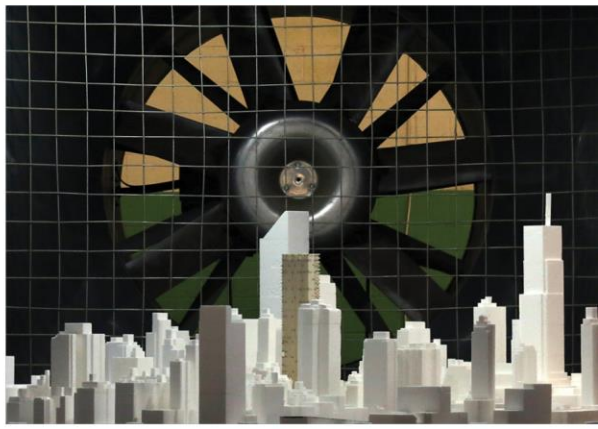


FIGURE 11C: AUTUMN – WIND COMFORT, PUBLIC PROMENADE

FIGURE 11D: WINTER – WIND COMFORT, PUBLIC PROMENADE







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, 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
49	0.24
74	0.24
103	0.24
167	0.24
197	0.24
217	0.24
237	0.22
262	0.24
282	0.26
301	0.25
324	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, 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 Engineering Symposium, IWES 2003*, Taiwan, 2003.