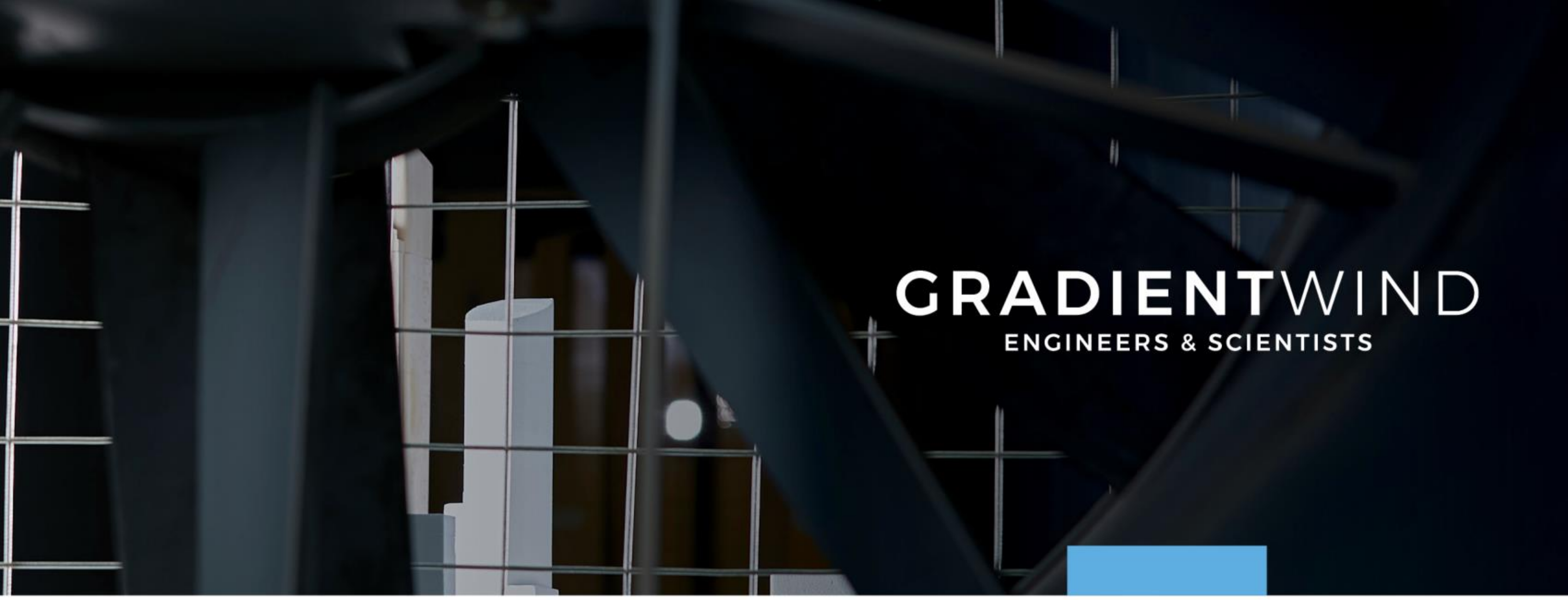
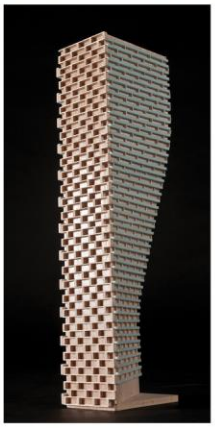
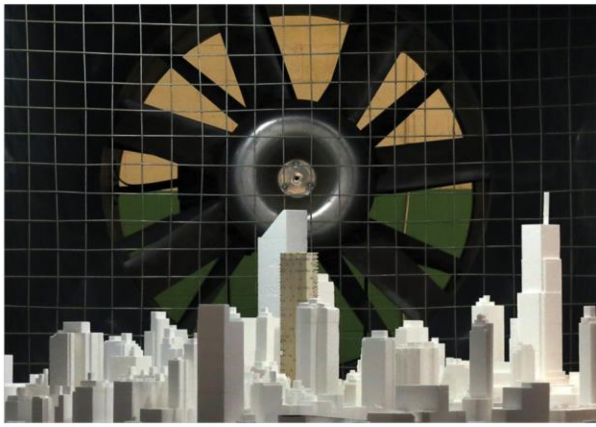


PEDESTRIAN LEVEL WIND STUDY

375-421 Kingston Road
Pickering, Ontario

REPORT: GW21-243-WTPLW





January 10, 2025

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EXECUTIVE SUMMARY

This report describes a wind tunnel pedestrian level wind study undertaken to assess wind conditions for the proposed Phase 1 & 2 mixed-use developments located at 375-421 Kingston Road in Pickering, Ontario. Three configurations were studied: (i) *existing scenario*, including all approved, surrounding developments and without the proposed development, (ii) *proposed Phase 1 scenario* with the proposed Phase 1 development in place, and (iii) *proposed Phase 1 & 2 scenario* with the proposed Phase 1 and Phase 2 developments in place. The study involves wind tunnel measurements of pedestrian wind speeds using a physical scale model, combined with meteorological data integration, to assess pedestrian comfort at key areas within and surrounding the study site. Grade-level areas investigated include sidewalks, walkways, laneways, parking areas, transit stops, the nearby Montessori School yard and playground, landscaped spaces, parks, and building access points. Wind comfort is also evaluated over the Level 4 outdoor amenity terraces. The results and recommendations derived from these considerations are summarized in the following paragraphs and detailed in the subsequent report.

Our work is based on industry standard wind tunnel testing and data analysis procedures, architectural drawings prepared by Studio JCI in November 2024, surrounding street layouts, as well as existing and approved future building massing information obtained from the City of Pickering, and recent site imagery.

A complete summary of the predicted wind conditions is provided in Section 5 of this report and is also illustrated in Figures 2A through 6D, as well as Tables A1-A3, B1-B3, and C1-C4 in the appendices. Based on wind tunnel test results, meteorological data analysis, and experience with similar developments in Pickering, we conclude that the proposed wind conditions, with respect to the proposed Phase 1 scenario, over all grade-level pedestrian wind-sensitive areas within and surrounding the study site will be acceptable for the intended uses on a seasonal basis provided the landscaping plan provided in December 2024 is implemented as proposed. To ensure the Level 4 outdoor amenity will be safe and suitable for sitting or more sedentary activities throughout the warmer months, mitigation is recommended, as described in Section 5.2.

With the Phase 1 and 2 developments in place (proposed Phase 1 & 2 scenario), most grade-level pedestrian wind-sensitive areas within and surrounding the study site will be acceptable for the intended

uses on a seasonal basis provided the landscaping plan provided in December 2024 is implemented as proposed. Exceptions include the walkways flanking Laneway C between the podia and several primary building access points, for which mitigation is recommended as per Section 5.3. To ensure that all Level 4 outdoor amenity terraces will be safe and suitable for sitting or more sedentary activities throughout the warmer months, mitigation is recommended, as described in Section 5.3.

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site, apart from the noted areas over the Level 4 terraces, were found to experience wind conditions that are considered unsafe.

TABLE OF CONTENTS

1. INTRODUCTION

This report describes a wind tunnel pedestrian level wind (PLW) study undertaken to assess wind conditions for the proposed Phase 1 & 2 mixed-use developments located at 375-421 Kingston Road in Pickering, Ontario. Three configurations were studied: (i) *existing scenario*, including all approved, surrounding developments and without the proposed development, (ii) *proposed Phase 1 scenario* with the proposed Phase 1 development in place, and (iii) *proposed Phase 1 & 2 scenario* with the proposed Phase 1 and Phase 2 developments in place. The study was performed in accordance with industry standard wind tunnel testing techniques, architectural drawings prepared by Studio JCI in November 2024, surrounding street layouts and existing and approved future building massing information, as well as recent site imagery.

2. TERMS OF REFERENCE

The focus of this wind tunnel pedestrian wind study is the proposed mixed-use development located at 375-421 Kingston Road in Pickering, Ontario. The study site is situated at the southeast corner of the intersection of Kingston Road and Rougemount Drive, with Highway 401 running along the southern boundary of the site.

The proposed development comprises Phases 1 and 2, which are aligned east-west, respectively (relative to project north), along Kingston Road, with a parkland dedication east of Phase 1. Proposed laneways provide access to the loading areas, surface parking, and the ramps to the two levels of underground and two levels of above-ground parking: Laneway A runs along the south elevation of Phase 1 and transitions to Evelyn Avenue to the southeast, Laneway B runs south of Phase 2 and connects to Rougemount Drive to the southwest, and Laneway C separates the Phase 1 and 2 buildings while connecting Kingston Road to the north with Laneways A and B to the south.

Phase 1 comprises 31- and 32-storey towers, aligned east-west, respectively, atop a shared 3-storey podium of trapezoidal planform with the tower bases aligned transverse to Kingston Road. Similarly, Phase 2 consists of 33- and 34-storey towers, aligned east-west, atop a shared 3-storey podium of trapezoidal planform with the tower bases aligned transverse to Kingston Road.

For Phase 1, the approximately U-shaped ground floor, open to the south, comprises a central north residential lobby and retail spaces at the northeast corner and along the west elevation all fronting Kingston Road, loading areas to the southeast and southwest, and building support services in the remaining spaces. The floorplate extends at Level 2 covering the south elevation opening below, and Levels 2 and 3 are reserved for internal parking. The floorplate generally sets back to the base of the towers at Level 4 accommodating outdoor amenities, indoor amenities to the north, and residential spaces elsewhere. The west tower further sets back from the northwest to the tower's typical floorplate at Level 5. The residential floorplate rises uniformly to the full height, with setbacks from the south side of the east tower at Level 31 and the west tower at Level 32, featuring private terraces. A mechanical penthouse completes each tower.

The configuration of Phase 2 is generally similar to Phase 1, except that the residential lobby is located at the northwest corner fronting Kingston Road and commercial space is also accessible from Rougemount Drive along the west elevation. Additionally, the east and west tower floorplates of Phase 2 set back from the south side at Levels 33 and 34, respectively.

Regarding wind exposures, the near-field surroundings of the development (defined as an area falling within a 200-metre radius of the site) comprise low-rise massing from the north clockwise to the northeast, mostly the open exposure of Highway 401 from the northeast clockwise to the southeast, a mix of the open exposure of Highway 401 and low-rise massing from the southeast clockwise to the southwest, and mostly low-rise massing for the remaining compass directions. The far-field surroundings (defined as the area beyond the near-field and within a two-kilometer radius) include mostly low-rise massing from the north clockwise to the east, a mix of low-rise buildings, green areas, and open water of Lake Ontario from the east clockwise to the southwest, mostly low-rise massing from the southwest clockwise to the west, and a mix of low-rise massing and fields for the remaining compass directions. Notably, Rosebank Park is approximately 790 m to the southeast, the Elizabeth B. Phin Public School is approximately 840 m to the north-northeast, and the Rouge River is approximately 500 m to the west.

Grade-level areas investigated include sidewalks, walkways, laneways, parking areas, transit stops, the nearby Montessori School yard and playground, landscaped spaces, parks, and building access points. Wind comfort is also evaluated over the Level 4 outdoor amenity terraces. Figures 1A, 1B, and 1C illustrate the *existing, proposed Phase 1,* and *proposed Phase 1 & 2* study sites and surrounding context, respectively, and Photographs 1 through 8 depict the wind tunnel model used to conduct the study.

3. OBJECTIVES

The principal objectives of this study are to (i) determine pedestrian level wind comfort and safety conditions at key areas within and surrounding the development site; (ii) identify areas where wind conditions may interfere with the intended uses of outdoor spaces; (iii) recommend suitable mitigation measures, where required; and (iv) evaluate the influence of the proposed development on the existing wind conditions surrounding the site, as well as the influence of future surrounding developments on wind conditions.

4. METHODOLOGY

The approach followed to quantify pedestrian wind conditions over the site is based on wind tunnel measurements of wind speeds at selected locations on a reduced-scale physical model, meteorological analysis of the Pickering area wind climate and synthesis of wind tunnel data with industry-accepted guidelines[1]. The following sections describe the analysis procedures, including a discussion of the pedestrian comfort and safety guidelines.

4.1 Wind Tunnel Context Modelling

A detailed PLW study is performed to determine the influence of local winds at the pedestrian level for a proposed development. The physical model of the proposed development and relevant surroundings, illustrated in Photographs 1 through 8 following the main text, was constructed at a scale of 1:400. The wind tunnel model includes all existing buildings and approved future developments within a full-scale diameter of approximately 840 metres. The general concept and approach to wind tunnel modelling is to provide building and topographic detail in the immediate vicinity of the study site on the surrounding model, and to rely on a length of wind tunnel upwind of the model to develop wind properties consistent with known turbulent intensity profiles that represent the surrounding terrain.

[1] Toronto Pedestrian Level Wind Study Terms of Reference Guide, 2022

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

4.2 Wind Speed Measurements

The PLW study was performed by testing a total of 122 sensor locations on the scale model in Gradient Wind's wind tunnel. Of these 122 sensors, 89 were located at grade and the remaining 33 sensors were located over the Level 4 outdoor amenity terraces. Wind speed measurements were performed for each of the 122 sensors for 36 wind directions at 10° intervals. Figures 1A, 1B, and 1C illustrate the *existing, proposed Phase 1,* and *proposed Phase 1 & 2* study sites and surrounding context, respectively, while sensor locations used to investigate wind conditions are illustrated in Figures 2A through 6D.

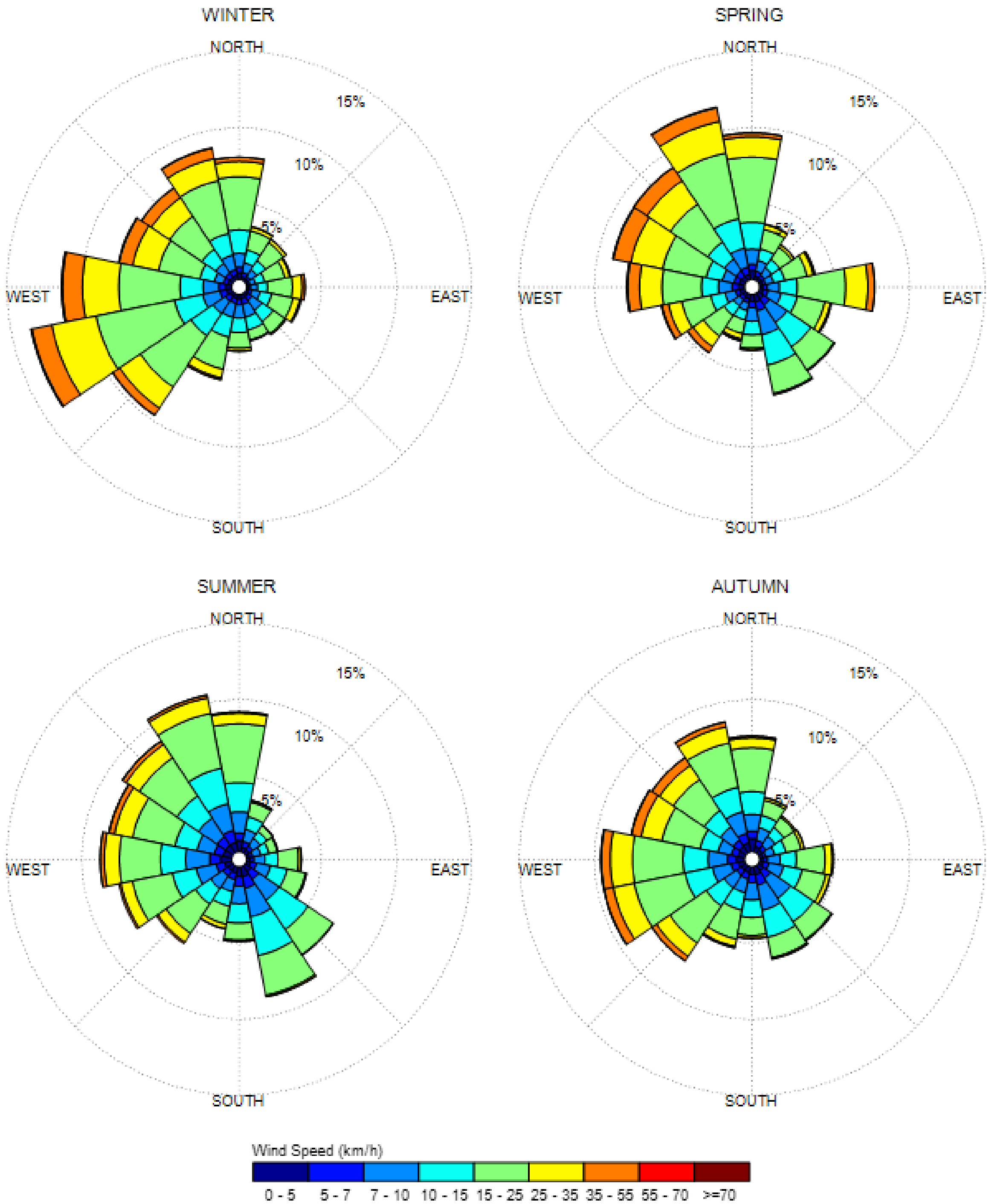
Mean and peak wind speed values for each location and wind direction were calculated from real-time pressure measurements, recorded at a sample rate of 500 samples per second, and taken over a 60-second time period. This period at model-scale corresponds approximately to one hour in full-scale, which matches the time frame of full-scale meteorological observations. Measured mean and gust wind speeds at grade were referenced to the wind speed measured near the ceiling of the wind tunnel to generate mean and peak wind speed ratios. Ceiling height in the wind tunnel represents the depth of the boundary layer of wind flowing over the earth's surface, referred to as the gradient height. Within this boundary layer, mean wind speed increases up to the gradient height and remains constant thereafter. Appendices C and D provide greater detail of the theory behind wind speed measurements. Wind tunnel measurements for this project, conducted in Gradient Wind's wind tunnel facility, meet or exceed guidelines found in the National Building Code of Canada 2015 and of 'Wind Tunnel Studies of Buildings and Structures', ASCE Manual 7 Reports on Engineering Practice No 67.

4.3 Meteorological Data Analysis - Pearson International Airport

A statistical model for winds in Pickering was developed from over 50 years of hourly meteorological wind data recorded at Pearson International Airport. Wind speed and direction data were analyzed for each month of the year in order to determine the statistically prominent wind directions and corresponding speeds and to characterize similarities between monthly weather patterns. Based on this portion of the analysis, the four seasons are represented by grouping data from consecutive months based on the similarity of weather patterns, and not according to the traditional calendar method.

The statistical model of the Toronto area wind climate, which indicates the directional character of local winds on a seasonal basis, is illustrated on the following page. The plots illustrate the seasonal distribution of measured wind speeds and directions in km/h. Probabilities of occurrence of different wind speeds are represented as stacked polar bars in sixteen azimuth divisions. The radial direction represents the percentage of time for various wind speed ranges per wind direction during the measurement period. The preferred wind speeds and directions can be identified by the longer length of the bars. For Pearson International Airport, the most common winds concerning pedestrian comfort occur from the southwest clockwise to the north, as well as those from the east. The directional preference and relative magnitude of the wind speed varies somewhat from season to season, with the summer months displaying the calmest winds relative to the remaining seasonal periods.

SEASONAL DISTRIBUTION OF WINDS FOR VARIOUS PROBABILITIES
PEARSON INTERNATIONAL AIRPORT, TORONTO, ONTARIO



Notes:

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

4.4 Pedestrian Comfort and Safety Guidelines

Pedestrian comfort and safety guidelines are based on the mechanical effects of wind without consideration of other meteorological conditions (i.e. temperature, relative humidity). The comfort guidelines assume that pedestrians are appropriately dressed for a specified outdoor activity during any given season. Four pedestrian comfort classes are based on 80% non-exceedance Guest Equivalent Mean (GEM) wind speed ranges, which include (i) Sitting; (ii) Standing; (iii) Walking; and (iv) Uncomfortable. More specifically, the comfort classes and associated GEM wind speed ranges are summarized as follows:

(i) **Sitting** – A wind speed below 10 km/h (i.e. 0 – 10 km/h) would be considered acceptable for sedentary activities, including sitting.

(ii) **Standing** – A wind speed below 15 km/h (i.e. 10 km/h – 15 km/h) is acceptable for activities such as standing or leisurely strolling.

(iii) **Walking** – A wind speed below 20 km/h (i.e. 15 km/h – 20 km/h) is acceptable for walking or more vigorous activities.

(iv) **Uncomfortable** – A wind speed over 20 km/h is classified as uncomfortable from a pedestrian comfort standpoint. Brisk walking and exercise, such as jogging, would be acceptable for moderate excesses of this criterion.

The pedestrian safety wind speed guideline 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 greater than 90 km/h is classified as dangerous.

Experience and research on people’s perception of mechanical wind effects has shown that if the wind speed levels are exceeded more than 20% of the time, the activity level would be judged to be uncomfortable by most people. For instance, if wind speeds of 10 km/h were exceeded for more than 20% of the time most pedestrians would judge that location to be too windy for sitting or more sedentary activities. Similarly, if 20 km/h at a location were exceeded for more than 20% of the time, walking or less vigorous activities would be considered uncomfortable. As most of 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 at tested locations, the assessment of pedestrian comfort involves determining the suitability of the predicted wind conditions for their associated spaces. This step involves comparing the predicted comfort class to the desired comfort class, which is dictated by the location type represented by the sensor (i.e. a sidewalk, building entrance, amenity space, or other). An overview of common pedestrian location types and their desired comfort classes are summarized below.

DESIRED PEDESTRIAN COMFORT CLASSES FOR VARIOUS LOCATION TYPES

Location Types	Desired Comfort Classes
Primary Building Entrance	Standing
Secondary Building Access Point	Walking
Public Sidewalks / Pedestrian Walkways	Walking
Outdoor Amenity Spaces	Sitting / Standing
Cafés / Patios / Benches / Gardens	Sitting / Standing
Plazas	Standing / Walking
Transit Stops	Standing
Public Parks	Sitting / Walking
Garage / Service Entrances	Walking
Vehicular Drop-Off Zones	Walking
Laneways / Loading Zones	Walking

5. RESULTS AND DISCUSSION

Tables A1-A3 in Appendix A provide a summary of seasonal comfort predictions for each sensor location under the *existing* massing scenario. Similarly, Tables B1-B3 in Appendix B provide the seasonal comfort predictions for the *proposed Phase 1* massing scenario, and Tables C1-C4 in Appendix C for the *proposed Phase 1 & 2* massing scenario. The tables indicate the 80% non-exceedance GEM wind speeds and corresponding comfort classifications as defined in Section 4.4. In other words, a wind speed threshold of 19.1 for the summer season indicates that 80% of the measured data falls at or below 19.1 km/h during the summer months and conditions are therefore suitable for walking, as the 80% threshold value falls within the exceedance range of 15-20 km/h for walking. The tables include the predicted threshold values for each sensor location during each season, accompanied by the corresponding predicted comfort class (i.e. sitting, standing, walking, etc.).

The most significant findings of the PLW study are summarized in Sections 5.1, 5.2, and 5.3. To assist with understanding and interpretation, predicted conditions for the proposed development are also illustrated in colour-coded format in Figures 2A through 6D. Conditions suitable for sitting are represented by the colour blue, while standing is represented by green, and walking by yellow. Conditions considered uncomfortable for walking are represented by the colour orange. For locations where the wind safety criterion is exceeded, the sensor is highlighted in red.

5.1 Pedestrian Comfort Suitability – *Existing Scenario*

Based on the analysis of the measured data, consideration of local climate data, and the suitability descriptors provided in Tables A1-A3 in Appendix A and illustrated in Figures 2A through 2D, this section summarizes the significant findings of the PLW study with respect to the *existing scenario*, as follows:

1. All public sidewalks, walkways, laneways, parking areas, and landscaped spaces within and surrounding the proposed development currently experience wind conditions suitable for walking or better, with most suitable for standing or better, during each seasonal period.
2. The nearby existing transit stops along Kingston Road (Sensors 8 & 13) are currently suitable for standing or better during all seasonal periods. It is noteworthy that the stops are currently equipped with transit shelters.
3. The nearby Montessori School yard and playground, to the east of the study site, (Sensor 5) is currently suitable for sitting year-round.
4. Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site were found to experience wind conditions that are considered too windy for walking or unsafe.

5.2 Pedestrian Comfort Suitability – *Proposed Phase 1 Scenario*

Based on the analysis of the measured data, consideration of local climate data, and the suitability descriptors provided in Tables B1-B3 in Appendix B and illustrated in Figures 3A through 4D, this section summarizes the significant findings of the PLW study with respect to the *proposed Phase 1 scenario*, as follows:

1. Most public sidewalks, walkways, laneways, parking areas, and landscaped spaces within and surrounding the proposed development will experience wind conditions suitable for walking or better throughout the year, which is acceptable for the intended uses of the spaces. Exceptions include areas of the sidewalk along Kingston Road (Sensor 17, 18, 36, 38, & 39), the existing laneway to the southwest (Sensors 27 & 48), and surface parking along Laneway A (Sensors 25 & 26), which intermittently exceeds the walking criterion during the colder months. Additionally, the sidewalk area to the northwest of the study building will marginally exceed the annual safety criterion (Sensor 36). Notably, the exceedance is generally marginal (<1.9km/h, See Appendix B) over the noted sidewalk areas (Sensors 16, 17, 36, 38, & 39), limited to the winter, and pedestrian traffic is limited in the laneways and surface parking (Sensors 25-27 & 48). Additionally, considering the proposed landscaping plans provided in December 2024, as well as the existing tall plantings, reduced wind speeds are expected in most noted areas (Sensors 17, 18, 25-27, 36, 38, 39, & 48), with all dangerous and most uncomfortable conditions eliminated. Overall, mitigation is not considered necessary to ensure the spaces are suitable for the intended seasonal pedestrian uses.

2. All primary and secondary (such as stairwell exits, loading areas, and vehicular) building access points serving the proposed development will experience wind conditions suitable for standing or better year-round, which is acceptable.

3. The nearby existing transit stops along Kingston Road (Sensors 8 & 13) will remain suitable for standing or better during all seasonal periods, which is appropriate.

4. The nearby Montessori School yard and playground, to the east of the study site, (Sensor 5) will continue to experience sitting conditions year-round, which is acceptable for the intended uses of the spaces.

5. The park dedication and amenity to the east of Phase 1 (Sensors 71-74) will generally experience a mix of walking and standing conditions throughout the year, with the north portion (Sensors 71 & 72) becoming uncomfortable for walking during the winter. The plantings delineated in the December 2024 landscaping plan are expected to buffer salient winds traversing the park, and generally promote conditions suitable for standing or sitting during the summer and autumn, and walking or better during the winter and spring, which is acceptable for the intended uses of the

space. If calmer conditions are desired at designated seating areas, then targeted wind barriers to the immediate northwest and southeast would be beneficial.

6. The Level 4 outdoor amenity (Sensors 90-103) will generally experience a mix of walking, standing, and sitting conditions, with mostly walking conditions, during the summer. Additionally, the areas at the centre and at the southwest corner of the terrace (Sensors 92, 96, & 97 and Sensor 103, respectively) will not achieve the annual safety criterion. It is recommended to provide perimeter barriers measuring 2.0 metres above the walking surface and provide 1.6-metre-tall targeted barriers upwind of seating to ensure safe and comfortable conditions suitable for sitting throughout the warmer months. Barriers may take the form of coniferous/marcescent plantings/planters, high-solidity windscreens, or a combination thereof. Additionally, install pergola/trellis structures overhead designated seating areas at the centre and near the southwest corner of the terrace (Sensors 92, 96, & 97 and Sensor 103, respectively). The terrace landscaping plan provided in December 2024 generally meets the mitigation strategy proposed above provided the recommended barrier heights and densities are observed.

7. Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site, apart from the sidewalk portion to the northwest and areas at the centre and at the southwest corner of the Level 4 terrace, were found to experience wind conditions that are considered unsafe.

5.3 Pedestrian Comfort Suitability – *Proposed Phase 1 & 2 Scenario*

Based on the analysis of the measured data, consideration of local climate data, and the suitability descriptors provided in Tables C1-C4 in Appendix C and illustrated in Figures 5A through 6D, this section summarizes the significant findings of the PLW study with respect to the *proposed Phase 1 & 2 scenario*, as follows:

1. With both the Phase 1 and 2 developments in place, most public sidewalks, walkways, laneways, parking areas, and landscaped spaces within and surrounding the proposed development will experience wind conditions suitable for walking or better throughout the year, which is acceptable for the intended uses of the spaces. Exceptions include areas of the sidewalk along Kingston Road (Sensor 33, 38, & 39) and Rougemount Drive (Sensor 3), an isolated portion of

undeveloped land to the south of Phase 2 (Sensor 28), as well as the walkways flanking Laneway C between the podia (Sensors 61-65 & 82), the northeast corner of Phase 1 (Sensor 70), and near the northwest corner of Phase 2 (Sensor 57), which intermittently exceeds the walking criterion during the colder months.

Notably, the exceedance is generally marginal (< 3.1 km/h, with most < 1.7 km/h, See Appendix C) and generally limited to the winter on the noted sidewalk areas (Sensors 3, 33, 38, & 39), and the northeast and northwest corners of Phase 1 and Phase 2 (Sensors 70 and 57, respectively). Additionally, the plantings proposed in the landscaping plans provided in December 2024 will somewhat buffer salient winds at the noted areas above and are generally expected to achieve local conditions suitable for walking or better throughout the year. For the proposed Laneway C and flanking walkways (Sensors 61-65 & 82), it is recommended to stagger tall vertical wind barriers along the laneway, or provide flanking overhead canopies, to buffer salient winds channelled between the podia. Barriers may take the form of coniferous/marcescent plantings/planters, high-solidity windscreens, or a combination thereof, and should measure at least 1.8-metres-tall.

2. All primary building access points serving Phase 1 (Sensors 66-68 & 82), and the entrance to the residential lobby (Sensor 56) and east retail (Sensor 62) of Phase 2, will exceed the standing criterion during the winter. It is recommended to either recess these entrances (if not already recessed) within the building façade, flank with vertical wind barriers, provide a canopy above, or substitute swing doors with sliding/revolving options.

   Most secondary building access points (such as building exits, loading areas, vehicle entrances, …) serving the proposed developments will experience wind conditions suitable for walking or better on a seasonal basis, which is acceptable. Exceptions include the exits fronting the proposed Laneway C (Sensors 61 & 64), which become intermittently uncomfortable for walking year-round. Notably, these exits are currently recessed within the wall; therefore, further mitigation is not necessary.

3. The nearby existing transit stops along Kingston Road (Sensors 8 & 13) will generally remain suitable for standing on seasonal basis with the westbound stop (Sensor 13) marginally exceeding

the standing criterion during the winter. As all stops are already equipped with transit shelters, additional mitigation is not necessary.

4. The nearby Montessori School yard and playground to the east of the study site (Sensor 5) will continue to experience sitting conditions year-round, which is acceptable for the intended uses of the spaces.

5. The park dedication (Sensors 71-74) will generally continue to experience a mix of walking and standing conditions throughout the year, with the north portion (Sensors 71 & 72) becoming intermittently uncomfortable for walking during the colder months. The plantings delineated in the December 2024 landscaping plan are expected to buffer salient winds traversing the park, and generally promote conditions suitable for standing or sitting during the summer and autumn, and walking or better during the winter and spring, which is acceptable for the intended uses of the space. If calmer conditions are desired at designated seating areas, then targeted wind barriers to the immediate northwest and southeast would be beneficial.

6. Both Level 4 outdoor amenities (Sensors 90-103) will generally experience a mix of uncomfortable, walking, standing, and sitting conditions, with mostly walking conditions, during the summer. Additionally, the areas at the centre of the amenities and the northeast corner of Phase 2 (Sensors 92, 96, 97, 109, & 113 and Sensor 104, respectively) will not achieve the annual safety criterion. It is recommended to provide perimeter barriers measuring 2.0 metres above the walking surface and provide 1.6-metre-tall targeted barriers upwind of seating to ensure safe and comfortable conditions suitable for sitting throughout the warmer months. Additionally, install pergola/trellis structures overhead designated seating areas at the centre of the terraces (Sensors 92, 96, 97, 109, & 113). Barriers may take the form of coniferous/marcescent plantings/planters, high-solidity windscreens, or a combination thereof. The terrace landscaping plan provided in December 2024 generally meets the mitigation strategy proposed above provided the recommended barrier heights and densities are observed.

7. Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site, apart from the areas at the centre and at the northeast corner of the Level 4 terraces, were found to experience wind conditions that are considered unsafe.

6. CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the methodology, results, and recommendations related to a pedestrian level wind study for the proposed mixed-use development at 375-471 Kingston Road in Pickering, Ontario. The study was performed in accordance with industry standard wind tunnel testing and data analysis procedures.

A complete summary of the predicted wind conditions is provided in Section 5 of this report and is also illustrated in Figures 2A through 6D, as well as Tables A1-A3, B1-B3, and C1-C4 in the appendices. Based on wind tunnel test results, meteorological data analysis, and experience with similar developments in Pickering, we conclude that the proposed wind conditions, with respect to the *proposed Phase 1* scenario, over all grade-level pedestrian wind-sensitive areas within and surrounding the study site will be acceptable for the intended uses on a seasonal basis provided the landscaping plan provided in December 2024 is implemented as proposed. To ensure the Level 4 outdoor amenity will be safe and suitable for sitting or more sedentary activities throughout the warmer months, mitigation is recommended, as described in Section 5.2.

With the Phase 1 and 2 developments in place (*proposed Phase 1 & 2* scenario), most grade-level pedestrian wind-sensitive areas within and surrounding the study site will be acceptable for the intended uses on a seasonal basis provided the landscaping plan provided in December 2024 is implemented as proposed. Exceptions include the walkways flanking Laneway C between the podia and several primary building access points, for which mitigation is recommended as per Section 5.3. To ensure that all Level 4 outdoor amenity terraces will be safe and suitable for sitting or more sedentary activities throughout the warmer months, mitigation is recommended, as described in Section 5.3.

Within the context of typical weather patterns, which exclude anomalous localized storm events such as tornadoes and downbursts, no areas over the study site, apart from the noted areas over the Level 4 terraces, were found to experience wind conditions that are considered unsafe.

This concludes our pedestrian level wind study and report. Please advise the undersigned of any questions or comments.

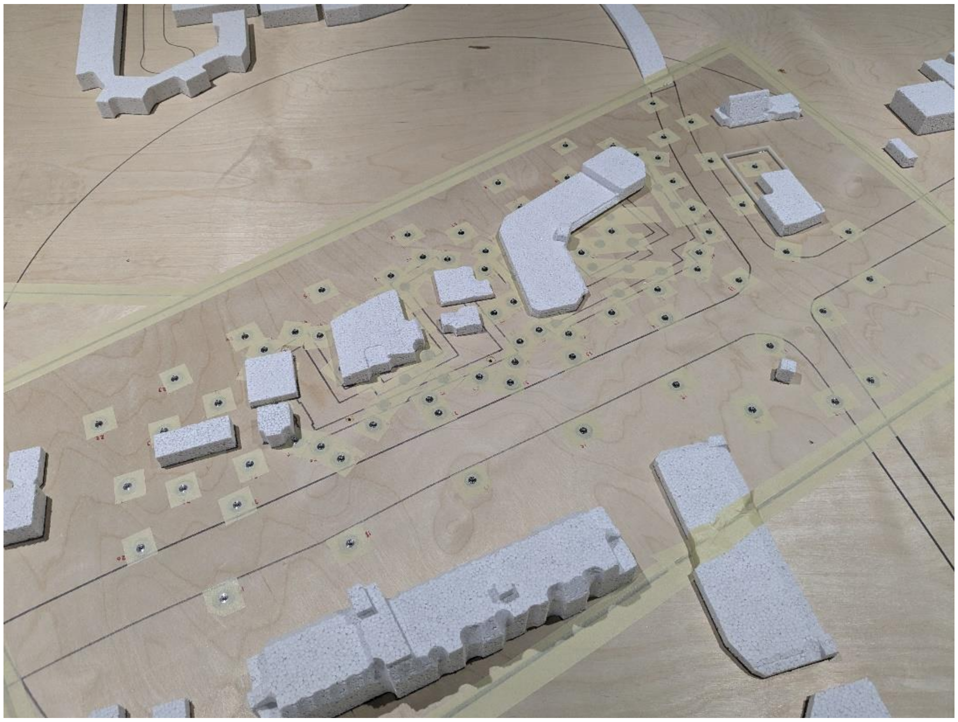
Sincerely,

Gradient Wind Engineering Inc.

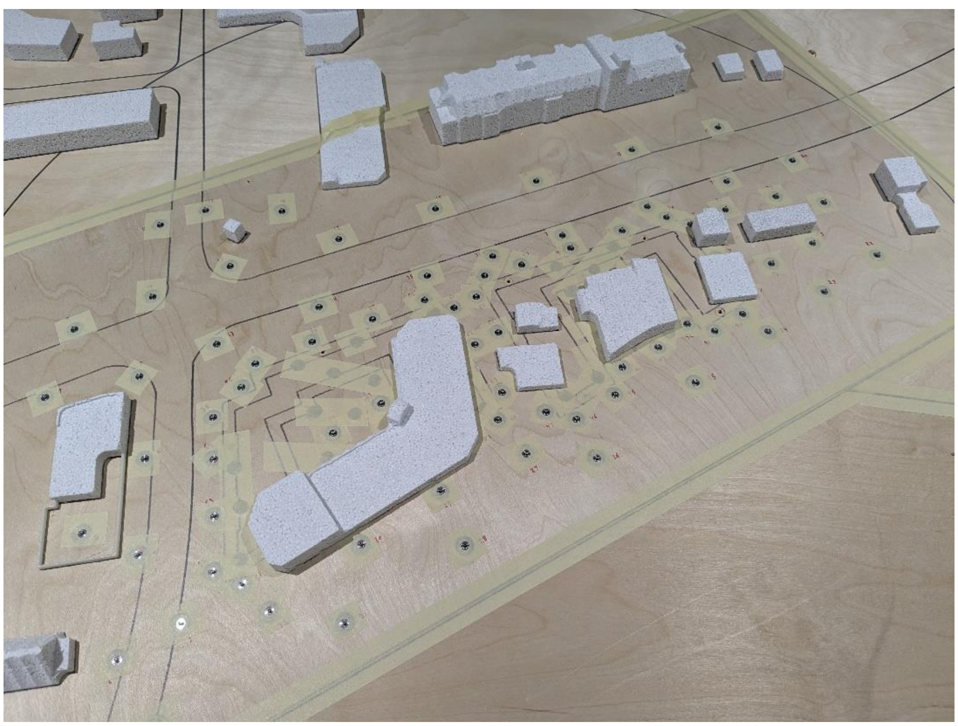
Cristiano Kondo, MESc.,
Junior Wind Scientist

Nick Petersen, P.Eng.,
Wind Engineer

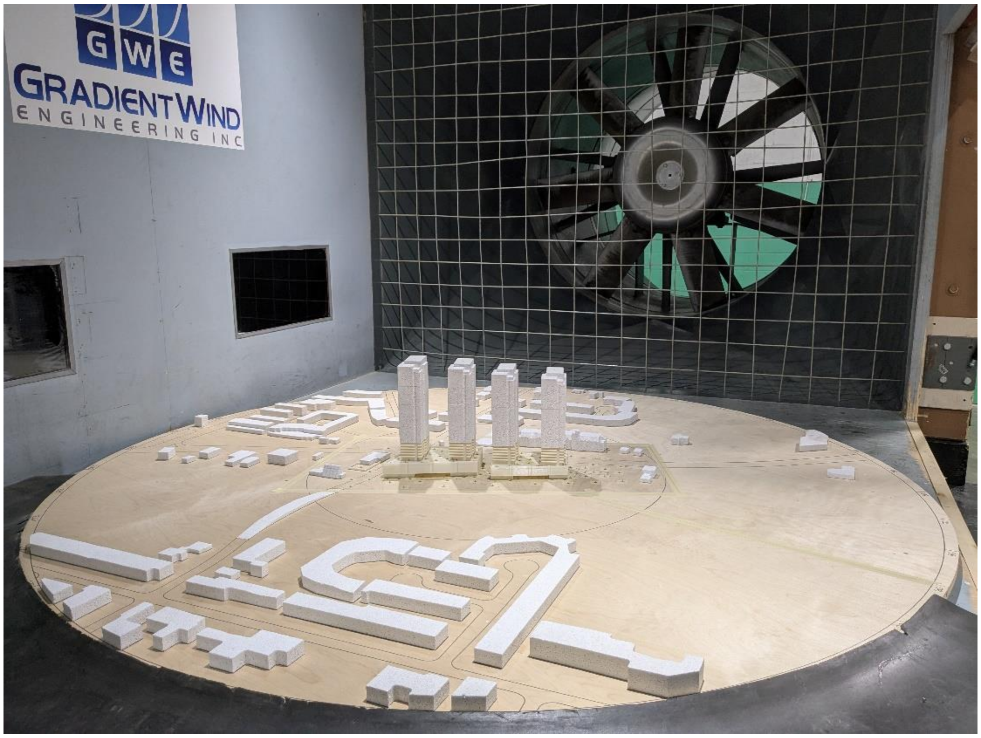
GW21-243-WTPLW



PHOTOGRAPH 1: CLOSE-UP VIEW OF EXISTING CONTEXT MODEL LOOKING SOUTH

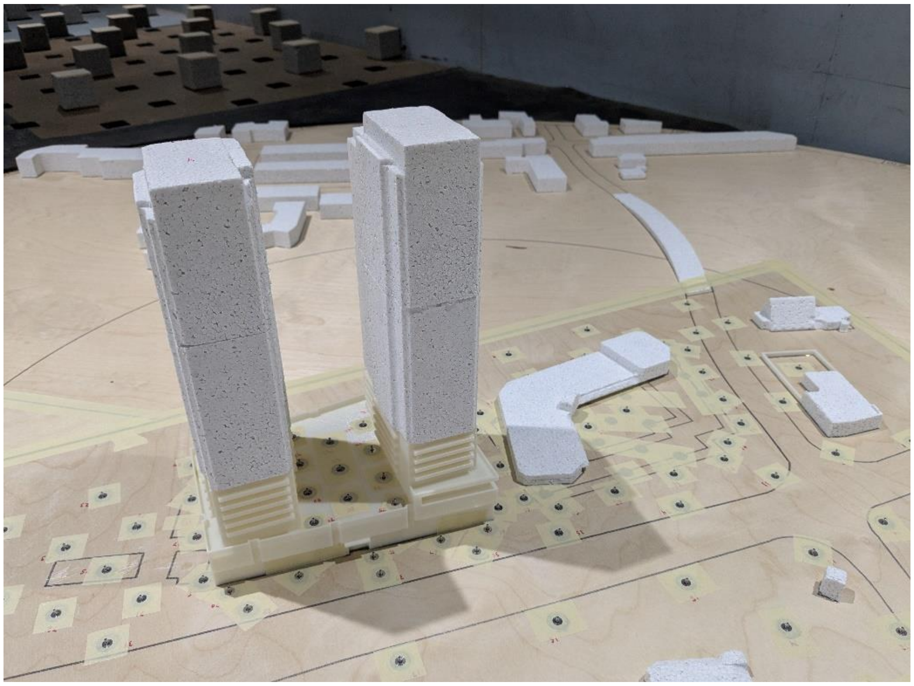


PHOTOGRAPH 2: CLOSE-UP VIEW OF EXISTING CONTEXT MODEL LOOKING NORTH

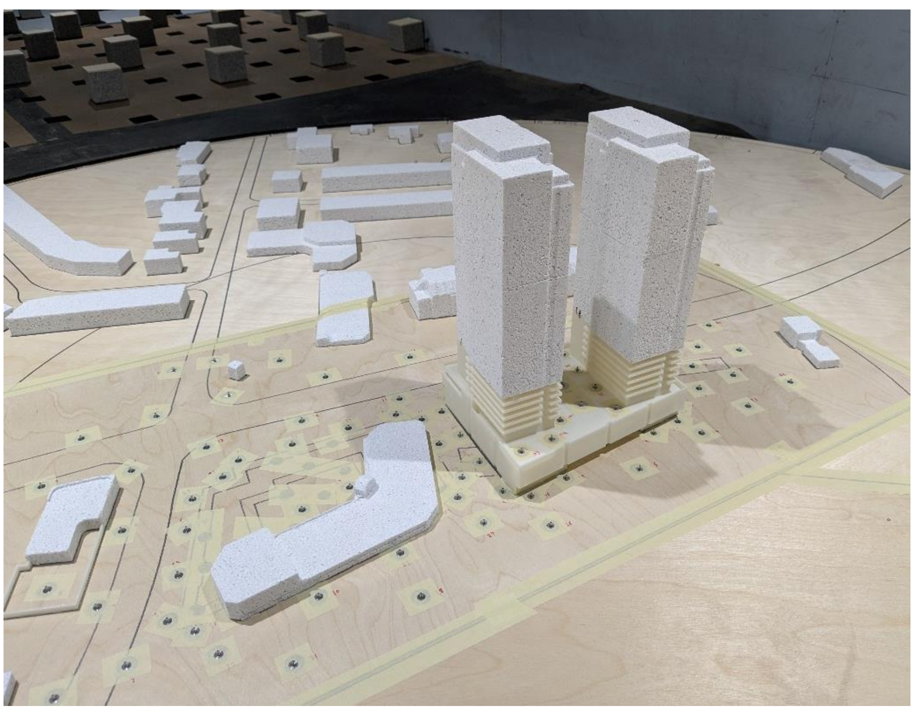


PHOTOGRAPH 3: PROPOSED STUDY MODELS INSIDE THE GWE WIND TUNNEL LOOKING DOWNWIND

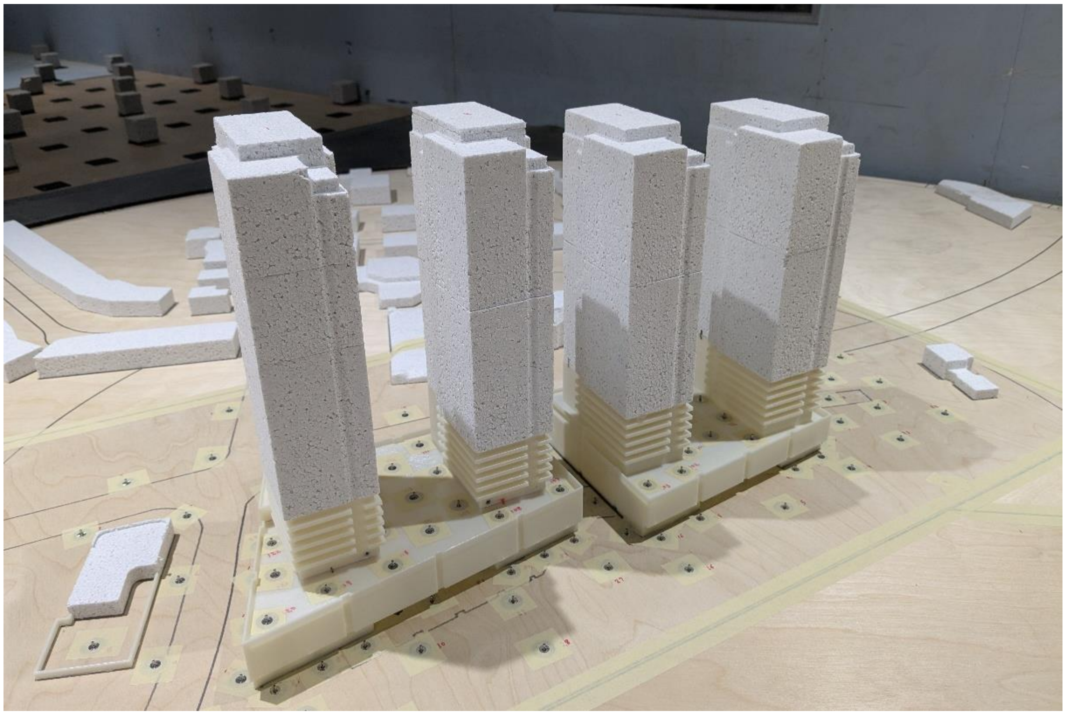
PHOTOGRAPH 4: PROPOSED STUDY MODELS INSIDE THE GWE WIND TUNNEL LOOKING UPWIND



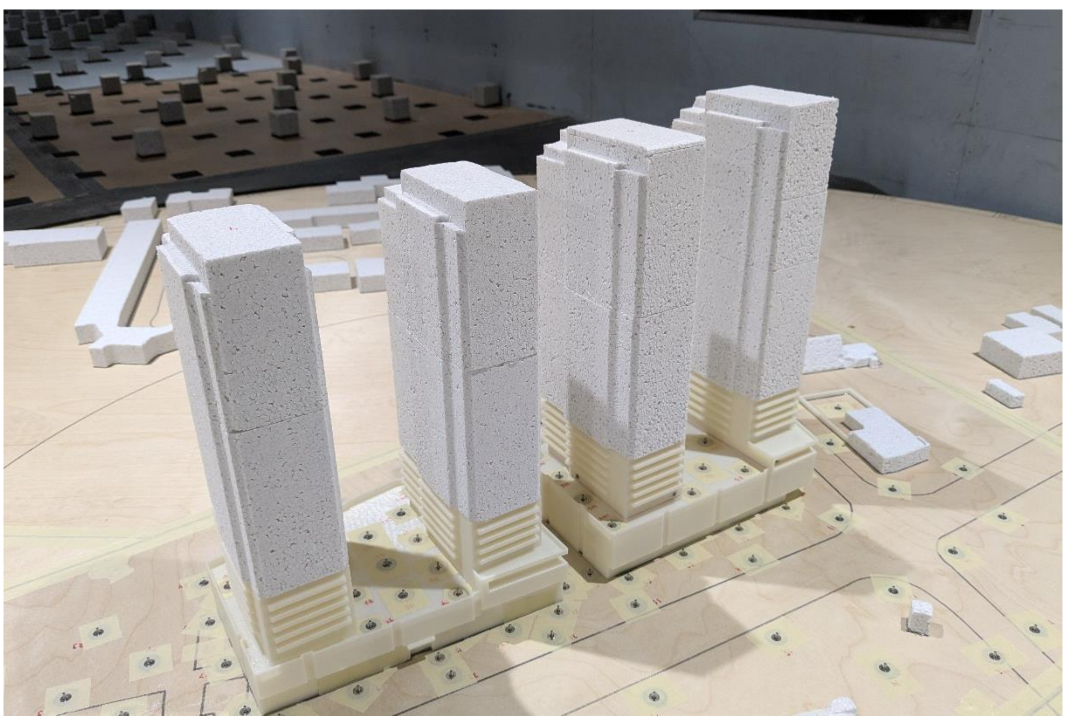
PHOTOGRAPH 5: CLOSE-UP VIEW OF PROPOSED PHASE 1 STUDY MODEL LOOKING SOUTH



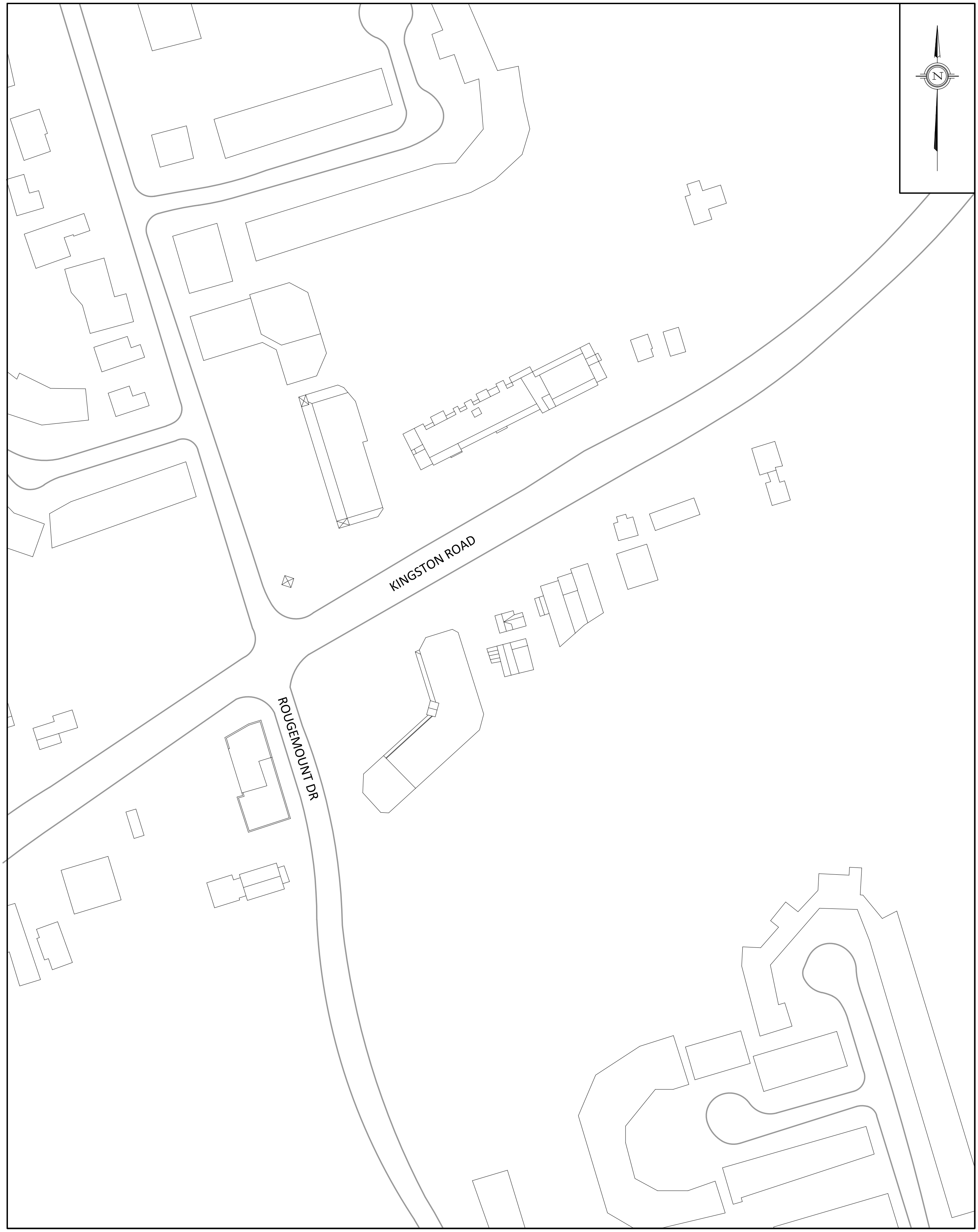
PHOTOGRAPH 6: CLOSE-UP VIEW OF PROPOSED PHASE 1 STUDY MODEL LOOKING NORTH



PHOTOGRAPH 7: CLOSE-UP VIEW OF <u>PROPOSED PHASE 1 & 2</u> STUDY MODELS LOOKING NORTH



PHOTOGRAPH 8: CLOSE-UP VIEW OF <u>PROPOSED PHASE 1 & 2</u> STUDY MODELS LOOKING SOUTH



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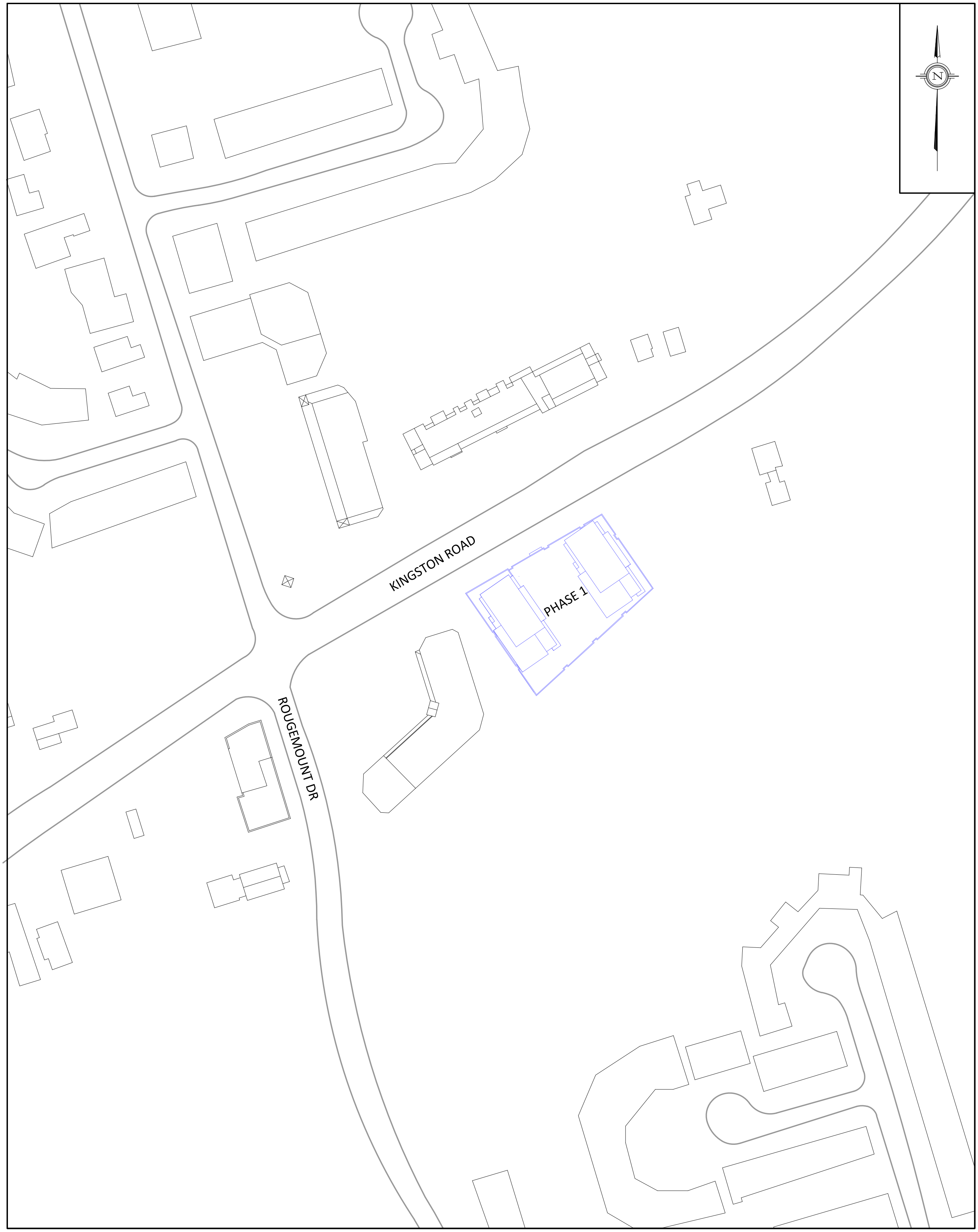
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY	
SCALE 1:2500 (APPROX.)	DRAWING NO. GW21-243-PLW-1A	
DATE JANUARY 10, 2025	DRAWN BY C.E.	

DESCRIPTION

FIGURE 1A:
EXISTING SITE PLAN
AND SURROUNDING CONTEXT



GRADIENTWIND ENGINEERS & SCIENTISTS	PROJECT 375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION FIGURE 1B: PROPOSED PHASE 1 SITE PLAN AND SURROUNDING CONTEXT
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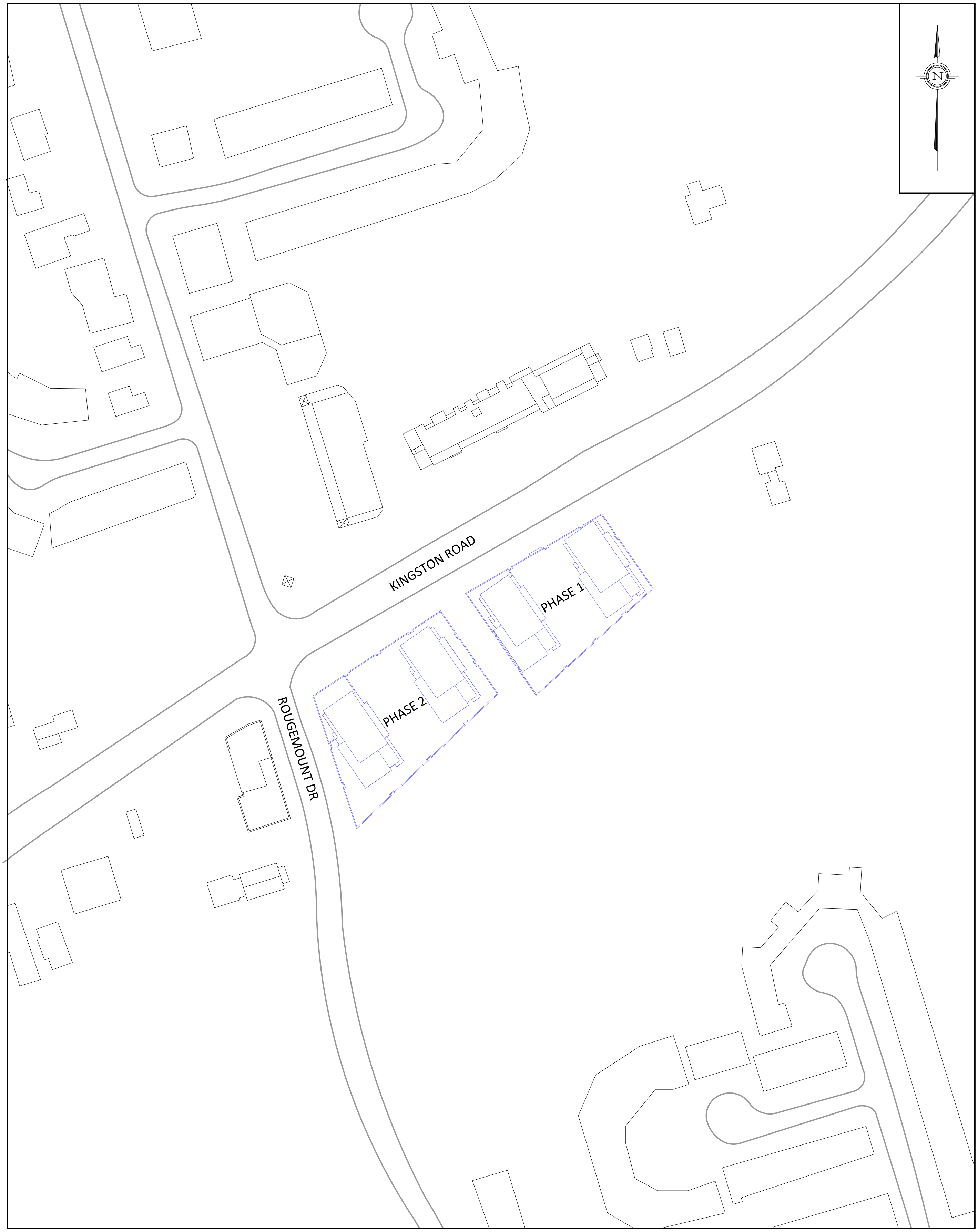
	DATE JANUARY 10, 2025	DRAWN BY C.E.	



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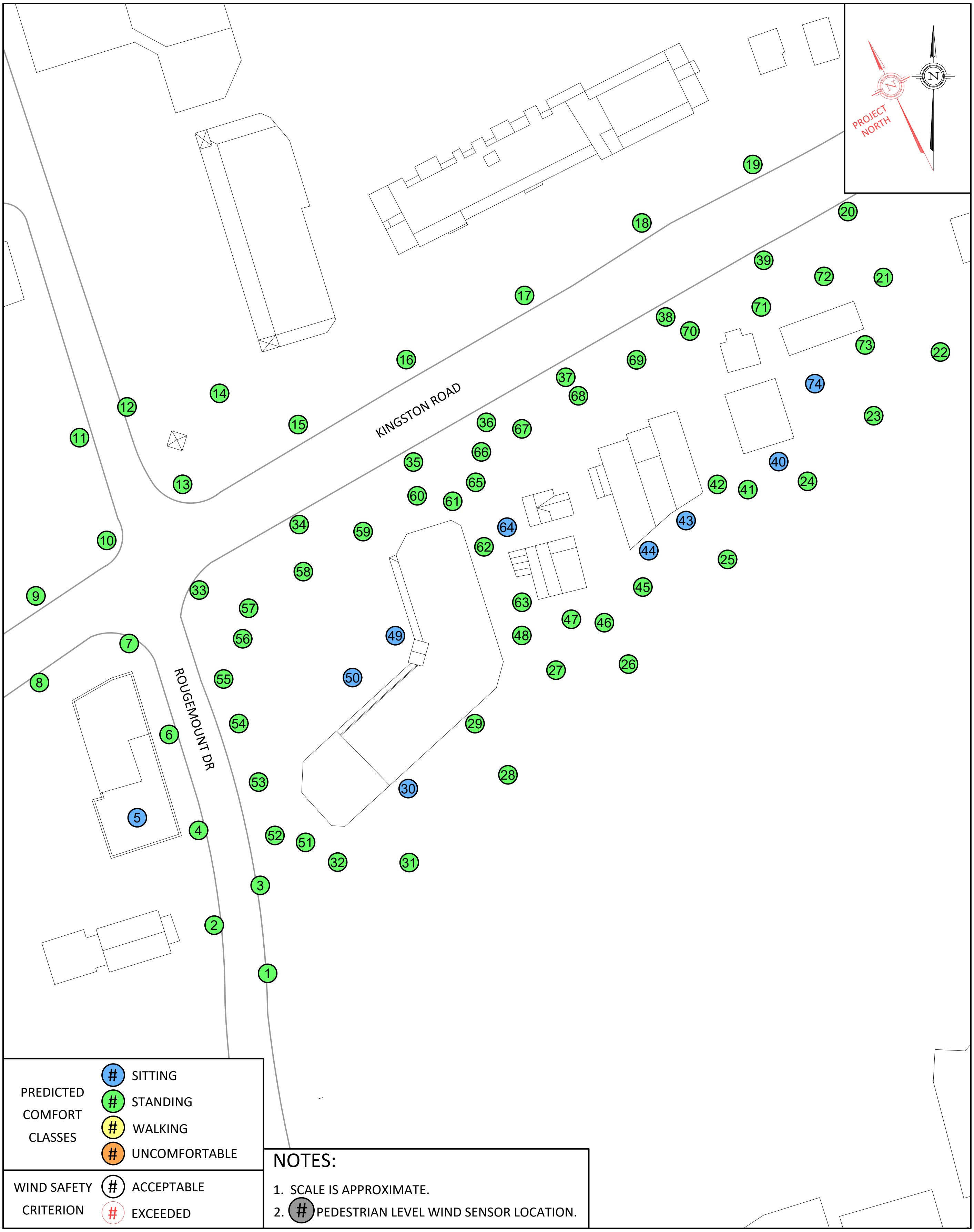
PROJECT 375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION FIGURE 1C: PROPOSED PHASE 1 & 2 SITE PLAN AND SURROUNDING CONTEXT
SCALE 1:2500 (APPROX.)	DRAWING NO. GW21-243-PLW-1C	
DATE JANUARY 10, 2025	DRAWN BY C.E.	



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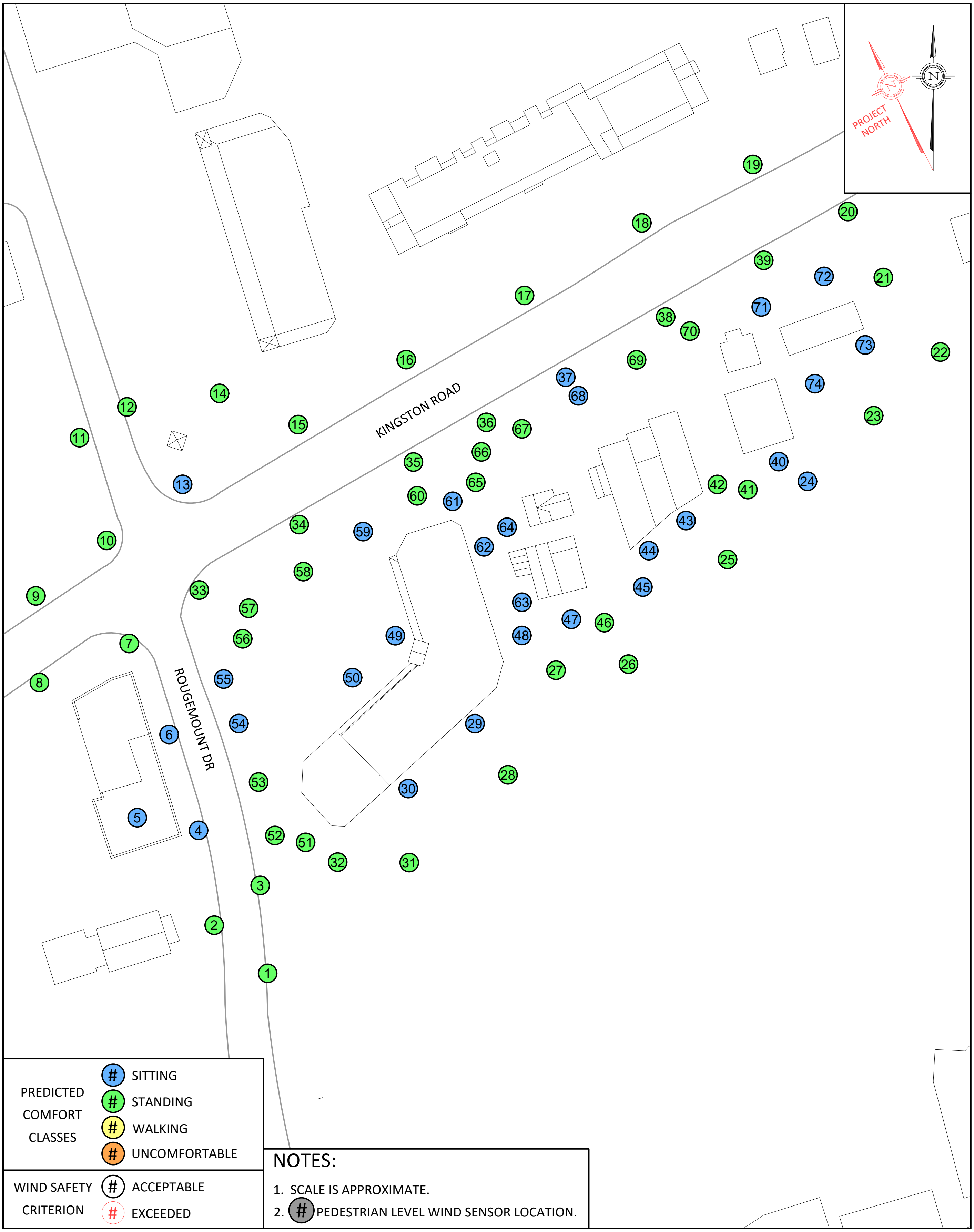
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION
SCALE	1:1500 (APPROX.)	DRAWING NO. GW21-243-PLW-2A	FIGURE 2A: SPRING EXISTING GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS
DATE	JANUARY 10, 2025	DRAWN BY C.E.	



NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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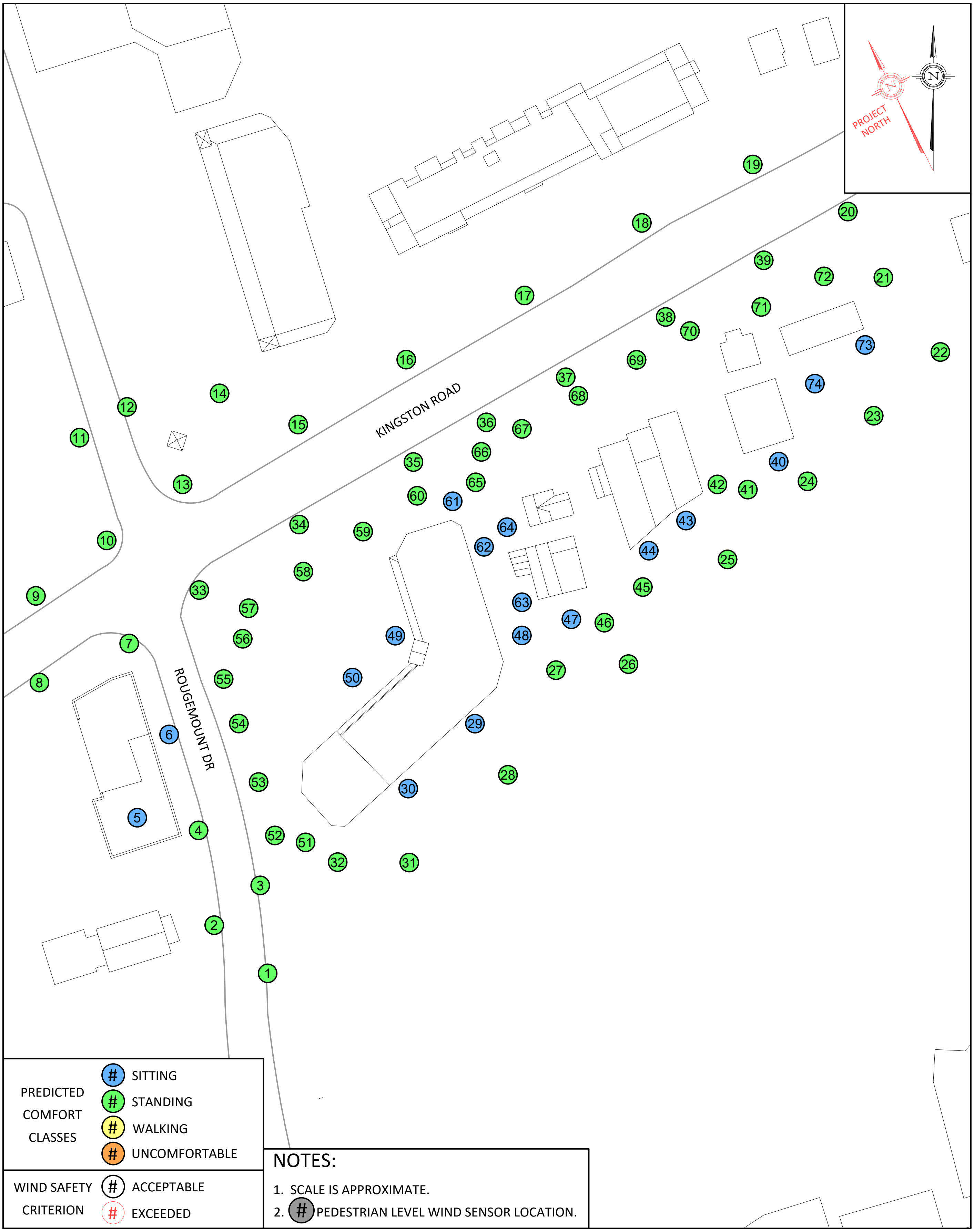
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1500 (APPROX.)
DRAWING NO.	GW21-243-PLW-2B
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 2B: SUMMER EXISTING GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES	
# (blue)	SITTING
# (green)	STANDING
# (yellow)	WALKING
# (orange)	UNCOMFORTABLE

WIND SAFETY CRITERION	
#	ACCEPTABLE
# (red)	EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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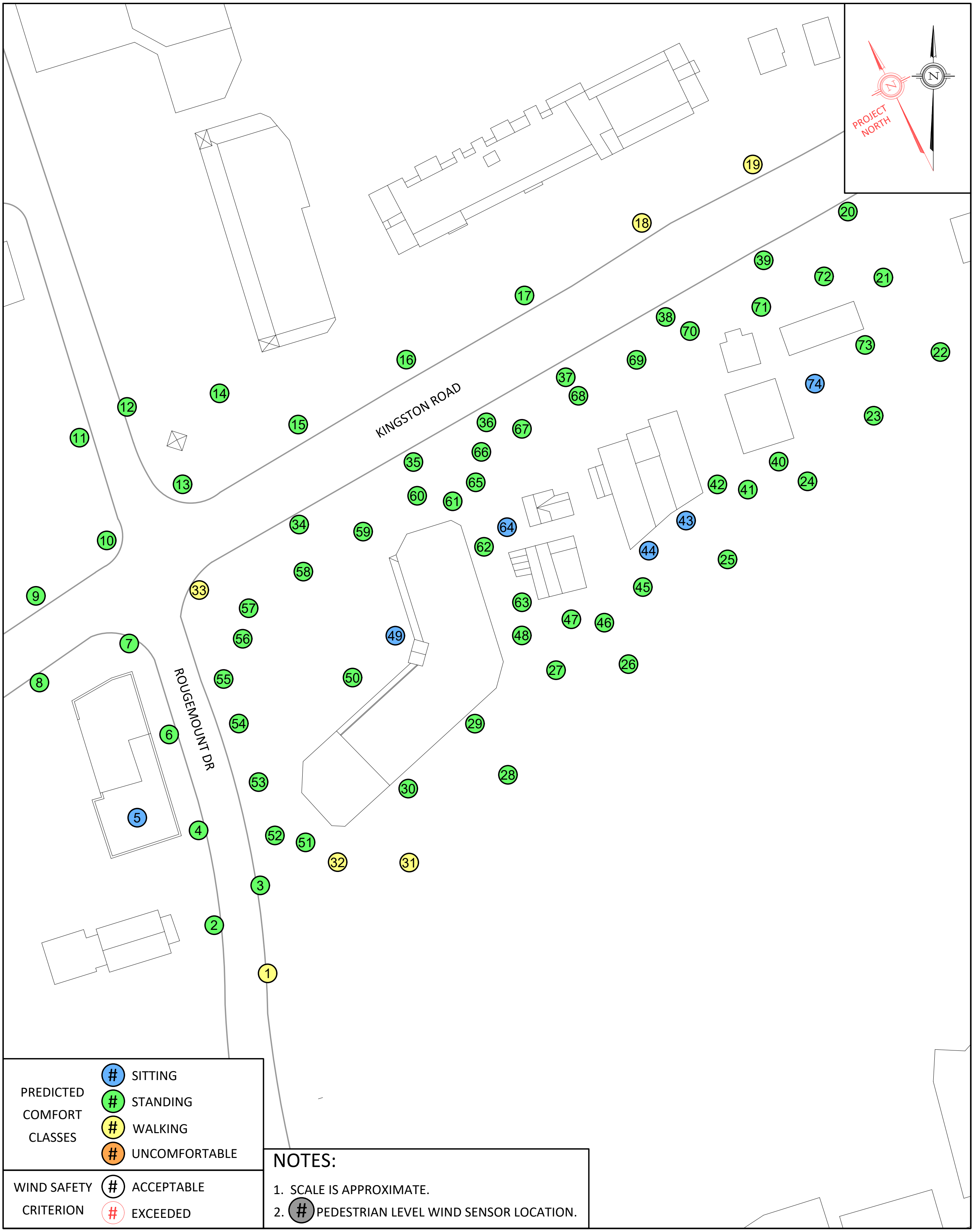
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:1500 (APPROX.)	DRAWING NO.	GW21-243-PLW-2C
DATE	JANUARY 10, 2025	DRAWN BY	C.E.

DESCRIPTION

FIGURE 2C: AUTUMN
EXISTING GROUND FLOOR PLAN
PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES	
#	SITTING
#	STANDING
#	WALKING
#	UNCOMFORTABLE

WIND SAFETY CRITERION	
#	ACCEPTABLE
#	EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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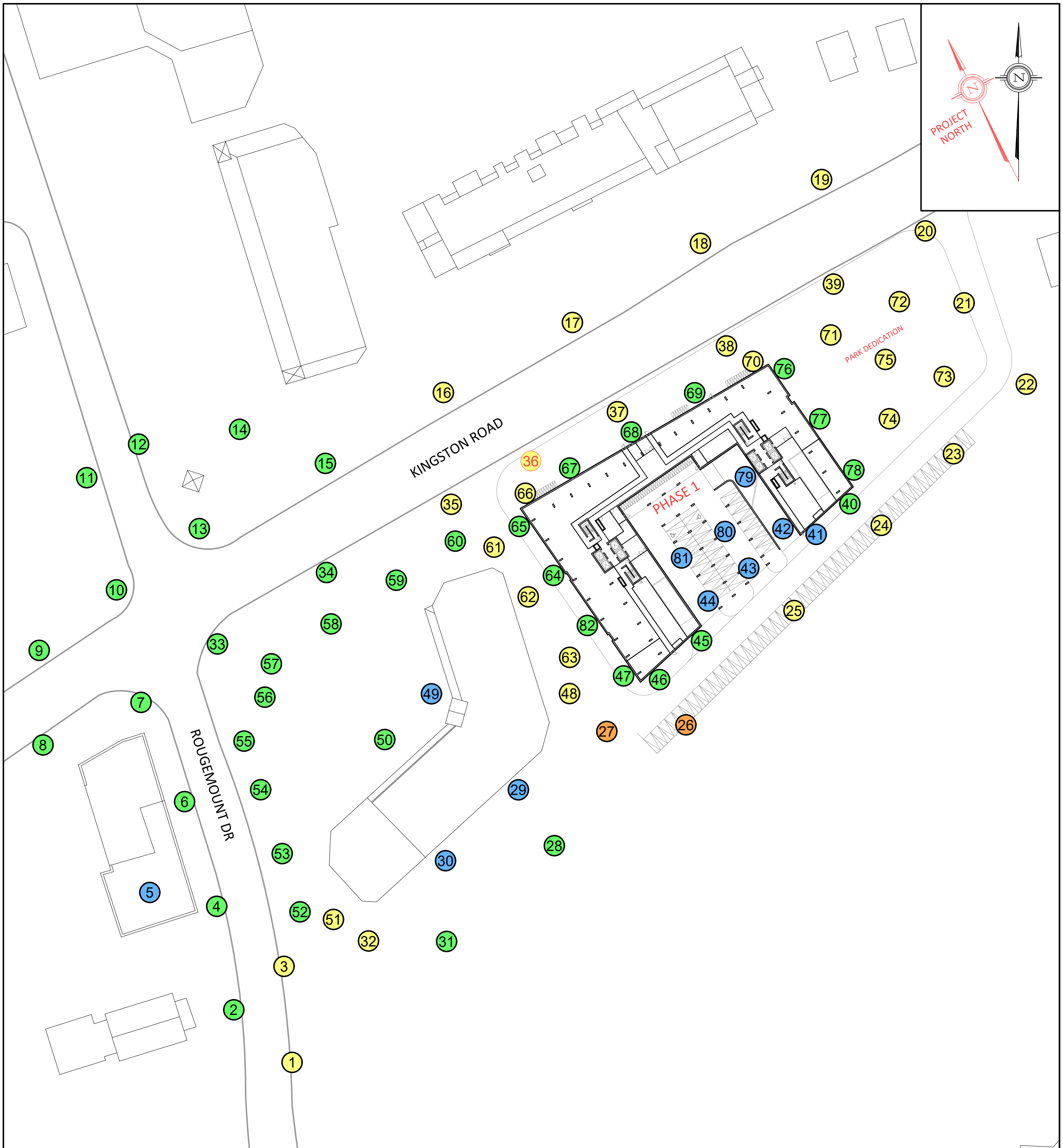
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1500 (APPROX.)
DRAWING NO.	GW21-243-PLW-2D
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 2D: WINTER EXISTING GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES

- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

WIND SAFETY CRITERION

- # ACCEPTABLE
- # EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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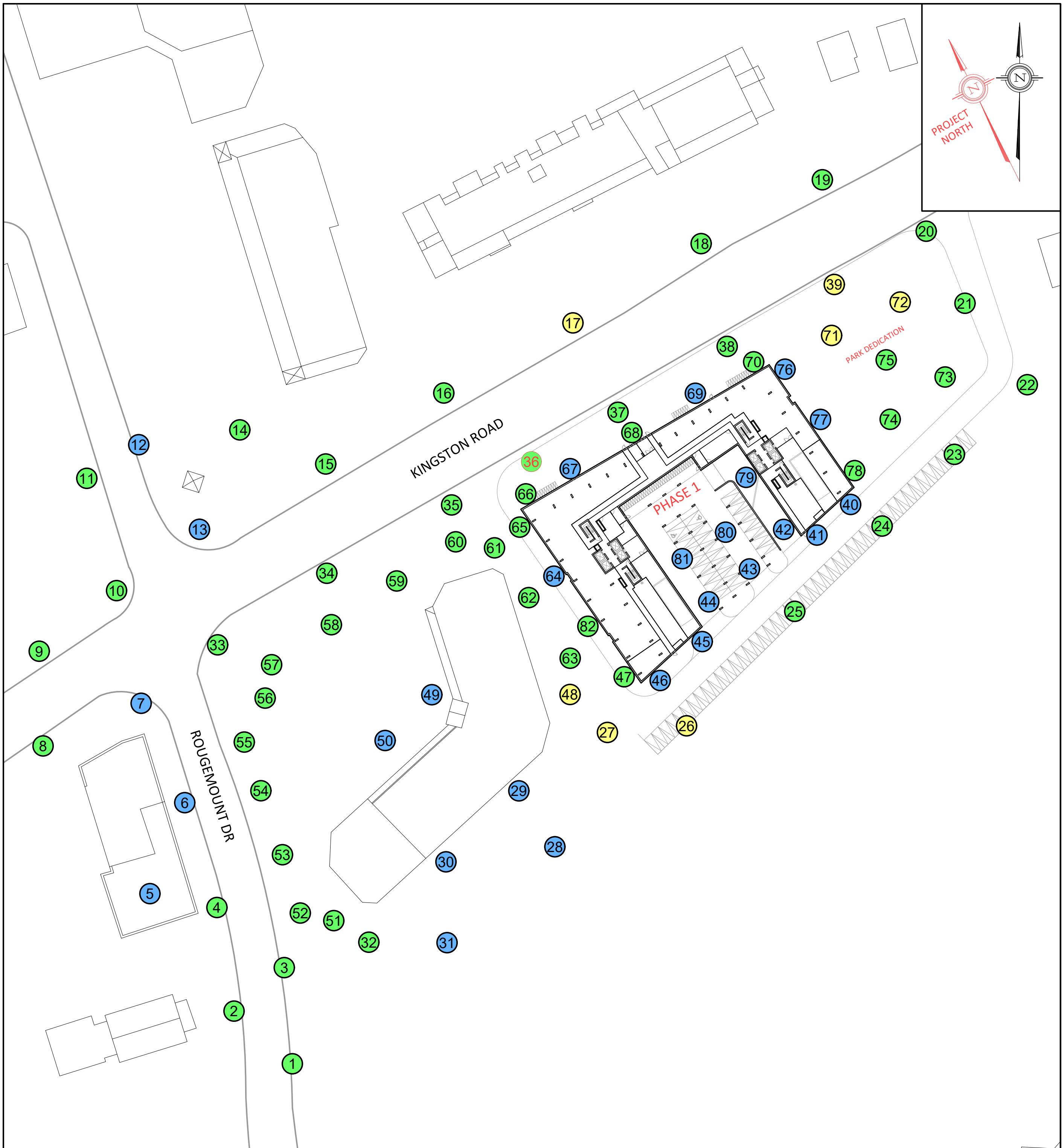
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1500 (APPROX.)
DRAWING NO.	GW21-243-PLW-3A
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 3A: SPRING PHASE 1 PROPOSED GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES
- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

WIND SAFETY CRITERION
- # ACCEPTABLE
- # EXCEEDED

NOTES:
1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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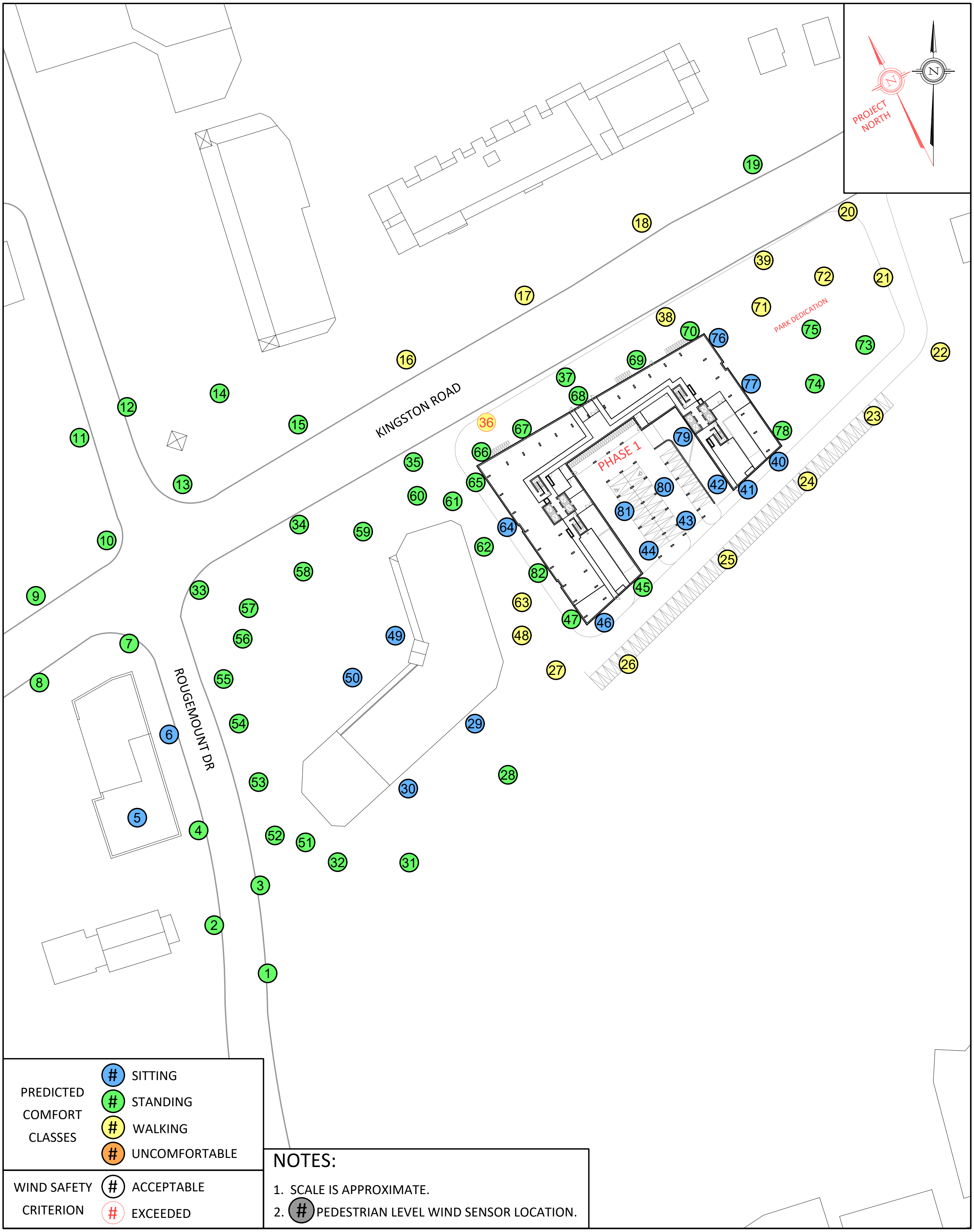
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1500 (APPROX.)
DRAWING NO.	GW21-243-PLW-3B
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 3B: SUMMER PHASE 1 PROPOSED GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS



NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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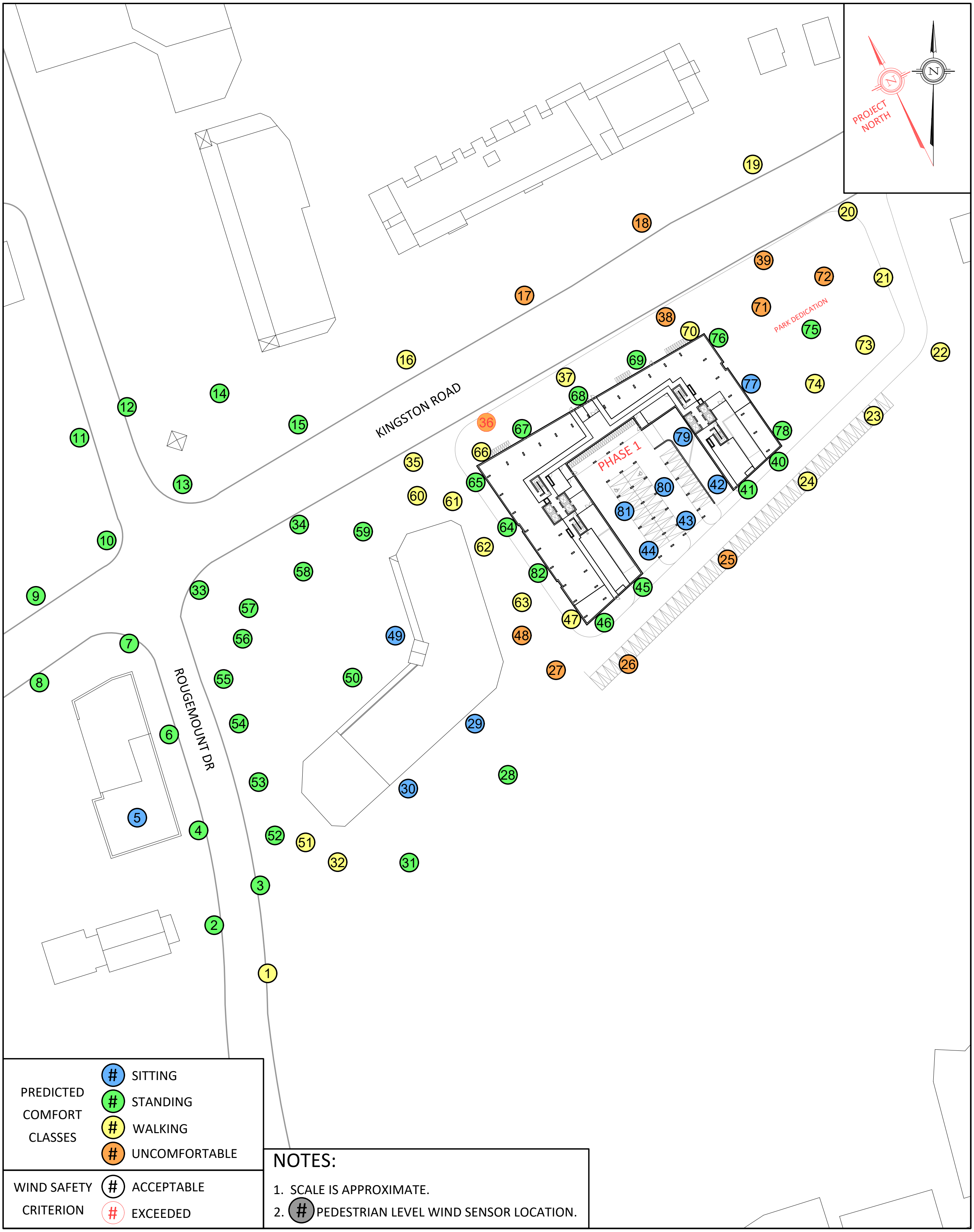
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1500 (APPROX.)
DRAWING NO.	GW21-243-PLW-3C
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 3C: AUTUMN PHASE 1 PROPOSED GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES
- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

WIND SAFETY CRITERION
- # ACCEPTABLE
- # EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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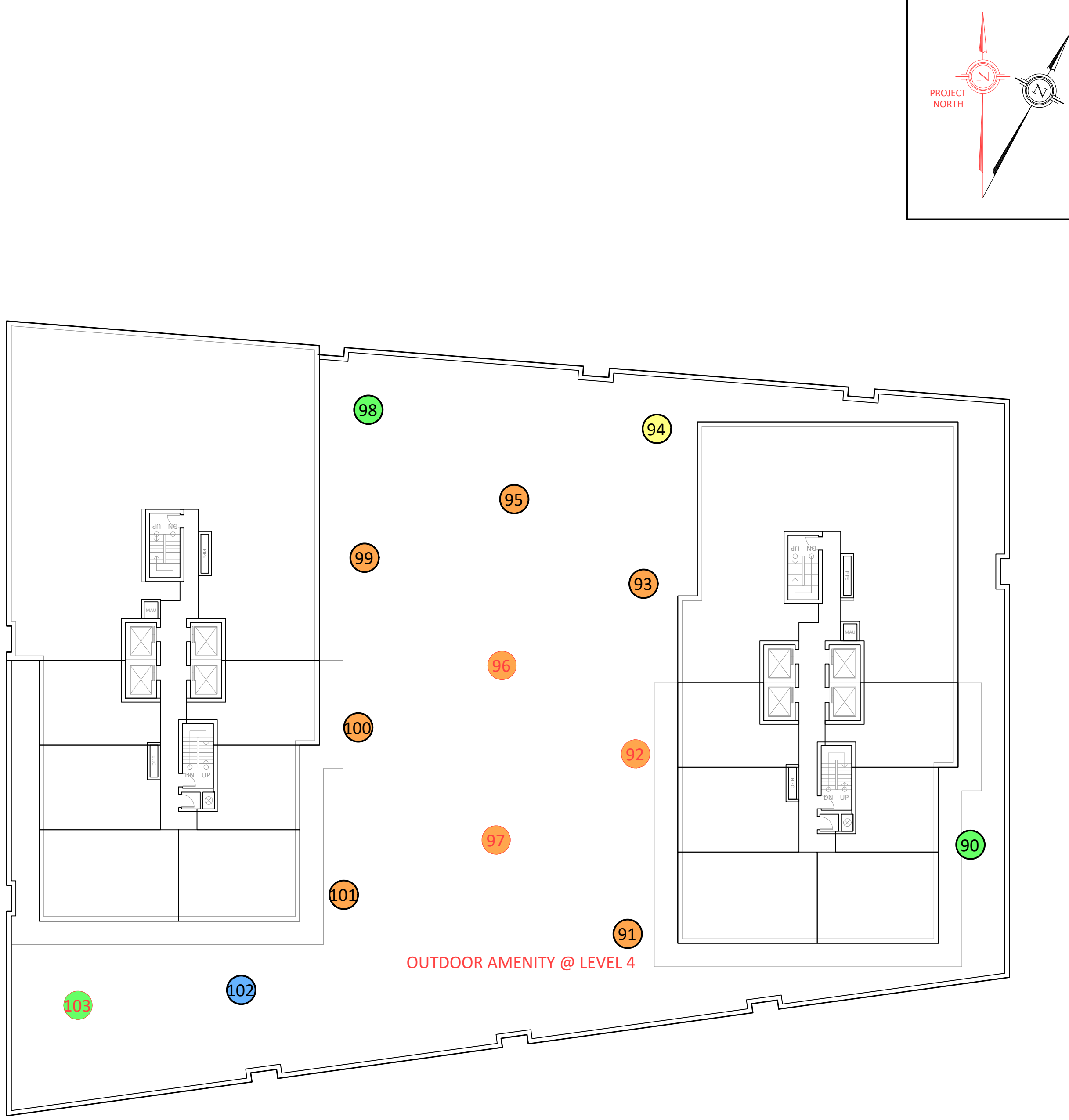
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1500 (APPROX.)
DRAWING NO.	GW21-243-PLW-3D
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 3D: WINTER PHASE 1 PROPOSED GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES
- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

WIND SAFETY CRITERION
- # ACCEPTABLE
- # EXCEEDED

NOTES:
1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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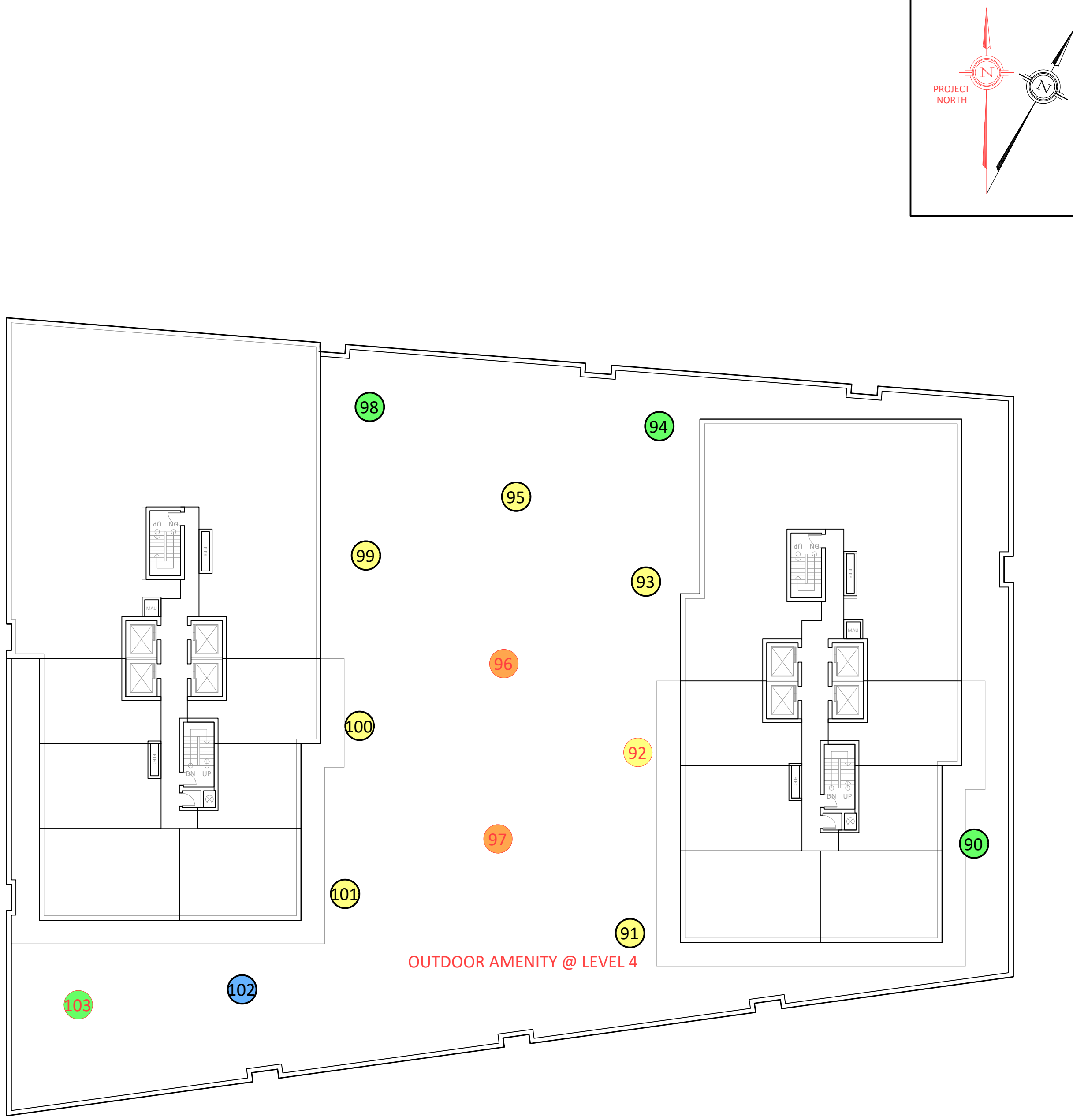
SCALE	1:500 (APPROX.)
DRAWING NO.	GW21-243-PLW-4A
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 4A: SPRING PHASE 1 FLOOR 4 AMENITY PLAN PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES
- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

WIND SAFETY CRITERION
- # ACCEPTABLE
- # EXCEEDED

NOTES:
1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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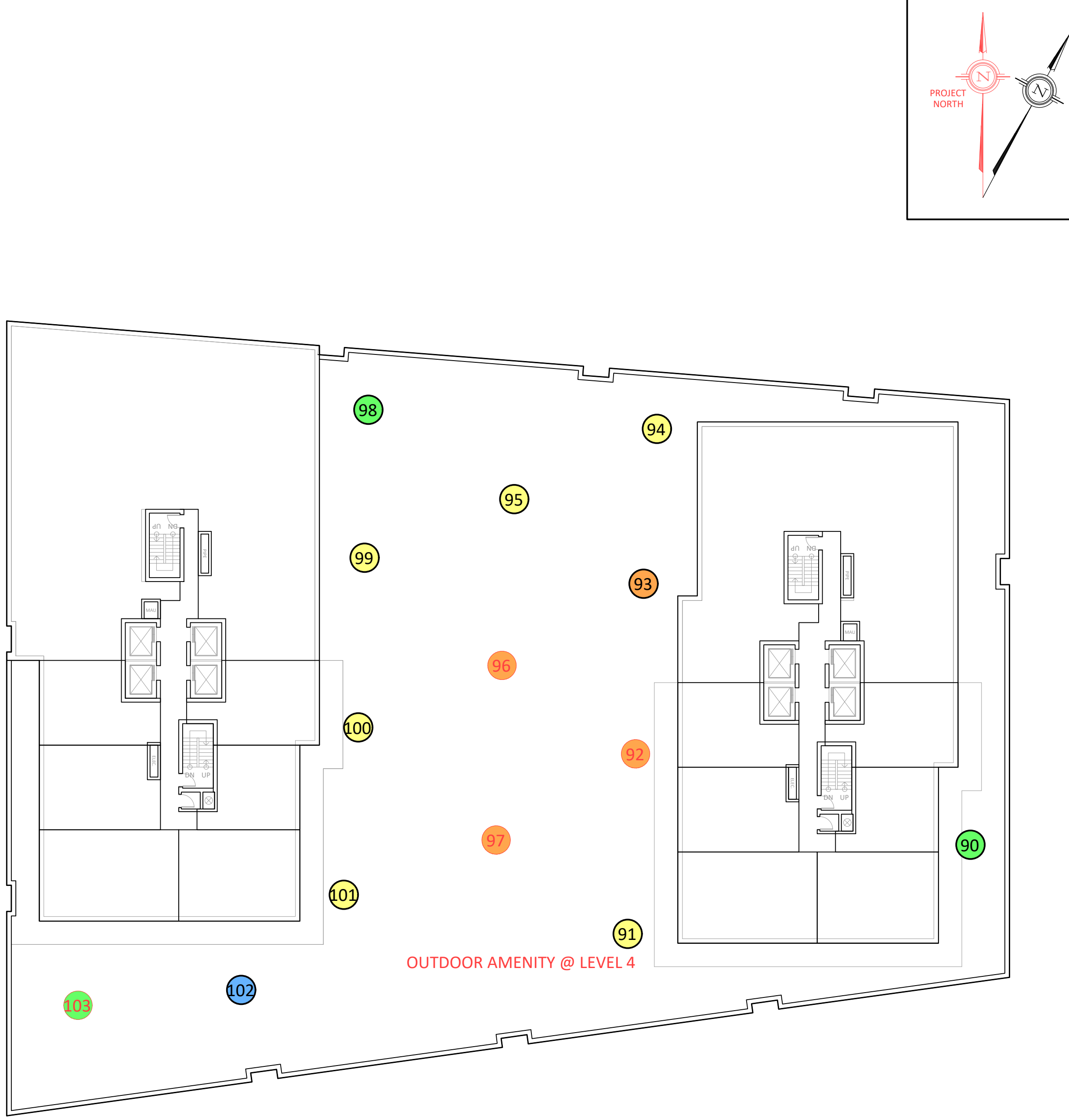
PROJECT: 375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 4B: SUMMER PHASE 1 FLOOR 4 AMENITY PLAN PEDESTRIAN COMFORT PREDICTIONS
SCALE: 1:500 (APPROX.)	DRAWING NO. GW21-243-PLW-4B	
DATE: JANUARY 10, 2025	DRAWN BY: C.E.	



PREDICTED COMFORT CLASSES	#	SITTING
	#	STANDING
	#	WALKING
	#	UNCOMFORTABLE
WIND SAFETY CRITERION	#	ACCEPTABLE
	#	EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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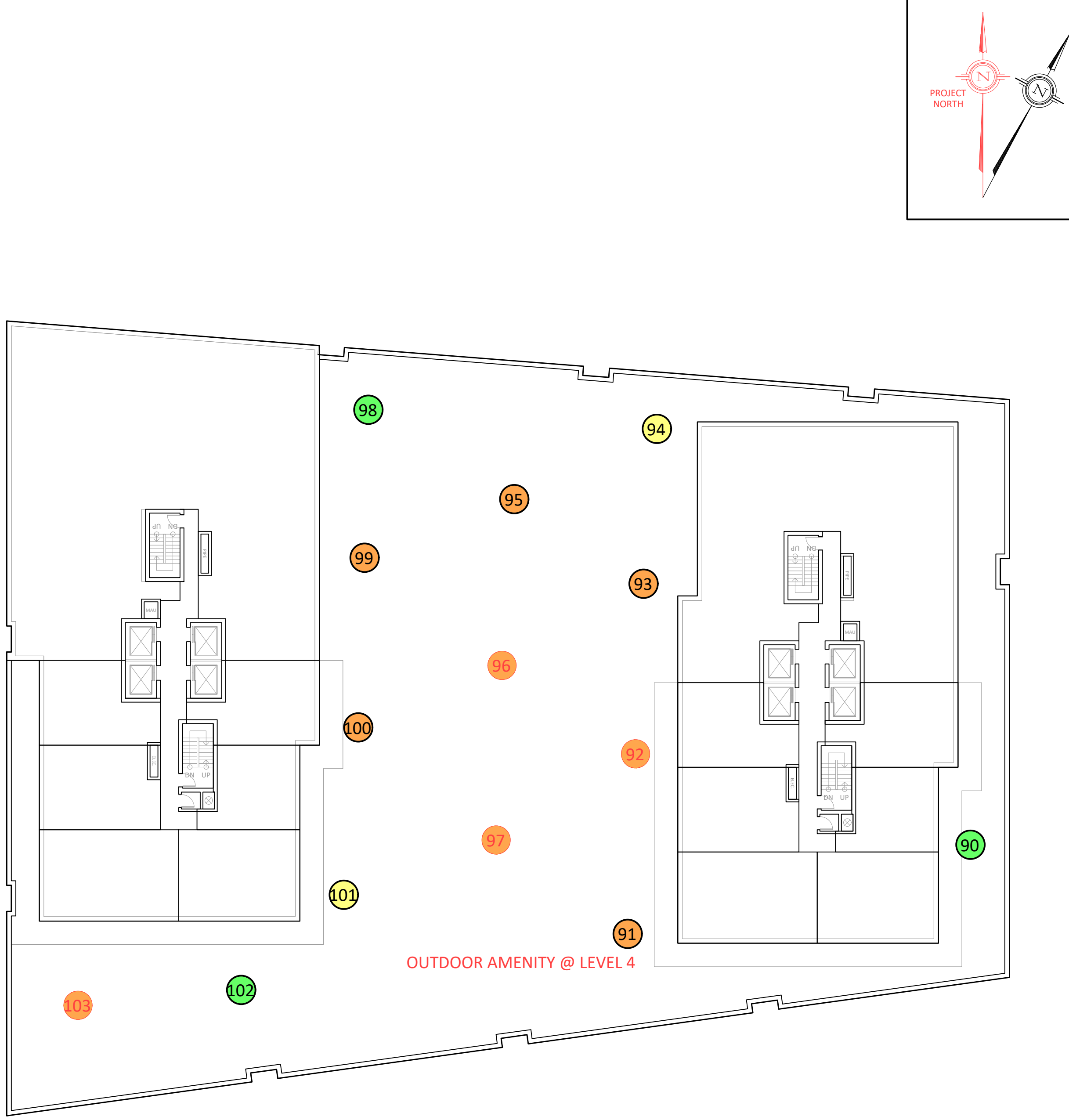
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY	DESCRIPTION	FIGURE 4C: AUTUMN PHASE 1 FLOOR 4 AMENITY PLAN PEDESTRIAN COMFORT PREDICTIONS
SCALE	1:500 (APPROX.)	DRAWING NO.	GW21-243-PLW-4C
DATE	JANUARY 10, 2025	DRAWN BY	C.E.



PREDICTED COMFORT CLASSES
- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

WIND SAFETY CRITERION
- # ACCEPTABLE
- # EXCEEDED

NOTES:
1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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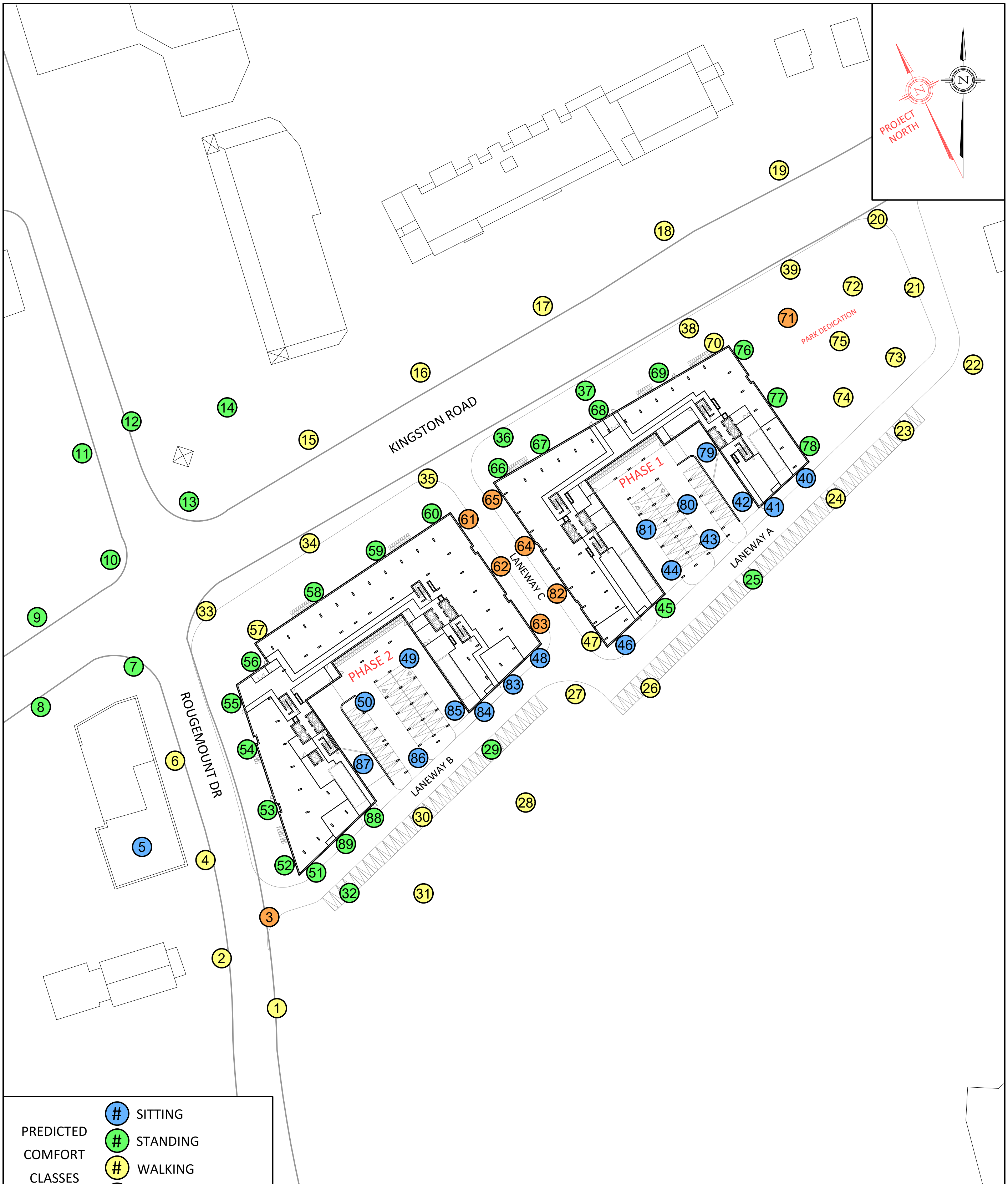
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:500 (APPROX.)	DRAWING NO.	GW21-243-PLW-4D
DATE	JANUARY 10, 2025	DRAWN BY	C.E.

DESCRIPTION

FIGURE 4D: WINTER
PHASE 1 FLOOR 4 AMENITY PLAN
PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES	
#	SITTING
#	STANDING
#	WALKING
#	UNCOMFORTABLE

WIND SAFETY CRITERION	
#	ACCEPTABLE
#	EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1500 (APPROX.)
DRAWING NO.	GW21-243-PLW-5A
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 5A: SPRING PHASE 1 & 2 GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS

PREDICTED COMFORT CLASSES	
# (blue)	SITTING
# (green)	STANDING
# (yellow)	WALKING
# (orange)	UNCOMFORTABLE

WIND SAFETY CRITERION	
# (black)	ACCEPTABLE
# (red)	EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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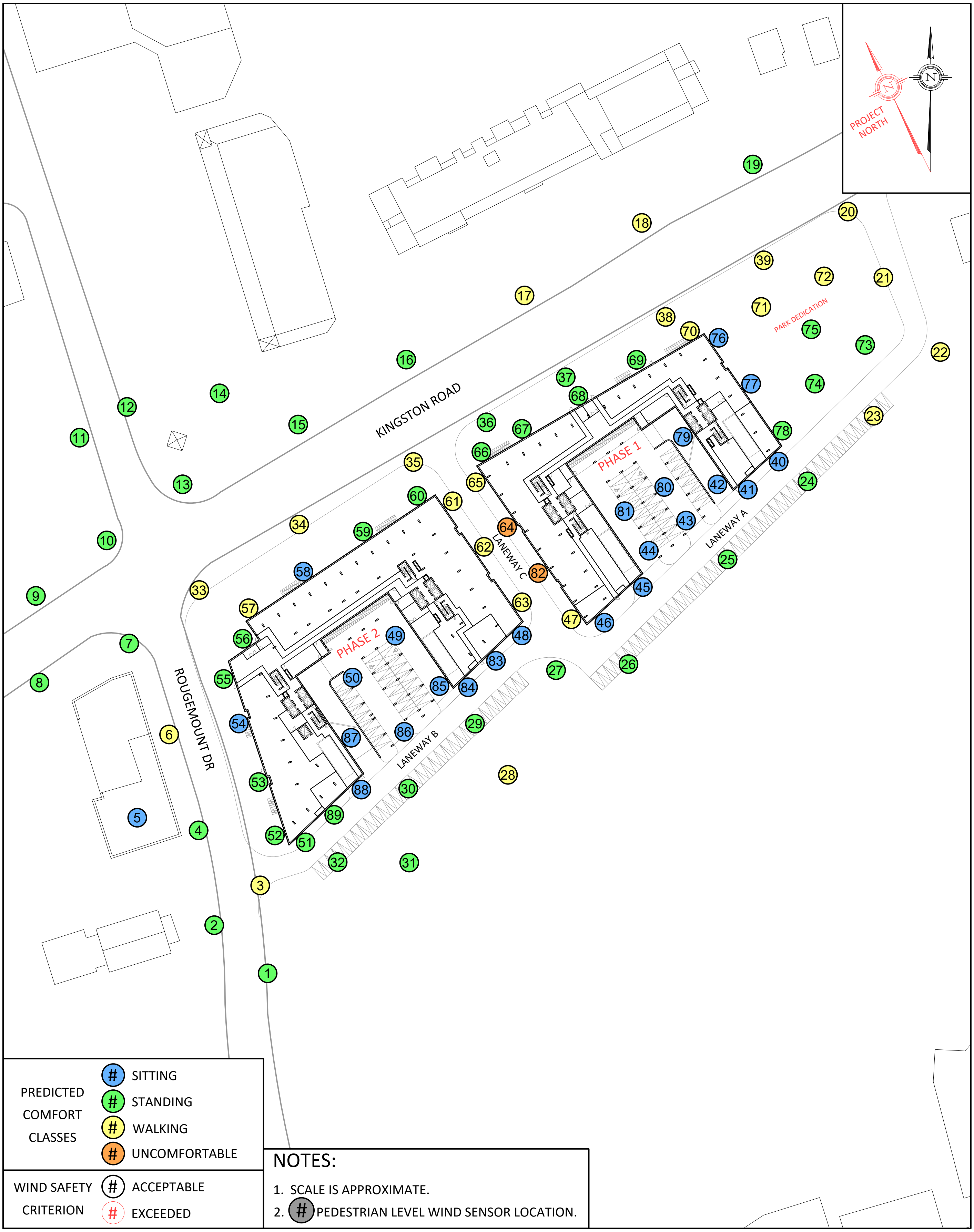
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1500 (APPROX.)
DRAWING NO.	GW21-243-PLW-5B
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 5B: SUMMER PHASE 1 & 2 GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES
- # SITTING
- # STANDING
- # WALKING
- # UNCOMFORTABLE

WIND SAFETY CRITERION
- # ACCEPTABLE
- # EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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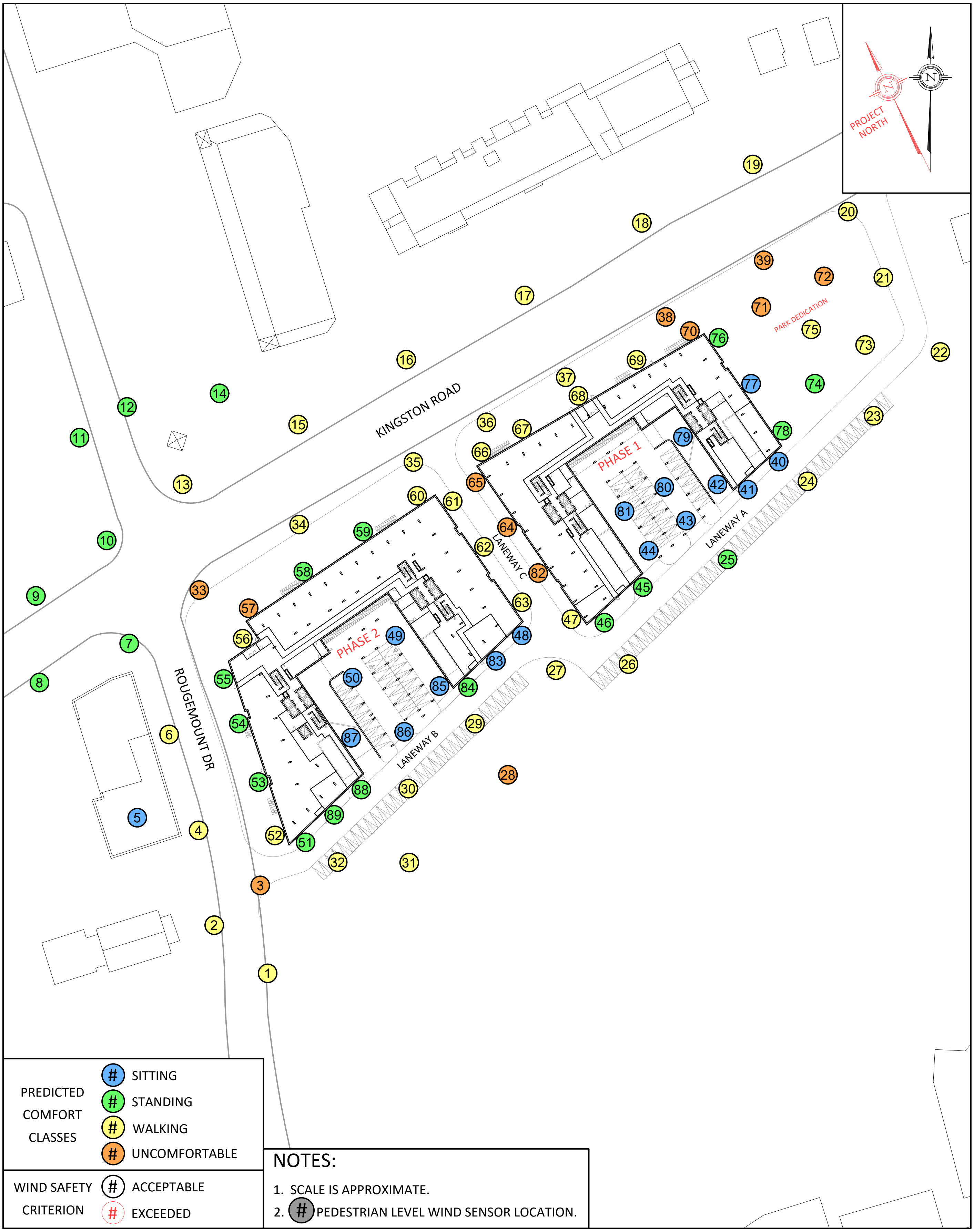
PROJECT: 375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY		DESCRIPTION: FIGURE 5C: AUTUMN PHASE 1 & 2 GROUND FLOOR PLAN PEDESTRIAN COMFORT PREDICTIONS
SCALE: 1:1500 (APPROX.)	DRAWING NO.: GW21-243-PLW-5C	
DATE: JANUARY 10, 2025	DRAWN BY: C.E.	



PREDICTED COMFORT CLASSES	
#	SITTING
#	STANDING
#	WALKING
#	UNCOMFORTABLE

WIND SAFETY CRITERION	
#	ACCEPTABLE
#	EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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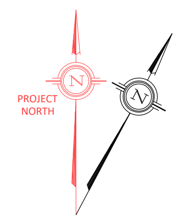
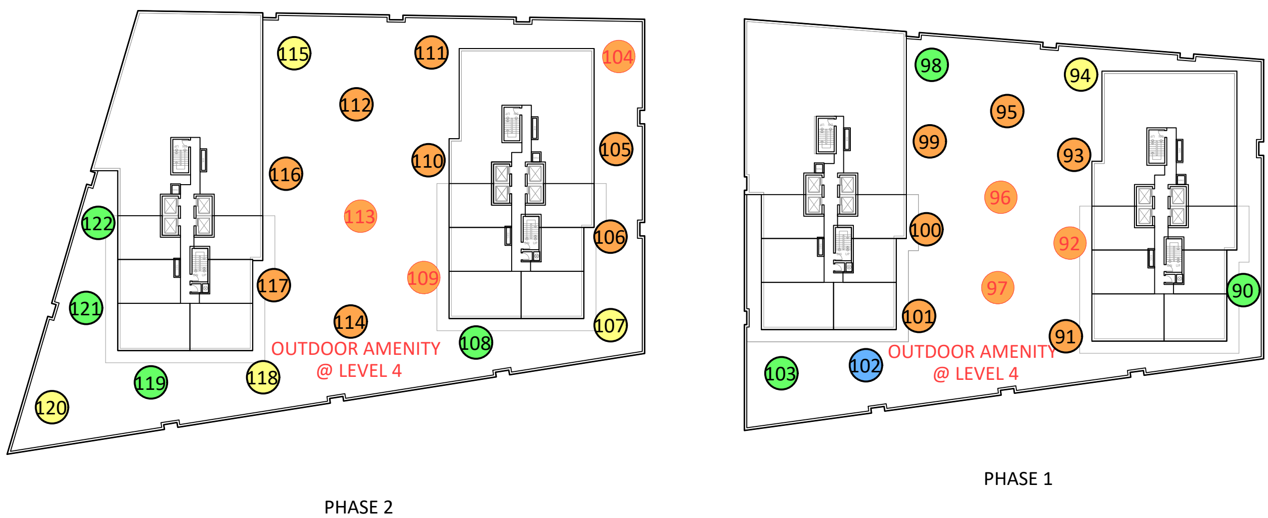
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:1500 (APPROX.)	DRAWING NO.	GW21-243-PLW-5D
DATE	JANUARY 10, 2025	DRAWN BY	C.E.

DESCRIPTION

FIGURE 5D: WINTER
PHASE 1 & 2 GROUND FLOOR PLAN
PEDESTRIAN COMFORT PREDICTIONS





PREDICTED COMFORT CLASSES	#	SITTING
	#	STANDING
	#	WALKING
	#	UNCOMFORTABLE
WIND SAFETY CRITERION	#	ACCEPTABLE
	#	EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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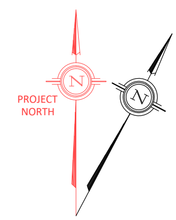
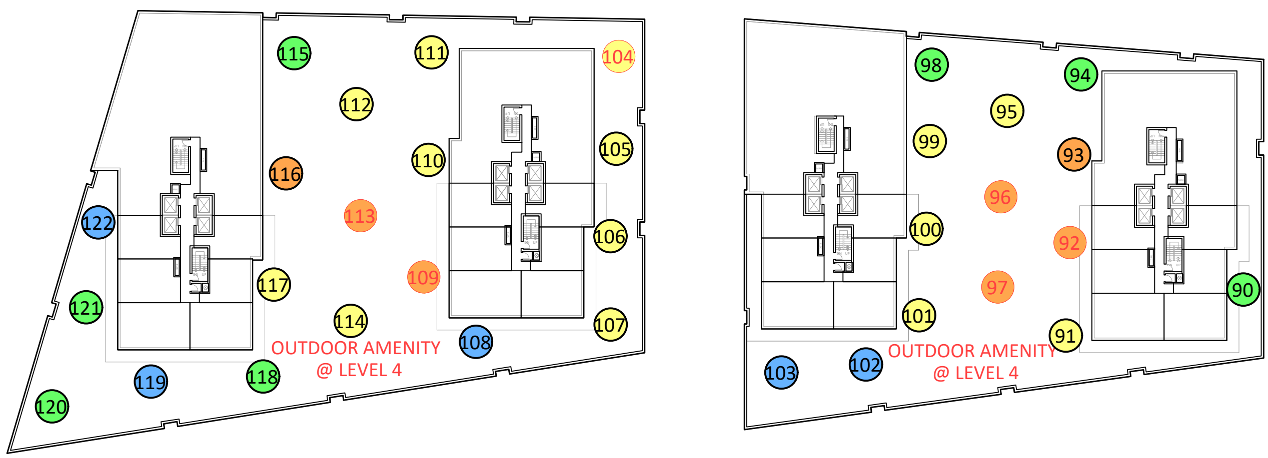
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:1100 (APPROX.)	DRAWING NO.	GW21-243-PLW-6A
DATE	JANUARY 10, 2025	DRAWN BY	C.E.

DESCRIPTION

FIGURE 6A: SPRING
PHASE 1 & 2 FLOOR 4 AMENITY PLAN
PEDESTRIAN COMFORT PREDICTIONS





PHASE 2

PHASE 1

PREDICTED COMFORT CLASSES	#	SITTING
	#	STANDING
	#	WALKING
	#	UNCOMFORTABLE
WIND SAFETY CRITERION	#	ACCEPTABLE
	#	EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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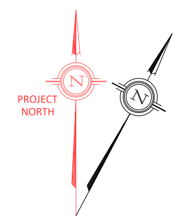
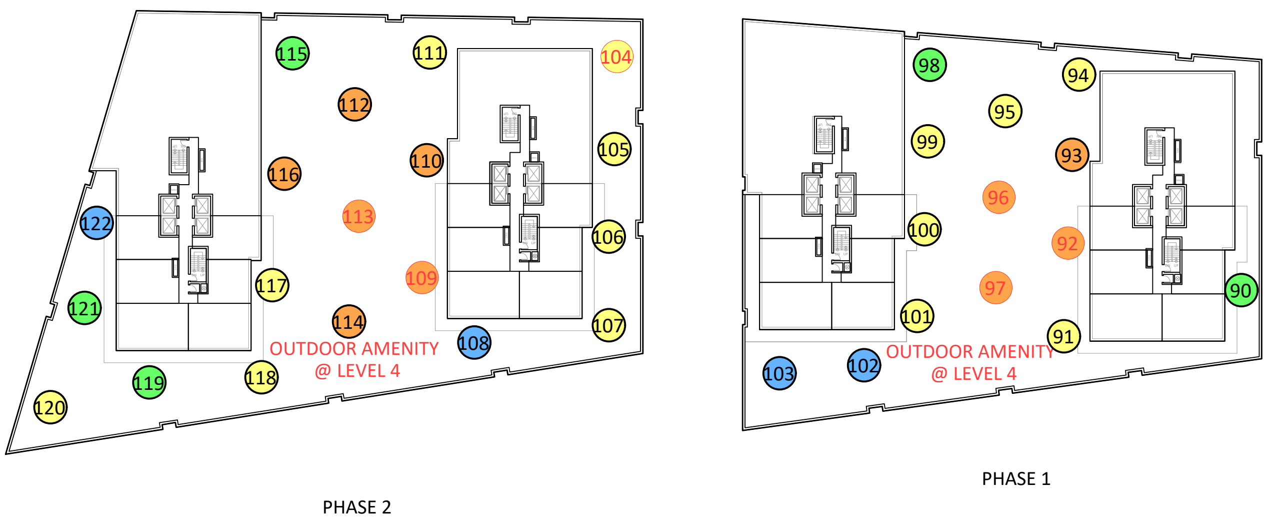
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1100 (APPROX.)
DRAWING NO.	GW21-243-PLW-6B
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 6B: SUMMER PHASE 1 & 2 FLOOR 4 AMENITY PLAN PEDESTRIAN COMFORT PREDICTIONS





PREDICTED COMFORT CLASSES	#	SITTING
	#	STANDING
	#	WALKING
	#	UNCOMFORTABLE
WIND SAFETY CRITERION	#	ACCEPTABLE
	#	EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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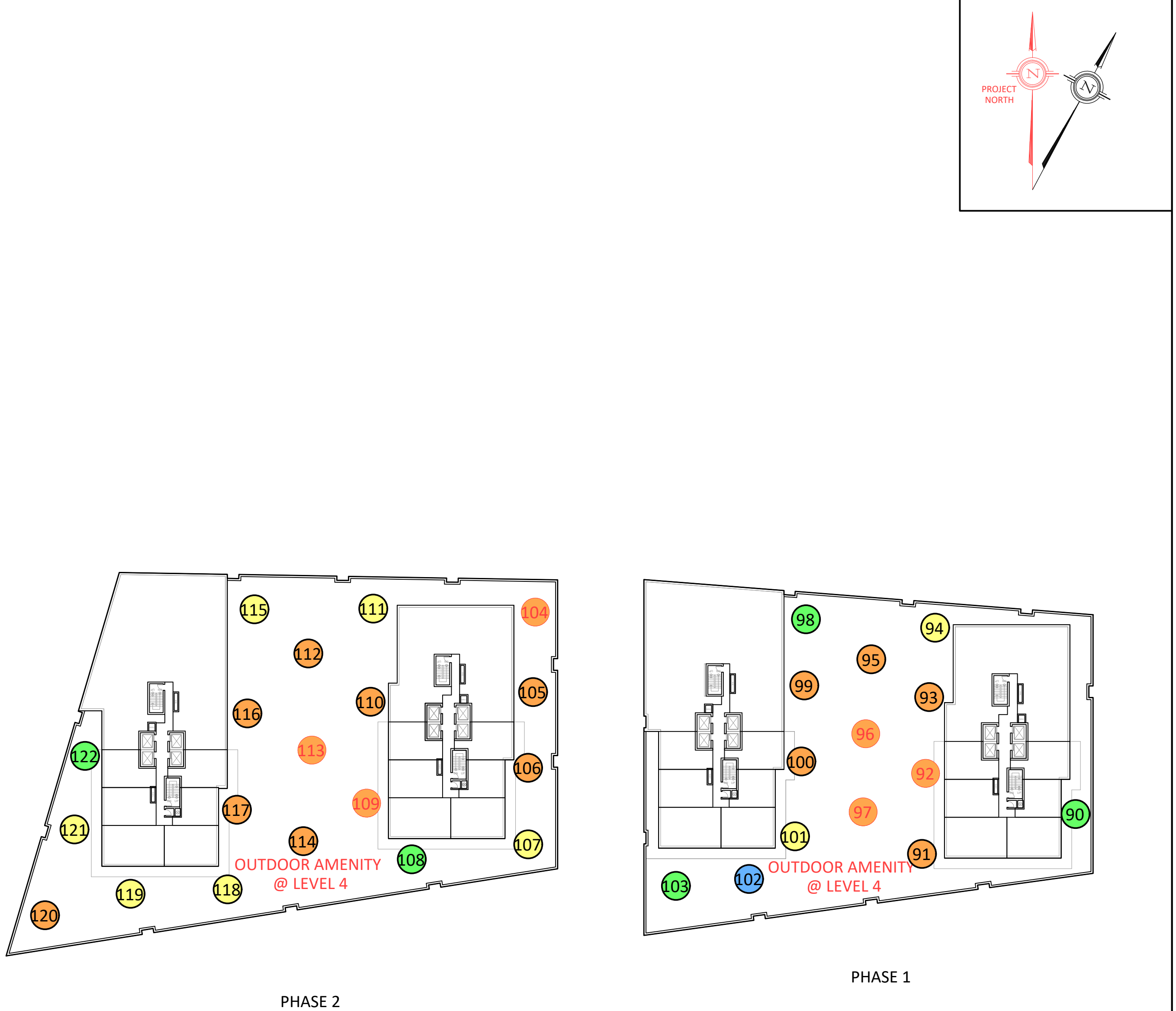
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY		
SCALE	1:1100 (APPROX.)	DRAWING NO.	GW21-243-PLW-6C
DATE	JANUARY 10, 2025	DRAWN BY	C.E.

DESCRIPTION

FIGURE 6C: AUTUMN
PHASE 1 & 2 FLOOR 4 AMENITY PLAN
PEDESTRIAN COMFORT PREDICTIONS



PREDICTED COMFORT CLASSES	#	SITTING
	#	STANDING
	#	WALKING
	#	UNCOMFORTABLE
WIND SAFETY CRITERION	#	ACCEPTABLE
	#	EXCEEDED

NOTES:

1. SCALE IS APPROXIMATE.
2. # PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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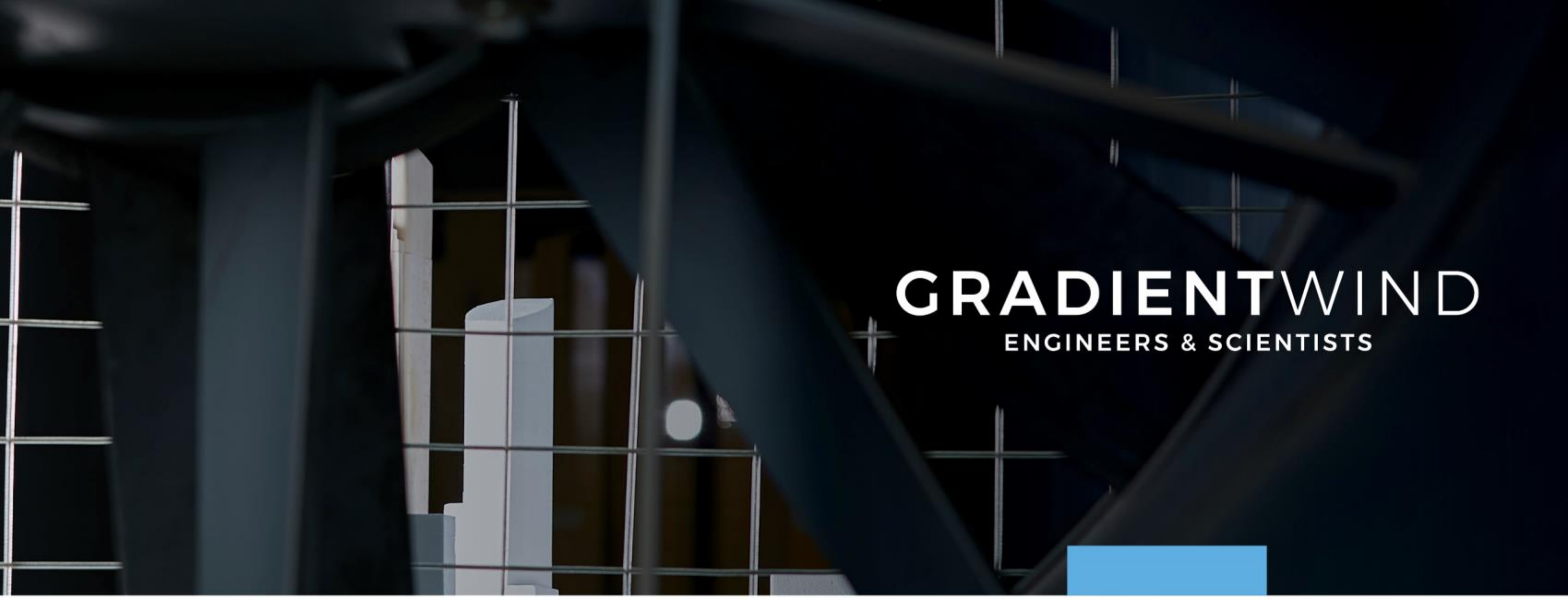
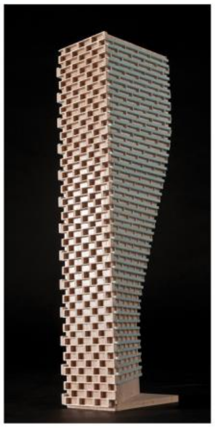
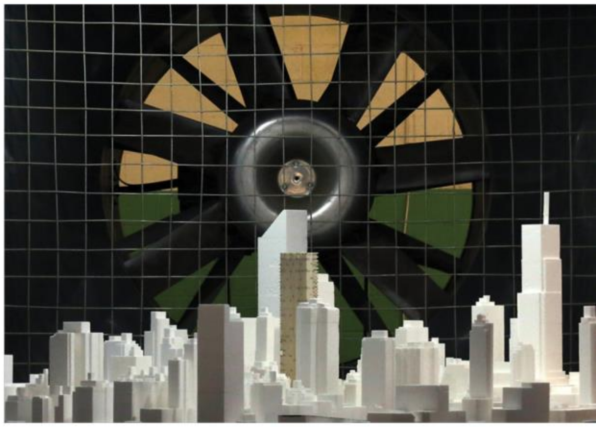
PROJECT	375 KINGSTON ROAD, TORONTO PEDESTRIAN LEVEL WIND STUDY
SCALE	1:1100 (APPROX.)
DRAWING NO.	GW21-243-PLW-6D
DATE	JANUARY 10, 2025
DRAWN BY	C.E.
DESCRIPTION	FIGURE 6D: WINTER PHASE 1 & 2 FLOOR 4 AMENITY PLAN PEDESTRIAN COMFORT PREDICTIONS







APPENDIX A

PEDESTRIAN COMFORT SUITABILITY, TABLES A1-A3
(EXISTING SCENARIO)

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE A1: SUMMARY OF PEDESTRIAN COMFORT (EXISTING SCENARIO)

Sensor	Pedestrian Comfort								Pedestrian Safety	
	Spring		Summer		Autumn		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
1	14.7	Standing	11.6	Standing	13.4	Standing	16.2	Walking	54.7	Safe
2	13.0	Standing	10.5	Standing	11.1	Standing	12.5	Standing	46.5	Safe
3	14.0	Standing	10.9	Standing	12.0	Standing	14.0	Standing	48.0	Safe
4	11.8	Standing	9.8	Sitting	10.5	Standing	12.2	Standing	41.9	Safe
5	7.8	Sitting	6.2	Sitting	7.0	Sitting	8.3	Sitting	31.4	Safe
6	10.7	Standing	8.6	Sitting	9.0	Sitting	10.4	Standing	36.3	Safe
7	13.5	Standing	10.3	Standing	11.9	Standing	14.2	Standing	49.0	Safe
8	12.6	Standing	10.6	Standing	11.8	Standing	14.1	Standing	48.4	Safe
9	13.7	Standing	10.9	Standing	12.1	Standing	14.5	Standing	47.4	Safe
10	13.9	Standing	11.1	Standing	12.5	Standing	14.8	Standing	48.9	Safe
11	12.9	Standing	10.5	Standing	11.6	Standing	13.4	Standing	43.9	Safe
12	12.8	Standing	10.2	Standing	11.1	Standing	12.9	Standing	43.4	Safe
13	12.7	Standing	9.9	Sitting	11.3	Standing	13.5	Standing	46.5	Safe
14	13.6	Standing	10.9	Standing	11.8	Standing	13.6	Standing	46.0	Safe
15	13.3	Standing	10.1	Standing	11.7	Standing	13.6	Standing	46.2	Safe
16	13.3	Standing	10.2	Standing	11.7	Standing	14.1	Standing	47.1	Safe
17	14.0	Standing	10.7	Standing	12.3	Standing	14.9	Standing	49.2	Safe
18	14.1	Standing	11.0	Standing	12.3	Standing	15.1	Walking	52.6	Safe
19	14.0	Standing	11.4	Standing	12.9	Standing	15.5	Walking	53.7	Safe
20	13.4	Standing	10.8	Standing	12.2	Standing	14.5	Standing	50.6	Safe
21	14.3	Standing	11.3	Standing	12.0	Standing	13.8	Standing	49.7	Safe
22	14.6	Standing	11.6	Standing	12.9	Standing	15.0	Standing	49.2	Safe
23	13.1	Standing	10.6	Standing	11.9	Standing	13.8	Standing	47.6	Safe
24	12.2	Standing	9.7	Sitting	11.0	Standing	12.9	Standing	43.9	Safe
25	12.7	Standing	10.4	Standing	11.7	Standing	14.2	Standing	49.6	Safe
26	13.9	Standing	11.3	Standing	12.8	Standing	14.8	Standing	48.0	Safe
27	12.6	Standing	10.4	Standing	11.2	Standing	12.9	Standing	42.7	Safe
28	13.0	Standing	10.6	Standing	11.8	Standing	14.1	Standing	46.6	Safe
29	10.5	Standing	8.5	Sitting	9.5	Sitting	11.2	Standing	39.4	Safe
30	10.0	Sitting	8.0	Sitting	8.9	Sitting	10.6	Standing	36.4	Safe
31	13.4	Standing	10.8	Standing	12.6	Standing	15.2	Walking	52.2	Safe
32	14.2	Standing	10.9	Standing	12.7	Standing	15.5	Walking	52.0	Safe
33	14.1	Standing	11.4	Standing	12.7	Standing	15.4	Walking	51.3	Safe
34	13.1	Standing	10.5	Standing	11.9	Standing	14.3	Standing	48.0	Safe
35	13.3	Standing	10.3	Standing	12.1	Standing	14.5	Standing	49.2	Safe

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

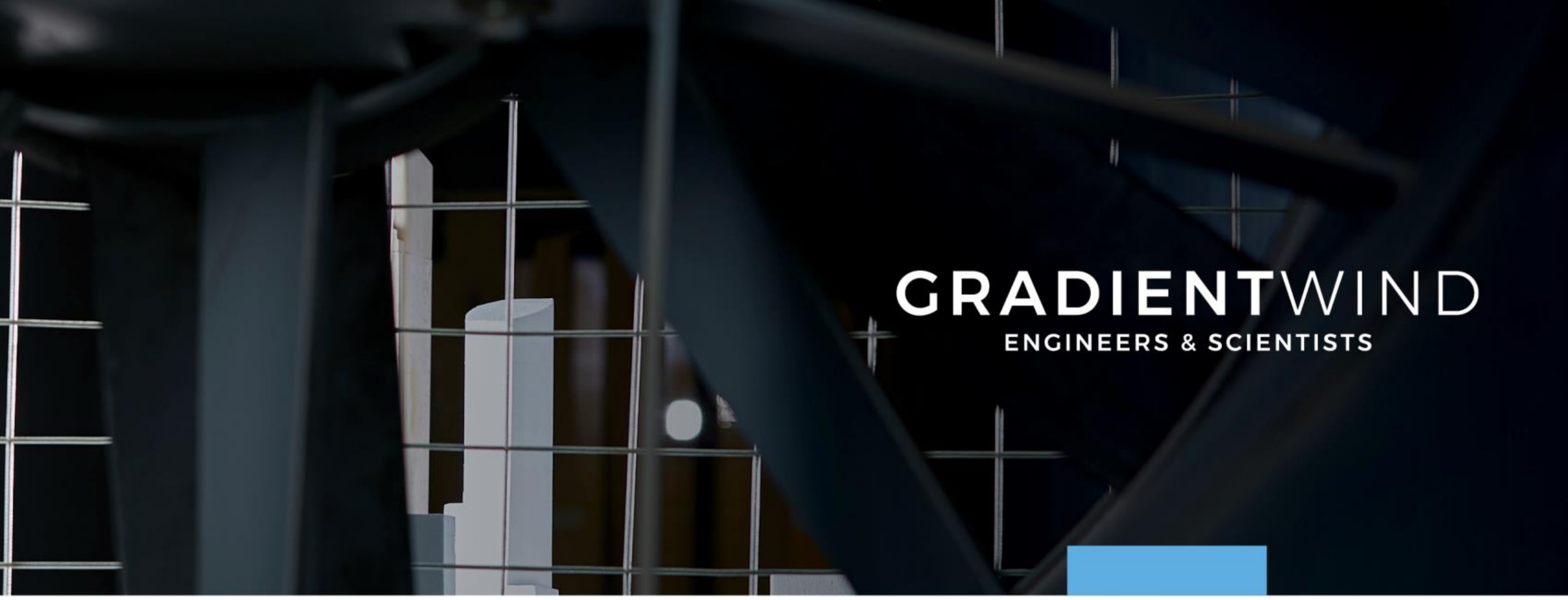
TABLE A2: SUMMARY OF PEDESTRIAN COMFORT (EXISTING SCENARIO)

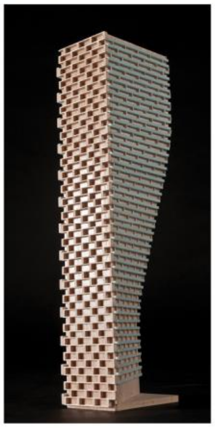
Sensor	Pedestrian Comfort								Pedestrian Safety	
	Spring		Summer		Autumn		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
36	13.7	Standing	10.8	Standing	12.2	Standing	14.9	Standing	49.5	Safe
37	12.5	Standing	10.0	Sitting	11.5	Standing	14.0	Standing	48.9	Safe
38	13.2	Standing	10.1	Standing	11.6	Standing	13.9	Standing	47.5	Safe
39	13.3	Standing	10.4	Standing	12.0	Standing	14.7	Standing	51.5	Safe
40	9.5	Sitting	7.5	Sitting	8.8	Sitting	10.3	Standing	39.6	Safe
41	11.8	Standing	9.4	Sitting	10.4	Standing	12.1	Standing	43.1	Safe
42	12.4	Standing	10.6	Standing	10.9	Standing	12.1	Standing	43.8	Safe
43	8.5	Sitting	6.8	Sitting	8.0	Sitting	9.5	Sitting	36.4	Safe
44	8.5	Sitting	6.6	Sitting	7.9	Sitting	9.6	Sitting	41.1	Safe
45	12.3	Standing	9.9	Sitting	11.7	Standing	14.1	Standing	49.2	Safe
46	12.6	Standing	10.2	Standing	11.5	Standing	13.6	Standing	47.9	Safe
47	10.8	Standing	8.7	Sitting	10.0	Sitting	11.7	Standing	43.2	Safe
48	11.2	Standing	9.3	Sitting	9.6	Sitting	10.8	Standing	39.8	Safe
49	7.5	Sitting	6.0	Sitting	6.8	Sitting	8.3	Sitting	31.1	Safe
50	9.5	Sitting	7.7	Sitting	8.9	Sitting	10.8	Standing	40.9	Safe
51	13.6	Standing	10.5	Standing	11.8	Standing	14.3	Standing	50.1	Safe
52	12.9	Standing	10.5	Standing	11.4	Standing	13.5	Standing	47.9	Safe
53	12.7	Standing	10.6	Standing	11.1	Standing	12.6	Standing	42.3	Safe
54	12.0	Standing	9.8	Sitting	10.4	Standing	12.0	Standing	41.7	Safe
55	12.0	Standing	9.6	Sitting	10.1	Standing	11.6	Standing	42.6	Safe
56	13.2	Standing	10.6	Standing	11.7	Standing	13.7	Standing	46.3	Safe
57	13.1	Standing	10.6	Standing	11.6	Standing	14.2	Standing	48.3	Safe
58	13.1	Standing	10.4	Standing	11.7	Standing	14.2	Standing	48.4	Safe
59	12.2	Standing	9.9	Sitting	11.4	Standing	13.8	Standing	47.3	Safe
60	12.7	Standing	10.1	Standing	11.8	Standing	14.7	Standing	51.5	Safe
61	10.8	Standing	8.4	Sitting	9.5	Sitting	11.7	Standing	43.3	Safe
62	10.2	Standing	8.3	Sitting	8.9	Sitting	10.1	Standing	41.6	Safe
63	10.8	Standing	8.7	Sitting	9.2	Sitting	10.3	Standing	40.2	Safe
64	9.1	Sitting	7.3	Sitting	7.8	Sitting	9.3	Sitting	37.2	Safe
65	13.0	Standing	10.3	Standing	11.3	Standing	13.6	Standing	45.9	Safe
66	13.2	Standing	10.6	Standing	12.1	Standing	14.7	Standing	51.8	Safe
67	13.1	Standing	10.3	Standing	11.7	Standing	13.8	Standing	47.0	Safe
68	12.3	Standing	9.6	Sitting	11.0	Standing	13.4	Standing	46.9	Safe
69	13.0	Standing	10.2	Standing	11.5	Standing	13.8	Standing	46.2	Safe
70	13.1	Standing	10.2	Standing	11.5	Standing	13.6	Standing	45.9	Safe

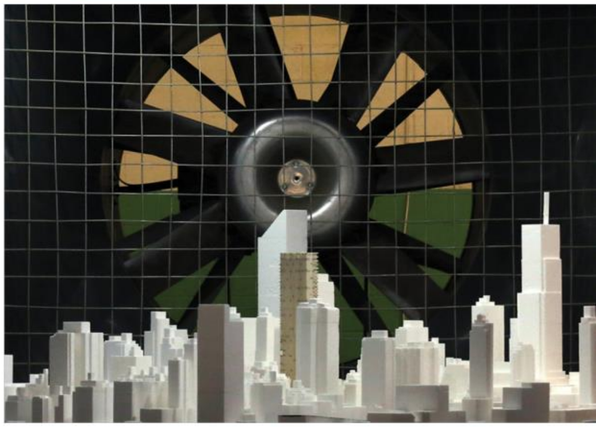
Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE A3: SUMMARY OF PEDESTRIAN COMFORT (EXISTING SCENARIO)

Sensor	Pedestrian Comfort								Pedestrian Safety	
	Spring		Summer		Autumn		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
71	11.7	Standing	9.0	Sitting	10.6	Standing	12.8	Standing	48.3	Safe
72	13.0	Standing	9.9	Sitting	11.5	Standing	13.6	Standing	50.0	Safe
73	10.9	Standing	8.6	Sitting	9.7	Sitting	11.5	Standing	46.0	Safe
74	9.9	Sitting	7.7	Sitting	8.5	Sitting	9.8	Sitting	41.5	Safe





APPENDIX B

PEDESTRIAN COMFORT SUITABILITY, TABLES B1-B3
(PROPOSED PHASE 1 SCENARIO)

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Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B1: SUMMARY OF PEDESTRIAN COMFORT (PHASE 1 SCENARIO)

Sensor	Pedestrian Comfort								Pedestrian Safety	
	Spring		Summer		Autumn		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
1	15.3	Walking	12.0	Standing	13.6	Standing	16.3	Walking	54.0	Safe
2	14.1	Standing	11.1	Standing	11.7	Standing	13.0	Standing	48.3	Safe
3	15.2	Walking	11.6	Standing	12.7	Standing	14.6	Standing	50.2	Safe
4	12.9	Standing	10.4	Standing	10.8	Standing	12.2	Standing	43.2	Safe
5	8.2	Sitting	6.5	Sitting	7.1	Sitting	8.4	Sitting	30.9	Safe
6	11.8	Standing	9.3	Sitting	9.6	Sitting	11.0	Standing	41.3	Safe
7	13.0	Standing	10.0	Sitting	11.1	Standing	13.0	Standing	48.5	Safe
8	12.7	Standing	10.7	Standing	11.5	Standing	13.6	Standing	45.5	Safe
9	13.9	Standing	11.1	Standing	12.2	Standing	14.2	Standing	46.7	Safe
10	13.5	Standing	11.1	Standing	12.0	Standing	13.8	Standing	46.5	Safe
11	12.4	Standing	10.3	Standing	11.1	Standing	12.6	Standing	42.3	Safe
12	11.9	Standing	10.0	Sitting	10.6	Standing	12.2	Standing	41.2	Safe
13	12.0	Standing	9.9	Sitting	10.7	Standing	12.4	Standing	42.1	Safe
14	12.6	Standing	10.5	Standing	11.1	Standing	12.4	Standing	41.1	Safe
15	13.9	Standing	10.9	Standing	11.9	Standing	13.6	Standing	51.4	Safe
16	17.8	Walking	13.5	Standing	15.3	Walking	18.0	Walking	67.7	Safe
17	19.0	Walking	15.1	Walking	17.2	Walking	20.5	Uncomfortable	69.1	Safe
18	18.9	Walking	14.9	Standing	17.1	Walking	20.8	Uncomfortable	69.9	Safe
19	16.4	Walking	13.2	Standing	15.0	Standing	18.8	Walking	67.8	Safe
20	16.8	Walking	13.8	Standing	15.2	Walking	19.0	Walking	69.1	Safe
21	17.4	Walking	14.4	Standing	15.7	Walking	18.8	Walking	72.1	Safe
22	17.1	Walking	14.2	Standing	15.2	Walking	17.6	Walking	71.5	Safe
23	17.2	Walking	14.7	Standing	15.1	Walking	17.0	Walking	71.1	Safe
24	18.6	Walking	15.0	Standing	15.8	Walking	19.0	Walking	68.9	Safe
25	16.2	Walking	13.0	Standing	15.5	Walking	20.3	Uncomfortable	82.1	Safe
26	20.7	Uncomfortable	16.5	Walking	19.6	Walking	25.4	Uncomfortable	86.1	Safe
27	20.7	Uncomfortable	15.5	Walking	18.5	Walking	23.2	Uncomfortable	80.5	Safe
28	12.5	Standing	9.4	Sitting	10.7	Standing	12.6	Standing	45.6	Safe
29	10.0	Sitting	7.4	Sitting	8.4	Sitting	9.8	Sitting	41.0	Safe
30	9.0	Sitting	6.9	Sitting	7.7	Sitting	8.8	Sitting	36.8	Safe
31	12.7	Standing	9.8	Sitting	11.5	Standing	13.9	Standing	48.2	Safe
32	15.2	Walking	11.3	Standing	13.0	Standing	15.7	Walking	52.2	Safe
33	15.0	Standing	12.0	Standing	12.8	Standing	14.9	Standing	49.2	Safe
34	14.0	Standing	11.3	Standing	11.7	Standing	13.6	Standing	55.1	Safe
35	17.0	Walking	13.9	Standing	14.9	Standing	17.6	Walking	64.8	Safe

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

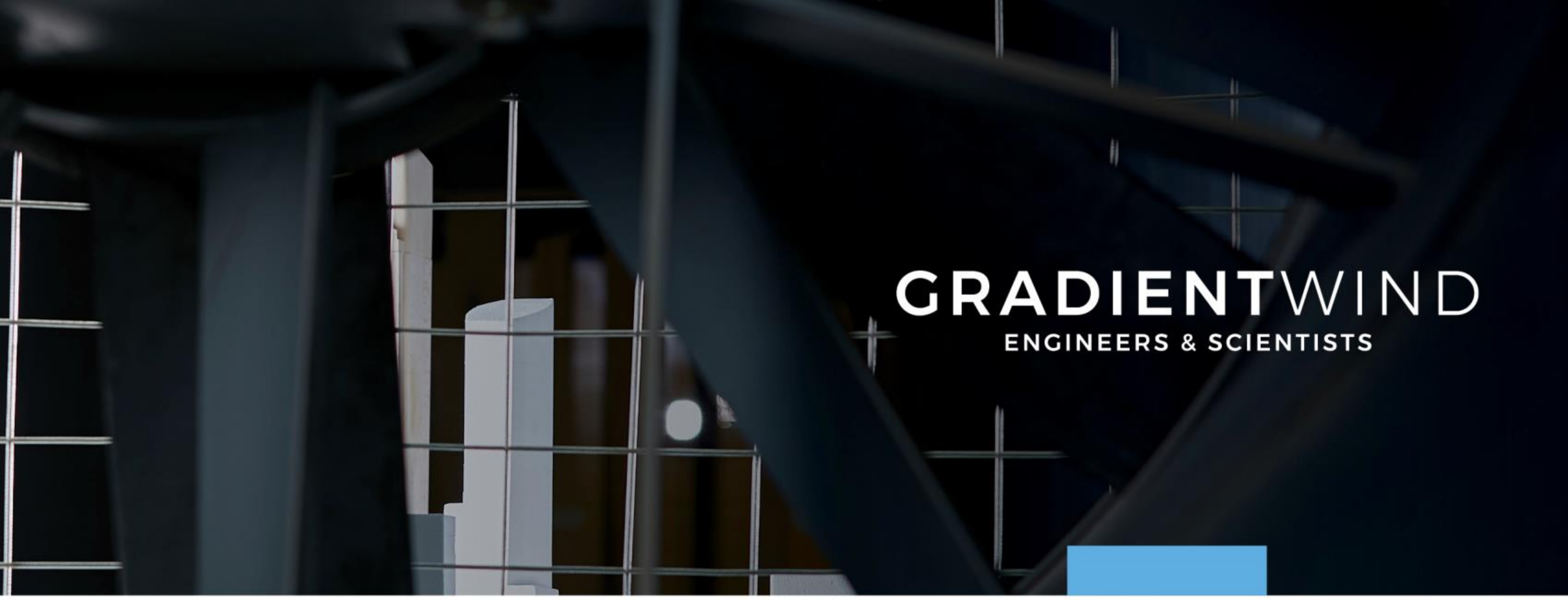
TABLE B2: SUMMARY OF PEDESTRIAN COMFORT (PHASE 1 SCENARIO)

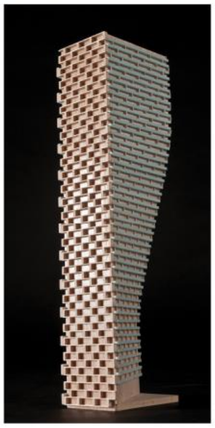
Sensor	Pedestrian Comfort								Pedestrian Safety	
	Spring		Summer		Autumn		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
36	17.5	Walking	14.4	Standing	16.8	Walking	21.9	Uncomfortable	91.3	Dangerous
37	15.4	Walking	12.5	Standing	14.6	Standing	18.5	Walking	71.2	Safe
38	18.1	Walking	13.5	Standing	16.5	Walking	20.6	Uncomfortable	70.6	Safe
39	18.7	Walking	15.2	Walking	16.9	Walking	21.0	Uncomfortable	73.4	Safe
40	10.2	Standing	8.8	Sitting	9.6	Sitting	10.7	Standing	45.7	Safe
41	9.2	Sitting	7.7	Sitting	8.6	Sitting	10.1	Standing	42.8	Safe
42	6.6	Sitting	5.3	Sitting	5.9	Sitting	7.1	Sitting	29.0	Safe
43	7.4	Sitting	5.7	Sitting	6.4	Sitting	7.6	Sitting	28.5	Safe
44	6.3	Sitting	5.0	Sitting	5.5	Sitting	6.6	Sitting	24.7	Safe
45	11.2	Standing	8.5	Sitting	10.1	Standing	12.2	Standing	48.2	Safe
46	10.8	Standing	8.3	Sitting	9.7	Sitting	11.5	Standing	47.2	Safe
47	14.3	Standing	12.0	Standing	14.1	Standing	18.5	Walking	71.7	Safe
48	19.4	Walking	15.2	Walking	17.5	Walking	21.9	Uncomfortable	74.9	Safe
49	8.2	Sitting	6.3	Sitting	6.9	Sitting	8.2	Sitting	30.6	Safe
50	10.7	Standing	8.5	Sitting	8.9	Sitting	10.3	Standing	42.6	Safe
51	15.6	Walking	12.0	Standing	13.1	Standing	15.3	Walking	52.6	Safe
52	14.3	Standing	11.5	Standing	12.2	Standing	13.9	Standing	49.8	Safe
53	14.1	Standing	11.4	Standing	11.5	Standing	12.9	Standing	49.9	Safe
54	14.1	Standing	11.0	Standing	11.3	Standing	13.0	Standing	51.3	Safe
55	14.1	Standing	11.0	Standing	11.3	Standing	12.9	Standing	50.1	Safe
56	14.7	Standing	11.7	Standing	12.3	Standing	13.8	Standing	51.0	Safe
57	14.6	Standing	11.6	Standing	12.1	Standing	14.1	Standing	50.9	Safe
58	14.7	Standing	11.1	Standing	11.7	Standing	13.7	Standing	57.2	Safe
59	14.1	Standing	11.0	Standing	11.4	Standing	13.4	Standing	58.6	Safe
60	15.0	Standing	12.3	Standing	13.0	Standing	15.6	Walking	59.7	Safe
61	15.9	Walking	13.1	Standing	14.5	Standing	17.5	Walking	68.6	Safe
62	17.4	Walking	13.6	Standing	14.8	Standing	17.0	Walking	64.9	Safe
63	17.4	Walking	14.6	Standing	16.1	Walking	19.4	Walking	68.5	Safe
64	11.8	Standing	9.8	Sitting	10.0	Sitting	10.8	Standing	46.7	Safe
65	13.1	Standing	11.3	Standing	11.9	Standing	13.3	Standing	55.7	Safe
66	15.1	Walking	12.0	Standing	13.0	Standing	16.5	Walking	68.6	Safe
67	12.3	Standing	9.8	Sitting	10.8	Standing	13.4	Standing	51.8	Safe
68	13.0	Standing	10.3	Standing	11.5	Standing	14.3	Standing	53.1	Safe
69	12.0	Standing	9.8	Sitting	11.1	Standing	13.9	Standing	52.8	Safe
70	15.3	Walking	12.1	Standing	14.4	Standing	18.9	Walking	69.8	Safe

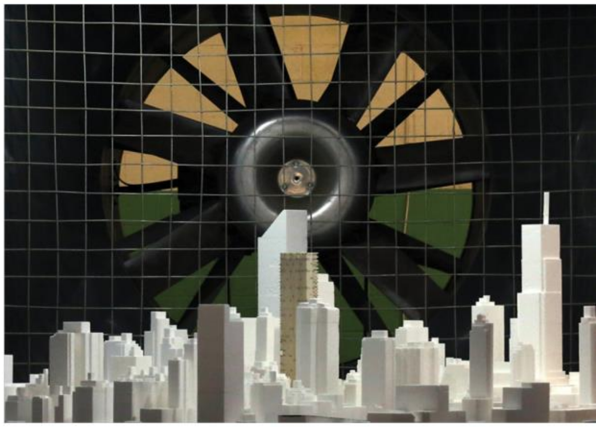
Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE B3: SUMMARY OF PEDESTRIAN COMFORT (PHASE 1 SCENARIO)

Sensor	Pedestrian Comfort								Pedestrian Safety	
	Spring		Summer		Autumn		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
71	19.8	Walking	15.7	Walking	17.6	Walking	21.9	Uncomfortable	77.2	Safe
72	19.0	Walking	15.6	Walking	17.1	Walking	21.6	Uncomfortable	77.7	Safe
73	16.3	Walking	13.8	Standing	14.4	Standing	15.9	Walking	68.2	Safe
74	17.5	Walking	14.7	Standing	14.7	Standing	15.8	Walking	68.3	Safe
75	16.3	Walking	13.2	Standing	13.6	Standing	15.0	Standing	69.6	Safe
76	12.2	Standing	8.8	Sitting	9.7	Sitting	10.6	Standing	53.8	Safe
77	11.0	Standing	8.4	Sitting	8.8	Sitting	10.0	Sitting	44.5	Safe
78	14.1	Standing	10.8	Standing	10.9	Standing	12.8	Standing	57.6	Safe
79	6.8	Sitting	5.4	Sitting	6.0	Sitting	7.2	Sitting	25.7	Safe
80	6.4	Sitting	5.1	Sitting	5.6	Sitting	6.8	Sitting	23.6	Safe
81	6.7	Sitting	5.3	Sitting	5.9	Sitting	7.1	Sitting	24.8	Safe
82	13.0	Standing	10.4	Standing	11.3	Standing	13.6	Standing	57.3	Safe
90	13.4	Standing	11.3	Standing	10.9	Standing	11.8	Standing	56.8	Safe
91	22.0	Uncomfortable	16.6	Walking	18.6	Walking	22.2	Uncomfortable	79.3	Safe
92	22.9	Uncomfortable	19.5	Walking	21.5	Uncomfortable	26.1	Uncomfortable	94.9	Dangerous
93	22.4	Uncomfortable	18.9	Walking	20.9	Uncomfortable	25.4	Uncomfortable	86.2	Safe
94	18.2	Walking	14.3	Standing	15.1	Walking	17.8	Walking	74.3	Safe
95	21.5	Uncomfortable	17.4	Walking	18.6	Walking	21.5	Uncomfortable	71.2	Safe
96	28.6	Uncomfortable	22.8	Uncomfortable	24.7	Uncomfortable	29.0	Uncomfortable	93.8	Dangerous
97	28.3	Uncomfortable	22.0	Uncomfortable	24.4	Uncomfortable	28.6	Uncomfortable	94.3	Dangerous
98	13.2	Standing	10.2	Standing	11.0	Standing	12.3	Standing	55.5	Safe
99	23.9	Uncomfortable	17.7	Walking	18.6	Walking	21.2	Uncomfortable	77.1	Safe
100	24.8	Uncomfortable	18.2	Walking	19.0	Walking	21.9	Uncomfortable	76.2	Safe
101	21.5	Uncomfortable	18.2	Walking	17.5	Walking	19.1	Walking	67.6	Safe
102	9.8	Sitting	8.3	Sitting	9.8	Sitting	11.8	Standing	70.1	Safe
103	14.4	Standing	11.6	Standing	14.8	Standing	20.3	Uncomfortable	91.7	Dangerous







APPENDIX C

PEDESTRIAN COMFORT SUITABILITY, TABLES C1-C4 (PROPOSED PHASE 1 & 2 SCENARIO)

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Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE C1: SUMMARY OF PEDESTRIAN COMFORT (PHASE 1 & 2 SCENARIO)

Sensor	Pedestrian Comfort								Pedestrian Safety	
	Spring		Summer		Autumn		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
1	16.1	Walking	11.9	Standing	13.6	Standing	16.7	Walking	53.4	Safe
2	16.4	Walking	12.3	Standing	13.4	Standing	15.4	Walking	54.5	Safe
3	21.4	Uncomfortable	16.3	Walking	18.9	Walking	22.7	Uncomfortable	78.7	Safe
4	17.5	Walking	14.2	Standing	14.7	Standing	17.5	Walking	61.2	Safe
5	8.8	Sitting	7.0	Sitting	7.6	Sitting	8.8	Sitting	32.2	Safe
6	19.3	Walking	15.7	Walking	16.4	Walking	19.4	Walking	65.5	Safe
7	13.6	Standing	11.2	Standing	11.7	Standing	13.2	Standing	52.0	Safe
8	14.4	Standing	11.9	Standing	12.5	Standing	14.2	Standing	49.7	Safe
9	13.3	Standing	11.0	Standing	11.7	Standing	13.7	Standing	46.0	Safe
10	13.3	Standing	11.0	Standing	12.3	Standing	14.6	Standing	49.6	Safe
11	13.6	Standing	11.0	Standing	12.2	Standing	14.2	Standing	47.8	Safe
12	13.4	Standing	10.8	Standing	12.1	Standing	14.2	Standing	48.7	Safe
13	14.2	Standing	11.6	Standing	13.0	Standing	15.4	Walking	53.7	Safe
14	12.2	Standing	9.8	Sitting	11.1	Standing	12.8	Standing	48.5	Safe
15	15.7	Walking	12.8	Standing	14.6	Standing	17.4	Walking	60.0	Safe
16	16.0	Walking	12.3	Standing	14.3	Standing	17.3	Walking	62.2	Safe
17	17.9	Walking	14.0	Standing	16.1	Walking	19.1	Walking	64.6	Safe
18	18.2	Walking	13.9	Standing	15.9	Walking	19.4	Walking	67.0	Safe
19	16.6	Walking	13.2	Standing	14.8	Standing	18.2	Walking	66.4	Safe
20	17.4	Walking	14.5	Standing	15.9	Walking	19.3	Walking	69.2	Safe
21	17.7	Walking	14.6	Standing	15.7	Walking	18.5	Walking	72.0	Safe
22	17.7	Walking	14.5	Standing	15.3	Walking	17.7	Walking	71.7	Safe
23	17.5	Walking	14.9	Standing	15.4	Walking	17.1	Walking	71.5	Safe
24	17.4	Walking	14.4	Standing	14.6	Standing	17.0	Walking	67.3	Safe
25	12.9	Standing	10.2	Standing	11.8	Standing	14.7	Standing	54.8	Safe
26	16.0	Walking	12.1	Standing	15.0	Standing	18.5	Walking	71.4	Safe
27	16.8	Walking	13.1	Standing	14.3	Standing	16.8	Walking	66.6	Safe
28	17.5	Walking	14.3	Standing	16.3	Walking	21.5	Uncomfortable	83.4	Safe
29	12.5	Standing	10.2	Standing	12.4	Standing	16.1	Walking	70.6	Safe
30	15.2	Walking	12.0	Standing	14.8	Standing	19.7	Walking	82.0	Safe
31	15.5	Walking	12.2	Standing	14.4	Standing	17.8	Walking	64.8	Safe
32	13.8	Standing	10.8	Standing	13.8	Standing	18.4	Walking	81.2	Safe
33	19.0	Walking	16.3	Walking	17.9	Walking	21.7	Uncomfortable	76.4	Safe
34	16.7	Walking	13.6	Standing	15.5	Walking	19.2	Walking	73.2	Safe
35	17.1	Walking	12.9	Standing	15.4	Walking	18.8	Walking	67.7	Safe

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE C2: SUMMARY OF PEDESTRIAN COMFORT (PHASE 1 & 2 SCENARIO)

Sensor	Pedestrian Comfort								Pedestrian Safety	
	Spring		Summer		Autumn		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
36	14.9	Standing	11.8	Standing	13.3	Standing	16.5	Walking	59.5	Safe
37	14.9	Standing	11.9	Standing	13.8	Standing	17.8	Walking	64.1	Safe
38	18.0	Walking	13.3	Standing	16.1	Walking	20.6	Uncomfortable	70.2	Safe
39	19.4	Walking	15.5	Walking	17.5	Walking	21.5	Uncomfortable	73.3	Safe
40	9.8	Sitting	8.5	Sitting	9.3	Sitting	9.8	Sitting	41.2	Safe
41	8.9	Sitting	7.4	Sitting	8.3	Sitting	9.2	Sitting	39.0	Safe
42	6.3	Sitting	5.0	Sitting	5.5	Sitting	6.4	Sitting	22.8	Safe
43	7.1	Sitting	5.5	Sitting	6.1	Sitting	7.1	Sitting	26.2	Safe
44	6.2	Sitting	4.8	Sitting	5.3	Sitting	6.3	Sitting	21.8	Safe
45	10.4	Standing	7.9	Sitting	9.3	Sitting	11.0	Standing	48.7	Safe
46	10.0	Sitting	7.6	Sitting	9.2	Sitting	11.1	Standing	52.1	Safe
47	17.9	Walking	14.0	Standing	15.7	Walking	19.8	Walking	78.1	Safe
48	8.7	Sitting	7.4	Sitting	8.1	Sitting	9.3	Sitting	36.0	Safe
49	7.3	Sitting	5.8	Sitting	6.4	Sitting	7.8	Sitting	28.5	Safe
50	6.8	Sitting	5.4	Sitting	5.9	Sitting	7.3	Sitting	26.6	Safe
51	12.0	Standing	9.2	Sitting	10.8	Standing	13.1	Standing	54.4	Safe
52	14.6	Standing	11.8	Standing	13.9	Standing	18.5	Walking	71.7	Safe
53	12.1	Standing	9.9	Sitting	10.2	Standing	12.5	Standing	52.9	Safe
54	11.2	Standing	9.2	Sitting	9.4	Sitting	10.5	Standing	45.9	Safe
55	14.5	Standing	12.2	Standing	12.5	Standing	13.9	Standing	60.2	Safe
56	12.2	Standing	10.3	Standing	11.9	Standing	15.7	Walking	77.5	Safe
57	18.2	Walking	15.4	Walking	17.8	Walking	23.1	Uncomfortable	86.3	Safe
58	12.2	Standing	9.2	Sitting	10.0	Sitting	12.0	Standing	51.5	Safe
59	12.6	Standing	10.2	Standing	11.0	Standing	13.9	Standing	50.4	Safe
60	14.1	Standing	11.5	Standing	13.3	Standing	18.2	Walking	72.3	Safe
61	20.4	Uncomfortable	14.9	Standing	16.0	Walking	18.4	Walking	67.5	Safe
62	20.6	Uncomfortable	15.1	Walking	16.3	Walking	18.9	Walking	69.6	Safe
63	20.5	Uncomfortable	15.7	Walking	17.0	Walking	19.8	Walking	66.6	Safe
64	23.8	Uncomfortable	19.3	Walking	21.8	Uncomfortable	26.8	Uncomfortable	88.0	Safe
65	22.3	Uncomfortable	17.9	Walking	20.0	Walking	24.3	Uncomfortable	76.4	Safe
66	14.1	Standing	11.1	Standing	12.2	Standing	15.2	Walking	57.9	Safe
67	13.3	Standing	10.8	Standing	12.4	Standing	15.9	Walking	61.8	Safe
68	14.1	Standing	11.6	Standing	13.2	Standing	17.2	Walking	67.2	Safe
69	12.7	Standing	10.3	Standing	11.9	Standing	15.5	Walking	60.8	Safe
70	16.8	Walking	12.9	Standing	15.6	Walking	20.5	Uncomfortable	74.5	Safe

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

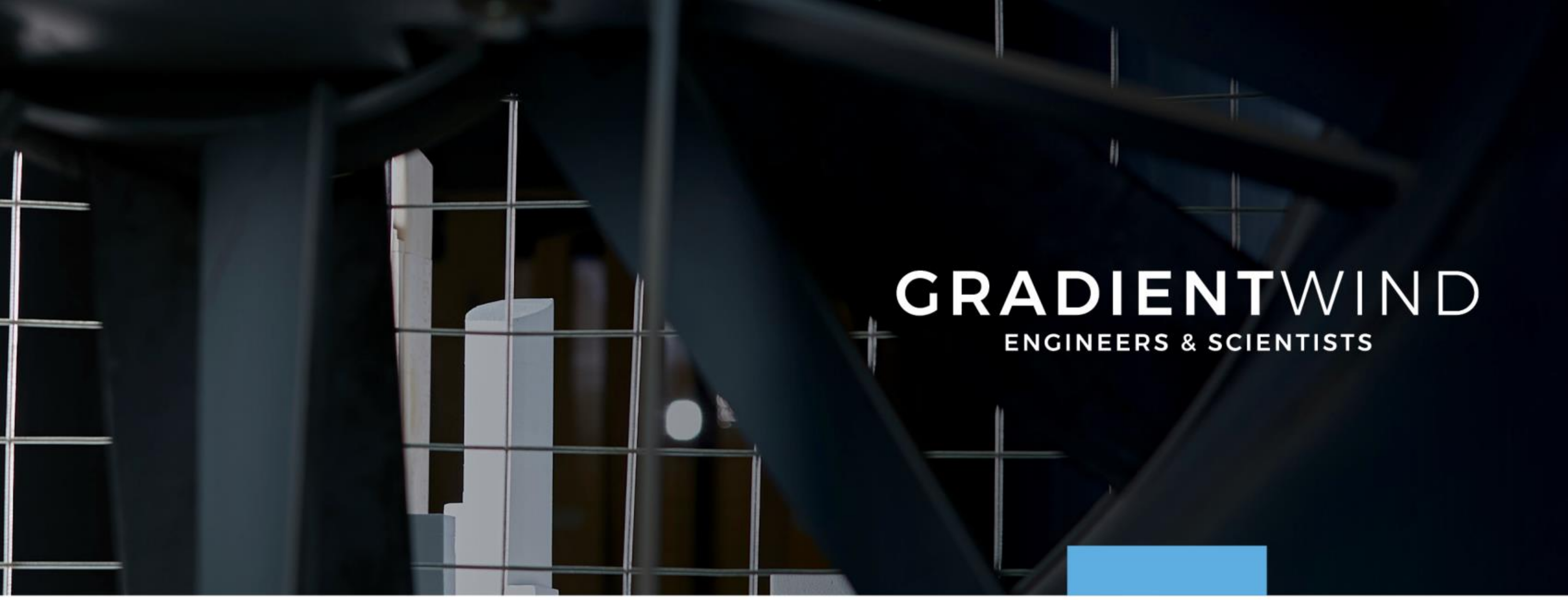
TABLE C3: SUMMARY OF PEDESTRIAN COMFORT (PHASE 1 & 2 SCENARIO)

Sensor	Pedestrian Comfort								Pedestrian Safety	
	Spring		Summer		Autumn		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
71	20.5	Uncomfortable	15.6	Walking	17.8	Walking	21.9	Uncomfortable	78.1	Safe
72	19.8	Walking	16.6	Walking	17.7	Walking	22.1	Uncomfortable	79.5	Safe
73	17.2	Walking	14.2	Standing	14.7	Standing	16.2	Walking	69.0	Safe
74	16.9	Walking	14.3	Standing	14.2	Standing	15.0	Standing	68.1	Safe
75	16.9	Walking	13.6	Standing	13.7	Standing	15.1	Walking	70.8	Safe
76	11.9	Standing	8.7	Sitting	9.4	Sitting	10.3	Standing	53.3	Safe
77	10.7	Standing	8.1	Sitting	8.6	Sitting	9.7	Sitting	42.6	Safe
78	13.4	Standing	10.1	Standing	10.4	Standing	12.1	Standing	56.0	Safe
79	6.8	Sitting	5.3	Sitting	5.8	Sitting	7.0	Sitting	24.7	Safe
80	6.4	Sitting	5.1	Sitting	5.6	Sitting	6.6	Sitting	23.4	Safe
81	6.7	Sitting	5.3	Sitting	5.8	Sitting	6.9	Sitting	24.5	Safe
82	24.9	Uncomfortable	20.2	Uncomfortable	22.5	Uncomfortable	27.0	Uncomfortable	88.6	Safe
83	8.8	Sitting	7.0	Sitting	7.9	Sitting	9.5	Sitting	36.4	Safe
84	9.6	Sitting	7.5	Sitting	8.8	Sitting	10.5	Standing	44.0	Safe
85	8.6	Sitting	6.8	Sitting	7.6	Sitting	9.1	Sitting	33.4	Safe
86	8.0	Sitting	6.2	Sitting	7.1	Sitting	8.5	Sitting	33.9	Safe
87	7.2	Sitting	5.7	Sitting	6.3	Sitting	7.6	Sitting	27.8	Safe
88	10.6	Standing	8.1	Sitting	9.8	Sitting	12.2	Standing	53.8	Safe
89	11.1	Standing	8.8	Sitting	10.5	Standing	13.1	Standing	52.3	Safe
90	13.2	Standing	10.9	Standing	10.8	Standing	11.7	Standing	54.5	Safe
91	22.8	Uncomfortable	17.0	Walking	19.7	Walking	23.8	Uncomfortable	81.3	Safe
92	24.7	Uncomfortable	21.0	Uncomfortable	23.0	Uncomfortable	28.9	Uncomfortable	98.6	Dangerous
93	24.6	Uncomfortable	20.6	Uncomfortable	22.6	Uncomfortable	27.8	Uncomfortable	89.7	Safe
94	18.2	Walking	14.4	Standing	15.3	Walking	17.8	Walking	72.1	Safe
95	22.1	Uncomfortable	17.9	Walking	19.2	Walking	22.0	Uncomfortable	72.8	Safe
96	29.5	Uncomfortable	23.7	Uncomfortable	25.4	Uncomfortable	29.5	Uncomfortable	94.7	Dangerous
97	29.0	Uncomfortable	23.3	Uncomfortable	25.1	Uncomfortable	29.6	Uncomfortable	96.2	Dangerous
98	13.3	Standing	10.3	Standing	11.0	Standing	12.2	Standing	56.3	Safe
99	24.0	Uncomfortable	17.3	Walking	18.2	Walking	21.1	Uncomfortable	78.9	Safe
100	23.8	Uncomfortable	17.1	Walking	18.1	Walking	20.8	Uncomfortable	74.9	Safe
101	21.8	Uncomfortable	18.5	Walking	17.9	Walking	19.1	Walking	67.8	Safe
102	8.9	Sitting	7.4	Sitting	8.1	Sitting	9.1	Sitting	38.4	Safe
103	10.7	Standing	8.0	Sitting	8.9	Sitting	10.2	Standing	43.2	Safe
104	22.0	Uncomfortable	16.0	Walking	18.9	Walking	24.7	Uncomfortable	93.7	Dangerous
105	24.7	Uncomfortable	18.0	Walking	19.0	Walking	21.8	Uncomfortable	78.3	Safe

Guidelines	
Pedestrian Comfort	**20% exceedance wind speed** 0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable
Pedestrian Safety	**0.1% exceedance wind speed** 0-90 km/h = Safe

TABLE C4: SUMMARY OF PEDESTRIAN COMFORT (PHASE 1 & 2 SCENARIO)

Sensor	Pedestrian Comfort								Pedestrian Safety	
	Spring		Summer		Autumn		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
106	24.8	Uncomfortable	18.3	Walking	18.6	Walking	21.3	Uncomfortable	78.9	Safe
107	17.9	Walking	15.2	Walking	15.5	Walking	17.3	Walking	57.4	Safe
108	11.4	Standing	8.3	Sitting	9.4	Sitting	10.8	Standing	53.8	Safe
109	24.3	Uncomfortable	20.4	Uncomfortable	22.1	Uncomfortable	27.8	Uncomfortable	97.2	Dangerous
110	21.8	Uncomfortable	18.1	Walking	20.6	Uncomfortable	25.5	Uncomfortable	87.9	Safe
111	21.1	Uncomfortable	16.1	Walking	16.5	Walking	19.4	Walking	85.9	Safe
112	25.0	Uncomfortable	19.8	Walking	21.4	Uncomfortable	25.6	Uncomfortable	82.7	Safe
113	30.5	Uncomfortable	24.3	Uncomfortable	26.6	Uncomfortable	31.8	Uncomfortable	99.8	Dangerous
114	24.3	Uncomfortable	19.4	Walking	21.3	Uncomfortable	26.0	Uncomfortable	87.4	Safe
115	15.8	Walking	12.0	Standing	13.5	Standing	16.0	Walking	70.7	Safe
116	29.0	Uncomfortable	22.1	Uncomfortable	23.5	Uncomfortable	27.2	Uncomfortable	85.9	Safe
117	22.6	Uncomfortable	17.8	Walking	18.1	Walking	21.6	Uncomfortable	77.1	Safe
118	17.8	Walking	14.3	Standing	15.8	Walking	18.1	Walking	64.7	Safe
119	12.8	Standing	9.9	Sitting	12.6	Standing	15.8	Walking	88.5	Safe
120	17.9	Walking	14.5	Standing	17.1	Walking	21.4	Uncomfortable	77.6	Safe
121	14.7	Standing	12.5	Standing	13.3	Standing	15.5	Walking	62.7	Safe
122	10.5	Standing	8.7	Sitting	9.2	Sitting	10.1	Standing	41.1	Safe



APPENDIX D

WIND TUNNEL SIMULATION OF THE NATURAL WIND

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WIND TUNNEL SIMULATION OF THE NATURAL WIND

Wind flowing over the surface of the earth develops a boundary layer due to the drag produced by surface features such as vegetation and man-made structures. Within this boundary layer, the mean wind speed varies from zero at the surface to the gradient wind speed at the top of the layer. The height of the top of the boundary layer is referred to as the gradient height, above which the velocity remains more-or-less constant for a given synoptic weather system. The mean wind speed is taken to be the average value over one hour. Superimposed on the mean wind speed are fluctuating (or turbulent) components in the longitudinal (i.e. along wind), vertical and lateral directions. Although turbulence varies according to the roughness of the surface, the turbulence level generally increases from nearly zero (smooth flow) at gradient height to maximum values near the ground. While for a calm ocean the maximum could be 20%, the maximum for a very rough surface such as the center of a city could be 100%, or equal to the local mean wind speed. The height of the boundary layer varies in time and over different terrain roughness within the range of 400 metres (m) to 600 m.

Simulating real wind behaviour in a wind tunnel requires simulating the variation of mean wind speed with height, simulating the turbulence intensity, and matching the typical length scales of turbulence. It is the ratio between wind tunnel turbulence length scales and turbulence scales in the atmosphere that determines the geometric scales that models can assume in a wind tunnel. Hence, when a 1:200 scale model is quoted, this implies that the turbulence scales in the wind tunnel and the atmosphere have the same ratios. Some flexibility in this requirement has been shown to produce reasonable wind tunnel predictions compared to full scale. In model scale the mean and turbulence characteristics of the wind are obtained with the use of spires at one end of the tunnel and roughness elements along the floor of the tunnel. The fan is located at the model end and wind is pulled over the spires, roughness elements and model. It has been found that, to a good approximation, the mean wind profile can be represented by a power law relation, shown below, giving height above ground versus wind speed.

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

Where; U = mean wind speed, U_g = gradient wind speed, Z = height above ground, Z_g = depth of the boundary layer (gradient height) and α is the power law exponent.

Figure D1 on the following page plots three velocity profiles for open country, and suburban and urban exposures.

The exponent α varies according to the type of upwind terrain; α ranges from 0.14 for open country to 0.33 for an urban exposure. Figure D2 illustrates the theoretical variation of turbulence for open country, suburban and urban exposures.

The integral length scale of turbulence can be thought of as an average size of gust in the atmosphere. Although it varies with height and ground roughness, it has been found to generally be in the range of 100 m to 200 m in the upper half of the boundary layer. Thus, for a 1:300 scale, the model value should be between 1/3 and 2/3 of a metre. Integral length scales are derived from power spectra, which describe the energy content of wind as a function of frequency. There are several ways of determining integral length scales of turbulence. One way is by comparison of a measured power spectrum in model scale to a non-dimensional theoretical spectrum such as the Davenport spectrum of longitudinal turbulence. Using the Davenport spectrum, which agrees well with full-scale spectra, one can estimate the integral scale by plotting the theoretical spectrum with varying L until it matches as closely as possible the measured spectrum:

$$f \times S(f) = \frac{\dfrac{4(Lf)^2}{U_{10}{}^2}}{\left[1 + \dfrac{4(Lf)^2}{U_{10}{}^2}\right]^{\frac{4}{3}}}$$

Where, f is frequency, S(f) is the spectrum value at frequency f, U10 is the wind speed 10 m above ground level, and L is the characteristic length of turbulence.

Once the wind simulation is correct, the model, constructed to a suitable scale, is installed at the center of the working section of the wind tunnel. Different wind directions are represented by rotating the model to align with the wind tunnel center-line axis.

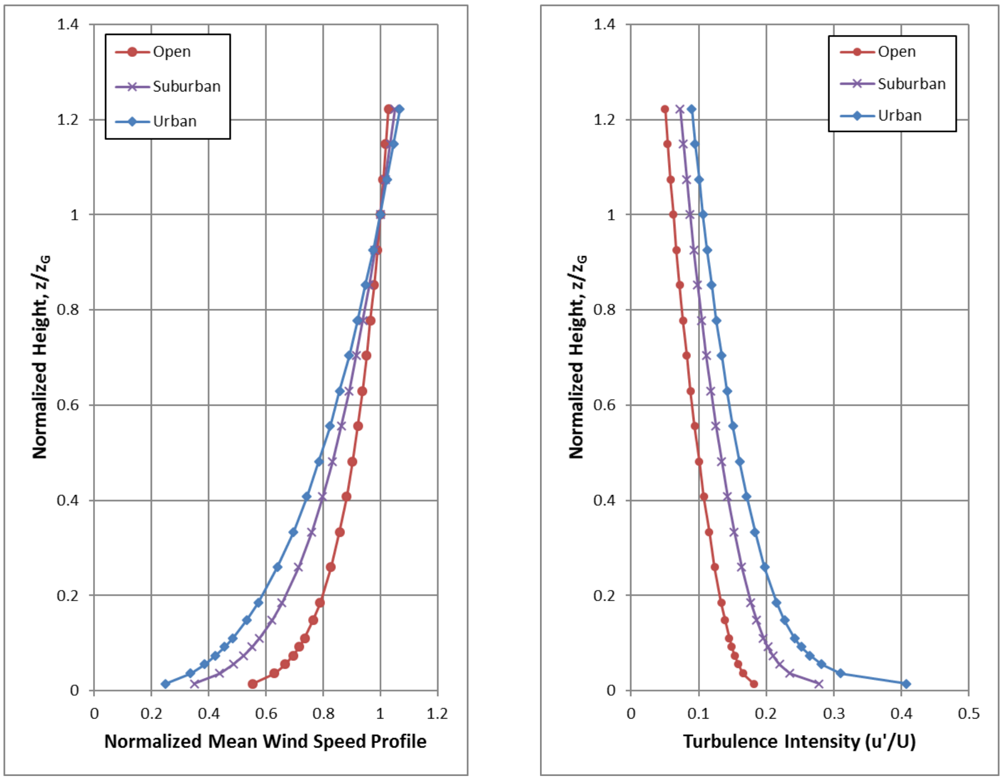

FIGURE D1 (LEFT): MEAN WIND SPEED PROFILES;
FIGURE D2 (RIGHT): TURBULENCE INTENSITY PROFILES

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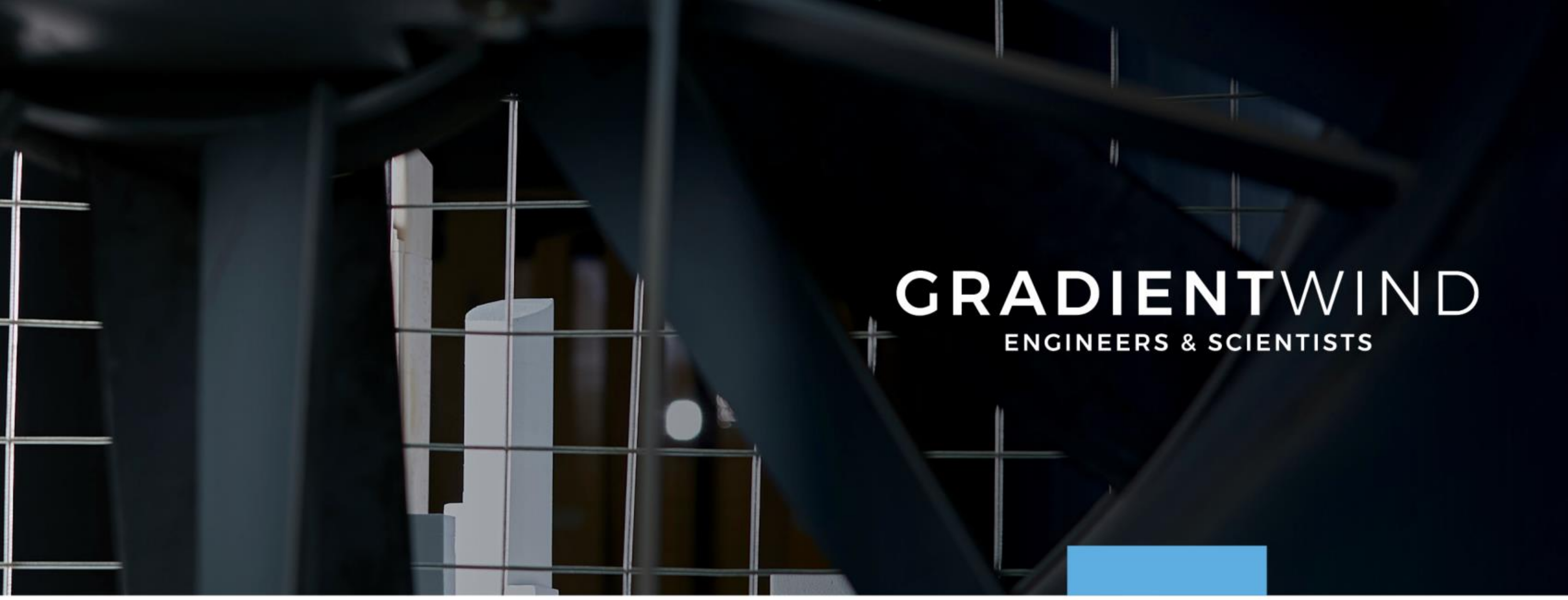

APPENDIX E

PEDESTRIAN LEVEL WIND MEASUREMENT METHODOLOGY

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PEDESTRIAN LEVEL WIND MEASUREMENT METHODOLOGY

Pedestrian level wind studies are performed in a wind tunnel on a physical model of the study buildings at a suitable scale. Instantaneous wind speed measurements are recorded at a model height corresponding to 1.5 m full scale using either a hot wire anemometer or a pressure-based transducer. Measurements are performed at any number of locations on the model and usually for 36 wind directions. For each wind direction, the roughness of the upwind terrain is matched in the wind tunnel to generate the correct mean and turbulent wind profiles approaching the model.

The hot wire anemometer is an instrument consisting of a thin metallic wire conducting an electric current. It is an omni-directional device equally sensitive to wind approaching from any direction in the horizontal plane. By compensating for the cooling effect of wind flowing over the wire, the associated electronics produce an analog voltage signal that can be calibrated against velocity of the air stream. For all measurements, the wire is oriented vertically so as to be sensitive to wind approaching from all directions in a horizontal plane.

The pressure sensor is a small cylindrical device that measures instantaneous pressure differences over a small area. The sensor is connected via tubing to a transducer that translates the pressure to a voltage signal that is recorded by computer. With appropriately designed tubing, the sensor is sensitive to a suitable range of fluctuating velocities.

For a given wind direction and location on the model, a time history of the wind speed is recorded for a period of time equal to one hour in full-scale. The analog signal produced by the hot wire or pressure sensor is digitized at a rate of 400 samples per second. A sample recording for several seconds is illustrated in Figure E1. This data is analyzed to extract the mean, root-mean-square (rms) and the peak of the signal. The peak value, or gust wind speed, is formed by averaging a number of peaks obtained from sub-intervals of the sampling period. The mean and gust speeds are then normalized by the wind tunnel gradient wind speed, which is the speed at the top of the model boundary layer, to obtain mean and gust ratios. At each location, the measurements are repeated for 36 wind directions to produce normalized polar plots, which will be provided upon request.

In order to determine the duration of various wind speeds at full scale for a given measurement location the gust ratios are combined with a statistical (mathematical) model of the wind climate for the project site. This mathematical model is based on hourly wind data obtained from one or more meteorological stations (usually airports) close to the project location. The probability model used to represent the data is the Weibull distribution expressed as:

$$P\left(>U_g\right)=A_\theta \bullet \exp\left[\left(-\frac{U_g}{C\theta}\right)^{K\theta}\right]$$

Where,

P (> U_g***)*** is the probability, fraction of time, that the gradient wind speed U_g is exceeded; θ is the wind direction measured clockwise from true north, ***A***, ***C***, ***K*** are the Weibull coefficients, (Units: A - dimensionless, C - wind speed units [km/h] for instance, K - dimensionless). A_θ is the fraction of time wind blows from a 10° sector centered on θ.

Analysis of the hourly wind data recorded for a length of time, on the order of 10 to 30 years, yields the A_θ, C_θ and K_θ values. The probability of exceeding a chosen wind speed level, say 20 km/h, at sensor *N* is given by the following expression:

$$P_N(>20)=\Sigma_\theta P\left[\frac{(>20)}{\left(\frac{U_N}{U_g}\right)}\right]$$

$$P_N(>20) = \Sigma_\theta P\{>20/(U_N/Ug)\}$$

Where, U_N/U_g is the gust velocity ratios, where the summation is taken over all 36 wind directions at 10° intervals.

If there are significant seasonal variations in the weather data, as determined by inspection of the C_θ and K_θ values, then the analysis is performed separately for two or more times corresponding to the groupings of seasonal wind data. Wind speed levels of interest for predicting pedestrian comfort are based on the comfort guidelines chosen to represent various pedestrian activity levels as discussed in the main text.

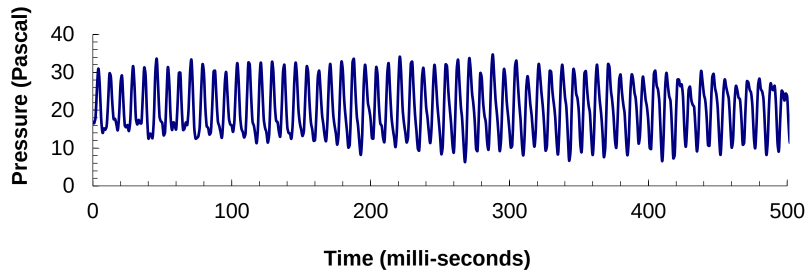

FIGURE E1: TIME VERSUS VELOCITY TRACE FOR A TYPICAL WIND SENSOR

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