

**PEDESTRIAN LEVEL
WIND STUDY**

1315 Bough Beeches Boulevard
Mississauga, Ontario

REPORT: GWE25-146-WTPLW-2026



March 10, 2026

PREPARED FOR

1315 Bough Beeches Boulevard Limited

2700 Dufferin Street, Unit 50

Toronto, Ontario

M6B 4J3

PREPARED BY

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EXECUTIVE SUMMARY

This report describes a wind tunnel pedestrian level wind study undertaken to assess wind conditions for a proposed residential development located at 1315 Bough Beeches Boulevard in Mississauga, Ontario. Two configurations were studied: (i) *existing conditions*, including all approved, surrounding developments and without the proposed development, and (ii) *proposed conditions* with the proposed development 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, transit stops, parking areas, landscaped spaces, outdoor amenity areas, and building access points. Wind comfort is also evaluated over the Level 2 elevated green roof. 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, City of Mississauga wind criteria, architectural drawings provided by Arcadis in March 2026, surrounding street layouts, as well as existing and approved future building massing information 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 4B, as well as Tables A1-A2 and B1-B2 in the appendices. Based on wind tunnel test results, meteorological data analysis, and experience with similar developments in Mississauga, we conclude that the future wind conditions 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.

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 conditions that could be considered unsafe.



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1. INTRODUCTION

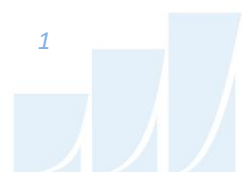
This report describes a comparative pedestrian level wind study undertaken to assess wind conditions for a proposed residential development located at 1315 Bough Beeches Boulevard in Mississauga, Ontario. Two configurations were studied: (i) *existing conditions*, including all approved, surrounding developments and without the proposed development, and (ii) *proposed conditions* with the proposed development in place. The study was performed in accordance with industry standard wind tunnel testing techniques, City of Mississauga wind criteria, architectural drawings provided by Arcadis in March 2026, 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 comparative pedestrian wind study is the proposed residential development located at 1315 Bough Beeches Boulevard in Mississauga, Ontario. The study site is situated at the northeast side of a parcel of land bounded by Dixie Road to the southwest, Rathburn Road East to the southeast, Bough Beeches Boulevard to the northeast, and existing low-rise developments along Poltava Crescent to the northwest.

The proposed development comprises a 13-storey residential tower with a one-storey podium, located at the west corner of the intersection of Bough Beeches Boulevard and Rathburn Road East. Two levels of below-grade parking are accessed via the existing underground parking to the northwest. At grade, the building contains a central residential lobby accessed from the east and west sides, indoor amenity space to the south and northeast, building support services to the northwest, and an outdoor amenity to the east. Level 2 contains residential units, and the podium sets back from all elevations to the typical floorplate accommodating private terraces and a green roof. Above, the building rises uniformly to Level 13, above which a set back mechanical penthouse and green roof complete the development.

Regarding wind exposures, the near-field surroundings of the development (defined as an area falling within a 200-metre radius of the site) are characterized by a primarily low-rise massing in all directions, with staggered high-rises throughout. More specifically, Claridge House (20 storeys) is located to the immediate northeast, 1359 Rathburn Road East (20 storeys) is to the southwest, and Rockwood Mall is to



the southeast. The far-field surroundings (defined as the area beyond the near-field and within a two-kilometer radius) are dominated by low-rise suburban exposure in all directions, with isolated taller developments to the south flanking Dixie Road and Bloor Street.

Grade-level areas investigated include sidewalks, walkways, laneways, transit stops, parking areas, landscaped spaces, outdoor amenity areas, and building access points. Wind comfort is also evaluated over the Level 2 elevated green roof. Figures 1A and 1B illustrate the *existing* and *proposed* study site and surrounding context, respectively, and Photographs 1 through 6 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 and of surrounding approved future developments, on the existing 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 Mississauga area wind climate and synthesis of wind tunnel data with industry-accepted guidelines. 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 6 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.

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 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 65 sensor locations on the scale model in Gradient Wind's wind tunnel. Of these 65 sensors, 63 were located at grade and the remaining two sensors were located over the Level 2 elevated green roof. Wind speed measurements were performed for each of the 65 sensors for 36 wind directions at 10° intervals. Figures 1A and 1B, illustrate the existing and proposed study site and surrounding context, while sensor locations used to investigate wind conditions are illustrated in Figures 2A through 4B.

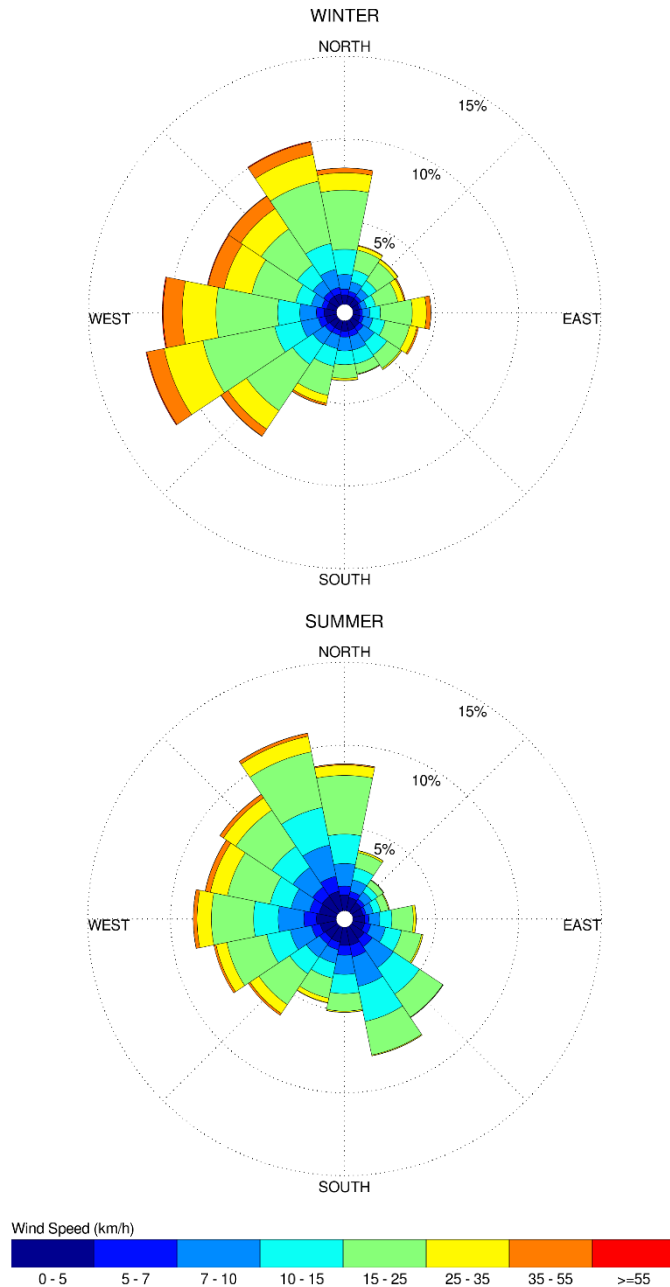
Mean and peak wind speed values for each location and wind direction were calculated from real-time pressure measurements, recorded at a sample rate of 500 samples per second, and taken over a 60-second time period. This period at model-scale corresponds approximately to one hour in full-scale, which 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

A statistical model for winds in Mississauga 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 similarity of weather patterns, and not according to the traditional calendar method.

The statistical model of the Mississauga 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 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.

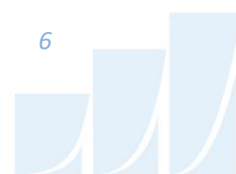
4.4 Pedestrian Comfort and Safety Guidelines

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 Gust 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 for 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

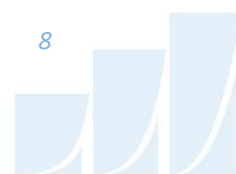
Tables A1 through A2 in Appendix A provide a summary of seasonal comfort predictions for each sensor location under the *existing* massing scenario. Similarly, Tables B1 through B2 in Appendix B provide the seasonal comfort predictions for under the *proposed* massing scenario. The tables indicate the 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 and 5.2. To assist with understanding and interpretation, predicted conditions for the proposed development are also illustrated in colour-coded format in Figures 2A through 4B. 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-A2 in Appendix A and illustrated in Figures 2A and 2B, this section summarizes the significant findings of the PLW study with respect to the *existing scenario*, as follows:

1. All public sidewalks, walkways, laneways, landscaped spaces, and parking areas within and surrounding the proposed development currently experience wind conditions suitable for walking or better during each seasonal period.
2. The nearby existing transit stops at the north (Sensor 8), and south (Sensor 34), corners of the intersection of Rathburn Road East and Bough Beeches Boulevard currently experience conditions comfortable for standing or better throughout each seasonal period.



3. All existing building access points serving the adjacent Claridge House (Sensors 15, 18, 22, & 43) currently experience wind conditions comfortable for standing or better during each seasonal period.
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 unsafe.

5.2 Pedestrian Comfort Suitability – Proposed Conditions

Based on the analysis of the measured data, consideration of local climate data, and the suitability descriptors provided in Tables B1-B2 in Appendix B and illustrated in Figures 3A through 4B, this section summarizes the most significant findings of the PLW study with respect to proposed conditions, as follows:

1. All surrounding public sidewalks, walkways, laneways, landscaped spaces, and parking areas within and surrounding the development site will continue to experience wind conditions suitable for walking or better during each seasonal period, which is acceptable.
2. All primary and secondary building access points serving the proposed development will be comfortable for standing or better throughout the year, which is acceptable.
3. The nearby existing transit stops at the north (Sensor 8), and south (Sensor 34), corners of the intersection of Rathburn Road East and Bough Beeches Boulevard will continue to experience conditions comfortable for standing throughout each seasonal period, which is acceptable.
4. The outdoor amenity area to the east of the proposed development (Sensors 51-53) will generally experience conditions comfortable for standing or better throughout the year without consideration for landscaping and other mitigatory elements not included in the wind tunnel model. Considering the extensive existing and proposed landscaping surrounding the space, conditions suitable for sitting during the summer and standing during the winter are expected without the need for additional mitigation.
5. All primary and secondary building access points to the adjacent Claridge House (Sensors 15, 18, 22, & 43) will remain comfortable for standing or better throughout the year, which is acceptable.



6. 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 unsafe.

6. CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the methodology, results, and recommendations related to a pedestrian level wind study for the proposed residential development located at 1315 Bough Beeches Boulevard in Mississauga, 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 4B, as well as Tables A1-A2 and B1-B2 in the appendices. Based on wind tunnel test results, meteorological data analysis, and experience with similar developments in Mississauga, we conclude that the future wind conditions 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.

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 conditions that could be 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.



Lauren Thomas, B.A.Sc.
Junior Wind Scientist



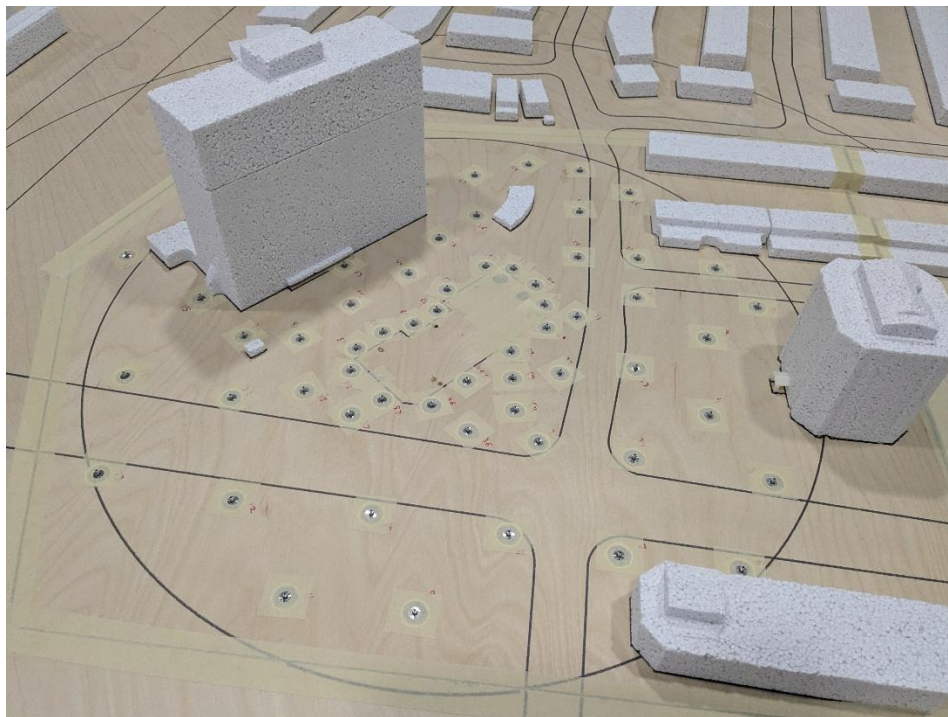
Nick Petersen, P.Eng.,
Wind Engineer

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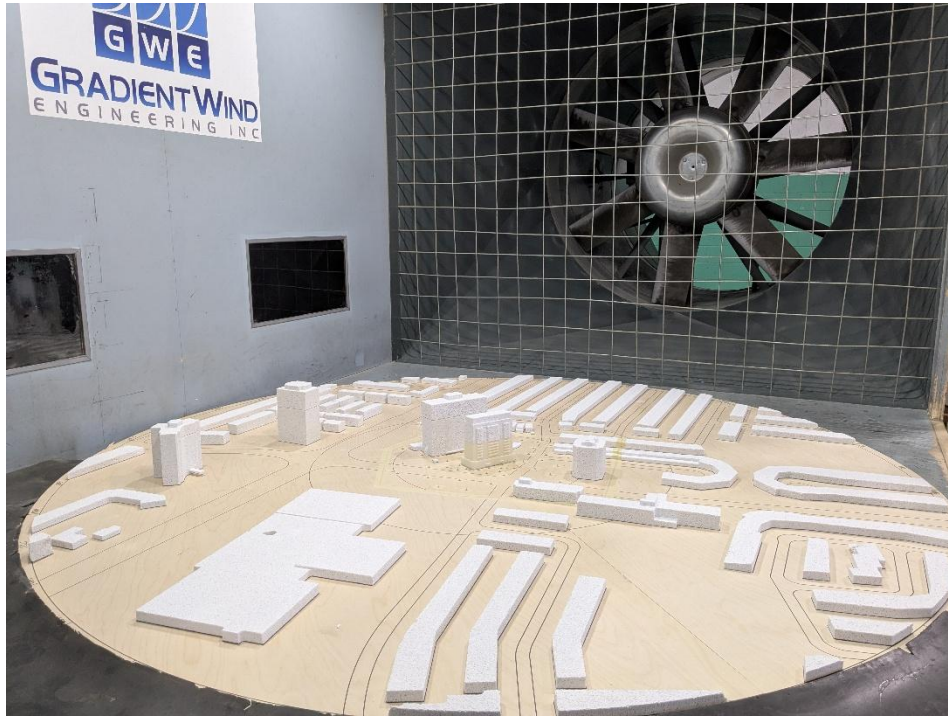


PHOTOGRAPH 1: CLOSE-UP VIEW OF EXISTING CONTEXT MODEL LOOKING SOUTHWEST



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





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

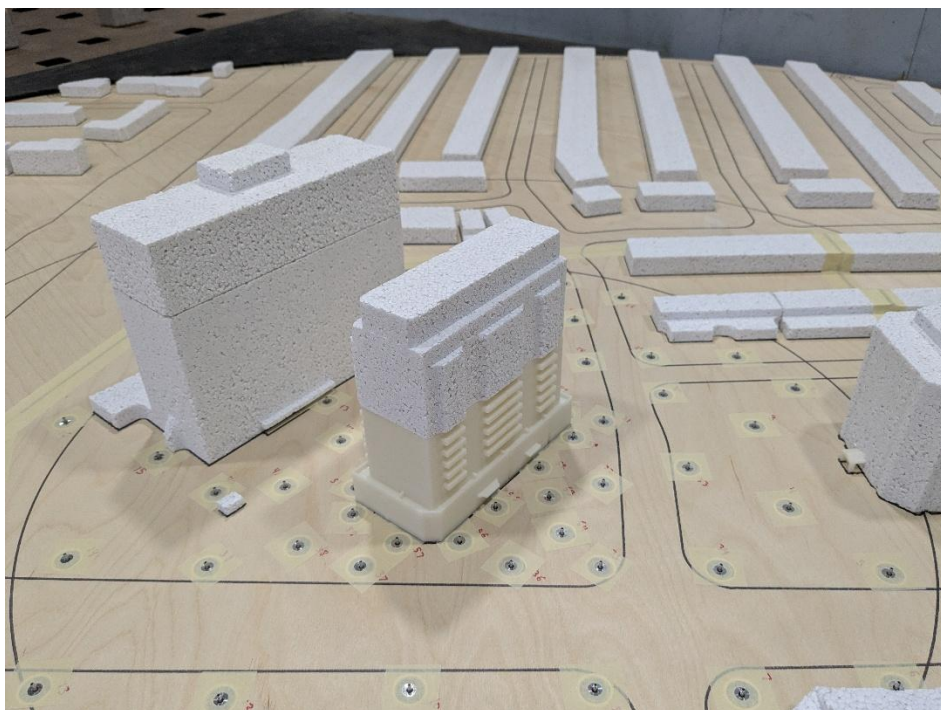


PHOTOGRAPH 4: PROPOSED STUDY MODEL INSIDE THE GWE WIND TUNNEL LOOKING UPWIND

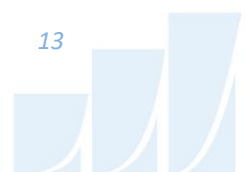


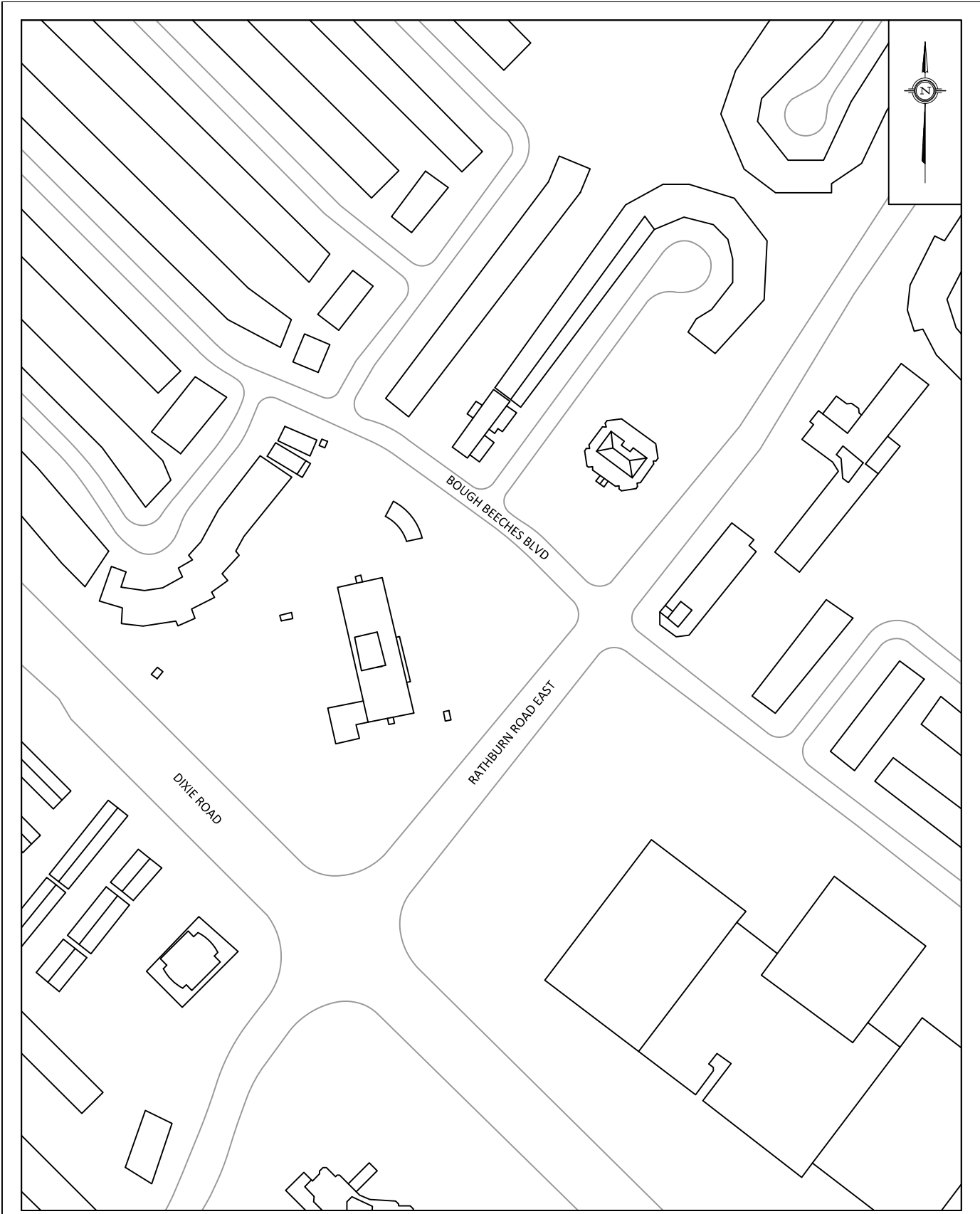


PHOTOGRAPH 5: CLOSE-UP VIEW OF PROPOSED STUDY MODEL LOOKING SOUTHWEST



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





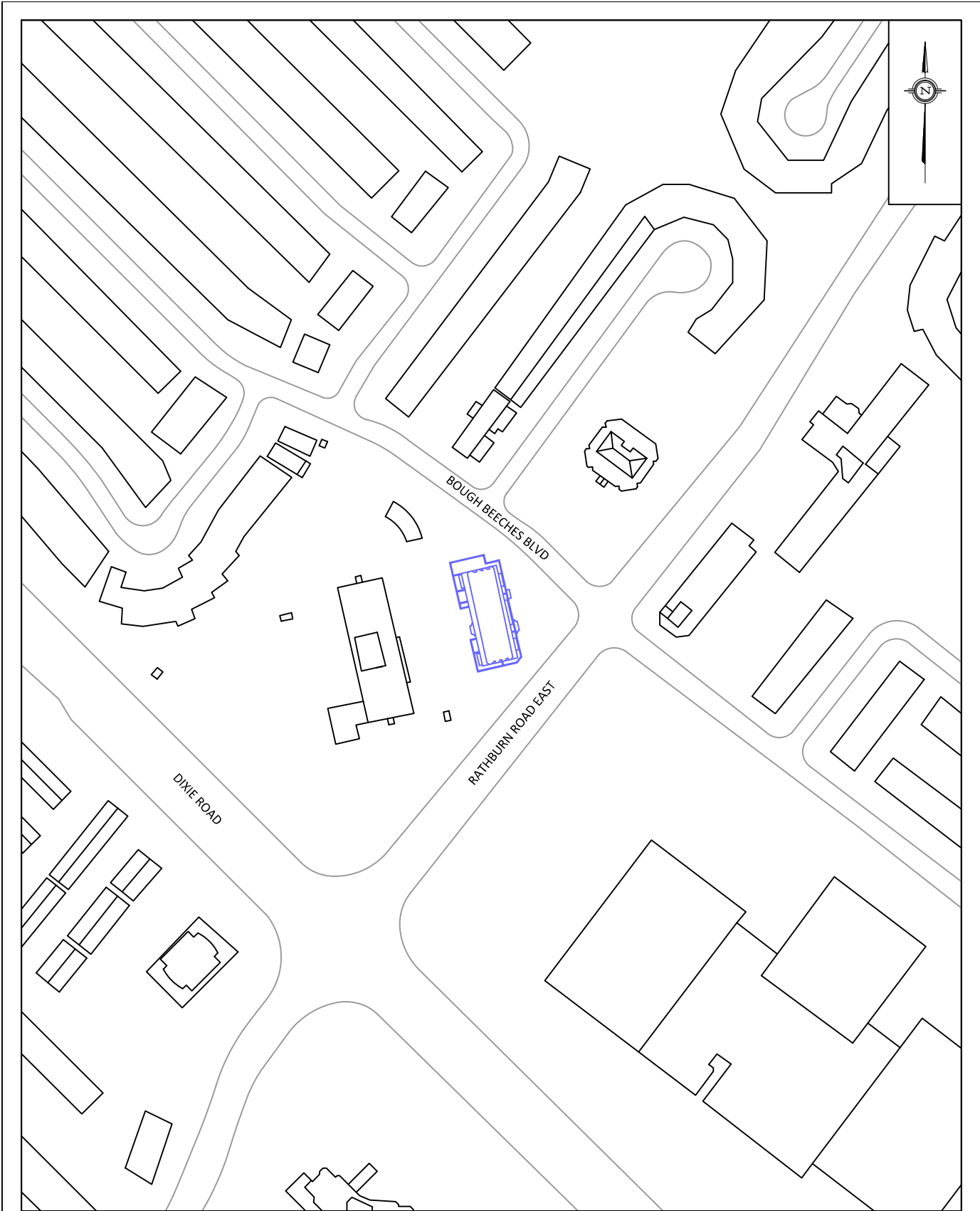
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PROJECT	1315 BOUGH BEECHES, MISSISSAUGA PEDESTRIAN LEVEL WIND STUDY	
SCALE	1:2500 (APPROX.)	DRAWING NO. GW25-146-PLW-1A
DATE	MARCH 9, 2026	DRAWN BY C.E.

DESCRIPTION	FIGURE 1A: EXISTING SITE PLAN AND SURROUNDING CONTEXT
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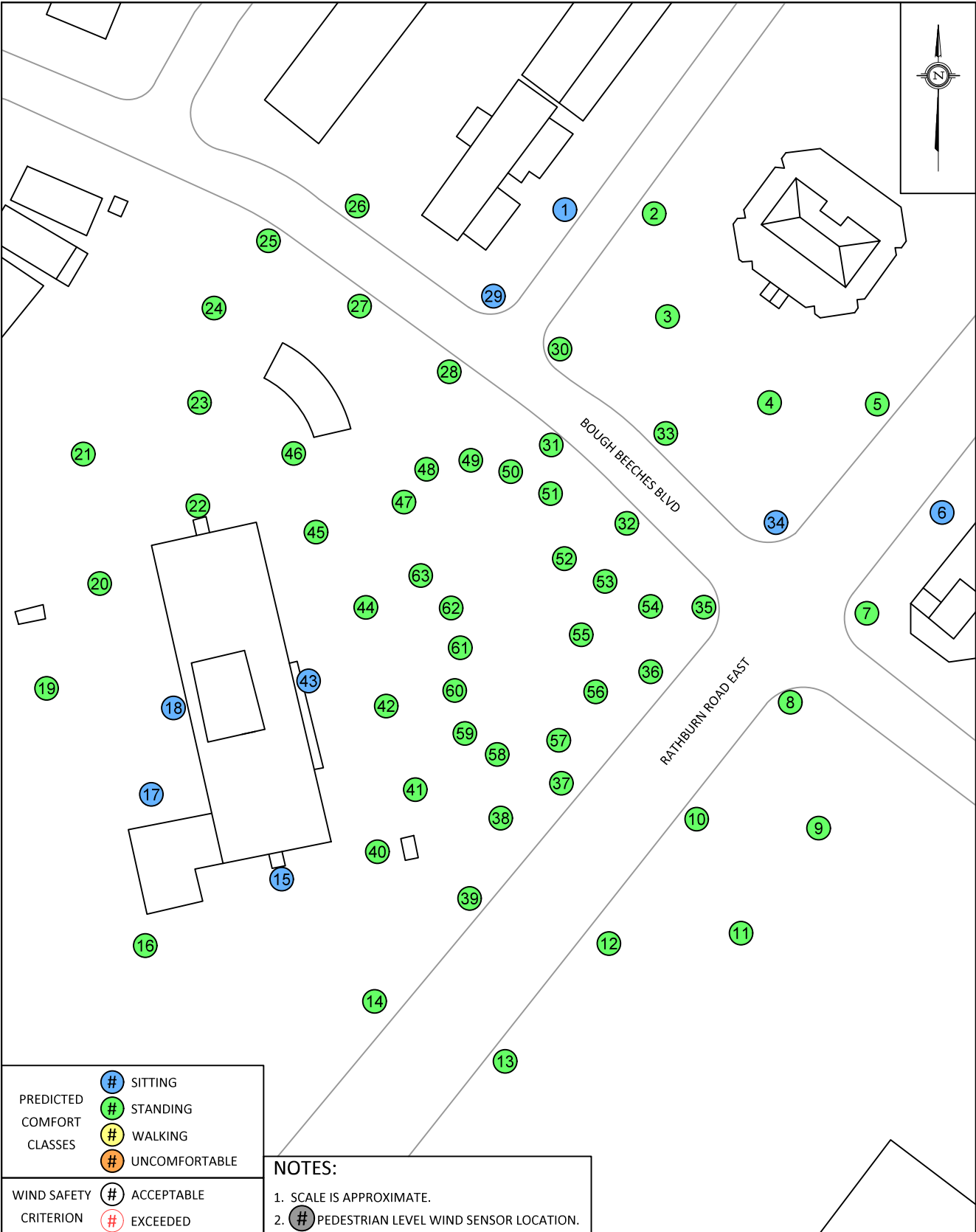
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DATE	MARCH 9, 2026	DRAWN BY C.E.

DESCRIPTION	FIGURE 1B: PROPOSED SITE PLAN AND SURROUNDING CONTEXT
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PREDICTED COMFORT CLASSES	(#) SITTING
	(#) STANDING
	(#) WALKING
	(#) UNCOMFORTABLE
WIND SAFETY CRITERION	(#) ACCEPTABLE
	(#) EXCEEDED

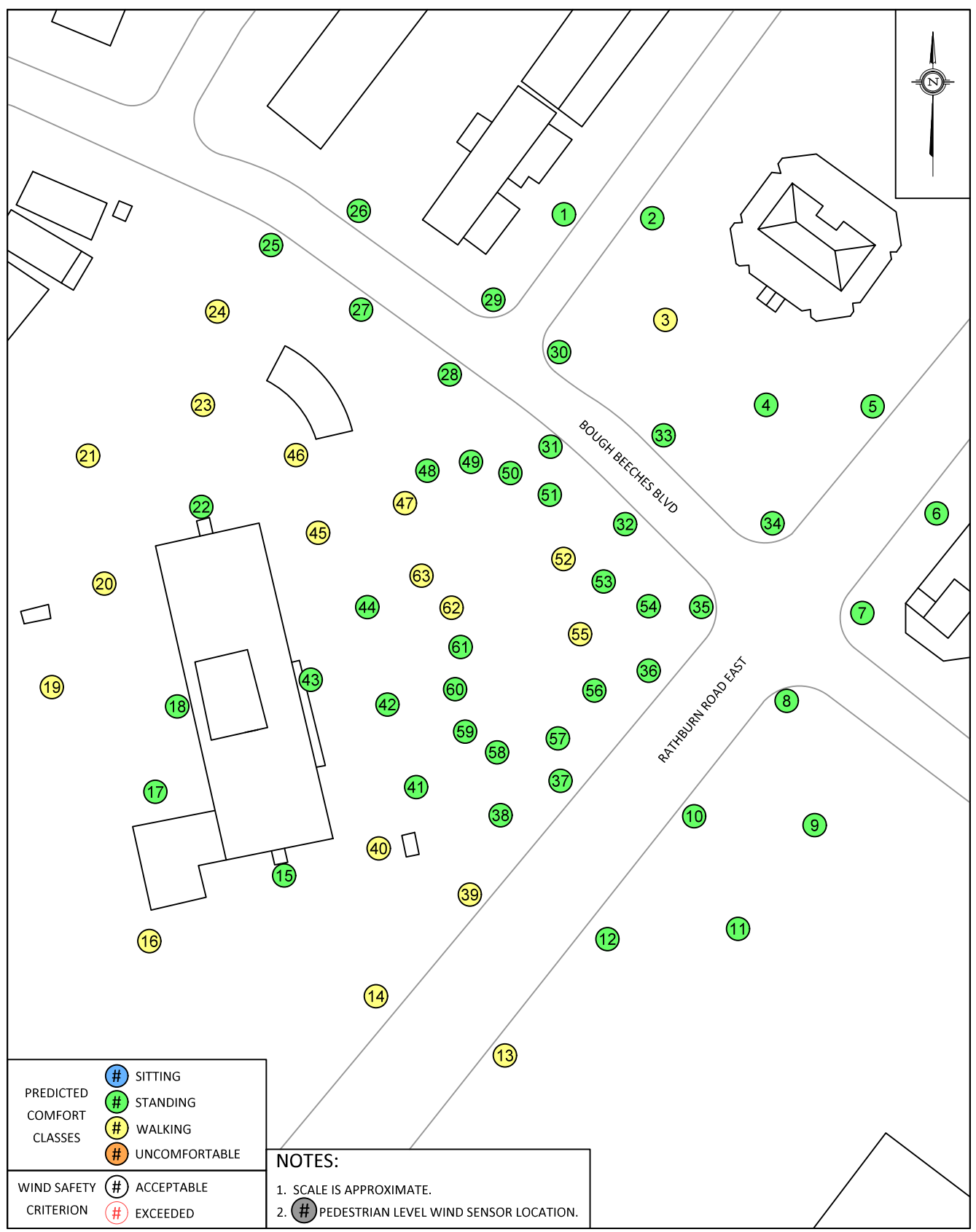
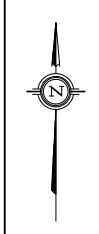
NOTES:

- SCALE IS APPROXIMATE.
- (#) PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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DATE	MARCH 9, 2026	DRAWN BY C.E.

DESCRIPTION
 FIGURE 2A: SUMMER
 EXISTING GROUND FLOOR PLAN
 PEDESTRIAN COMFORT PREDICTIONS



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

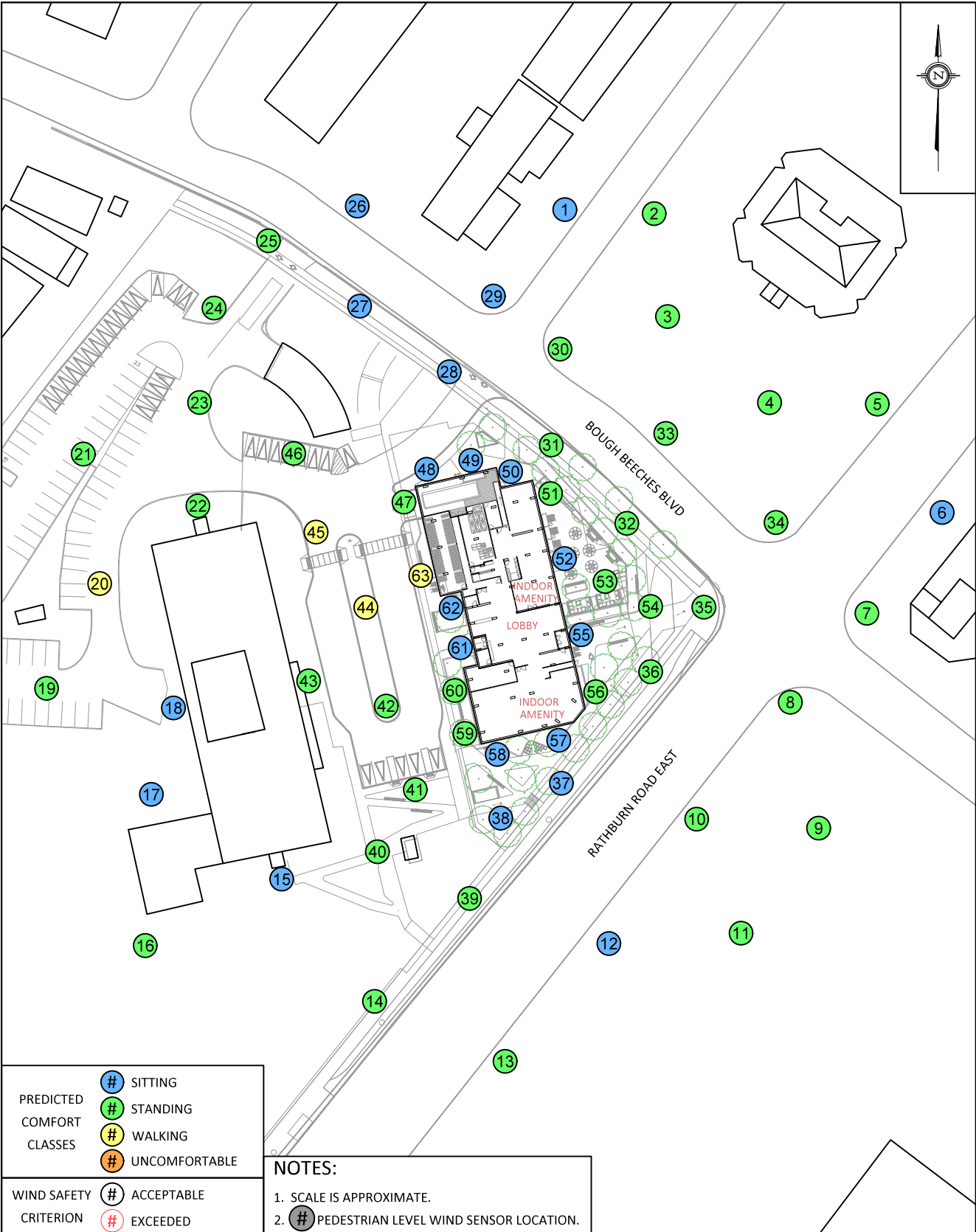
NOTES:

- SCALE IS APPROXIMATE.
- (#) PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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SCALE	1:1100 (APPROX.)	DRAWING NO. GW25-146-PLW-2B
DATE	MARCH 9, 2026	DRAWN BY C.E.

DESCRIPTION
 FIGURE 2B: WINTER
 EXISTING GROUND FLOOR PLAN
 PEDESTRIAN COMFORT PREDICTIONS



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

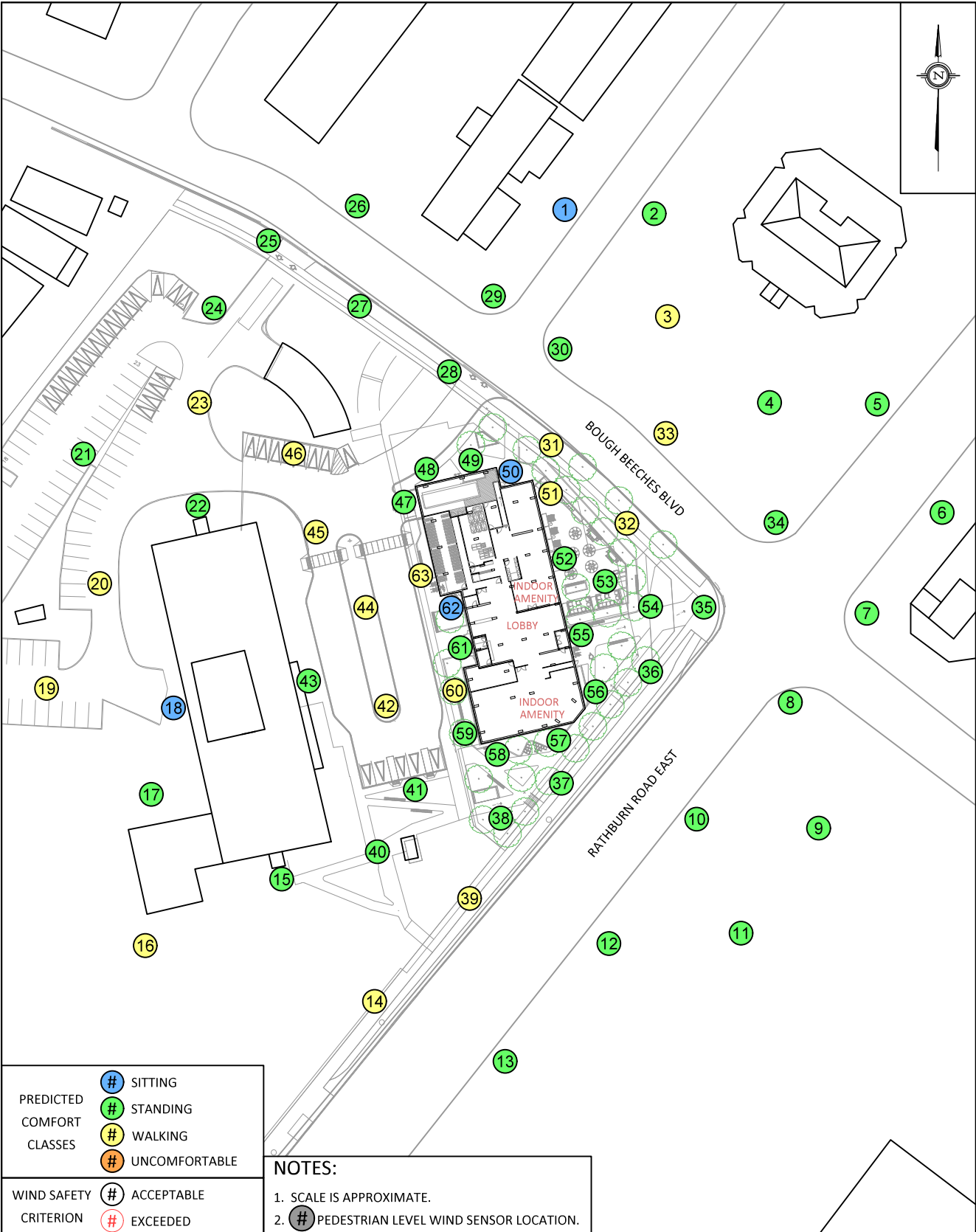
NOTES:

- SCALE IS APPROXIMATE.
- (#) PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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SCALE	1:1100 (APPROX.)	DRAWING NO. GW25-146-PLW-3A
DATE	MARCH 9, 2026	DRAWN BY C.E.

DESCRIPTION
 FIGURE 3A: SUMMER
 PROPOSED GROUND FLOOR PLAN
 PEDESTRIAN COMFORT PREDICTIONS



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

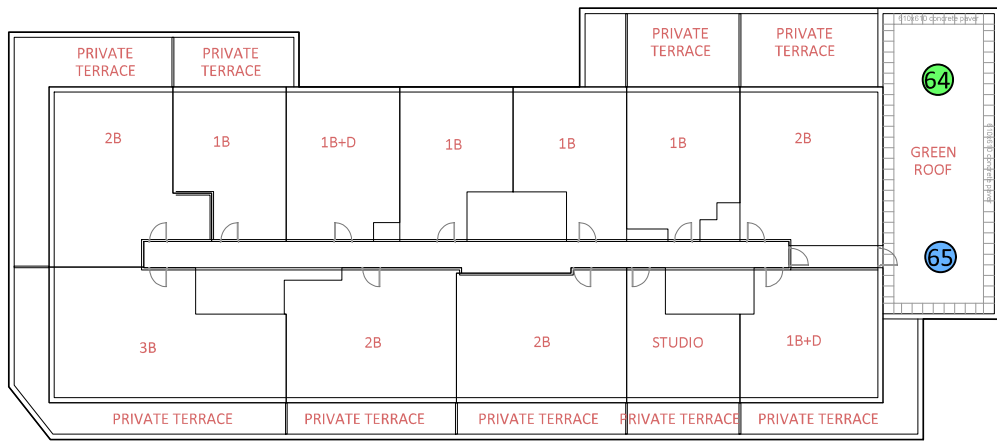
NOTES:

- SCALE IS APPROXIMATE.
- (#) PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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DATE	MARCH 9, 2026	DRAWN BY C.E.

DESCRIPTION
 FIGURE 3B: WINTER
 PROPOSED GROUND FLOOR PLAN
 PEDESTRIAN COMFORT PREDICTIONS



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

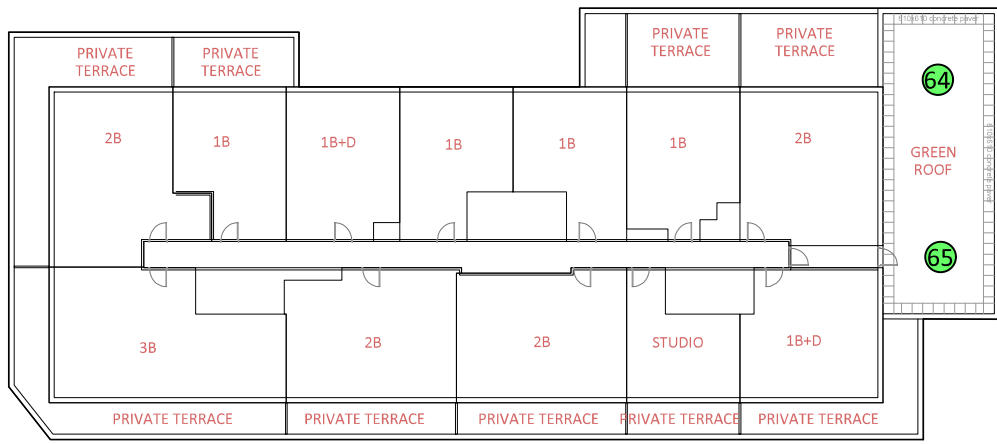
NOTES:

- SCALE IS APPROXIMATE.
- PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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DESCRIPTION
 FIGURE 4A: SUMMER
 LEVEL 2 PLAN
 PEDESTRIAN COMFORT PREDICTIONS



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

NOTES:

- SCALE IS APPROXIMATE.
- PEDESTRIAN LEVEL WIND SENSOR LOCATION.

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DESCRIPTION
 FIGURE 4B: WINTER
 LEVEL 2 PLAN
 PEDESTRIAN COMFORT PREDICTIONS

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APPENDIX A

PEDESTRIAN COMFORT SUITABILITY, TABLES A1-A2 (EXISTING CONDITIONS)

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 CONDITIONS)

Sensor	Pedestrian Comfort				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
1	8.4	Sitting	10.1	Standing	36.5	Safe
2	12.2	Standing	13.9	Standing	50.3	Safe
3	13.3	Standing	15.9	Walking	60.6	Safe
4	11.0	Standing	14.8	Standing	59.1	Safe
5	11.1	Standing	14.2	Standing	52.8	Safe
6	8.7	Sitting	10.6	Standing	41.5	Safe
7	10.9	Standing	12.8	Standing	46.2	Safe
8	10.9	Standing	13.0	Standing	48.6	Safe
9	10.6	Standing	12.9	Standing	47.3	Safe
10	11.1	Standing	13.4	Standing	49.5	Safe
11	10.6	Standing	13.1	Standing	48.7	Safe
12	11.0	Standing	13.9	Standing	54.2	Safe
13	11.6	Standing	15.2	Walking	60.8	Safe
14	12.7	Standing	17.2	Walking	72.8	Safe
15	9.3	Sitting	13.1	Standing	66.6	Safe
16	13.2	Standing	16.8	Walking	58.3	Safe
17	9.2	Sitting	12.4	Standing	50.3	Safe
18	8.2	Sitting	10.2	Standing	45.3	Safe
19	12.5	Standing	15.4	Walking	60.8	Safe
20	14.7	Standing	18.9	Walking	68.0	Safe
21	11.5	Standing	15.8	Walking	69.4	Safe
22	10.0	Standing	13.9	Standing	66.2	Safe
23	13.8	Standing	19.5	Walking	74.8	Safe
24	11.1	Standing	15.1	Walking	66.4	Safe
25	11.2	Standing	14.8	Standing	59.9	Safe
26	10.0	Standing	12.6	Standing	51.1	Safe
27	11.3	Standing	14.9	Standing	59.4	Safe
28	10.8	Standing	14.0	Standing	55.7	Safe
29	9.6	Sitting	12.3	Standing	53.3	Safe
30	11.0	Standing	13.6	Standing	49.4	Safe
31	11.5	Standing	14.3	Standing	52.1	Safe
32	11.4	Standing	14.1	Standing	54.1	Safe
33	11.5	Standing	14.3	Standing	54.7	Safe
34	9.9	Sitting	12.0	Standing	48.7	Safe
35	11.0	Standing	13.2	Standing	52.1	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 CONDITONS)

Sensor	Pedestrian Comfort				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
36	11.4	Standing	14.0	Standing	54.8	Safe
37	11.5	Standing	14.2	Standing	55.6	Safe
38	11.6	Standing	14.4	Standing	55.9	Safe
39	12.3	Standing	16.0	Walking	66.6	Safe
40	12.4	Standing	15.1	Walking	55.0	Safe
41	11.6	Standing	14.1	Standing	51.6	Safe
42	11.1	Standing	13.0	Standing	55.6	Safe
43	9.1	Sitting	11.0	Standing	42.3	Safe
44	12.0	Standing	14.8	Standing	76.4	Safe
45	14.9	Standing	19.1	Walking	77.1	Safe
46	14.3	Standing	18.9	Walking	68.0	Safe
47	13.0	Standing	16.9	Walking	71.0	Safe
48	11.6	Standing	14.7	Standing	60.0	Safe
49	11.7	Standing	14.7	Standing	57.1	Safe
50	11.4	Standing	14.0	Standing	51.1	Safe
51	11.3	Standing	13.9	Standing	54.0	Safe
52	12.2	Standing	15.4	Walking	62.1	Safe
53	11.6	Standing	14.0	Standing	53.0	Safe
54	11.4	Standing	13.9	Standing	55.4	Safe
55	12.1	Standing	15.2	Walking	62.3	Safe
56	11.9	Standing	14.7	Standing	61.3	Safe
57	11.9	Standing	14.6	Standing	58.2	Safe
58	11.8	Standing	14.6	Standing	57.3	Safe
59	11.5	Standing	13.8	Standing	57.1	Safe
60	11.6	Standing	13.8	Standing	65.2	Safe
61	11.9	Standing	14.4	Standing	72.7	Safe
62	12.0	Standing	15.2	Walking	72.4	Safe
63	12.6	Standing	16.5	Walking	79.5	Safe

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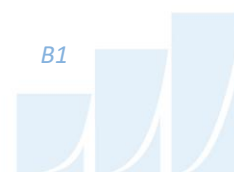
APPENDIX B

PEDESTRIAN COMFORT SUITABILITY, TABLES B1-B2 (PROPOSED CONDITIONS)

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 (PROPOSED CONDITONS)

Sensor	Pedestrian Comfort				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
1	8.0	Sitting	9.6	Sitting	35.7	Safe
2	11.7	Standing	13.4	Standing	48.8	Safe
3	13.2	Standing	15.7	Walking	57.1	Safe
4	11.2	Standing	14.8	Standing	58.5	Safe
5	10.6	Standing	13.7	Standing	53.6	Safe
6	8.9	Sitting	10.7	Standing	41.4	Safe
7	12.0	Standing	14.1	Standing	50.7	Safe
8	11.1	Standing	13.3	Standing	52.9	Safe
9	10.4	Standing	12.8	Standing	47.3	Safe
10	11.1	Standing	13.5	Standing	48.2	Safe
11	10.3	Standing	13.0	Standing	48.0	Safe
12	10.0	Sitting	12.9	Standing	53.2	Safe
13	11.2	Standing	14.8	Standing	60.3	Safe
14	11.6	Standing	15.8	Walking	67.3	Safe
15	9.3	Sitting	13.0	Standing	68.2	Safe
16	12.8	Standing	16.2	Walking	55.4	Safe
17	9.0	Sitting	12.2	Standing	50.1	Safe
18	8.1	Sitting	10.0	Sitting	45.1	Safe
19	12.6	Standing	15.6	Walking	60.3	Safe
20	15.0	Walking	19.1	Walking	68.1	Safe
21	11.0	Standing	14.8	Standing	68.7	Safe
22	10.1	Standing	13.9	Standing	67.2	Safe
23	12.2	Standing	17.7	Walking	73.6	Safe
24	10.7	Standing	14.9	Standing	65.4	Safe
25	10.6	Standing	14.3	Standing	60.0	Safe
26	9.8	Sitting	12.9	Standing	52.6	Safe
27	10.0	Sitting	13.8	Standing	56.9	Safe
28	9.2	Sitting	12.5	Standing	50.4	Safe
29	10.0	Sitting	13.3	Standing	51.4	Safe
30	11.2	Standing	14.2	Standing	49.8	Safe
31	13.1	Standing	16.7	Walking	58.8	Safe
32	14.2	Standing	18.0	Walking	73.0	Safe
33	13.2	Standing	16.1	Walking	58.3	Safe
34	11.5	Standing	14.2	Standing	59.1	Safe
35	12.5	Standing	14.8	Standing	64.2	Safe



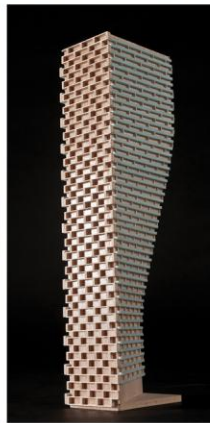
Guidelines	
Pedestrian Comfort	20% exceedance wind speed (0-10 km/h = Sitting, 10-15 km/h = Standing, 15-20 km/h = Walking, >20 km/h = Uncomfortable)
Pedestrian Safety	0.1% exceedance wind speed 0-90 km/h = Safe

TABLE B2: SUMMARY OF PEDESTRIAN COMFORT (PROPOSED CONDITONS)

Sensor	Pedestrian Comfort				Pedestrian Safety	
	Summer		Winter		Annual	
	Wind Speed	Comfort Class	Wind Speed	Comfort Class	Wind Speed	Safety Class
36	12.1	Standing	13.9	Standing	53.0	Safe
37	8.8	Sitting	11.6	Standing	46.8	Safe
38	9.3	Sitting	12.2	Standing	48.9	Safe
39	11.8	Standing	15.8	Walking	64.2	Safe
40	11.9	Standing	14.5	Standing	54.9	Safe
41	12.5	Standing	14.9	Standing	56.8	Safe
42	14.9	Standing	17.3	Walking	66.1	Safe
43	12.2	Standing	14.6	Standing	50.5	Safe
44	16.4	Walking	19.6	Walking	79.0	Safe
45	15.4	Walking	19.6	Walking	76.7	Safe
46	13.1	Standing	17.4	Walking	65.7	Safe
47	11.3	Standing	13.7	Standing	54.1	Safe
48	8.9	Sitting	11.5	Standing	46.0	Safe
49	8.9	Sitting	12.4	Standing	55.7	Safe
50	7.4	Sitting	9.7	Sitting	38.5	Safe
51	13.0	Standing	16.0	Walking	63.6	Safe
52	9.7	Sitting	11.1	Standing	48.7	Safe
53	11.2	Standing	12.7	Standing	58.3	Safe
54	12.0	Standing	14.1	Standing	63.1	Safe
55	9.9	Sitting	11.0	Standing	41.6	Safe
56	10.9	Standing	12.2	Standing	45.2	Safe
57	7.9	Sitting	10.4	Standing	47.1	Safe
58	8.7	Sitting	10.2	Standing	47.8	Safe
59	12.2	Standing	14.0	Standing	53.9	Safe
60	13.0	Standing	15.9	Walking	64.0	Safe
61	8.4	Sitting	10.2	Standing	39.2	Safe
62	7.5	Sitting	8.9	Sitting	34.4	Safe
63	15.7	Walking	19.9	Walking	73.1	Safe
64	10.6	Standing	13.4	Standing	55.1	Safe
65	8.4	Sitting	11.3	Standing	51.6	Safe

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APPENDIX C

WIND TUNNEL SIMULATION OF THE NATURAL WIND

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 C1 on the following page plots three velocity profiles for open country, and suburban and urban exposures.

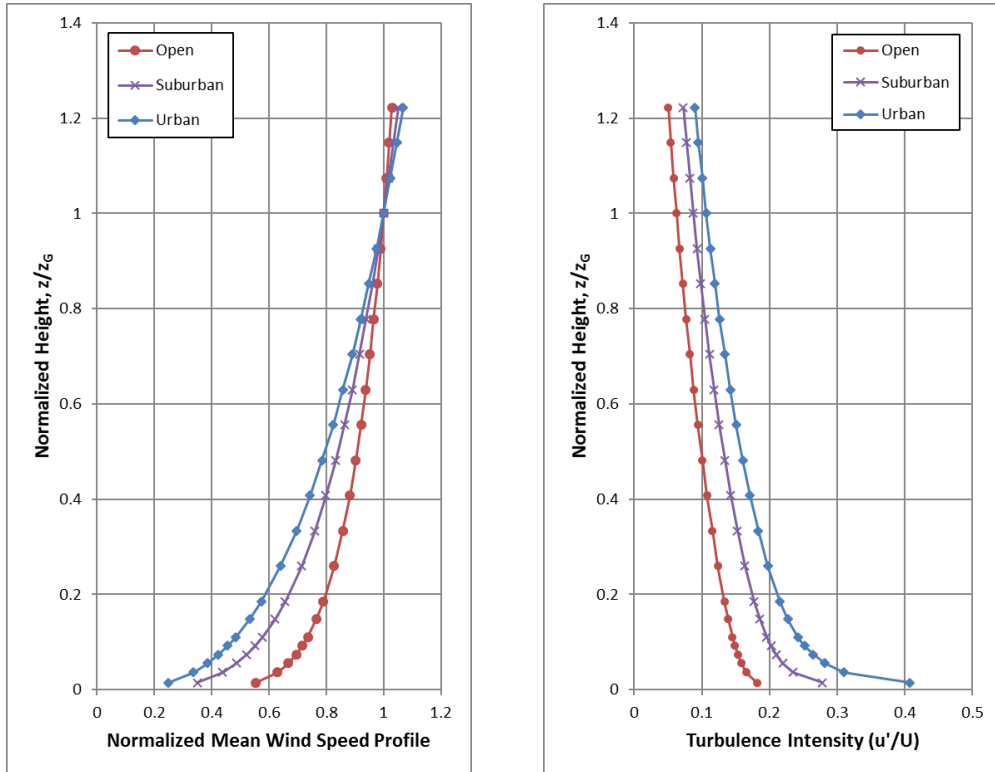
The exponent α varies according to the type of upwind terrain; α ranges from 0.14 for open country to 0.33 for an urban exposure. Figure C2 illustrates the theoretical variation of turbulence for open country, suburban and urban exposures.

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:

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

Where, f is frequency, $S(f)$ is the spectrum value at frequency f , U_{10} 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.



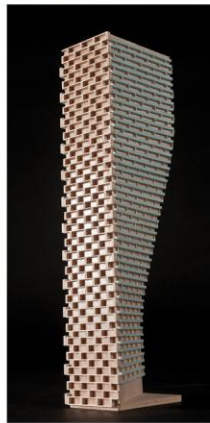
**FIGURE C1 (LEFT): MEAN WIND SPEED PROFILES;
FIGURE C2 (RIGHT): TURBULENCE INTENSITY PROFILES**

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1. Teunissen, H.W., 'Characteristics of The Mean Wind And Turbulence In The Planetary Boundary Layer', Institute For Aerospace Studies, University Of Toronto, UTIAS # 32, Oct. 1970
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3. ESDU, 'Characteristics of Atmospheric Turbulence Near the Ground', 74030
4. Bradley, E.F., Coppin, P.A., Katen, P.C., '*Turbulent Wind Structure Above Very Rugged Terrain*', 9th Australian Fluid Mechanics Conference, Auckland, Dec. 1966

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APPENDIX D

PEDESTRIAN LEVEL WIND MEASUREMENT METHODOLOGY

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 D1. 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:

$$P(>U_g) = A_\theta \cdot \exp\left[-\left(\frac{U_g}{C_\theta}\right)^{K_\theta}\right]$$

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:

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

$$P_N(>20) = \sum_\theta P\{>20/(U_N/U_g)\}$$

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.

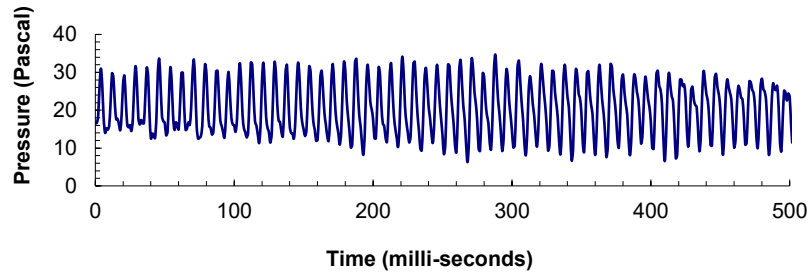


FIGURE D1: TIME VERSUS VELOCITY TRACE FOR A TYPICAL WIND SENSOR

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2. Wu, S., Bose, N., *'An Extended Power Law Model for the Calibration of Hot-wire/Hot-film Constant Temperature Probes'*, Int. J. of Heat Mass Transfer, Vol.17, No.3, pp.437-442, Pergamon Press.