The Boundary Layer Wind Tunnel Laboratory

Pedestrian Level Wind Study

2225 Erin Mills Parkway, Mississauga, Ontario

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MAIN FINDINGS

This report describes the pedestrian-level wind study performed at the Boundary Layer Wind Tunnel Laboratory for the proposed development at 2225 Erin Mills Parkway, Mississauga ON. The development contains two sites, namely the Building A site and the Building G site. The two sites are described in more detail below. A detailed discussion of the results is contained in Section 3.5. A description of the criteria used can be found in Section 3.4.

Tests were carried out for two configurations described as follows, and as pictured in Figure 5:

> **Existing Site** - The existing site consists of a single storey shopping mall surrounded by expansive bare parking lot. The existing Building A site is located in the southwestern end of the parking lot and currently contains a low-rise restaurant building. The existing Building G site is located on the eastern end of the parking area and is currently open parking area. An aerial view of the existing site can be seen in Figure 2.
>
> **Proposed Site** – The proposed Building A and Building G developments each consist of 15-storey multi-unit residential buildings. Perspective views of the buildings are shown in Figure 1.

Figure 9 indicates the 117 locations at which wind speeds were measured for the Existing configuration. Figure 10 indicates the 122 locations at which wind speeds were measured for the Proposed configuration. Locations 12 and 13 are located on the Building A Roof Level outdoor amenity space and Locations 72 and 73 are located on the Building G Roof Level outdoor amenity space and were only tested in the Proposed configuration. Probe location 6 is located at the southwest Building A building entrance in the Proposed Configuration; this location is covered by the restaurant building in the Existing Configuration.

The evaluation for safety is summarized schematically in Figure 11. Comfort results for each of summer and winter seasons are summarized schematically in Figures 12 and 13, respectively. These summarize the suitability of each measurement location with respect to pedestrian-level safety or comfort. The comfort and safety categories used correspond to those summarized in section 3.4.

Colour-coded diagrams further summarize the suitability of each measurement location with respect to pedestrian-level safety and pedestrian comfort for each tested configuration. Figure 14 presents these for safety considerations for the Existing configuration and Figure 15 for the Proposed configuration. For comfort considerations these are presented for the summer season in Figures 16 and 17 for the Existing and Proposed configurations, respectively. Figures 18 and 19 present comfort colour diagrams for the winter season for the Existing and Proposed configurations, respectively. The comfort and safety categories used in these figures correspond to those summarized in section 3.4.

The introduction of a mid-rise to high-rise building development in a suburban environment will invariably create local wind speed-ups for some wind directions. With that expectation, the focus is to identify and develop strategies to make wind conditions suitable for the intended usage for negatively affected areas.

Existing Site

The immediate site surroundings are comprised of a typical suburban environment for the southern through to the northern wind directions, with areas to the immediate east consisting of being a mid- to high-rise residential buildings. An aerial view of the Existing site is shown in Figure 2.

Given the suburban surroundings, it is not surprising that the measured wind speeds for the existing site are generally consistent with a typical suburban environment.

With respect to pedestrian safety, Locations 114 and 117 found at the southwest and northwest corner of the building located at 1980 Fowler Drive exceed the safety criteria for the Existing Configuration. All other tested locations meet the recommended criterion (see Figures 14) in the Existing configuration.

With respect to pedestrian comfort, in summer all measurement areas are rated for standing or sitting (see Figures 16). In winter, some sidewalk areas are rated for walking while most areas are rating for standing, with a few sheltered areas rated for sitting (see Figure 18). In all cases, the measured wind speeds are suited for the intended usage for their respective areas except for Location 117 at the northwest corner of 1980 Fowler Drive which is rated as uncomfortable in the winter.

Influence of Proposed Developments

The proposed developments were tested without any on-site or off-site landscaping and are thus can be expected to be somewhat conservative.

Given that the Existing Site and surroundings are comprised of many low buildings, the inclusion of a multi-tower development will undoubtedly influence local winds at ground and over raised amenity areas. The proposed development is no exception, and its influence is most noticeable on and near each building site. The expectation then should not be to return winds to their pre-development state, but rather ensure that the winds in all areas are appropriate for the intended usage. For example, entry areas should be suited for standing or better, while walking classification would be suitable for typical sidewalk areas.

Typically, for buildings of the heights proposed, observed changes in wind speed at locations somewhat removed from the proposed development (say more than 50m away) are minimal, and not substantial enough to affect the comfort from a usage perspective. As such, those locations will generally remain suited for the intended usage. Closer to the site, increases in the wind locally can often lead to a change of the comfort classification. However, this change in and of itself does not suggest that the associated wind speeds are uncomfortable. For example, wind speeds at Locations 20 through 23 along the sidewalk directly southwest of the development on Erin Mills Parkway increase to walking from standing in the winter months, yet remain suitable for typical sidewalk usage.

In summer, all ground level locations are rated for standing or better. Wind conditions during the summer season are therefore expected to be suited for the intended usage. During winter season, wind speeds are typically higher. At locations near to and throughout the development site, many sidewalk locations on both sides of Erin Mills Parkway and Fowler Drive increase to walking, yet remain suitable for sidewalk usage.

At ground level, with respect to comfort the following are noted:

- Location 2 on the west side of Building A is near an entrance and rated for walking in the winter, above the recommended standing category for entry areas.
- Location 1 at the northwest corner of Building A falls is marginally uncomfortable in the winter season.
- Location 71 on the west side of Building G is near an entrance and rated for walking during the winter.
- Locations 100, 102 and 103 east of Building G and on the east side of Fowler Drive increase to uncomfortable in the winter. This stretch of sidewalk in general is expected to require some mitigation.

These above locations will require mitigation to improve winds to recommended comfort levels of standing year-round at entry areas, and walking at general pedestrian areas such as sidewalks.

During the summer, measurements at the Roof Level amenity spaces for both Buildings A and G indicate some areas are suited for standing activities with other areas suited for walking. In the winter, the Building A Roof Level amenity space is suitable for walking on the southern portion while the northern portion is uncomfortable. The Building G rooftop amenity space is suitable for walking in winter. It is expected that the Roof Level amenity areas will require mitigation if the intent is to use them during winter, or if greater comfort levels are required during the summer season. If a sitting classification during summer is desired, then all spaces will require some broad-scale mitigation over and around the amenity spaces.

With respect to safety, though there is a modest decrease in the wind speed at Location 114 compared to the Existing case, it again fails to meet the safety criteria. Location 117, which fail to meet the safety criteria in the Existing configuration, is expected to be rated as safe with the introduction of the proposed development.

Mitigation Strategies

In areas that are windier than desired for the intended usage incorporating mitigation strategies will be beneficial.

Recessing the entrance doors on the northwestern side of Building A and the western side of Building G, near probe locations 2 and 71, would be beneficial in this area. Alternatively, dense evergreens or locally placed windscreens will be required to improve the winds at these entryways.

Wind screens or closely spaced evergreens (min. 8' tall) placed in the general area of the northwestern corner of Building A near Location 1 will improve conditions in that area.

For Locations 100, 102 and 103, mitigation in the form of canopies, evergreens, windscreens to the west of these areas will need to be explored to improve wind conditions. Concept mitigation would include evergreens or windscreens along the north and south sides of Building G. Generally, inclusion of landscaping will be beneficial.

For the Roof Level outdoor amenity terraces, testing was conducted modelling a standard 42" solid railing around the terrace perimeter. Increasing the perimeter railing height (to 7' or greater) would be beneficial. Localized windscreens or planters with coniferous plantings along the western and southwestern portion of the Building A amenity space and along the northern, southern and western portions of the Building G amenity space should be considered. Examples of effective pedestrian level wind mitigation options can be seen in Figure 20. Depending on the level of comfort required, amenity features (vertical fireplaces, moderate height landscaping, windscreens, overhead trellises) may be required throughout the space.

1 THE WIND CLIMATE FOR MISSISSAUGA

1.1 Meteorological Data

The Integrated Surface Data (ISD) records are maintained by the National Climatic Data Center (NCDC), and provide a climatological database of approximately 20,000 stations around the world. The ISD contains many meteorological variables, typically recorded at intervals of 1 hour. An analysis of historical wind data from the Lester B. Pearson International Airport (ISD Station 716240) was performed to develop a statistical wind climate for Hamilton. The historical data consists of the time period 1982 – 2017.

Based on the analysis of hourly wind records probability distributions of wind speed and wind direction are developed for each of Safety and Comfort purposes. The models predict similar hourly mean wind speeds at 10m of about 14 m/s and 18.3m/s for return periods of 1 month and 1 year, respectively. These have been adjusted to be consistent with for standard open country exposure and are shown in Figure 3.

1.2 Statistical Wind Climate Model

For the analysis of the wind tunnel data, the wind climate models are converted to a reference height of 500m using a standard open country exposure profile. The predicted wind speeds are similar between each model (safety and comfort) and are shown in Figure 3. The predicted hourly mean wind speed at the 500m reference height, used in the analysis and reporting of pedestrian-level wind speeds, is 33.4 m/s for a return period of 1 year.

The directional characteristics of winds associated with various return periods are plotted in terms of Relative Importance (%) in Figure 3a for the Safety climate, and Figure 3b for the Comfort climate. Both wind climate models indicate that westerly winds are the most important.

Based on the Urban Design Terms of Reference: Pedestrian Wind Comfort and Safety Studies, issued by the City of Mississauga [Ref 4], separate wind climates were developed to be used for the Comfort and Safety criteria. The development of the Safety climate utilized the complete set of historical wind data (i.e. 24 hours), while the development of the Comfort climate utilized a subset of historical wind data (i.e. between 06:00 and 23:00). The wind climate data are grouped on a two-season basis as follows:

- Summer: May through October
- Winter: November through April

The directional characteristics of winds associated with various return periods are plotted in terms of Relative Importance (%) in Figures 4a and 4b for the Safety (Annual) and Comfort (Seasonal) climates, respectively. Each wind climate model indicates that southwesterly winds are the most important.

The design probability distribution of hourly mean wind speed at 500m reference height and wind direction is shown in Appendix A. Annual and seasonal distributions are shown.

2 THE MODELLING OF THE SITE AND THE WIND

2.1 Overall Approach

The basic tool used is the Laboratory's boundary layer wind tunnel. The tunnel is designed with a very long test section, which allows extended models of upwind terrain to be placed in front of the model of the building under test. The modelling is done in more detail close to the site. The wind flow then develops characteristics which are similar to the wind over the terrain approaching the actual site. This methodology has been highly developed (see References 2 and 3) and is detailed below.

2.2 Model Design

Close-up views of the 1:400 scale model are shown in Figure 5a for the Existing configuration and 5b for the Proposed configuration.

Aerodynamic model components:

The model of the 2225 Erin Mills Parkway developments model built in detail from foam.

1. A detailed proximity model of the surrounding city built in block outline from Styrofoam for a radius of approximately 400m - 500m.
2. Generic models of upstream terrain, modelled by setting appropriate heights of generic roughness blocks and by turbulence-generating spires to produce wind characteristics representative of those at the project site.

The building model and the proximity model are rotated to simulate different wind directions with the upstream terrain being changed as appropriate.

The upstream terrain was modelled using generic roughness blocks and turbulence-generating spires to produce wind characteristics representative of those at the project site. Two different terrain models were used, these are shown in Figure 6 and the azimuth ranges over which they were used are shown in Figure 7.

Testing was carried out for 2 configurations of the surroundings, namely the Existing and Proposed. Photographs of each configuration during wind tunnel testing are shown in Figure 5.

Existing Site – The existing site consists of a single storey shopping mall surrounded by expansive bare parking lot. The existing Building A site is located in the southwestern end of the parking lot and currently contains a low-rise restaurant building. The existing Building G site is located on the eastern end of the parking area and is currently an open parking area. An aerial view of the existing site can be seen in Figure 2.

Proposed Site – The proposed Building A and G developments each consist of a 15-storey multi-unit residential building. Perspective views of the buildings are shown in Figure 1.

2.3 Characteristics of the Modelled Wind

Figure 8 presents the vertical profiles of the mean speed and of the intensity of the longitudinal component of turbulence, measured just upstream of the centre of the turntable, for the upstream terrain exposure.

The model profiles are good representations of the expected variation of full-scale wind speed and turbulence over relevant heights. The reference wind speed measured in the wind tunnel has been scaled such that the expected full-scale wind speeds over the lower 50m are achieved.

3 THE DETERMINATION OF PEDESTRIAN-LEVEL WIND SPEEDS

3.1 Overall Approach

Detailed measurements were made of pedestrian-level wind speeds at locations of interest around the project. Views of the model in the wind tunnel are shown in Figure 6 for each of the tested configurations. These wind-tunnel findings were then combined with the comfort and safety extratropical wind climates to provide statistical predictions of expected pedestrian-level wind speeds around the site.

Assessment for pedestrian safety is based on the gust wind speed predicted to occur 0.1% of time or approximately 9 hours in a year. Assessment for pedestrian comfort is based on the gust equivalent mean wind speed predicted to occur 80% of the time.

General descriptions of the testing and analysis procedure are given in Reference 1.

3.2 Model Instrumentation

Figure 9 indicates the 117 locations at which wind speeds were measured for the Existing configuration. Figure 10 indicates the 122 locations at which wind speeds were measured for the Proposed configuration. Locations 12 and 13 are located on the Building A Roof Level outdoor amenity space and Locations 72 and 73 are located on the Building G Roof Level outdoor amenity space and were only tested in the Proposed configuration. Probe location 6 is located at the southwest Building A building entrance in the Proposed Configuration; this location is covered by the existing building in the Existing Configuration.

Wind speed measurement locations were placed systematically along the sidewalk areas around the proposed development and on existing neighbouring pedestrian traffic routes and entrances.

Measurements were made using omni-directional pressure sensors which measure both mean and fluctuating components of the wind speed parallel to the ground at a height of about 1.5 to 2m in full scale.

3.3 Aerodynamic Data

Measurements were taken at 10° intervals for the full range of azimuths. Evaluation were made of the gust equivalent mean (GEM) wind speed and the gust speeds. The GEM wind speed is defined as the maximum of the mean wind speed or the gust wind speed divided by 1.85. The gust speed is evaluated as the mean speed + (3 x RMS speed).

The polar plots in Appendix B show the GEM wind speed at each of the sensors, expressed as a ratio of the mean wind speed at reference height. The angular coordinate gives the direction of the approach wind, relative to true North.

The radial magnitudes and the shapes of the polar plots in Appendix B provide valuable indications of the relative magnitudes of wind speeds at different locations and their sensitivity to the direction of the approach wind.

These plots can be useful to identify important wind directions that can influence conditions at a particular location. In turn, this information can be used to inform and develop mitigation strategies.

3.4 Statistical Prediction of Pedestrian-Level Winds

The directional characteristics of the extratropical wind climate are shown in Figure 4.

The predicted wind speeds are obtained by combining the statistical wind climate model of wind speed and direction with the aerodynamic data measured in the wind tunnel. Two types of prediction are provided:

1. Wind speeds exceeded during 0.1% of the time on an annual basis.
2. Wind speeds exceeded 20% of the time on a seasonal basis.

These predictions are compared against the following specified criteria to evaluate pedestrian comfort and safety:

CRITERIA	DESCRIPTION	GEM WIND SPEED EXCEEDED 20% OF THE TIME
Comfort level 4	**Sitting**	**≤ 10 km/h**
Comfort level 3	**Standing**	**≤ 15 km/h**
Comfort level 2	**Walking**	**≤ 20 km/h**
Comfort level 1	**Uncomfortable**	**> 20 km/h**

CRITERIA	DESCRIPTION	GUST WIND SPEED EXCEEDED 0.1% OF THE TIME
Safety level	**Exceeded**	**> 90 km/h**

The comfort categories are described as follows:

- **Comfort Level 4 - Sitting:** Calm or light breezes desired at outdoor restaurants and seating areas where one can read a paper without having it blown away
- **Comfort Level 3 - Standing:** Gentle breezes suitable for main building entrances and bus stops
- **Comfort Level 2 - Walking:** Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
- **Comfort Level 1 - Uncomfortable:** Strong winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended

The safety category is described as follows:

- **Areas which exceed the Safety Level**: Excessive gust speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is typically required.

These criteria are consistent with pedestrian level wind study Terms of Reference for the City of Mississauga [Ref. 4].

3.5 Test Results and Discussion

The tested configurations include the Existing site and the Proposed development. These configurations are described in Section 2.2.

General broad-scale landscaping was not modelled during wind tunnel testing. Results can therefore be expected to reflect a somewhat conservative representation of expected wind conditions around the development in areas where trees and other landscaping elements will be present.

Figure 11 compares the predicted wind speeds at the various locations for the two tested configurations along with the criteria for pedestrian safety. Similar plots of predicted wind speeds compared to the criteria for pedestrian comfort can be found in Figures 12 and Figure 13 for summer and winter seasons, respectively.

Colour-coded diagrams are also used to summarize the suitability of each measurement location with respect to pedestrian safety and pedestrian comfort for each tested configuration. Figures 14 and 15 present these for safety considerations for the Existing and Proposed configurations respectively. For comfort considerations colour-coded diagrams for the summer season are presented in Figures 16 and 17 for Existing and Proposed configurations respectively. Similarly, Figures 18 and 19 present the comfort results for the winter season.

Results are discussed below for each of the tested configurations.

3.5.1 Existing Site Configuration

Results for the Existing configuration reflect current expected wind conditions at and around the 2225 Erin Mills Parkway properties.

With respect to pedestrian safety for the Existing Configuration (Figures 14a & 14b):

1. Locations 114 and 117 found at the southwest and northwest corner of the building located at 1980 Fowler Drive exceed the safety criteria.
2. All other tested locations meet the recommended criterion.

With respect to pedestrian comfort for the Existing Configuration (Figures 16a,b and 18a,b):

1. In summer (see Figure 16) all measurement areas are rated for standing or sitting.
2. In winter (see Figure 18), some sidewalk areas are rated for walking while most areas are rating for standing. Some sheltered areas rated for sitting.
3. In all cases, the measured wind speeds are expected to be suited for the intended usage for their respective areas with the exception of Location 117. This location is at the northwest corner of the building at 1980 Fowler Drive and is rated as uncomfortable in the winter.

Given the suburban surroundings, it is not surprising that the measured wind speeds for the Existing site are generally consistent with a typical suburban environment.

3.5.2 Proposed Development Configuration

Tests of the Proposed development were carried out with the removal of the existing restaurant from the southwest area of the parking lot, and each of the 15-storey Buildings A and G installed in their respective locations, along with the associated podium structures. All other details of the surroundings are unchanged from the Existing configuration.

With respect to pedestrian safety (Figures 15a & 15b):

1. As with the Existing configuration, Location 114 fails to meet the safety criterion. It is worth noting that the wind speeds at this Location have marginally decreased compared to the Existing configuration. Furthermore, Location 117 rated unsafe in the Existing configuration meets the safety criterion in the Proposed configuration.
2. All other tested locations meet the recommendations for pedestrian safety.

With respect to pedestrian comfort (Figures 17a,b and 19a,b):

1. The proposed developments have a moderate influence to wind speeds on and around their sites. As can be expected, the influence is generally most noticeable adjacent to the site and diminishes as the distance from the site increases. Nonetheless, most influenced areas generally remain suited for their intended usage.
2. At locations farther away from the project site small changes in wind speed do not notably affect the comfort classification, particularly in summer season. In the winter season, there are some locations northwest and northeast of the Building G site where the comfort category shifts from standing in the Existing condition, and a small wind speed increase has caused a change in comfort to a walking category in the Proposed configuration. Nonetheless, the locations all remain suited for the intended sidewalk usage.
3. For locations near or directly adjacent to the site, some variations in the predicted wind speeds are observed:
   - In summer (see Figure 17), all ground level locations are rated for standing or better. Wind conditions during the summer season are therefore expected to be suited for the intended usage.
   - During winter season (see Figure 19) wind speeds are typically higher than in summer. At locations near to and throughout the development site, many sidewalk

locations on both sides of Erin Mills Parkway and Fowler Drive increase to walking (from standing) yet remain suitable for sidewalk usage. Locations 100, 102 and 103 east of Building G and on the east side of Fowler Drive increase to uncomfortable in the winter and are expected to require some mitigation.

- Location 2 on the west side of Building A is located at an entrance and is suitable for walking in winter, and will require mitigation to achieve a standing category required for entry areas.
- Location 1 at the northwest corner of Building A is marginally uncomfortable; this area will require mitigation.
- During winter season wind speeds are typically higher than in summer. At locations near to and throughout the Building G development site, many sidewalk locations on both sides of Fowler Drive increase to walking (from standing) yet remain suitable for sidewalk usage. Locations 100, 102 and 103 east of Building G and on the east side of Fowler Drive increase to uncomfortable in the winter. This stretch of sidewalk in general is expected to require some mitigation.
- Location 71 on the west side of Building G is rated for walking during the winter and will require mitigation to achieve the rating of standing or better recommended for entrances.

4. With respect to the rooftop amenity spaces:
   - In the summer months the southern end of the rooftop amenity locations are suited for standing activities while the north ends are suited for walking. Mitigation is expected for these areas if a rating of standing and/or sitting is required throughout the summer season.
   - In the winter months, the Building A Roof Level amenity space is suitable for walking on the southern portion while the northern portion is uncomfortable. The Building G rooftop amenity space is suitable for walking. Mitigation will be required if extending use of these areas is required into the winter season. Alternately, select areas could be closed off during winter.

3.6 Seasonal Differences

The amount and type of activity for a given location can vary by season. For example, a terrace or outdoor amenity area may have limited or restricted usage during the winter season. Thus, in some cases it is valuable to look at the wind speeds and the corresponding classification of pedestrian comfort on a more detailed season-by-season basis.

In general, compared to annual wind speeds, wind speeds during the winter months are about 8% higher, and in the summer they are about 16% lower.

3.7 Summary Remarks

The proposed development can be expected to affect wind patterns locally in regions throughout the development site. This is consistent with the introduction of a relatively tall development to a otherwise homogeneous site. Nonetheless, conditions are expected to remain suitable for their intended uses, subject to suggested mitigation features, and to be confirmed at the detailed design stage.

With this expectation to changes in the local wind speeds, the focus should not be to return wind conditions to an 'as-it-was' state, but rather identify and develop strategies to make wind conditions suitable for the intended usage. For example, entry areas should have a comfort category consistent with standing activities, while sidewalks should meet the condition of being comfortable for walking.

In areas that are windier than that desired for the intended usage, incorporating mitigation strategies will be beneficial.

Recessing the entrance doors on the northwestern side of Building A and the western side of Building G, near probe locations 2 and 71, respectively, would be beneficial for these entry areas. Alternatively, densely spaced evergreens or locally placed windscreens will be required to improve the winds at these entryways.

Wind screens or closely spaced evergreens (min. 8’ tall) placed in the general area of the northwestern corner of Building A near Location 1 will improve wind conditions in that area.

For sidewalk areas in the vicinity of Locations 100, 102, and 103, mitigation in the form of canopies, evergreens, windscreens to the west of these areas will need to be explored to improve wind conditions. Concept mitigation would include evergreens or windscreens along the north and south sides of Building G. Generally, inclusion of landscaping details will be beneficial.

For the Roof Level outdoor amenity terraces, testing was conducted modelling a standard 42” solid railing around the terrace perimeter. Increasing the perimeter railing height (to 7’ or greater) would be beneficial. Localized windscreens or planters with coniferous plantings along the western and southwestern portion of the Building A amenity space and along the northern, southern and western portions of the Building G amenity space should be considered. Examples of effective pedestrian level wind mitigation options are shown in Figure 20. Depending on the level of comfort required, amenity features (e.g. vertical fireplaces, moderate height landscaping, windscreens, overhead trellises) may be required throughout the space.

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FIGURES

BUILDING A VIEW FROM THE SOUTHWEST

BUILDING G VIEW FROM THE SOUTHEAST

FIGURE 1 PERSPECTIVE VIEWS OF THE PROPOSED BUILDINGS

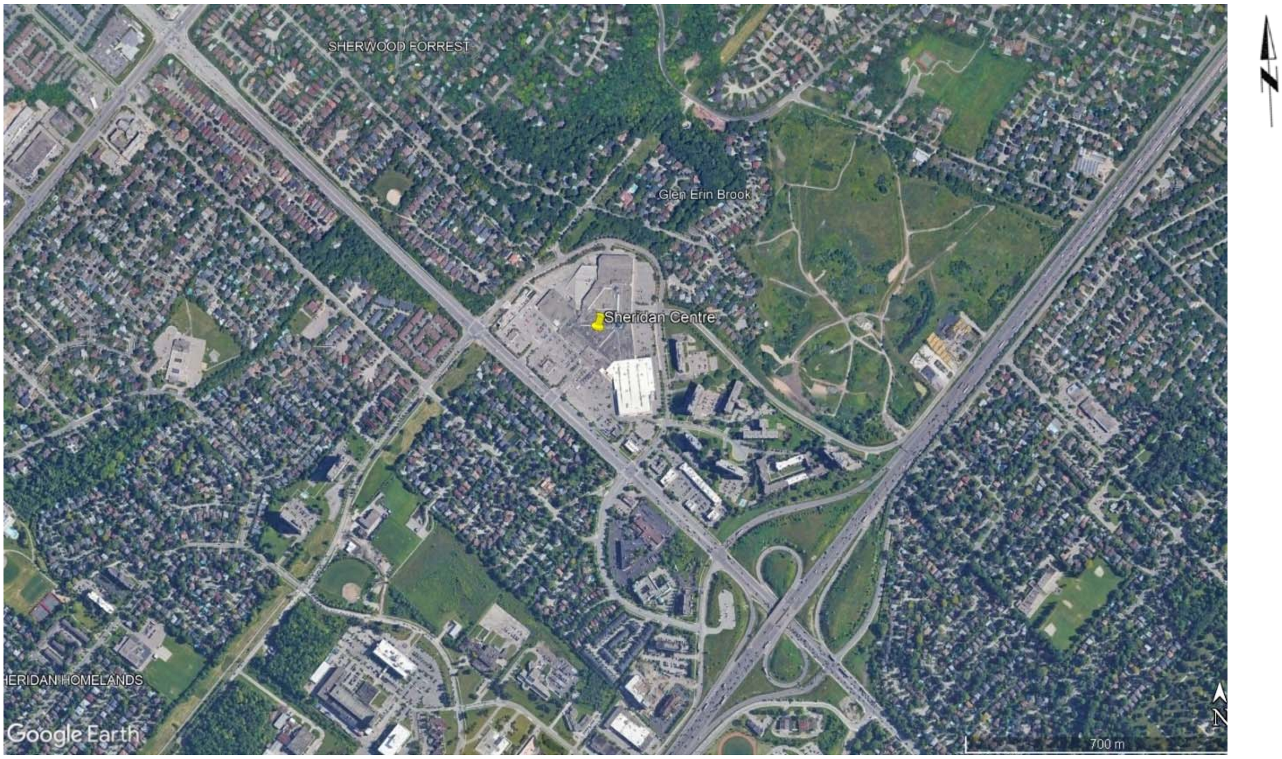


Photo Credit: Google

Photo Credit: Google

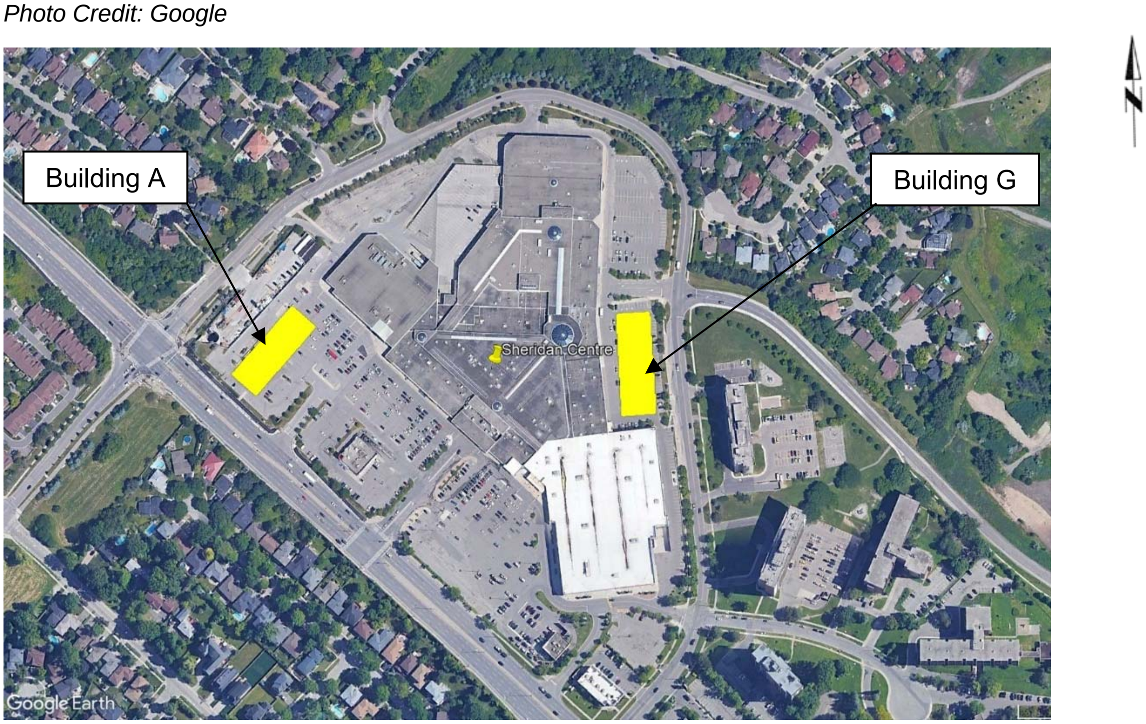


FIGURE 2 AERIAL VIEWS OF EXISTING SITE LOCATION

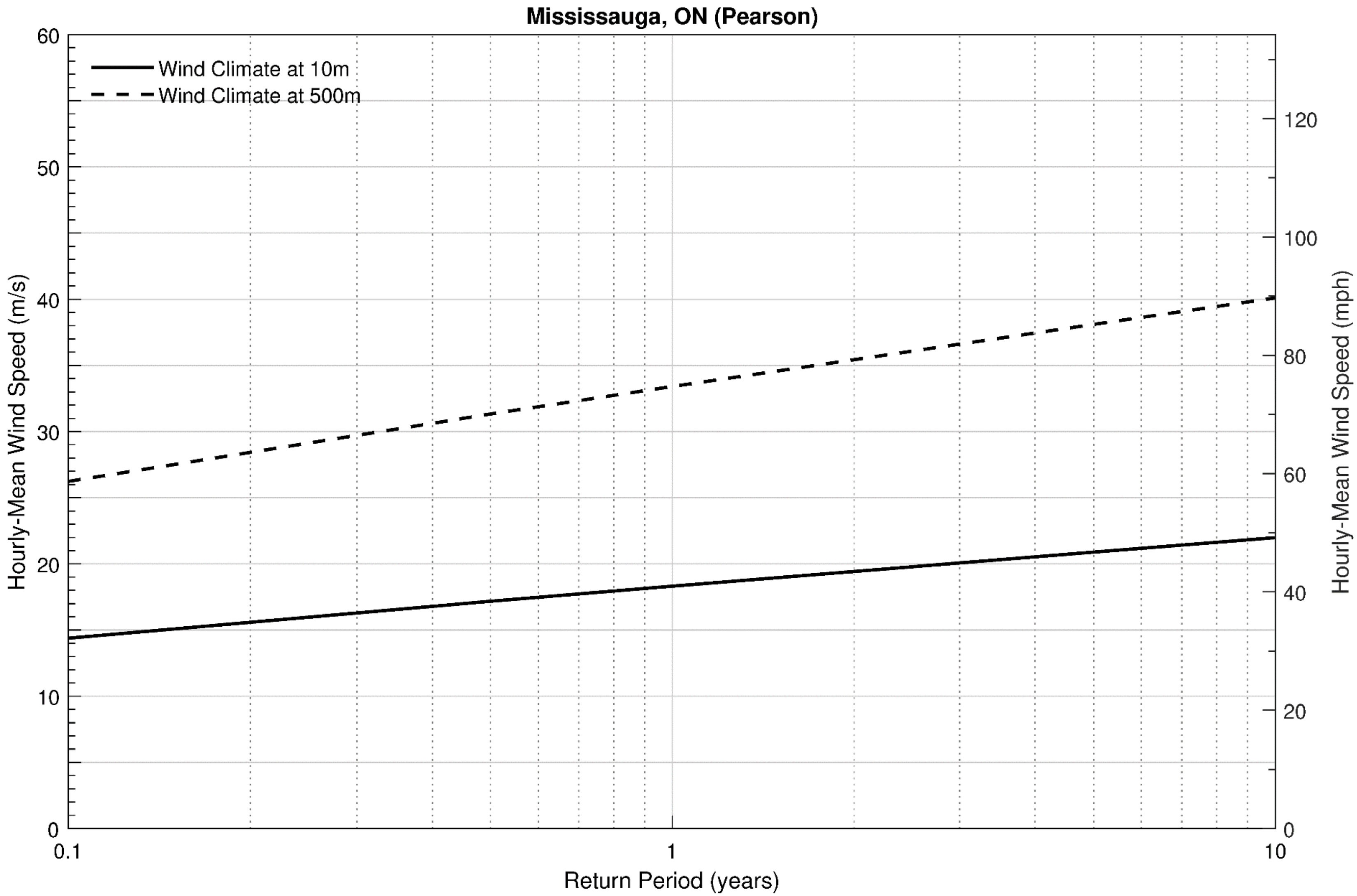


FIGURE 3 PREDICTED ANNUAL EXTREME WINDS SPEEDS FOR VARIOUS RETURN PERIODS

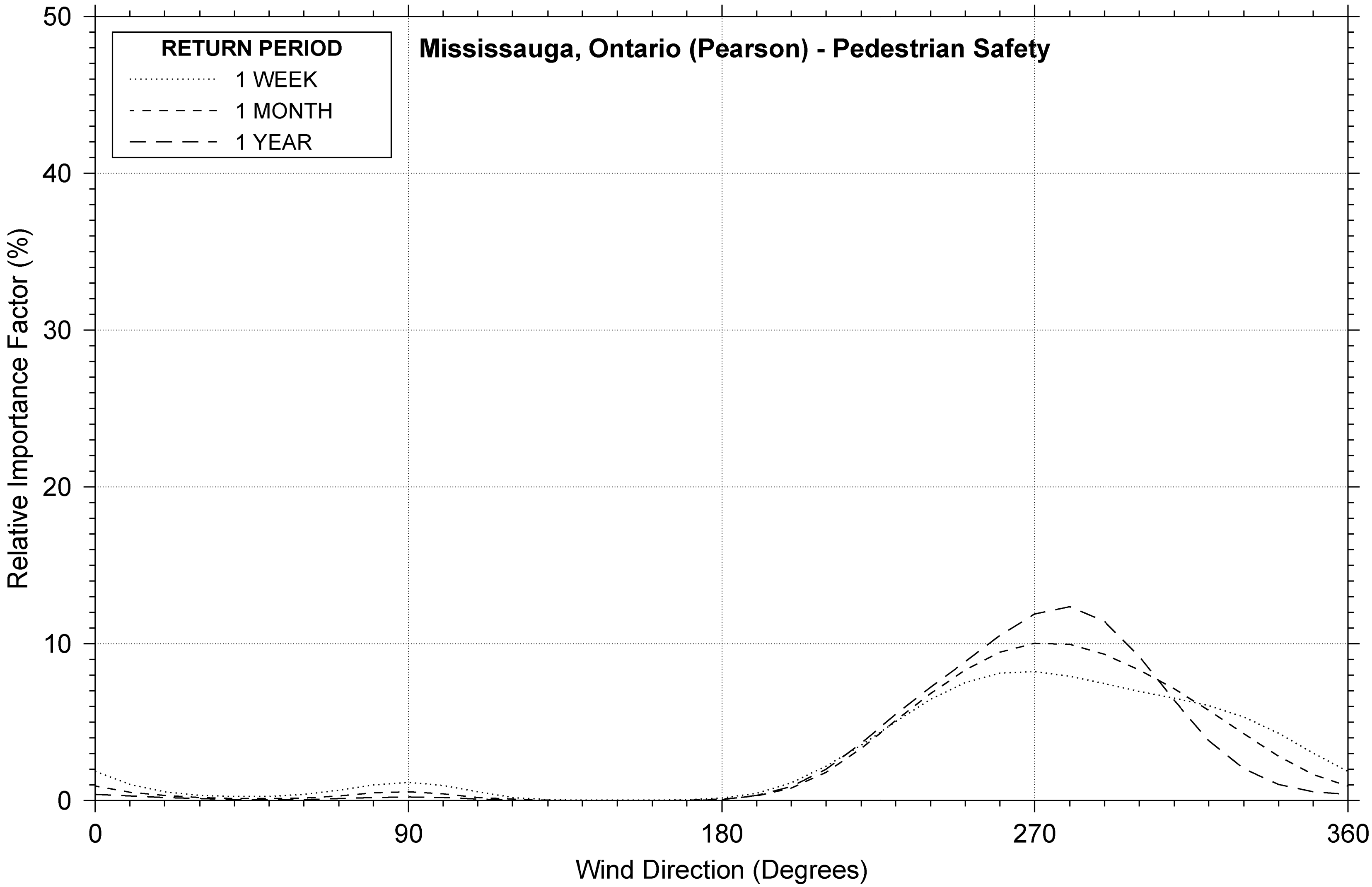


FIGURE 4a **RELATIVE IMPORTANCE OF AZIMUTHAL SECTOR TO THE PROBABILITY OF EXCEEDING VARIOUS RETURN-PERIOD WIND SPEEDS - ANNUAL**

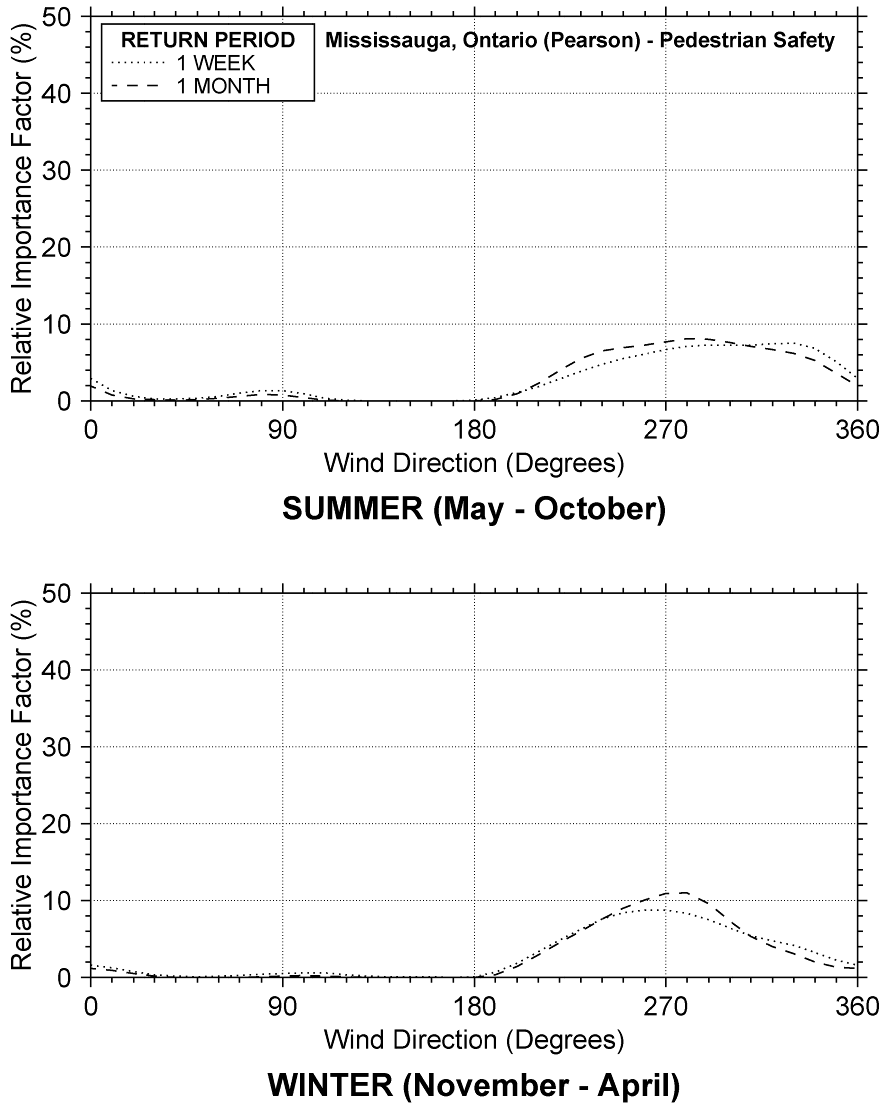
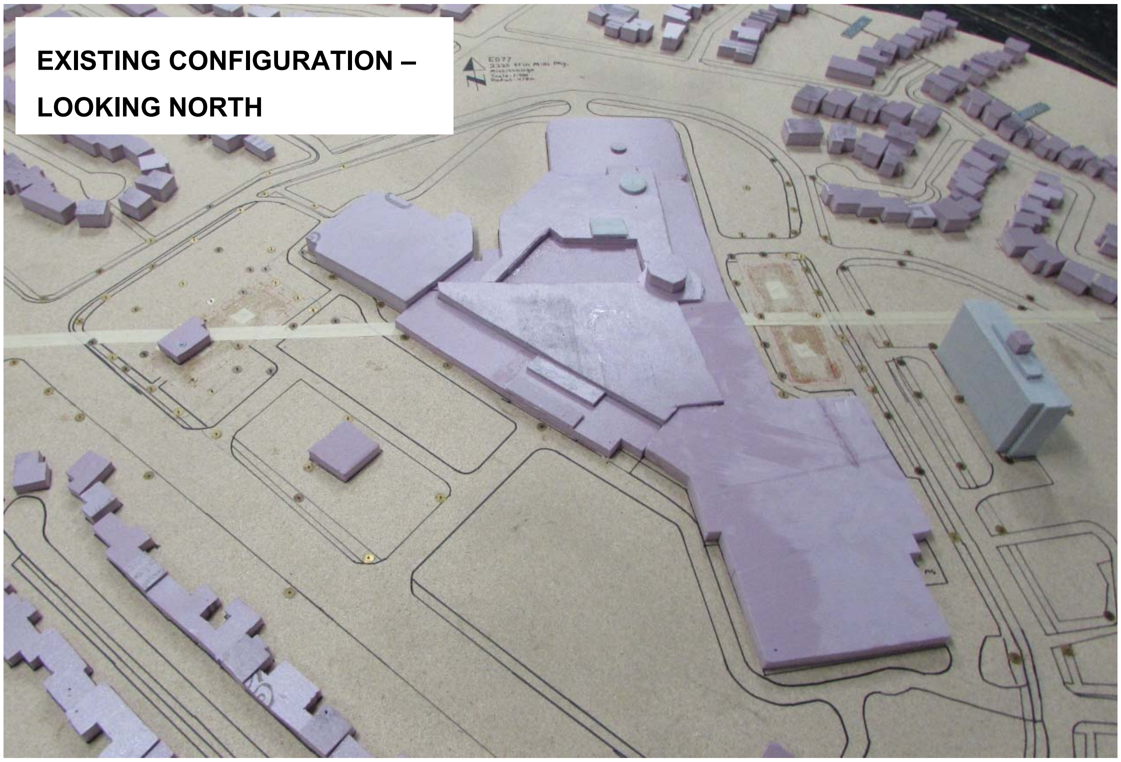


FIGURE 4b **RELATIVE IMPORTANCE OF AZIMUTHAL SECTOR TO THE PROBABILITY OF EXCEEDING VARIOUS RETURN-PERIOD WIND SPEEDS - SEASONAL**



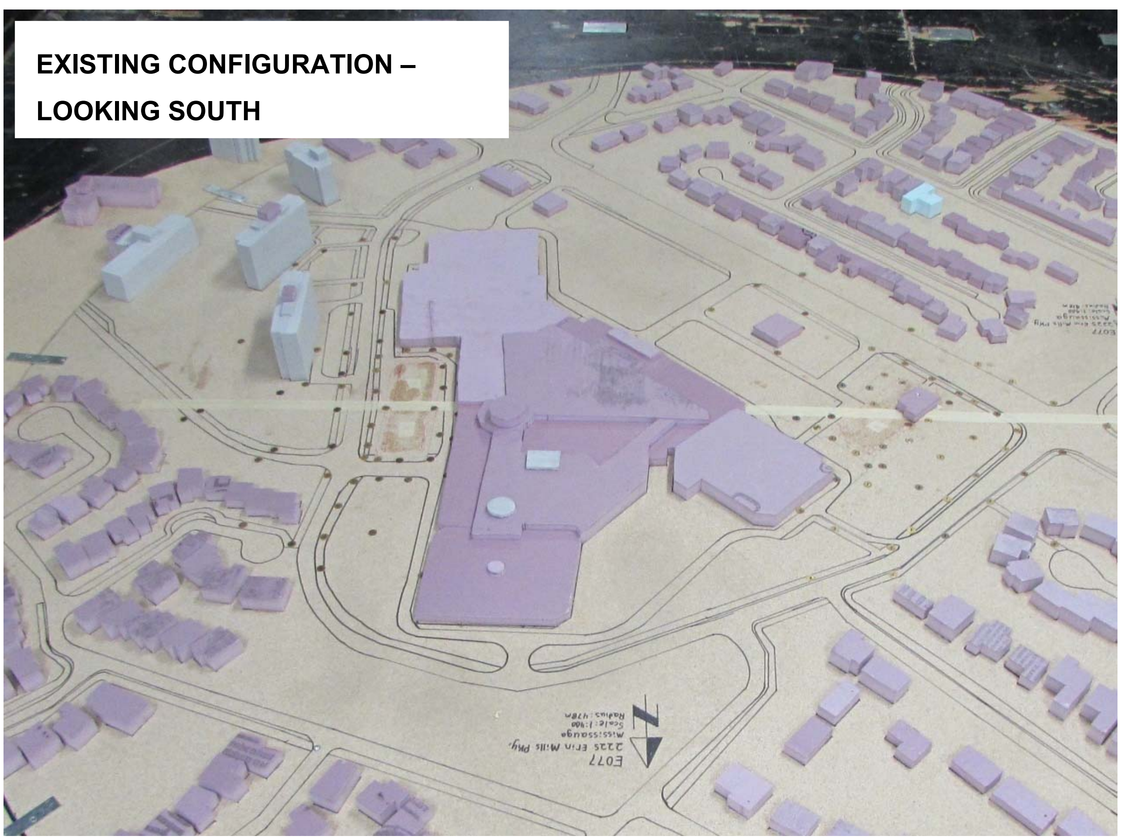
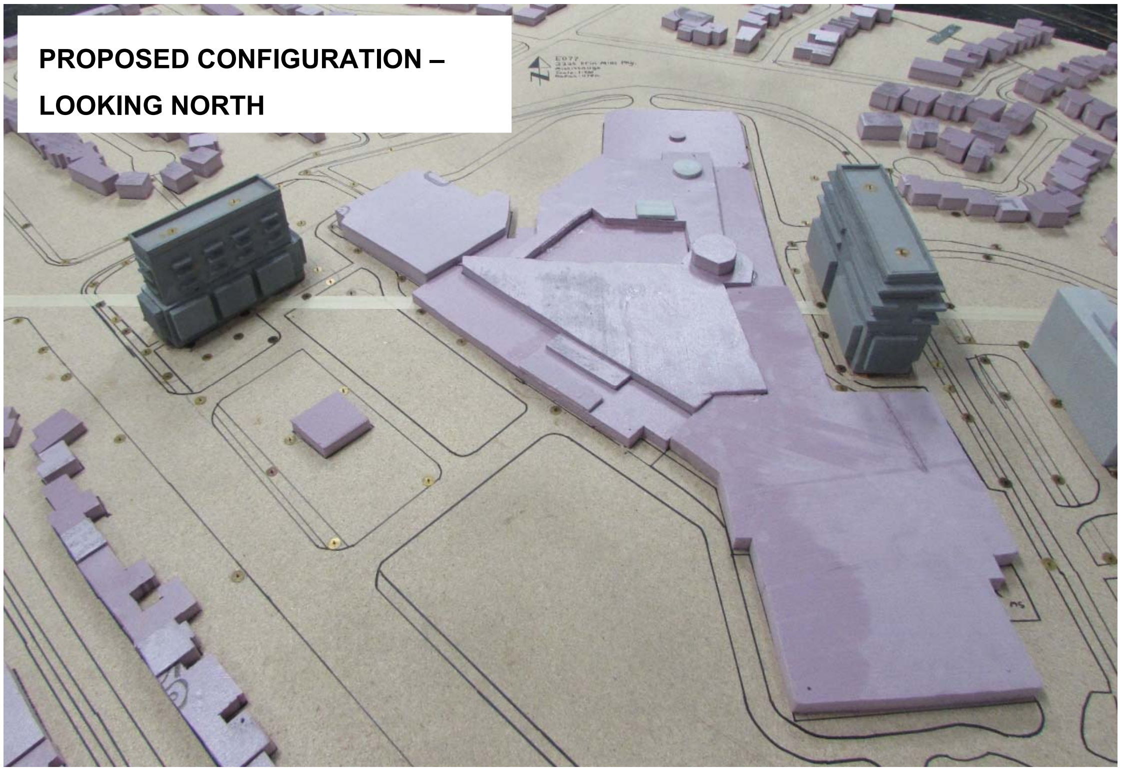


FIGURE 5a CLOSE UP VIEWS OF THE PEDESTRIAN LEVEL WIND SPEED MODEL FOR THE 'EXISTING' CONFIGURATION



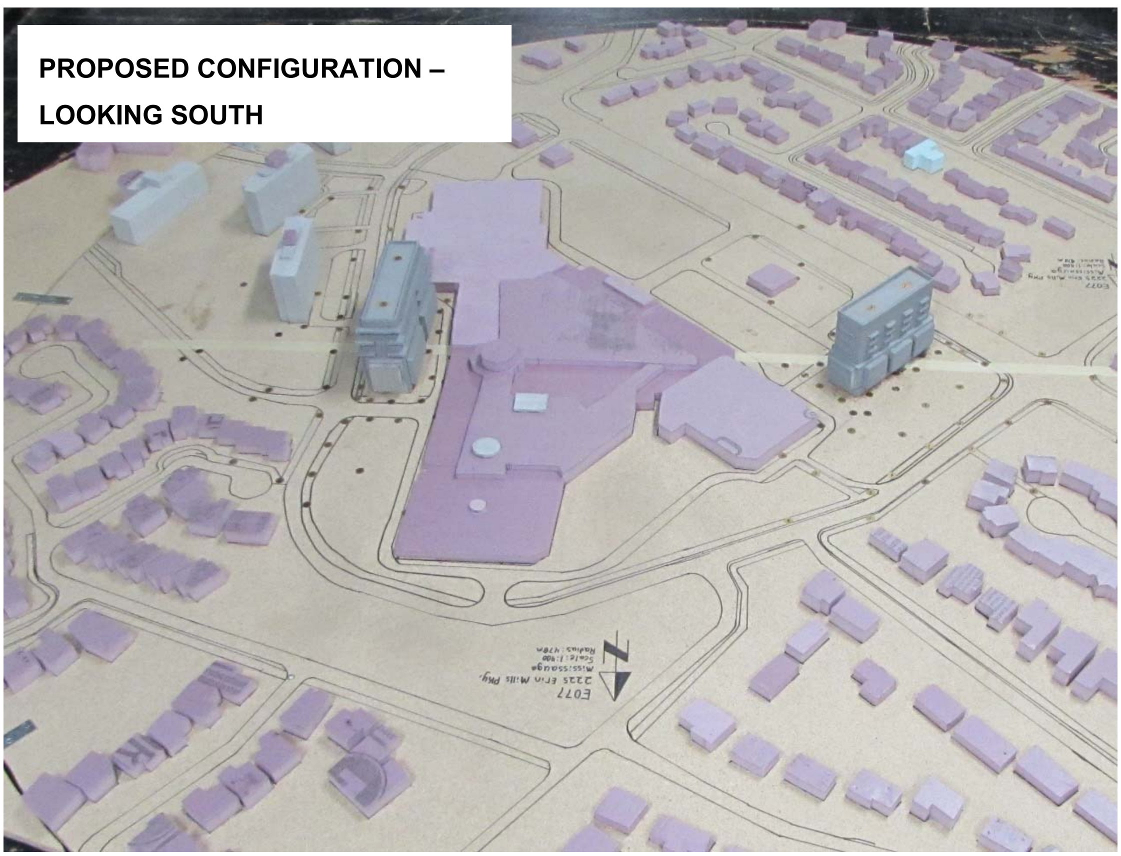
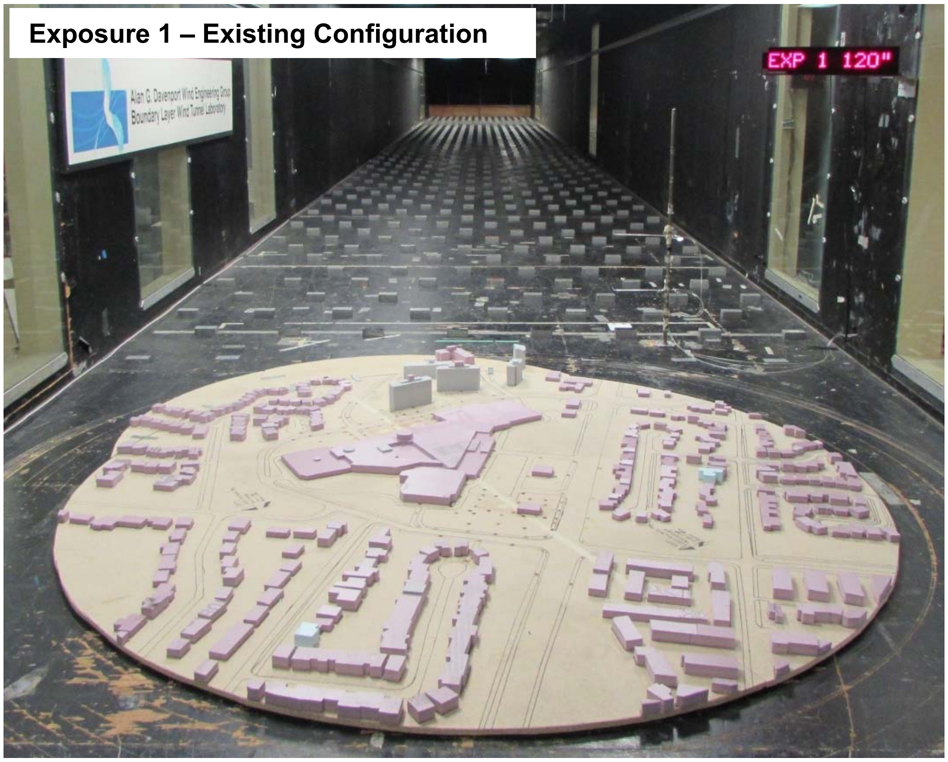


FIGURE 5b CLOSE UP VIEWS OF THE PEDESTRIAN LEVEL WIND SPEED MODEL FOR THE 'PROPOSED' CONFIGURATION



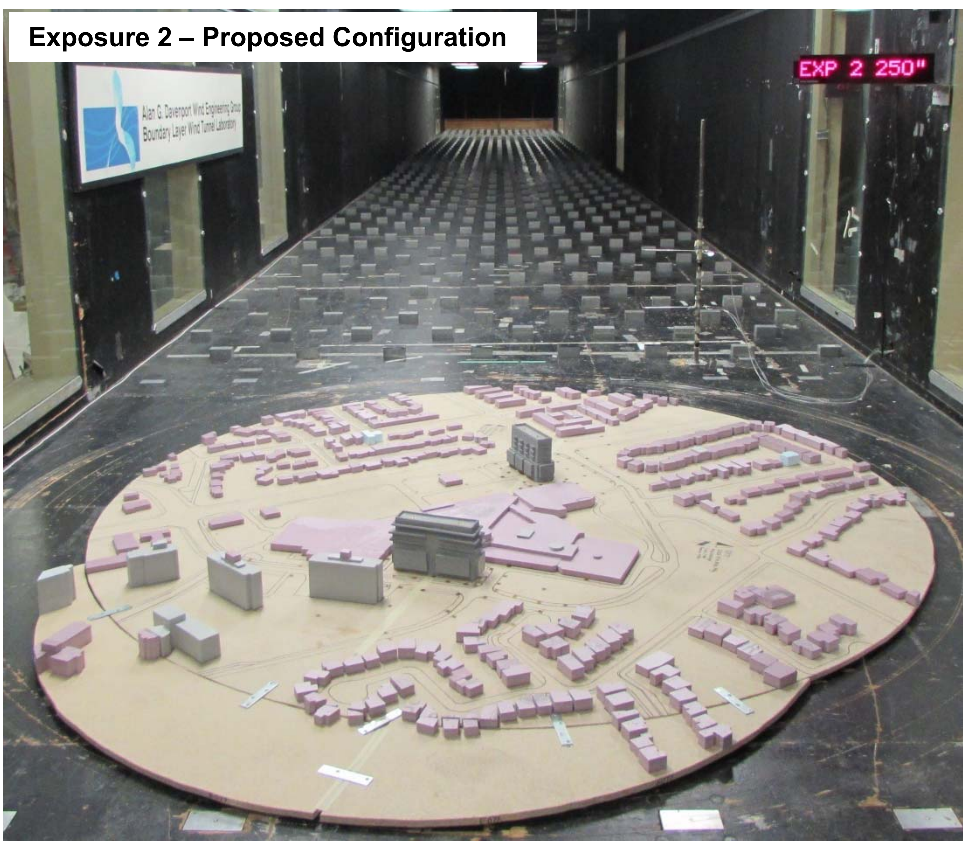


FIGURE 6 PHOTOGRAPH OF THE MODEL IN THE WIND TUNNEL SHOWING THE UPSTREAM TERRAIN MODEL (EXPOSURES) USED

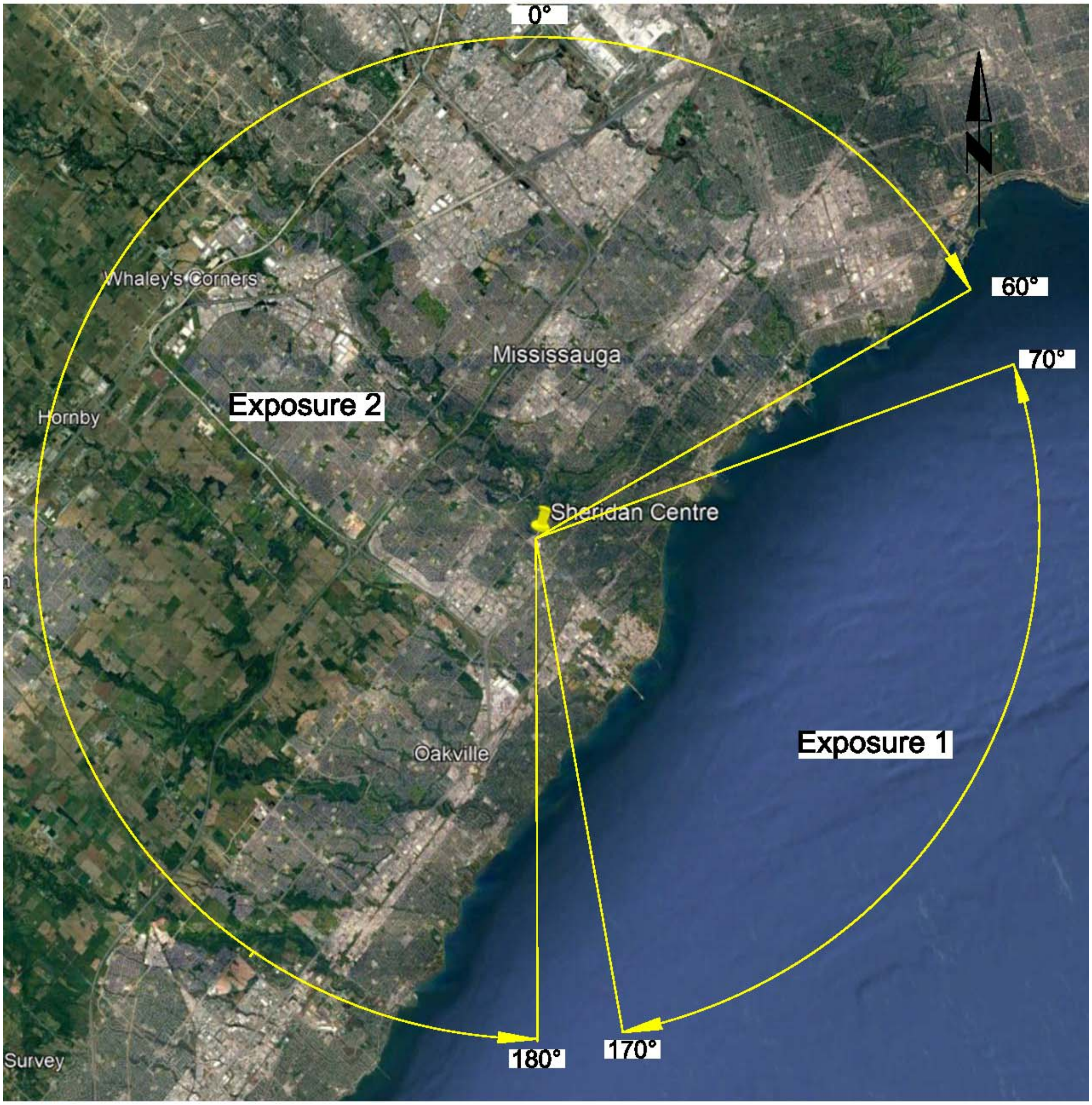


FIGURE 7 AZIMUTH RANGES OVER WHICH THE UPSTREAM TERRAIN MODELS WERE USED

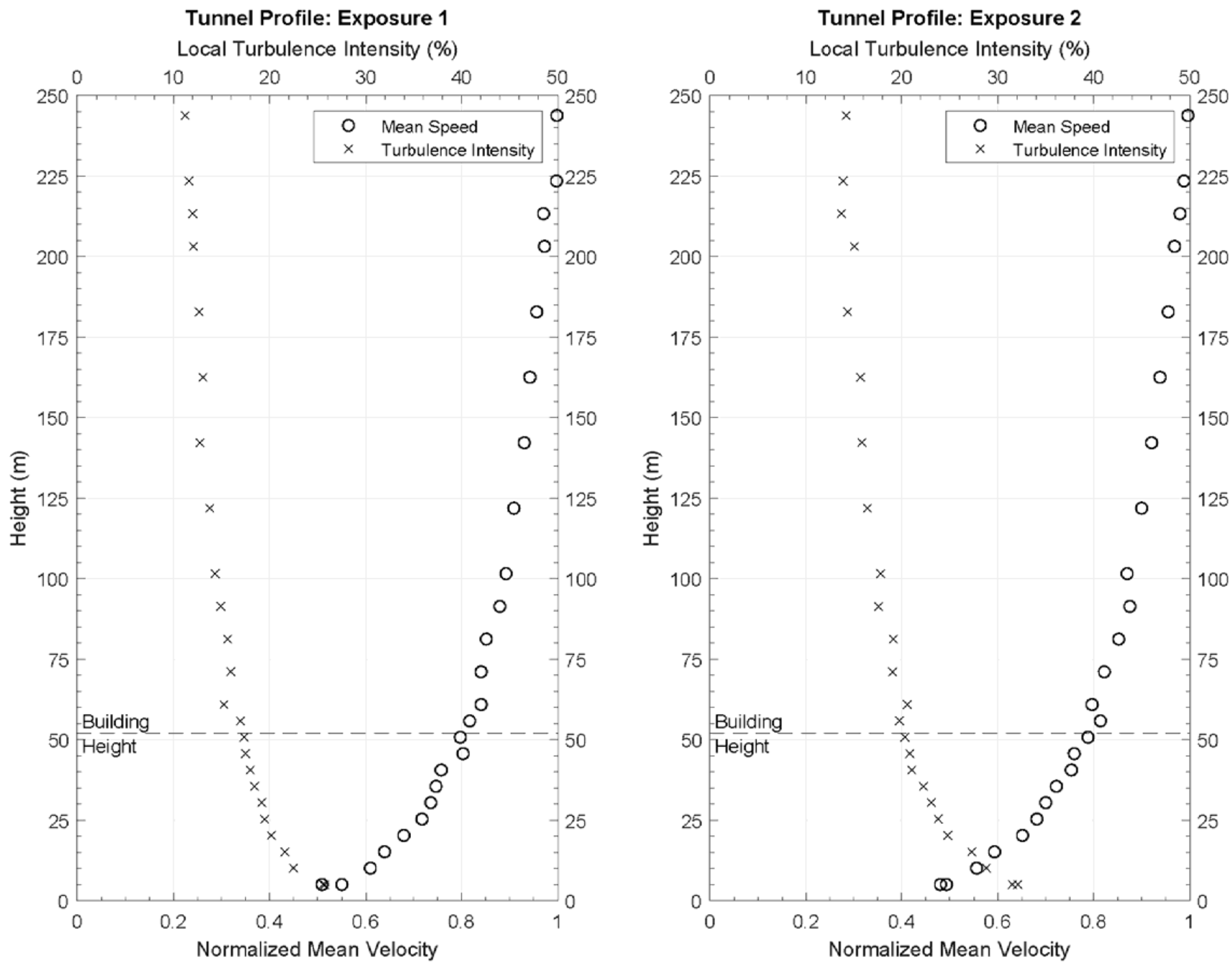


FIGURE 8 VERTICAL PROFILES OF MEAN WIND SPEED AND LONGITUDINAL TURBULENCE INTENSITY MEASURED JUST UPSTREAM OF THE PROXIMITY MODEL.

FIGURE 9a MEASUREMENT LOCATIONS FOR PEDESTRIAN-LEVEL WIND SPEEDS –EXISTING BUILDING A SITE

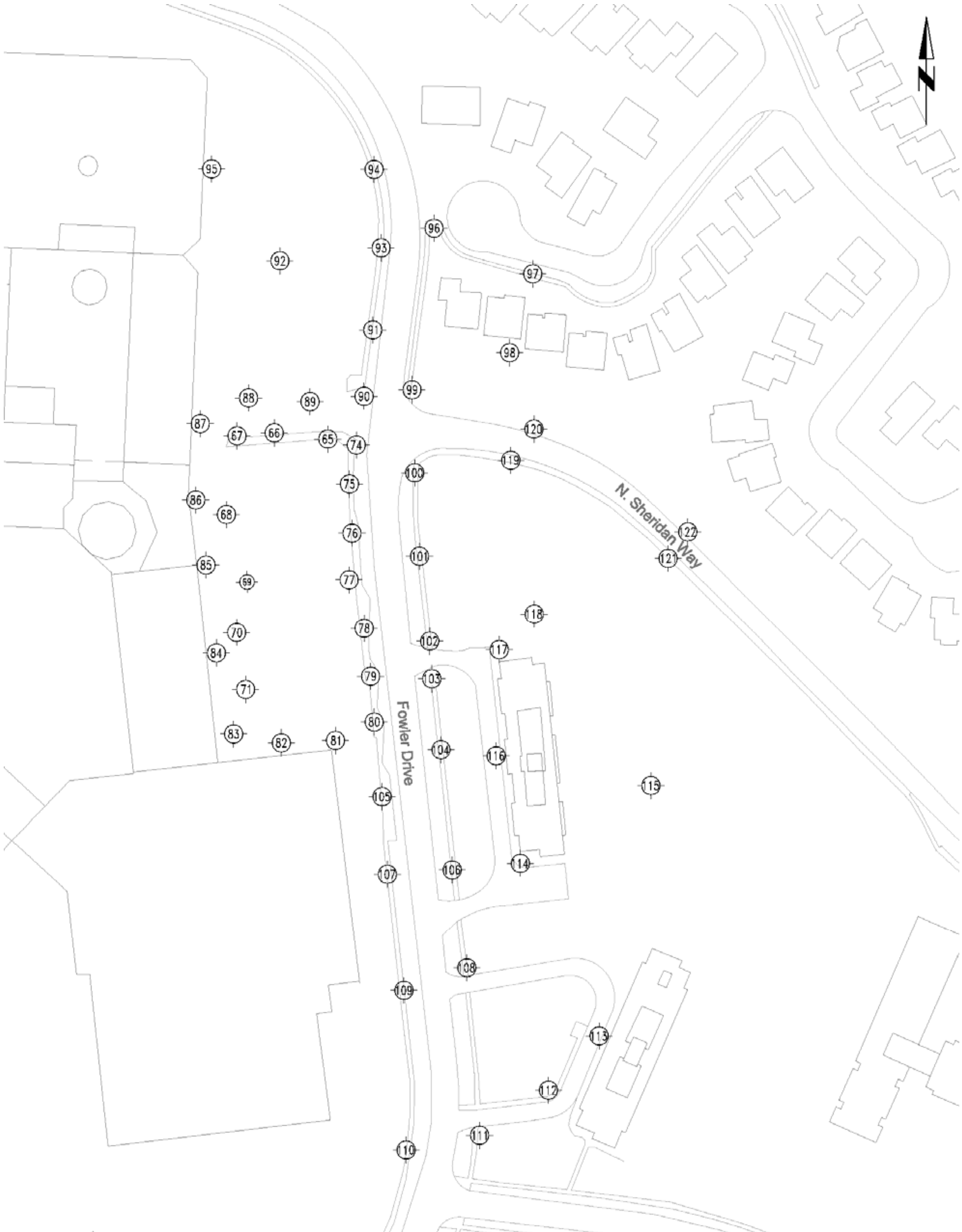


FIGURE 9b MEASUREMENT LOCATIONS FOR PEDESTRIAN-LEVEL WIND SPEEDS –EXISTING BUILDING G SITE

FIGURE 10a MEASUREMENT LOCATIONS FOR PEDESTRIAN-LEVEL WIND SPEEDS – PROPOSED BUILDING A DEVELOPMENT

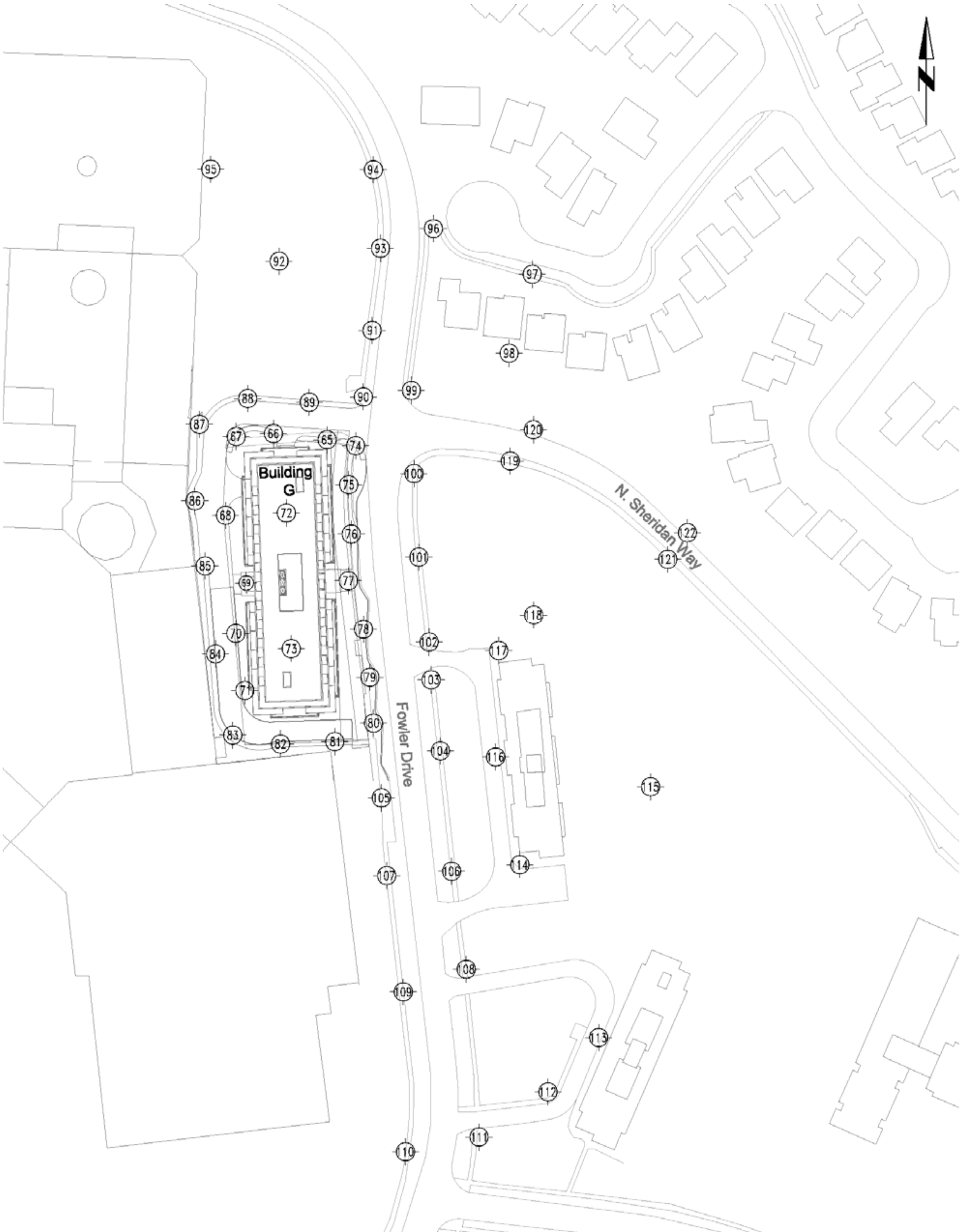


FIGURE 10b MEASUREMENT LOCATIONS FOR PEDESTRIAN-LEVEL WIND SPEEDS – PROPOSED BUILDING G DEVELOPMENT

FIGURE 11a PREDICTED WIND SPEEDS COMPARED WITH CRITERIA FOR PEDESTRIAN SAFETY

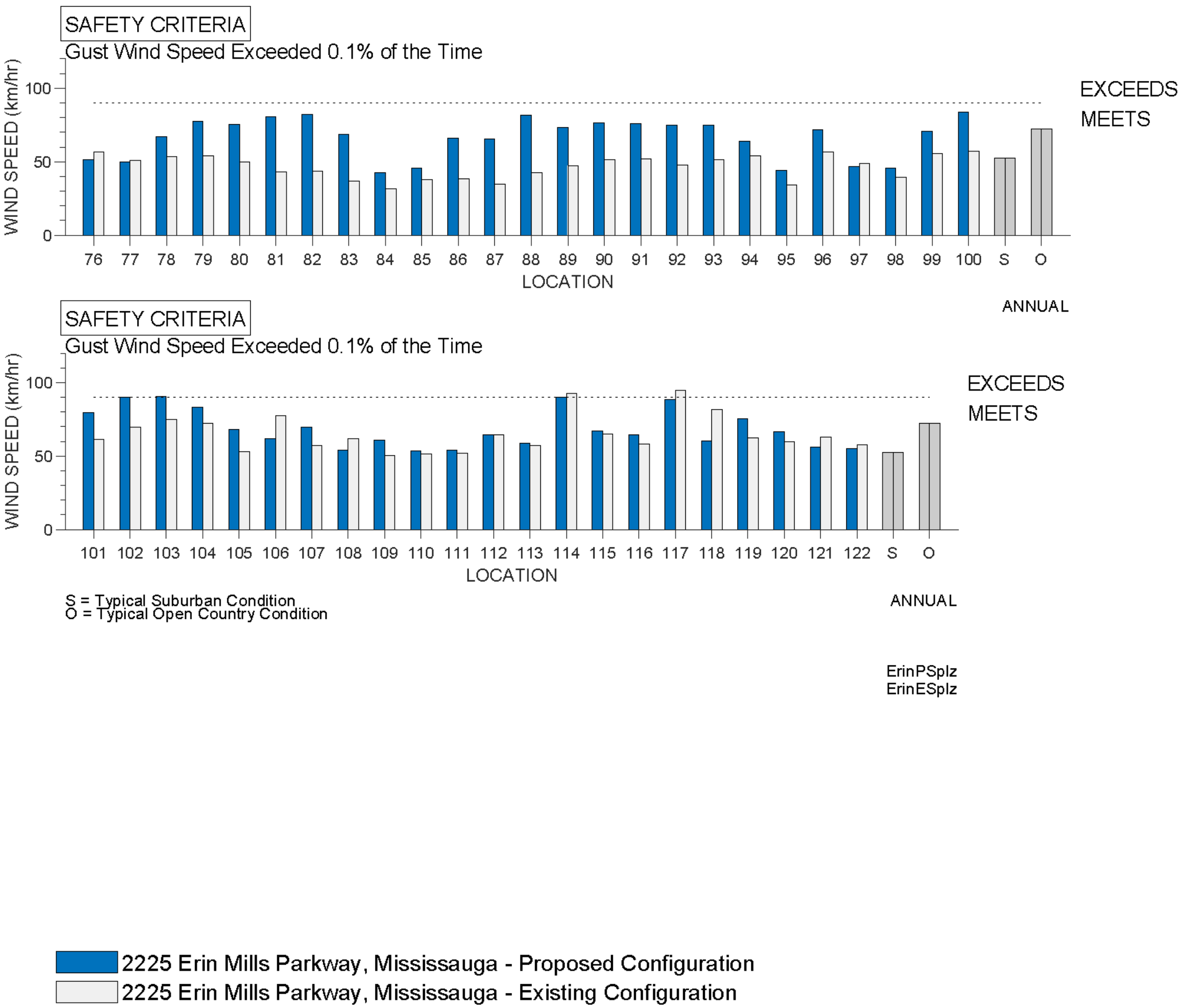


FIGURE 11b PREDICTED WIND SPEEDS COMPARED WITH CRITERIA FOR PEDESTRIAN SAFETY

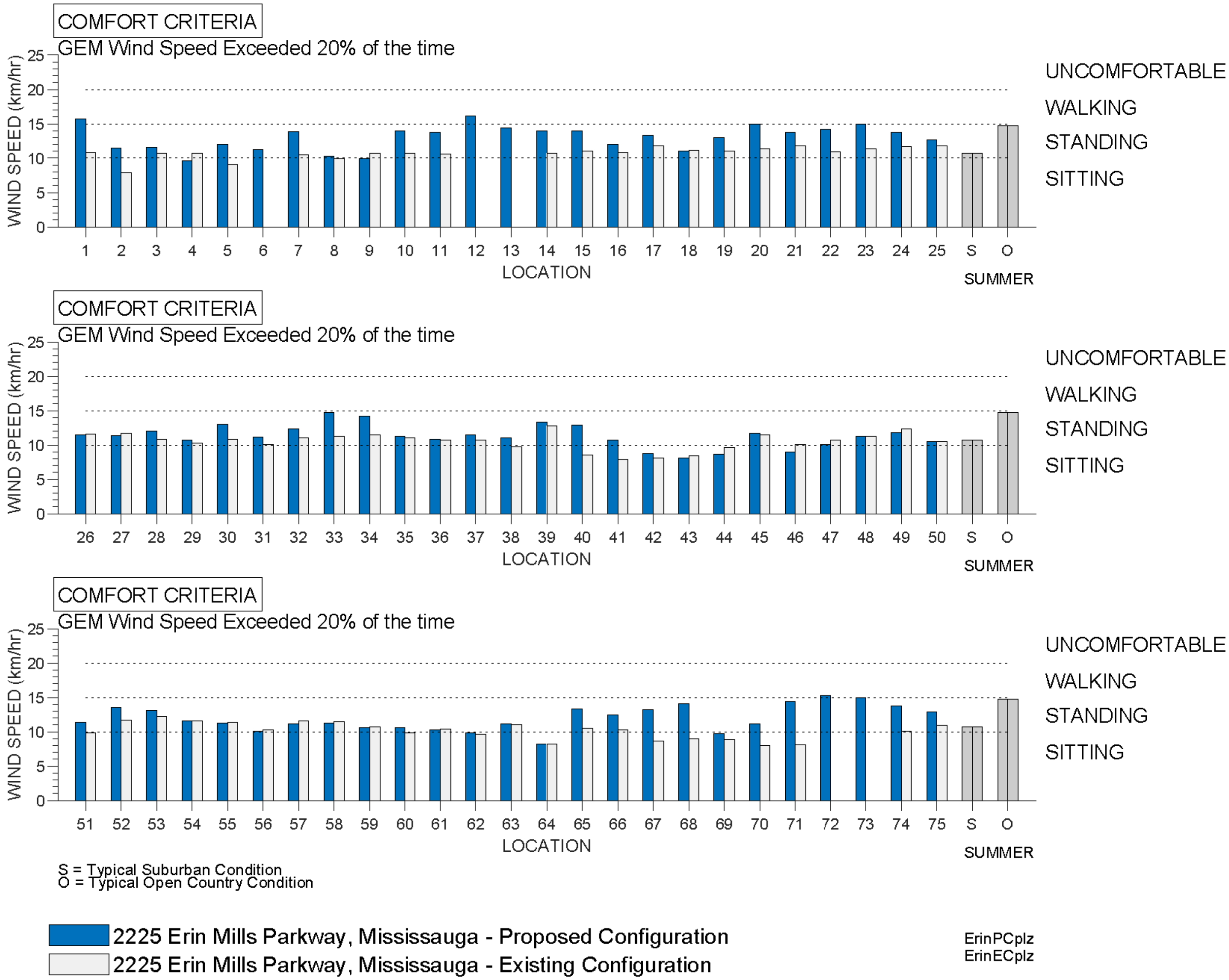


FIGURE 12a PREDICTED WIND SPEEDS COMPARED WITH CRITERIA FOR PEDESTRIAN COMFORT – SUMMER

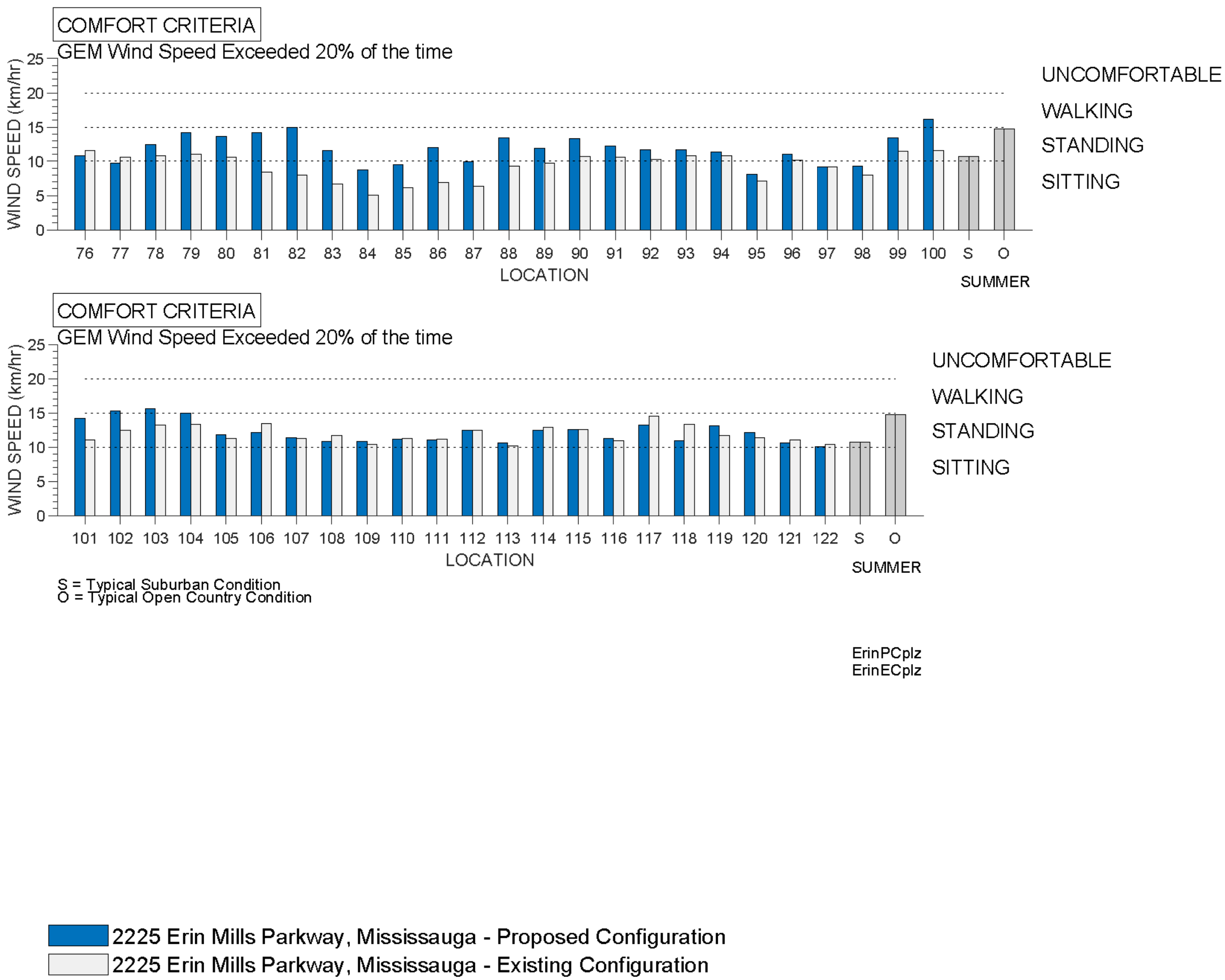


FIGURE 12b PREDICTED WIND SPEEDS COMPARED WITH CRITERIA FOR PEDESTRIAN COMFORT – SUMMER

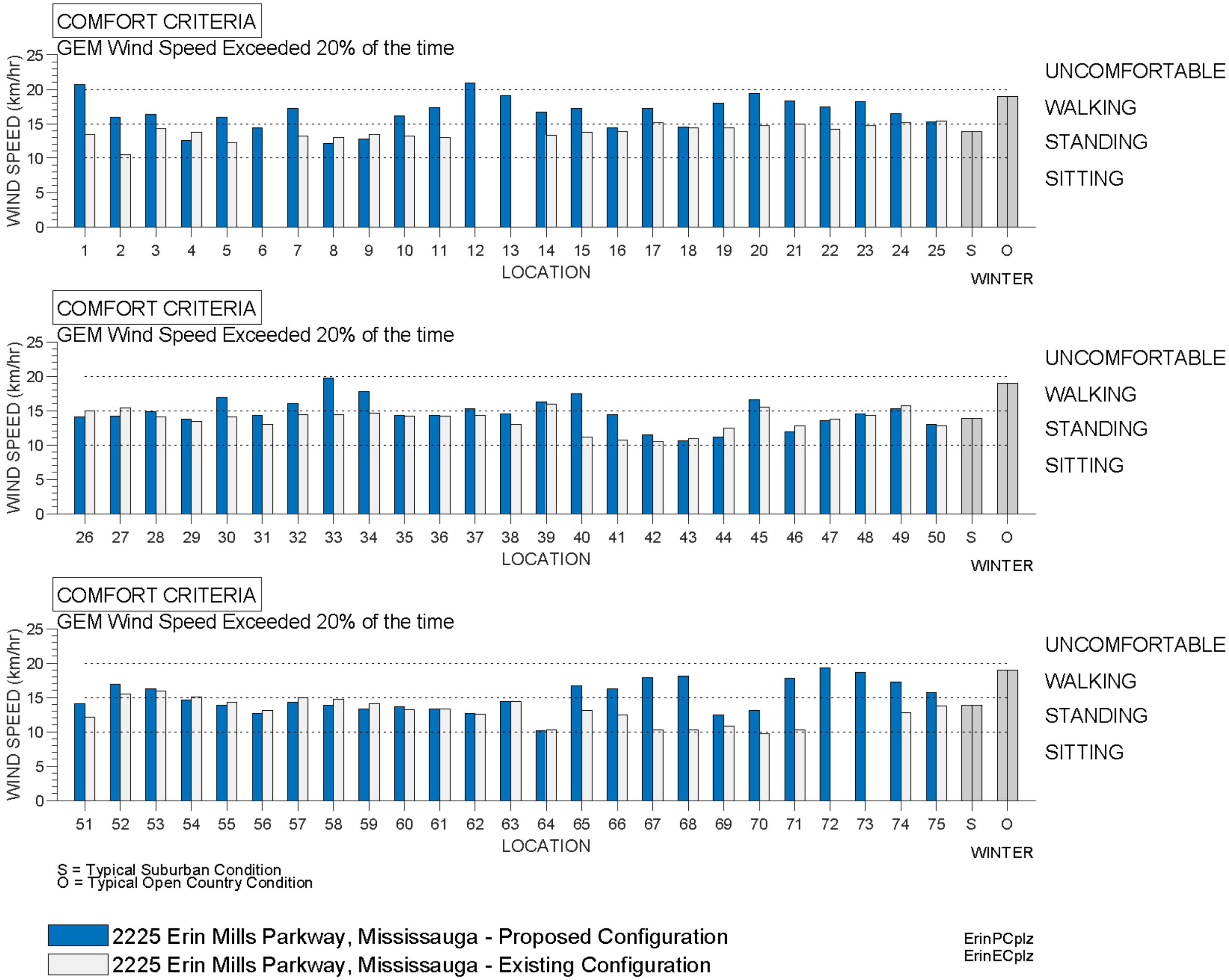


FIGURE 13a PREDICTED WIND SPEEDS COMPARED WITH CRITERIA FOR PEDESTRIAN COMFORT – WINTER

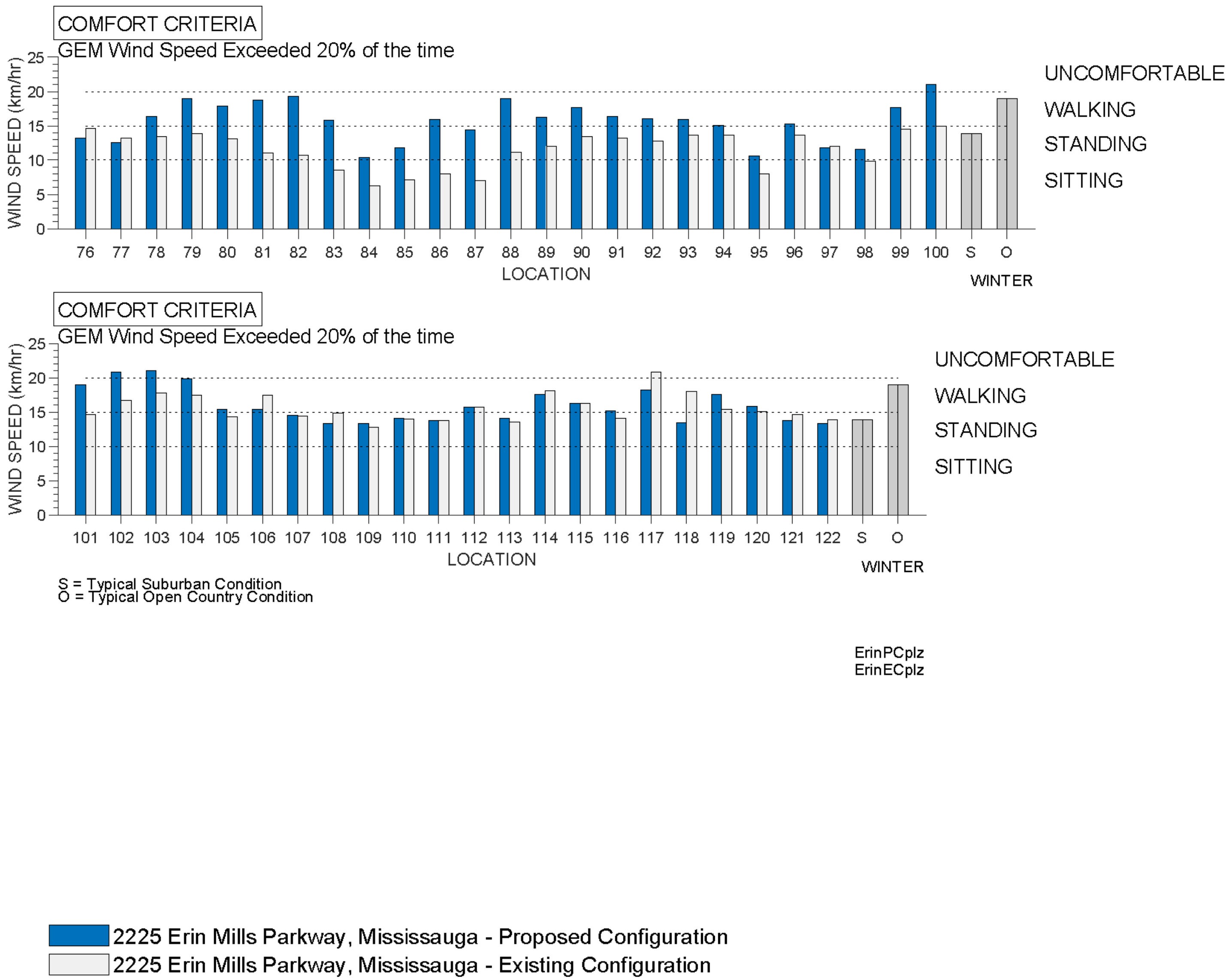


FIGURE 13b PREDICTED WIND SPEEDS COMPARED WITH CRITERIA FOR PEDESTRIAN COMFORT – WINTER

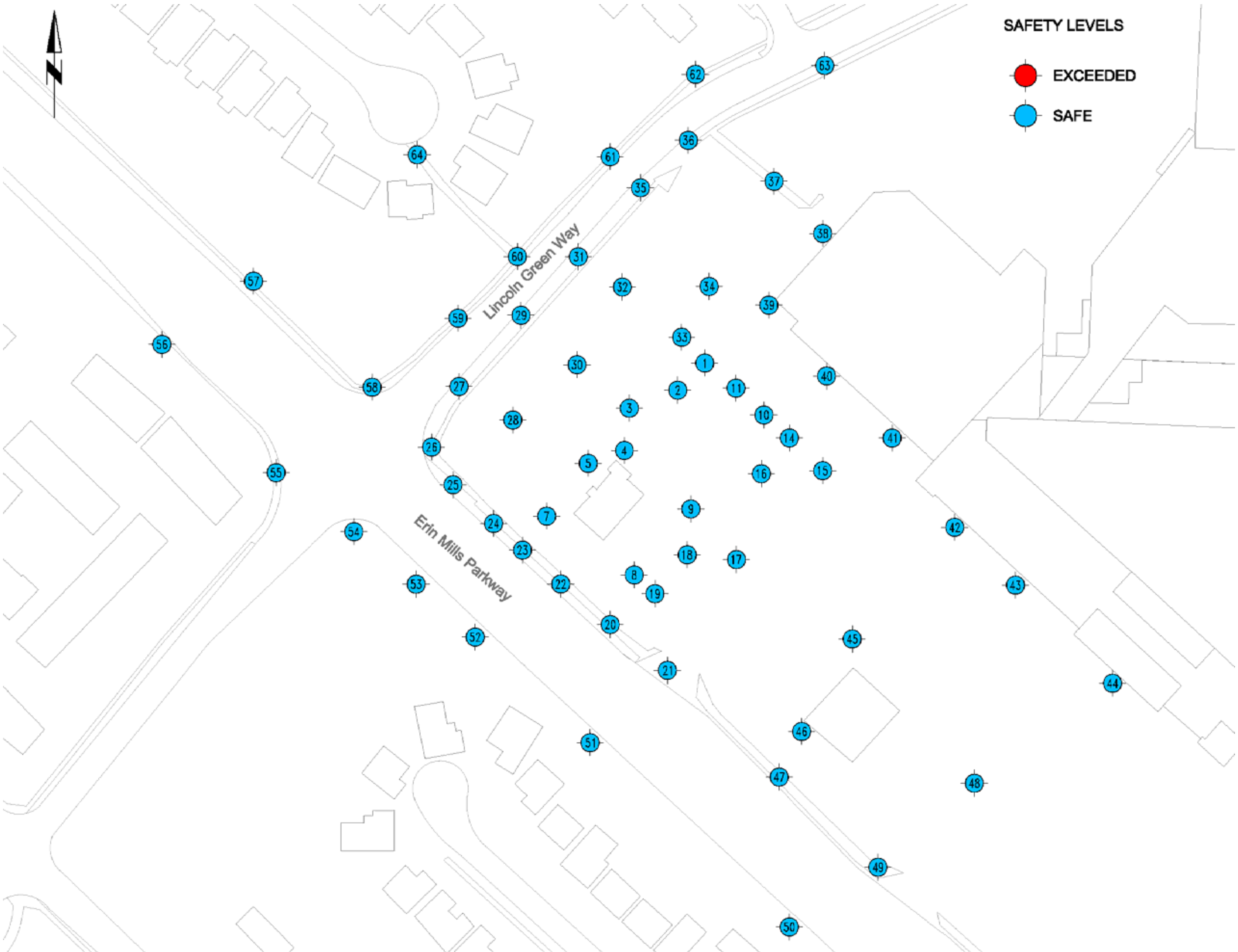


FIGURE 14a SUMMARY OF PREDICTED SAFETY LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS –EXISTING BUILDING A SITE

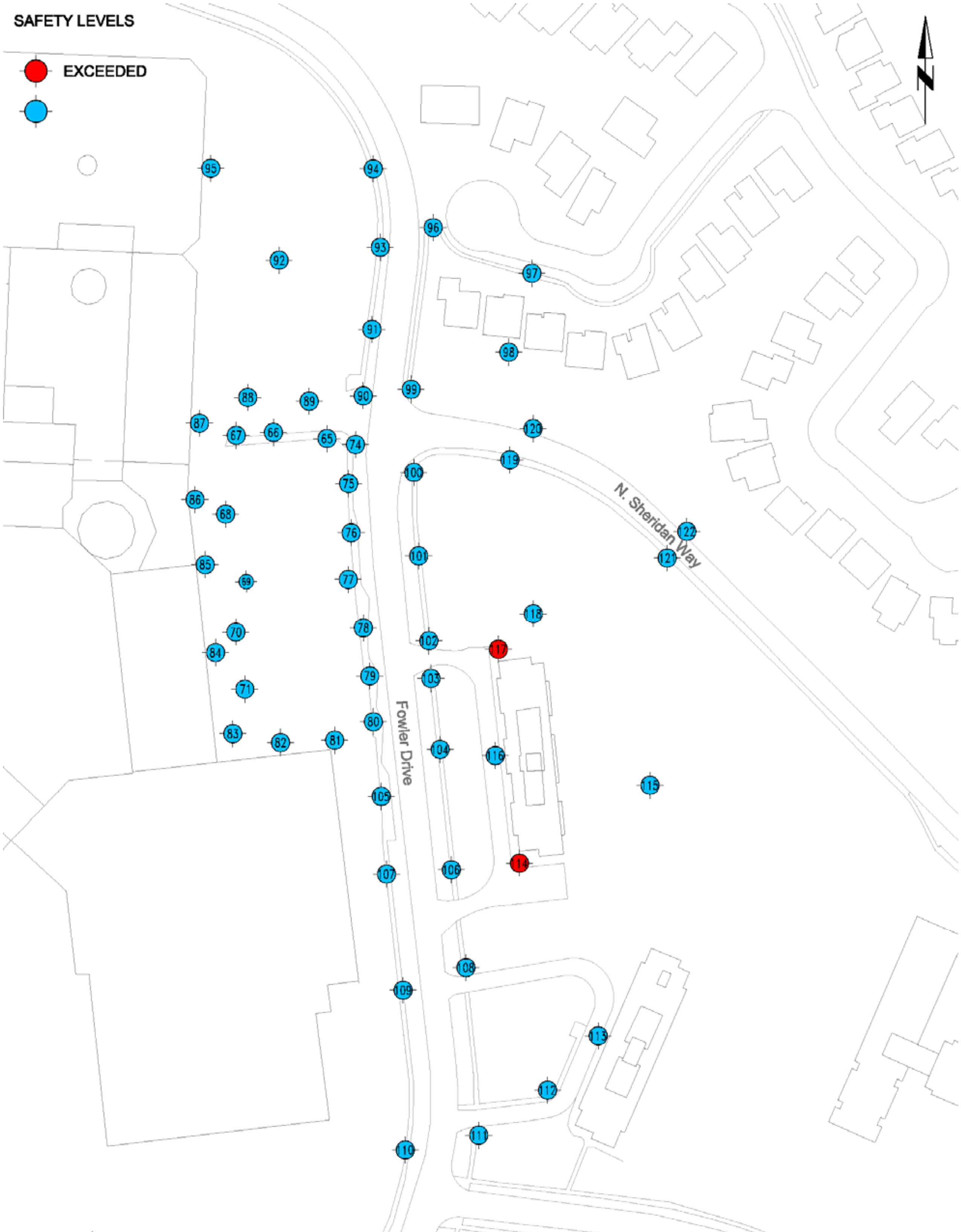


FIGURE 14b SUMMARY OF PREDICTED SAFETY LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS –EXISTING BUILDING G SITE

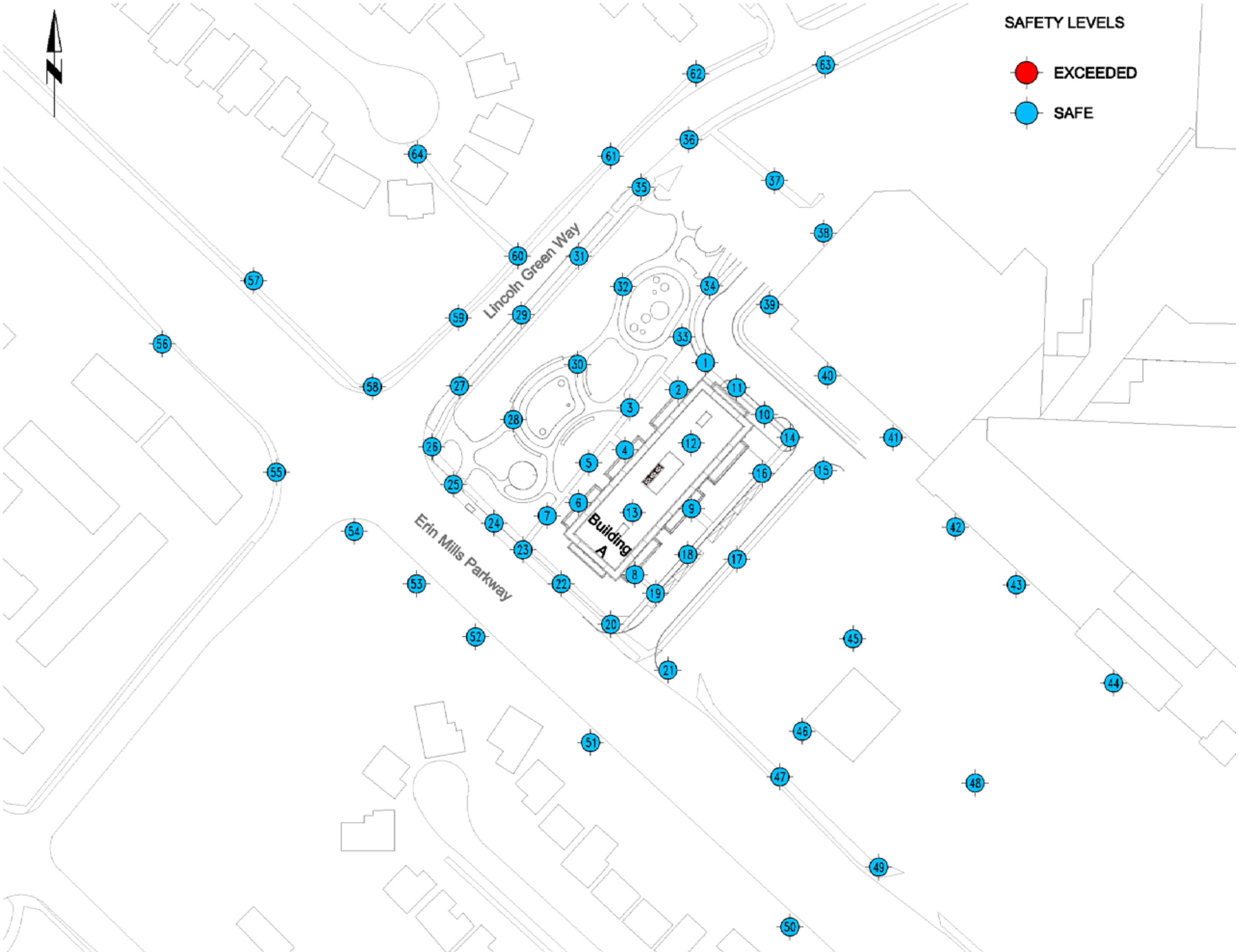


FIGURE 15a SUMMARY OF PREDICTED SAFETY LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS – PROPOSED BUILDING A DEVELOPMENT

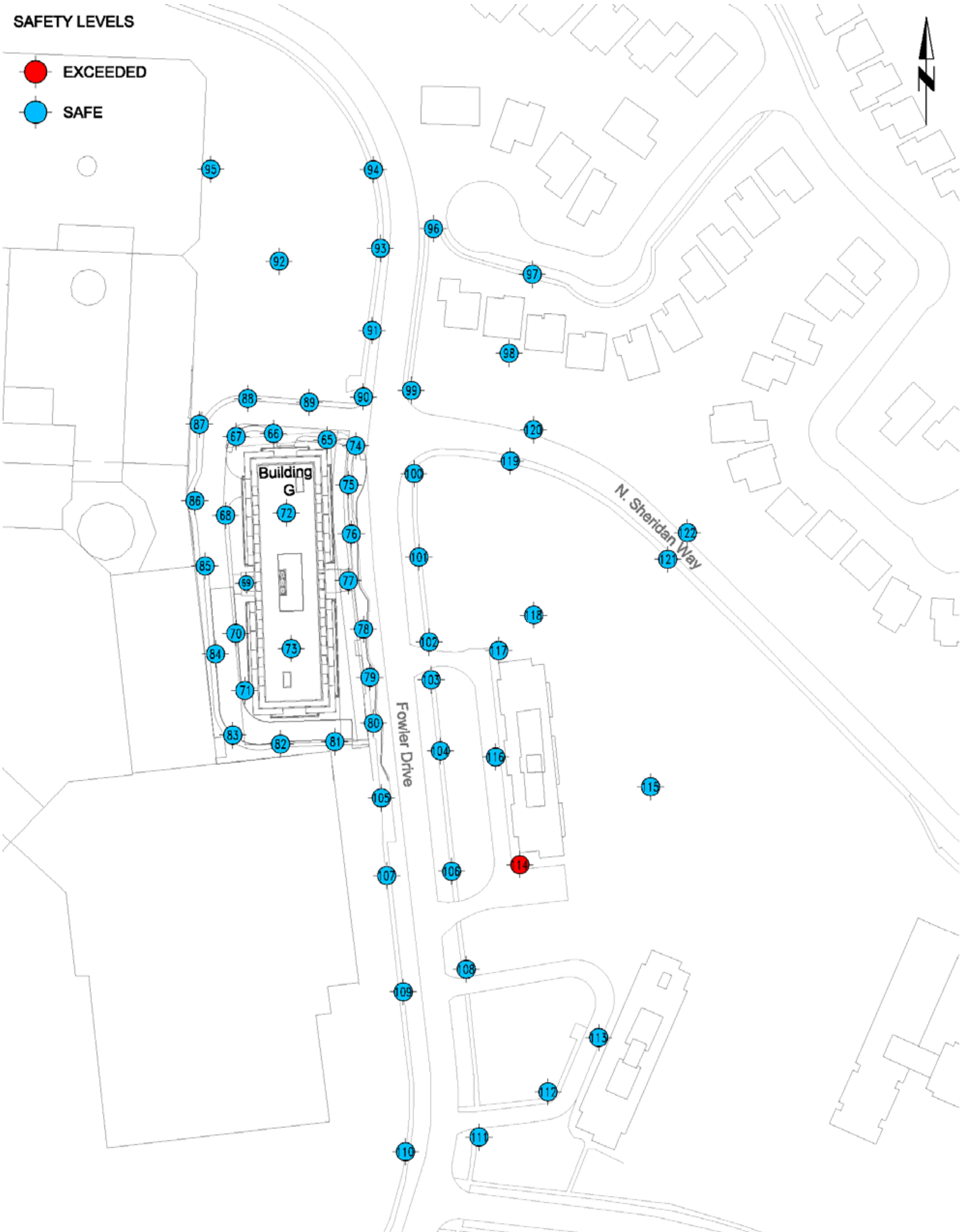


FIGURE 15b SUMMARY OF PREDICTED SAFETY LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS – PROPOSED BUILDING G DEVELOPMENT

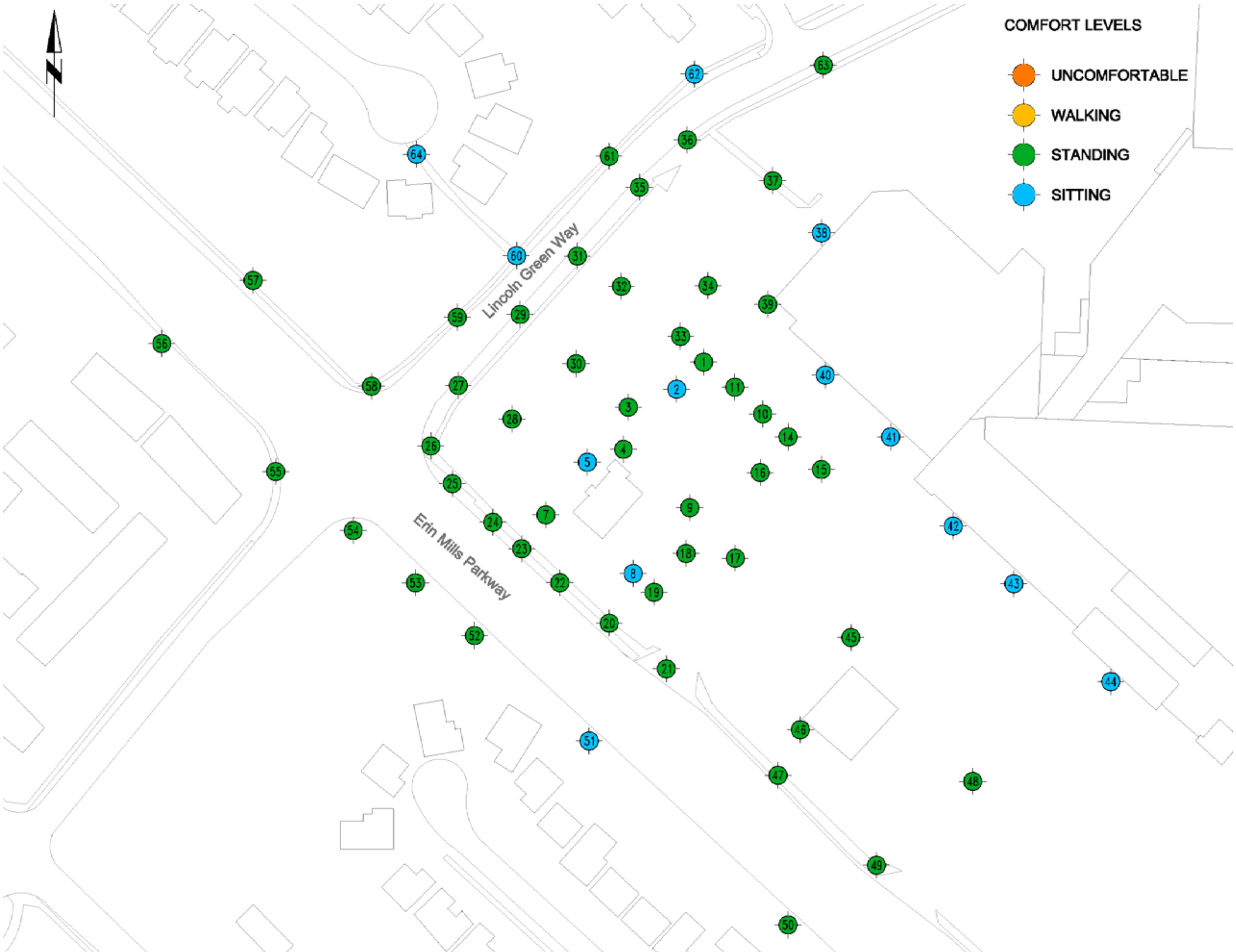


FIGURE 16a SUMMARY OF PREDICTED COMFORT LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS –EXISTING BUILDING A SITE - SUMMER

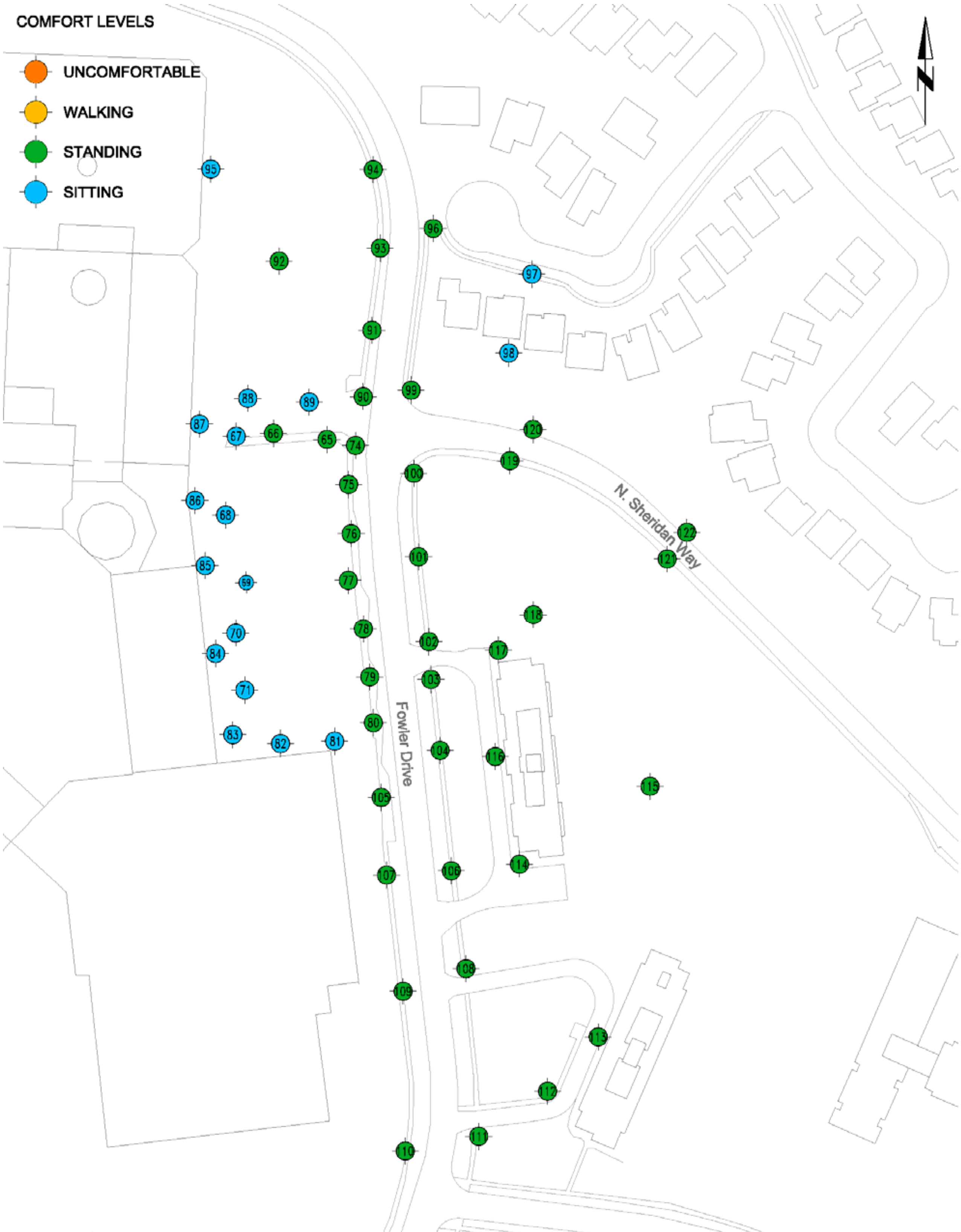


FIGURE 16b SUMMARY OF PREDICTED <u>COMFORT</u> LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS –EXISTING BUILDING G SITE - SUMMER

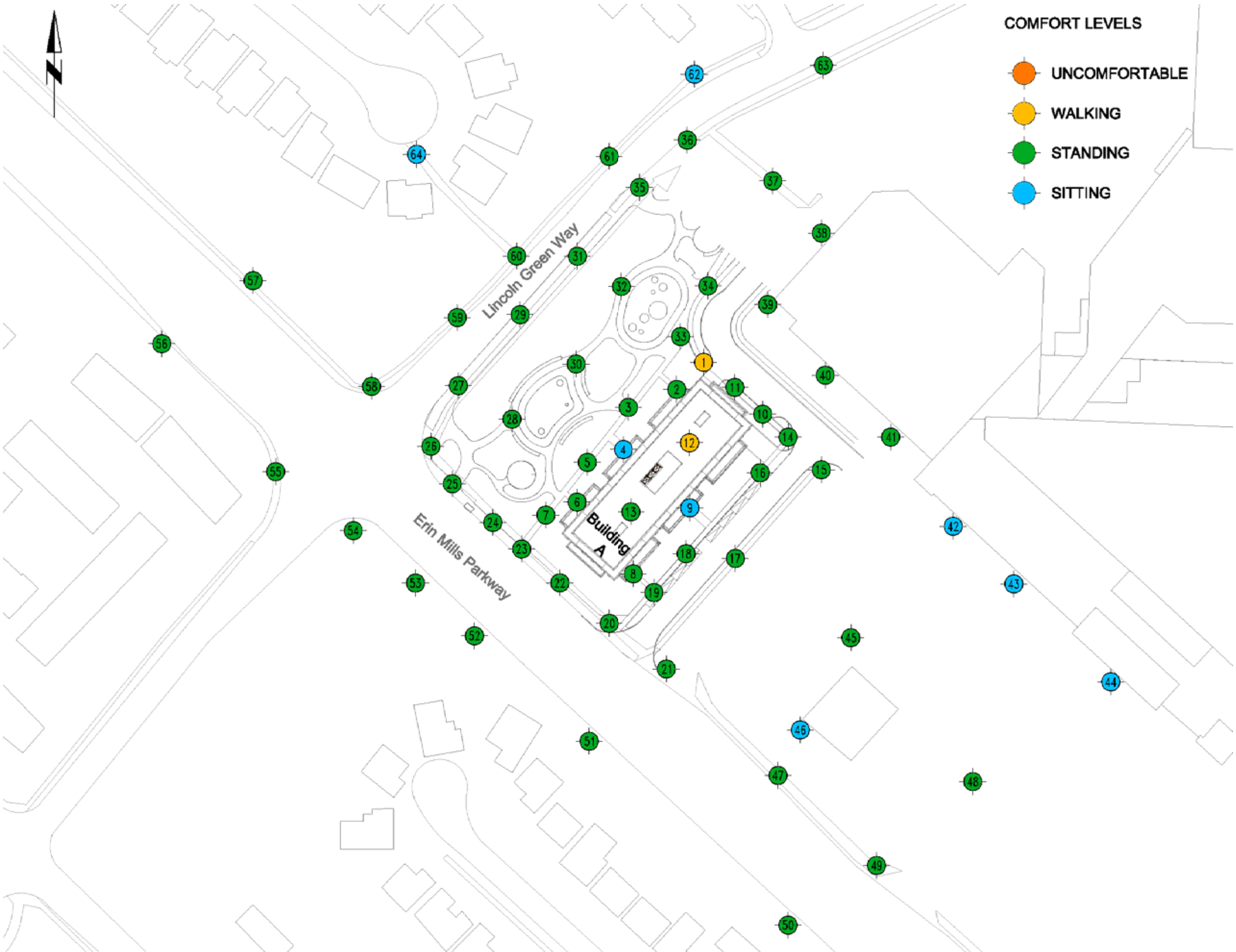


FIGURE 17a SUMMARY OF PREDICTED <u>COMFORT</u> LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS – PROPOSED BUILDING A DEVELOPMENT - SUMMER

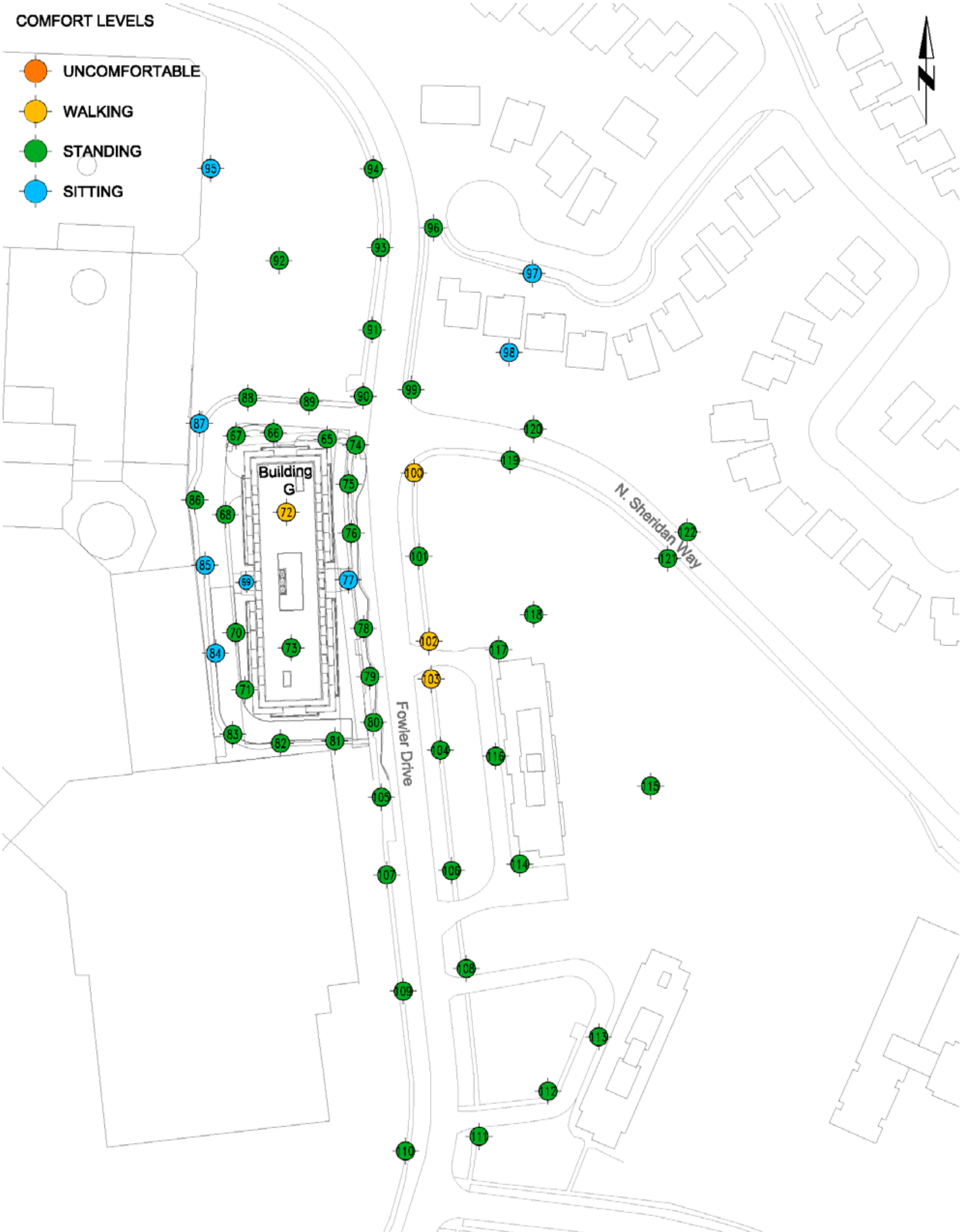


FIGURE 17b SUMMARY OF PREDICTED COMFORT LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS – PROPOSED BUILDING G DEVELOPMENT - SUMMER

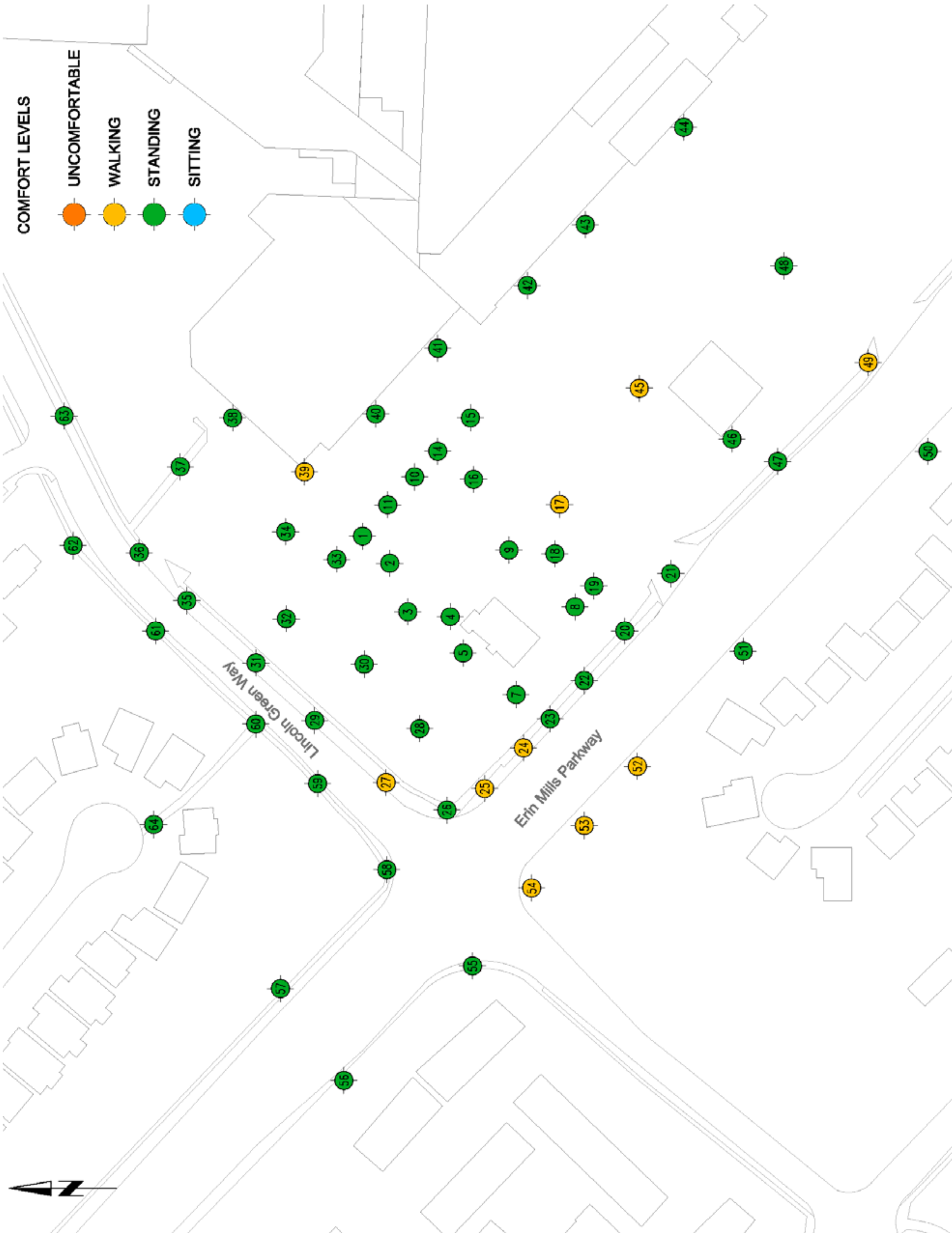


FIGURE 18a SUMMARY OF PREDICTED COMFORT LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS – EXISTING BUILDING A SITE - WINTER

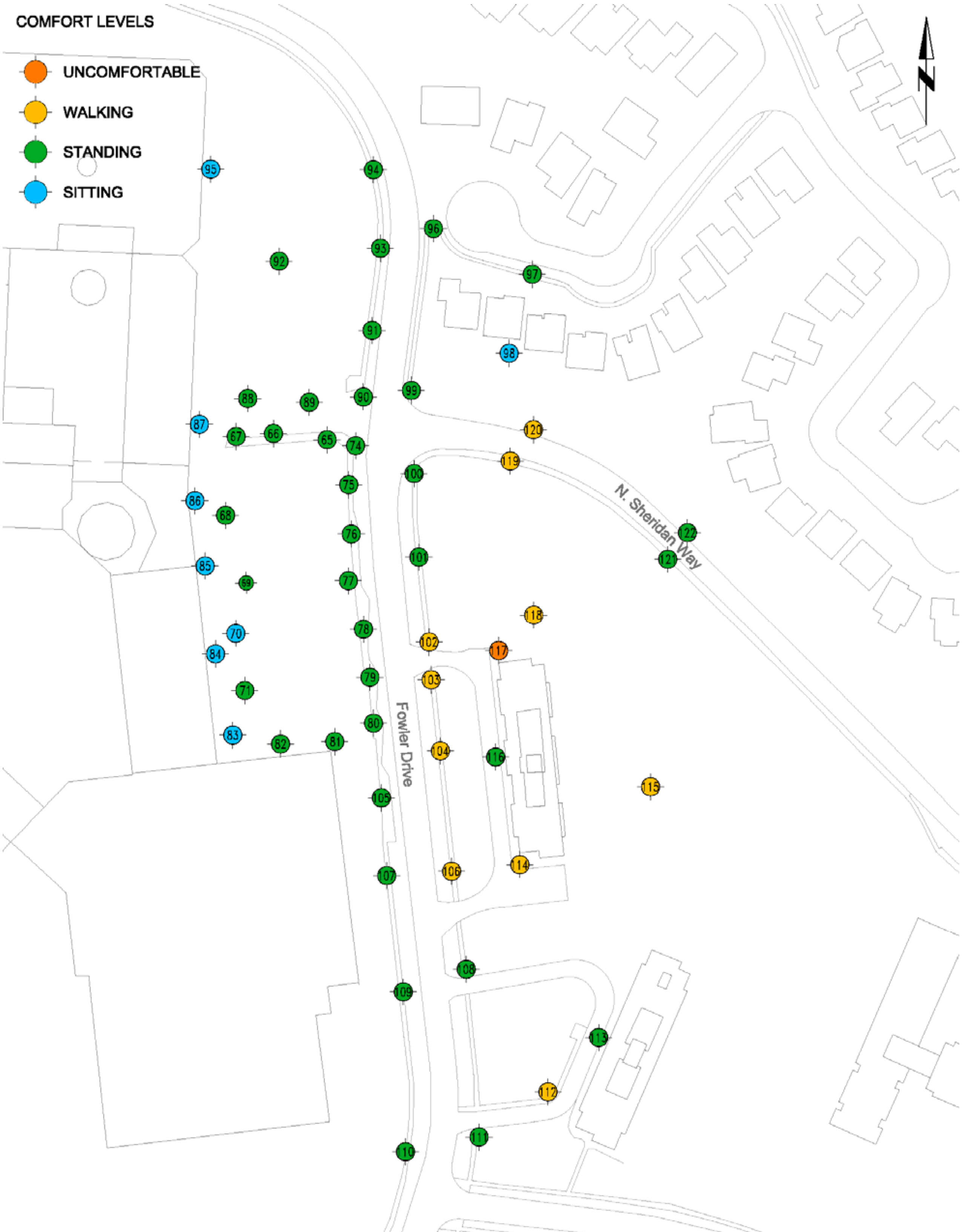


FIGURE 18b SUMMARY OF PREDICTED <u>COMFORT</u> LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS – EXISTING BUILDING G SITE - WINTER

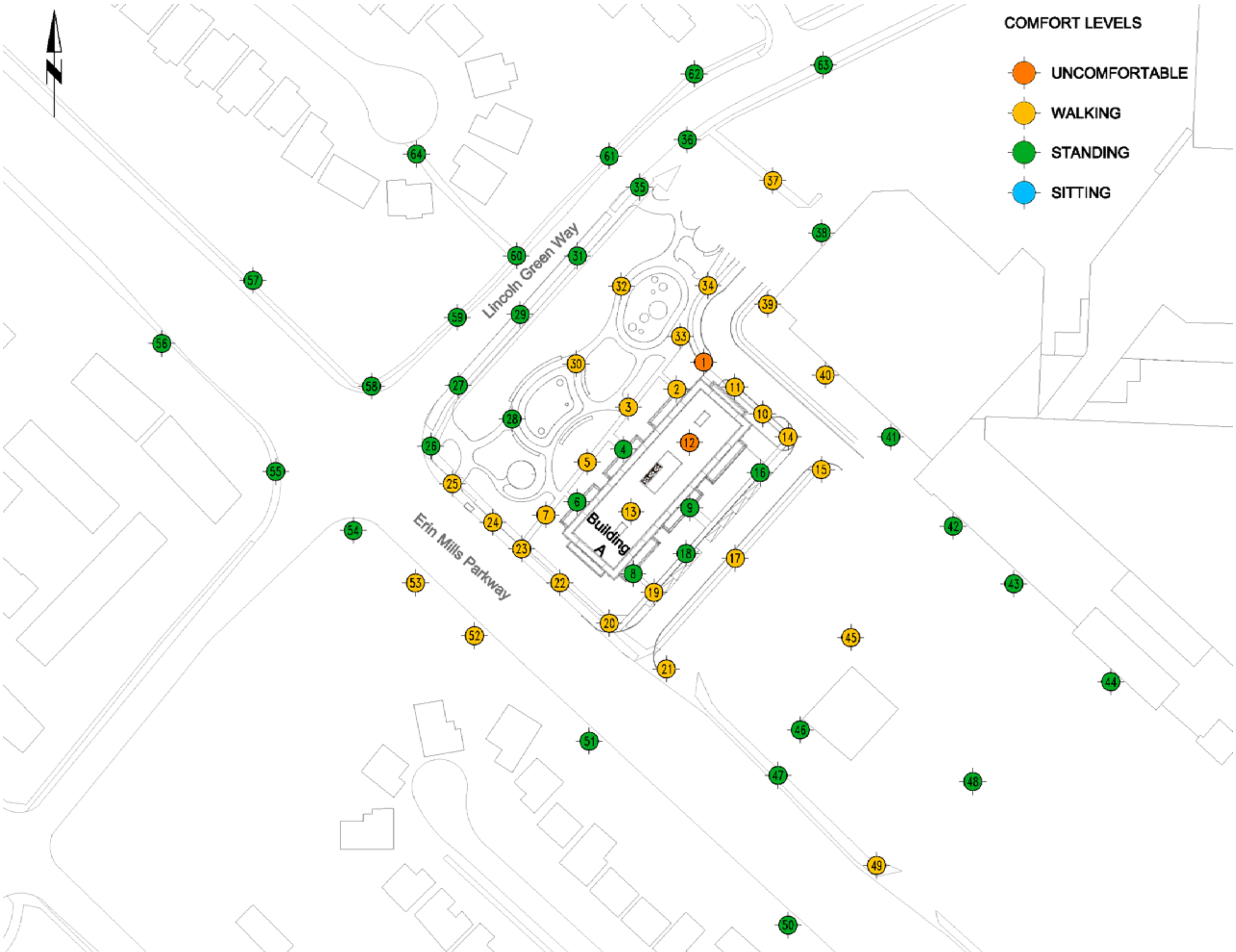


FIGURE 19a SUMMARY OF PREDICTED <u>COMFORT</u> LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS – PROPOSED BUILDING A DEVELOPMENT - WINTER

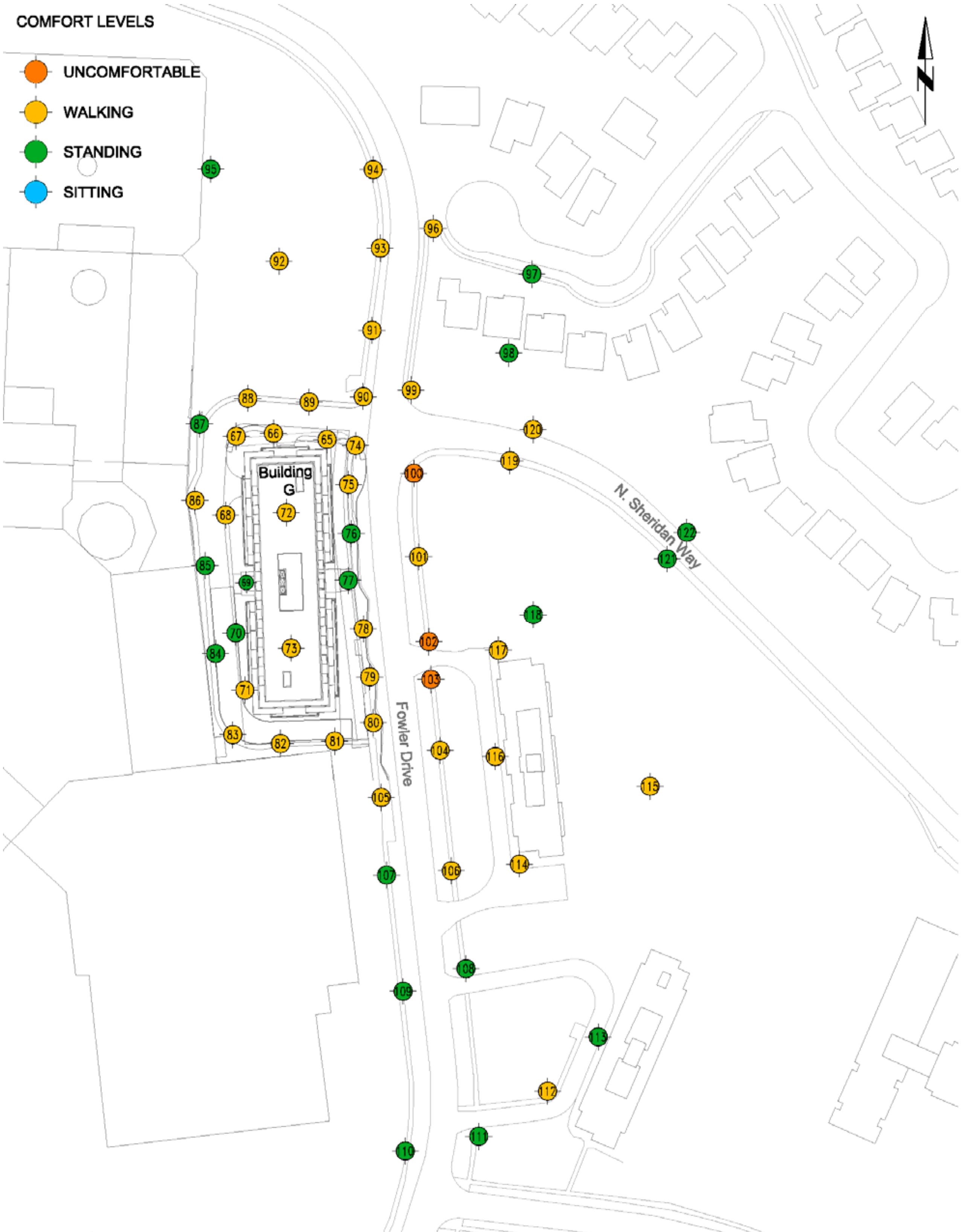


FIGURE 19b SUMMARY OF PREDICTED COMFORT LEVELS FOR PEDESTRIAN-LEVEL WIND SPEEDS – PROPOSED BUILDING G DEVELOPMENT - WINTER

FIGURE 20 EXAMPLES OF VARIOUS MITIGATION OPTIONS FOR THE OUTDOOR AMENITY AREAS

APPENDIX A

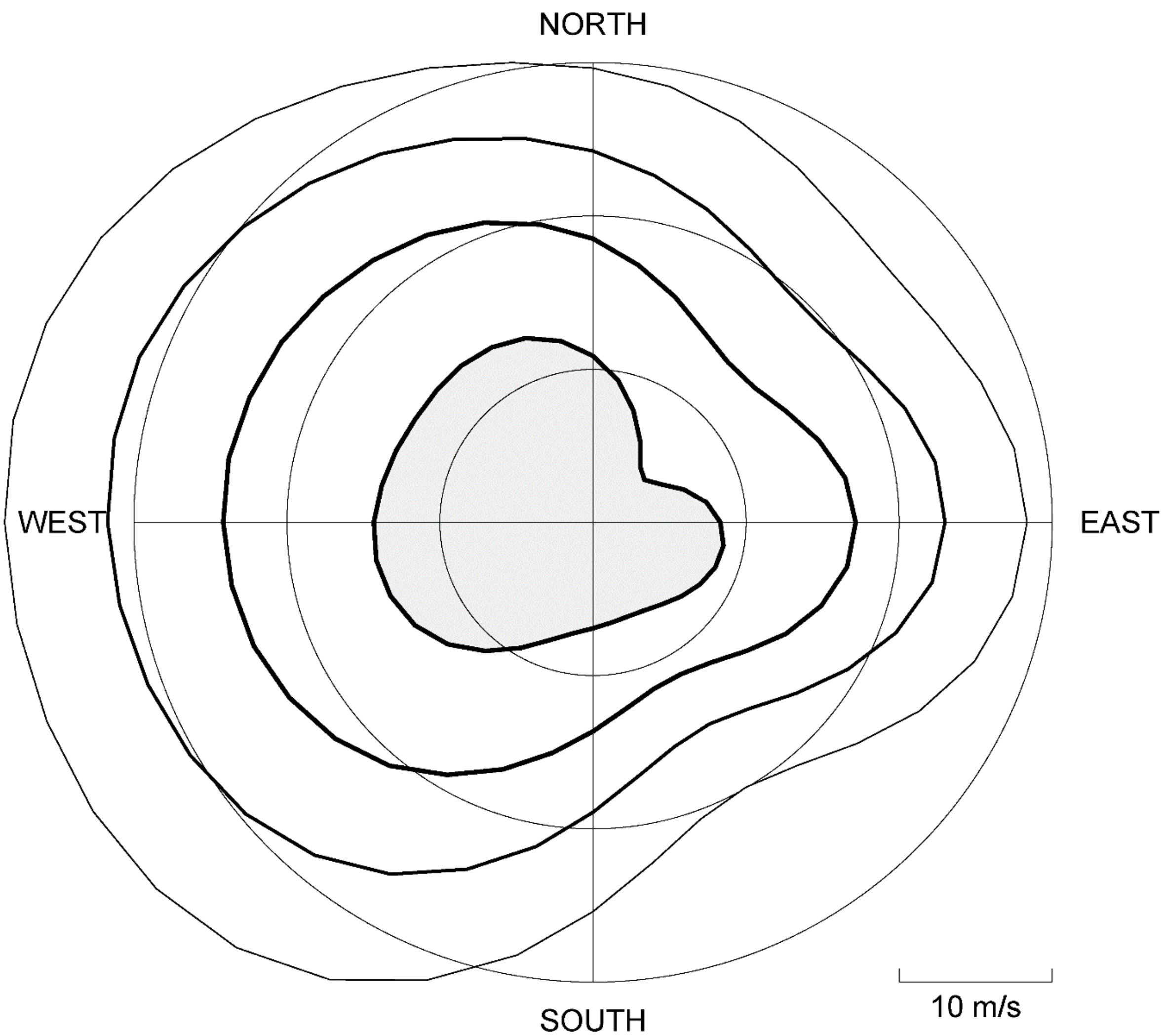
PROBABILITY DISTRIBUTIONS OF WIND SPEED AND DIRECTION

In the plots, the radial distance represents the wind speed at a reference height of 500 m in standard open country exposure. Contours are plotted for four probability levels: the innermost contour is for a probability level of 0.01 or 1% of the time. The other contours represent 0.1%, 0.01% and 0.001% of the time. Thus, the more-common winds are represented by the inner contours and the more-rare winds by the outer contours.

These plots have been derived using data at 16 compass directions, which were interpolated to every 10°. Thus, a point on the innermost contour would represent the wind speed that is exceeded 1% of the time within a 10° sector centred on that wind direction.

To determine the probability of exceeding a particular wind speed at a particular direction, interpolate between the contour levels. For example, to determine the probability of exceeding 20 m/s from the west, find the point on the plot corresponding to this speed and direction. In this case (for 20 m/s at 270°), the probability of exceeding 20 m/s from the west falls between the 1% and 0.1% contours and is approximately 0.35%.

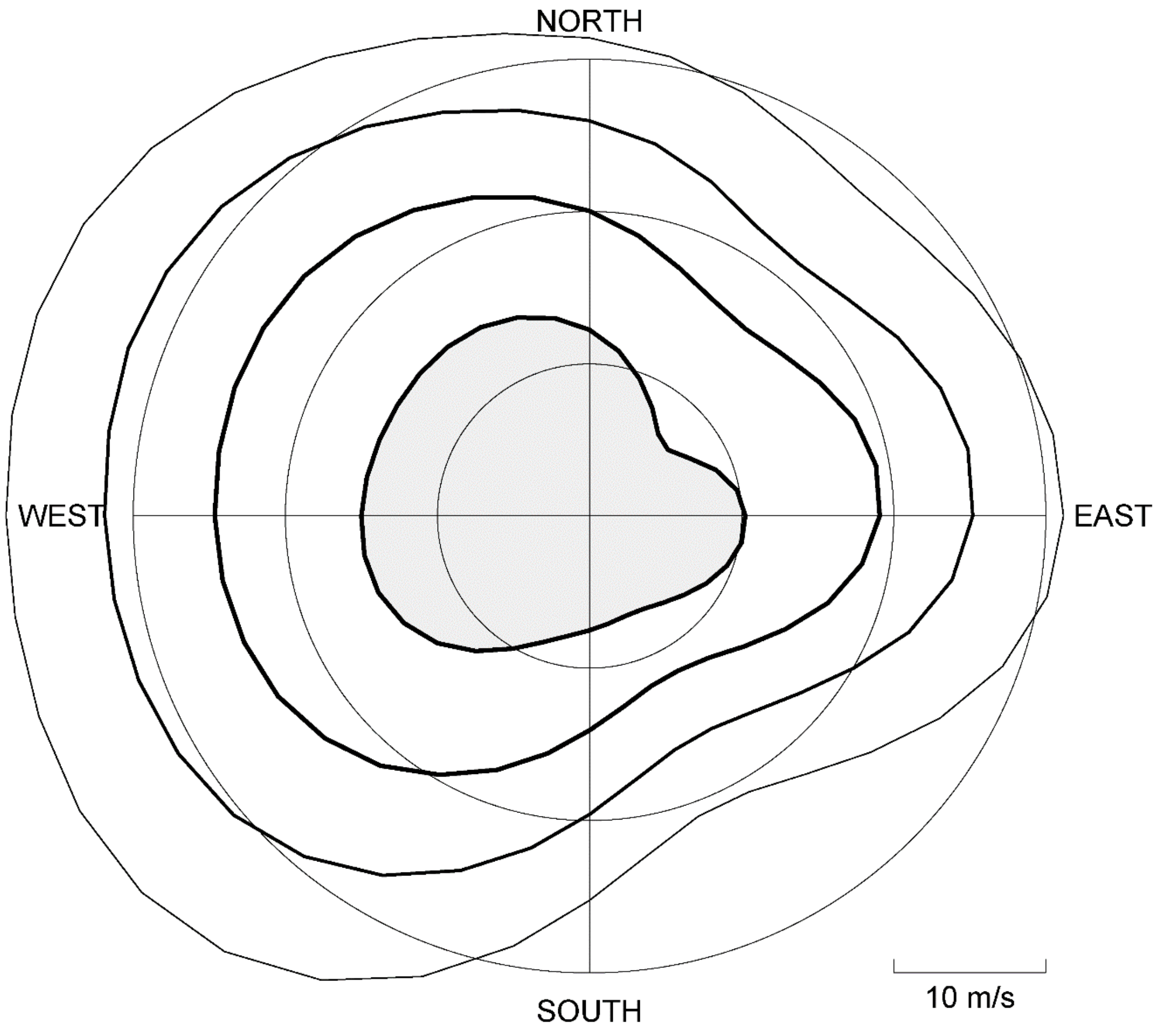
The probability of a particular wind speed being exceeded regardless of direction can be obtained by summing the probabilities of exceeding that wind speed at every 10° over the full 360° azimuth range.



ANNUAL

A point on the innermost contour represents the wind speed exceeded
1% of the time within a 10 degree sector centred on that direction.
Other contours represent probability levels of:
0.1%, 0.01% and 0.001% respectively.

Mississauga, ON (Pearson) - Pedestrian Safety



ANNUAL

A point on the innermost contour represents the wind speed exceeded 1% of the time within a 10 degree sector centred on that direction. Other contours represent probability levels of: 0.1%, 0.01% and 0.001% respectively.

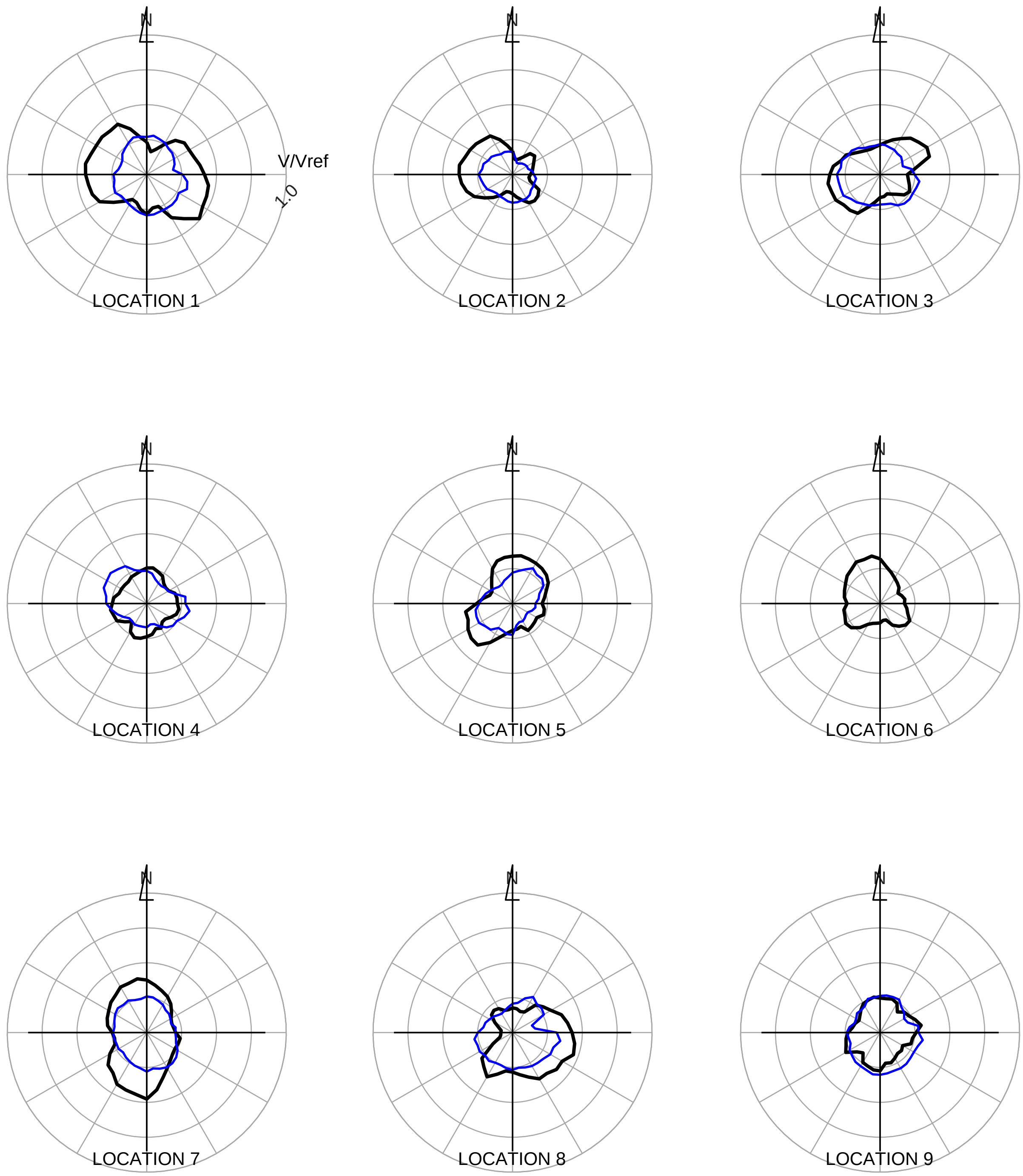
Mississauga, ON (Pearson) - Pedestrian Comfort

APPENDIX B

POLAR PLOTS OF SPEED COEFFICIENTS

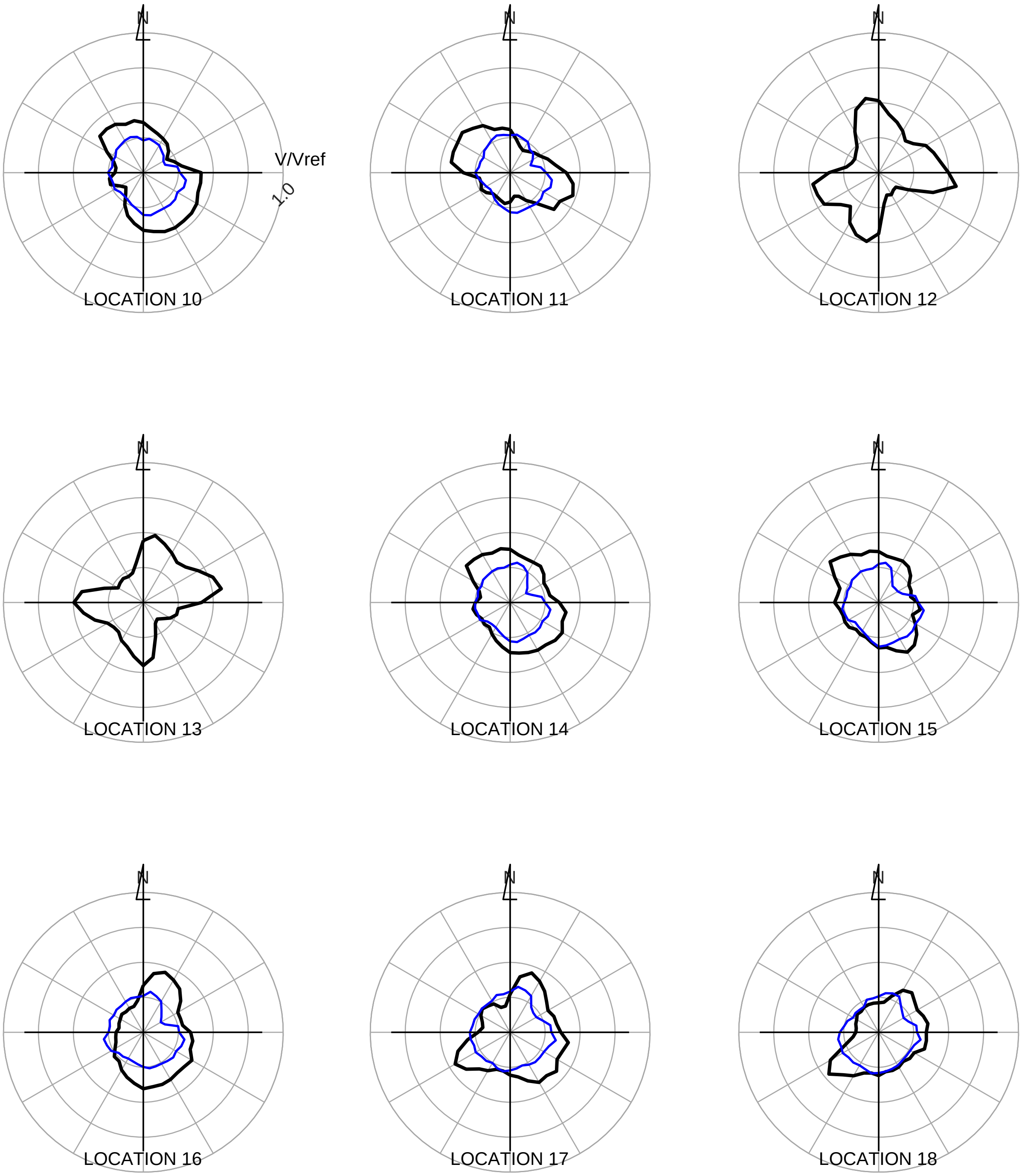
Speed ratios are the speed at the probe height divided by the speed at reference height (see Figure 3).

The azimuth indicated refers to the direction of the oncoming reference-height wind flow, measured from true North. Surface wind directions may vary considerably from these.



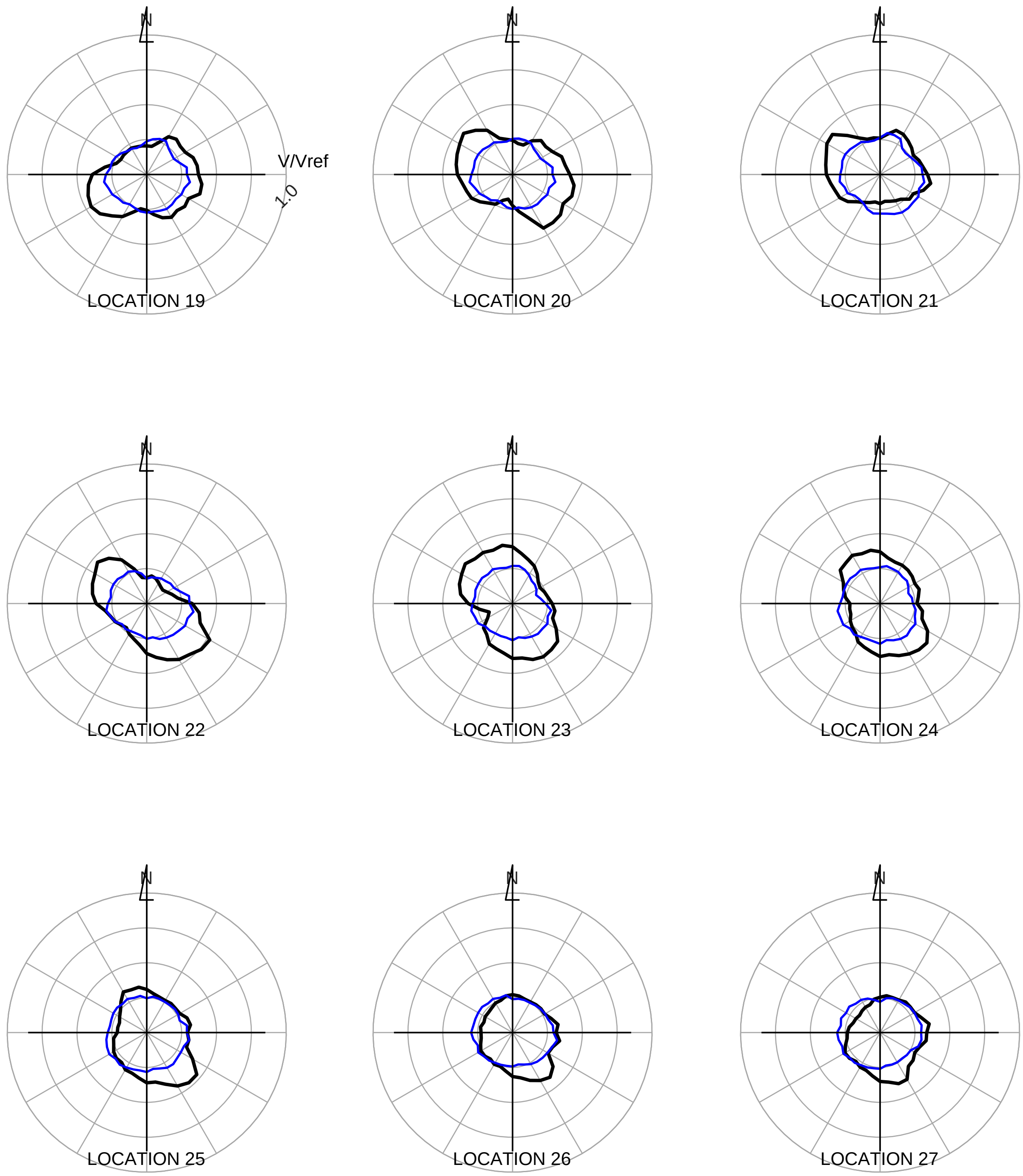
2225 Erin Mills Parkway, Mississauga - Proposed Configuration ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration ErinECplz/GEMean



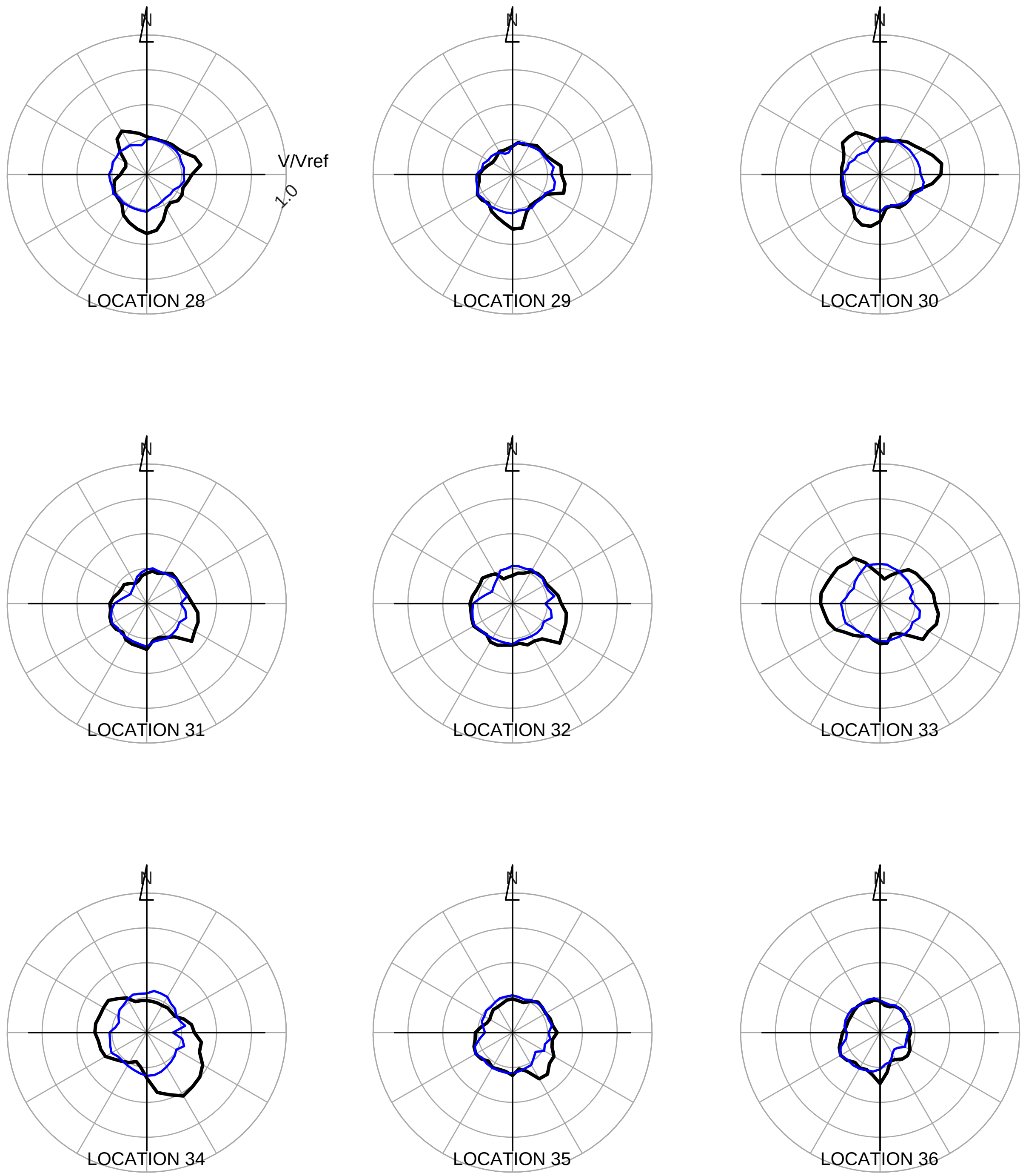
2225 Erin Mills Parkway, Mississauga - Proposed Configuration ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration ErinECplz/GEMean



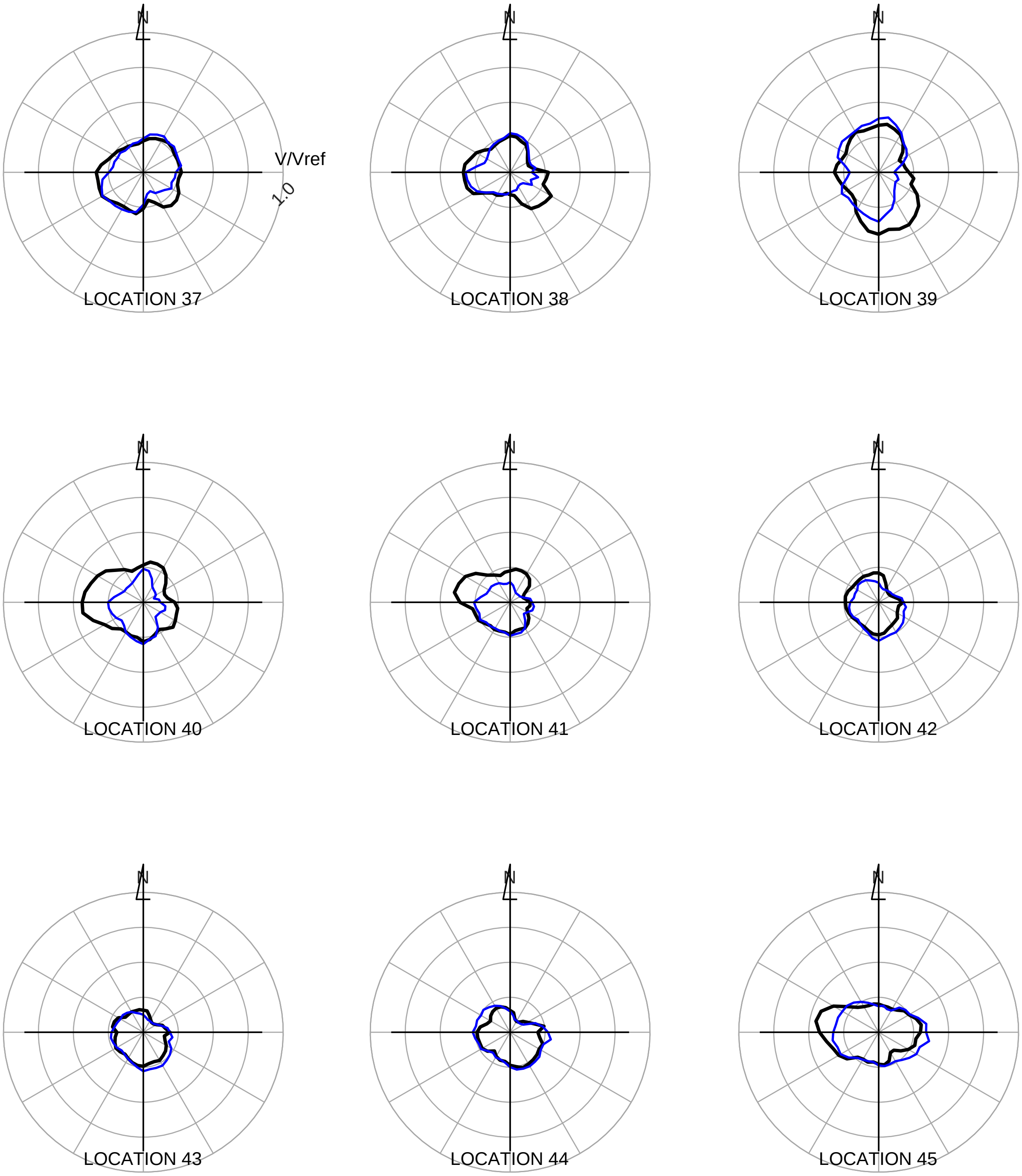
2225 Erin Mills Parkway, Mississauga - Proposed Configuration ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration ErinECplz/GEMean



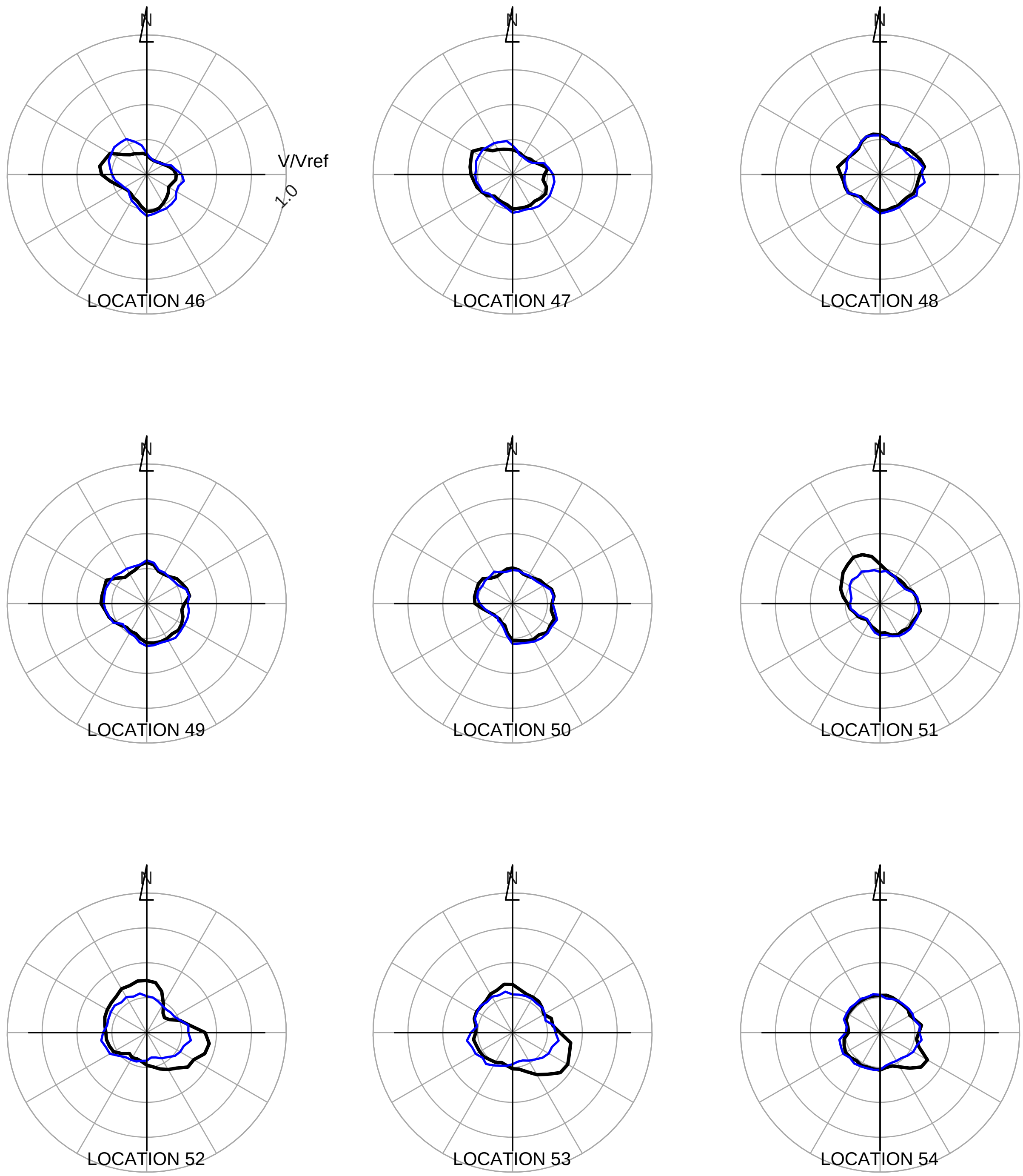
2225 Erin Mills Parkway, Mississauga - Proposed Configuration ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration ErinECplz/GEMean



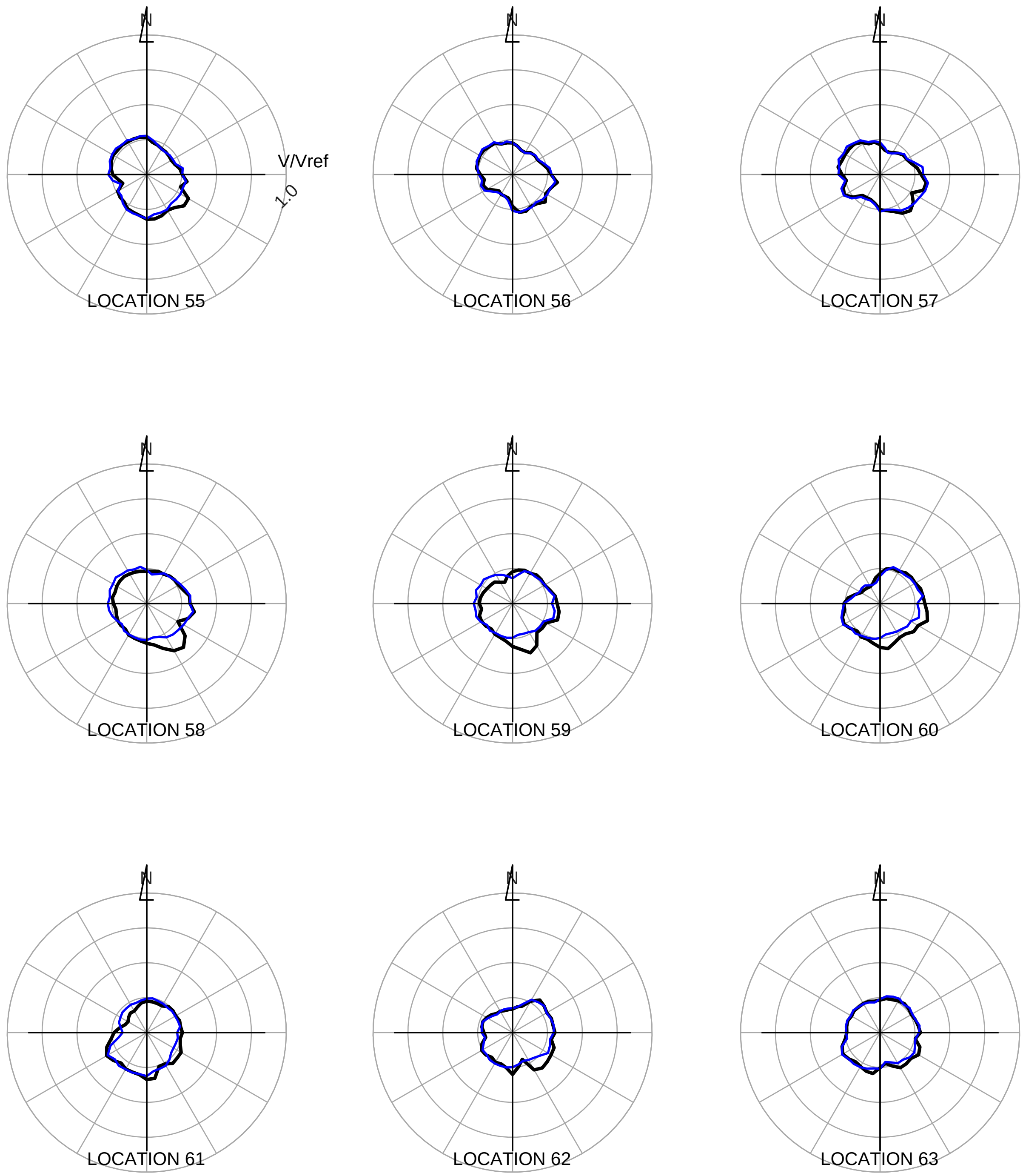
2225 Erin Mills Parkway, Mississauga - Proposed Configuration ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration ErinECplz/GEMean



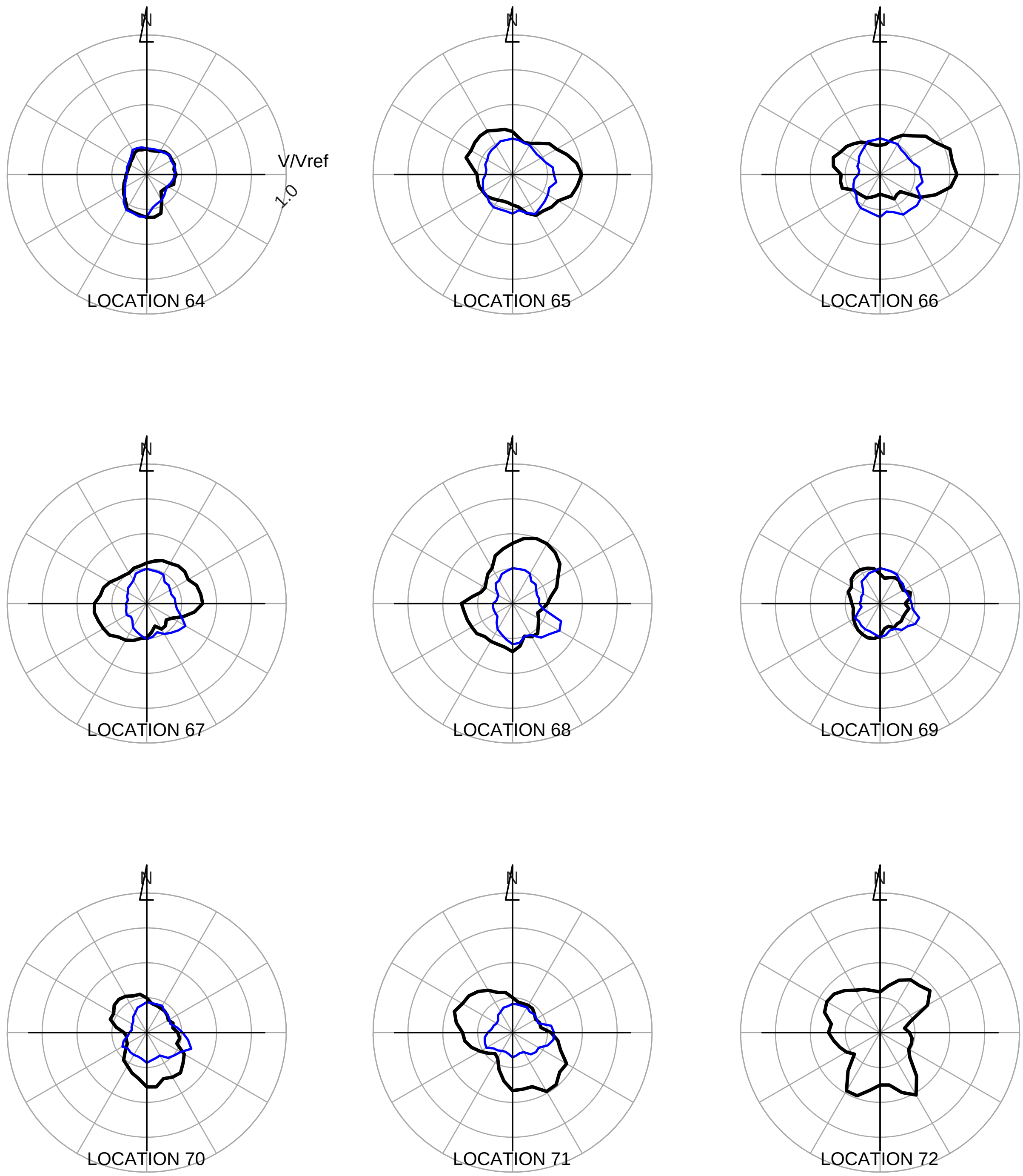
2225 Erin Mills Parkway, Mississauga - Proposed Configuration ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration ErinECplz/GEMean



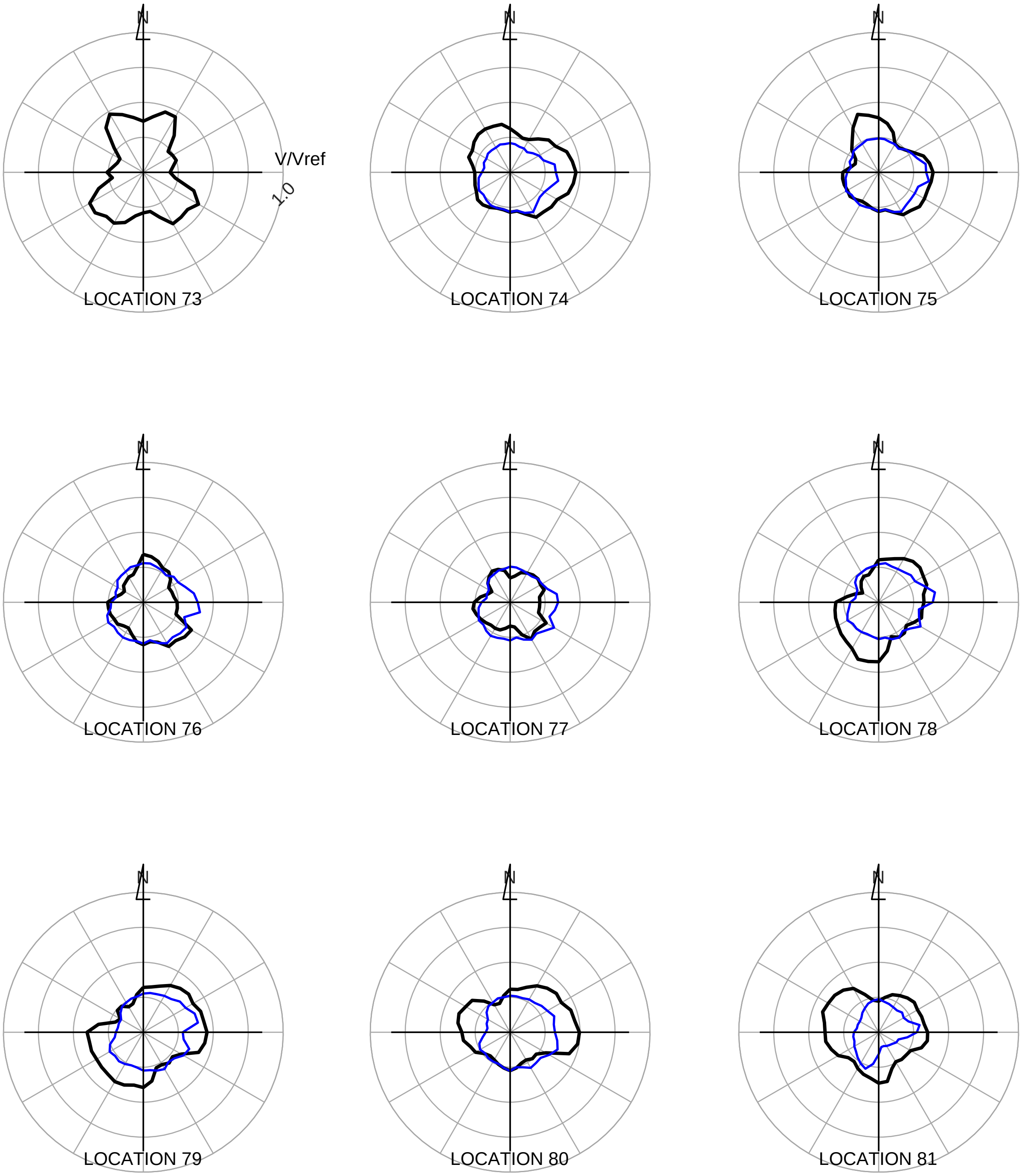
2225 Erin Mills Parkway, Mississauga - Proposed Configuration ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration ErinECplz/GEMean



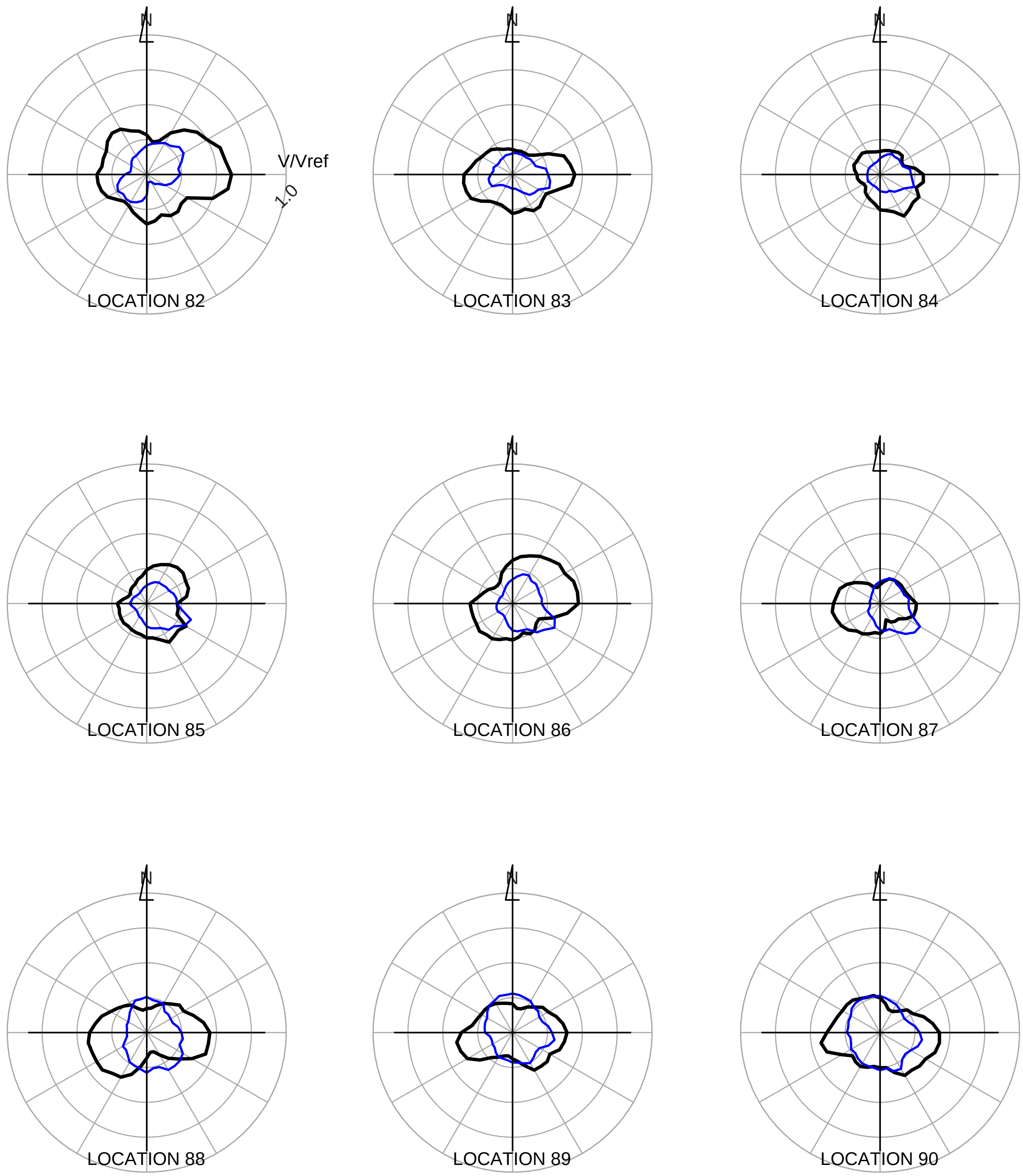
2225 Erin Mills Parkway, Mississauga - Proposed Configuration ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration ErinECplz/GEMean



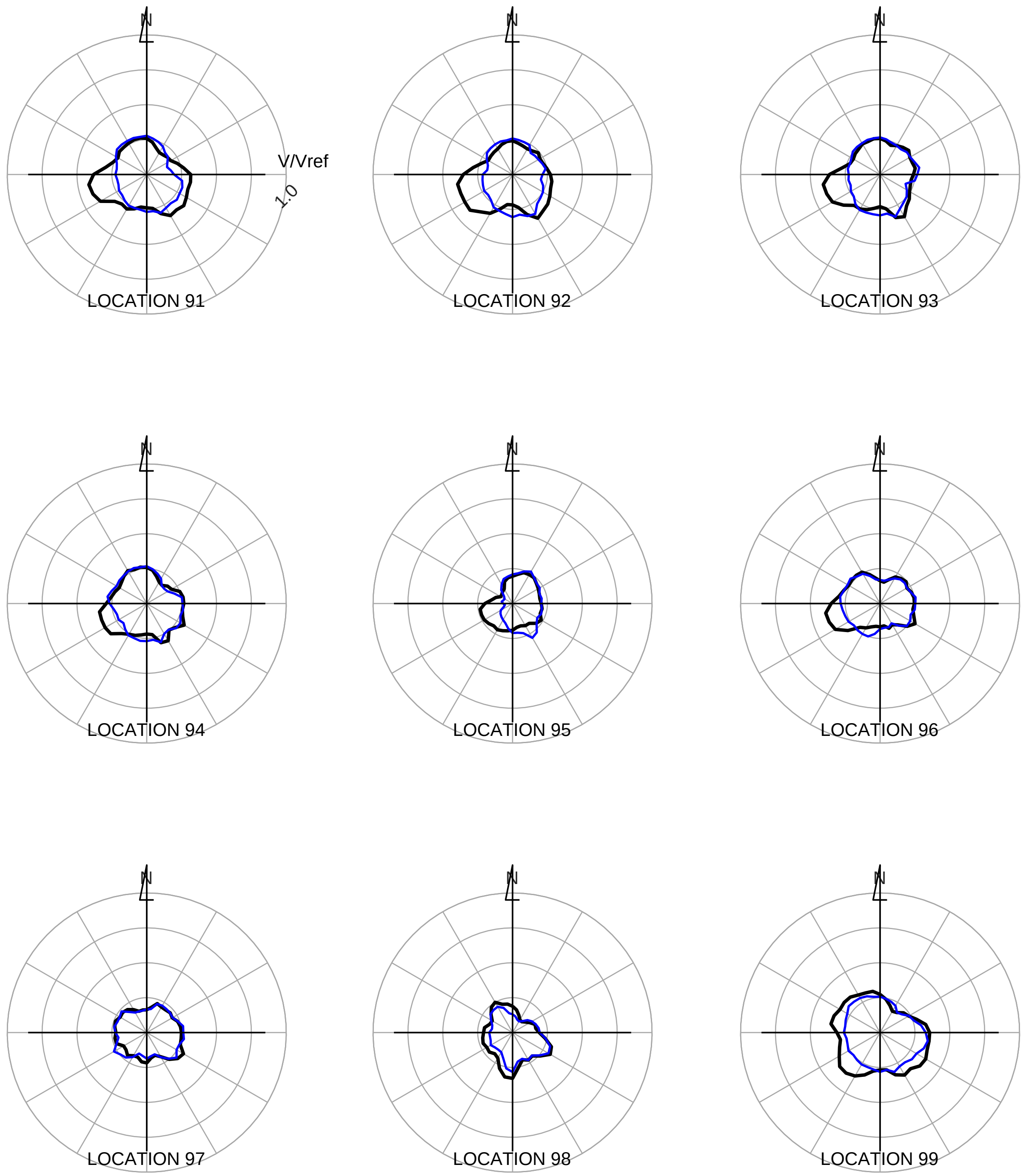
2225 Erin Mills Parkway, Mississauga - Proposed Configuration — ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration — ErinECplz/GEMean



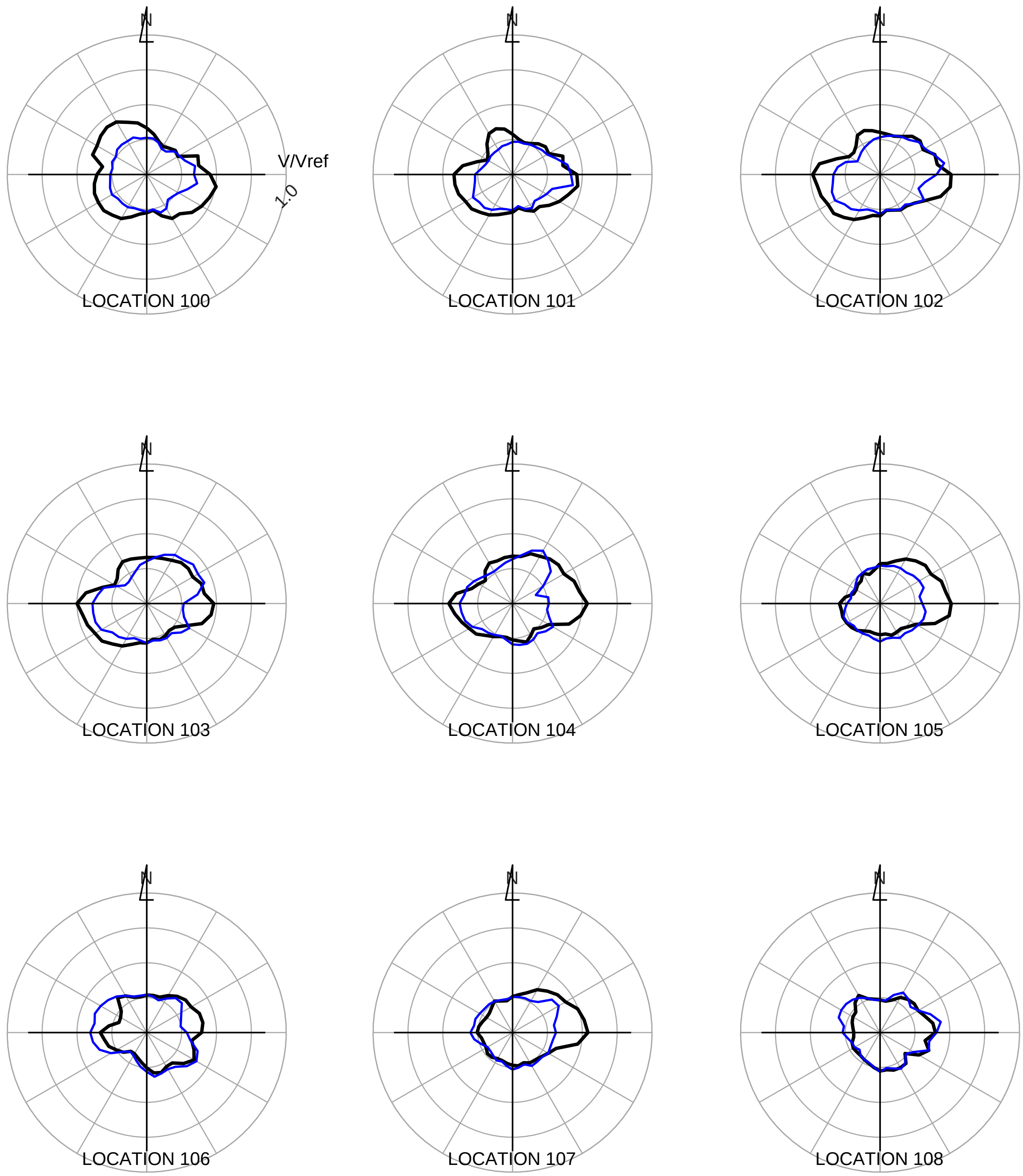
2225 Erin Mills Parkway, Mississauga - Proposed Configuration   ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration   ErinECplz/GEMean



2225 Erin Mills Parkway, Mississauga - Proposed Configuration ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration ErinECplz/GEMean



2225 Erin Mills Parkway, Mississauga - Proposed Configuration — ErinPCplz/GEMean

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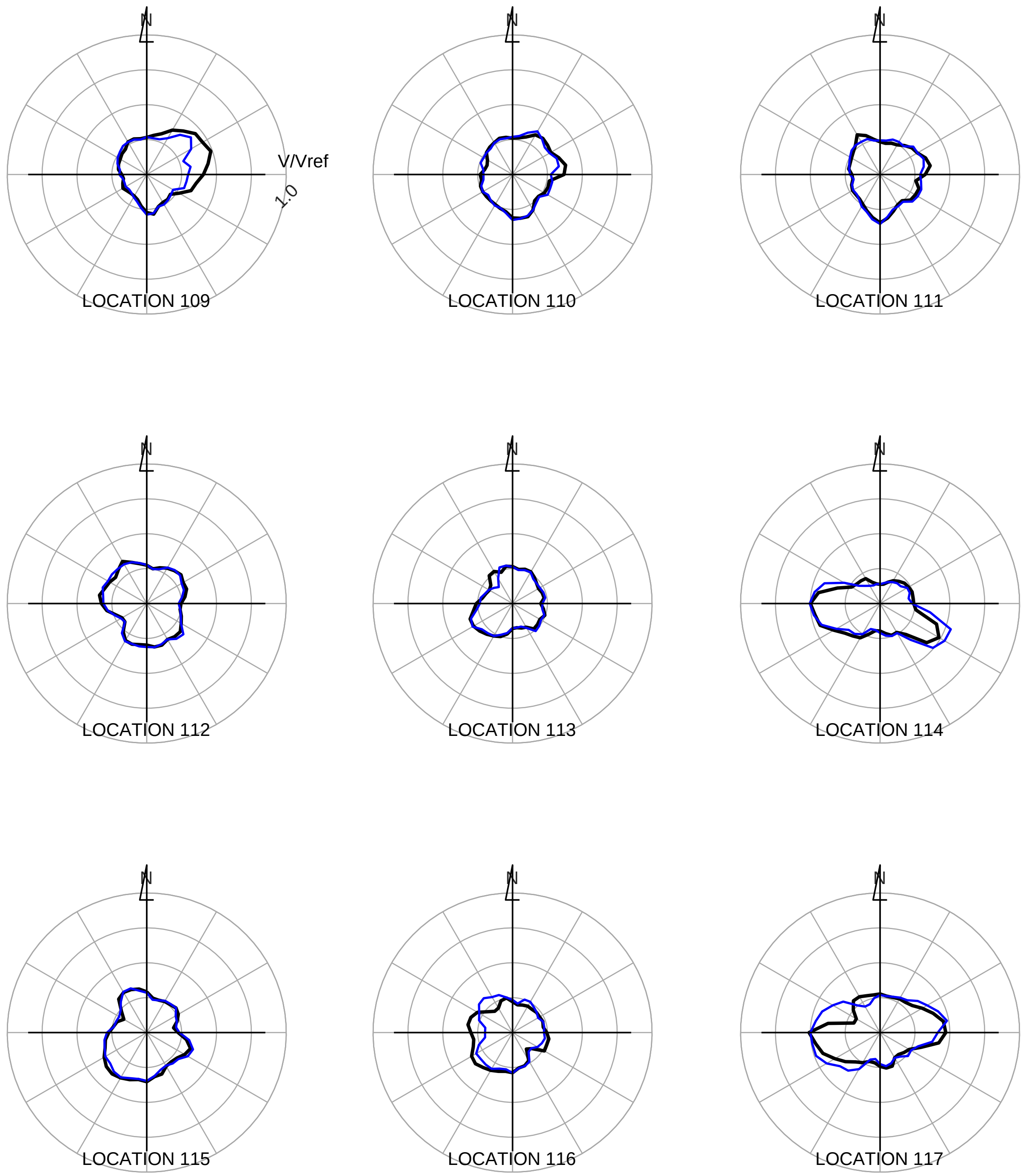
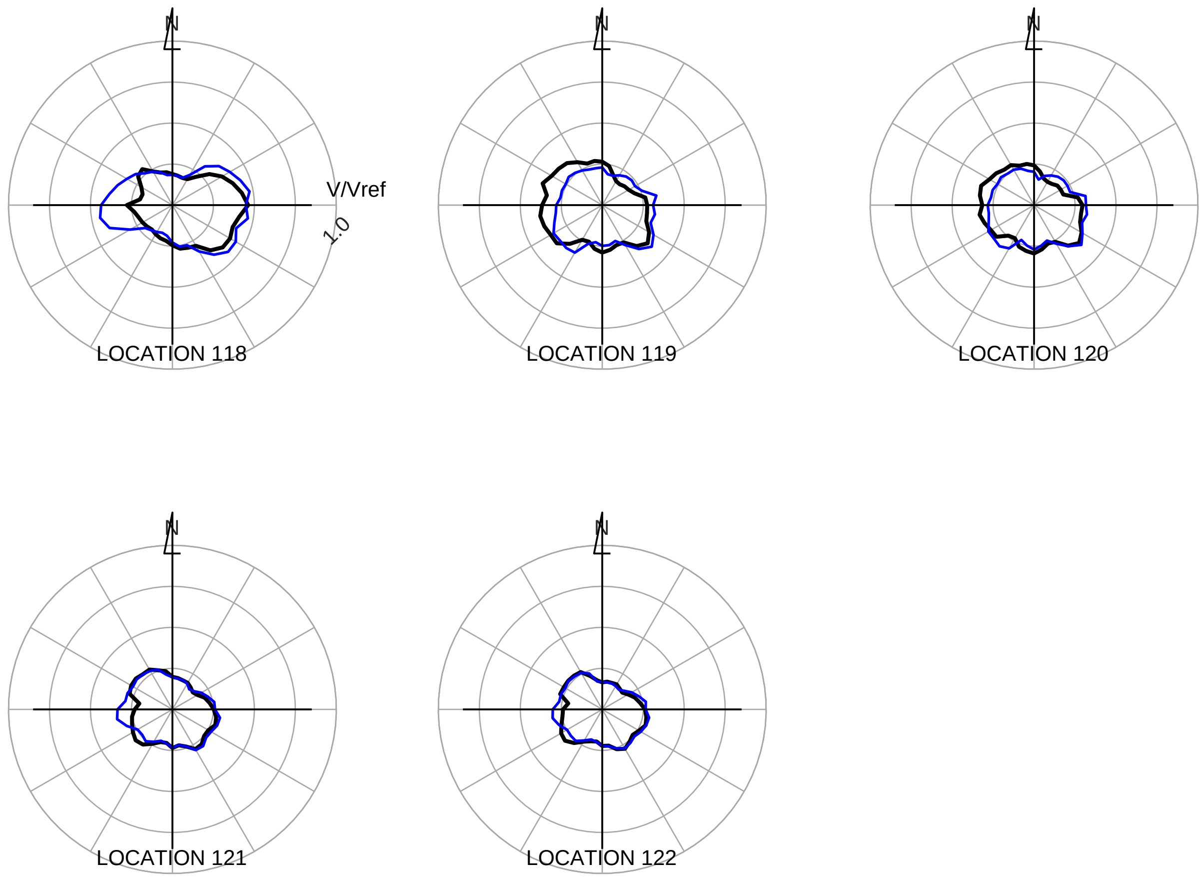


2225 Erin Mills Parkway, Mississauga - Proposed Configuration — ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration — ErinECplz/GEMean



2225 Erin Mills Parkway, Mississauga - Proposed Configuration ErinPCplz/GEMean

2225 Erin Mills Parkway, Mississauga - Existing Configuration ErinECplz/GEMean