THEAKSTON ENVIRONMENTAL
Consulting Engineers • Environmental Control Specialists

REPORT

PEDESTRIAN LEVEL WIND STUDY

Part of Lots 6, 7, 8 & 9
Concession 9
City of Mississauga, Region of Peel

Derry Britannia Developments Inc.

REPORT NO. 19565 **April 7, 2020**

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1. EXECUTIVE SUMMARY

The Development proposed by Derry Britannia Developments Inc. for their property situated southwest of the intersection of Ninth Line and Doug Leavens Boulevard, in the City of Mississauga, has been assessed for environmental standards with regard to pedestrian level wind relative to comfort and safety.

The Derry Britannia Development involves a proposal to construct two 6 storey L-shaped buildings flanking a future 'Street F'. The main residential lobby for the west building is accessed via an entrance near the southeast corner of the building along Ninth Line. An internal driveway and drop-off area provides vehicular access to a secondary entrance at the inside corner. The east building is a mirror of the west building and is on the opposite side of the future 'Street F', however, it is set back from the future street by a proposed park.

The Development is, for all intents and purposes, surrounded to prevailing windward directions by agricultural lands, a suburban mix of low-rise commercial, 1-2 storey single family dwelling neighbourhoods, and open areas slated for future phases of the Derry Britannia Development. These buildings and related open areas have a sympathetic relationship with the pending wind climate.

Urban development provides turbulence inducing surface roughness that can be wind friendly, while open settings afford wind the opportunity to accelerate as the wind's boundary layer profile thickens at the pedestrian level, owing to lack of surface roughness. High-rise buildings typically exacerbate wind conditions within their immediate vicinity, to varying degrees, by redirecting wind currents to the ground level and along streets and open areas. Transition zones from open to urban, and to a lesser degree suburban, settings may prove problematic, as winds exacerbated by the relatively more open settings are redirected to flow over, around, and between urban buildings.

These phenomena were observed at the site with winds that have opportunity to accelerate over the open lands to the northwest through west to southeast of the site. The Proposed Development penetrates winds that formerly flowed over the existing lands. These winds are redirected, tending to split with portions flowing over, around and down the proposed buildings' façades. At the pedestrian level, the winds redirect to travel horizontally along the buildings, around the corners and beyond, creating minor windswept areas and, on occasion, windy, though not uncomfortable, conditions at or near the buildings' corners, and in the gaps between, and these conditions are primarily attributable to the setting.

Winds emanating from remaining compass points are more effectively mitigated, though to varying degrees, by the local surrounds, and as such, upon impact with the proposed, tend to split, flowing over, and to a lesser extent around and down the buildings' faces. At the pedestrian level, the winds redirect to travel horizontally along the ground, around corners and beyond.

Comfort conditions expected at the proposed Development site are generally more comfortable, relative to the existing setting. This is primarily attributable to the exposure of the existing setting, which is well managed by the proposed design, and the resulting conditions are considered acceptable to the suburban context. Where mitigation was recommended, it was achieved through: irregular façades, canopies, balconies, landscaping, plantings, and others, that were incorporated into the proposed Development's massing and landscape design.

Safety criteria are included in the analysis to ensure that strong winds do not cause a loss of balance to individuals occupying the area. The sidewalks, parks and entrances fall within the pedestrian level wind velocity safety criteria as All Weather Areas.

In summary, the proposed Development's design features will contribute to anticipated pedestrian comfort conditions that are suitable to the context. Minor variations of the aforementioned landscape plan, designed in consultation with the architects, and applied to the park areas may improve the functionality of the spaces further into the shoulder seasons. The proposed Development will realize wind conditions acceptable to a typical suburban context.

Respectfully submitted,

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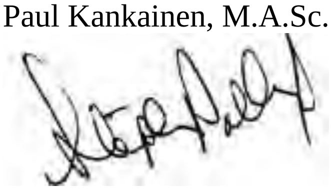


Stephen Pollock, P. Eng.

2. INTRODUCTION

Theakston Environmental Consulting Engineers, Fergus, Ontario, were retained by Derry Britannia Developments Inc., to study the pedestrian level wind environment for their proposed residential Development occupying a portion of the property to the southwest of the intersection of Ninth Line and Doug Leavens Boulevard. The Development will be located in the City of Mississauga, with the site as depicted on the Aerial Photo in Figure 2a. The Development involves a proposal to build two 6 storey L-shaped buildings, in the configuration shown in Figure 2b.

Flora Tang of Mattamy Homes Canada, initiated the request, and Q4 Architects provided drawings. The co-operation and interest of the Client and their sponsors in all aspects of this study is gratefully acknowledged.

The specific objective of the study is to determine areas of higher than normal wind velocities induced by the shape and orientation of the proposed buildings and surroundings. The wind velocities are rated in accordance with the safety and comfort of pedestrians, notably at entrances to the buildings, sidewalks, courtyards on the property, as well as other buildings in the immediate vicinity.

In order to obtain an objective analysis of the wind conditions for the property, the wind environment was tested in two configurations. The existing configuration included existing and proposed buildings in the surrounding area. The proposed configuration included the Development's subject buildings as well as the future townhouse blocks of Derry Brittania's North Draft Plan. Mitigation procedures were assessed during these tests to determine their impact on the various wind conditions.

The laboratory techniques used in this study are established procedures that have been developed specifically for analyses of this kind. The methodology, summarized herein, describes criteria used in the determination of pedestrian level wind conditions. The facilities used by Theakston are ideal for observance of the Development at various stages of testing, and the development of wind mitigation measures, if necessary.

3. OBJECTIVES OF THE STUDY

1. To quantitatively assess, by model analyses, the pedestrian level wind environment under existing conditions and future conditions with the Development.

2. To assess mitigative solutions.

3. To publish a Consultant's report documenting the findings and recommendations.

4. METHOD OF STUDY

4.1 General

The Theakston Environmental wind engineering facility was developed for the study of, among other sciences, the pedestrian level wind environment occurring around buildings, with focus on the safety and comfort of pedestrians. To this end, physical scale models of proposed Development sites, and immediate surroundings, are built, instrumented and tested at the facility with resulting wind speeds measured for different wind directions at various locations likely to be frequented by pedestrians. This quantitative analysis provides predictions of wind speeds for various probabilities of occurrence and for various percentages of time that are ultimately weighted relative to a historical range of wind conditions, and provided to the client.

The techniques applied to wind and other studies carried out at the facility, utilise a boundary layer wind tunnel and/or water flume (Figure 1). The testing facility has been developed for these kinds of environmental studies, and has been adapted with equipment, testing procedures and protocols, in order to provide results comparable to full scale. The Boundary Layer Wind Tunnel lends itself well to the simultaneous acquisition of large data streams while the water flume is excellent for flow visualisation.

The purpose of this Pedestrian Level Wind Study is to evaluate the pedestrian level wind speeds for a full range of wind directions. To accomplish this, the wind's mean speed boundary layer profiles are simulated and applied to a site-specific model under test, instrumented with differential pressure probes at locations of interest. During testing, pressure readings are taken over a one-hour model scale period of time, at a full-scale height of approximately 1.8m and correlated to mean and gust wind speeds, expressed as ratios of the gradient wind speed.

The mean and gust wind speeds at the thirty-two (32) points tested were subsequently combined with the design probability distribution of gradient wind speed and direction, (wind statistics) recorded at Airports in the vicinity, to provide predictions of the full-scale pedestrian level wind environment. Predictions of the full-scale pedestrian level wind environment are presented as the wind speed exceeded 20% of the time, based on annual, and wind for the seasons in Figures 6a – 6e. Criterion employed by Theakston Environmental was developed by others and us and published in the attached references. The methodology has been applied to over 800 projects on this continent and abroad.

4.2 Meteorological Data

The wind climate for the Mississauga region that was used in the analysis was based on historical records of wind speed and direction measured at Pearson International Airport for the period between 1980 and 2017. The meteorological data includes hourly wind records and annual extremes. The analysis of the hourly wind records provides information to develop the statistical climate model of wind speed and direction. From this model, predicted wind speeds regardless of wind direction for various return periods can be derived. The record of annual extremes was also used to predict wind speeds at various return periods. Based on the analysis of the hourly records, the predicted hourly-mean wind speed at 10*m*, corrected for a standard open exposure definition, is 25*m/s* for a return period of 50 years.

4.3 Statistical Wind Climate Model

For the analysis of the data, the wind climate model is converted to a reference height of 500*m* using a standard open exposure wind profile. The mean-hourly wind speed at a 500*m* reference height used for this study is 45.6*m/s* for a return period of 50 years. The corresponding 1-year return period wind speed at the 500*m* height is 36*m/s*.

The design probability distribution of mean-hourly wind speed and wind direction at reference height is shown for Pearson International Airport in Figure 5. Both annual and seasonal distributions are shown. From this it is apparent that winds can occur from any direction, however, historical data indicates the directional characteristics of strong winds are north through west to southwest and said winds are most likely to occur during the winter and fall seasons.

4.4 Wind Simulation

To simulate the correct macroclimate, the upstream flow passes over conditioning features placed upstream of the model, essentially strakes and an appropriately roughened surface, as required to simulate the full-scale mean speed boundary layer approach flow profiles occurring at the site.

4.5 Pedestrian Level Wind Velocity Study

A physical model of the proposed Development and pertinent surroundings, including existing buildings, roadways, pathways, terrain and other features, was constructed to a scale of 1:500. The model is based upon information gathered during a site visit to the proposed Development site, and surrounding area. Q4 Architects provided architectural drawings. City of Mississauga aerial photographs were also used in development of the model to ensure the model reasonably represents conditions at the proposed Development. The model is constructed on a circular base so that, by rotation, any range of wind directions can be assessed. Structures and features that are deemed to have an impact on the wind flows are included upwind of the scale model.

In these studies, the effects of wind were analysed using omni-directional wind velocity probes that are placed on the model and located at the usual positions of pedestrian activity. The probes measure both mean and fluctuating wind speeds at a height of approximately 1.8m. During testing, the model sample period is selected to represent 1hr of sampling time at full scale. The velocities measured by the probes are recorded by a computerized data acquisition system and combined with historical meteorological data via a post-processing program.

4.6 Pedestrian Comfort Criteria

The assignment of pedestrian comfort takes into consideration pedestrian safety and comfort attributable to mean and gust wind speeds. Gusts have a significant bearing on safety, as they can affect a person's balance, while winds flowing at or near mean velocities have a greater influence upon comfort.

Figure 6 presents results for the Gust Equivalent Mean (GEM) wind speed that is exceeded 20% of the time. These speeds are directly related to the pedestrian comfort at a particular point. The overall comfort rating, for existing and proposed, are depicted in Figure 7. Table 1, below, summarizes the comfort criteria used in the presentation of the results depicted in Figures 6 and 7.

Table 1: Comfort Criteria

ACTIVITY	**Gust Equivalent Mean Speed Exceeded 20% of the Time**		**Description**
COMFORT	***km/h***	***m/s*** (used in Fig. 6)	
Sitting	0-10	0-2.8	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away.
Standing	0-15	0-4.2	Gentle breezes suitable for main building entrances and bus stops.
Walking	0-20	0-5.6	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.
Uncomfortable	>20	>5.6	Strong winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended.

The activities are described as suitable for Sitting, Standing, Walking, or Uncomfortable, depending on average wind speed exceeded 20% of the time. For a point to be rated as suitable for Sitting, for example, the wind conditions must not exceed 10*km/h* (2.8*m/s*), more than 20% of the time. Thus, in the plots (Figure 6), the upper limit of each bar ends within the range described by the comfort category. For sitting, the rating would include conditions ranging from calm up to wind speeds that would rustle tree leaves or wave flags slightly, as presented in the Beaufort Scale included in the Appendices. As the name infers, the category is recommended for outdoor space where people might sit for extended periods.

The Standing category is slightly more tolerant of wind, including wind speeds from calm up to 15*km/h* (4.2*m/s*). In this situation, the wind would rustle tree leaves and, on occasion, move smaller branches while flags flap. This category would be suitable for locations where people might sit for short periods or stand in relative comfort. The Walking category includes wind speeds from calm up to 20*km/h* (5.6*m/s*). These winds would set tree limbs in motion, lift leaves, litter and dust, and the locations are suitable for activity areas. The Uncomfortable category covers a broad range of wind conditions that are generally a nuisance for most activities, including wind speeds above 20*km/h* (15.6*m/s*).

In Figure 6, the probe locations are listed along the bottom of the chart; beneath the graphical representation of the Mean Wind Speed exceeded 20% of the time. Along the right edge of the plot the comfort categories are shown. The background of the plot is lightly shaded in colours corresponding to the categories shown in Table 1. Each category represents a 5*km/h* (or more) interval. The location is rated as suitable for Sitting, Standing, Walking, or Uncomfortable, if the bar extends into the corresponding interval.

The charts represent the average person's response to wind force annually and for four seasons. Effects such as wind chill and humidex (based on perception) are not considered. Also clothing is not considered, since clothing and perceived comfort varies greatly among the population. There are many variables that contribute to a person's perception of the wind environment beyond the seasonal variations presented. While people are generally more tolerant of wind during the summer months, than during the winter, due to the wind cooling effect, people become acclimatized to a particular wind environment. Persons dwelling near the shore of an ocean, large lake or open field are more tolerant of wind than someone residing in a sheltered wind environment.

4.7 Pedestrian Safety Criteria

Safety criteria are also included in the analysis to ensure that strong winds do not cause a loss of balance to individuals occupying the area. The safety criteria are based on wind speeds exceeded nine times per year as shown in Table 2.

Both the Comfort and Safety Criteria are based on those developed at the Allan G. Davenport Wind Engineering Group Boundary Layer Wind Tunnel Laboratory, located on the campus of The University of Western Ontario. The comfort criteria were subsequently revised for the Mississauga Urban Design Terms of Reference for Wind Comfort and Safety Studies, in consultation with RWDI and more closely respects the Lawson criteria.

Table 2: Safety Criteria

ACTIVITY	Mean Wind Speed Exceeded 9 times per year		Description
SAFETY	***km/h***	***m/s*** (used in Fig. 8)	
All-Weather	0-90	0-25	Acceptable gust speeds that will not adversely affect a pedestrian's balance and footing.
Exceeding All-Weather	>90	>25	Excessive gust speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is typically required.

4.8 Pedestrian Comfort Criteria – Seasonal Variation

The level of comfort perceived by an individual is highly dependent on seasonal variations of climate. Perceived comfort is also specific to each individual, and depends on the clothing choices. The comfort criterion that is being used averages the results across the general population to remove effects of individuals and clothing choices, however, seasonal effects are important. For instance, a terrace or outdoor amenity space may have limited use during the winter season, but require acceptable comfort during the summer.

The comfort of a site is based on the "annual" results of the study, Figures 6a and 7a and 7b. In cases where seasonal comfort is important, results have been included for the seasons; winter, spring, summer, and fall (see Figures 6b to 6e and Figures 7c to 7j).

When compared to the annual average wind speed, winter winds are about 12.5% higher and summer winds are about 16% lower.

5. RESULTS

5.1 Study Site and Test Conditions

Proposed Development

The proposed Development occupies lands that are currently vacant, situated to the southwest of the intersection of Ninth Line and Doug Leavens Boulevard, in the City of Mississauga.

The Development involves a proposal to construct two 6 storey L-shaped buildings flanking a future 'Street F'. The main residential lobby for the west building is accessed via an entrance near the southeast corner of the building along Ninth Line. An internal driveway and drop-off area provides vehicular access to a secondary entrance at the inside corner. The east building is a mirror of the west building across the future 'Street F', however it is set back from the future street by a proposed park. The Development is proposed in the configuration shown in Figure 2b.

Although the townhouse blocks of Derry Brittania's North Draft Plan are not part of the proposal, they will influence the wind climate and were also included in the proposed configuration.

The Development, located in the City of Mississauga, is depicted in the Aerial Photo in Figure 2a. Note: Mississauga's street orientation is relative to the Lake Ontario Shoreline resulting in east/west orientated streets in the subject area being offset by approximately 45 degrees north.

Proposed Derry Britannia Development Site Looking Southwest (Google)

<u>Surrounding Area</u>

The proposed Development site, for all intents and purposes, is surrounded to prevailing windward directions by suburban development and open areas, as indicated in Figure 2a.

To the northwest through west to southeast of the site are open lands that are associated with future phases of the Derry Britannia Development, with Highway 407 and agricultural lands beyond. To the north of the site, on the other side of Ninth Line, is a low-rise commercial building with 1-2 storey single family dwelling neighbourhoods beyond to the north through east of the site. Farther beyond to the northeast and southeast are open lands associated with

Lisgard Fields and Cordingley Park, respectively. The setting is open to the prevailing winds to many compass points, affording wind opportunity to accelerate upon approach.

Macroclimate

For the proposed Development, the upstream wind flow during testing was conditioned to simulate an atmospheric boundary layer passing over suburban/open terrain. The terrain within the site's immediate vicinity was incorporated into the proximity model. Historical meteorological data recorded from the Toronto Pearson International Airport was used in this analysis. For studies in the City of Mississauga, the data is split up into four seasons, spring, summer, fall and winter, and the resulting wind roses are presented as mean velocity and percent frequency in Figures 5b-e. The mean velocities presented in the wind roses are measured at an elevation of 10*m*. Thus, representative ground level velocities at a height of 2*m*, for an urban macroclimate, are 52% of the mean values indicated on the wind rose, (for suburban and rural macroclimates the values are 63% and 78% respectively). The macroclimate for this area is predominantly suburban.

Winter (November 16 to March 31) has the highest mean velocities of the seasons with prevailing winds from the north and west, with significant components from north through west to southwest as indicated in Figure 5b. Spring (April 1 to June 15) has the second highest mean wind velocities and the prevailing winds tend to be from the North to West quadrant (Figure 5c). Summer (June 16 to September 15) has the lowest mean wind velocities of the seasons with prevailing winds from north through west to south as indicated in Figure 5d. During the fall, (September 16 to November 15) the possible directions for prevailing winds include the North to Southwest sector (Figure 5e). The magnitudes of the mean wind velocities are between spring and summer winds. Reported pedestrian comfort conditions generally pertain to annual conditions unless stated otherwise.

5.2 Pedestrian Level Wind Velocity Study

On the site model, thirty-two (32) wind velocity measurement probes were located around the Proposed Development and other buildings and activity areas to determine conditions related to comfort and safety. Figure 4 depicts probe locations at which pedestrian level wind velocity measurements were taken in the existing and proposed scenarios. For the existing setting, the subject building and townhouse blocks of Derry Brittania's North Draft Plan were removed, and the "existing" site model retested with the current site.

Measurements of pedestrian level mean and gust wind speeds at the various locations shown were taken over a period of time equivalent to one hour of measurements at full-scale. The mean ground level wind velocity measured is presented as a ratio of gradient wind speed, in the plots of Figure B in the Appendix, for each point in the existing and proposed scenarios. These relative wind speeds are presented as polar plots in which the radial distance for a particular wind direction represents the wind speed at the location for that wind direction, expressed as a ratio of the corresponding wind speed at gradient height. They do not assist in assessing wind comfort conditions until the probability distribution gradient wind speed and direction are applied.

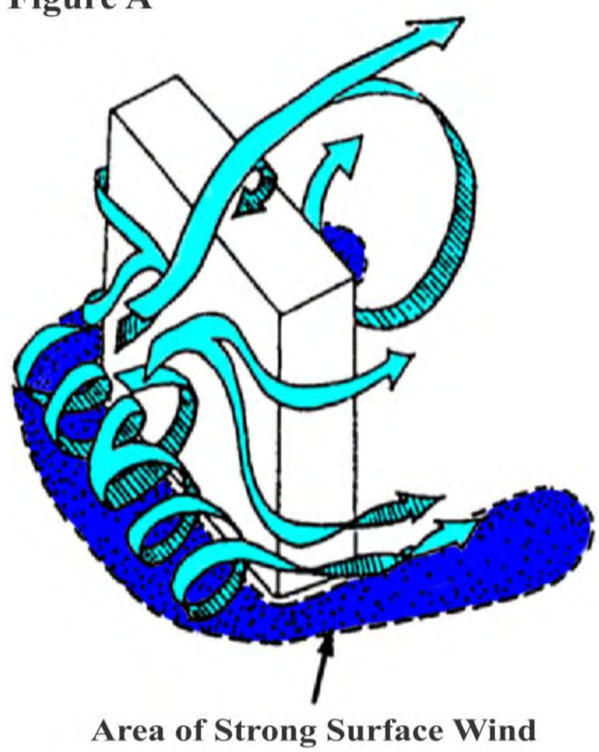
The design probability distribution gradient wind speed and direction, taken from historical meteorological data for the area (see Figures 5a – 5e) was combined with pedestrian level mean and gust wind speeds measured at each point to provide predictions of the percentage of time a point will be comfortable for a given activity. These predictions of mean and maximum or "gust" wind speeds are provided on a seasonal basis in Figures 6a – 6e.

The ratings for a given location are conservative by design; when the existing surroundings and proposed building's fine massing details and actual landscaping are taken into consideration, the results tend toward a more comfortable site than quantitative testing alone would indicate.

Venturi action, scour action, downwash and other factors, as discussed in the Appendix on wind flow phenomena, can be associated with large buildings, depending on their orientation and configuration. These serve to increase wind velocities. Open areas within a heavily developed area may also encounter high wind velocities. Consequently, wind force effects are common in heavily built-up areas. The Development site is open to a predominantly suburban setting to prevailing and remaining compass points with winds flowing over and between mature vegetation, low-rise buildings and open spaces. As such, the surroundings can be expected to influence wind at the site to varying degrees. Note: Probes are positioned at points typically subject to windy conditions in a suburban environment in order to determine the worst-case scenario.

High-rise buildings may exacerbate wind conditions within their immediate vicinity, to varying degrees, by redirecting wind currents to the ground level and along streets and open areas. In general, wind will split upon impact with a high-rise building, with portions flowing down the face of the building to the pedestrian level as downwash, where it is deflected, or otherwise redirected to flow along the building and around its corners, creating localized zones of increased pedestrian level wind (Figure A). Conversely, points situated to the leeside, or in the wake of buildings will often enjoy an improvement in pedestrian comfort. As such, it is reasonable to expect inclusion of the proposed development will alter wind conditions under specific wind directions and velocities from those of the existing site condition, resulting in an improvement over the existing conditions at some points, with more windy conditions at others.

Figure A



It should be noted that probes are positioned at points typically subject to windy conditions in a suburban/urban environment in order to determine the worst-case scenario.

5.3 Review of Probe Results

The probe results, as follows, were clustered into groups comprised of Public Street Conditions, Future Street Conditions, Park Conditions, and Pedestrian Entrance Conditions. The measurement locations are depicted in Figure 4 and the resulting pedestrian comfort conditions are listed in Figures 6a – 6e annually and for the seasons for the existing and proposed configurations. The results are also graphically depicted annually, and for the seasons in Figures 7a – 7j. The following discusses anticipated wind conditions and suitability for the points' intended use.

Public Street Conditions

Ninth Line

Probes 1 through 7 were located along Ninth Line within the zone of influence of the proposed Development, as indicated in Figure 4. Of these probe locations, all indicate annual wind conditions that are suitable for standing in the existing setting, with the exception of probe 1 that is rated suitable for walking. The ratings are attributable to the open setting to the northwest through west to southeast that affords winds opportunity to accelerate over the open lands and along the street.

Most of these points realise an improvement over the existing setting with inclusion of the proposed Development for specific wind directions, however, there are directions from which the wind is exacerbated. As such, many of the points retain their annual comfort rating, with the exception of probe 1 that improves from walking to standing, and probe 5 that improves from standing to sitting. The street realises improvements due to the significant blockage from the inclusion of the proposed and the future townhouse blocks to winds emanating from the west through southeast. However, the street is exposed to winds emanating from the northwest, in general alignment with the street, as well as winds emanating from the southern directions, flowing around the subject buildings and through gaps between.

During the winter months there is a greater propensity for westerly through southwesterly winds, and winter winds tend to be stronger, resulting in generally windier conditions along the street, suitable for walking in the existing setting. Inclusion of the proposed Development results in more comfortable winter conditions, with points 1, 2, 6, and 7 improving to standing and point 5 improving to sitting.

With inclusion of the proposed Development, Ninth Line falls within the pedestrian level wind velocity safety criteria as All-Weather Areas, as described in Section 4.7 and depicted in Figure 9.

Doug Leavens Boulevard
Probes 8 through 13 were located along Doug Leavens Boulevard and indicate annual wind conditions that are suitable for standing in the existing setting.

With inclusion of the proposed Development, Doug Leavens Boulevard realises similar, though slightly improved conditions, the improvement realised at probe 11 sufficient to cause a change from annually appropriate for standing to sitting. The improvements realised can be attributed to the proposed development presenting increased blockage to winds emanating from the southwest, resulting in the observed leeward effect.

With inclusion of the proposed Development, Doug Leavens Boulevard falls within the pedestrian level wind velocity safety criteria as All-Weather Areas, as described in Section 4.7 and depicted in Figure 9.

Future Street Conditions

Future Street F
Probes 14 through 18 were located along the Future Street F, extending southwest from the existing Doug Leavens Boulevard. The future street is not present in the existing setting, however, the probes on the open lands associated with the area are rated as annually suitable for walking or standing. Note: this open area realises annual comfort ratings that are very near the transition between the walking and standing comfort ratings. As such a minor variation in the measured wind velocity may be enough to cause a switch in the ratings.

The proposed Development provides blockage to winds flowing over the future street, and as a result the street will realise annually comfortable conditions in the proposed setting, suitable for standing, with the exception of probe 15 that is suitable for sitting. In the winter months, the street will realise slightly windier conditions, but with inclusion of the proposed Development, all probes change from walking to standing with the exception of probe 17 which remains suitable for walking. These conditions are typical of such areas where pedestrian level winds are moderately mitigated on approach by the surrounding low-rise buildings, related parking and green space. A rating of walking is appropriate for sidewalks and as such the Future Street F will realise comfortable conditions, suitable for the intended use.

With inclusion of the proposed Development, Future Street F falls within the pedestrian level wind velocity safety criteria as All-Weather Areas, as described in Section 4.7 and depicted in Figure 9.

Future Street A
Probes 19 through 22 were located along the Future Street A, extending along the southwest border of the site. The future street is not present in the existing setting, however, the probes on the open lands associated with the area are rated as annually suitable for walking or standing.

With inclusion of the proposed Development the area realises a general improvement to wind, sufficient for conditions suitable for standing along the future street, with the exception of probe 22 that is suitable for sitting. A rating of walking is appropriate for sidewalks and as such the area will realise comfortable conditions, appropriate for the intended use.

With inclusion of the proposed Development, Future Street A falls within the pedestrian level wind velocity safety criteria as All-Weather Areas, as described in Section 4.7 and depicted in Figure 9.

Future Streets D & E

Probes 23 and 28 are situated on Streets D and E, to the south and north of the proposed Development, respectively. The future streets are not present in the existing setting, however the probes on the open lands associated with the area are rated as annually suitable for standing.

Streets D and E are located between the proposed Development and the adjacent future townhouse blocks of Derry Brittania's North Draft Plan. With inclusion of the proposed Development and the adjacent townhouses, the future streets are well protected from the majority of the wind climate, resulting in conditions suitable for sitting year-round. A rating of walking is appropriate for sidewalks and as such the streets will realise comfortable conditions, appropriate for the intended use.

With inclusion of the proposed Development, Future Streets D and E fall within the pedestrian level wind velocity safety criteria as All-Weather Areas, as described in Section 4.7 and depicted in Figure 9.

Park Conditions

A Linear Park is proposed between the proposed subject buildings, to the southeast of the Future Street F. The park area is represented by probes 24 through 26 and is predicted to be suitable for standing year-round. Slightly windier winter conditions are realised at the north extents of the park, suitable for walking, and more comfortable summer conditions are realised at the south of the park, suitable for sitting. The park is well protected from much of the dominant wind climate by the proposed Development and surroundings, however, the area is susceptible to winds from the northeasterly and southwesterly quadrants being deflected to flow down, around and through the gap between the buildings.

Probe 27 is located in the park area to the southwest of the proposed west building. The area is predicted to be relatively comfortable, suitable for sitting in the summer, and standing throughout the balance of the seasons.

The analysis was conducted without the subject buildings' fine design features or existing and proposed hard and soft landscape features in place. The park areas will realise more comfortable conditions with consideration of these fine design elements, likely resulting in conditions suitable for sitting in the summer and into the shoulder seasons. If more comfortable conditions are desired further into the shoulder seasons and winter months, a mitigation plan may be developed in cooperation with the wind consultant in order to accommodate activities requiring longer exposure times than those predicted.

The aforementioned park areas fall within the pedestrian level wind velocity safety criteria as All Weather Areas.

Pedestrian Entrance Conditions

Probes 29 and 30 were situated proximate to the west building's Main Entrances at the interior drop off area and along Ninth Line, respectively. The probes indicate comfortable conditions, annually suitable for sitting and standing, respectively, and as such, the locations are appropriate to the intended purpose.

Probes 31 and 32 were similarly situated proximate to the east building's Main Entrances along Ninth Line and the interior drop off area, respectively. The probes indicate comfortable conditions, suitable for sitting year-round, and as such are appropriate to the intended purpose.

Wind conditions comfortable for standing or better are preferable at building entrances, while conditions suitable for walking are suitable for sidewalks. Conditions at the proposed main residential entrances are suitable for standing or better, year-round, and appropriate to the intended purpose. Consideration of existing and proposed surface roughness features too fine to incorporate into the massing model will further improve the comfort ratings.

With inclusion of the proposed Development, the above-mentioned entrances, fall within the pedestrian level wind velocity safety criteria as All-Weather Areas, as described in Section 4.7 and depicted in Figure 9.

6. SUMMARY

The observed wind velocity and flow patterns at the Development are largely influenced by approach wind characteristics that are dictated by the suburban/open mix of low-rise residential development, agricultural lands, and green spaces supporting mature vegetation, mitigating the wind to different degrees, on approach. Historical weather data indicates that strong winds of a mean wind speed greater than 30 km/h occur approximately 13 percent of the time during the winter months and 4 percent of the time during the summer. Once the subject site is developed, ground level winds at several locations will improve, with occasional localized areas of higher pedestrian level winds. The relationship between surface roughness and wind is discussed in the Appendix and shown graphically in Figure A of the same section.

Consideration of existing and proposed building features too fine to incorporate into the massing model, along with recommended mitigation through the implementation of the landscape plan, will improve the predicted comfort ratings beyond those reported herein, resulting in conditions suitable for the intended use, most of the time.

As such, the site is predicted comfortable under normal wind conditions annually; however, under high ambient winter wind conditions with winds emanating from specific directions several localized areas may be windy from time to time, but the area remains appropriate to the intended purpose. The consideration of proposed surface roughness will result in conditions more comfortable than those reported herein.

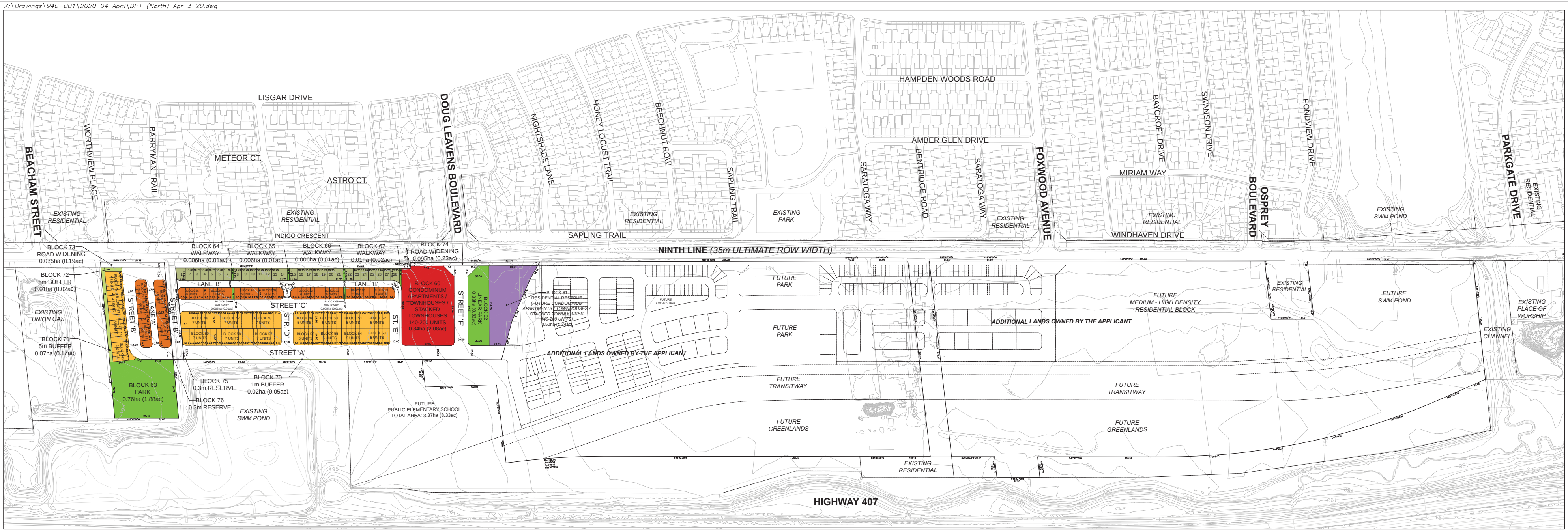
The proposed Park area may require application of a mitigation plan if longer exposure times are desired further into the shoulder seasons and winter months.

7. FIGURES

Figure 1: Laboratory Testing Facility

Figure 2a: Site Aerial Photo

Figure 2b: Site Plan



DRAFT PLAN OF SUBDIVISION DERRY BRITANNIA DEVELOPMENTS LIMITED (NORTH PROPERTIES)

PART OF LOTS 6,7,8 & 9, CONCESSION 9, N.S.
CITY OF MISSISSAUGA
REGIONAL MUNICIPALITY OF PEEL

OWNERS CERTIFICATE

I HEREBY AUTHORIZE GLEN SCHNARR & ASSOCIATES INC. TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION TO THE CITY OF MISSISSAUGA FOR APPROVAL.

SIGNED [signature] DATE MAY 9, 2019
TIM WARNER, A.S.O.
DERRY BRITANNIA DEVELOPMENTS LIMITED

SURVEYORS CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AS SHOWN ON THIS PLAN AND THEIR RELATIONSHIP TO ADJACENT LANDS ARE CORRECTLY AND ACCURATELY SHOWN.

SIGNED [signature] DATE MAY 23, 2019
SUNIL PERERA, O.L.S.
J.D. BARNES LIMITED

ADDITIONAL INFORMATION

(UNDER SECTION 51(17) OF THE PLANNING ACT) INFORMATION REQUIRED BY CLAUSES A,B,C,D,E,F,G,J & L ARE SHOWN ON THE DRAFT AND KEY PLANS.

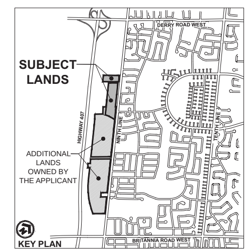
H) MUNICIPAL AND PIPED WATER TO BE PROVIDED
I) SANDY LOAM AND CLAY LOAM
K) SANITARY AND STORM SEWERS TO BE PROVIDED

NOTES

- ALL DAYLIGHT ROUNDINGS ARE 5m UNLESS OTHERWISE NOTED

LAND USE SCHEDULE

LAND USE	LOTS / BLOCKS	AREA (ha)	AREA (ac)	TOTAL UNITS	DENSITY (UPNHA)
REAR LANE DETACHED - 10.7m (35')	1-28	0.56	1.38	28	50.0
REAR LANE TOWNHOUSE - 6.05m (20')	29-41	0.80	1.98	69	86.3
STREET TOWNHOUSE - 6.0m (20')	42-59	1.70	4.20	101	59.4
CONDO APARTMENTS / TOWNS / STACKS	60	0.84	2.08	140-200	166.7-238.1
RESIDENTIAL RESERVE	61	0.50	1.24		
PARK / WALKWAY	62-69	1.13	2.79		
BUFFERS	70-72	0.10	0.25		
ROAD WIDENINGS	73,74	0.17	0.42		
0.3m RESERVES	75,76	0.00	0.00		
10.0m LANEWAY (447m LENGTH)		0.46	1.14		
17.0m LOCAL ROW (634m LENGTH)		1.10	2.72		
20.0m LOCAL ROW (572m LENGTH)		1.17	2.89		
TOTAL	**76**	**8.53**	**21.08**	**338-398**	**86.7-102.1**



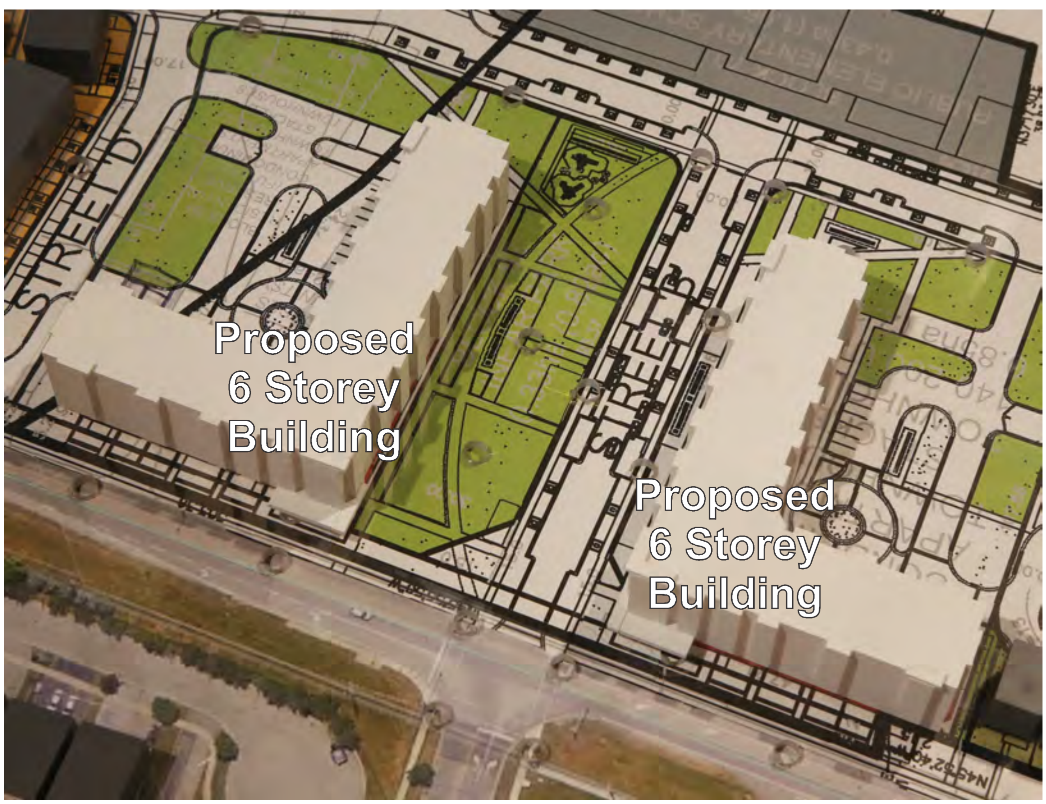
SCALE: 1:2000
(24" x 45")
APRIL 3, 2020

mattamyHOMES

GSAI
Glen Schnarr & Associates Inc.

Figure 3: 1:500 Scale model of test site

a) Overall view of model - Proposed Site



b) Close-up view of model - Proposed Site

Figure 4: Location plan for pedestrian level wind velocity measurements.

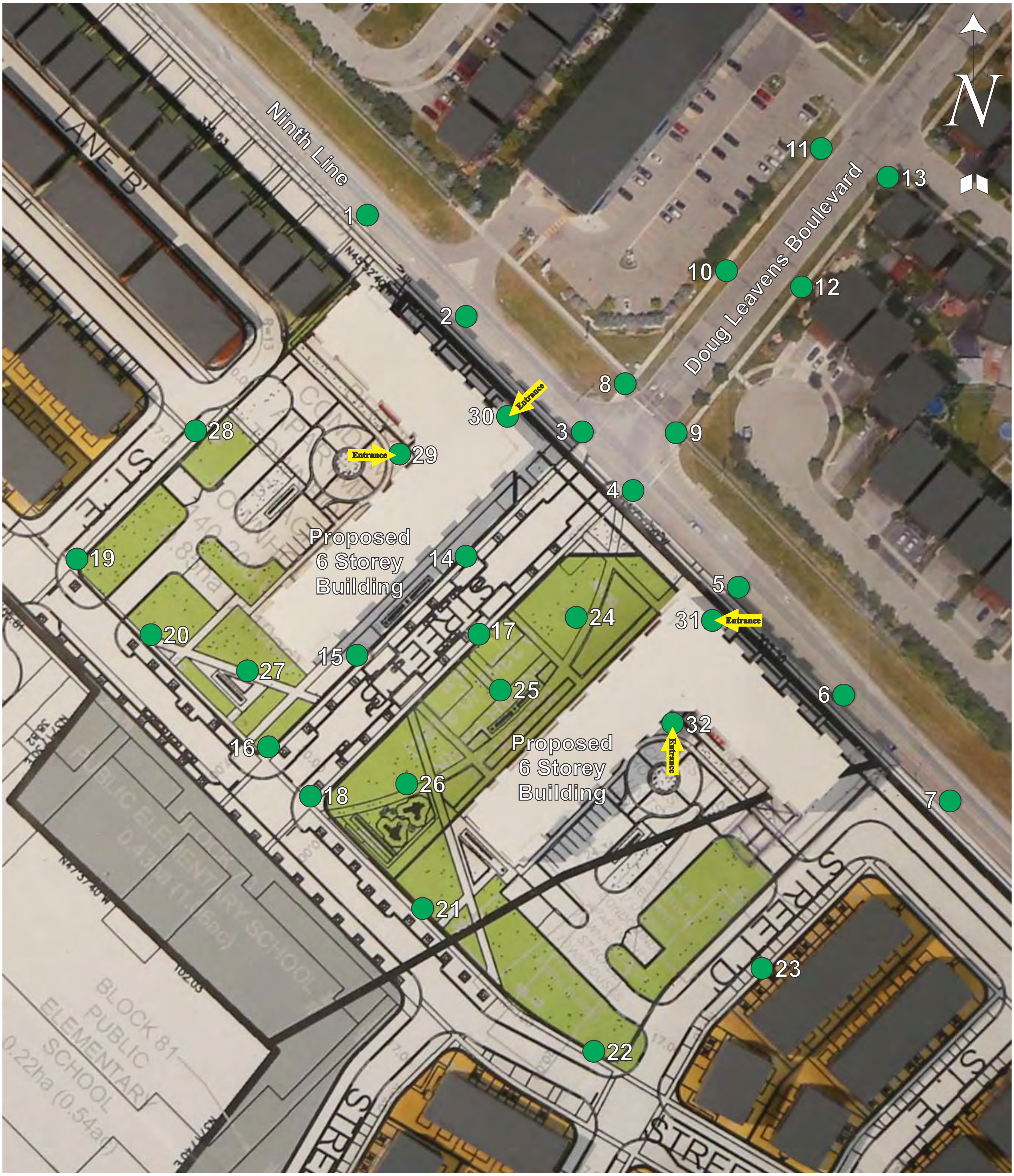
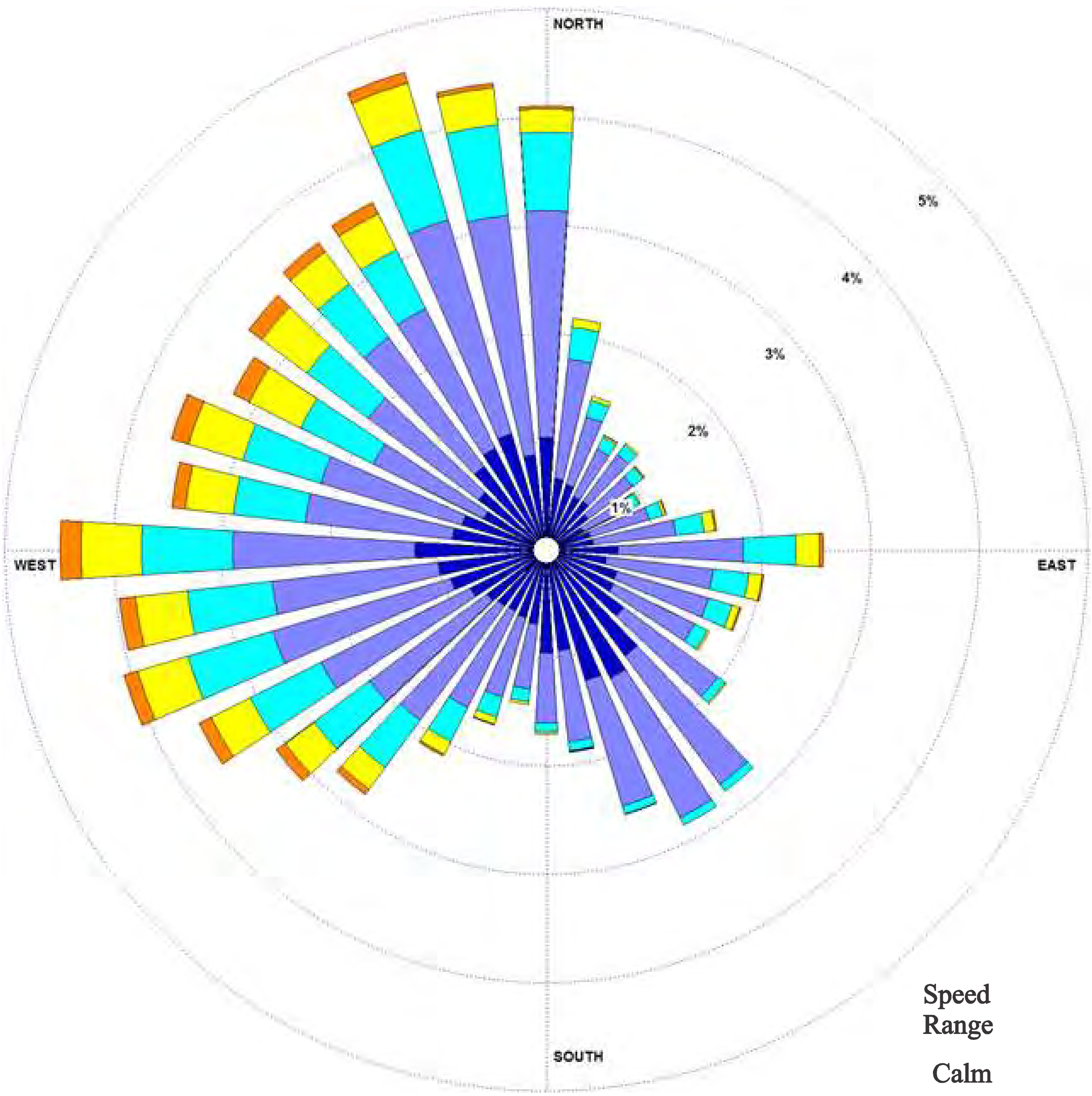


Figure 5a: Annual Wind Rose - Pearson International Airport.

Historical Directional Distribution of Winds (@ 10*m* height)
(1980 - 2017)



Speed Range	
Calm	6%
1 - 10*km/h*	29%
11 - 20*km/h*	42%
21 - 30*km/h*	14%
31 - 40*km/h*	7%
> 40*km/h*	2%

Figure 5b: Winter Wind Rose - Pearson International Airport.

Historical Directional Distribution of Winds (@ 10*m* height)
November 16 through March 31 (1980 - 2017)

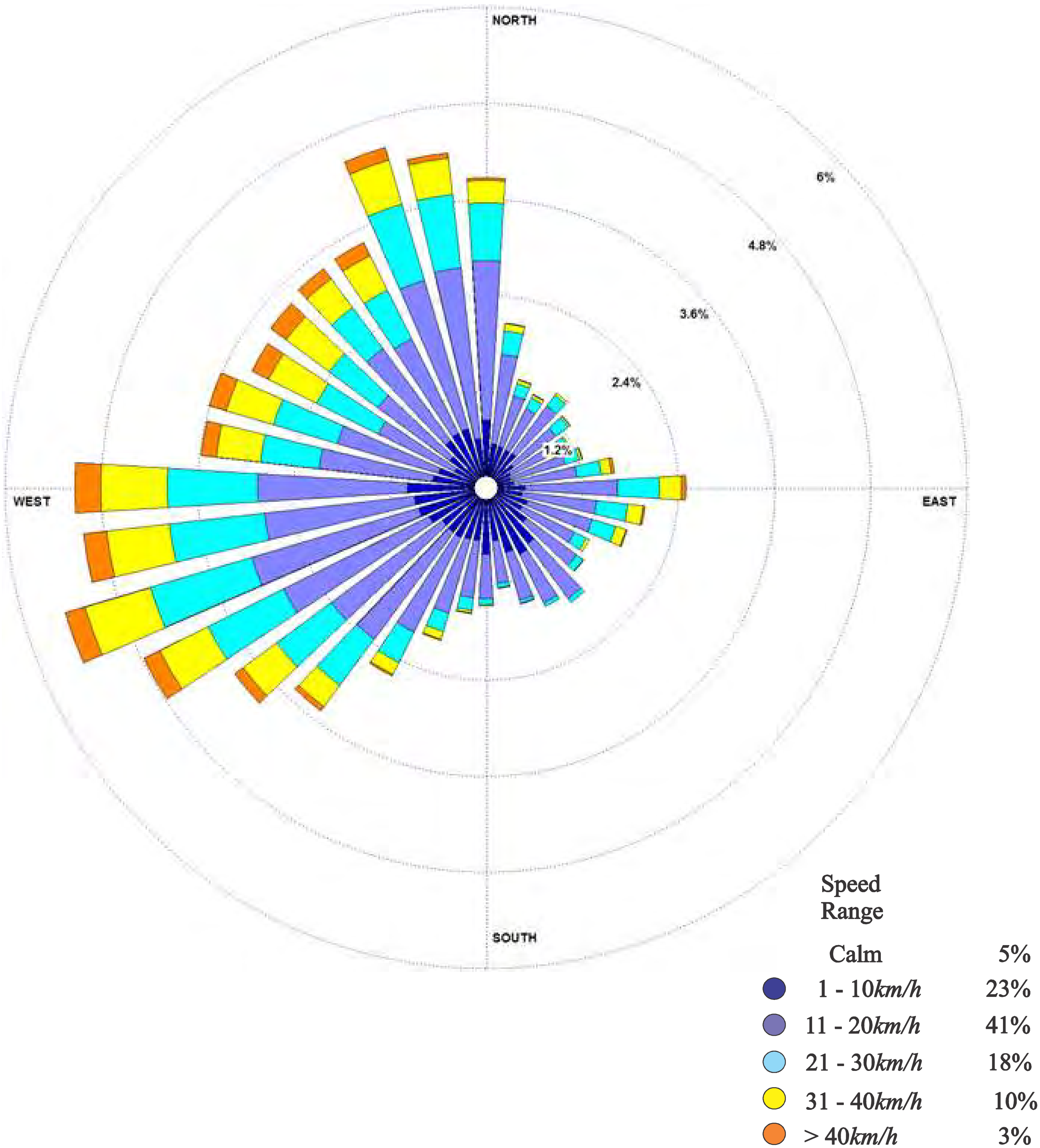
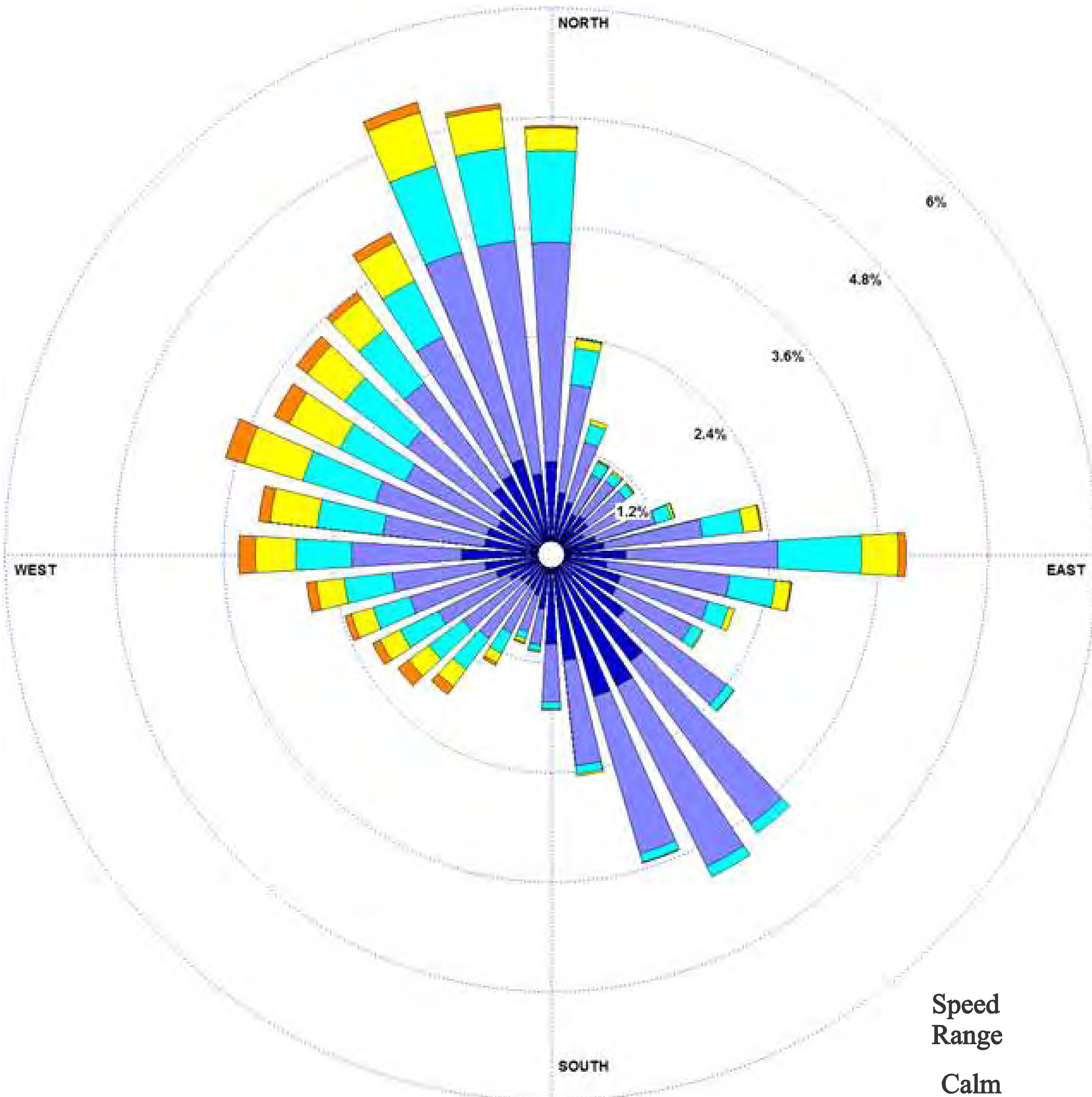


Figure 5c: Spring Wind Rose - Pearson International Airport.

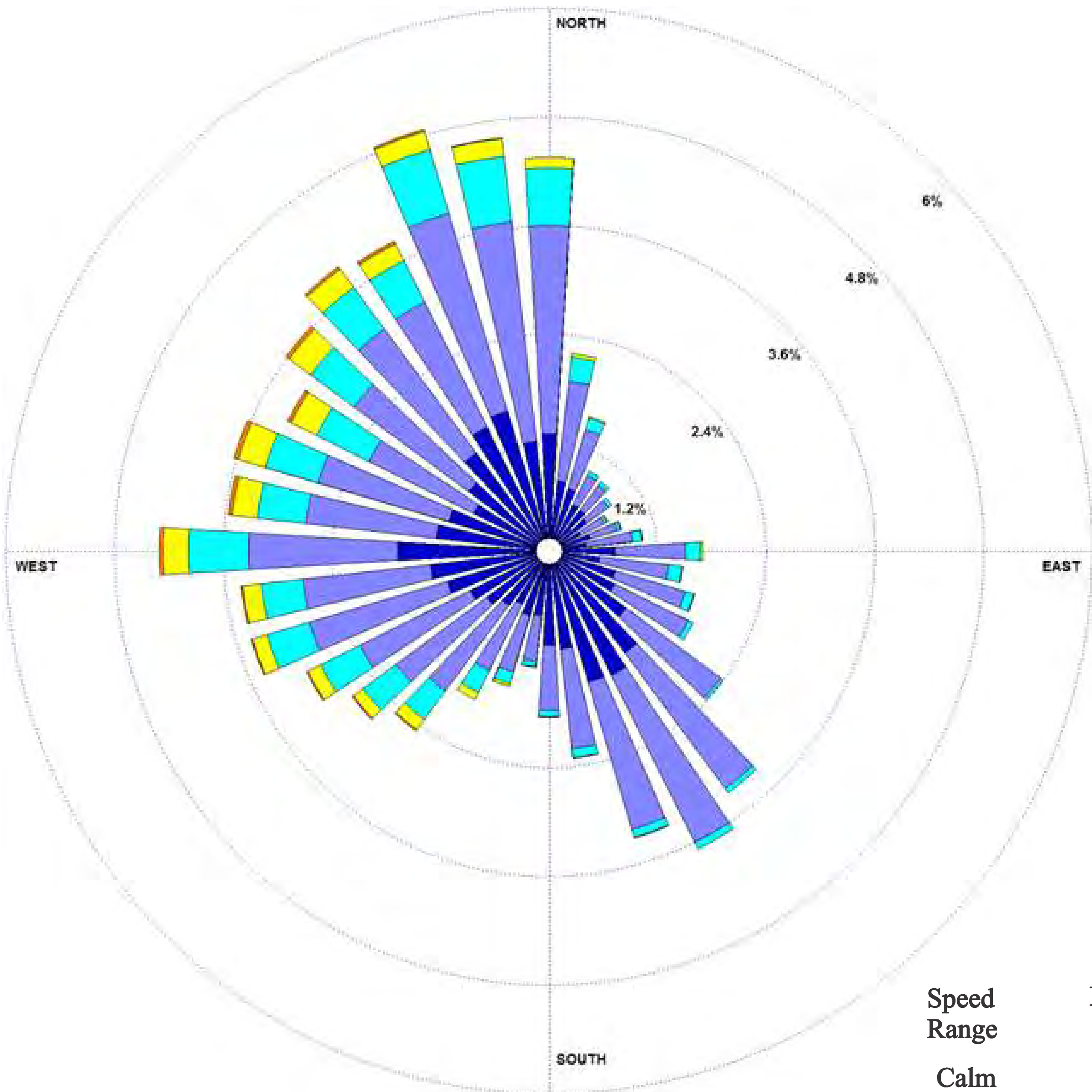
Historical Directional Distribution of Winds (@ 10*m* height)
April 1 through June 15 (1980 - 2017)



Speed Range	Probability (%)
Calm	5%
1 - 10*km/h*	28%
11 - 20*km/h*	42%
21 - 30*km/h*	15%
31 - 40*km/h*	8%
> 40*km/h*	2%

Figure 5d: Summer Wind Rose - Pearson International Airport.

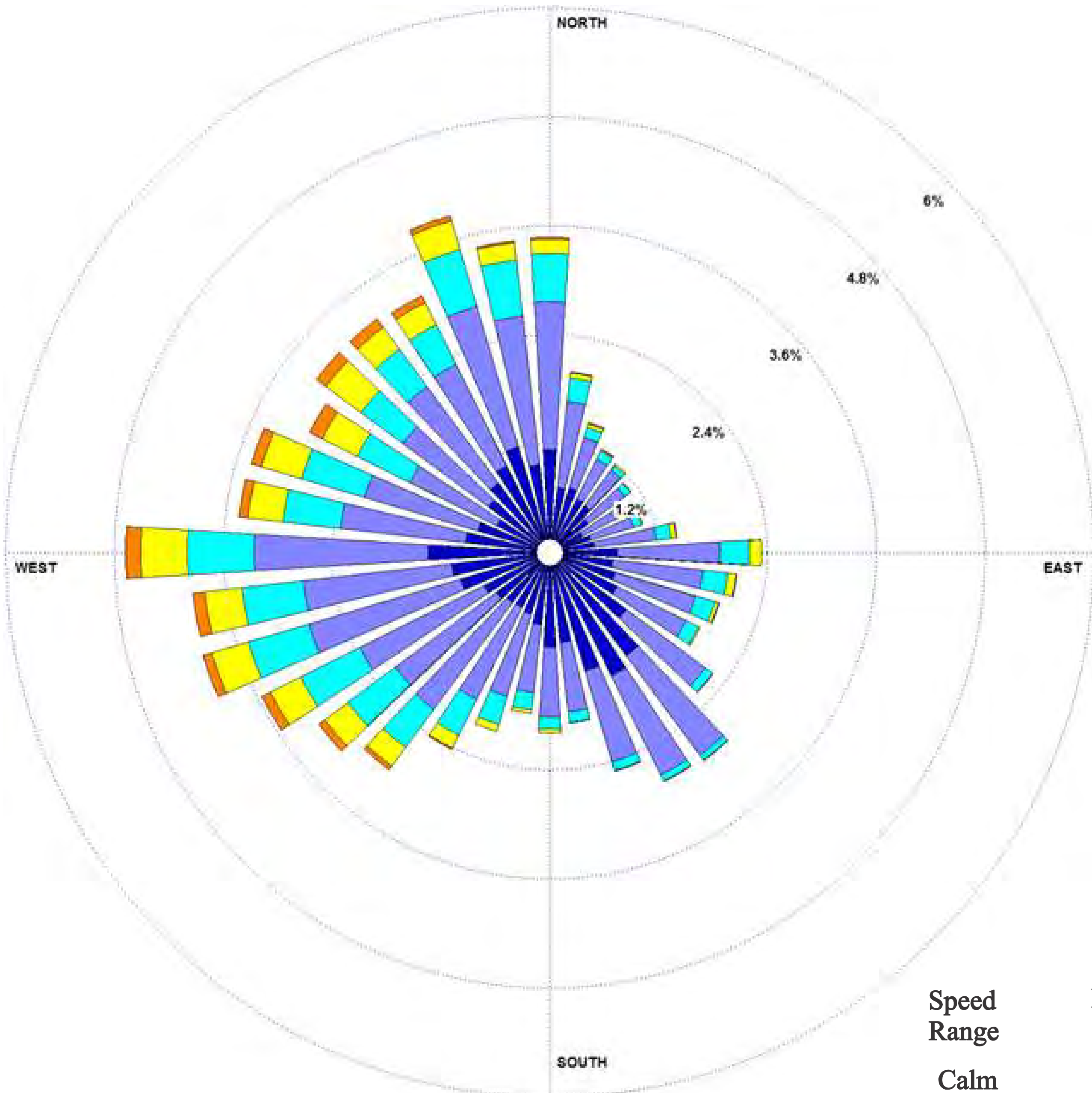
Historical Directional Distribution of Winds (@ 10*m* height)
June 16 through September 15 (1980 - 2017)



Speed Range	Probability (%)
Calm	8%
1 - 10*km/h*	35%
11 - 20*km/h*	42%
21 - 30*km/h*	11%
31 - 40*km/h*	4%
> 40*km/h*	<1%

Figure 5e: Fall Wind Rose - Pearson International Airport.

Historical Directional Distribution of Winds (@ 10*m* height)
September 16 through November 15 (1980 - 2017)



Speed Range	Probability (%)
Calm	8%
1 - 10*km/h*	31%
11 - 20*km/h*	40%
21 - 30*km/h*	13%
31 - 40*km/h*	6%
> 40*km/h*	2%

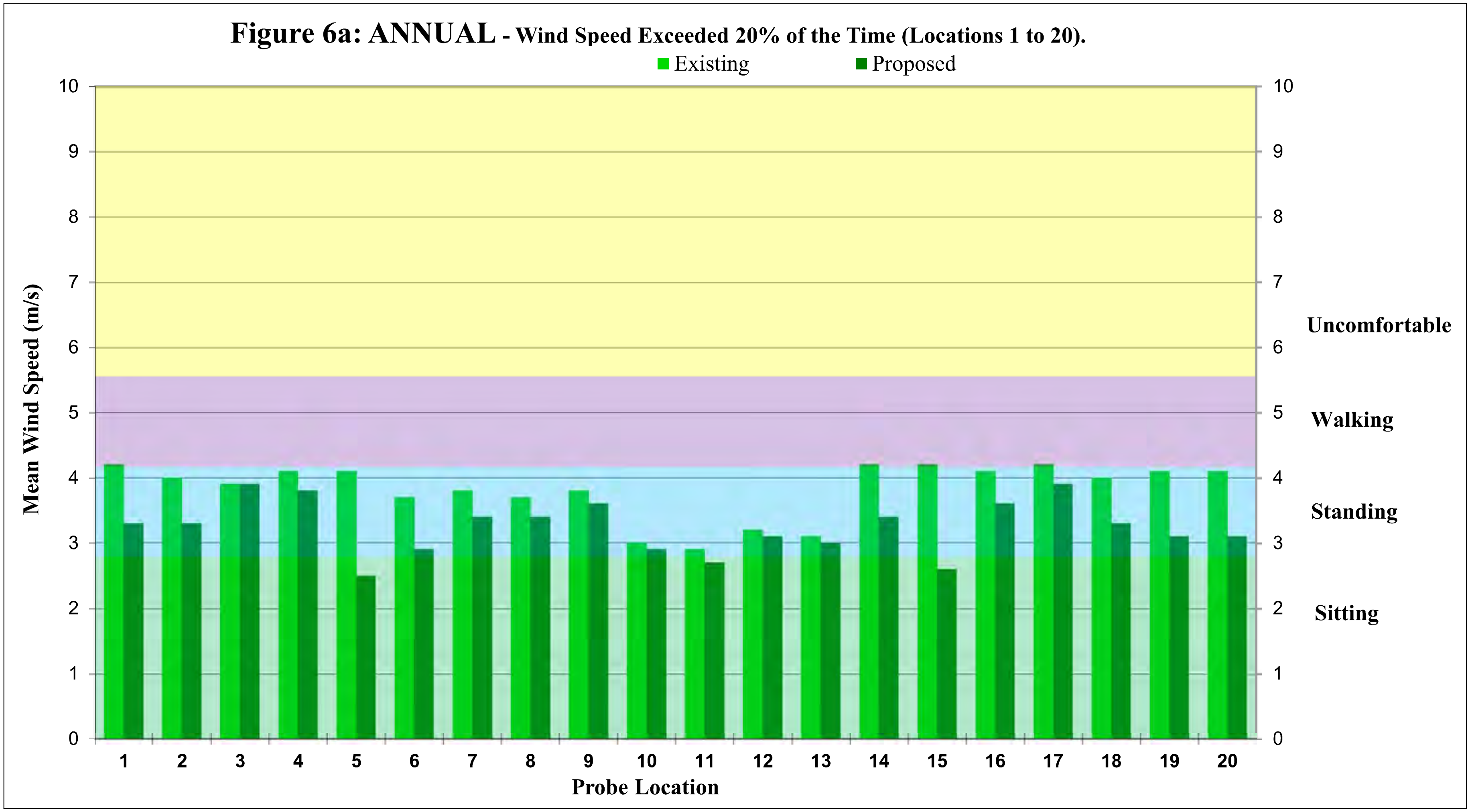


Figure 6a: ANNUAL - Wind Speed Exceeded 20% of the Time (Locations 1 to 20).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
Uncomfortable
Walking
Standing
Sitting
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

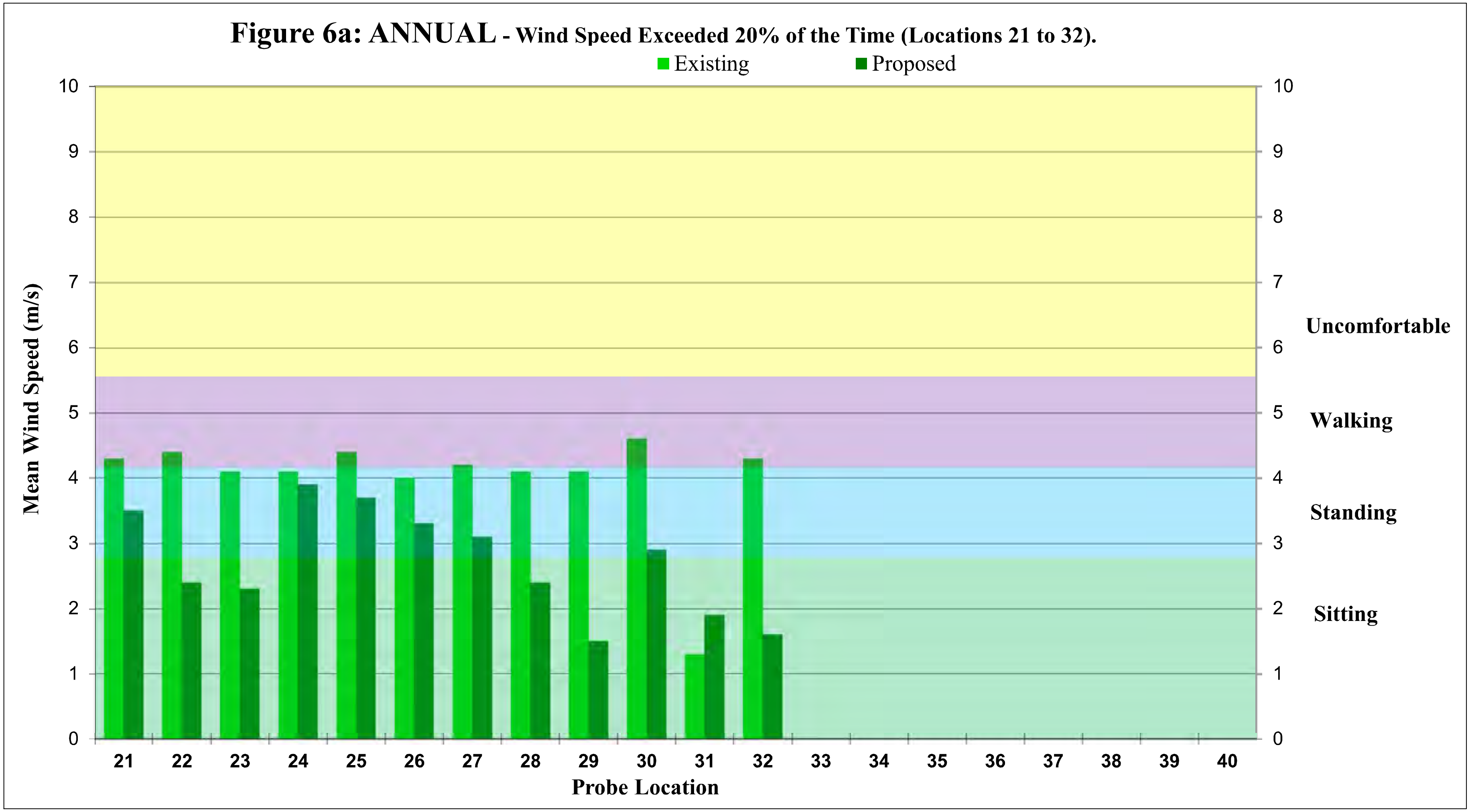


Figure 6a: ANNUAL - Wind Speed Exceeded 20% of the Time (Locations 21 to 32).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
Uncomfortable
Walking
Standing
Sitting
0
1
2
3
4
5
6
7
8
9
10
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

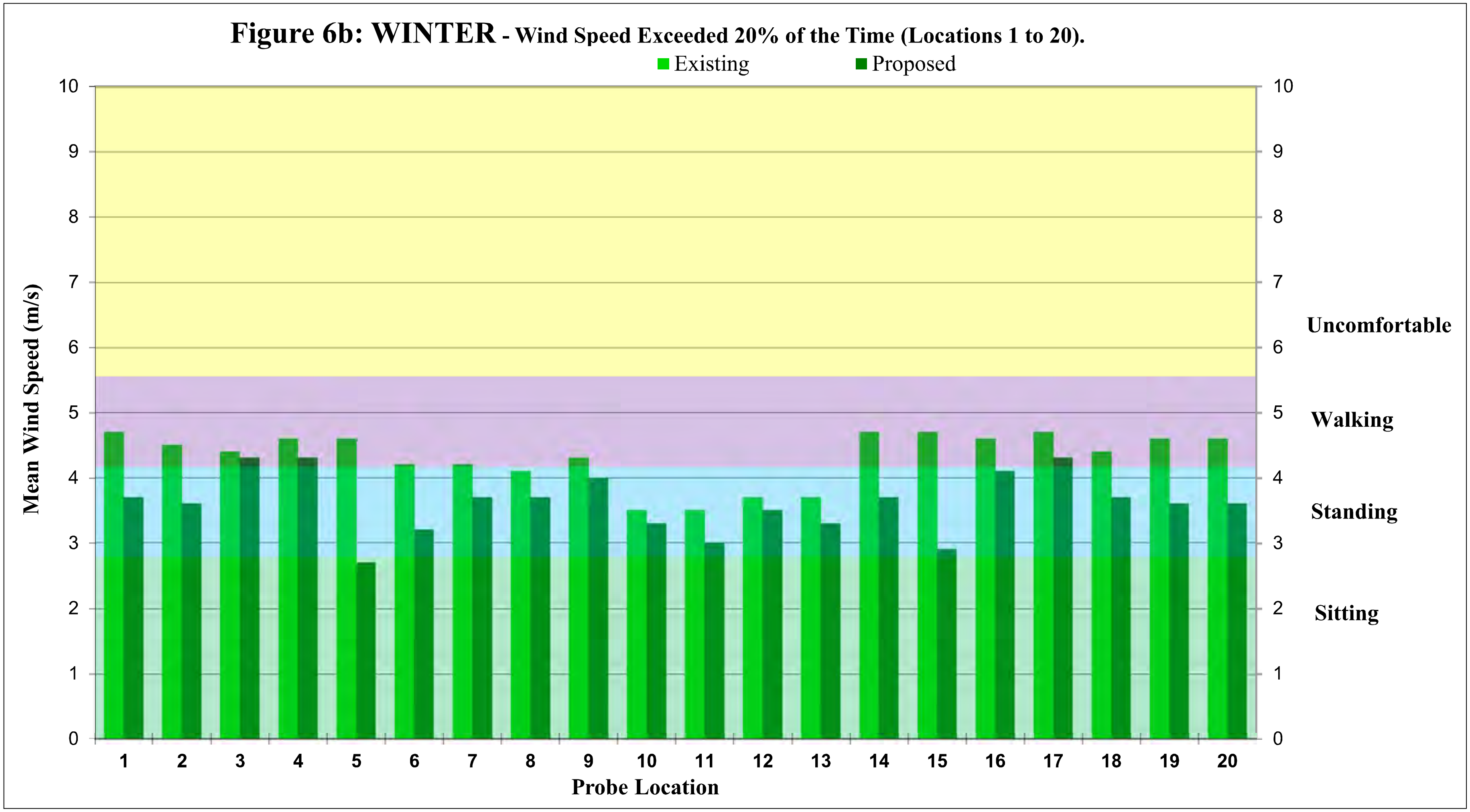


Figure 6b: WINTER - Wind Speed Exceeded 20% of the Time (Locations 1 to 20).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
Uncomfortable
Walking
Standing
Sitting
0
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

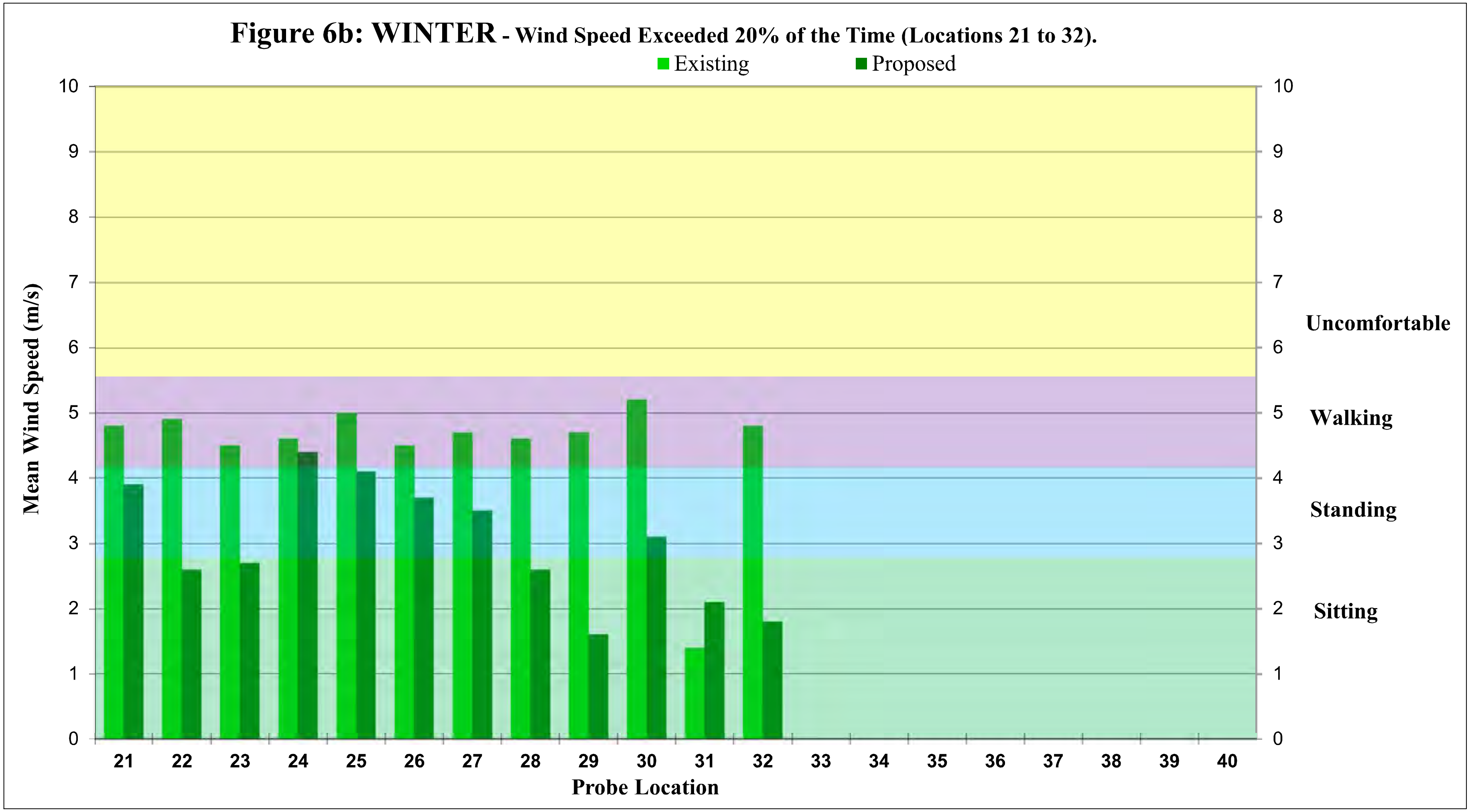


Figure 6b: WINTER - Wind Speed Exceeded 20% of the Time (Locations 21 to 32).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
Uncomfortable
Walking
Standing
Sitting
0
1
2
3
4
5
6
7
8
9
10
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

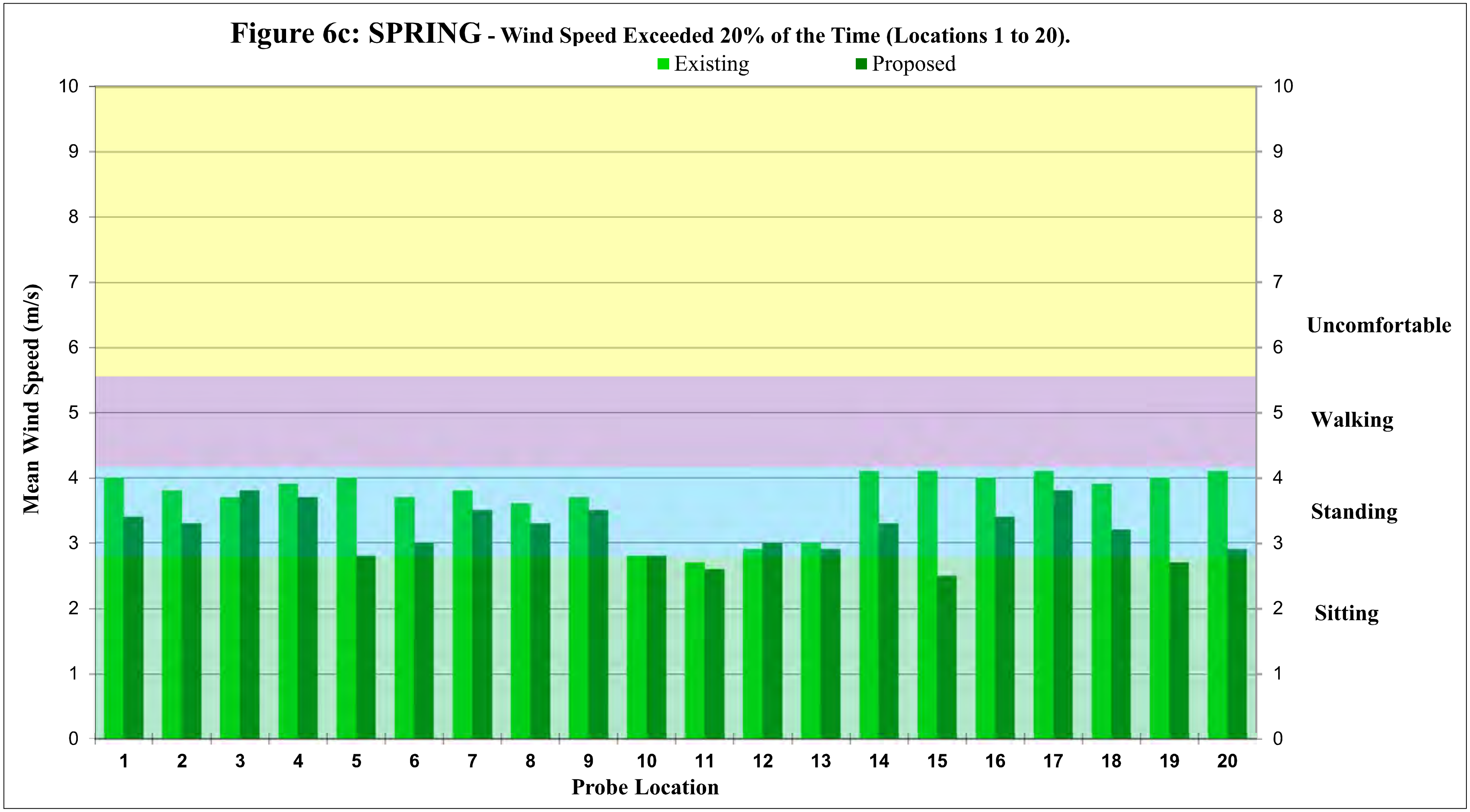
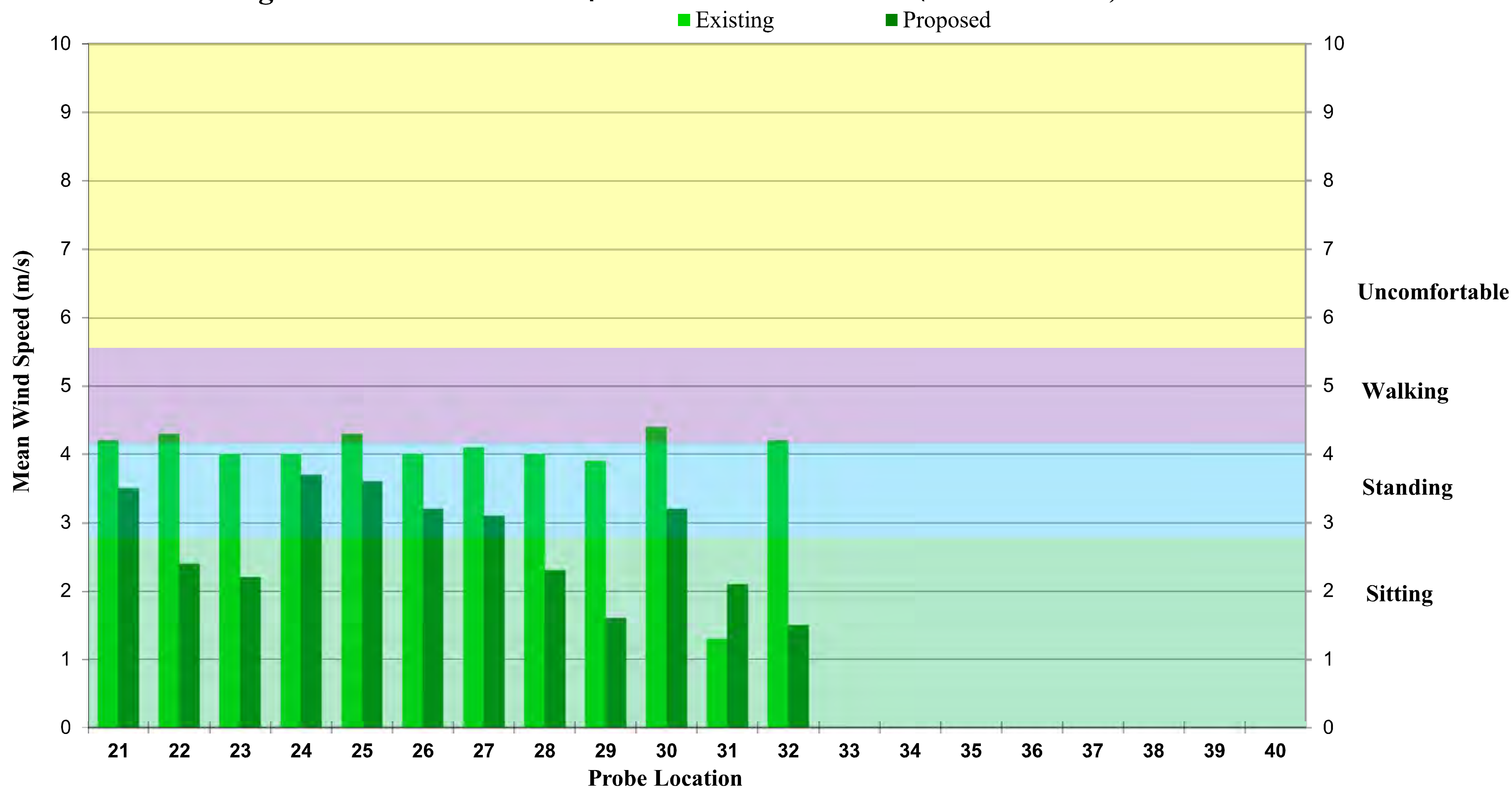


Figure 6c: SPRING - Wind Speed Exceeded 20% of the Time (Locations 1 to 20).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
Uncomfortable
Walking
Standing
Sitting
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Figure 6c: SPRING - Wind Speed Exceeded 20% of the Time (Locations 21 to 32).



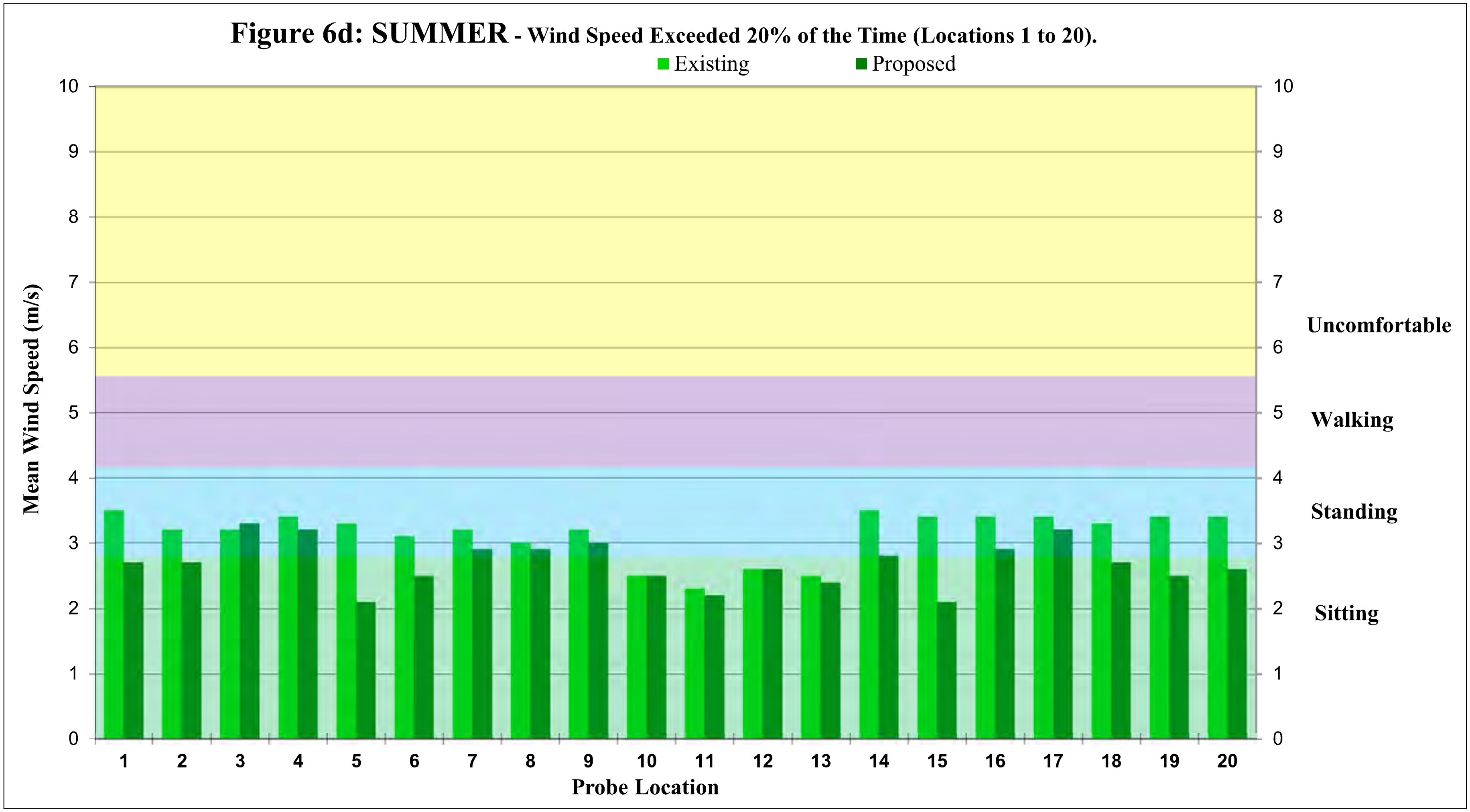


Figure 6d: SUMMER - Wind Speed Exceeded 20% of the Time (Locations 1 to 20).
Existing
Proposed
Mean Wind Speed (m/s)
0
1
2
3
4
5
6
7
8
9
10
Uncomfortable
Walking
Standing
Sitting
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Probe Location

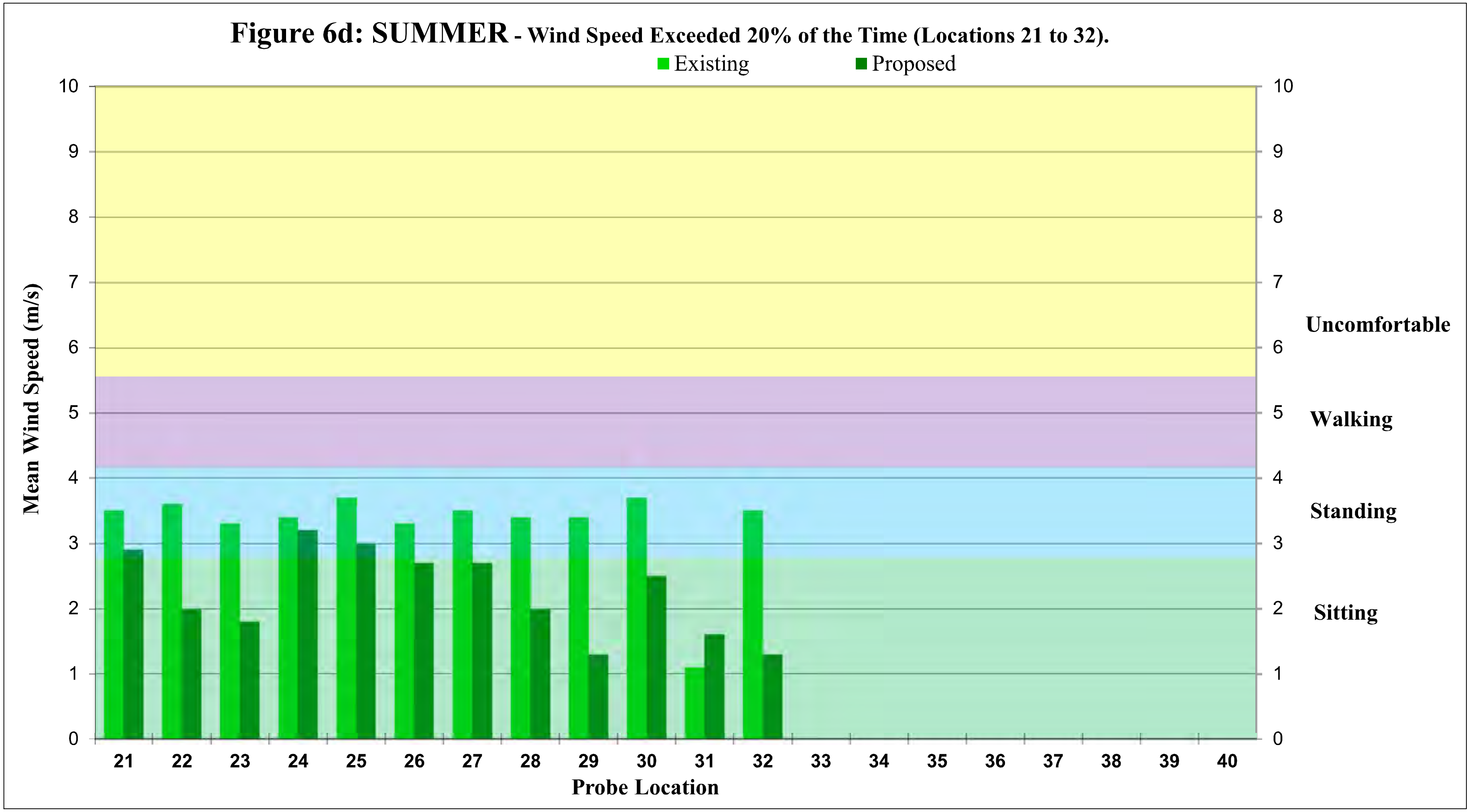


Figure 6d: SUMMER - Wind Speed Exceeded 20% of the Time (Locations 21 to 32).
Existing
Proposed
Mean Wind Speed (m/s)
0
1
2
3
4
5
6
7
8
9
10
Uncomfortable
Walking
Standing
Sitting
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Probe Location

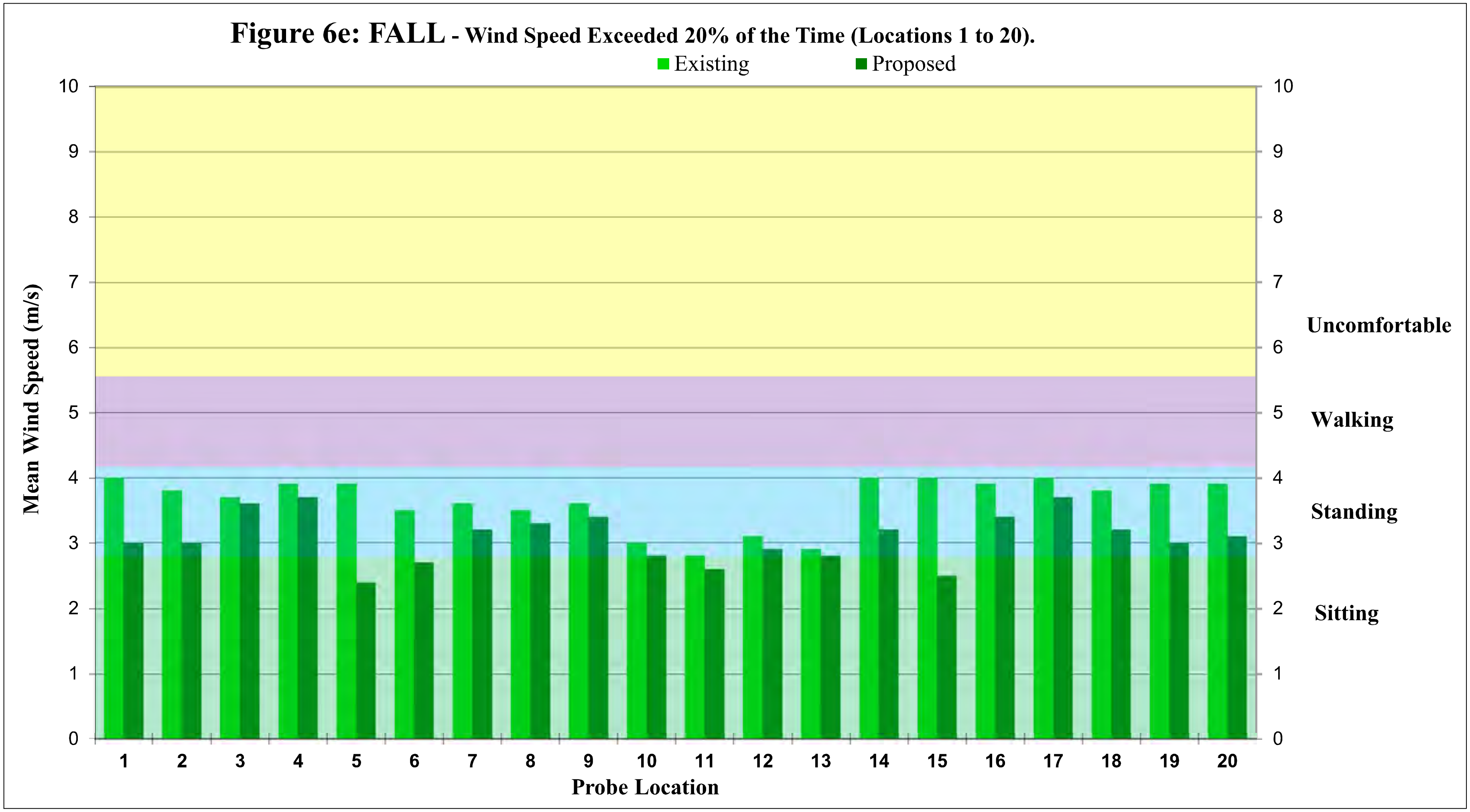


Figure 6e: FALL - Wind Speed Exceeded 20% of the Time (Locations 1 to 20).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
Uncomfortable
Walking
Standing
Sitting
0
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

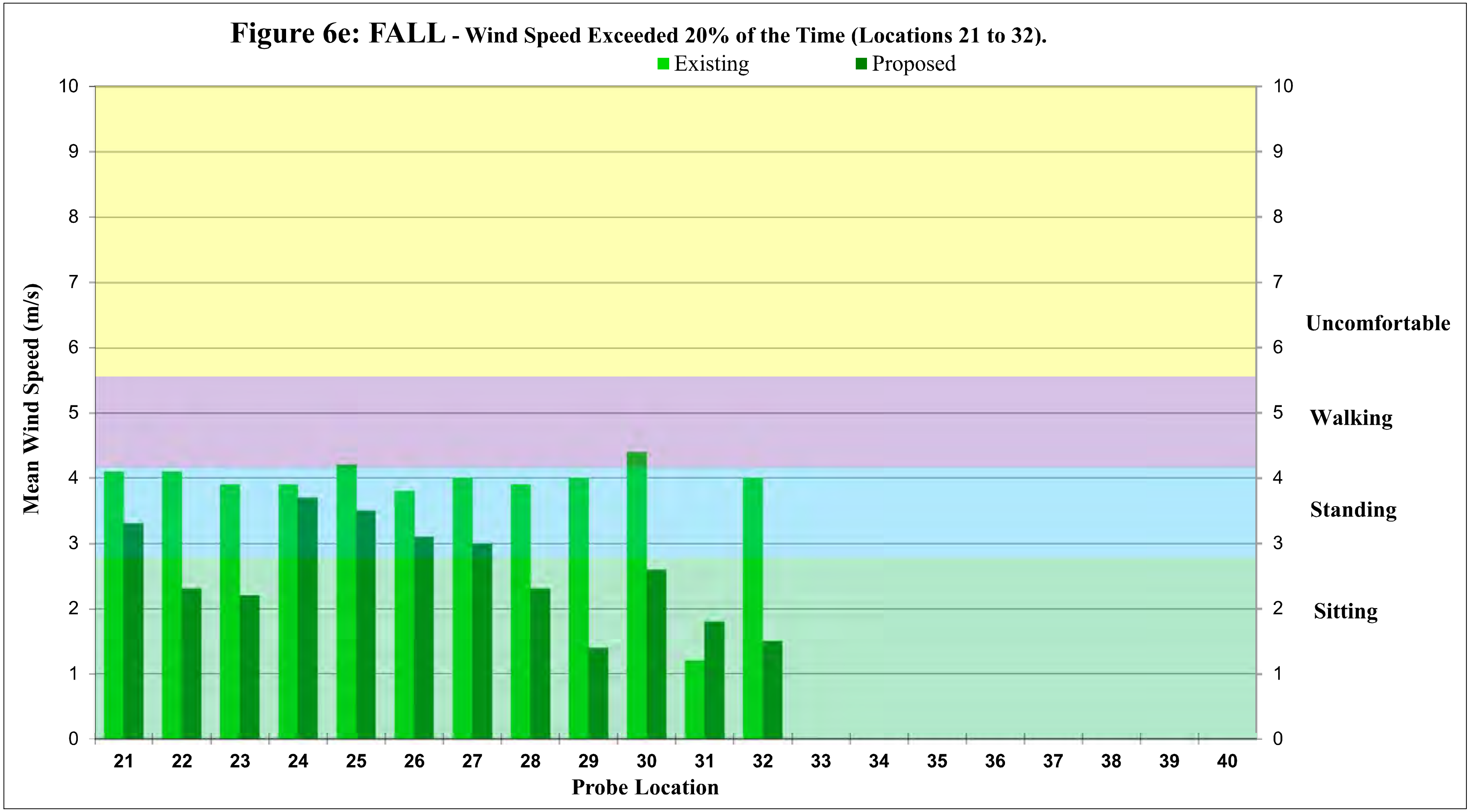
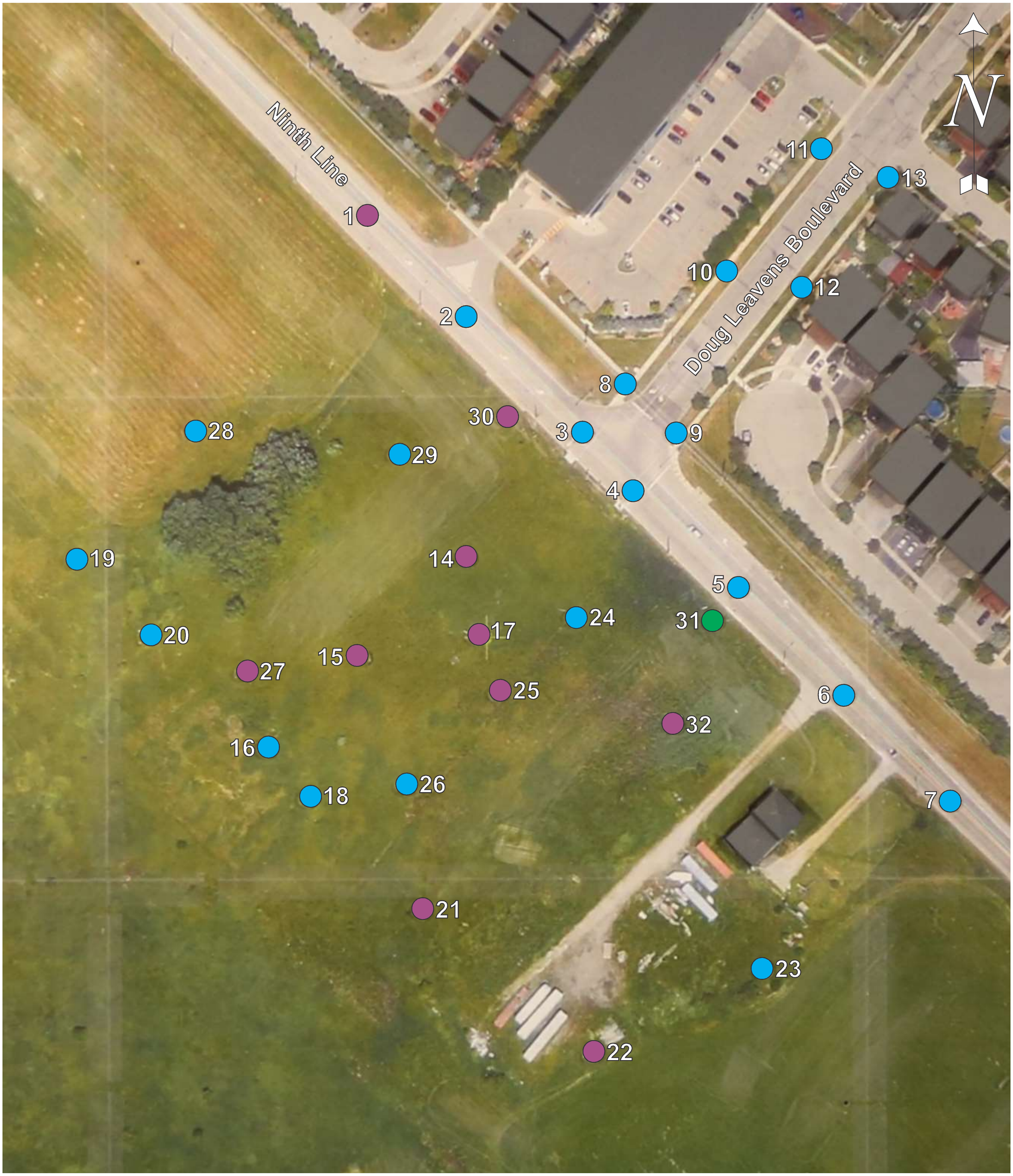


Figure 6e: FALL - Wind Speed Exceeded 20% of the Time (Locations 21 to 32).
Existing
Proposed
Mean Wind Speed (m/s)
Probe Location
Uncomfortable
Walking
Standing
Sitting

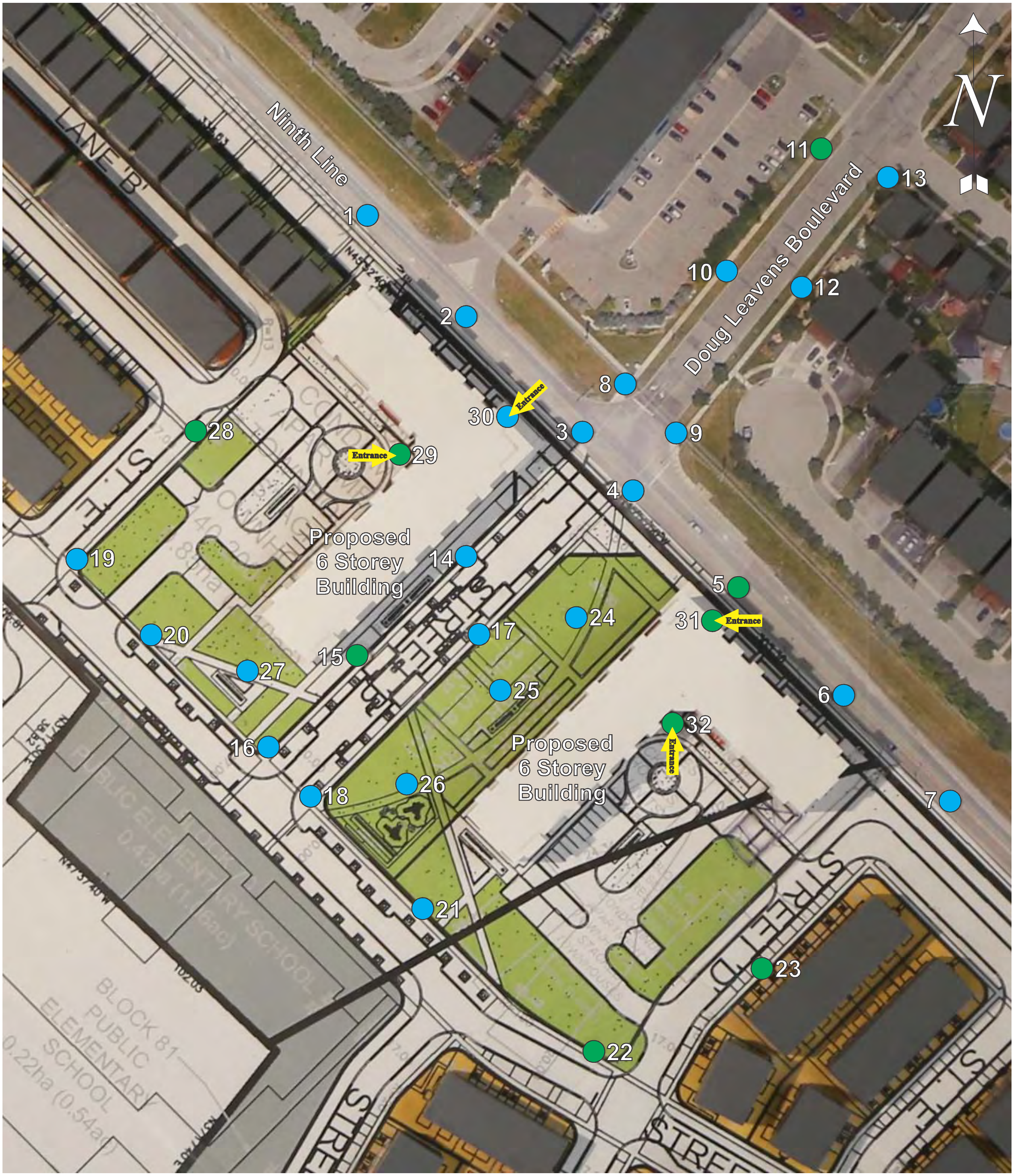
Figure 7a: Pedestrian level wind velocity comfort categories.



Comfort Categories - Annual - Existing

Sitting Standing Walking Uncomfortable

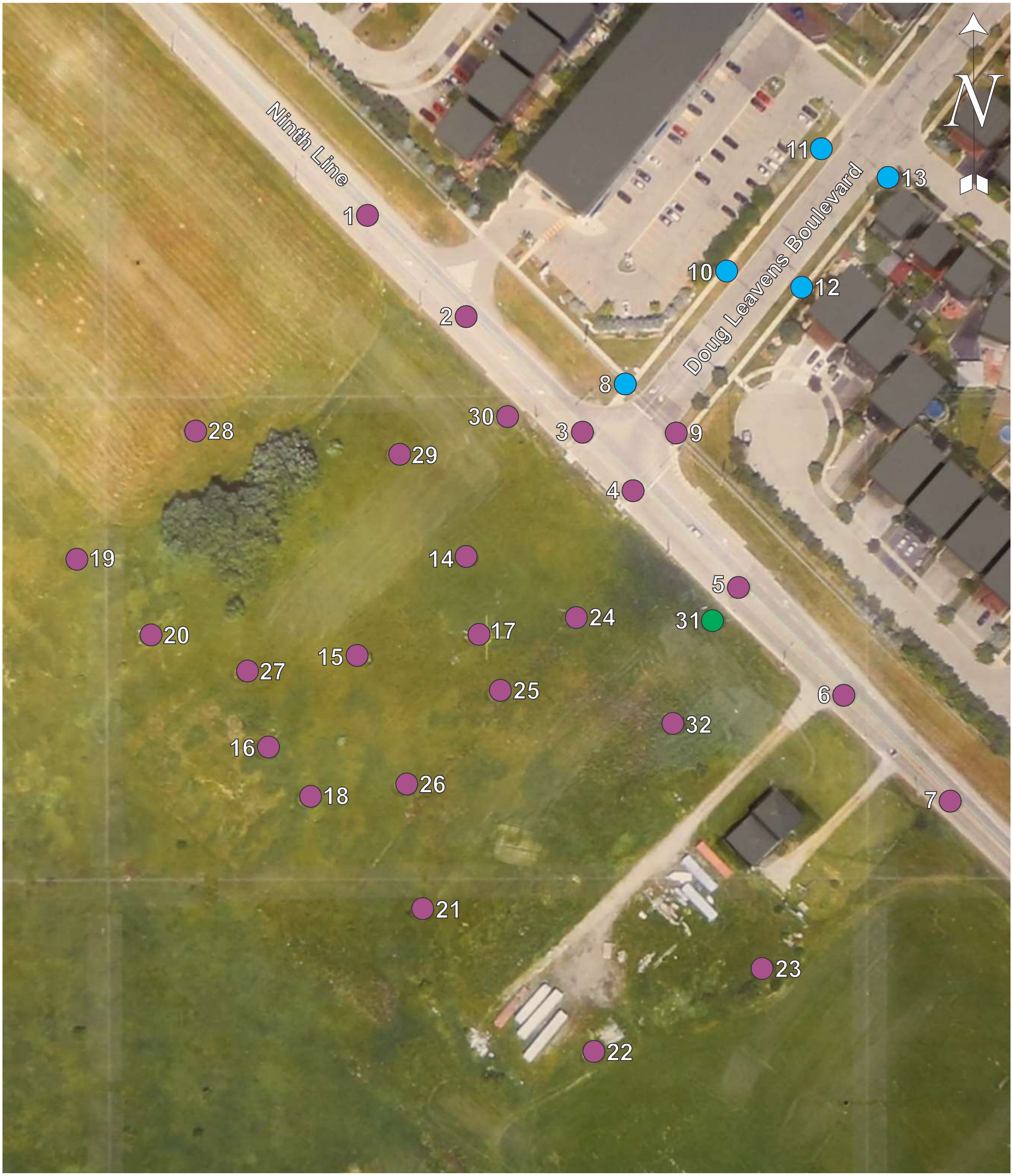
Figure 7b: Pedestrian level wind velocity comfort categories.



Comfort Categories - Annual - Proposed

Sitting · Standing · Walking · Uncomfortable

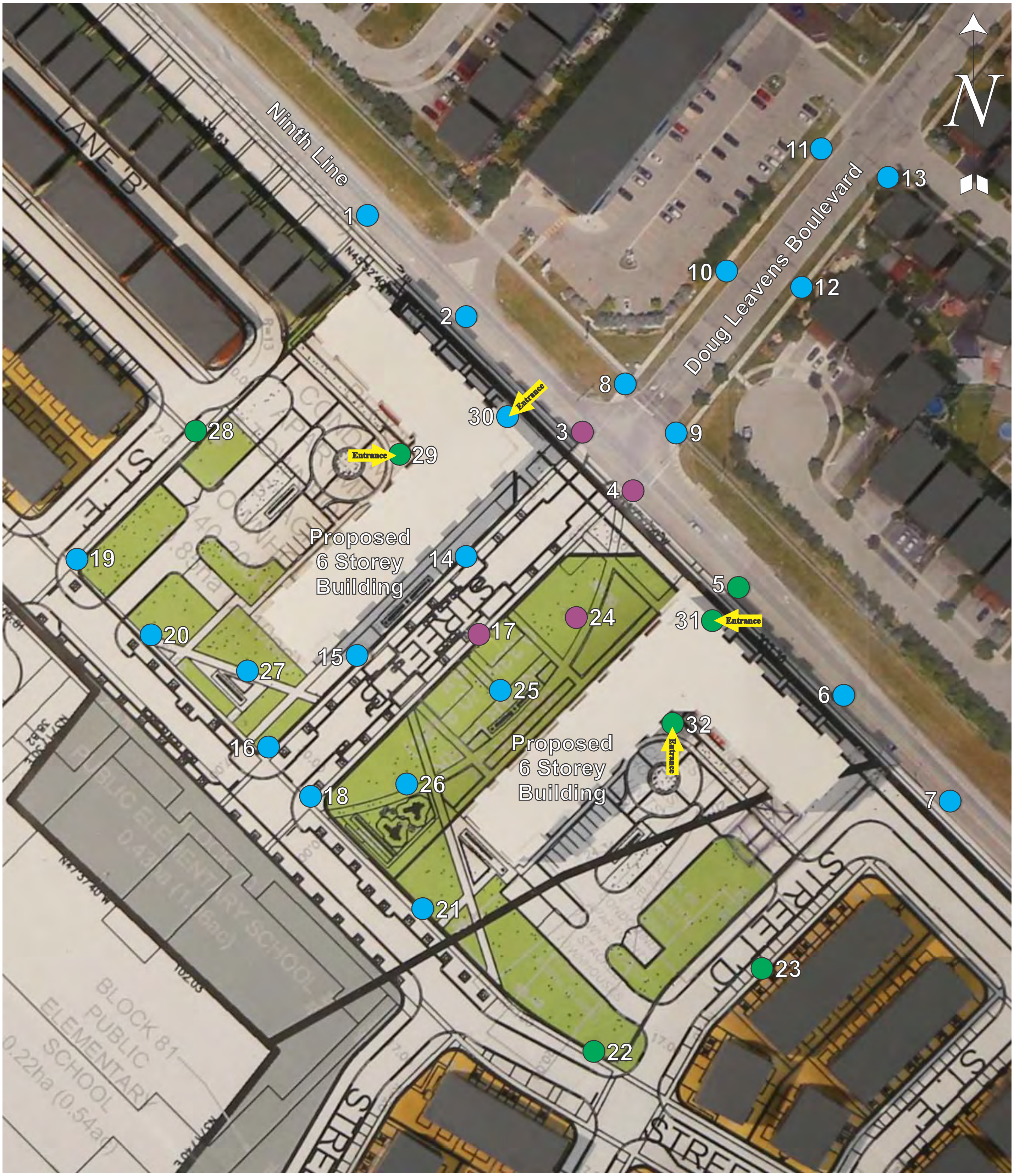
Figure 7c: Pedestrian level wind velocity comfort categories.



Comfort Categories - Winter - Existing

Sitting Standing Walking Uncomfortable

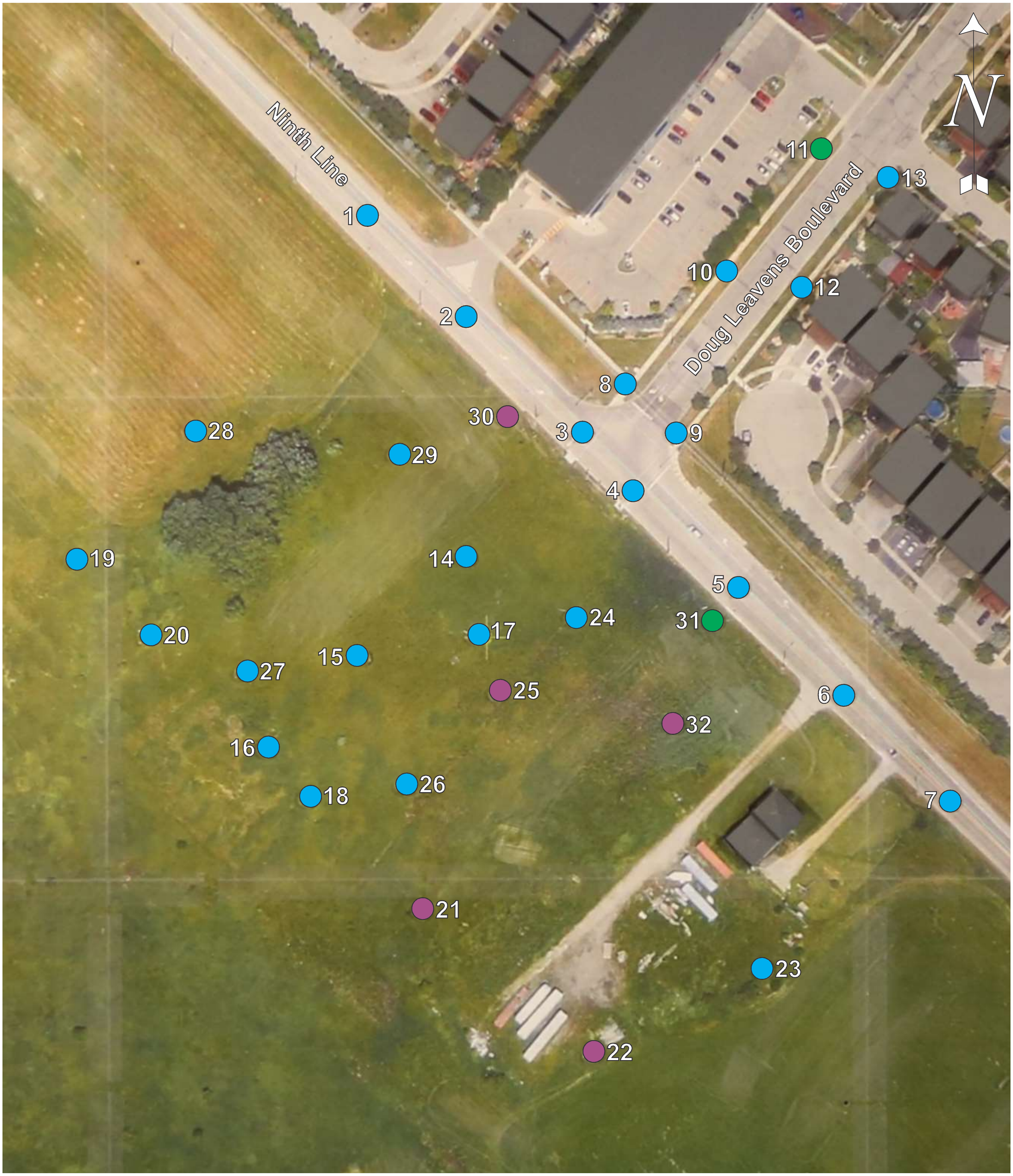
Figure 7d: Pedestrian level wind velocity comfort categories.



Comfort Categories - Winter - Proposed

Sitting Standing Walking Uncomfortable

Figure 7e: Pedestrian level wind velocity comfort categories.



Comfort Categories - Spring - Existing

Sitting Standing Walking Uncomfortable

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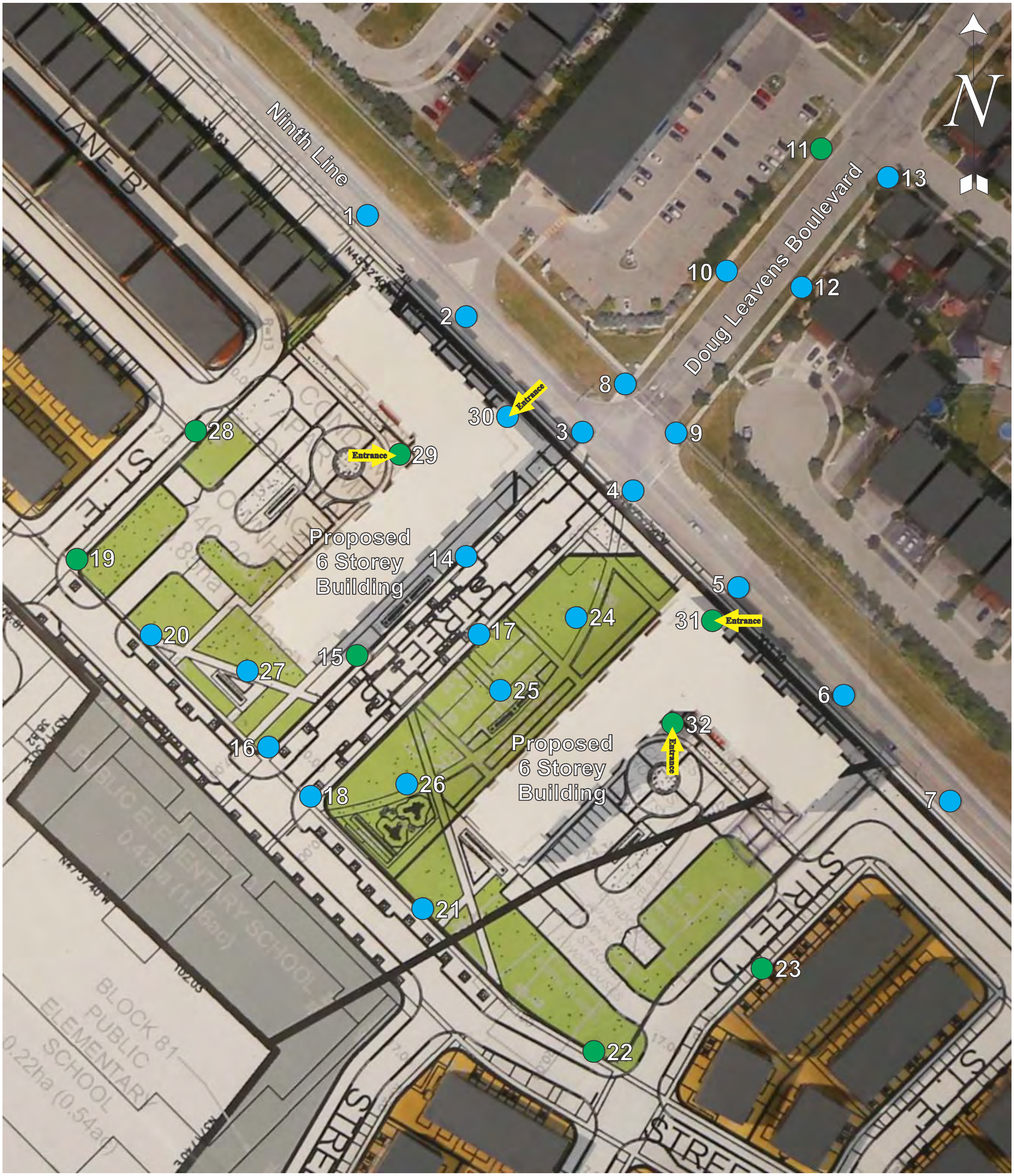
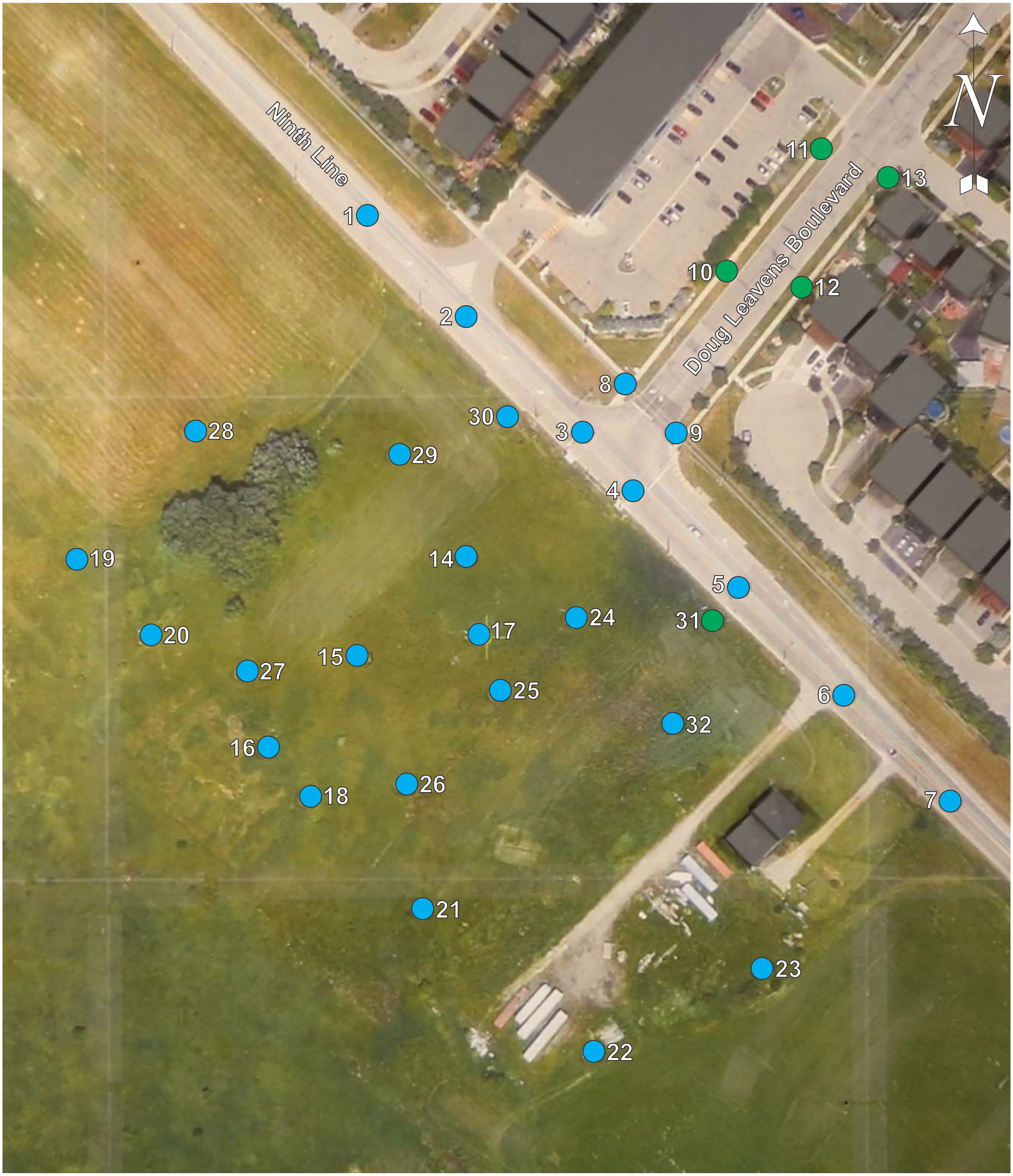
Figure 7f: Pedestrian level wind velocity comfort categories.



Comfort Categories - Spring - Proposed

Sitting · Standing · Walking · Uncomfortable

Figure 7g: Pedestrian level wind velocity comfort categories.

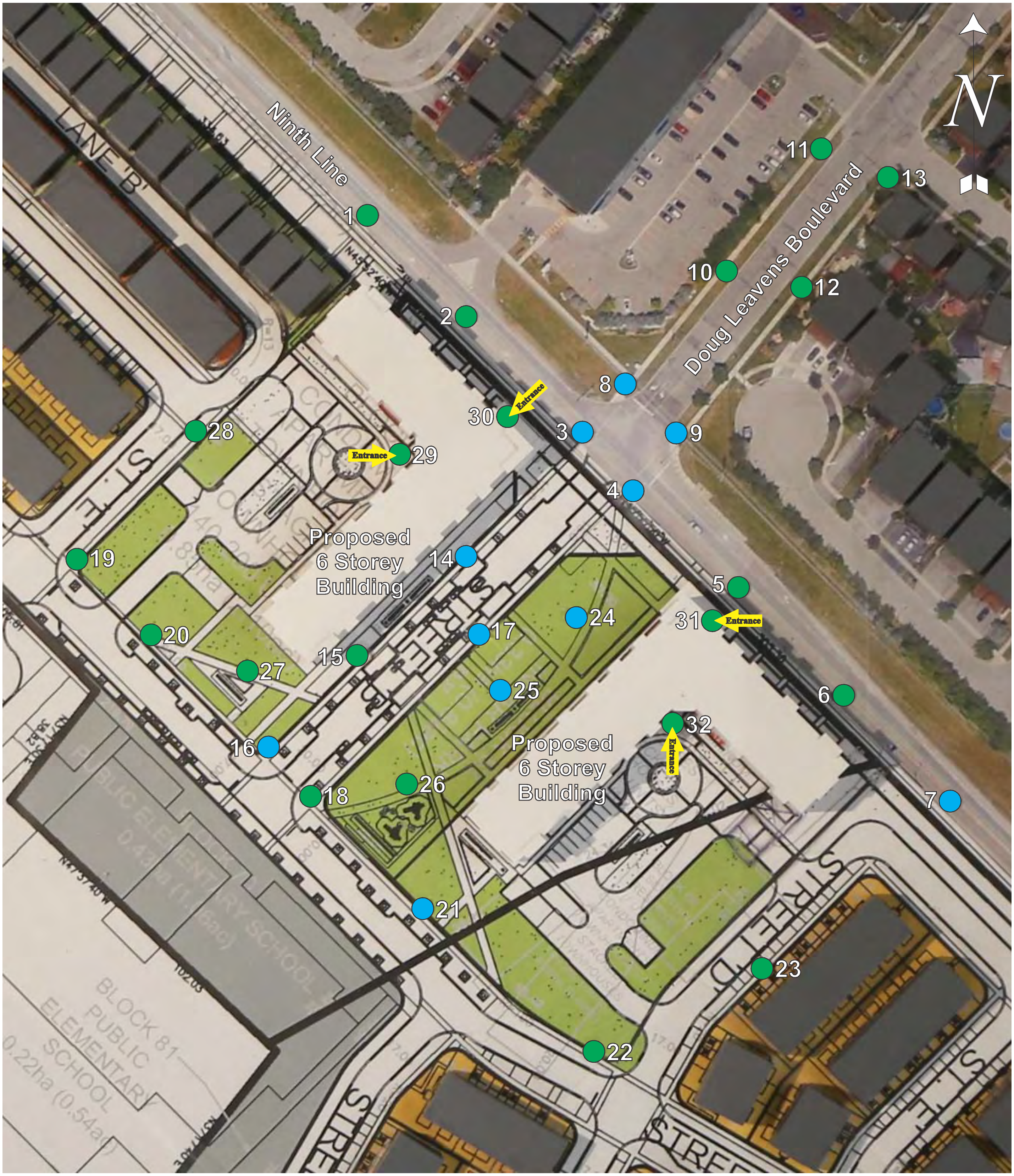


Comfort Categories - Summer - Existing

Sitting Standing Walking Uncomfortable

Theakston Environmental

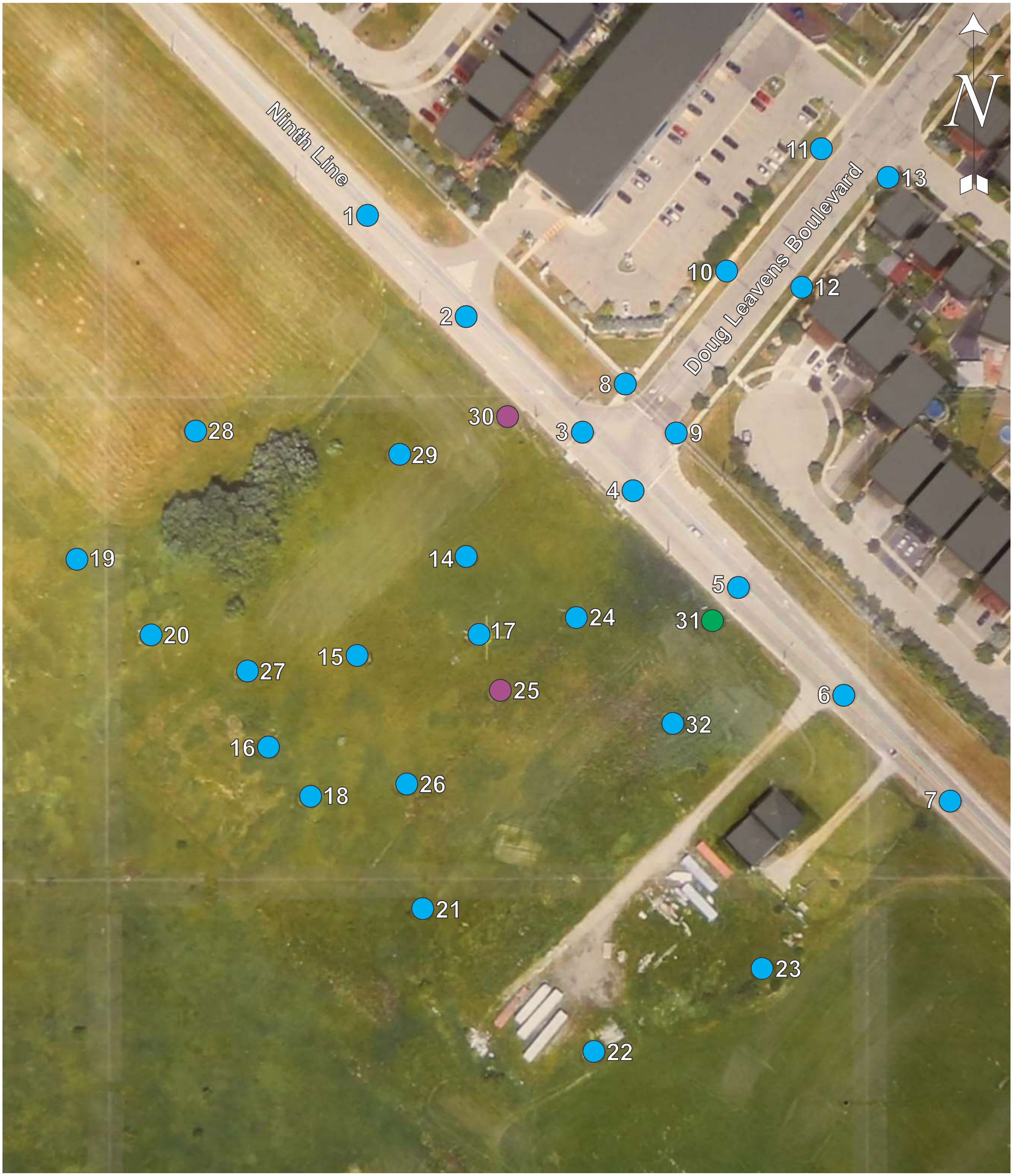
Figure 7h: Pedestrian level wind velocity comfort categories.



Comfort Categories - Summer - Proposed

Sitting Standing Walking Uncomfortable

Figure 7i: Pedestrian level wind velocity comfort categories.

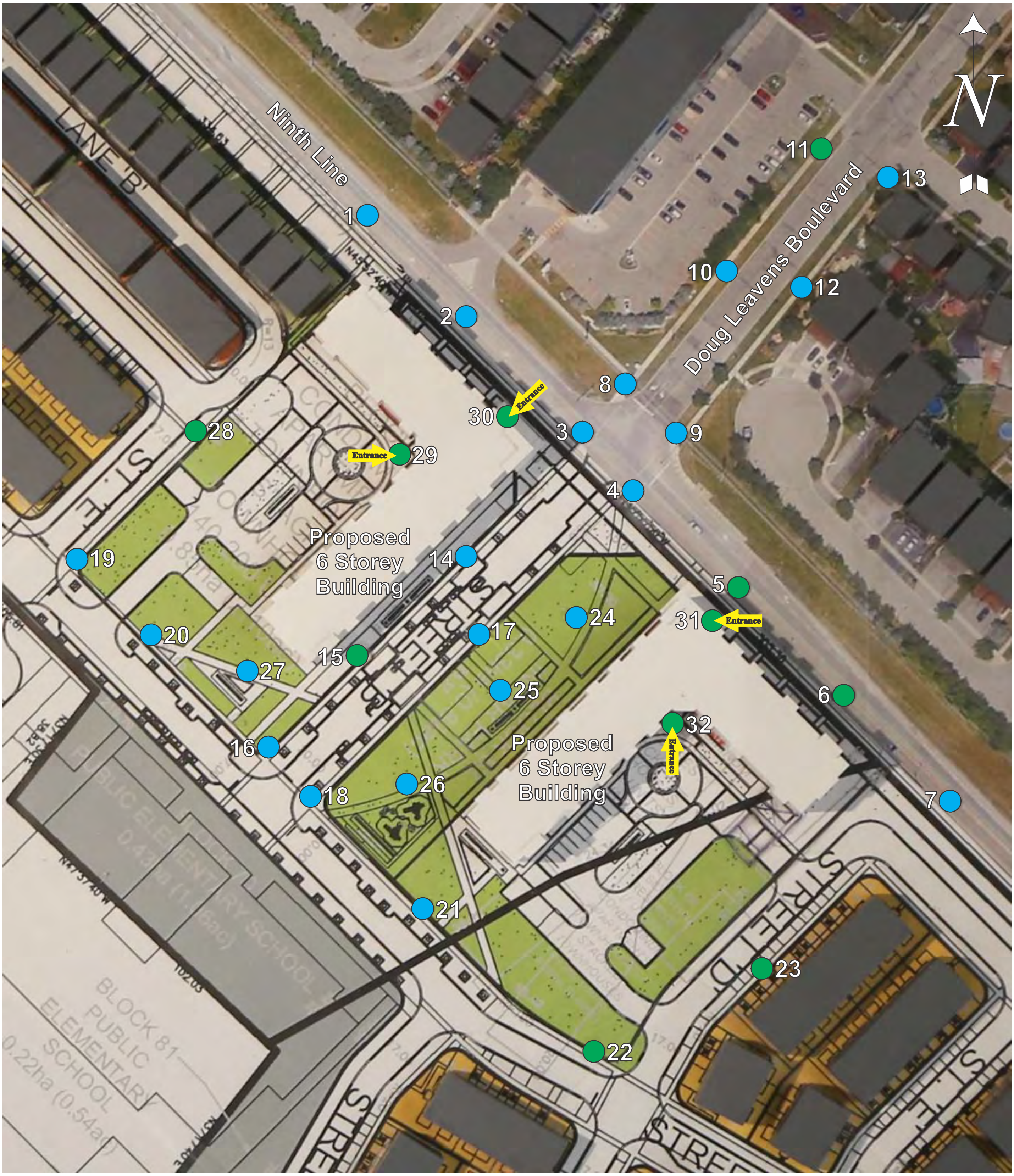


Comfort Categories - Fall - Existing

Sitting Standing Walking Uncomfortable

Theakston Environmental

Figure 7j: Pedestrian level wind velocity comfort categories.



Comfort Categories - Fall - Proposed

Sitting Standing Walking Uncomfortable

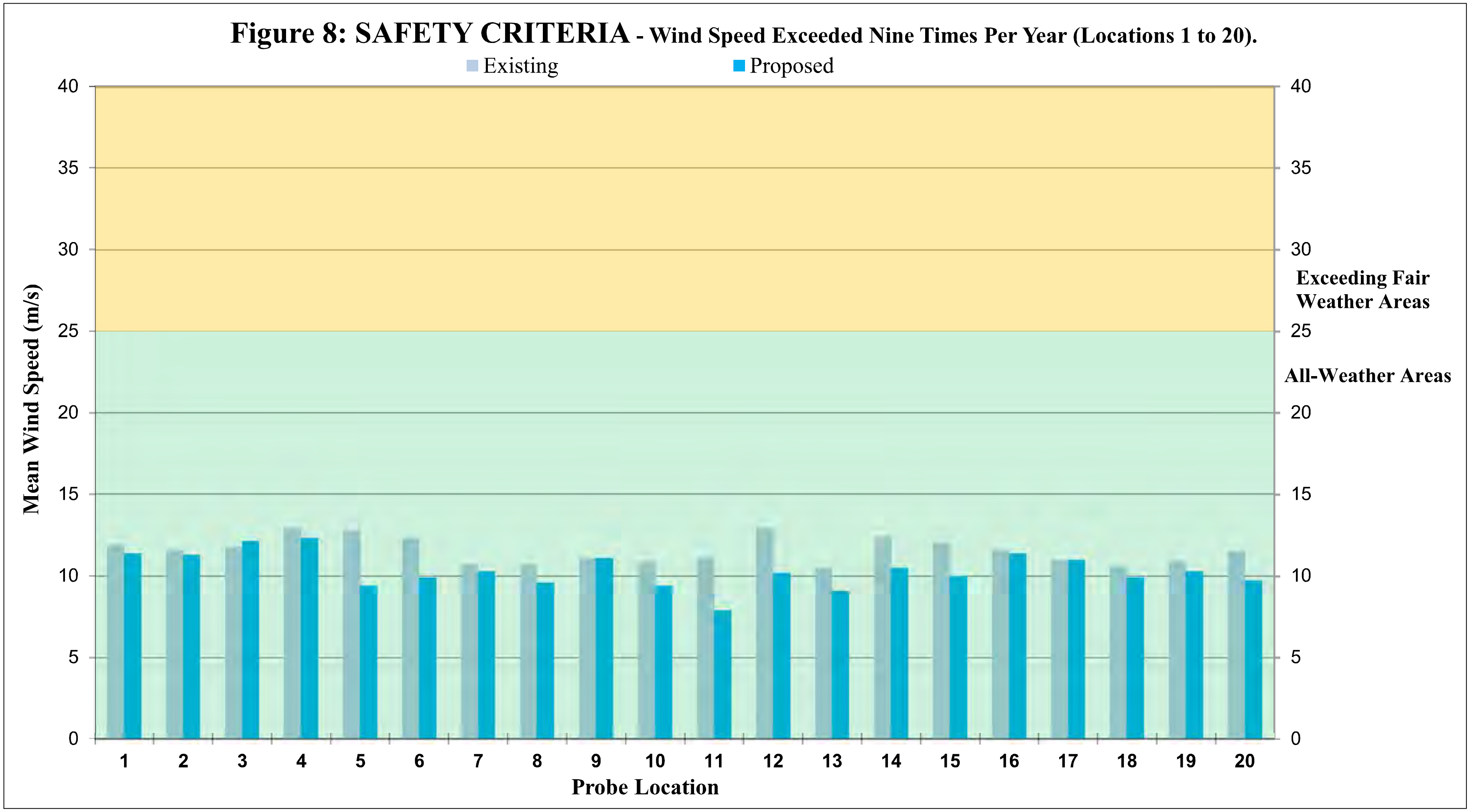


Figure 8: SAFETY CRITERIA - Wind Speed Exceeded Nine Times Per Year (Locations 1 to 20).
Existing
Proposed
Mean Wind Speed (m/s)
Exceeding Fair Weather Areas
All-Weather Areas
Probe Location
0
5
10
15
20
25
30
35
40
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

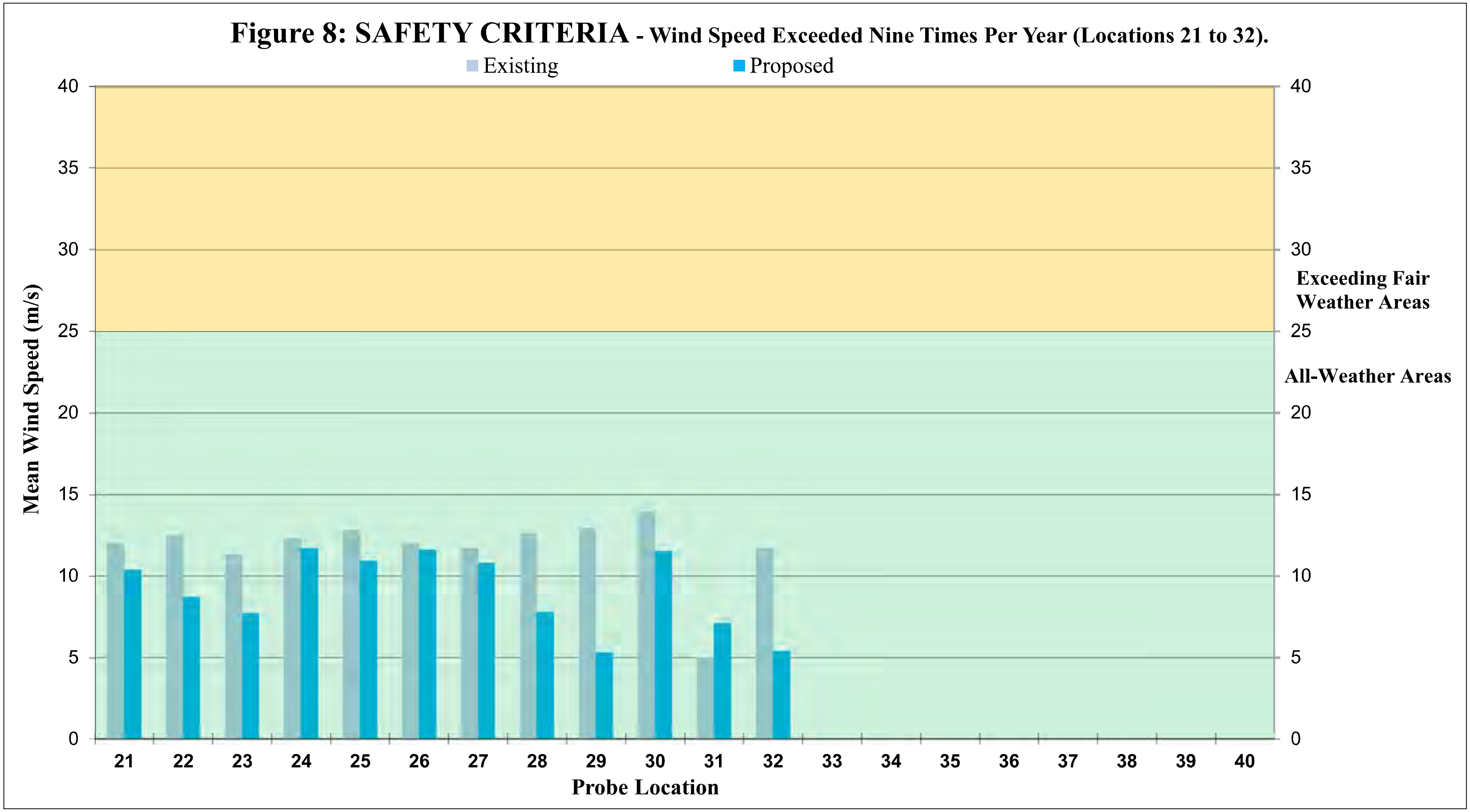


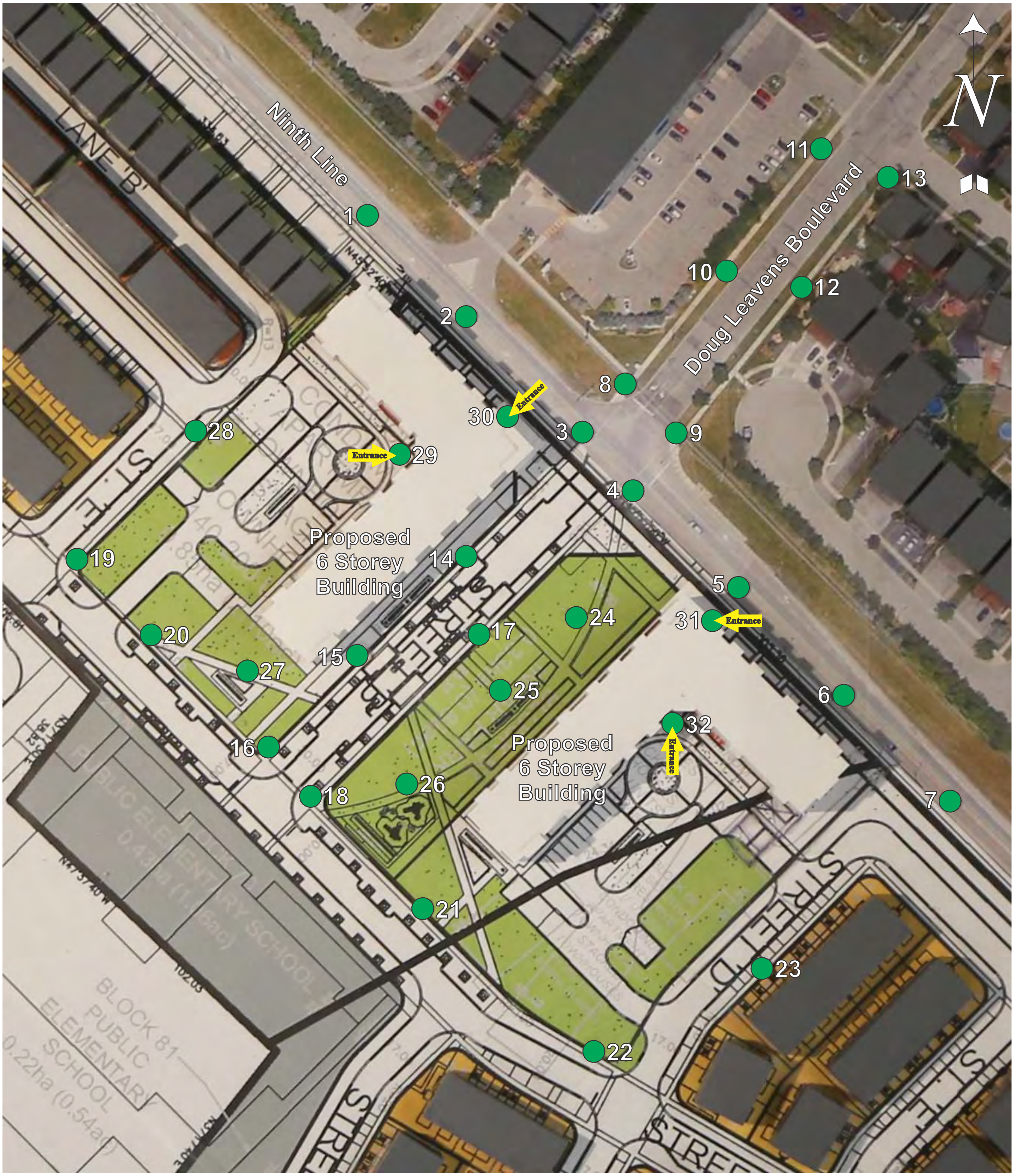
Figure 8: SAFETY CRITERIA - Wind Speed Exceeded Nine Times Per Year (Locations 21 to 32).
Existing
Proposed
Mean Wind Speed (m/s)
Exceeding Fair Weather Areas
All-Weather Areas
Probe Location
0
5
10
15
20
25
30
35
40
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

Figure 9a: Pedestrian level wind velocity safety criteria.

Safety Criteria - Existing

All-Weather Areas   Exceeding Fair-Weather Areas

Figure 9b: Pedestrian level wind velocity safety criteria.



Safety Criteria - Proposed

All-Weather Areas   Exceeding Fair-Weather Areas

8. APPENDIX A

BACKGROUND AND THEORY OF WIND MOVEMENT

During the course of a modular analysis of an existing or proposed site, pertinent wind directions must be analysed with regard to the macroclimate and microclimate. In order for the results of the study to be valid, the effects of both climates must be modelled in test procedures.

Macroclimate

Wind velocity, frequency and directions are used in tests with models to establish part of the macroclimate. These variables are determined from meteorological data collected at the closest weather monitoring station. This information is used in the analysis of the site to establish upstream (approach) wind and weather conditions.

When evaluating approach wind velocities and characteristic profiles in the field it is necessary to evaluate certain boundary conditions. At the earth's surface, "no slip" conditions require the wind speed to be zero. At an altitude of approximately one kilometre above the earth's surface, the motion of the wind is governed by pressure distributions associated with large-scale weather systems. Consequently, these winds, known as "geostrophic" or "freestream" winds, are independent of the surface topography. In model simulation, as in the field, the area of concern is the boundary layer between the earth's surface and the geostrophic winds. The term boundary layer is used to describe the velocity profile of wind currents as they increase from zero to the geostrophic velocity.

The approach boundary layer profile is affected by specific surface topography upstream of the test site. Over relatively rough terrain (urban) the boundary layer is thicker and the wind speed increases rather slowly with height. The opposite is true over open terrain (rural). The following power law equation is used to represent the mean velocity profile for any given topographic condition:

$$\frac{U}{U_F} = \left(\frac{z}{z_F}\right)^a$$

where U = wind velocity (m/s) at height z (m)
a = power law exponent
and subscript $_F$ refers to freestream conditions

Typical values for a and z_F are summarized below:

Terrain	a	z_F (m)
Rural	0.14 - 0.17	260 - 300
Suburban	0.20 - 0.28	300 - 420
Urban	0.28 - 0.40	420 - 550

Wind data is recorded at meteorological stations at a height z_{ref}, usually equal to about 10m above grade. This historical mean wind velocity and frequency data is often presented in the form of a wind rose. The mean wind velocity at z_{ref}, along with the appropriate constants based on terrain type, are used to determine the value for U_F, completing the definition of the boundary layer profile specific to the site. The following Figure shows representations of the boundary layer profile for each of the above terrain conditions:

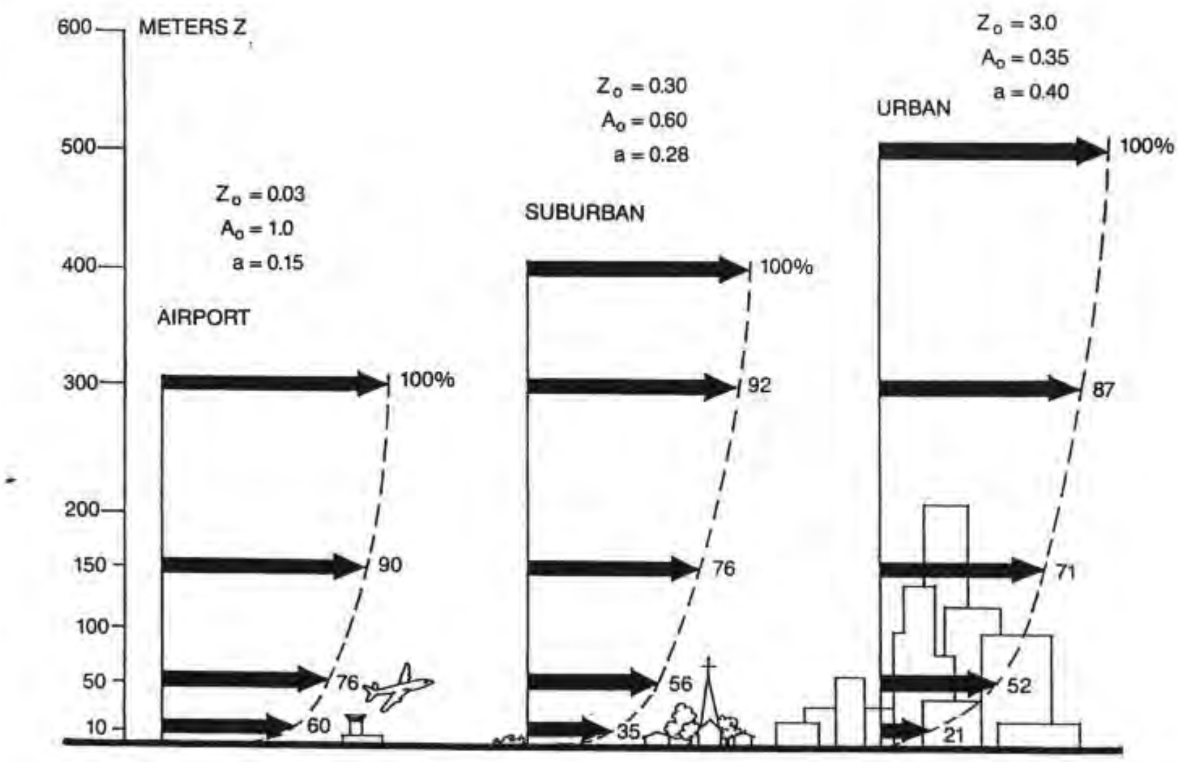


Figure A: Mean wind speed profiles for various terrain (from ASHRAE 1989).

For the above velocity profiles, ground level velocities at a height of $z = 2m$, for an urban macroclimate are approximately 52% of the mean values recorded at the meteorological station at a height equal to $z_{ref} = 10m$. For suburban and rural conditions, the values are 63% and 78% respectively. Thus, for a given wind speed at z_{ref} open terrain or fields (rural) will experience significantly higher ground level wind velocities than suburban or urban areas.

When a boundary layer wind flows over one terrain onto another, the boundary layer profile shape rapidly changes to that dictated by the new terrain. If the preceding wind flow is over rough suburban terrain and an open area is encountered a rapid increase in ground level winds will be realized. A similar effect will occur when large low-density residential areas are demolished to accommodate high-rise developments. The transitional open area will experience significantly higher pedestrian level winds than the previous suburban setting. Once the high-rise development is established, ground level winds will moderate with localized areas of higher pedestrian level winds likely to occur. Pedestrian level wind velocities respond to orientation and shape of the development and if the site is not appropriately engineered or mitigated, pedestrian level wind may be problematic.

Microclimate

The specific wind conditions related to the study site are known as the microclimate, which are dictated mainly by the following factors:

- The orientation and conformation of buildings within the vicinity of the site.
- The surrounding contours and pertinent landscape features.

The microclimate establishes the effect that surrounding buildings or landscape features have on the subject building and the effect the subject building has on the surrounds. For the majority of urban test sites the proper microclimate can be established by modelling an area of 300*m* in radius around the subject building. If extremely tall buildings are present then the study area must be larger, and if the building elevations are on the order of a few floors, smaller areas will suffice to establish the required microclimate.

General Wind Flow Phenomena

Wind flow across undulating terrain contains parallel streamlines with the lowest streamline adjacent to the surface. These conditions continue until the streamlines approach vertical objects. When this occurs there is a general movement of the streamlines upward ("Wind Velocity Gradient") and as they reach the top of the objects turbulence is generated on the lee side. This is one of the reasons for unexpected high wind velocities as this turbulent action moves to the base of the objects on the lee side.

Other fluid action occurs through narrow gaps between buildings (Venturi Action) and at sharp edges of a building or other vertical objects (Scour Action). These conditions are predictable at selected locations but do not conform to a set direction of wind as described by a macroclimate condition. In fact, the orientation and conformation of buildings, streets and landscaping establish a microclimate.

Because of the "Wind Velocity Gradient" phenomena, there is a "downwash" of wind at the face of buildings and this effect is felt at the pedestrian level. It may be experienced as high gusty winds or drifting snow. These effects can be obviated by windbreak devices on the windward side or by canopies over windows and doors on the lee side of the building.

The intersection of two streets or pedestrian walkways have funnelling effects of wind currents from any one of the four directions and is particularly severe at corners if the buildings project to the street line or are close to walkways.

Some high-rise buildings have gust effects as the wind velocities are generated suddenly due to the orientation and conformation of the site. Since wind velocities are the result of energy induced wind currents the solution to most problems is to reduce the wind energy at selected locations by carefully designed windbreak devices, often landscaping, to blend with the surrounds.

The Beaufort Scale is often used as a numerical relationship to wind speed based upon an observation of the effects of wind. Rear-Admiral Sir Francis Beaufort, commander of the Royal Navy, developed the wind force scale in 1805, and by 1838 the Beaufort wind force scale was made mandatory for log entries in ships of the Royal Navy. The original scale was an association of integers from 0 to 12, with a description of the effect of wind on the behaviour of a full-rigged man-of-war. The lower Beaufort numbers described wind in terms of ship speed, mid-range numbers were related to her sail carrying ability and upper numbers were in terms of survival. The Beaufort Scale was adopted in 1874 by the International Meteorological Committee for international use in weather telegraphy and, with the advent of anemometers, the scale was eventually adopted for meteorological purposes. Eventually, a uniform set of equivalents that non-mariners could relate to was developed, and by 1955, wind velocities in knots had replaced Beaufort numbers on weather maps. While the Beaufort Scale lost ground to technology, there remains the need to relate wind speed to observable wind effects and the Beaufort Scale remains a useful tool.

Abbreviated Beaufort Scale

Beaufort Number	Description	Wind Speed			Observations
		km/h	*m/s*	h=2*m* for Urban *m/s*	
2	Slight Breeze	6-11	1.6-3.3	< ~2	Tree leaves rustle; flags wave slightly; vanes show wind direction; small wavelets or scale waves.
3	Gentle Breeze	12-19	3.4-5.4	< ~3	Leaves and twigs in constant motion; small flags extended; long unbreaking waves.
4	Moderate Breeze	20-28	5.5-7.9	< ~4	Small branches move; flags flap; waves with whitecaps.
5	Fresh Breeze	29-38	8.0-10.7	< ~6	Small trees sway; flags flap and ripple; moderate waves with many whitecaps.
6	Strong Breeze	39-49	10.8-13.8	< ~8	Large branches sway; umbrellas used with difficulty; flags beat and pop; larger waves with regular whitecaps.
7	Moderate Gale	50-61	13.9-17.1	< ~10	Sea heaps up, white foam streaks; whole trees sway; difficult to walk; large waves.
8	Fresh Gale	62-74	17.2-20.7	> ~10	Twigs break off trees; moderately high sea with blowing foam.
9	Strong Gale	75-88	20.8-24.4		Branches break off trees; tiles blown from roofs; high crested waves.

Wind speeds indicated above, in *km/h* and *m/s*, are at a reference height of 10 metres, as are the wind speeds indicated on the Figure 5 wind roses. The mean wind speeds at pedestrian level, for an urban climate, would be approximately 56% of these values. The 3rd column for wind speed is shown for reference, at a height of 2*m*, in an urban setting. The approximate Comfort Category Colours are shown above. The relationship between wind speed and height relative to terrain is discussed in the appendices.

Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

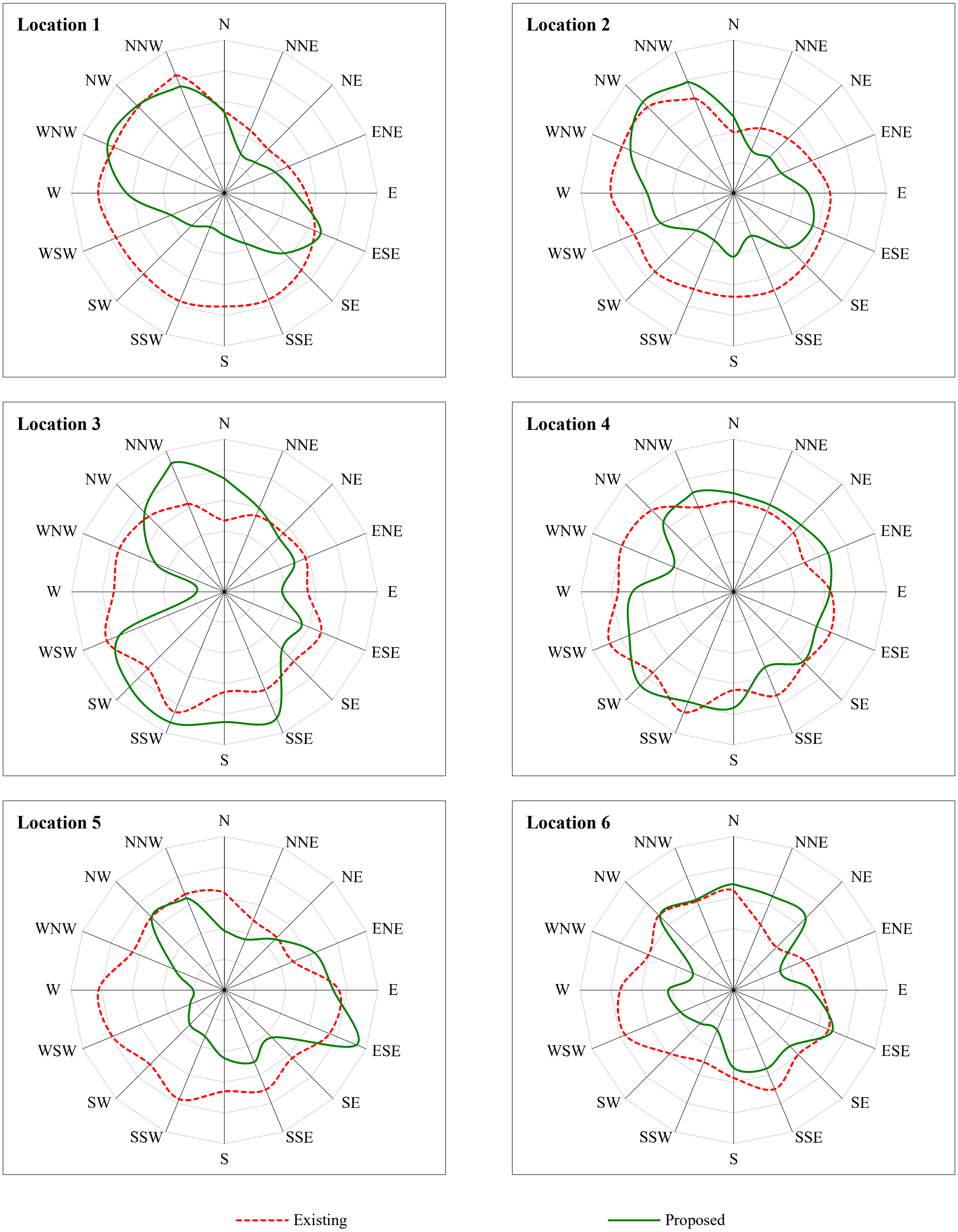


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

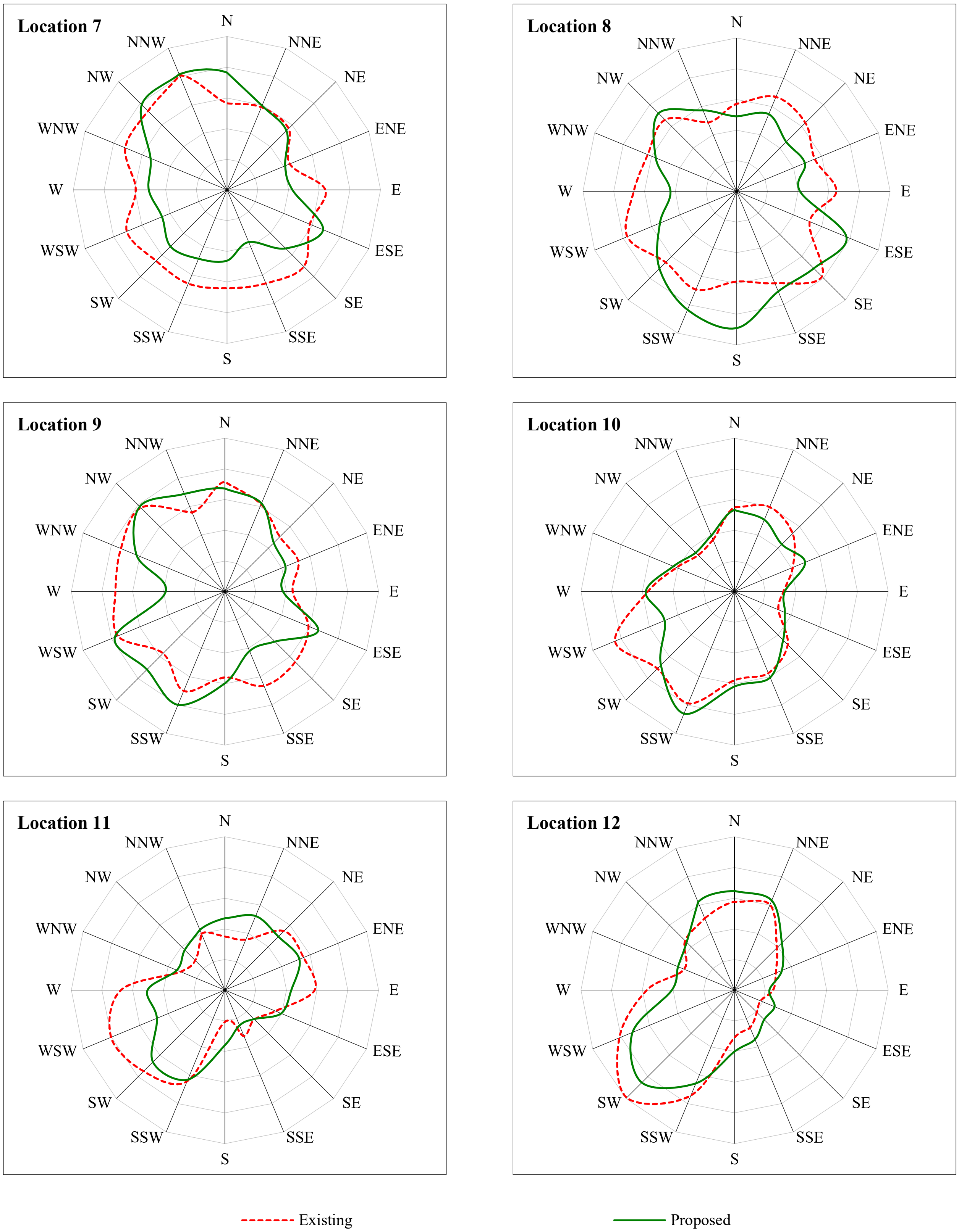


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

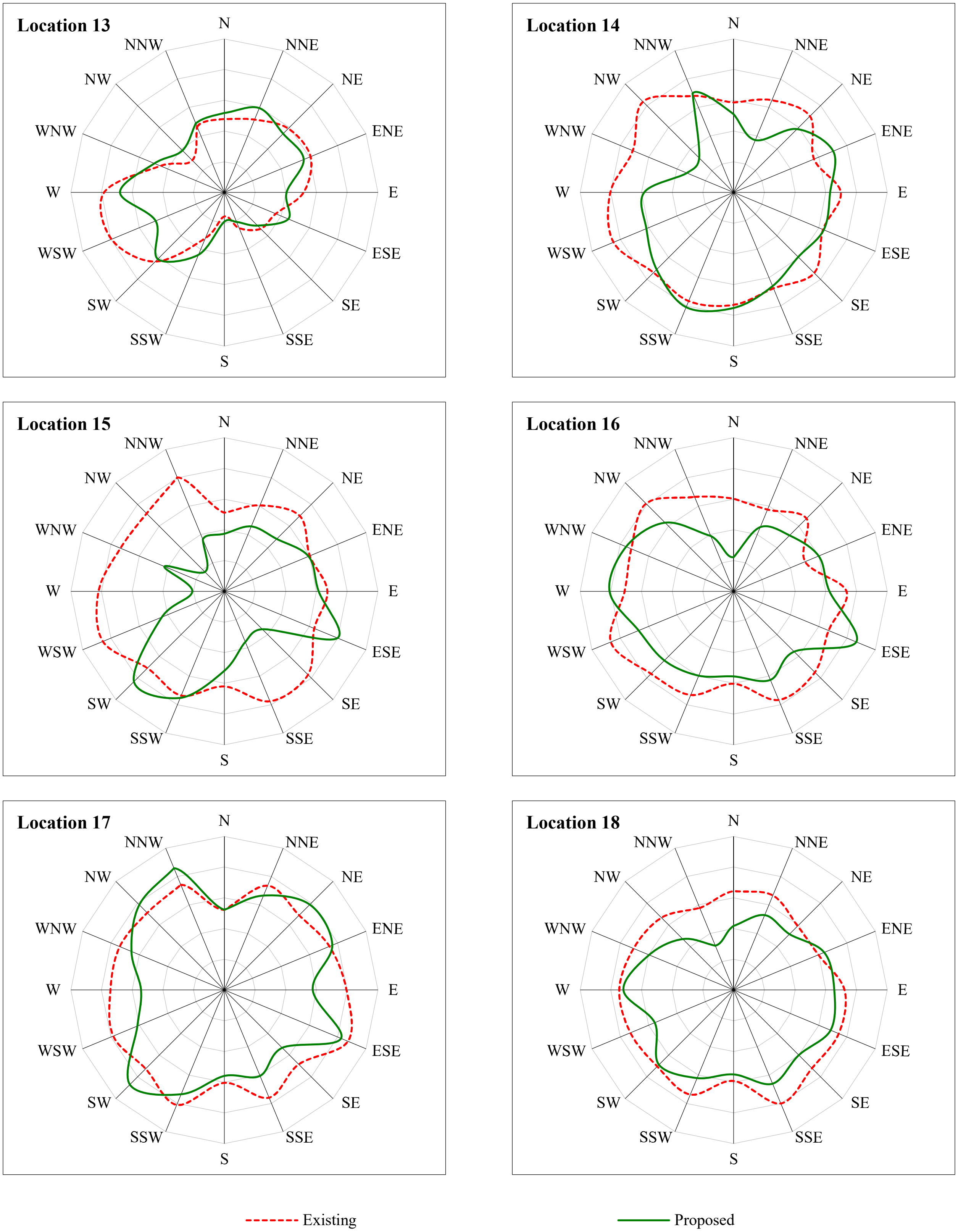


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

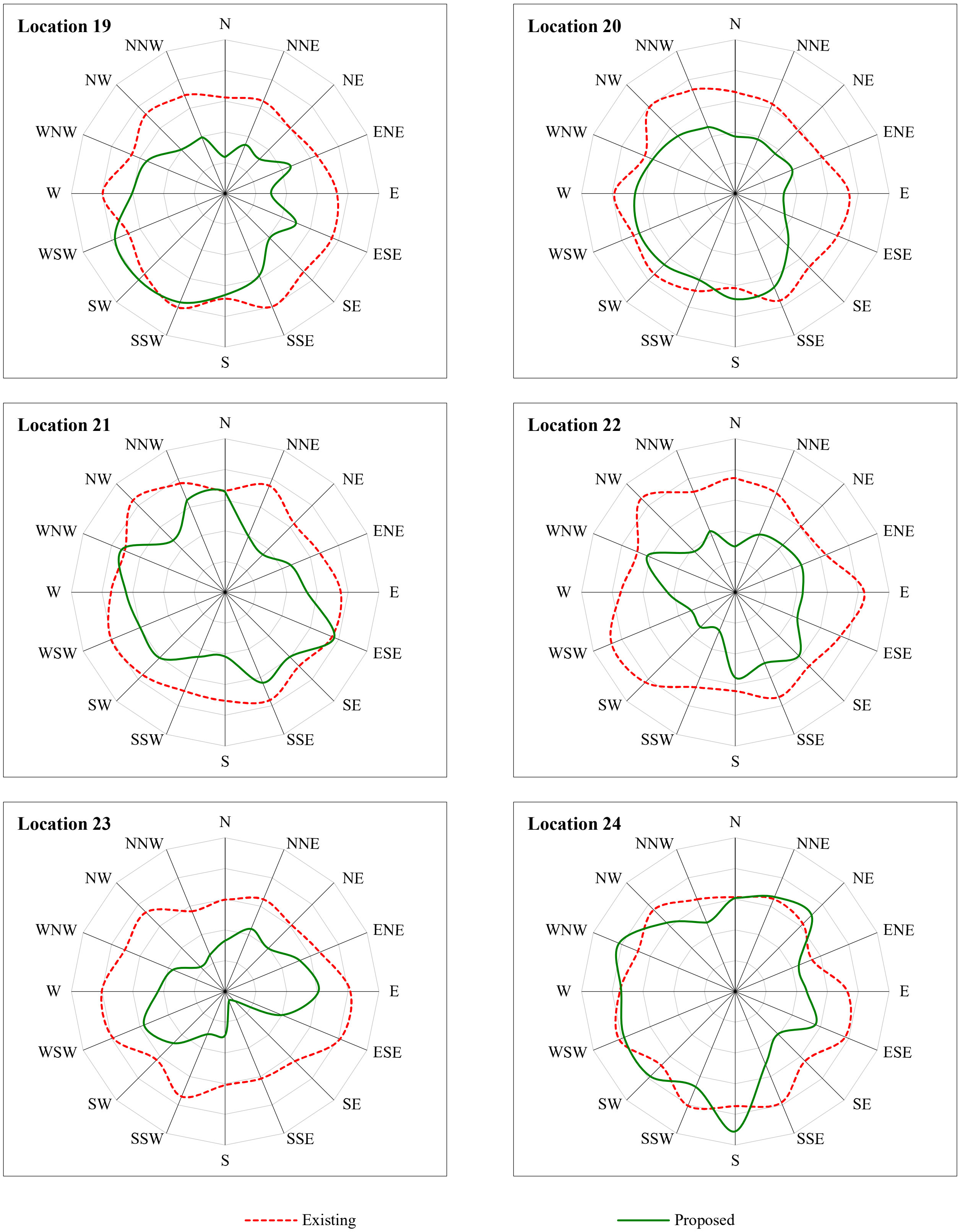


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.

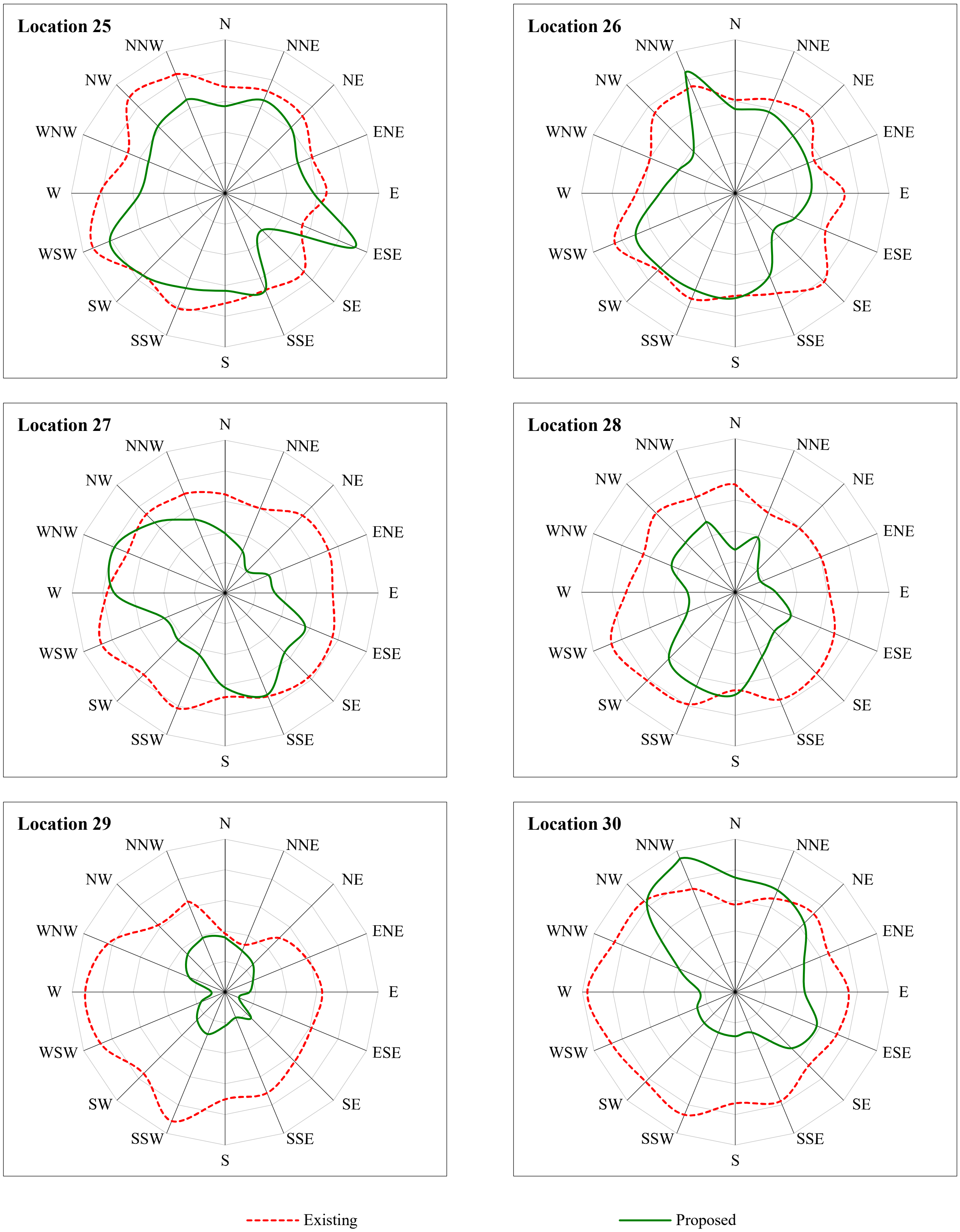
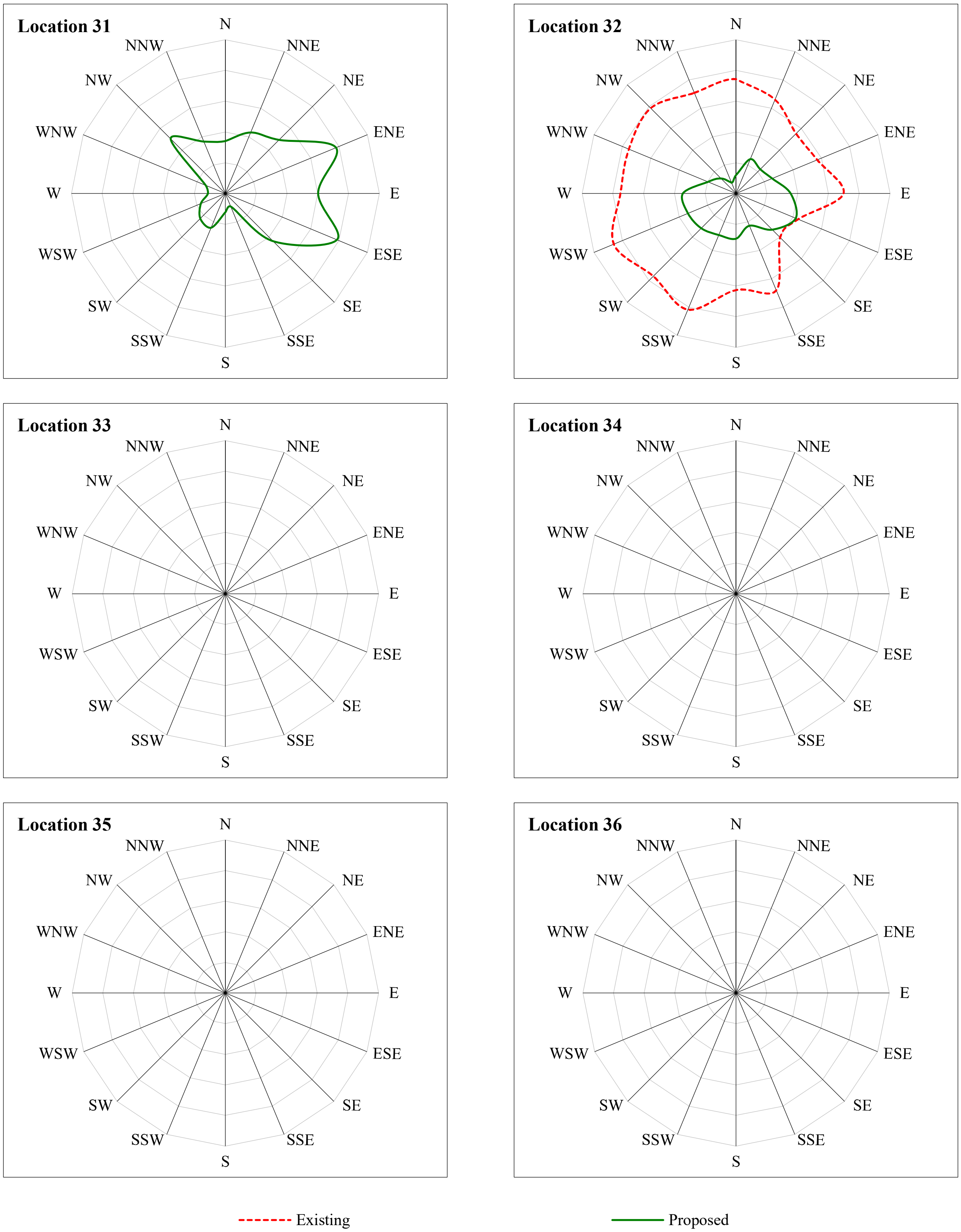


Figure B : Ground level wind velocity as a ratio of gradient wind velocity.



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