

Blackwattle Bay
State Significant Precinct

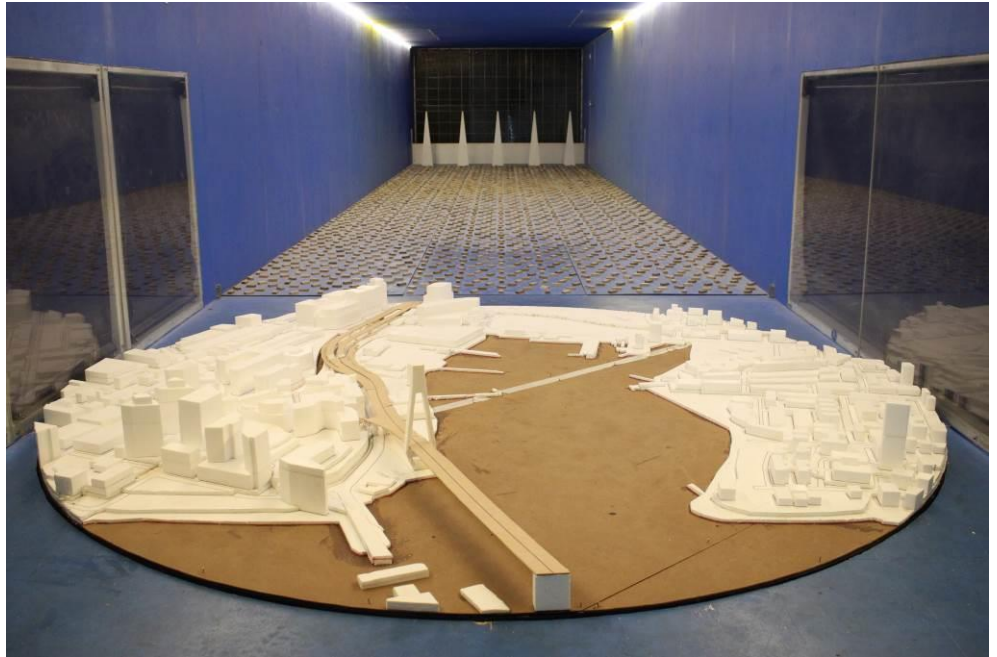
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Pedestrian Wind Environment Study

Stage 1

June 2021





BAYS MARKET DISTRICT, BLACKWATTLE BAY PEDESTRIAN WIND ENVIRONMENT STUDY

WD758-01F03(REV1)- WE REPORT - STAGE 1

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EXECUTIVE SUMMARY

This report presents the results of a detailed investigation into the existing wind environment conditions for the proposed Bays Market District Investigation Area, located in Blackwattle Bay, Sydney. Testing was performed using Windtech's boundary layer wind tunnel, which has a 3.0m wide working section and has a fetch length of 14m. Measurements were made in the wind tunnel at selected critical trafficable outdoor locations within and around the Bays Market District from 16 wind directions at 22.5 degree increments using a 1:400 scale detailed model of the Bays Market District. The effect of nearby buildings and land topography has been accounted for through the use of a proximity model, which represents an area with a radius of 600m.

Testing undertaken as part of this report for the proposed Bays Market District Investigation Area is for the existing site conditions only.

Wind velocity coefficients representing the local wind speeds are derived from the wind tunnel and are combined with a statistical model of the regional wind climate (which accounts for the directional strength and frequency of occurrence of the prevailing regional winds) to provide the equivalent full-scale wind speeds at the Bays Market District Investigation Area.

This report provides a baseline wind case for the existing site conditions of the proposed Bays Market District Investigation Area to be established, taking into account the prevailing wind directions for the area, as well as the local topographical effects of the terrain and the surrounding buildings of the Bays Market District. This information will be used as part of the development of the masterplan options being prepared to support a rezoning proposal for the Bays Market District Investigation Area.

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APPENDIX A - Directional Plots of the Wind Tunnel Results

APPENDIX B - Velocity and Turbulence Intensity Profiles

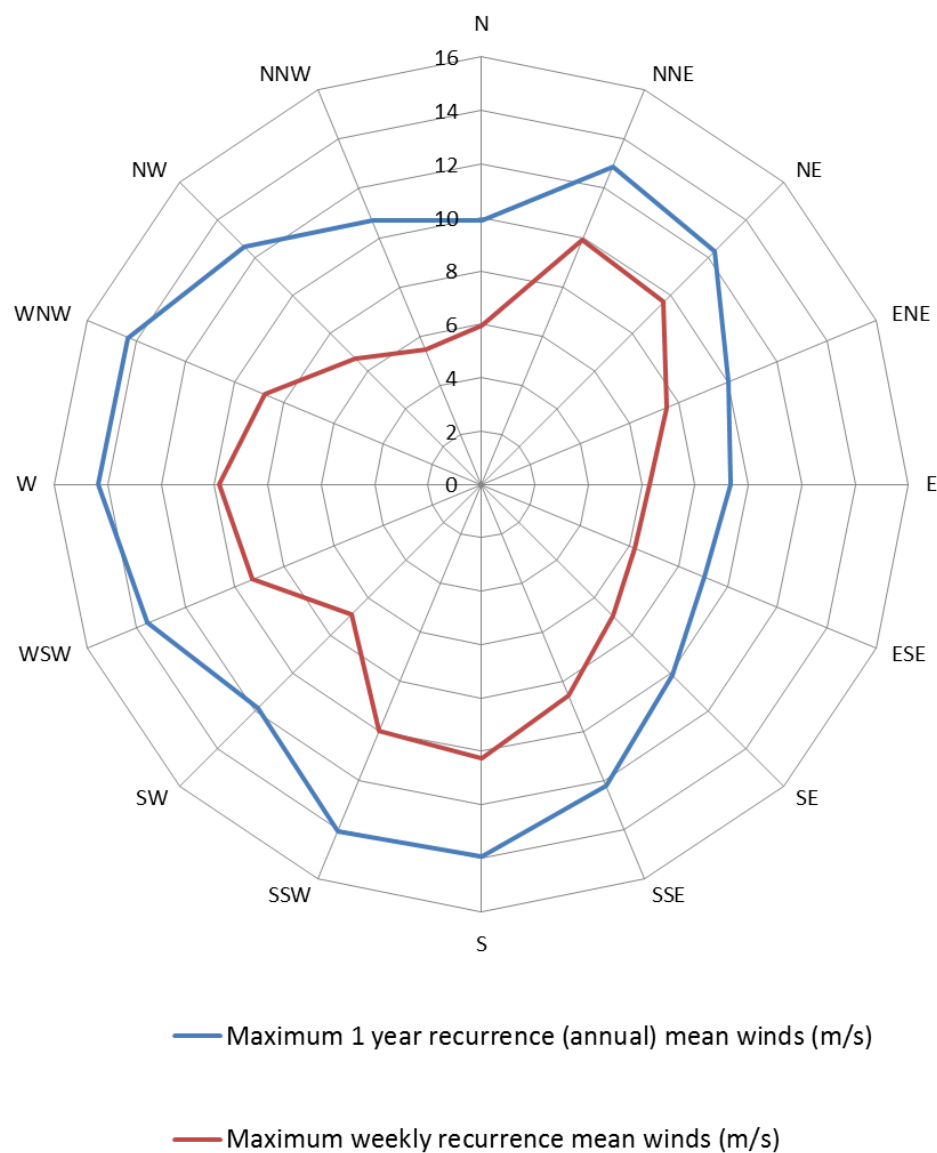
1 WIND CLIMATE FOR THE SYDNEY REGION

Details of the wind climate of the Sydney region have been determined from a detailed statistical analysis of measured mean wind speed data from the meteorological observation station located at Kingsford Smith Airport (Sydney Airport). The data has been collected from this station from 1995 to 2016, and corrected so that it represents winds over standard open terrain at a height of 10m above ground. The corrected data is summarised Table 1 for the weekly and annual return periods in the form of hourly means and the corresponding 3-second gust values. These directional wind speeds are also presented in Figure 1a (referenced as hourly mean wind speeds), and their corresponding directional frequency of occurrences for the region are presented in Figure 1b.

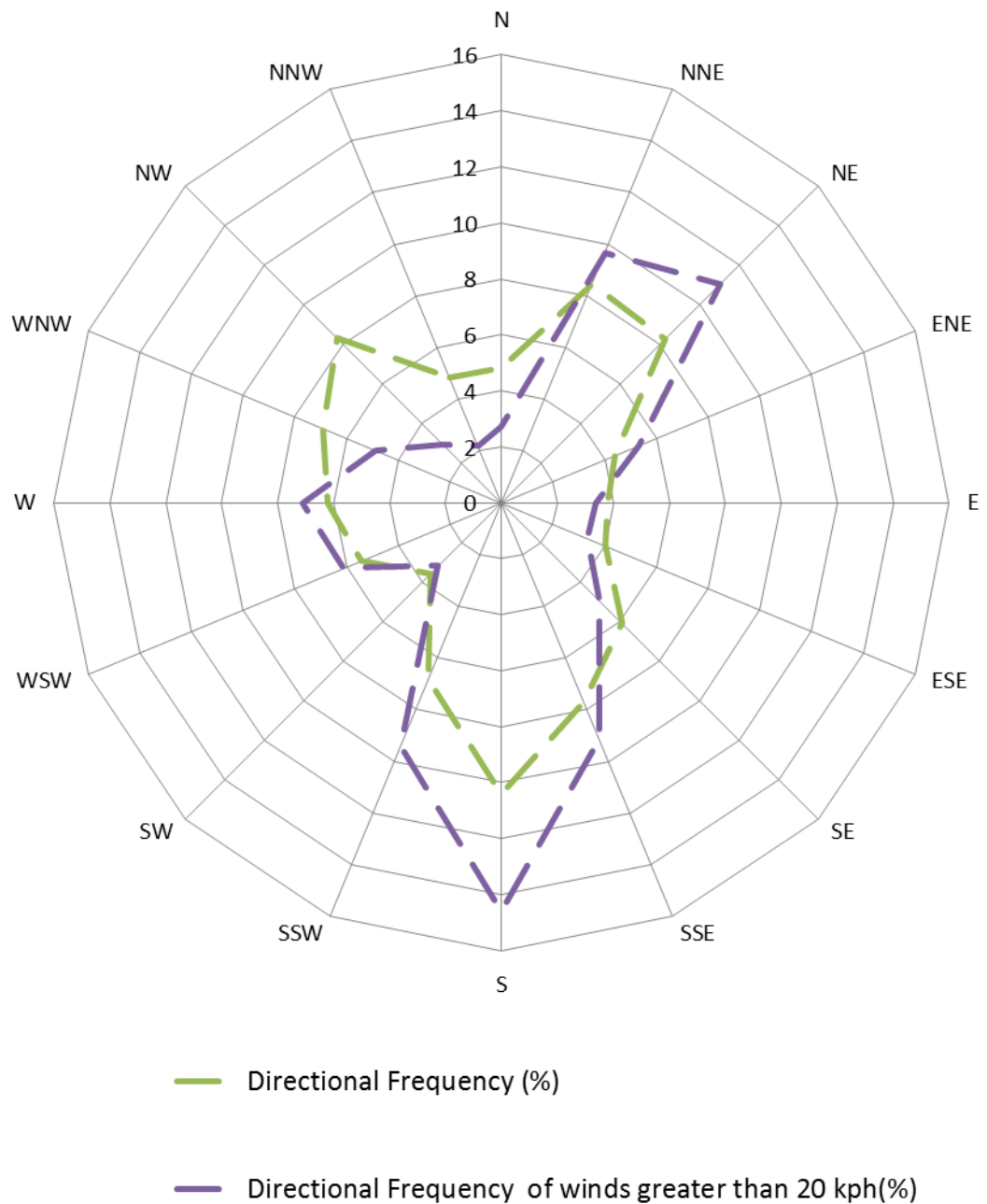
The data indicates that, for the weekly and annual return periods, the southerly winds are by far the most frequent wind for the Sydney region, and are also the strongest. The westerly winds occur most frequently during the winter season for the Sydney region, and although they are typically not as strong as the southerly winds, they are usually a cold wind since they occur during the winter and hence can be a cause for discomfort for outdoor areas. North-easterly winds occur most frequently during the warmer months of the year for the Sydney region, and hence are usually welcomed within outdoor areas since they are typically not as strong as the southerly or westerly winds.

**Table 1: Directional Mean and Gust Wind Speeds for the Sydney Region
(referenced to 10m height above ground in standard open terrain)**

Wind Direction	Reference Wind Speeds (m/s)			
	Weekly Recurrence		Annual Recurrence	
	Hourly Mean	3-second Gust	Hourly Mean	3-second Gust
N	5.9	9.1	9.9	15.1
NNE	9.9	15.1	12.9	19.6
NE	9.7	14.7	12.3	18.8
ENE	7.5	11.5	10.0	15.3
E	6.3	9.6	9.3	14.2
ESE	6.2	9.5	9.1	13.8
SE	7.0	10.6	10.1	15.4
SSE	8.5	13.0	12.2	18.6
S	10.3	15.7	13.9	21.3
SSW	10.0	15.3	14.1	21.5
SW	6.9	10.5	11.9	18.1
WSW	9.3	14.2	13.6	20.7
W	9.8	15.0	14.4	22.0
WNW	8.8	13.4	14.3	21.9
NW	6.7	10.2	12.6	19.2
NNW	5.5	8.4	10.7	16.4



**Figure 1a: Directional Hourly Mean Wind Speeds (m/s) for the Sydney Region
(referenced to standard open terrain at a height of 10m above ground)**



**Figure 1b: Frequency of occurrence of Mean Winds (%) for the Sydney Region
(referenced to standard open terrain at a height of 10m above ground)**

2 THE WIND TUNNEL MODEL

Measurements were made in the wind tunnel at selected critical trafficable outdoor locations within and around the development from 16 wind directions at 22.5 degree increments using a 1:400 scale detailed model of the Bays Market District Investigation Area. The study model incorporates all necessary architectural features to ensure an accurate wind flow is achieved. The effect of nearby buildings and land topography has been accounted for through the use of a proximity model, which represents a radius of approximately 600m. Photographs of the wind tunnel model are presented below for the existing site conditions in Figures 2a to 2f on the following pages.

The model of the Bays Market District Investigation Area was tested in the wind tunnel without the effect of any forms of wind ameliorating devices such as screens, balustrades, awnings, etc, which are not already shown in the architectural drawings.



Figure 2a: Photograph of the Wind Tunnel Model – (View from the north)

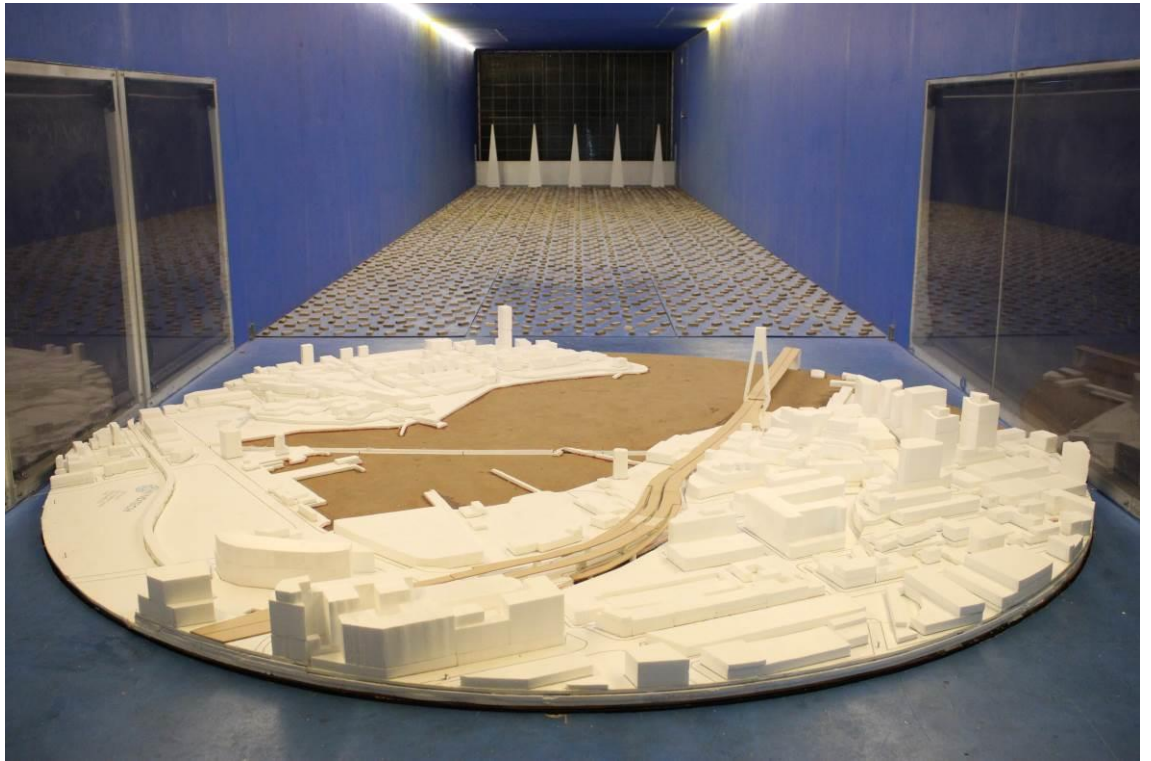


Figure 2b: Photograph of the Wind Tunnel Model – (View from the east)

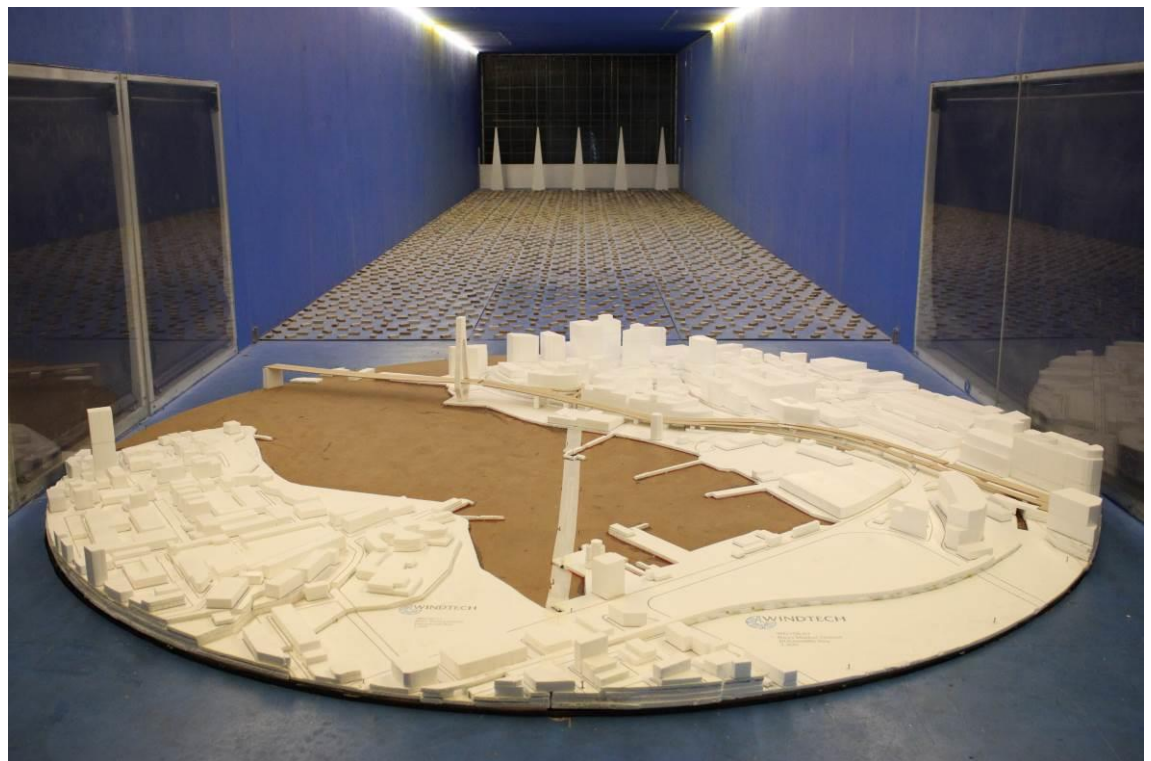


Figure 2c: Photograph of the Wind Tunnel Model – (View from the south)

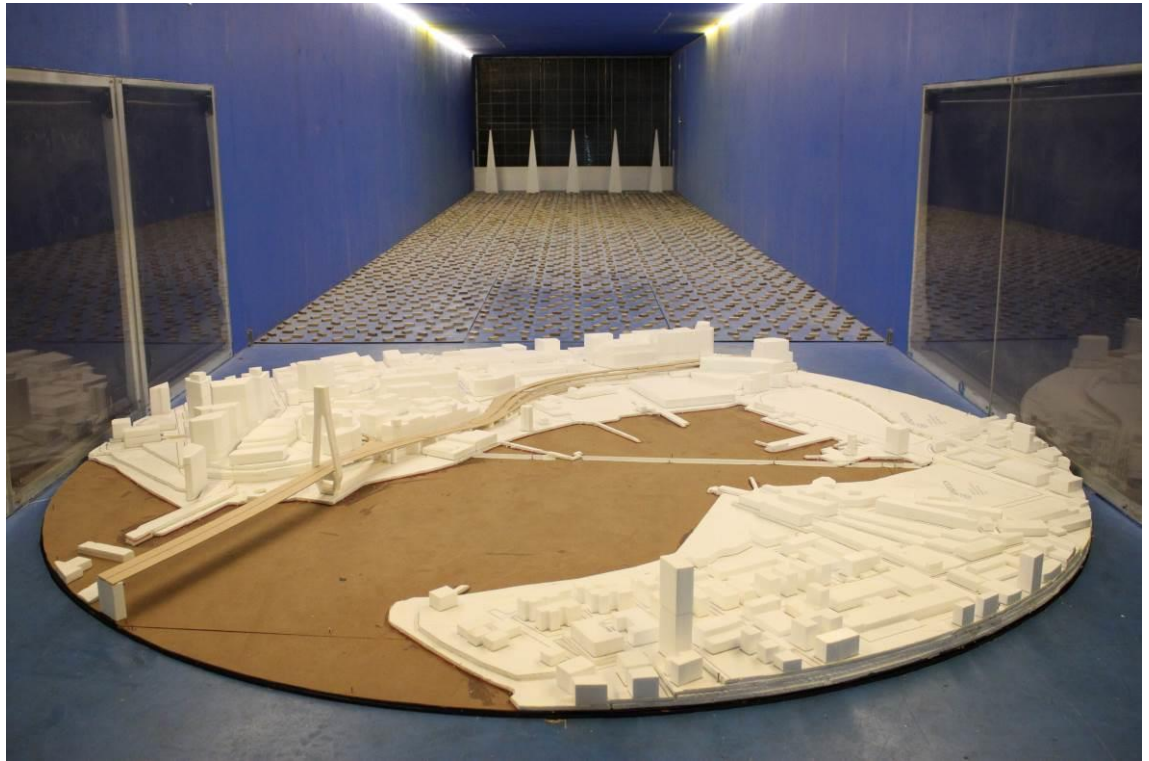


Figure 2d: Photograph of the Wind Tunnel Model – (View from the west)

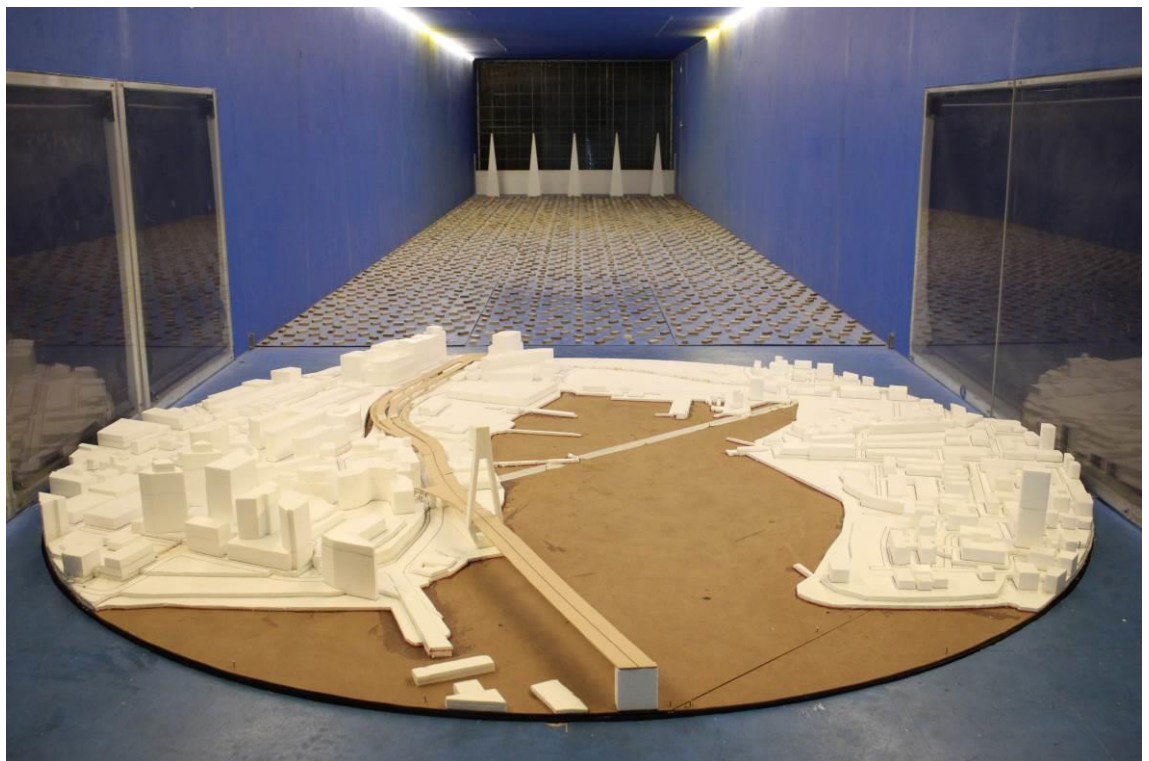


Figure 2e: Photograph of the Wind Tunnel Model – (View from the north-west)

3 BOUNDARY LAYER WIND FLOW MODEL

Testing was performed using Windtech's boundary layer wind tunnel, which has a 3.0m wide working section and has a fetch length of 14m. The model was placed in the appropriate standard boundary layer wind flow for each of the prevailing wind directions for the wind tunnel testing. The type of wind flow used in a wind tunnel study is determined by a detailed analysis of the surrounding terrain types around the Bays Market District Investigation Area. Details of the analysis of the surrounding terrain for this study are provided in the following pages of this report.

The roughness of the earth's surface has the effect of slowing down the prevailing wind near the ground. This effect is observed up to what is known as the *boundary layer height*, which can range between 500m to 3km above the earth's surface depending on the roughness of the surface (ie: oceans, open farmland, dense urban cities, etc). Within this range the prevailing wind forms what is known as a *boundary layer wind profile*.

Various wind codes and standards classify various types of boundary layer wind flows depending on the surface roughness. However, it should be noted that the wind profile does not change instantly due to changes in the terrain roughness. It can take many kilometres (at least 100km) of a constant surface roughness for the boundary layer profile to achieve a state of equilibrium. Descriptions of the standard boundary layer profiles for various terrain types are summarised as follows (as per the definitions in AS/NZS1170.2:2011):

- **Terrain Category 1.0:** Extremely flat terrain. Examples include enclosed water bodies such as lakes, dams, rivers, bays, etc.
- **Terrain Category 1.5:** Relatively flat terrain. Examples include the open ocean, deserts, and very flat open plains.
- **Terrain Category 2.0:** Open terrain. Examples include grassy fields and plains and open farmland (without buildings or trees).
- **Terrain Category 2.5:** Relatively open terrain. Examples include farmland with scattered trees and buildings and very low-density suburban areas.
- **Terrain Category 3.0:** Suburban and forest terrain. Examples include suburban areas of towns and areas with dense vegetation such as forests, bushland, etc.
- **Terrain Category 3.5:** Relatively dense suburban terrain. Examples include centres of small cities, industrial parks, etc.
- **Terrain Category 4.0:** Dense urban terrain. Examples include CBD's of large cities with many high-rise towers, and areas with many closely-spaced mid-rise buildings.

For this study, the shape of the boundary layer wind flows over standard terrain types is defined as per ISO4354:2009. These are summarised in Table 2, referenced to the study reference height of 50m above ground.

Table 2: Terrain and Height Multipliers, Turbulence Intensities, and Corresponding Roughness Lengths, for the Standard ISO4354:2009 Boundary Layer Profiles (at the study reference height)

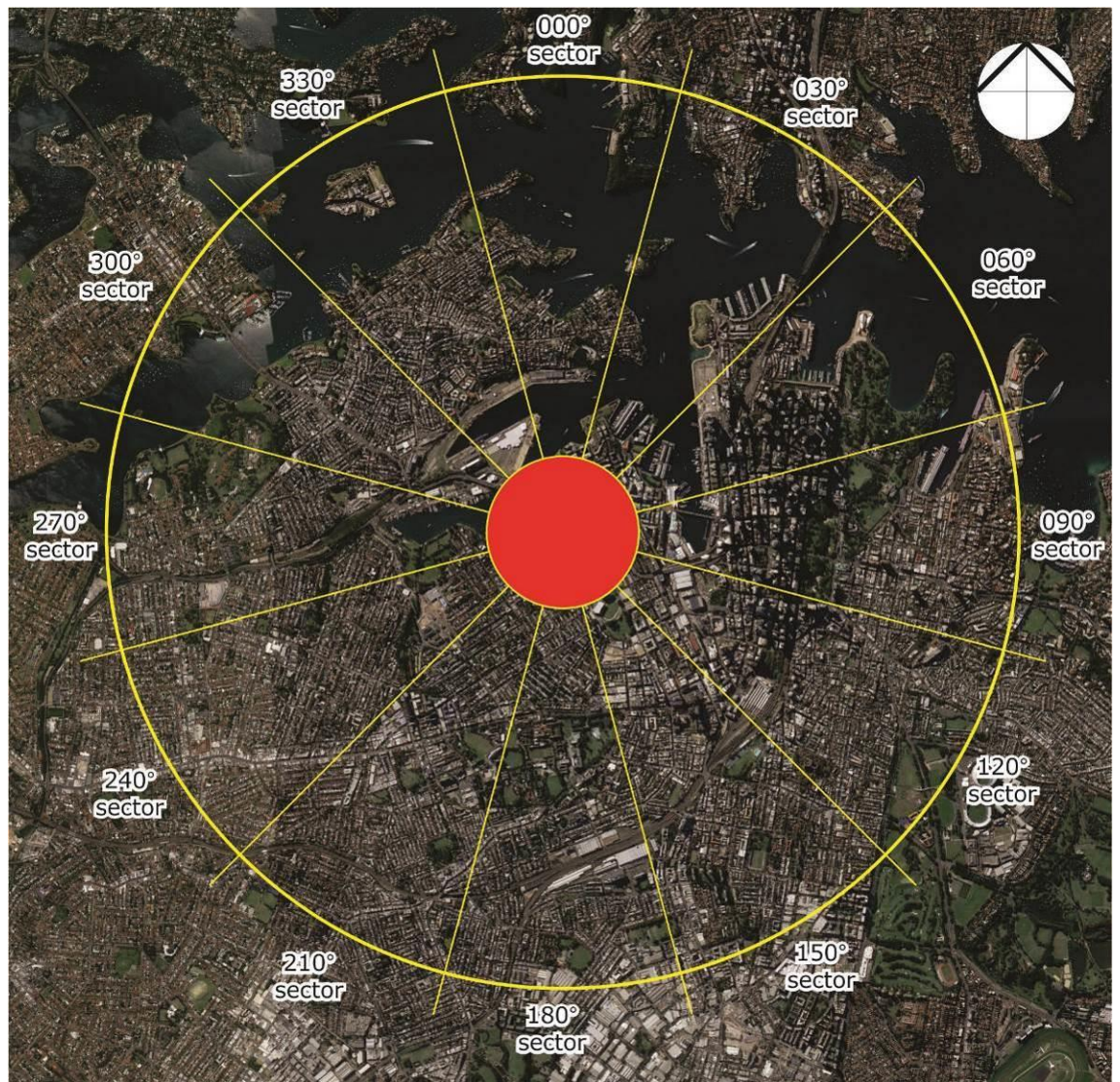
Terrain Category	Terrain and Height Multipliers			Turbulence Intensity I_v	Terrain Roughness Length (m) $z_{0,r}$
	$k_{tr,T=3600s}$ (hourly)	$k_{tr,T=600s}$ (10-minute)	$k_{tr,T=3s}$ (3-second)		
1.0	0.96	0.99	1.28	0.112	0.003
1.5	0.90	0.93	1.25	0.128	0.01
2.0	0.84	0.88	1.21	0.147	0.03
2.5	0.77	0.81	1.17	0.174	0.1
3.0	0.69	0.73	1.12	0.208	0.3
3.5	0.58	0.62	1.04	0.265	1
4.0	0.46	0.51	0.96	0.355	3

An analysis of the effect of changes in the upwind terrain roughness was carried out for each of the wind directions studied. This has been undertaken based on the method given in AS/NZS1170.2:2011, which uses a “fetch” length of 40 times the study reference height. However, it should be noted that this “fetch” commences *beyond* a “lag distance” area, which has a length of 20 times the study reference height (in accordance with AS/NZS1170.2:2011), so the actual “fetch” of terrain analysed is the area between 20 and 60 times the study reference height away from the Bays Market District Investigation Area. An aerial image showing the surrounding terrain is presented in Figure 3 for a radius of 3.0 km from the edge of the wind tunnel proximity model. The resulting mean and gust terrain and height multipliers at the Bays Market District Investigation Area are presented in Table 3, referenced to the study reference height.

For each of the 16 wind directions tested in this study, the approaching boundary layer wind profiles modelled in the wind tunnel matched the model scale and the overall surrounding terrain characteristics beyond the extent of the proximity model. Plots of the wind tunnel boundary layer wind profiles are presented in Appendix B of this report.

**Table 3: Directional Mean and Gust Terrain and Height Multipliers at the Site
(at the study reference height)**

Wind Sector (degrees)	$k_{tr,T=3600s}$ (hourly mean)	$k_{tr,T=600s}$ (10-minute mean)	$k_{tr,T=3s}$ (3-second gust)
0	0.89	0.92	1.24
30	0.90	0.93	1.25
60	0.75	0.79	1.15
90	0.65	0.69	1.09
120	0.64	0.68	1.08
150	0.66	0.70	1.09
180	0.69	0.73	1.12
210	0.69	0.73	1.12
240	0.69	0.73	1.12
270	0.73	0.76	1.14
300	0.78	0.82	1.17
330	0.83	0.87	1.20



**Figure 3: Aerial Image of the Surrounding Terrain
(radius of 3.0km from the edge of the proximity model, which is coloured red)**

4 ENVIRONMENTAL WIND SPEED CRITERIA

4.1 Wind Effects on People

The acceptability of wind in any area is dependent upon its use. For example, people walking or window-shopping will tolerate higher wind speeds than those seated at an outdoor restaurant. Various other researchers, such as A.G. Davenport, T.V. Lawson, W.H. Melbourne, A.D. Penwarden, etc, have published criteria for pedestrian comfort for pedestrians in outdoor spaces for various types of activities. These are discussed in the following sub-sections of this report.

4.1.1 A.D. Penwarden (1975) Criteria for Gust Wind Speeds

The following table developed by A.D. Penwarden (1975) is a modified version of the Beaufort Scale, and describes the effects of various wind intensities on people. Note that the applicability column related to wind conditions occurring frequently (approximately once per week on average). Higher ranges of wind speeds can be tolerated for rarer events.

Table 4: Summary of Wind Effects on People (after A.D. Penwarden, 1975)

Type of Winds	Beaufort Number	Mean Wind Speed (m/s)	Effects
Calm, light air	1	0 - 1.5	Calm, no noticeable wind
Light breeze	2	1.6 - 3.3	Wind felt on face
Gentle breeze	3	3.4 - 5.4	Hair is disturbed, Clothing flaps
Moderate breeze	4	5.5 - 7.9	Raises dust, dry soil and loose paper - Hair disarranged
Fresh breeze	5	8.0 - 10.7	Force of wind felt on body
Strong breeze	6	10.8 - 13.8	Umbrellas used with difficulty, Hair blown straight, Difficult to walk steadily, Wind noise on ears unpleasant.
Near gale	7	13.9 - 17.1	Inconvenience felt when walking.
Gale	8	17.2 - 20.7	Generally impedes progress, Great difficulty with balance.
Strong gale	9	20.8 - 24.4	People blown over by gusts.

4.1.2 A.G. Davenport (1972) Criteria for Mean Wind Speeds

A.G. Davenport (1972) had also determined a set of criteria in terms of the Beaufort Scale and for various return periods. The values presented in Table 5 below are based on a frequency of exceedance of approximately once per week (a probability of exceedance of 5%).

Table 5: Criteria by A.G. Davenport (1972)

Classification	Activities	95 Percentile Maximum Mean (approximately once per week)
Walking Fast	Acceptable for brisk walking.	$7.5 \text{ m/s} < \bar{V} < 10.0 \text{ m/s}$
Strolling, Skating	Slow walking, etc.	$5.5 \text{ m/s} < \bar{V} < 7.5 \text{ m/s}$
Short Exposure Activities	Generally acceptable for walking & short duration stationary activities such as window-shopping, standing or sitting in plazas.	$3.5 \text{ m/s} < \bar{V} < 5.5 \text{ m/s}$
Long Exposure Activities	Generally acceptable for long duration stationary activities such as in outdoor restaurants & theatres and in parks.	$\bar{V} < 3.5 \text{ m/s}$

4.1.3 T.V. Lawson (1975) Criteria for Mean Wind Speeds

In 1973, T.V. Lawson quotes that A.D. Penwarden's Beaufort 4 wind speeds (as listed in Table 4) would be acceptable if it is not exceeded for more than 4% of the time; and a Beaufort 6 as being unacceptable if it is exceeded more than 2% of the time. Later, in 1975, T.V. Lawson presented a set of criteria very similar to those of A.G. Davenport's. These are presented in Tables 6 and 7.

Table 6: Safety Criteria by T.V. Lawson (1975)

Classification	Activities	Annual Maximum Mean
Safety (all weather areas)	Accessible by the general public.	15 m/s
Safety (fair weather areas)	Private outdoor areas (balconies, terraces, etc)	20 m/s

Table 7: Comfort Criteria by T.V. Lawson (1975)

Classification	Activities	95 Percentile Maximum Mean (approximately once per week)
Business Walking	Objective Walking from A to B.	$8 \text{ m/s} < \bar{V} < 10 \text{ m/s}$
Pedestrian Walking	Slow walking, etc.	$6 \text{ m/s} < \bar{V} < 8 \text{ m/s}$
Short Exposure Activities	Pedestrian standing or sitting for short times.	$4 \text{ m/s} < \bar{V} < 6 \text{ m/s}$
Long Exposure Activities	Pedestrian sitting for a long duration.	$\bar{V} < 4 \text{ m/s}$

4.1.4 W.H. Melbourne (1978) Criteria for Gust Wind Speeds

W.H. Melbourne (1978) introduced a set of criteria for the assessment of environmental wind conditions, which were developed for a temperature range of 10°C to 30°C and for people suitably dressed for outdoor conditions. These criteria are based on peak annual maximum gust wind speeds, and are outlined in Table 8 below. It should be noted that this criteria tends to be more conservative than criteria suggested by other researchers.

Table 8: Criteria by W.H. Melbourne (1978)

Classification	Human Activities	Annual Maximum Gust
Limit for safety	Completely unacceptable: people likely to get blown over.	$\hat{V} > 23\text{m/s}$
Marginal	Unacceptable as main public accessways.	$23\text{ m/s} > \hat{V} > 16\text{ m/s}$
Comfortable Walking	Acceptable for walking, main public accessways	$16\text{ m/s} > \hat{V} > 13\text{ m/s}$
Short Exposure Activities	Generally acceptable for walking & short duration stationary activities such as window-shopping, standing or sitting in plazas.	$13\text{ m/s} > \hat{V} > 10\text{ m/s}$
Long Exposure Activities	Generally acceptable for long duration stationary activities such as in outdoor restaurants & theatres and in parks.	$10\text{ m/s} > \hat{V}$

4.2 Comparison of the Various Wind Speed Criteria

The criteria by W.H. Melbourne (1978) mentioned in Table 8, and criteria from other researchers, are compared on a probabilistic basis in Figure 4. This indicates that the criteria by W.H. Melbourne (1978) are quite conservative. This was also observed by A.W. Rofail (2007) when undertaking on-site remedial studies, who concluded that the criteria by W.H. Melbourne (1978) generally overstates the wind effects in a typical urban setting, which is caused by the assumption by W.H. Melbourne of a fixed 15% turbulence intensity for all areas. This value tends to be at the lower end of the range of turbulence intensities, and the A.W. Rofail (2007) study found that, in an urban setting, the range of the *minimum* turbulence intensities is typically in the range of 20% to 60%.

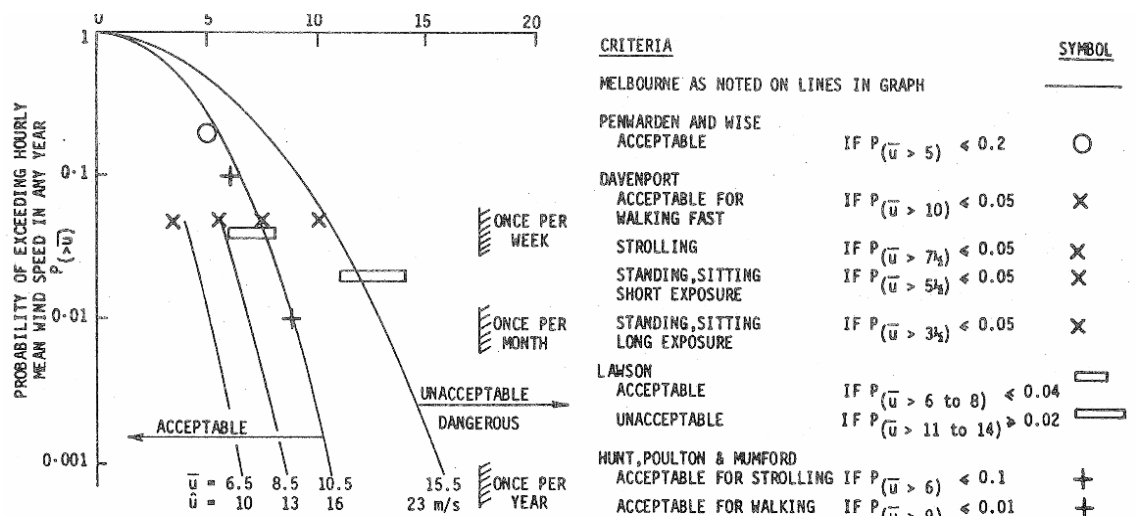


Figure 4: Comparison of Various Mean and Gust Wind Environment Criteria, assuming 15% turbulence and a Gust Factor of 1.5 (after W.H. Melbourne, 1978)

4.3 Wind Speed Criteria Used for This Study

For this study, the measured wind conditions for the various critical outdoor trafficable areas within and around the Bays Market District Investigation Area are compared against the criteria presented in the City of Sydney DCP (2012) in accordance with the Draft Sydney DCP 2012 – Central Sydney Planning Review Amendment. For comfort, the Draft Sydney DCP 2012 – Central Sydney Planning Amendment requires that the hourly mean wind speed, or gust equivalent mean wind speed (GEM), whichever is greater for each wind direction, must not exceed 8m/s for comfortable walking and 6m/s for standing. Similarly, the safety limit criterion of annual maximum peak 0.5 second gust wind speed of 24m/s is also applied to all areas.

For the Sydney DCP draft (2012, Central Sydney Planning Review Amendment), the following criteria were used, referenced to a range of outdoor activities (where applicable):

- **Walking:** 8m/s maximum GEM wind speeds
(representative of approximately a weekly recurrence).
- **Sitting in Parks:** 4m/s maximum GEM wind speeds, for areas protected by the sun access plane. (representative of approximately a weekly recurrence).
- **Standing:** 6m/s maximum GEM wind speeds for standing.
(representative of approximately a weekly recurrence).
- **Safety Limit:** 24.0m/s annual maximum gust wind speeds.

The wind tunnel testing undertaken is for the existing site conditions (i.e. - before the commencement of the masterplan development) to establish a baseline case for the wind environment conditions currently experienced within and around the Bays Market District Investigation Area. The results of the study have been presented against the future Sydney DCP Draft (2012, Central Sydney Planning Review Amendment) in the study point layout and criteria figures, as a form of comparison against comfort criteria, as shown in Appendix A of this report. This information will be used to help provide design guidance on the prevailing winds to consider during the conceptual design phase of the masterplan.

The results of the wind tunnel study are summarised in the following section, and presented in the form of directional plots attached in Appendices A of this report. Each study point has 2 points, one comparing to the maximum GEM wind speeds (which are representative of approximately a weekly recurrence), and the other comparing to the Melbourne (1978) criteria for the annual maximum peak gust wind speeds.

Notes:

- The GEM is defined as the maximum of the mean wind speed and the gust wind speed divided by a gust factor of 1.85.
- The gust wind speed is defined as 3.44 standard deviations from the mean.
- In all areas, the wind conditions are also checked against the safety limit.

5 TEST PROCEDURE AND METHODOLOGY

5.1 Measurement of the Velocity Coefficients

Testing was performed using Windtech's boundary layer wind tunnel facility, which has a 3.0m wide working section and has a fetch length of 14m. The test procedures followed for the wind tunnel testing performed for this study generally adhere to the guidelines set out in the Australasian Wind Engineering Society Quality Assurance Manual (AWES-QAM-1-2001), ASCE-7-10 (Chapter C31), and CTBUH (2013) guidelines.

The model of the Bays Market District Investigation Area was setup within the wind tunnel, and the wind velocity measurements were monitored using Dantec hot-wire probe anemometers at selected critical outdoor locations at a full-scale height of approximately 1.5m above ground/slab level. The probe support for each study location was mounted such that the probe wire was vertical as much as possible, which ensures that the measured wind speeds are independent of wind direction along the horizontal plane. In addition, care was taken in the alignment of the probe wire and in avoiding wall-heating effects. Wind speed measurements are made in the wind tunnel for 16 wind directions, at 22.5° increments. The output from the hot-wire probes was obtained using a National Instruments 12-bit data acquisition card. A sample rate of 1,024Hz was used, which is more than acceptable for the given frequency band. The signal was low pass filtered at 32Hz, which results in the peak gust being the equivalent of a 0.5 second gust (which is what the criteria for pedestrian comfort and safety are based upon).

The mean and the maximum 0.5 second duration peak gust velocity coefficients are derived from the wind tunnel test by the following relation:

$$\hat{C}_v = \bar{C}_v + g \cdot \sigma_v \quad (4.1)$$

where: \hat{C}_v is the 0.5-second gust velocity coefficient.

\bar{C}_v is the mean velocity coefficient.

g is the gust factor, which is taken to be 3.44.

σ_v is the standard deviation of the velocity measurement.

The mean free-stream wind speed measured in the wind tunnel for this study was approximately 9.0m/s. Note that the measurement location for the mean free-stream wind speed is at a height of 200m at the upwind edge of the proximity model. A sample length of 12 seconds was used for each wind direction tested, which is equivalent to a minimum sample time of approximately 31 minutes in full-scale for the annual maximum gust wind speeds, which is suitable for this type of study.

5.2 Calculation of the Full-Scale Results

To determine if the wind conditions at each study point location will satisfy the relevant criteria for pedestrian comfort and safety, the measured velocity coefficients need to be combined with information about the local wind climate. The aim of combining the wind tunnel measurements with wind climate information is to determine the probability of exceedance of a given wind speed at the site. The local wind climate is normally described using a statistical model, which relates wind speed to a probability of exceedance. Details of the wind climate model used in this study are outlined in Section 1.

A feature of this process is to include the impact of wind directionality, which includes any local variations in wind speed or frequency with wind direction. This is important as the wind directions which produce the highest wind speed events for a region may not coincided with the most wind exposed direction at the site.

The methodology adopted for the derivation of the full-scale results for the annual maximum gust and the weekly maximum GEM wind speeds are outlined in the following sub-sections.

5.2.1 Annual Maximum Gust Wind Speeds

The full-scale annual maximum gust wind speed at each study point location is derived from the measured velocity coefficient using the following relationship:

$$V_{study} = V_{ref,RH} \left(\frac{k_{200m,tr,T=3600s}}{k_{RH,tr,T=3600s}} \right) C_V \quad (4.2)$$

V_{study} is the full-scale wind velocity at the study point location, in m/s.

$V_{ref,RH}$ is the full-scale reference wind speed at the upwind edge of the proximity model at the study reference height. This value is determined by combining the directional wind speed data for the region (detailed in Section 1) and the upwind terrain and height multipliers for the site (detailed in Section 3).

$k_{200m,tr,T=3600s}$ is the hourly mean terrain and height multiplier at 200m for the standard terrain category setup used in the wind tunnel tests.

$k_{RH,tr,T=3600s}$ is the hourly mean terrain and height multiplier at the study reference height (see Table 3).

C_V is the velocity coefficient measurement obtained from the hot-wire anemometer, which is derived from the following relationship:

$$C_V = \frac{C_{V,study}}{C_{V,200m}} \quad (4.3)$$

$C_{V,study}$ is the velocity coefficient measurement obtained from the hot-wire anemometer at the study point location.

$C_{V,200m}$ is the measurement obtained from the hot-wire anemometer at the free-stream reference location at 200m height upwind of the model in the wind tunnel.

The value of $V_{ref,RH}$ varies with each prevailing wind direction. Wind directions where there is a high probability that a strong wind will occur will have a higher directional wind speed than other directions. To determine the directional wind speeds, a probability level must be assigned for each wind direction. These probability levels are set following the approach used in AS/NZS1170.2:2011, which assumes that the major contributions to the combined probability of exceedance of a typical load effect comes from only two 45 degree sectors.

5.2.2 Weekly Maximum Gust-Equivalent Mean Wind Speeds

The contribution to the probability of exceedance of a specified wind speed (ie: the desired wind speed for pedestrian comfort, as per the criteria) is calculated for each wind direction. These contributions are then combined over all wind directions to calculate the total probability of exceedance of the specified wind speed. To calculate the probability of exceedance for a specified wind speed a statistical wind climate model was used to describe the relationship between directional wind speeds and the probability of exceedance. A detailed description of the methodology is given by T.V. Lawson (1980).

The criteria of A.G. Davenport (1972), which is used in this study, is referenced to a probability of exceedance of 5% of a specified wind speed and is representative of approximately a weekly recurrence interval.

5.3 Layout of Study Points, and Relevant Wind Speed Criteria

For this study a total of 52 study point locations have been selected for analysis in the wind tunnel located within and around various locations of the Bays Market District Investigation Area.

The locations of the various study points tested for each configuration of this study are presented in Figures 5a to 5e in the form of a marked-up plan drawing.

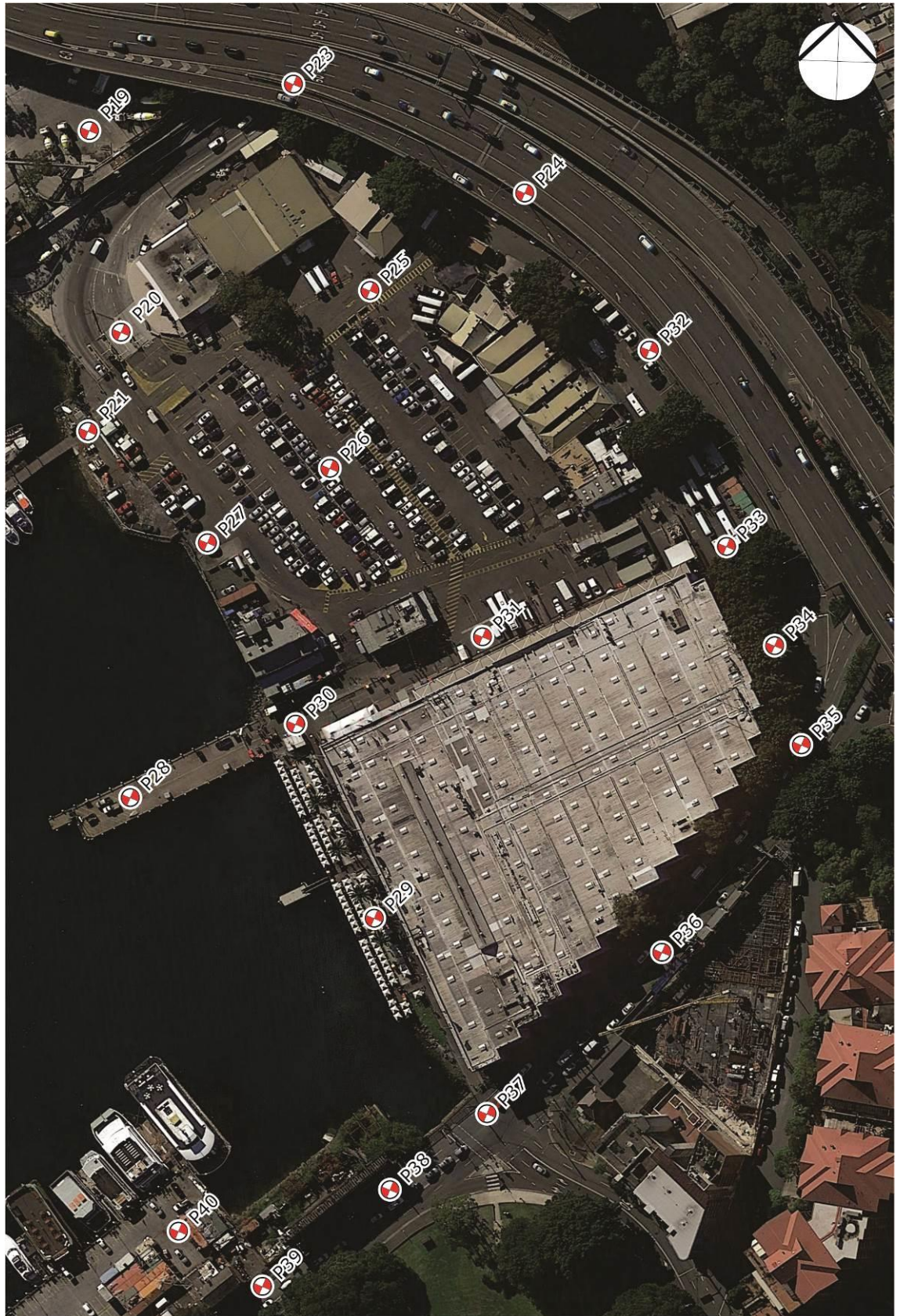
It should also be noted that only the most critical outdoor locations have been selected for analysis which will help with the masterplan design input.



Figure 5a: Study Point Locations and Target Criteria – Regions 1-3
Existing Site of the Bays Market District Investigation Area



Figure 5b: Study Point Locations and Target Criteria – Regions 4-8
Existing Site of the Bays Market District Investigation Area



**Figure 5c: Study Point Locations and Target Criteria – Regions 9-10, 14
Existing Site of the Bays Market District Investigation Area**

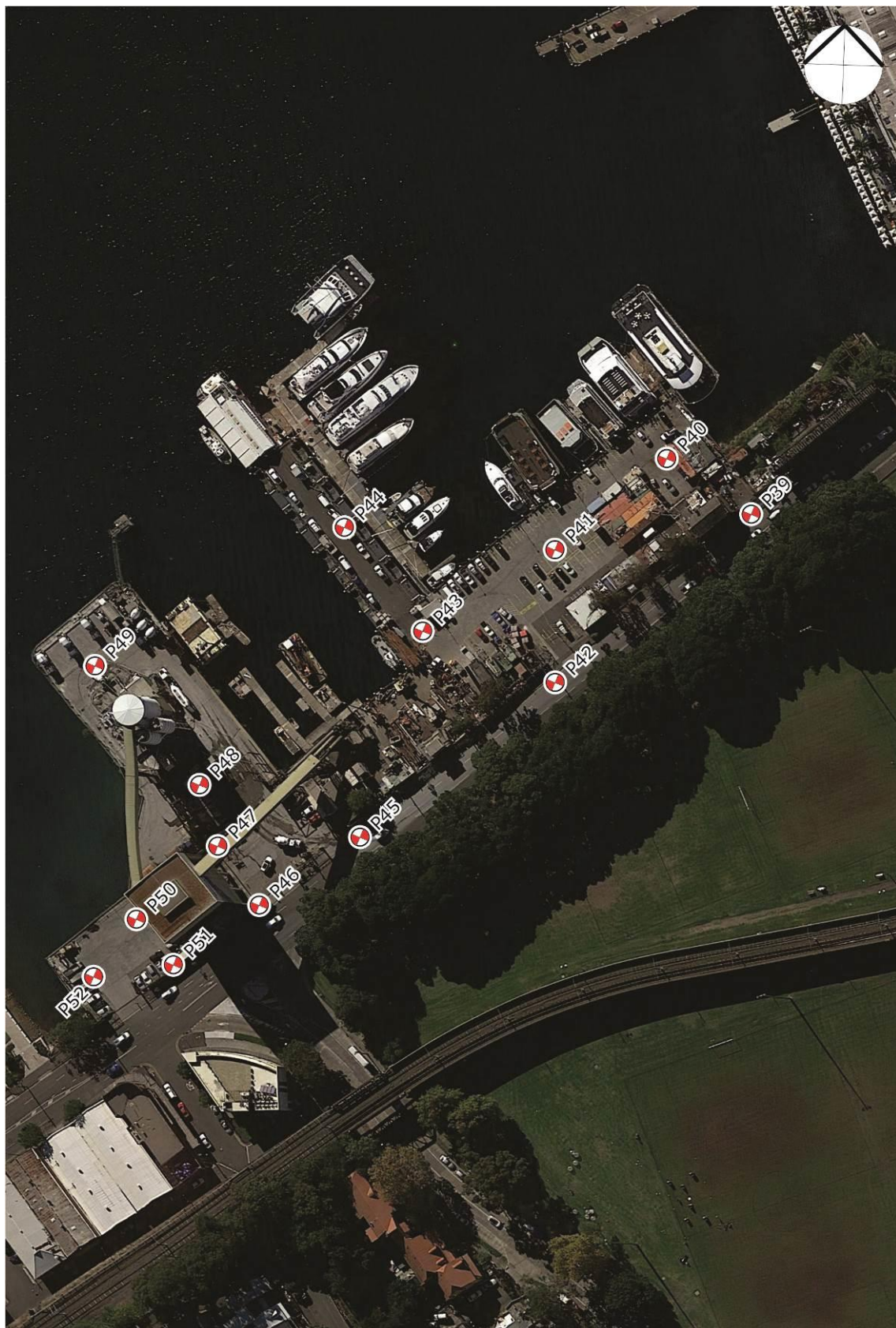


Figure 5d: Study Point Locations and Target Criteria – Regions 11-13
Existing Site of the Bays Market District Investigation Area

6 RESULTS AND DISCUSSION

The results for all study point locations are presented in the form of directional plots in Appendix A, and are summarised in Tables 9a and 9b, and in Figures 6a to 6e below. The wind speed criteria that the wind conditions should achieve are also listed in Tables 9a and 9b for each study point location, as well as in Figures 5a to 5d.

The baseline conditions established from this pedestrian wind environment report will then be compared against the results of the future wind tunnel testing of the masterplan development stage of this project to understand the effect of the masterplan built form on the surrounding wind conditions.

Note that the current wind conditions have been compared against the comfortable walking criterion at this stage which is applicable for pedestrian footpaths. This criterion will be adjusted for the masterplan design once intended uses of spaces around the Bays Market District Investigation Area have been developed. This adjustment will account for short and long exposure activities such as comfortable walking, standing/sitting in plazas and open space including the Waterfront Promenade and outdoor dining.

**Table 9: Wind Tunnel Results Summary – Existing Site Conditions
Sydney DCP draft (2012, Central Sydney Planning Review Amendment)**

Study Point	Wind Speed Criteria and Overall Rating			
	Weekly GEM (m/s)	Rating	Annual Peak (m/s)	Rating
Point 01	8.0	PASS	24.0	PASS
Point 02	8.0	PASS	24.0	PASS
Point 03	8.0	FAIL	24.0	PASS
Point 04	8.0	PASS	24.0	PASS
Point 05	8.0	FAIL	24.0	PASS
Point 06	8.0	FAIL	24.0	FAIL
Point 07	8.0	PASS	24.0	PASS
Point 08	8.0	PASS	24.0	PASS
Point 09	8.0	PASS	24.0	PASS
Point 10	8.0	PASS	24.0	PASS
Point 11	8.0	PASS	24.0	PASS
Point 12	8.0	PASS	24.0	PASS
Point 13	8.0	PASS	24.0	PASS
Point 14	8.0	PASS	24.0	PASS
Point 15	8.0	FAIL	24.0	PASS
Point 16	8.0	FAIL	24.0	FAIL
Point 17	8.0	FAIL	24.0	FAIL
Point 18	8.0	PASS	24.0	PASS

Study Point	Wind Speed Criteria and Overall Rating			
	Weekly GEM (m/s)	Rating	Annual Peak (m/s)	Rating
Point 19	8.0	PASS	24.0	PASS
Point 20	8.0	PASS	24.0	PASS
Point 21	8.0	FAIL	24.0	PASS
Point 22	8.0	FAIL	24.0	FAIL
Point 23	8.0	PASS	24.0	PASS
Point 24	8.0	PASS	24.0	PASS
Point 25	8.0	PASS	24.0	PASS
Point 26	8.0	FAIL	24.0	PASS
Point 27	8.0	FAIL	24.0	FAIL
Point 28	8.0	FAIL	24.0	PASS
Point 29	8.0	FAIL	24.0	PASS
Point 30	8.0	FAIL	24.0	PASS
Point 31	8.0	FAIL	24.0	FAIL
Point 32	8.0	FAIL	24.0	PASS
Point 33	8.0	PASS	24.0	PASS
Point 34	8.0	PASS	24.0	PASS
Point 35	8.0	PASS	24.0	PASS
Point 36	8.0	PASS	24.0	PASS
Point 37	8.0	FAIL	24.0	PASS
Point 38	8.0	FAIL	24.0	PASS
Point 39	8.0	FAIL	24.0	PASS
Point 40	8.0	FAIL	24.0	FAIL
Point 41	8.0	FAIL	24.0	PASS
Point 42	8.0	FAIL	24.0	FAIL
Point 43	8.0	FAIL	24.0	FAIL
Point 44	8.0	FAIL	24.0	PASS
Point 45	8.0	FAIL	24.0	PASS
Point 46	8.0	FAIL	24.0	FAIL
Point 47	8.0	FAIL	24.0	FAIL
Point 48	8.0	FAIL	24.0	FAIL
Point 49	8.0	FAIL	24.0	PASS
Point 50	8.0	FAIL	24.0	FAIL
Point 51	8.0	PASS	24.0	PASS
Point 52	8.0	FAIL	24.0	PASS

Note that when classifying a “Pass” or “Fail” for the weekly GEM wind speeds, the desired criterion is exceeded if the probability of exceedance is greater than 5% and hence awarded a “Fail”.

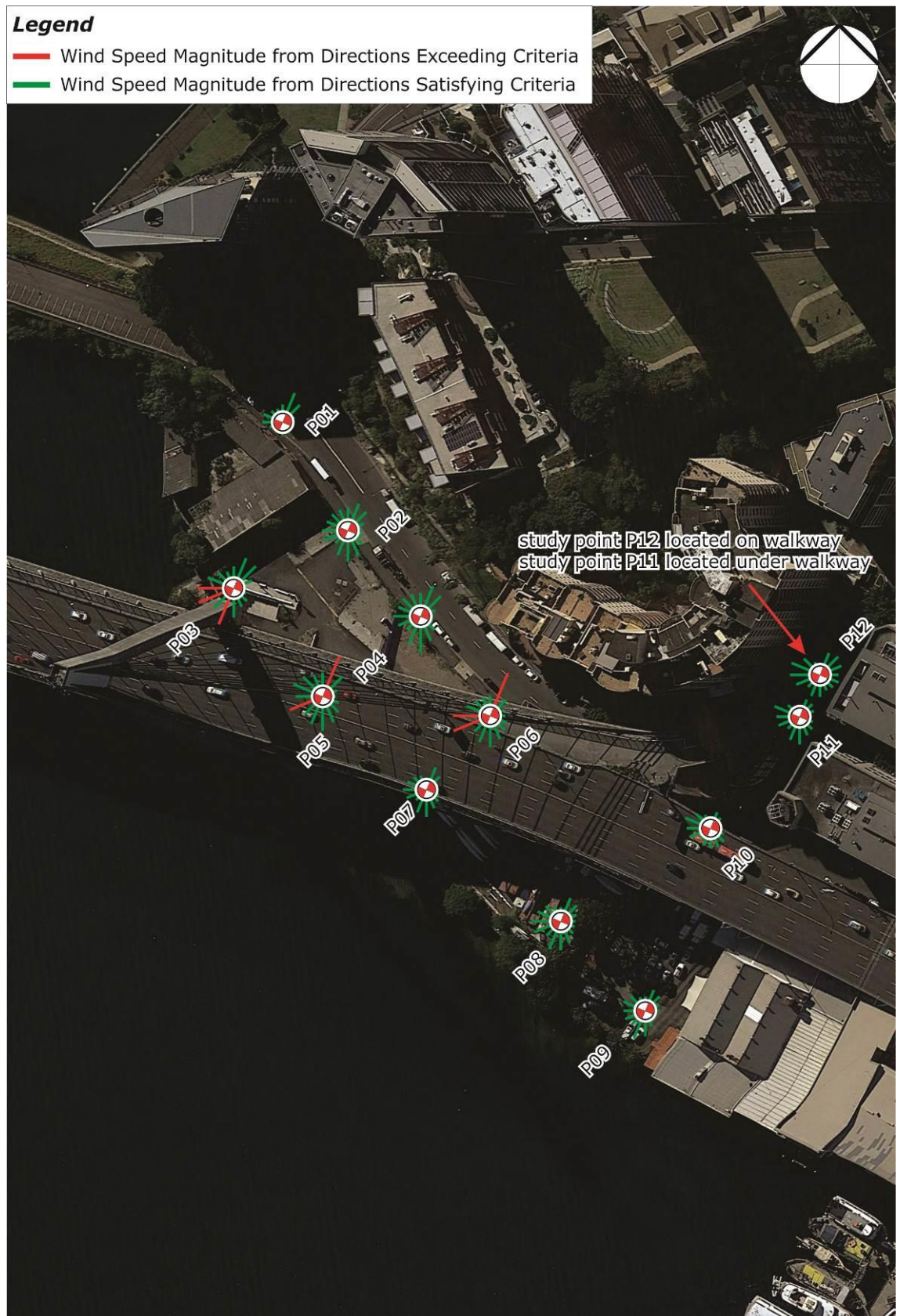
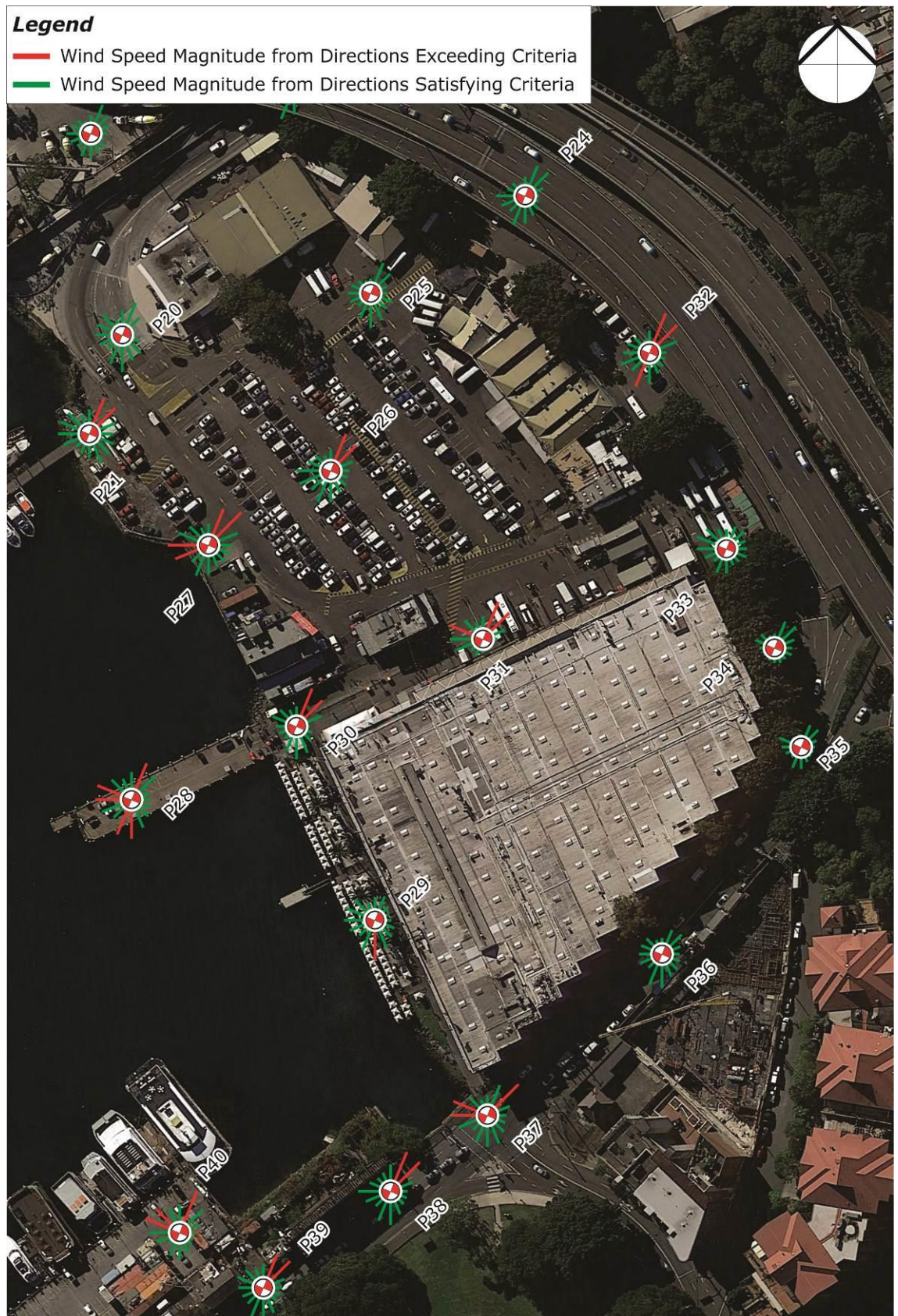


Figure 6a: Wind Directionality Plots – Regions 1-3
Existing Site of the Bays Market District Investigation Area



Figure 6b: Wind Directionality Plots – Regions 4-8
Existing Site of the Bays Market District Investigation Area



**Figure 6c: Wind Directionality Plots – Regions 9-10, 14
Existing Site of the Bays Market District Investigation Area**

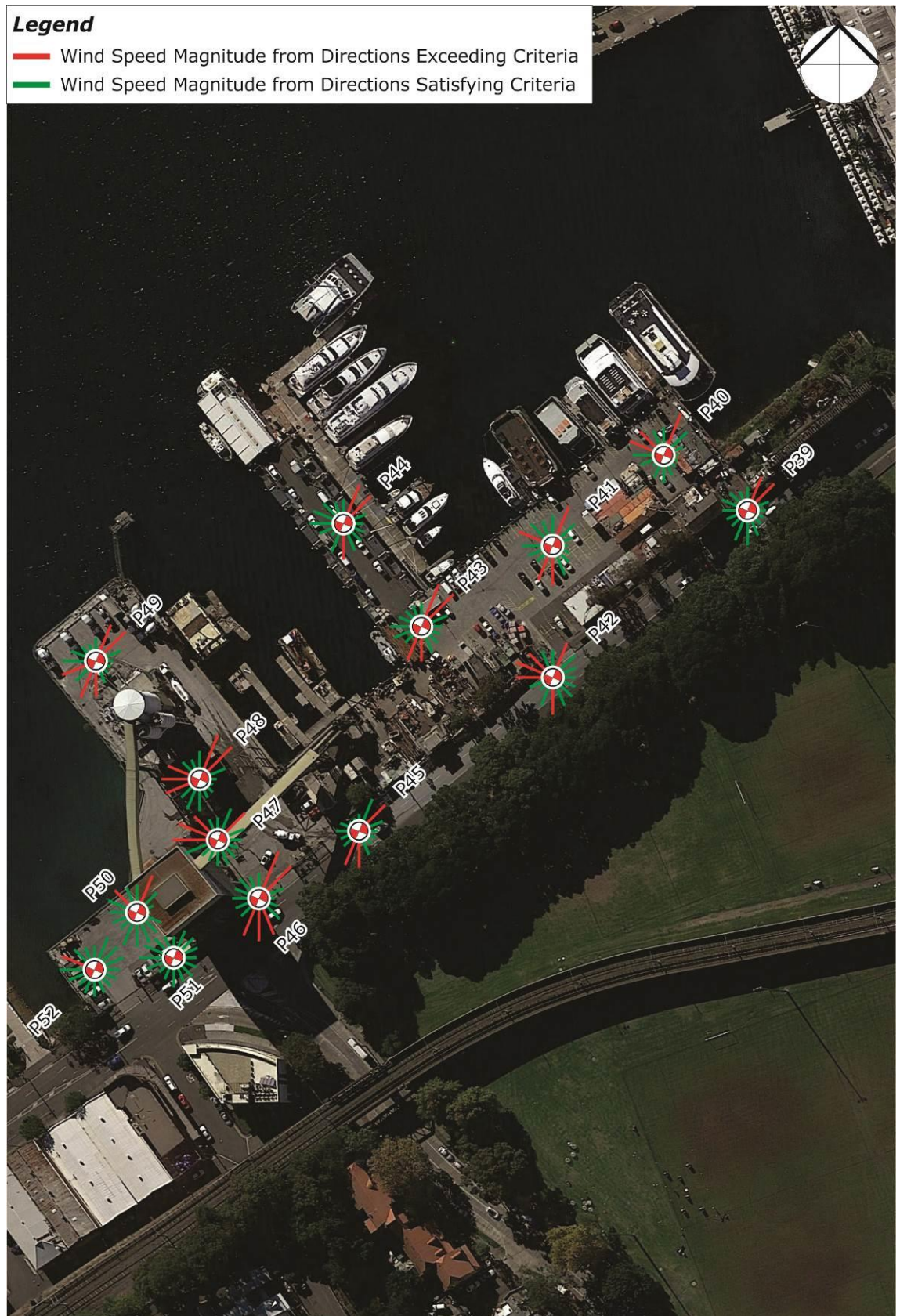


Figure 6d: Wind Directionality Plots – Regions 11-13
Existing Site of the Bays Market District Investigation Area

6.1 Discussion of Results

In analysing the initial wind conditions of the existing site for the Bays Market District Investigation Area, a baseline scenario has been established, which will allow for comparison of design guidance and future wind tunnel testing as masterplan options are developed and evolve.

It is important to note that due to the open water front and relatively low-rise and scattered nature of the existing buildings within and around the Bays Market District Investigation Area, the wind conditions from the wind tunnel test generally indicate the exposed nature of the site to the predominant wind directions for the Sydney region, with some localised wind effects detected.

6.1.1 Regions 1-3

Regions 1-3, shown in Figure 6a, are along the northern end of the Bays Market District Investigation Area and benefit from the shielding of the prevailing winds due to the positioning of existing structures in the area. There are a few areas located along the waterfront that are more exposed to direct winds and hence are failing the established criteria.

The areas along Bank Street are largely shielded due to the escarpment to the northwest, except for the region near Point 06. Point 06 is a reattachment zone where winds from the escarpment to the north-east are reattaching to the ground. Some localised interaction is also noted with the winds funnelling beneath the Anzac Bridge road deck.

6.1.2 Regions 4-8

Regions 4-8, shown in Figure 6b, are largely shielded from the prevailing north-easterlies due to the existing buildings, however areas further away from the building line are increasingly exposed. The maximum exposed areas are the jetties at Point 17 and Point 22. These areas are also most exposed to the direct winds coming from the west and south and hence are failing the wind comfort criteria. This will be an important consideration when considering the use of waterfront spaces for long term stationary uses by pedestrians.

6.1.3 Regions 9-10, 14

Regions 9-10, 14, shown in Figure 6c, are largely shielded from the prevailing southerlies and north-easterlies due to the buildings to the north, east and south. Areas further away from these buildings show increases in wind speeds from these directions. The existing parking lot and the jetties show the most significant increases in wind speeds with the prevailing winds coming over these open spaces.

Areas around the edges and corners of the existing Sydney Fish Market Building, are exposed to winds side-streaming along the edge of the façade and around the corners. This is most predominant along the edges that face the waterfront to the north-west. This effect will be an important consideration for future built form to account for this effect in the design process.

Point 32 in Region 14 is exposed to winds coming between the bridges to the north-east. Note that this is without consideration of the trees and landscaping of the park to the north-east of this area which will provide a notable reduction to the wind conditions experienced.

6.1.4 Regions 11-13

Regions 11-13, shown in Figure 6d, are more exposed to the prevailing north-easterlies and southerlies than the other regions and this is shown in the results with more study locations failing the wind comfort criteria. The area is also slightly less exposed to westerly winds due to the closer proximity of upwind buildings to the west. This shielding is increased for areas at the most western end of Region 13. The westerly winds also predominantly occur during the winter months hence will have a significantly adverse impact on thermal comfort due to “wind chill” effects.

Some areas along Bridge Road are exposed to direct southerlies coming from Wentworth Park to the south. This is most pronounced for Regions 11 and 12 with the areas toward the western end of Region 13 benefiting from some shielding from the prevailing southerlies. The existing tree line along the southern side of Bridge Road will have some added benefit to these measured wind conditions.

6.1.5 Overview of Conditions

From the results of the wind tunnel testing for the existing site conditions of the Bays Market District Investigation Area, the baseline conditions of the current development site may be observed.

Due to the open water front and relatively low-rise and scattered nature of the existing buildings within and around the Bays Market District Investigation Area, the wind conditions from the wind tunnel test generally indicate that the site is exposed to the predominant north-easterly, westerly and southerly winds for the region. More specifically, the majority of wind effects detected from the wind tunnel testing were observed to be direct wind effects due to this exposed nature. Note that this is without consideration of the future significant landscaping which could provide a notable reduction to the wind conditions experienced.

The location of existing buildings to the north east play a large role in shielding the Bays Market District Investigation Area from the prevailing north-easterlies. Similarly, the Wentworth Park to the south of the Bays Market District Investigation Area leaves areas along Bridge Road relatively exposed to the prevailing southerlies.

Furthermore, due to the currently exposed nature of the Bays Market District Investigation Area, it is important to consider the effect that medium to high-rise building forms will have on the surrounding streetscapes of the region. As observed from the wind tunnel testing of the existing site conditions, various medium-rise existing building forms had a significant impact on the wind conditions around them, inducing adverse wind effects as the incoming predominant winds were influenced by the building forms, while also providing additional shielding

downstream from their location. This is an important consideration for the masterplanning, in conjunction with the abovementioned points.

In addition, the impacts of climate change on the prevailing wind speeds and probability of occurrence is currently being investigated. This will be accounted for and modelled as masterplan options are developed and evolve throughout the project.

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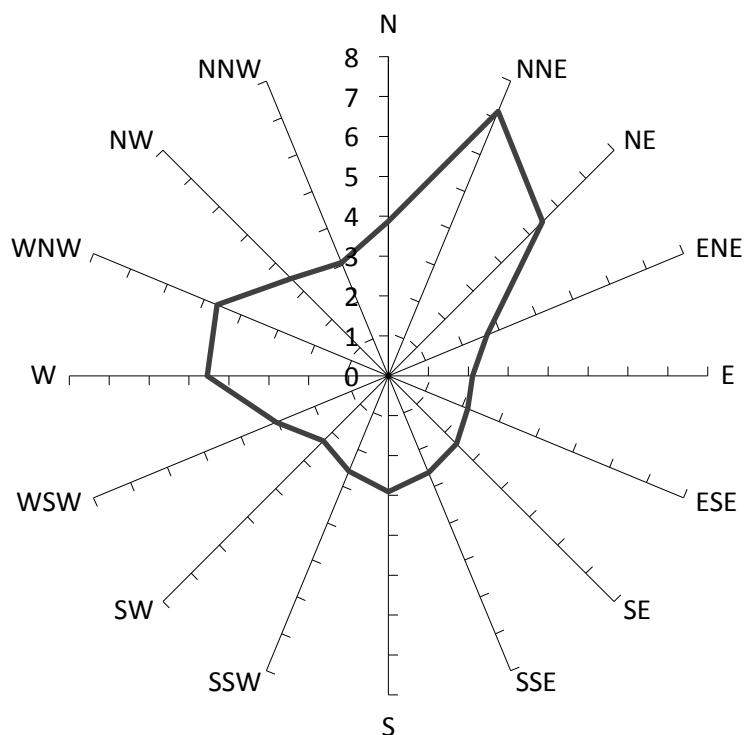
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APPENDIX A - DIRECTIONAL PLOTS OF THE WIND TUNNEL RESULTS

Measured Wind Speeds at P01

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

1%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

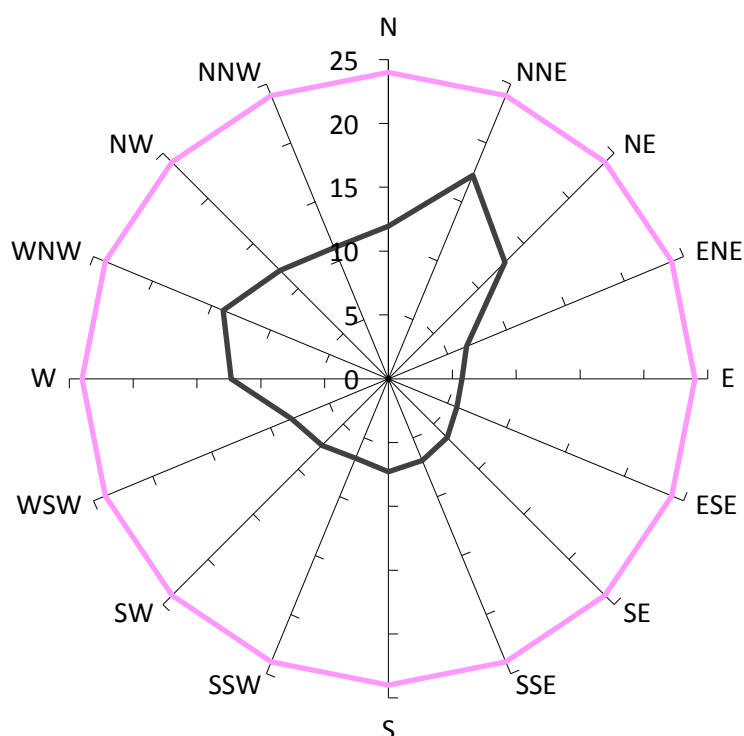
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

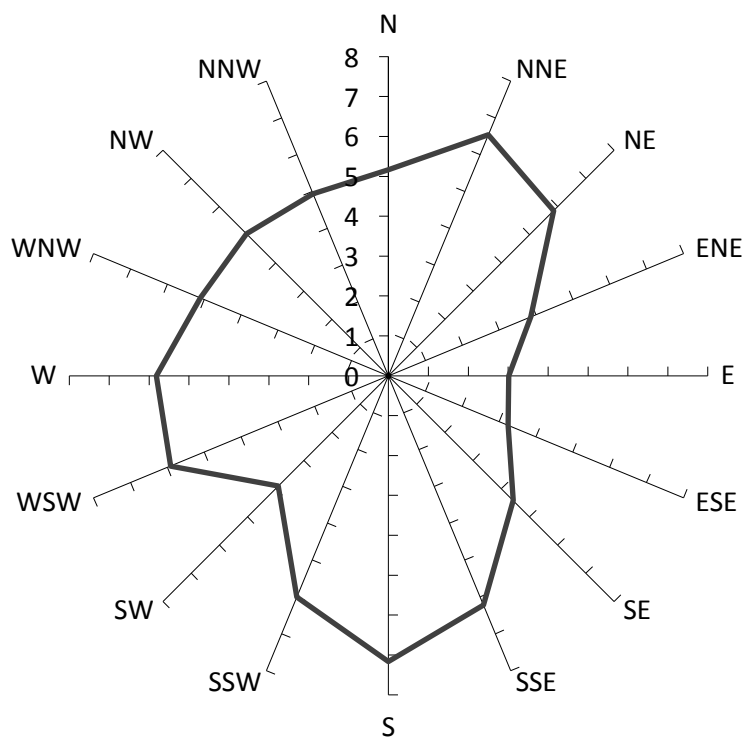


Desired Criterion

24m/s

Measured Wind Speeds at P02

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

2%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

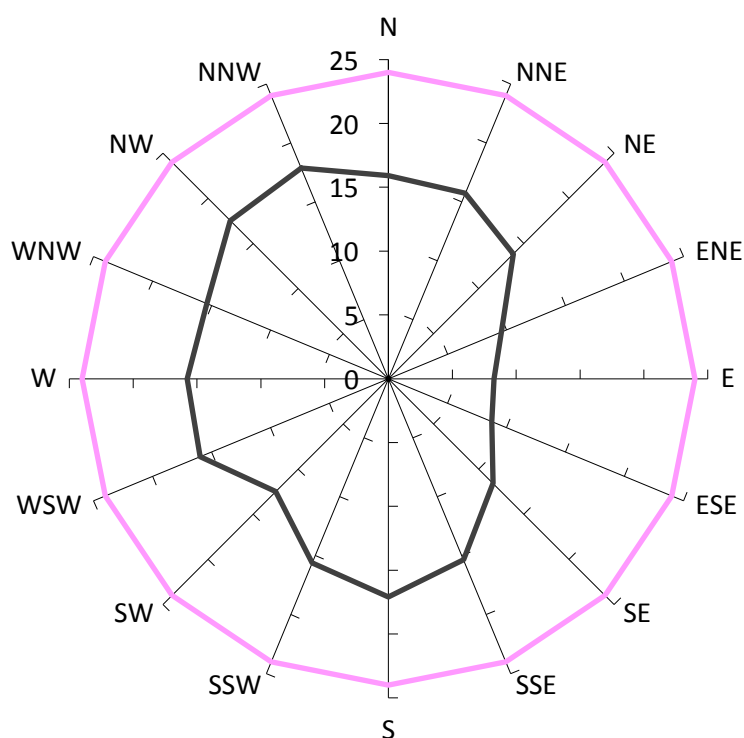
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

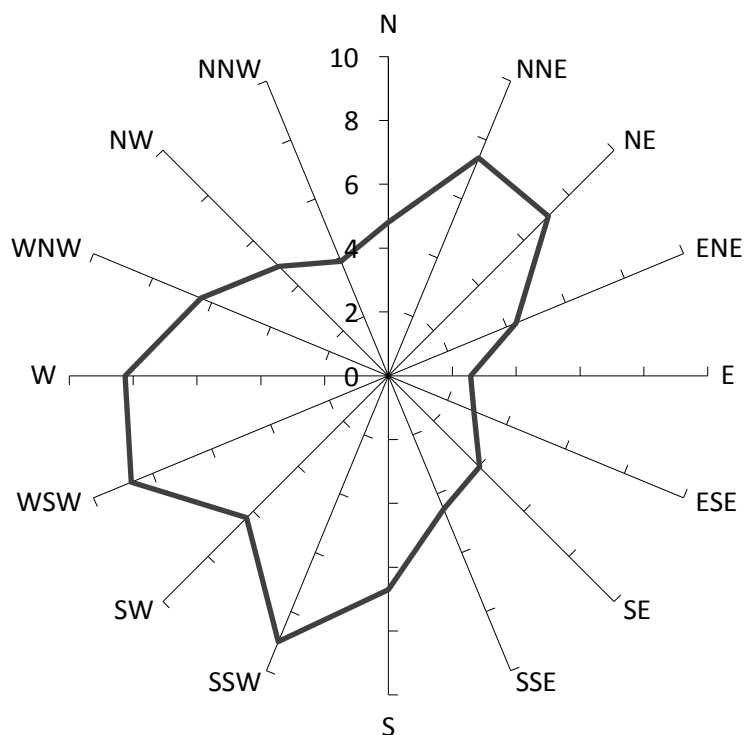


Desired Criterion

24m/s

Measured Wind Speeds at P03

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

8%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

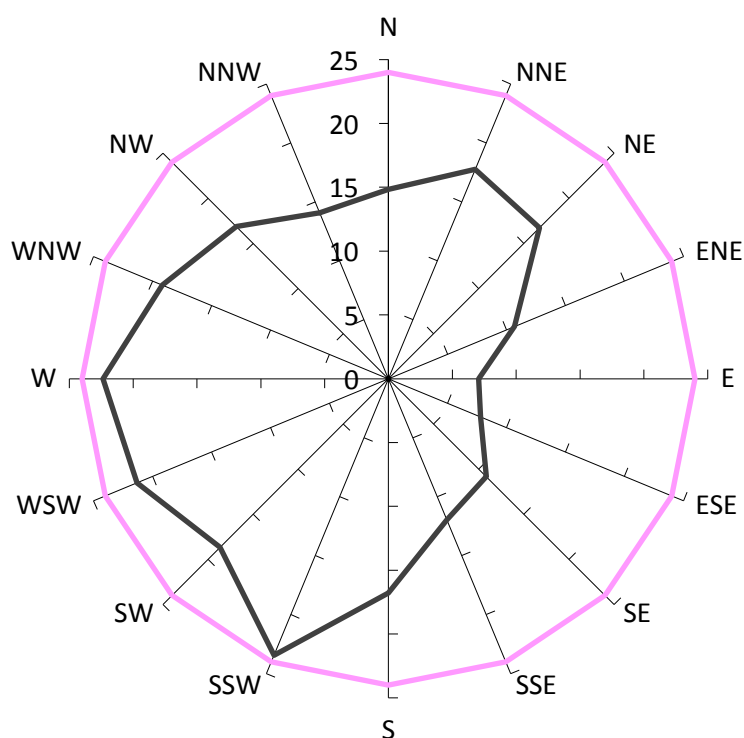
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

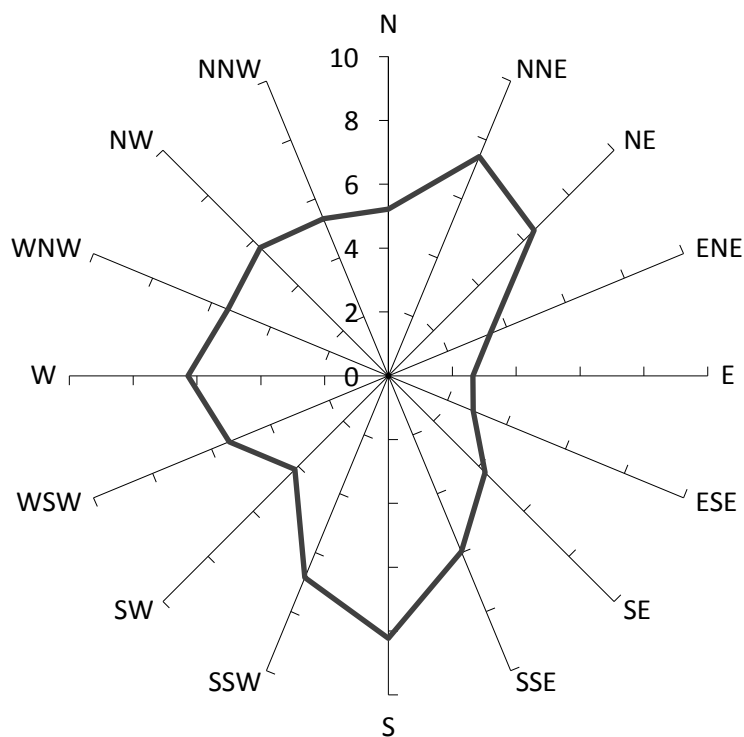


Desired Criterion

24m/s

Measured Wind Speeds at P04

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

4%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

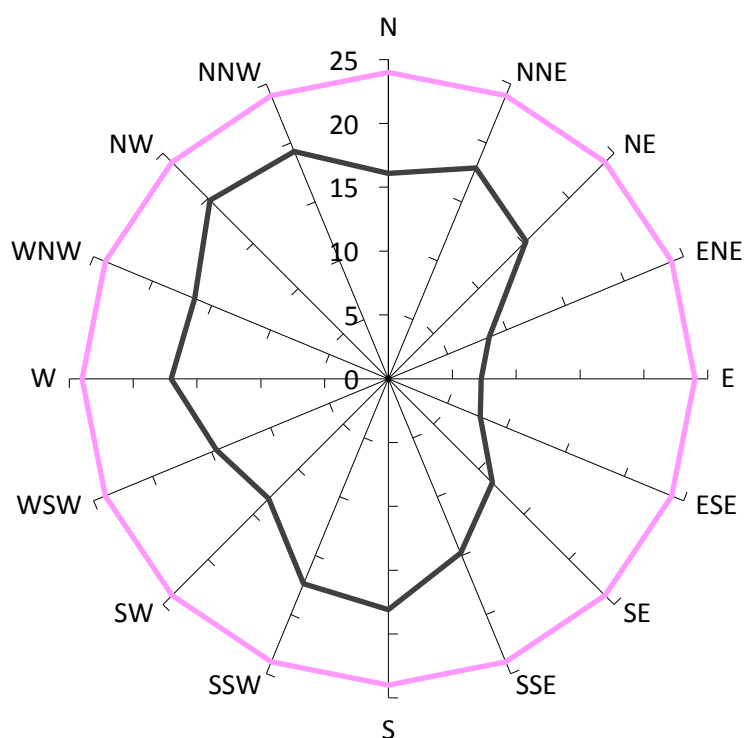
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

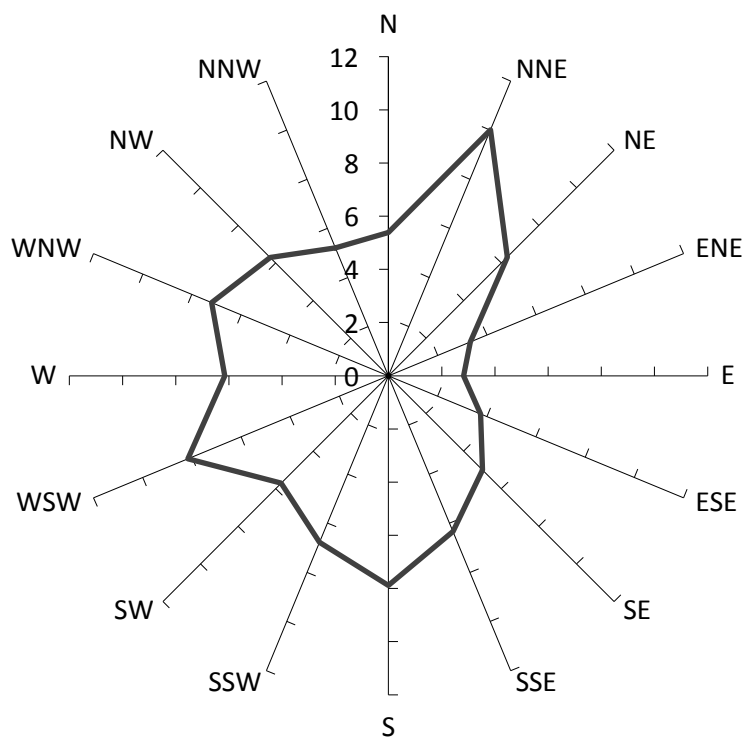


Desired Criterion

24m/s

Measured Wind Speeds at P05

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

10%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

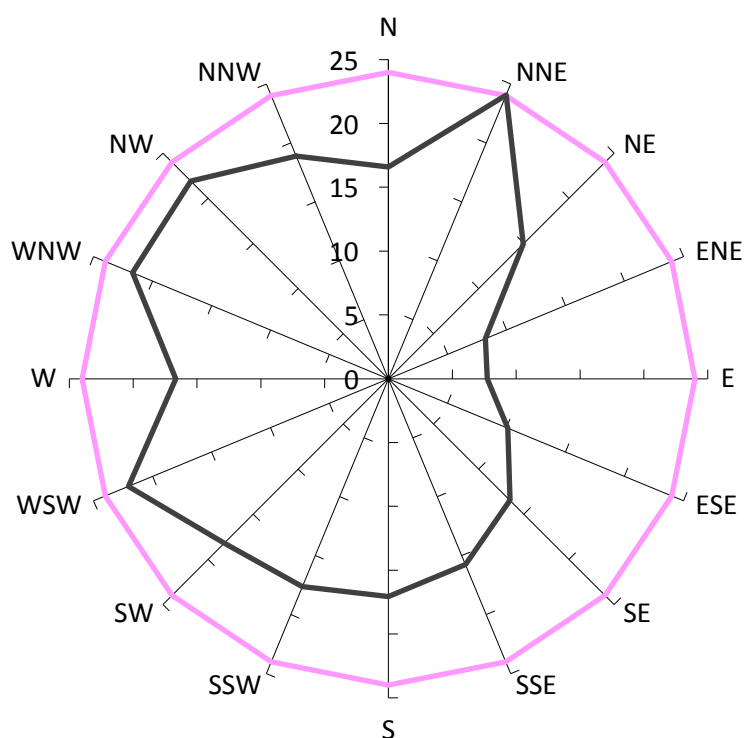
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

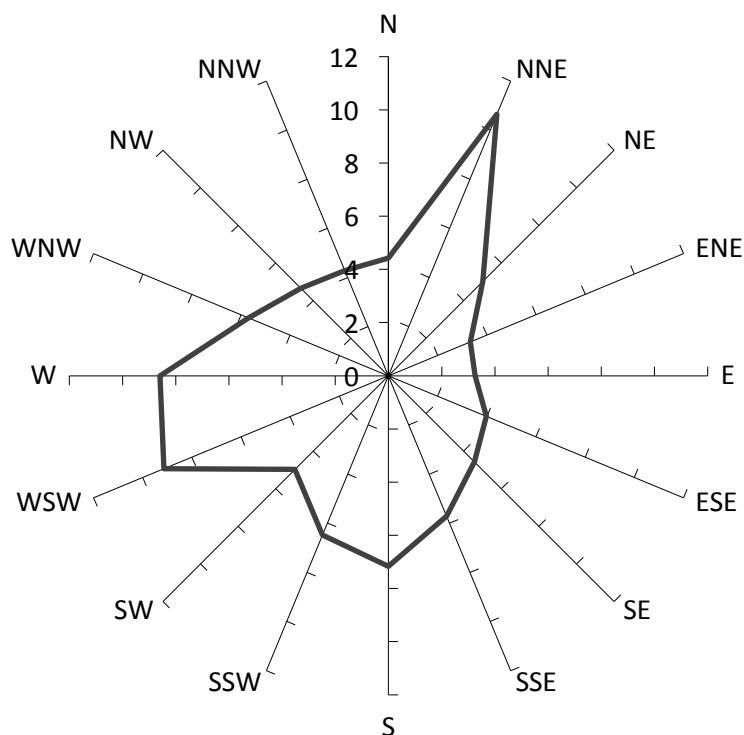


Desired Criterion

24m/s

Measured Wind Speeds at P06

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

10%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

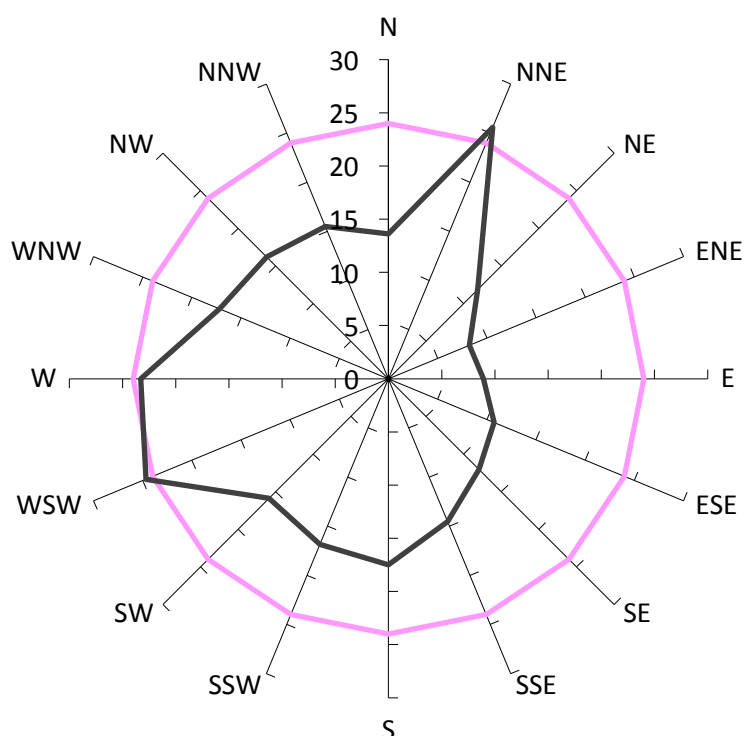
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

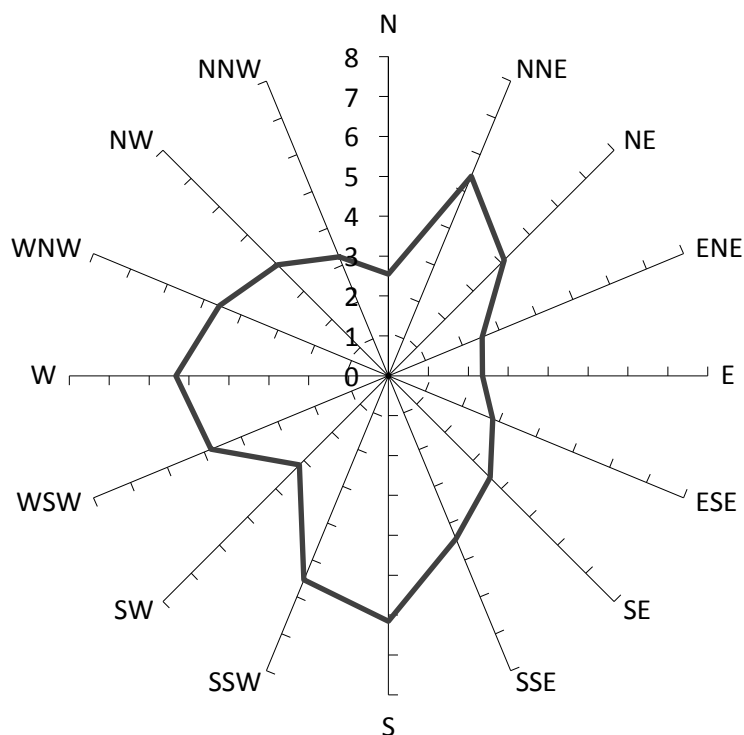


Desired Criterion

24m/s

Measured Wind Speeds at P07

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

1%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

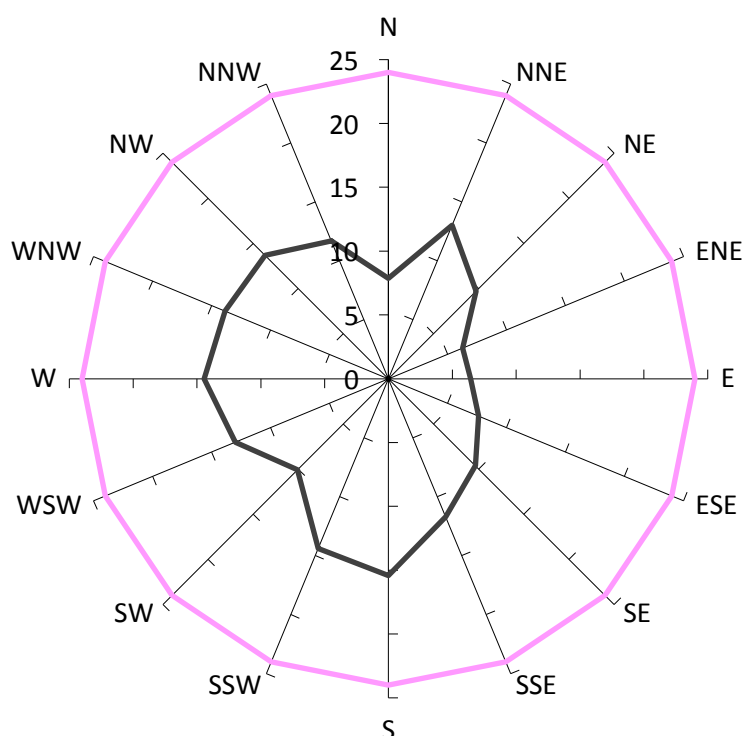
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

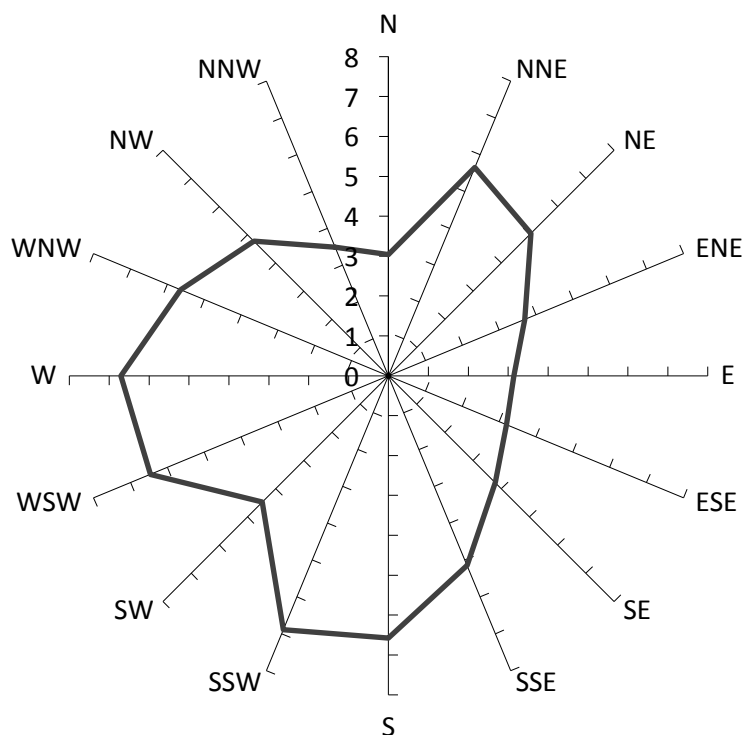


Desired Criterion

24m/s

Measured Wind Speeds at P08

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

2%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

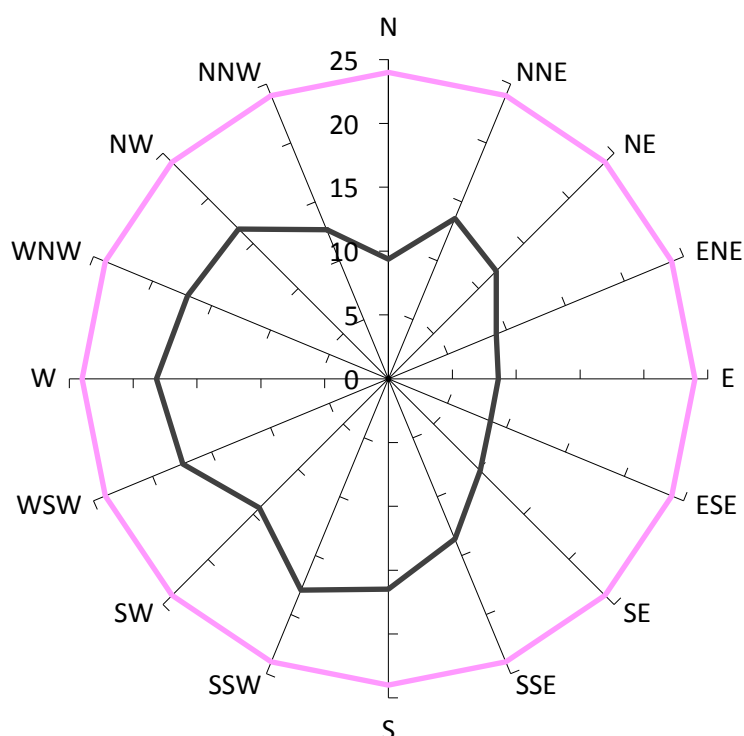
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

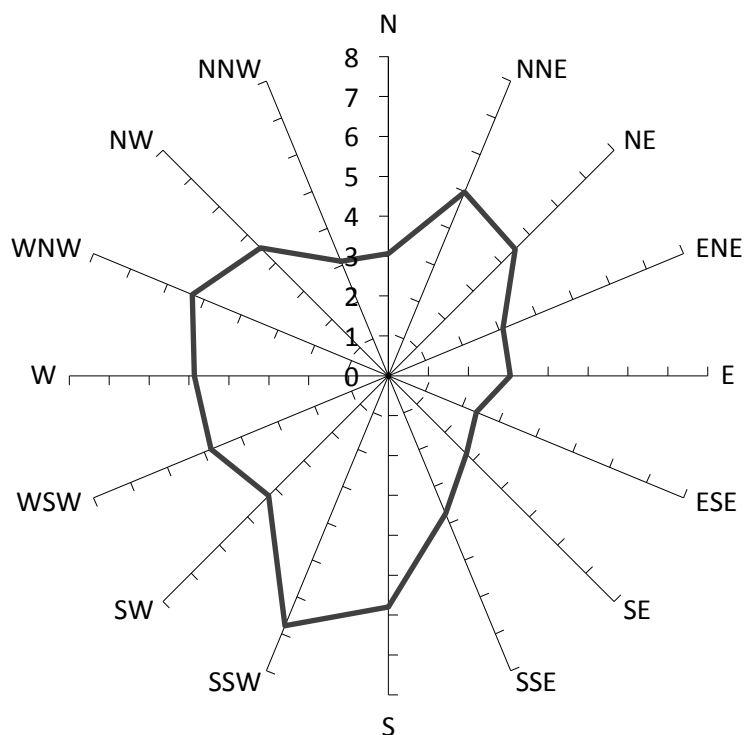


Desired Criterion

24m/s

Measured Wind Speeds at P09

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

1%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

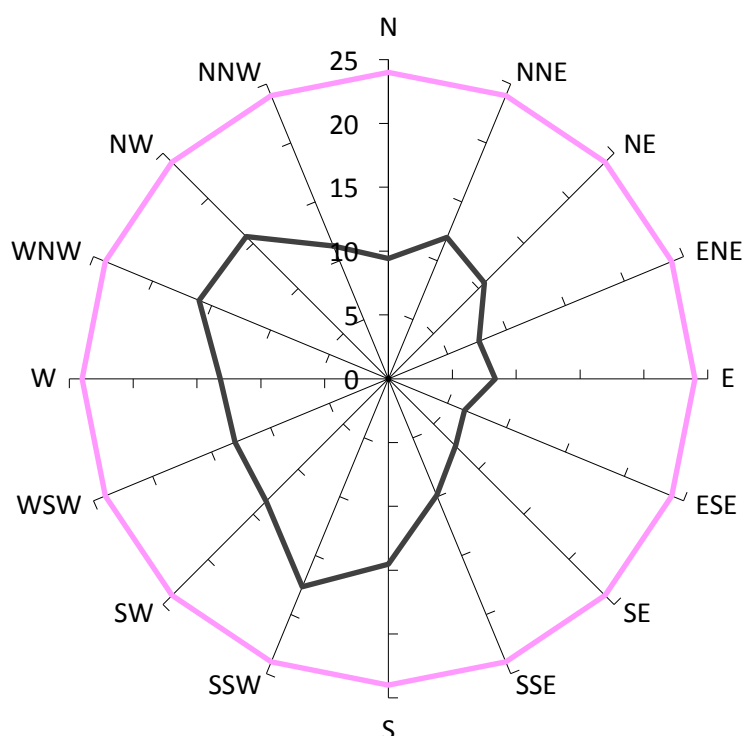
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

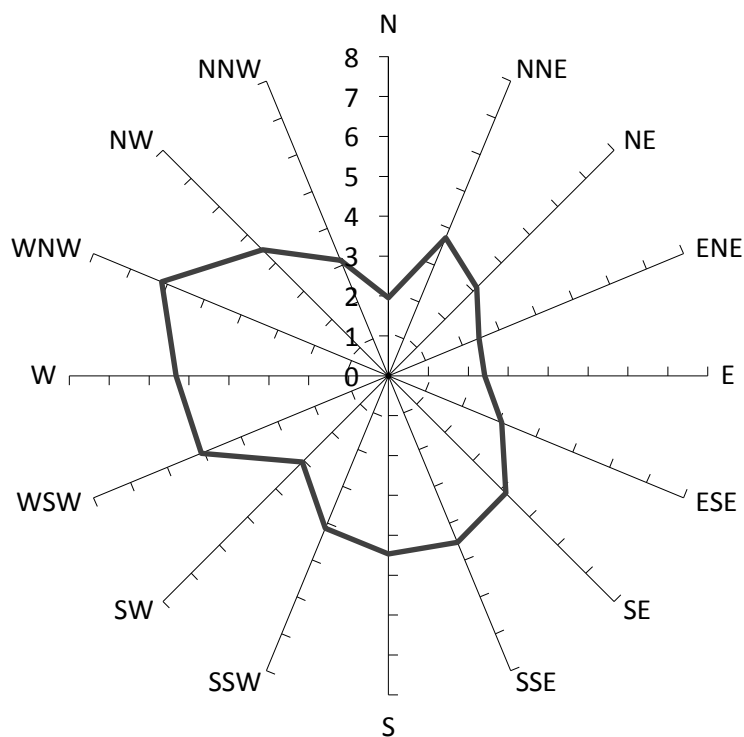


Desired Criterion

24m/s

Measured Wind Speeds at P10

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

1%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

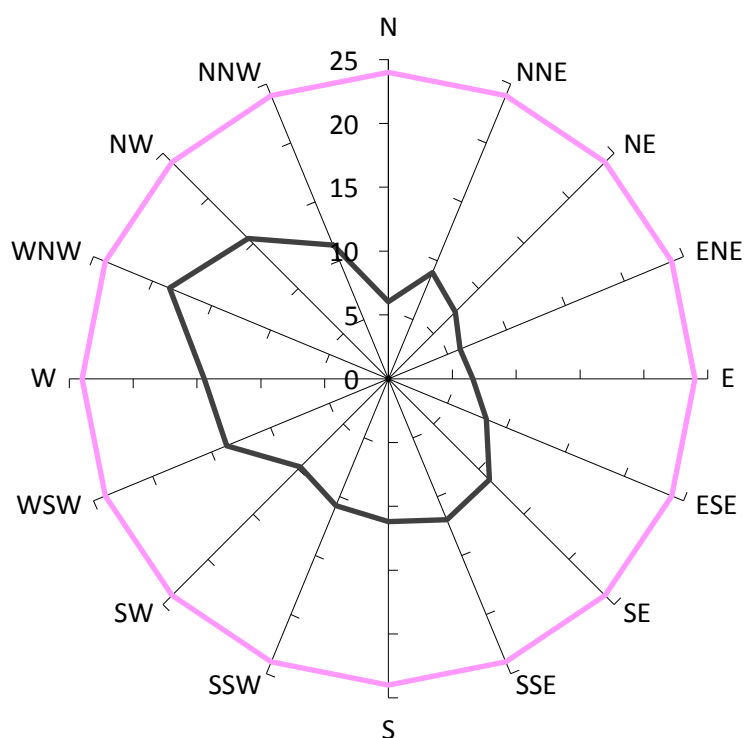
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

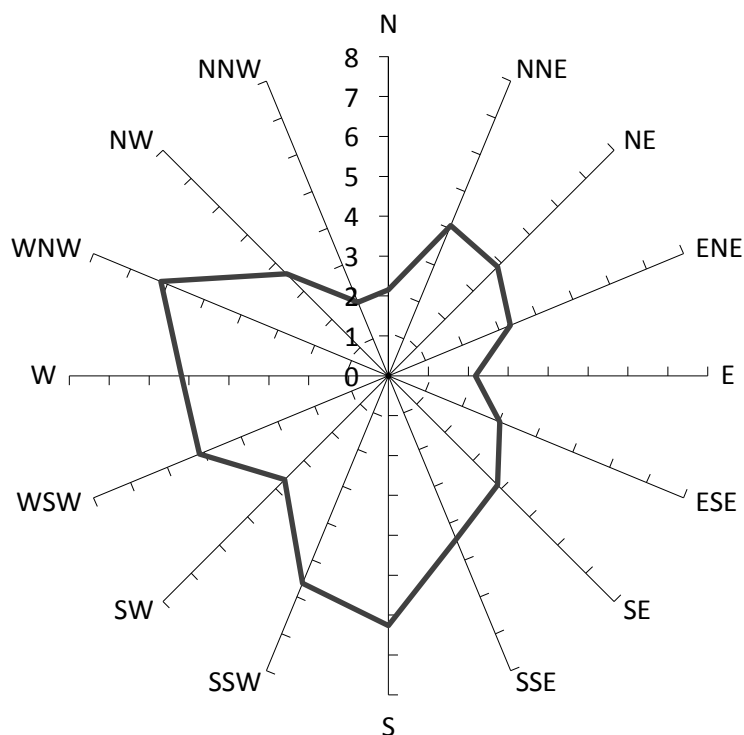


Desired Criterion

24m/s

Measured Wind Speeds at P11

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

1%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

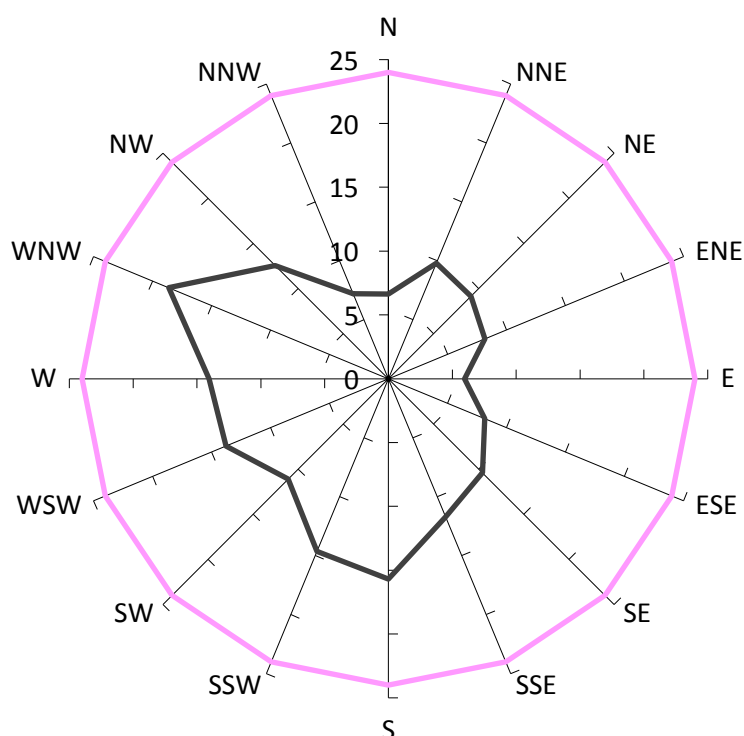
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

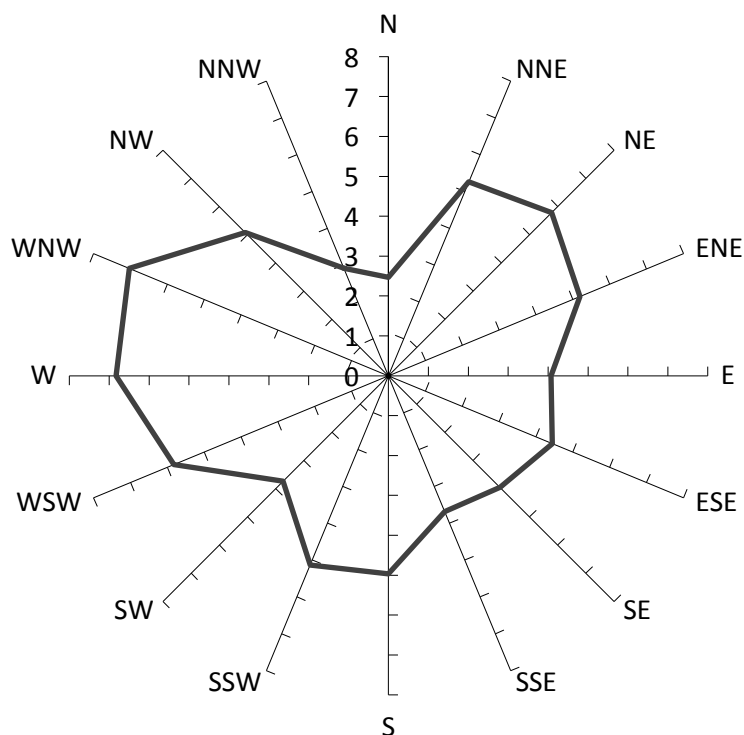


Desired Criterion

24m/s

Measured Wind Speeds at P12

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

2%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

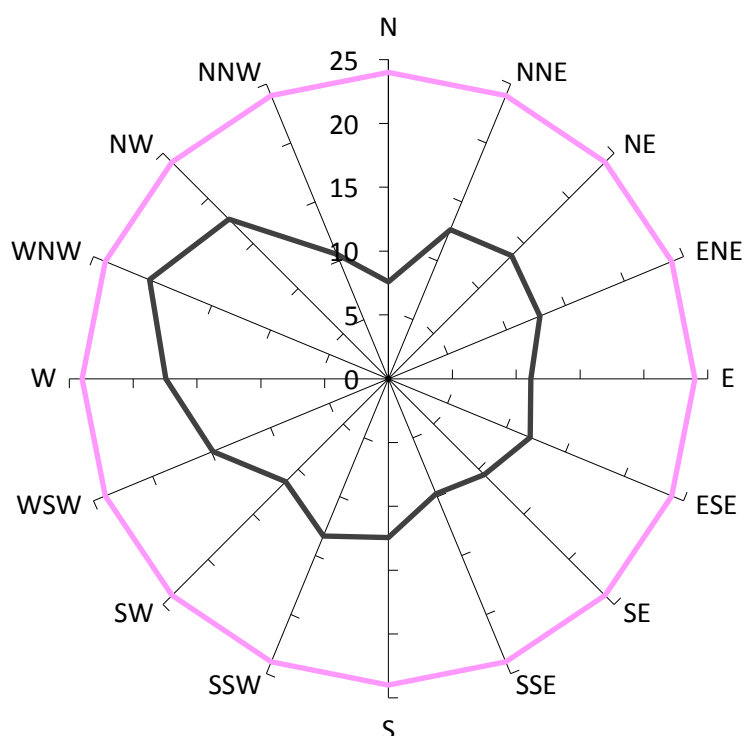
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

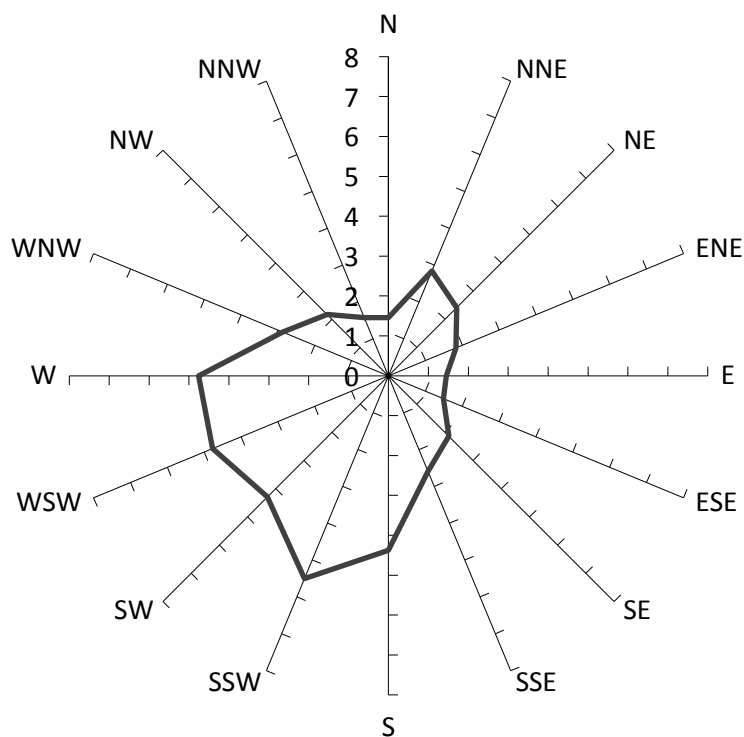


Desired Criterion

24m/s

Measured Wind Speeds at P13

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

0%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

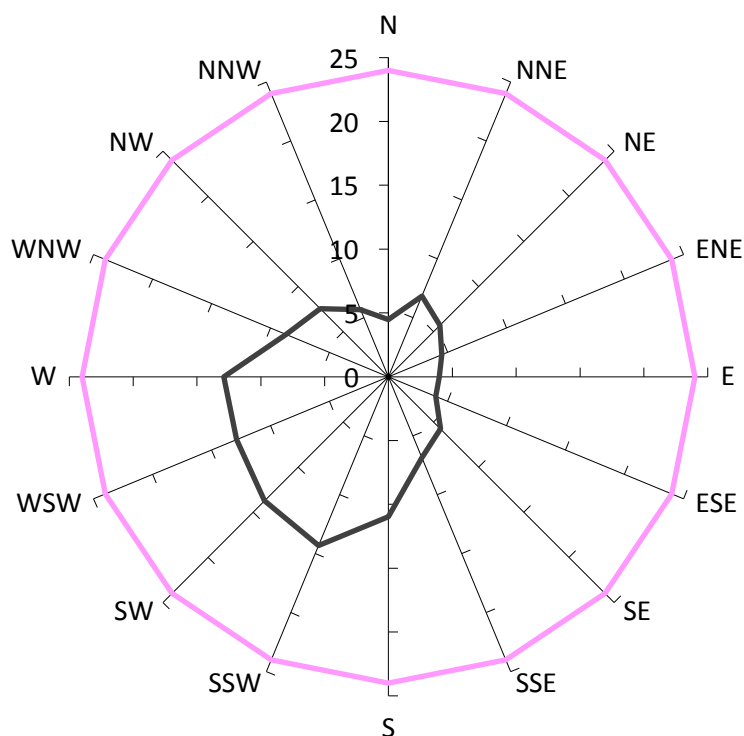
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

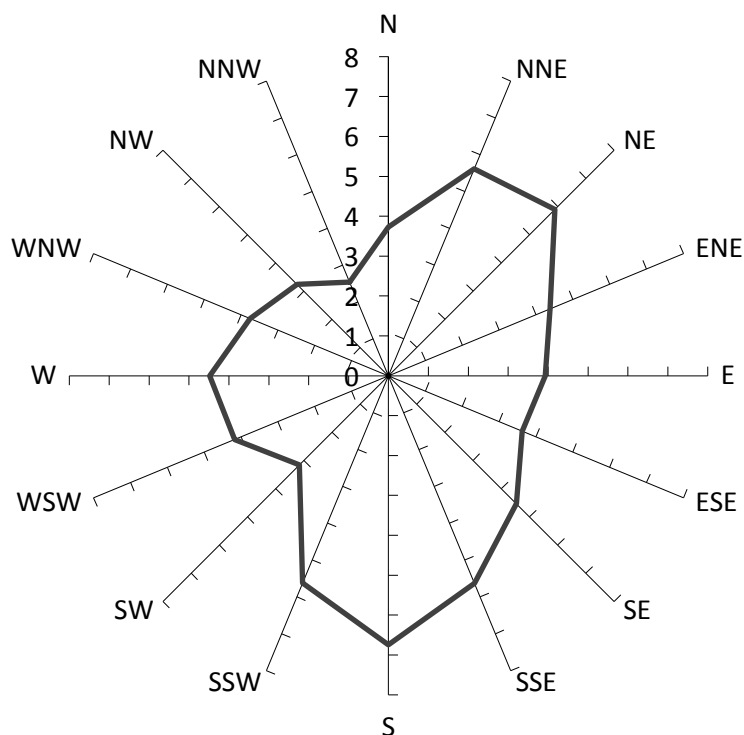


Desired Criterion

24m/s

Measured Wind Speeds at P14

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

1%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

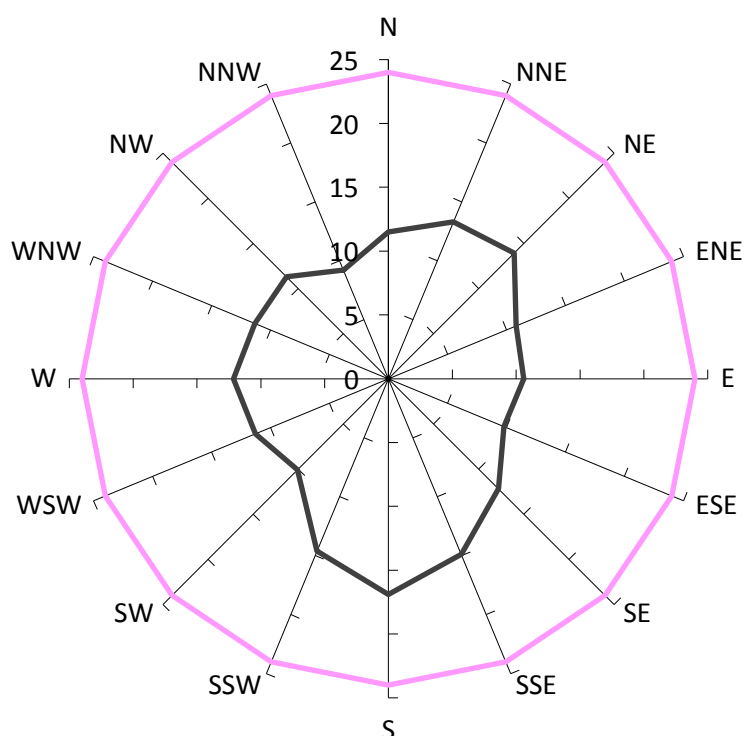
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

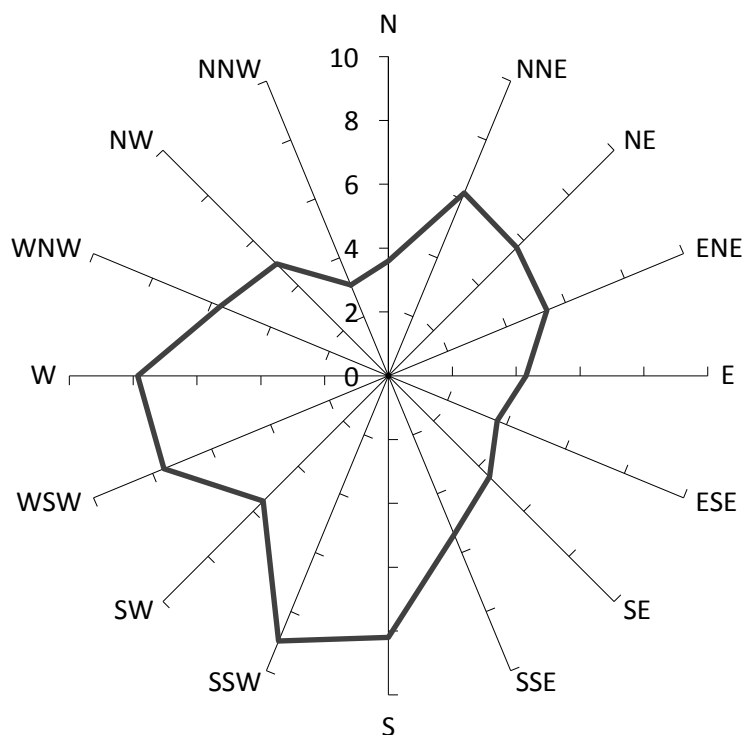


Desired Criterion

24m/s

Measured Wind Speeds at P15

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

6%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

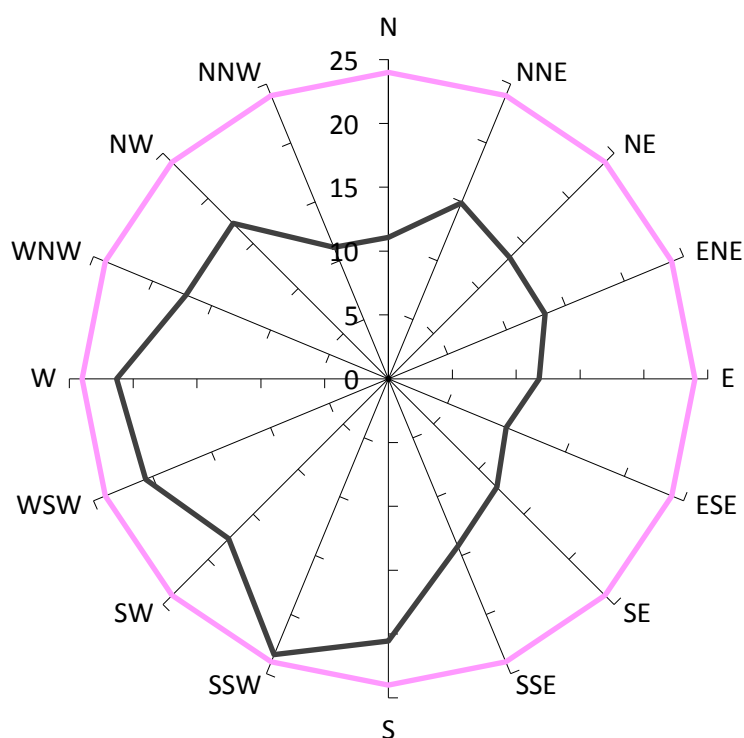
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

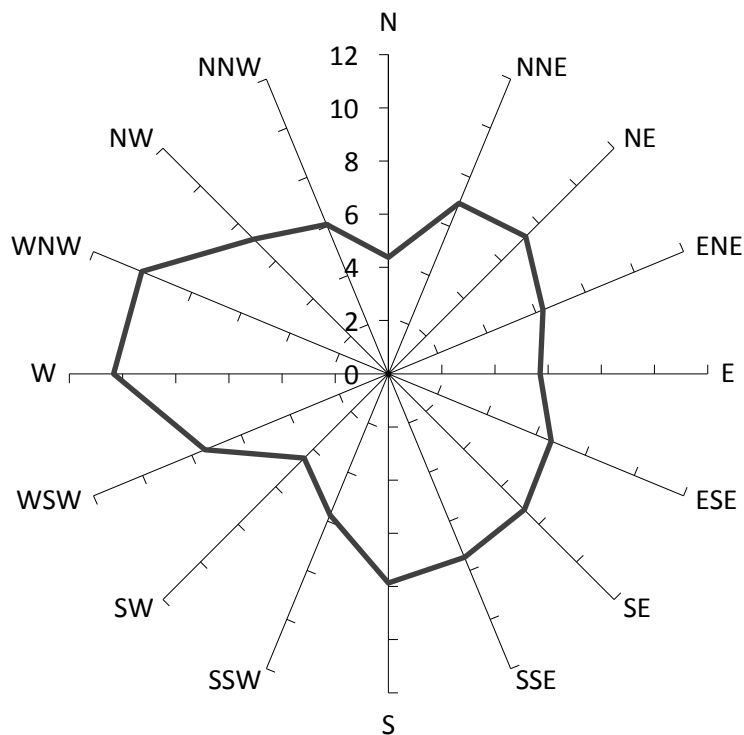


Desired Criterion

24m/s

Measured Wind Speeds at P16

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

12%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

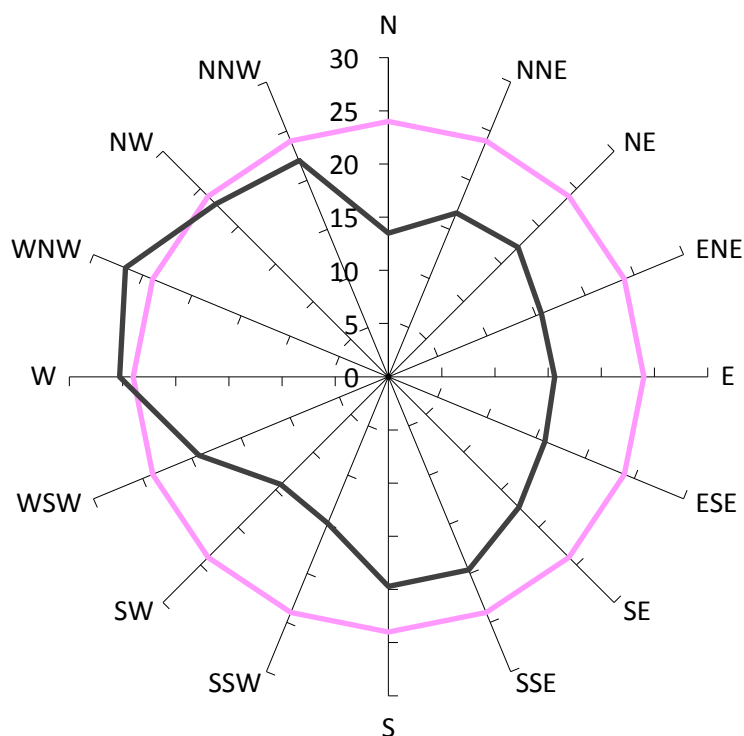
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

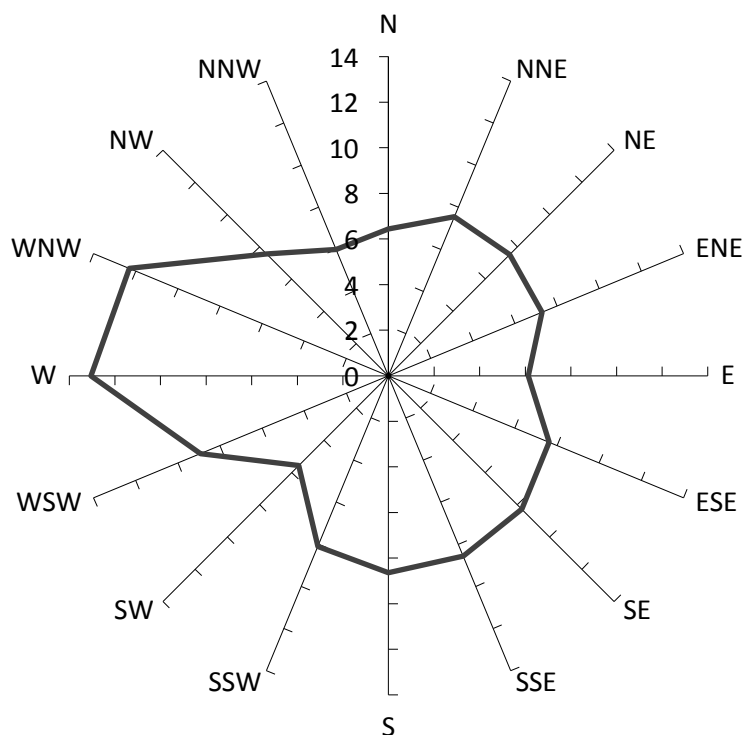


Desired Criterion

24m/s

Measured Wind Speeds at P17

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

21%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

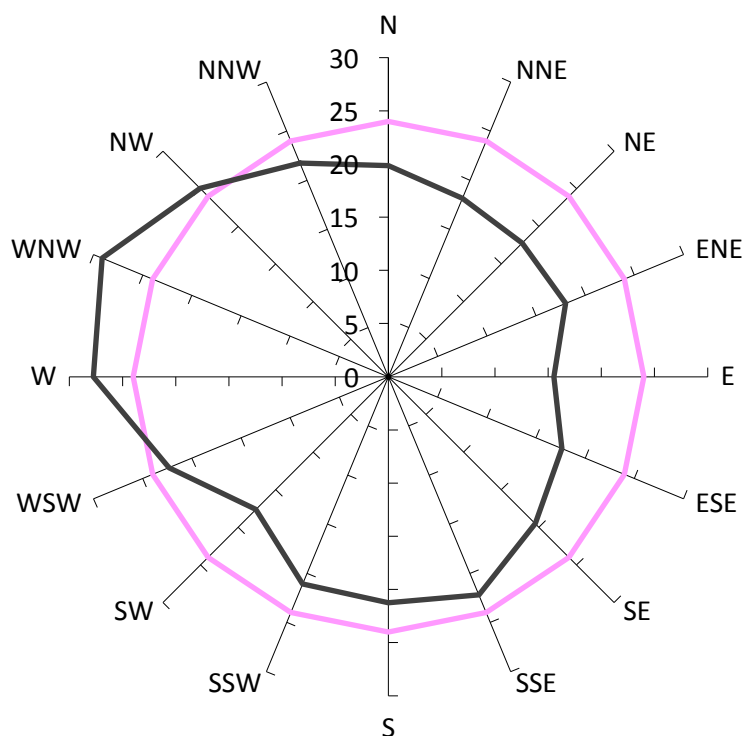
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

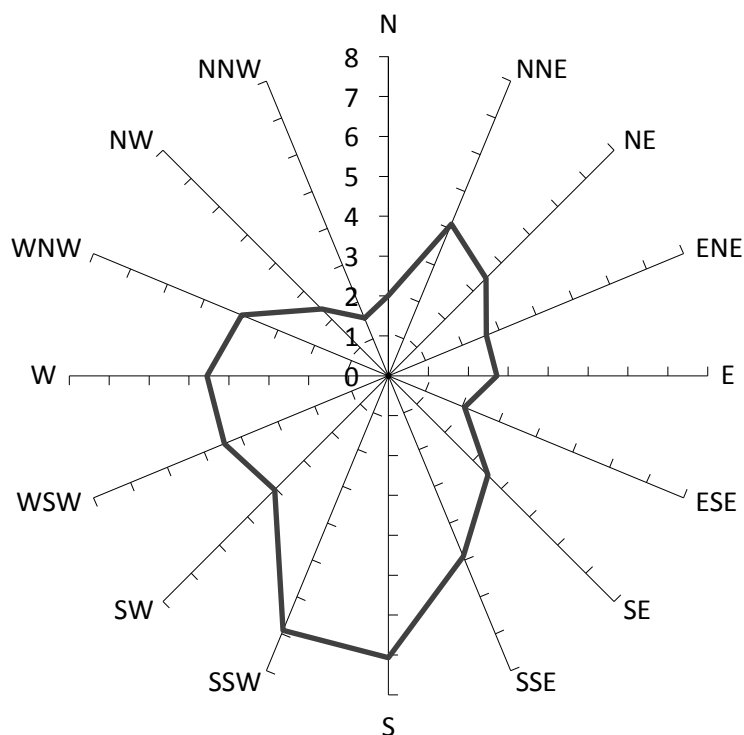


Desired Criterion

24m/s

Measured Wind Speeds at P18

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

1%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

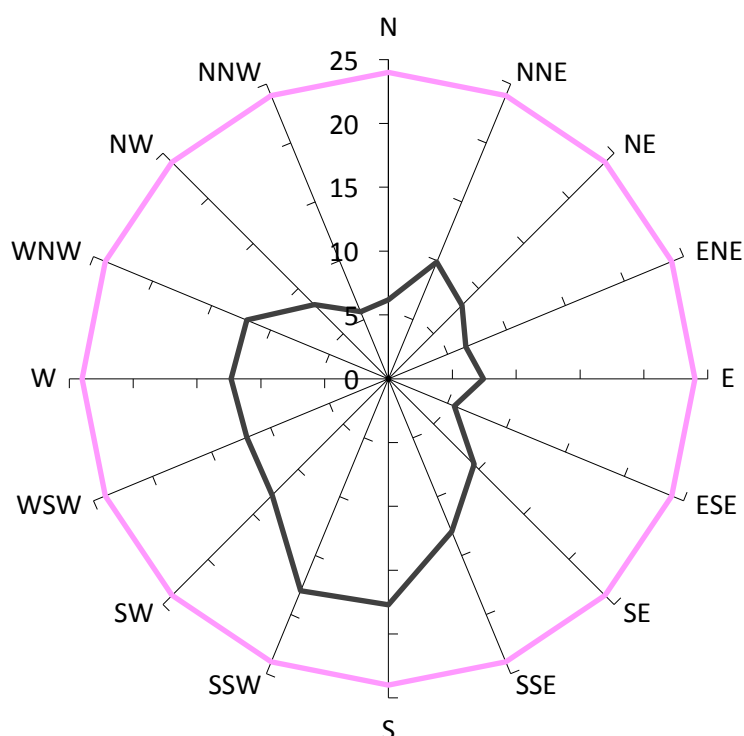
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

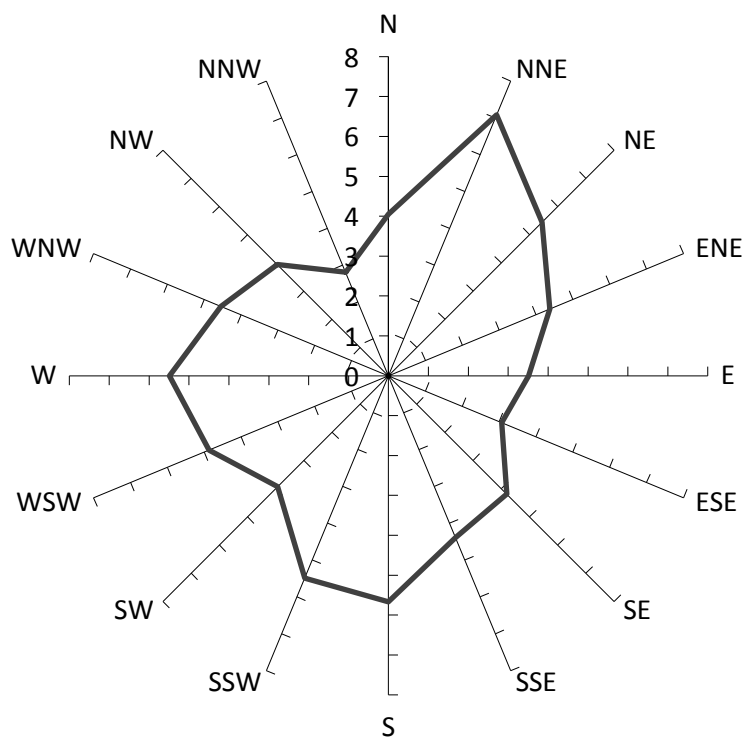


Desired Criterion

24m/s

Measured Wind Speeds at P19

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

1%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

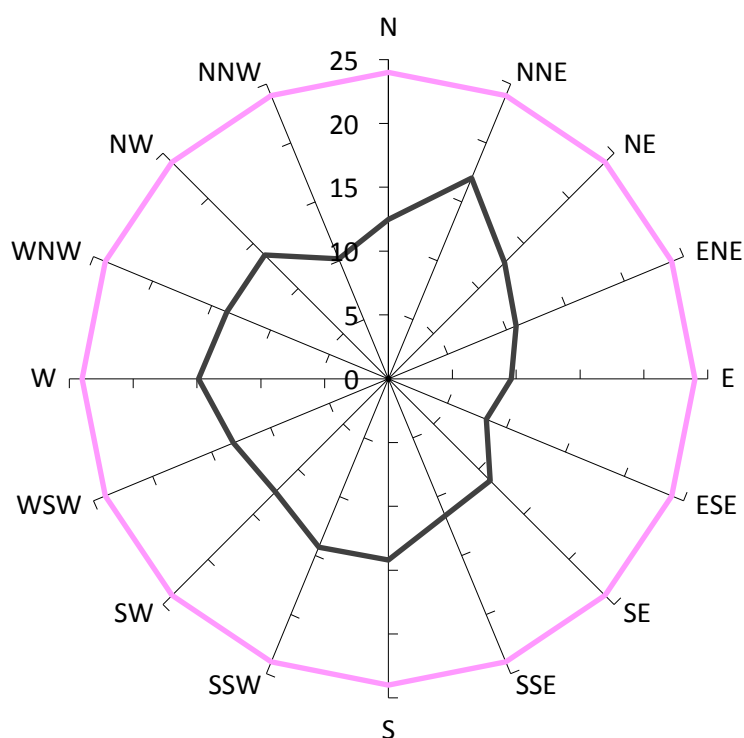
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

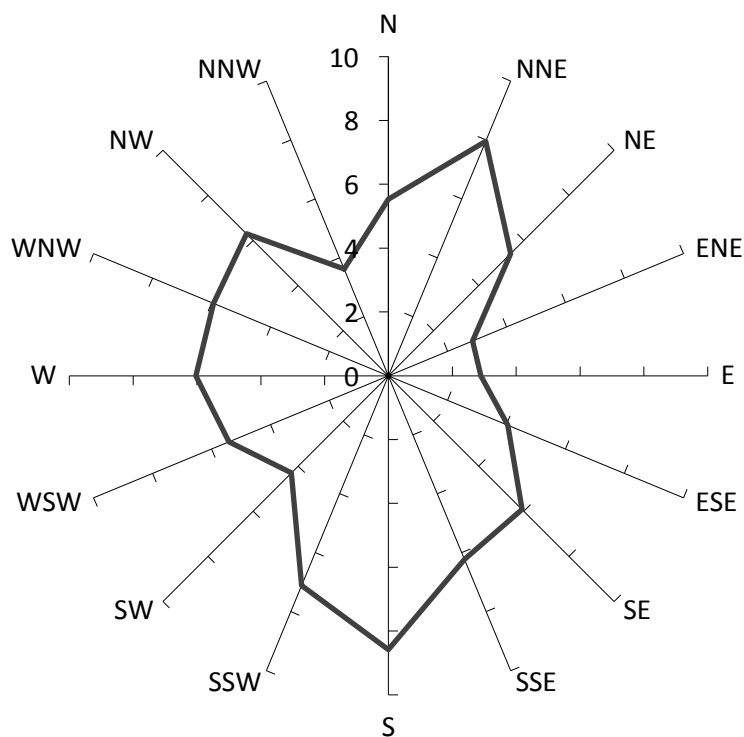


Desired Criterion

24m/s

Measured Wind Speeds at P20

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

5%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

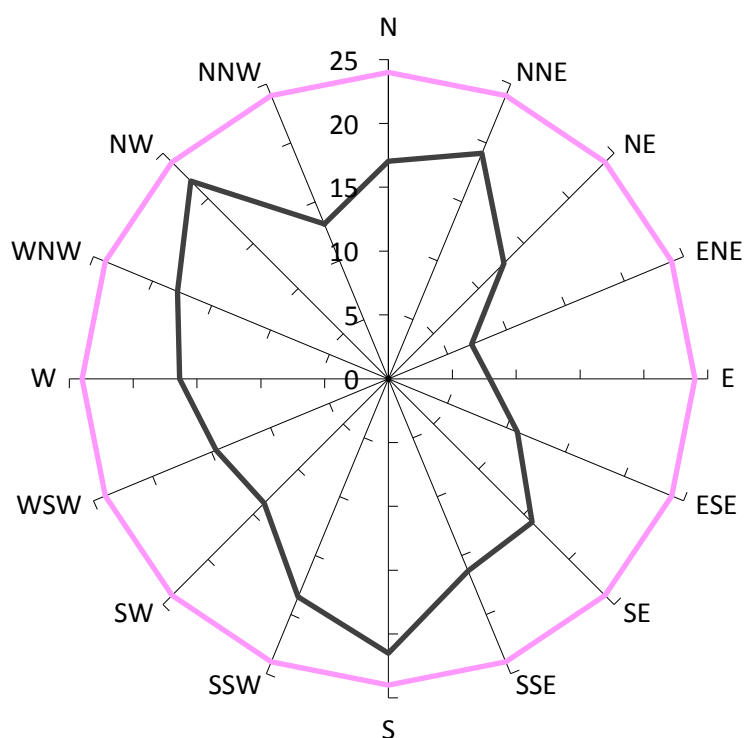
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

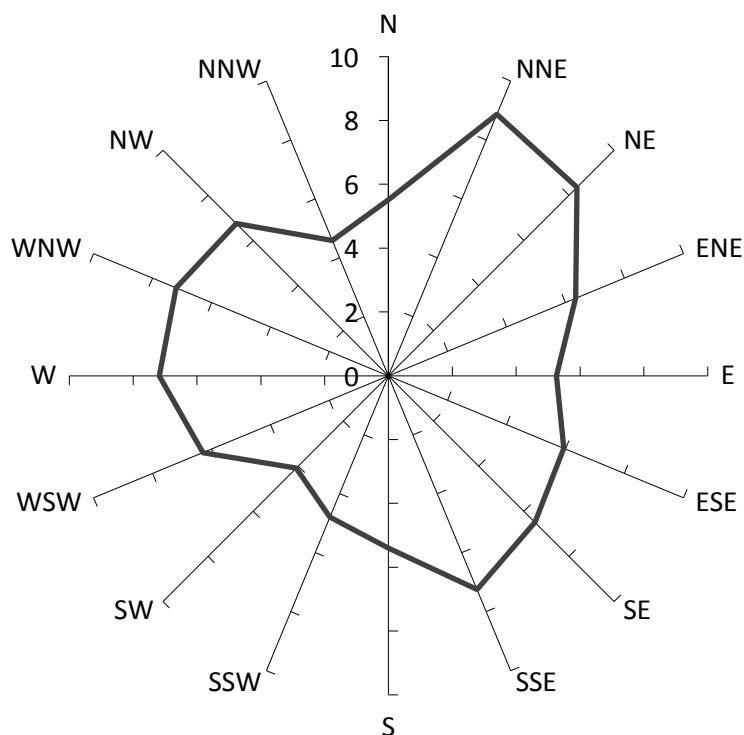


Desired Criterion

24m/s

Measured Wind Speeds at P21

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

8%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

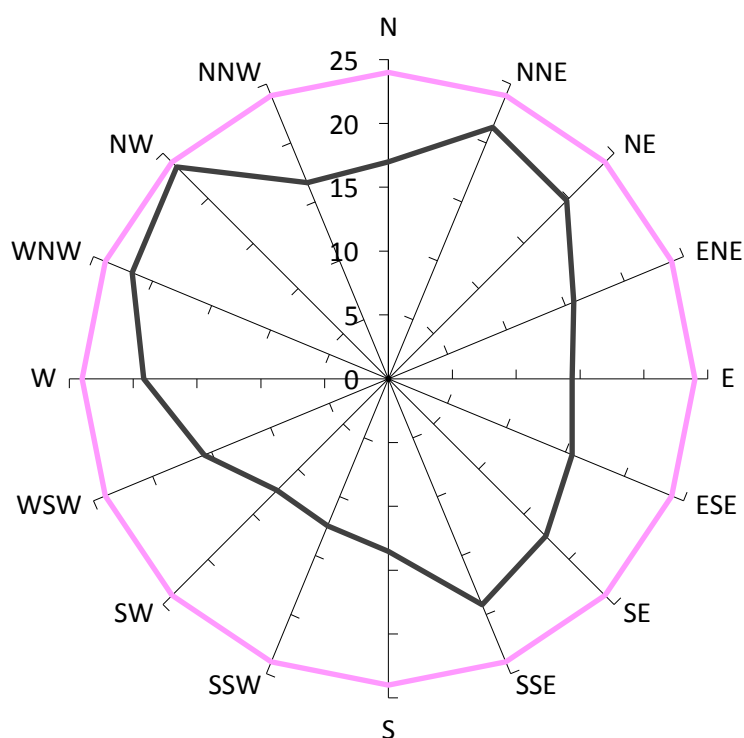
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

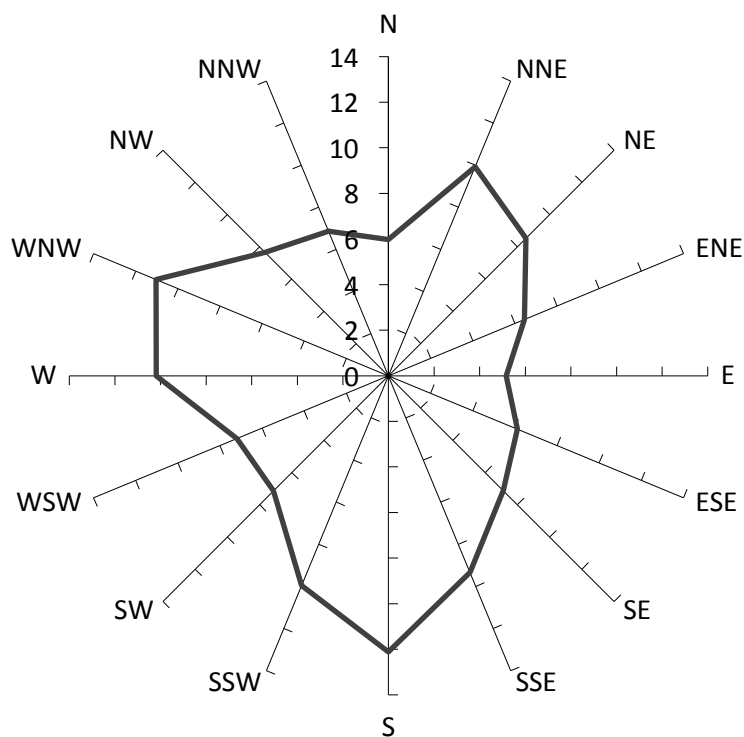


Desired Criterion

24m/s

Measured Wind Speeds at P22

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

30%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

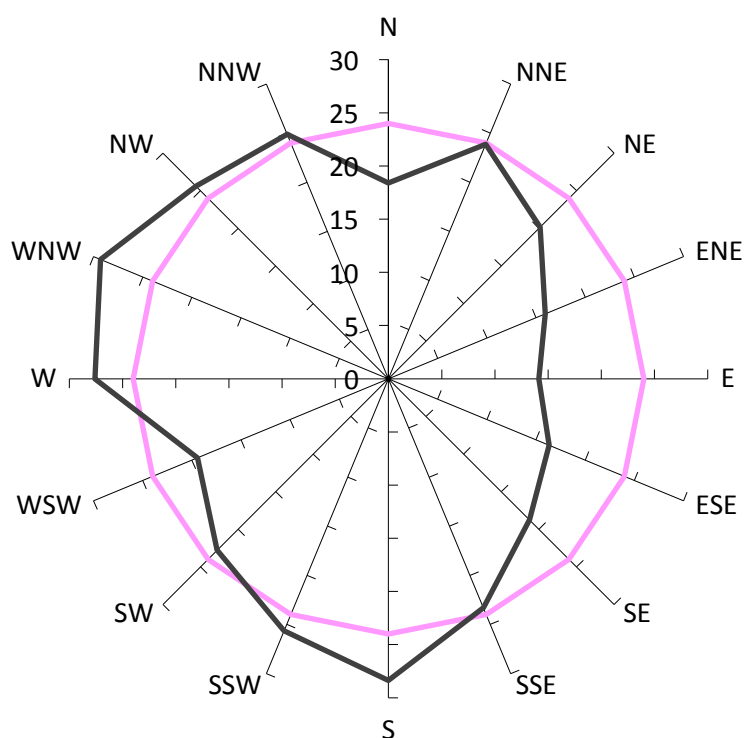
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

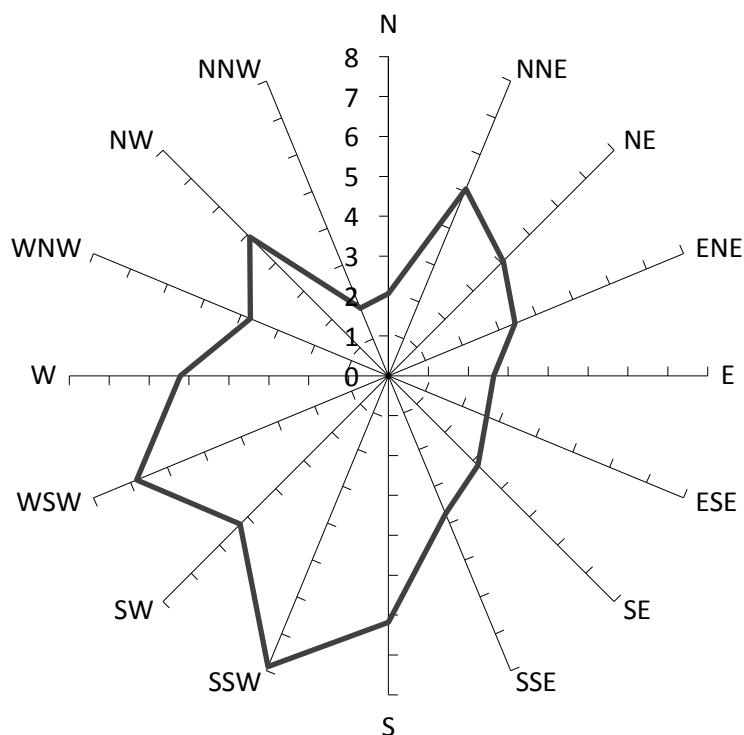


Desired Criterion

24m/s

Measured Wind Speeds at P23

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

2%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

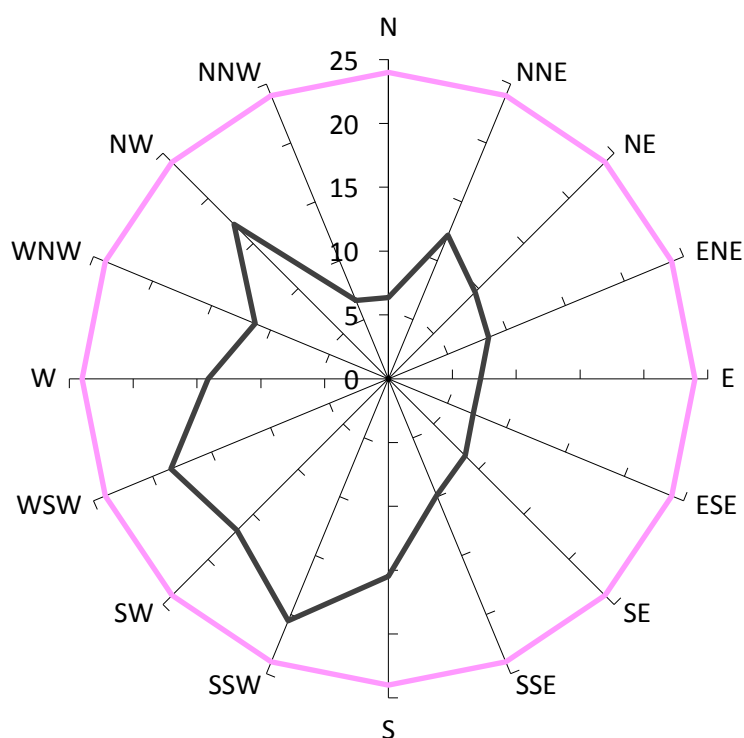
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

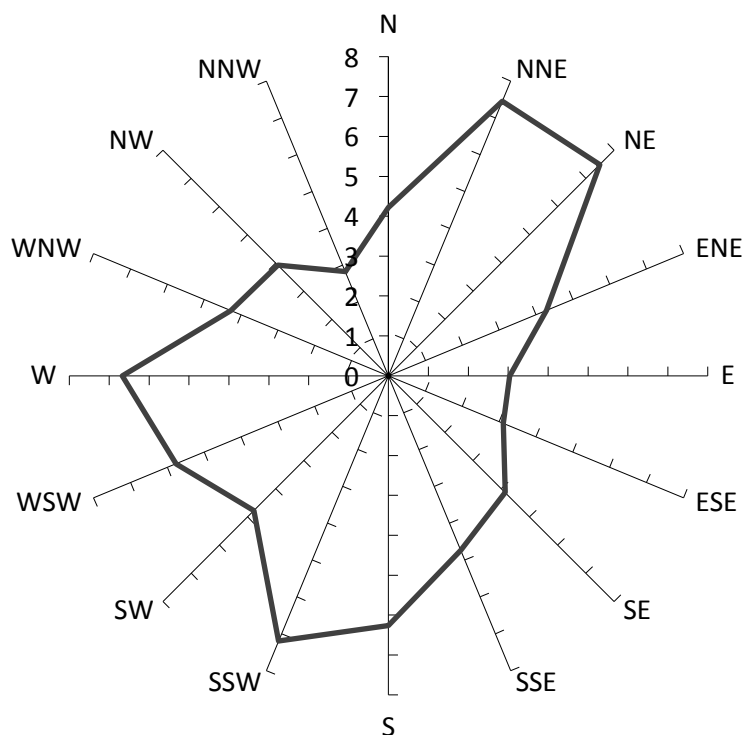


Desired Criterion

24m/s

Measured Wind Speeds at P24

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

3%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

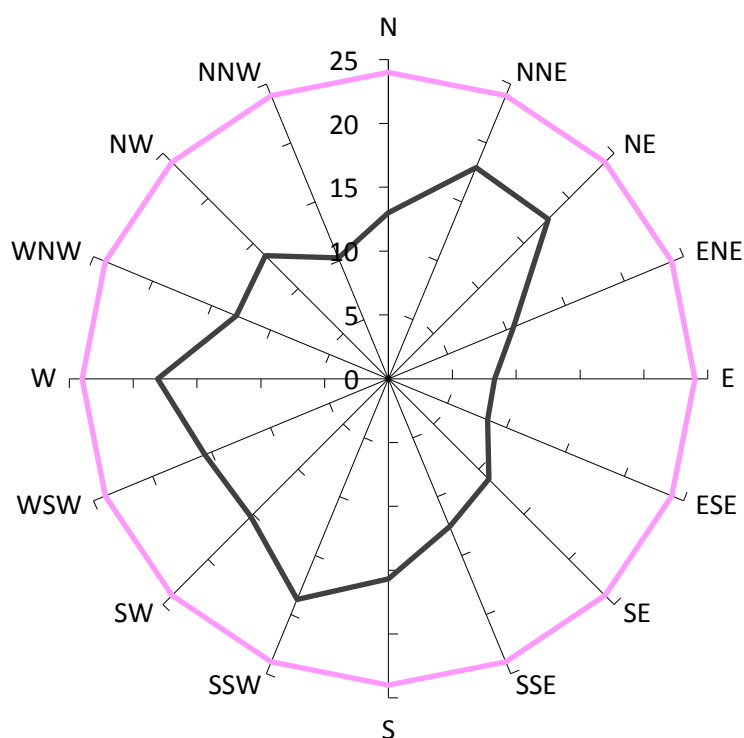
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

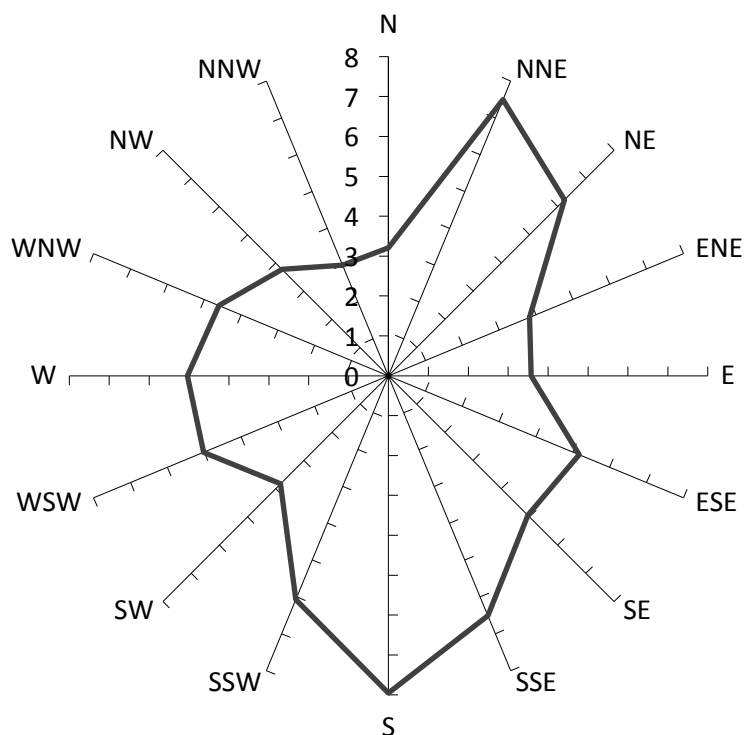


Desired Criterion

24m/s

Measured Wind Speeds at P25

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

3%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

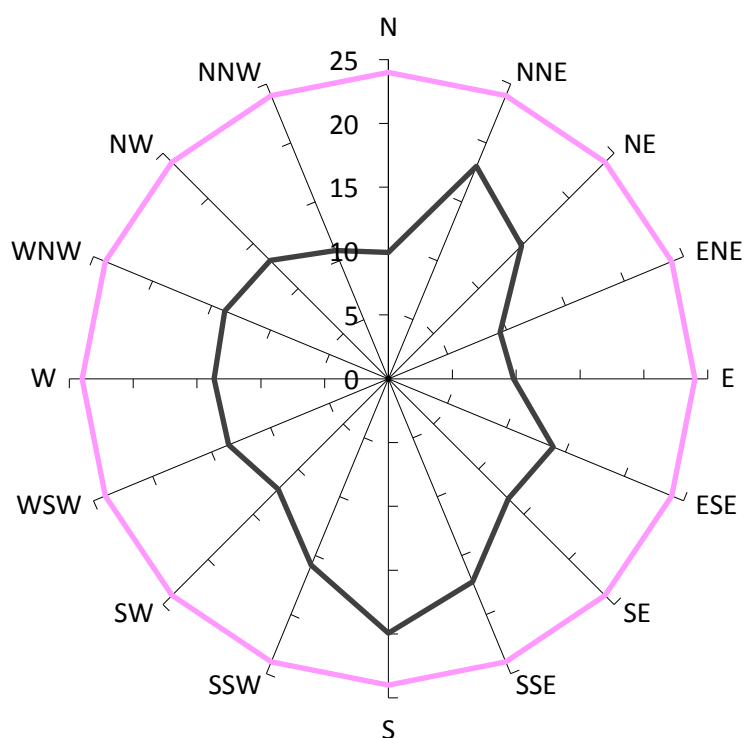
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

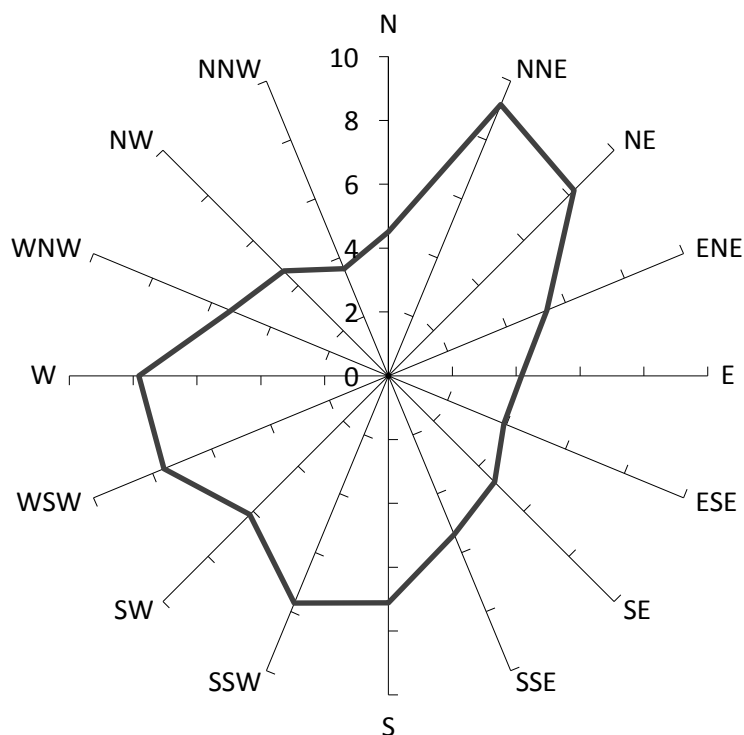


Desired Criterion

24m/s

Measured Wind Speeds at P26

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

8%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

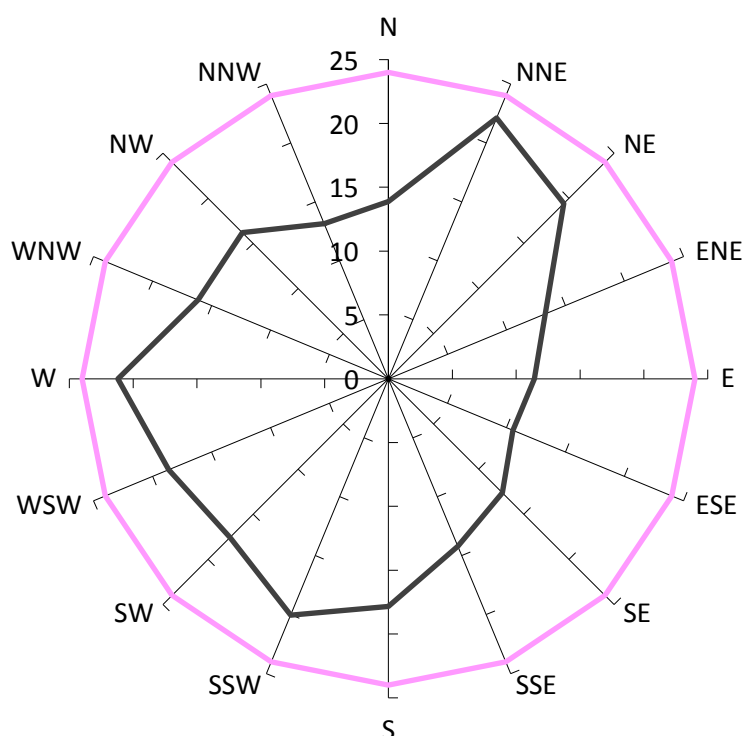
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

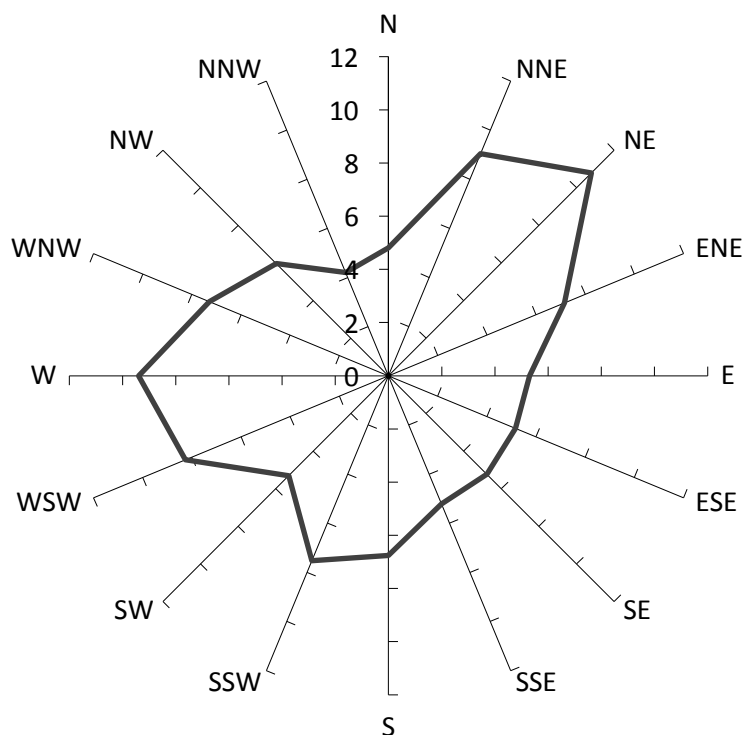


Desired Criterion

24m/s

Measured Wind Speeds at P27

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

15%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

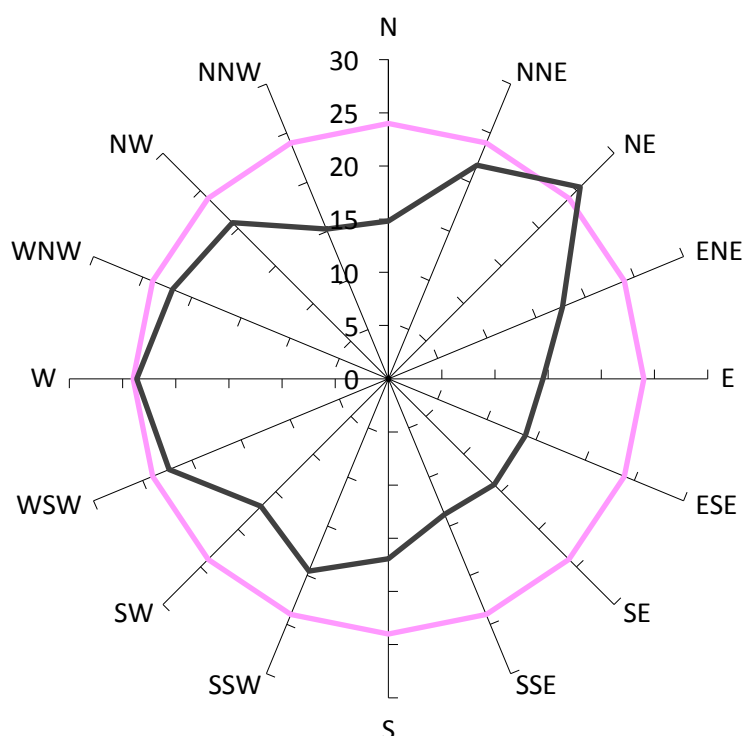
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

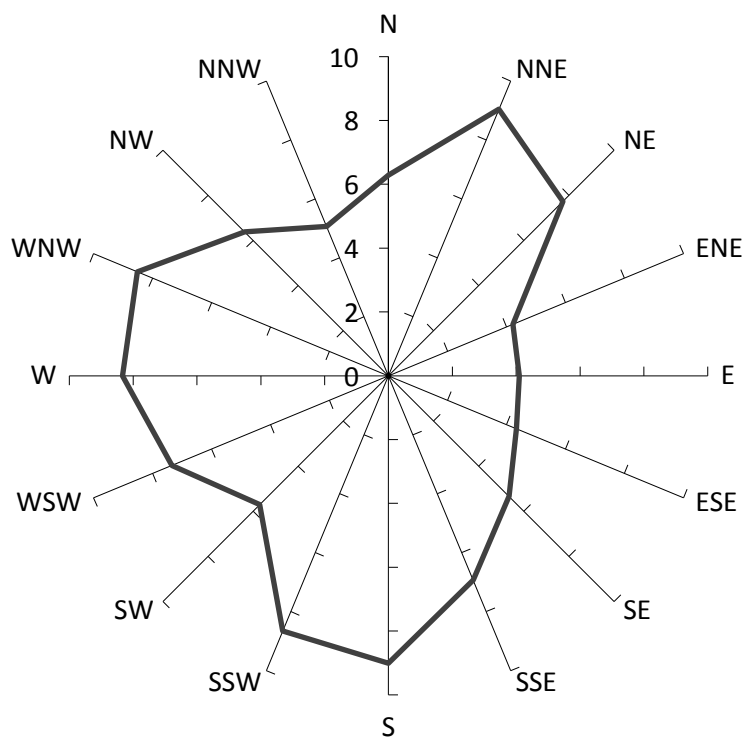


Desired Criterion

24m/s

Measured Wind Speeds at P28

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

13%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

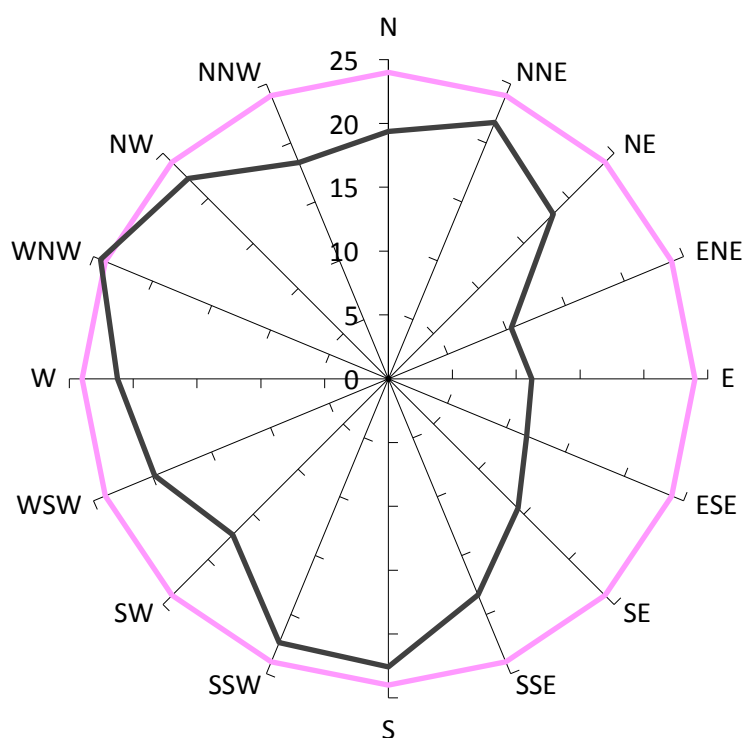
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

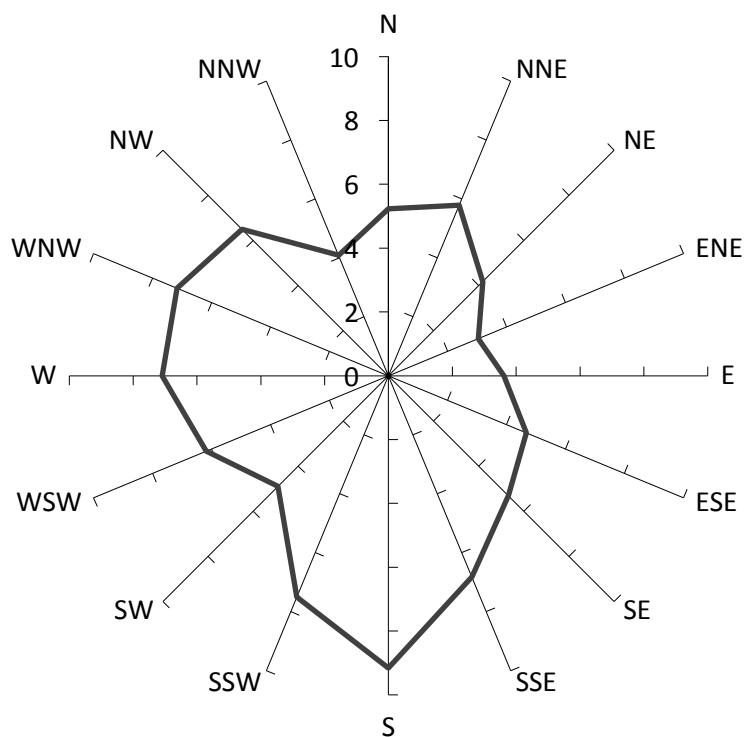


Desired Criterion

24m/s

Measured Wind Speeds at P29

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

7%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

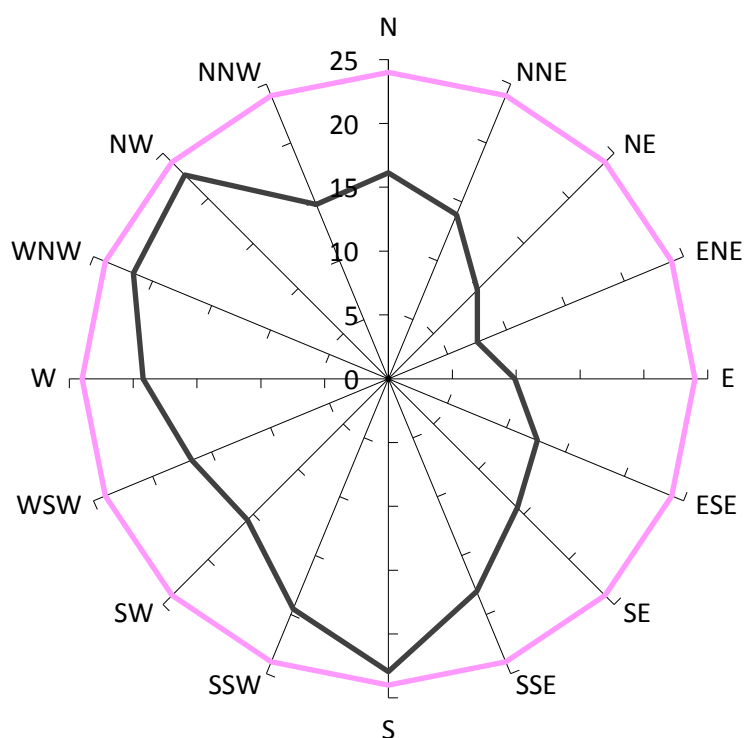
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

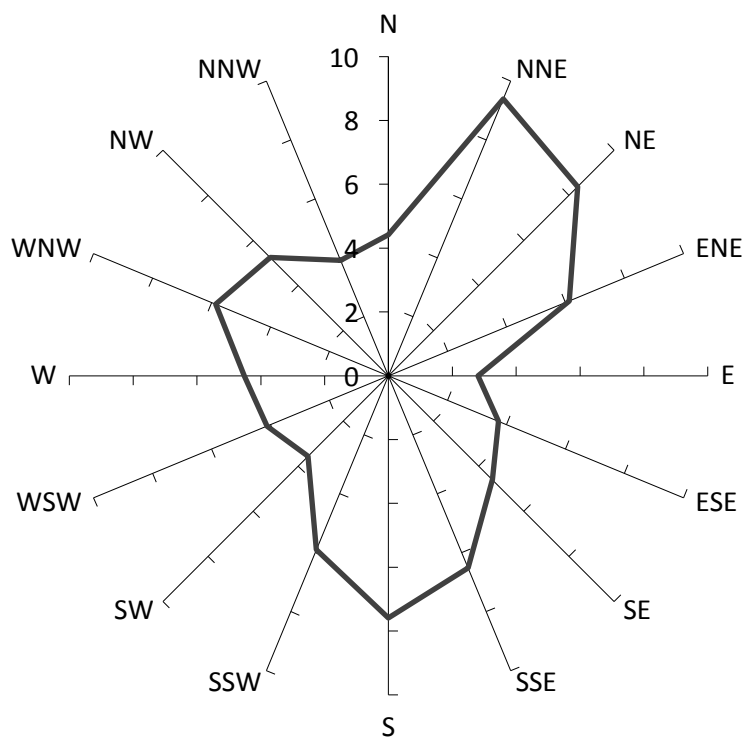


Desired Criterion

24m/s

Measured Wind Speeds at P30

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

6%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

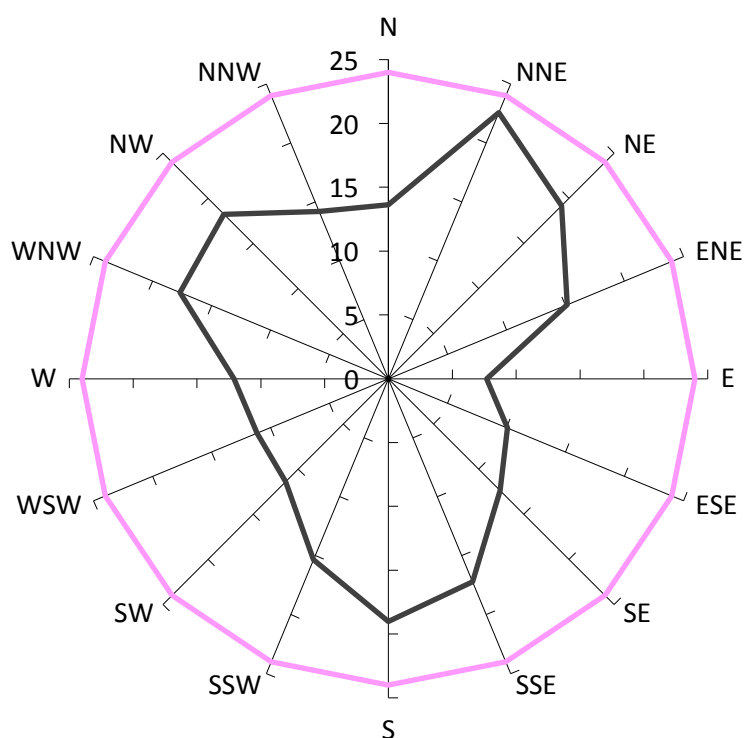
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

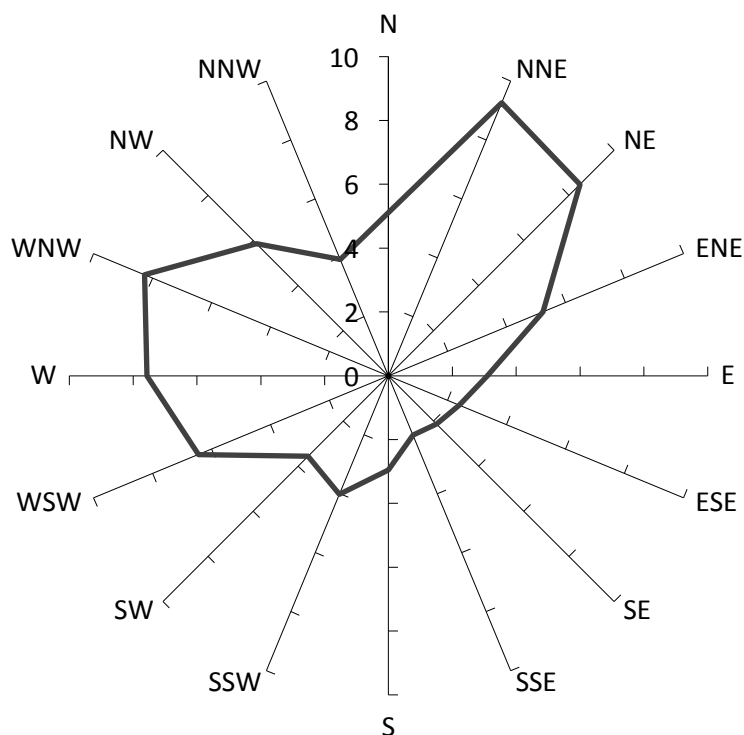


Desired Criterion

24m/s

Measured Wind Speeds at P31

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

7%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

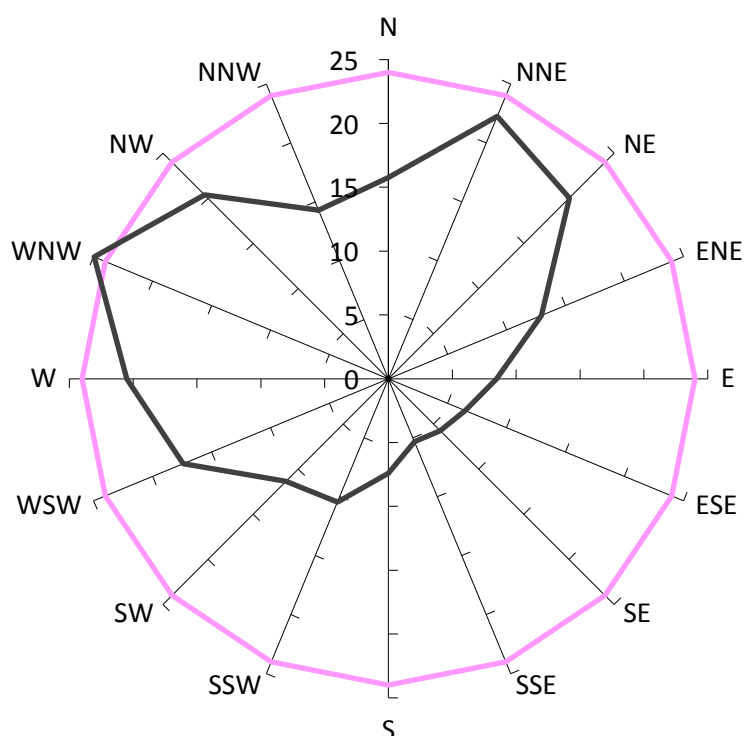
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

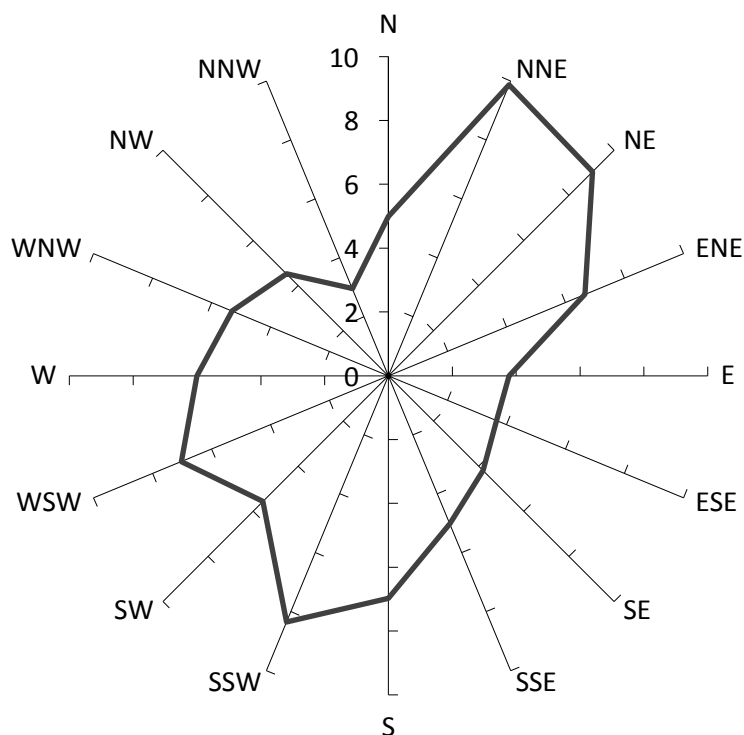


Desired Criterion

24m/s

Measured Wind Speeds at P32

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

10%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

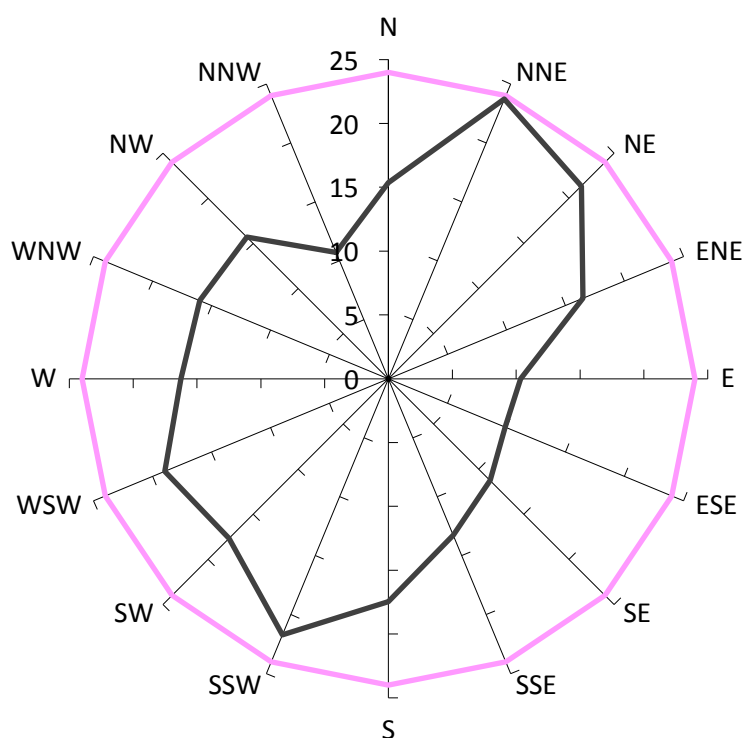
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

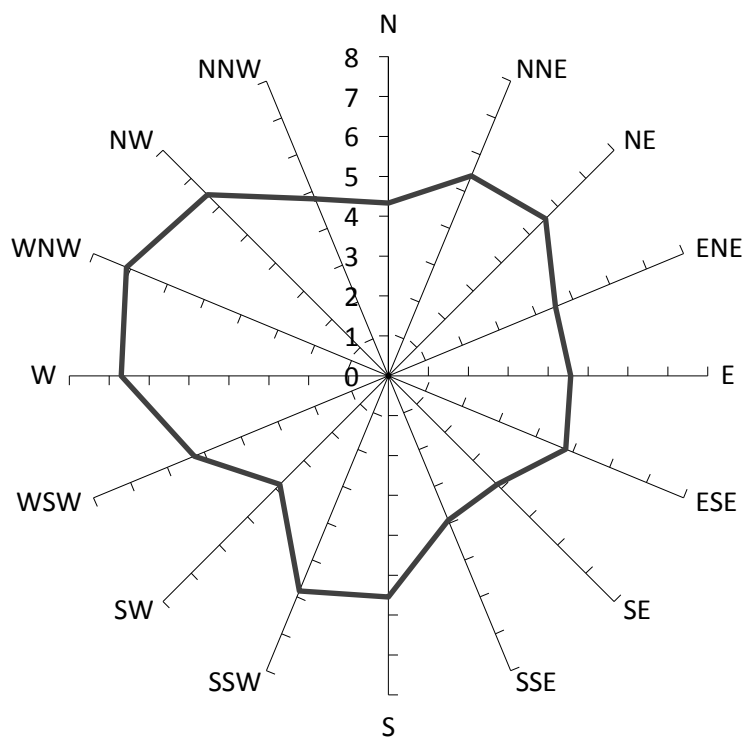


Desired Criterion

24m/s

Measured Wind Speeds at P33

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

2%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

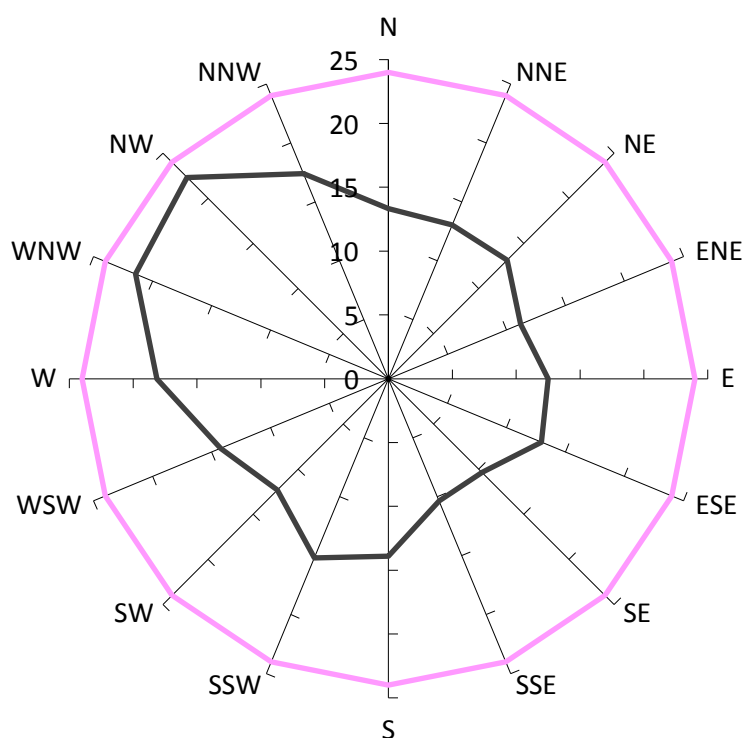
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

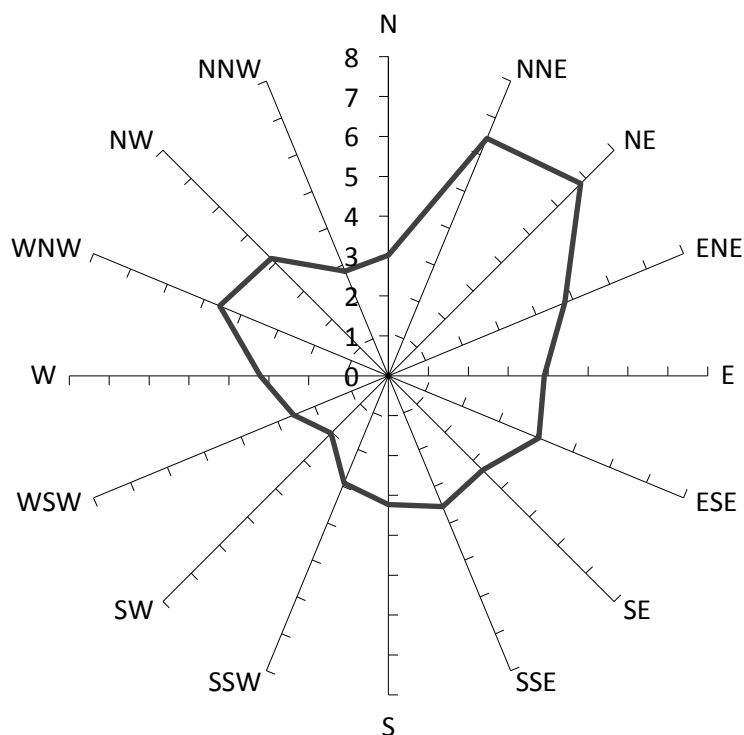


Desired Criterion

24m/s

Measured Wind Speeds at P34

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

1%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

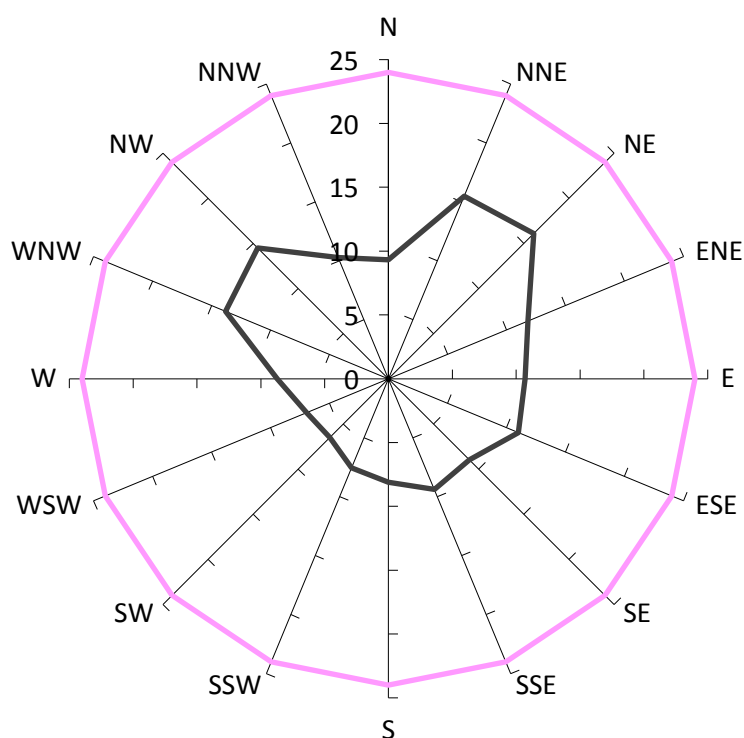
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

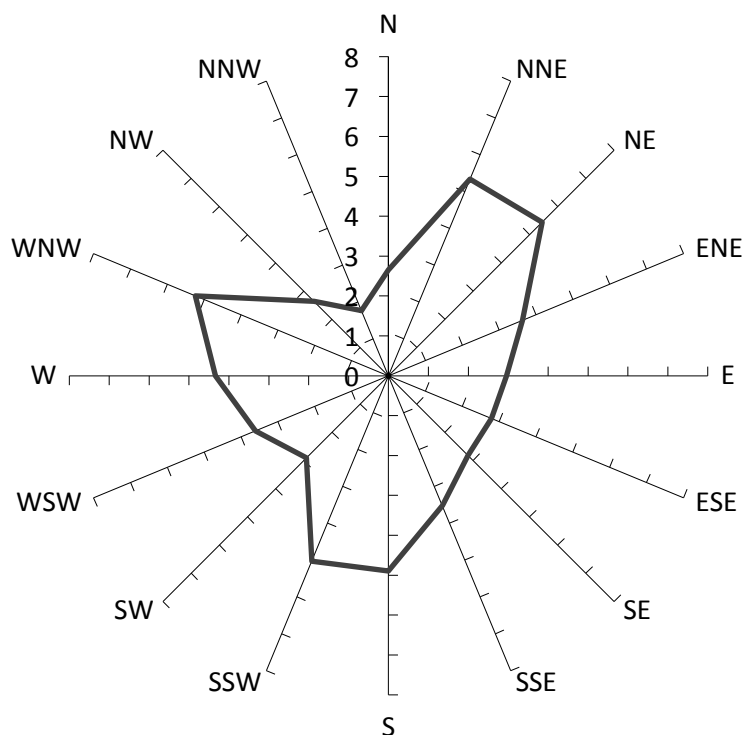


Desired Criterion

24m/s

Measured Wind Speeds at P35

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

0%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

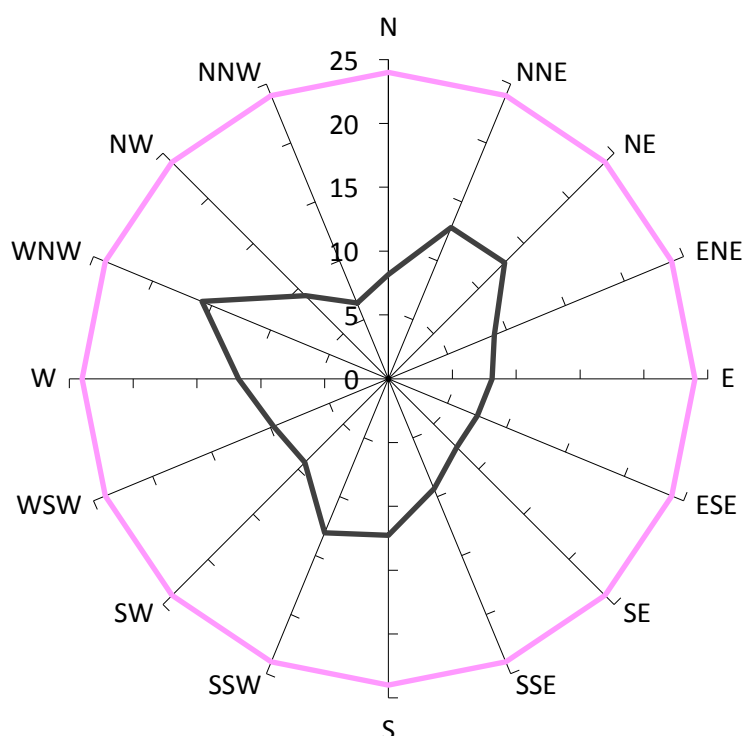
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

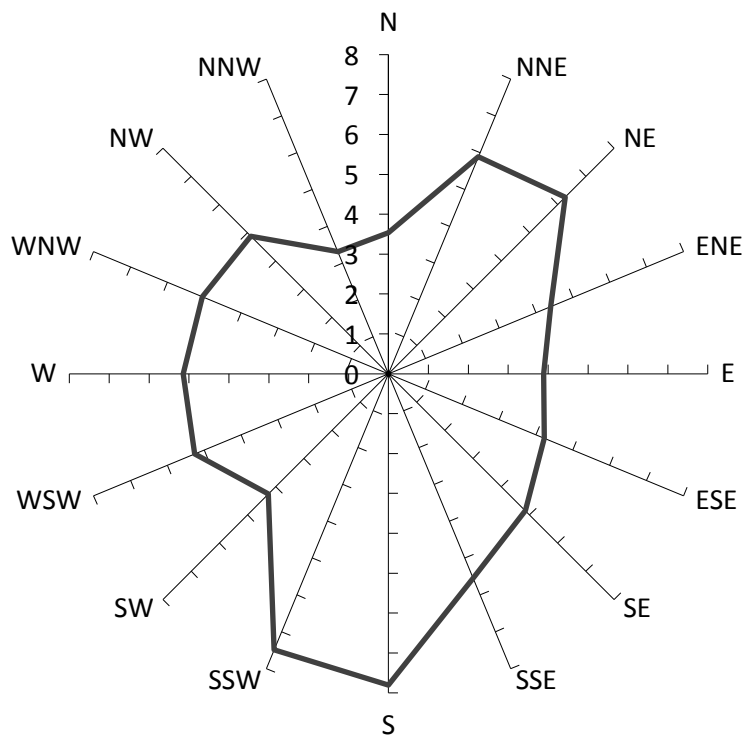


Desired Criterion

24m/s

Measured Wind Speeds at P36

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

3%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

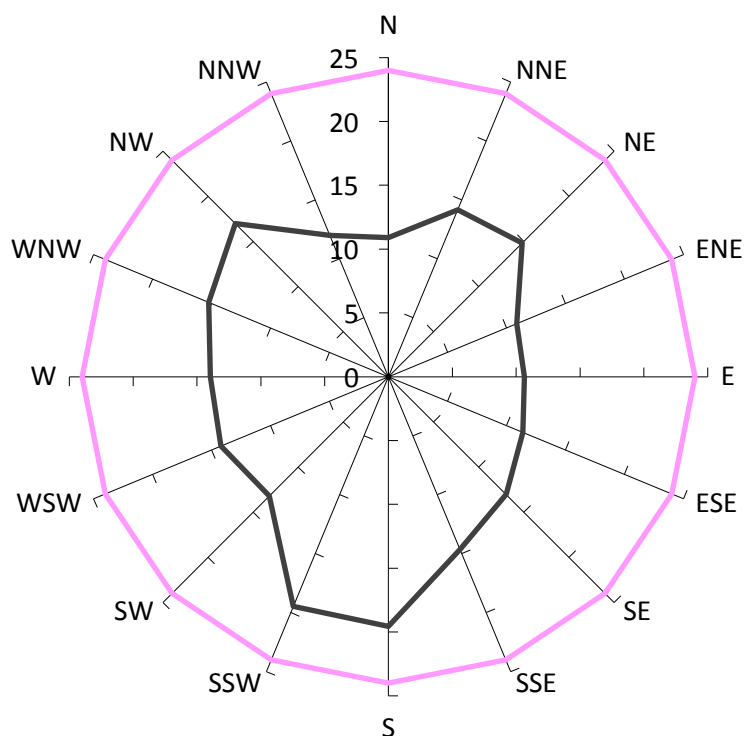
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

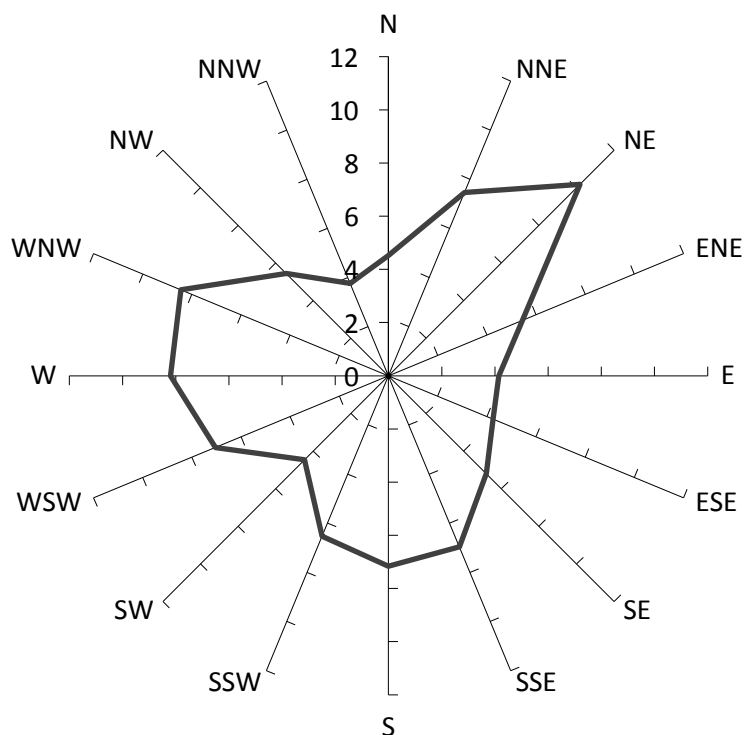


Desired Criterion

24m/s

Measured Wind Speeds at P37

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

11%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

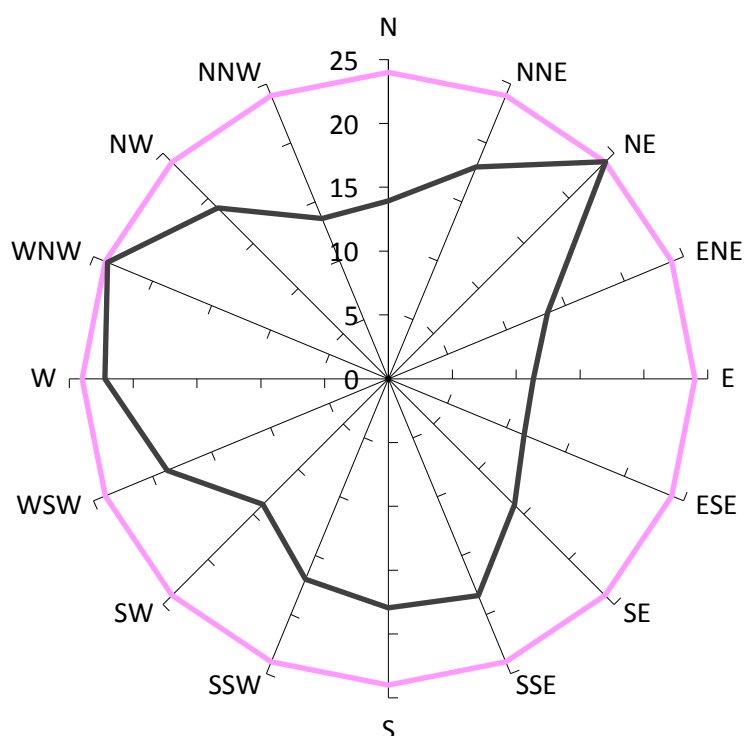
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

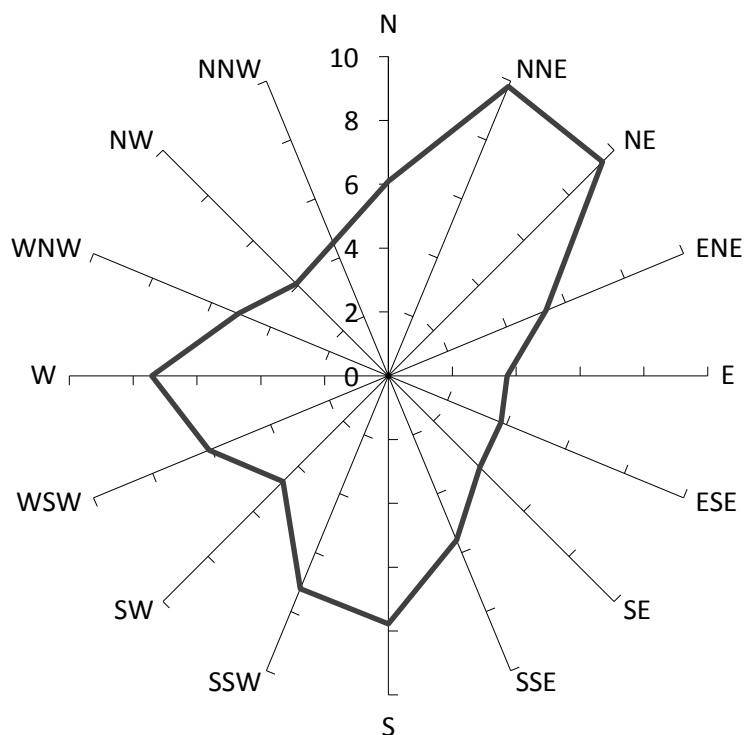


Desired Criterion

24m/s

Measured Wind Speeds at P38

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

11%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

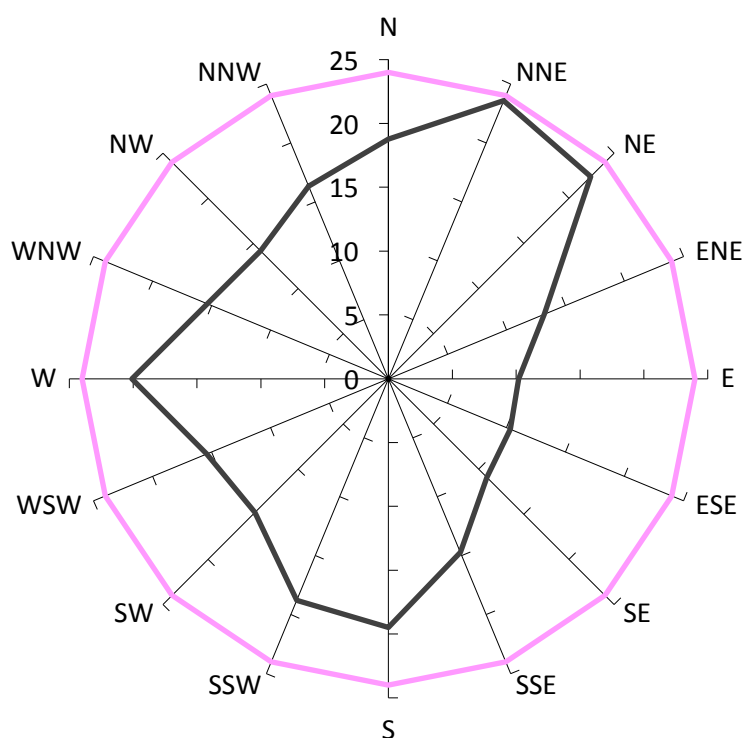
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

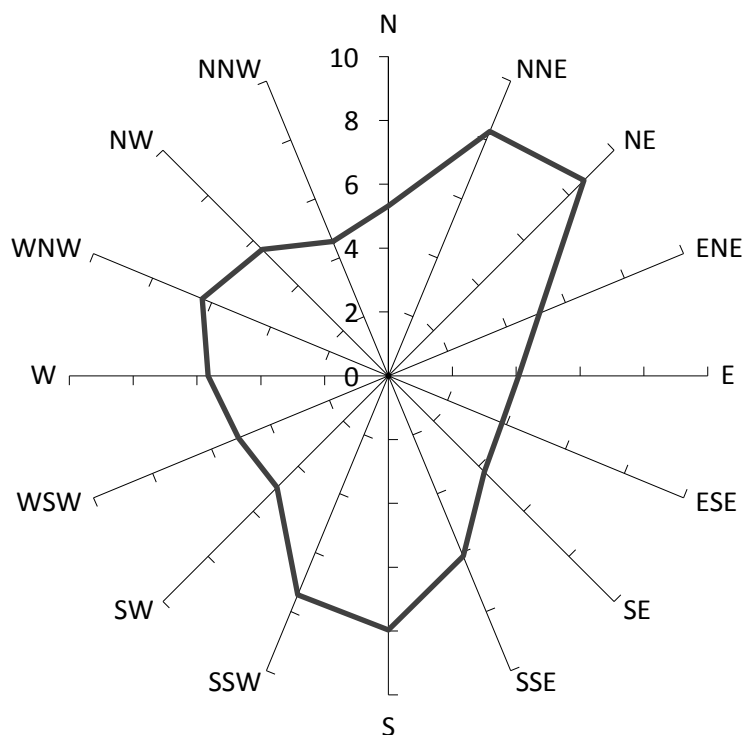


Desired Criterion

24m/s

Measured Wind Speeds at P39

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

7%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

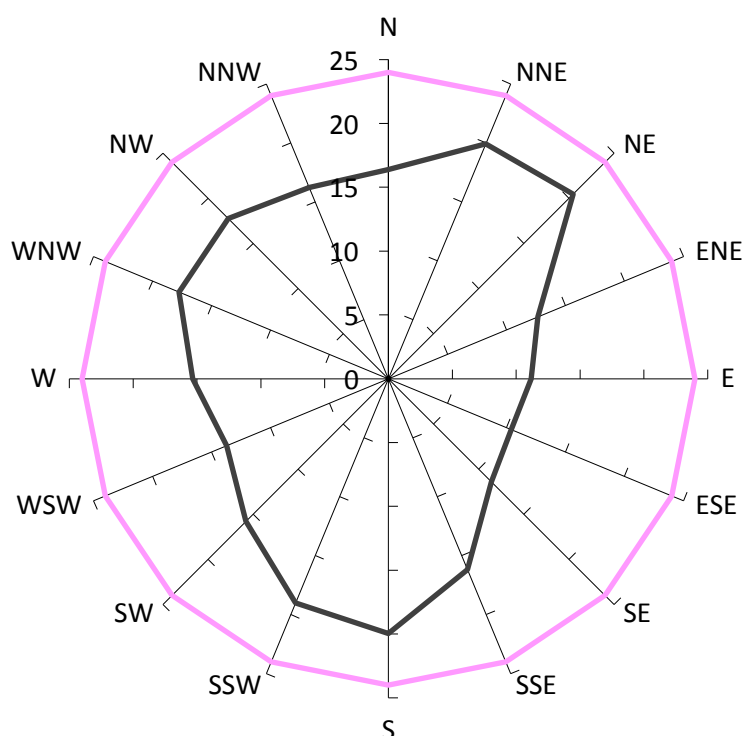
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

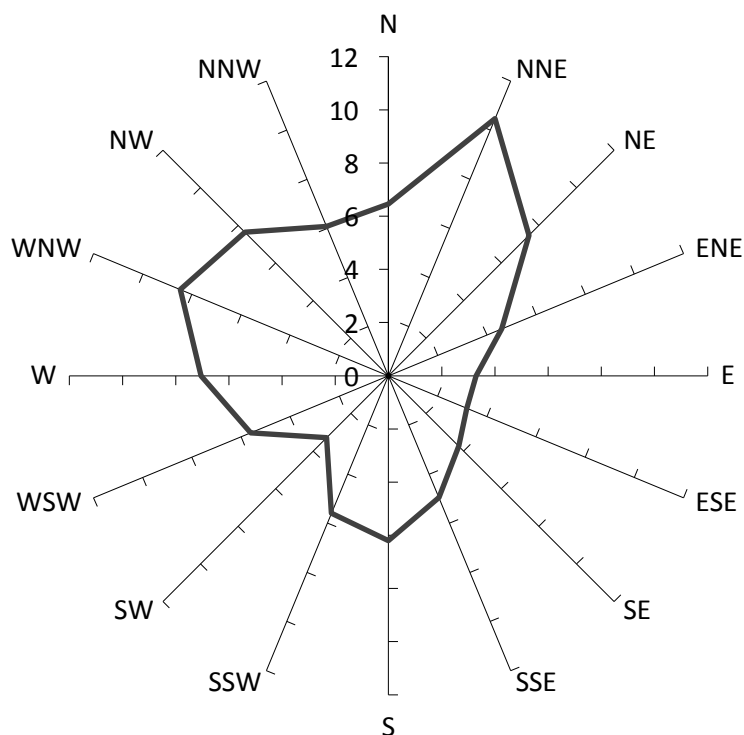


Desired Criterion

24m/s

Measured Wind Speeds at P40

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

10%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

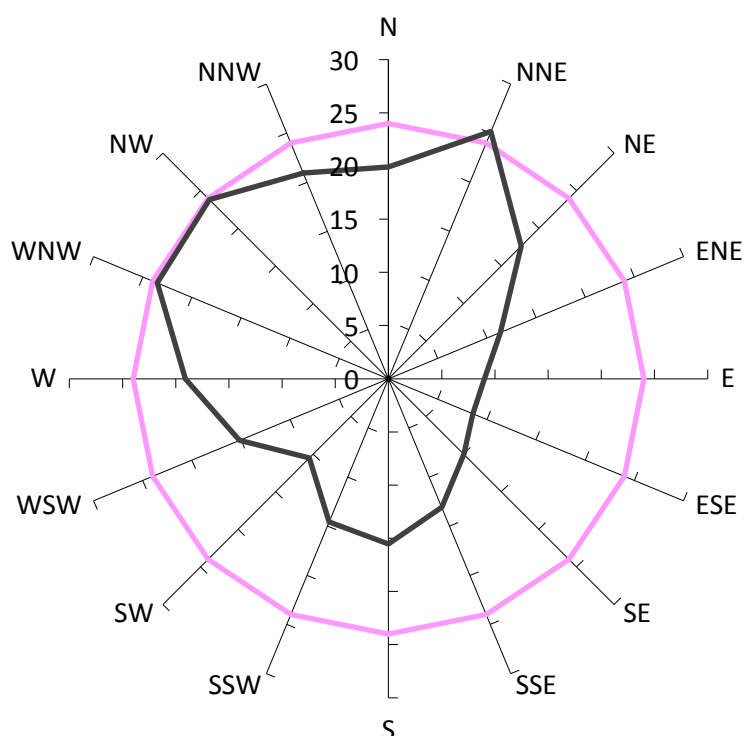
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

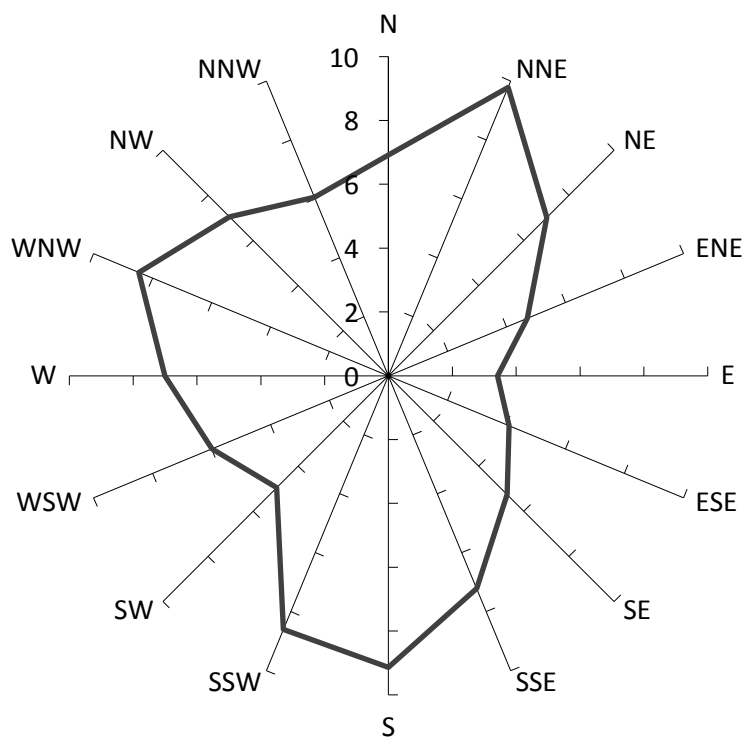


Desired Criterion

24m/s

Measured Wind Speeds at P41

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

13%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

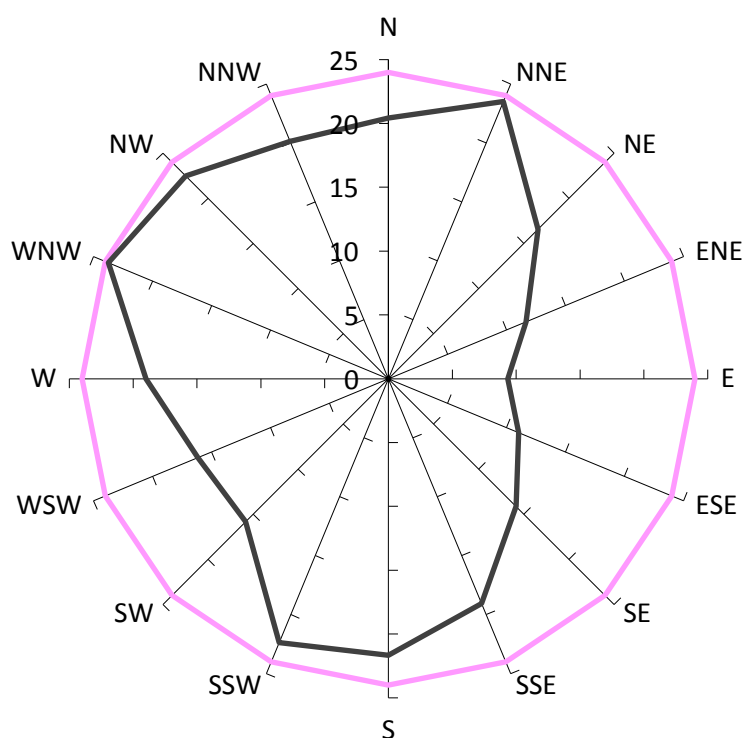
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

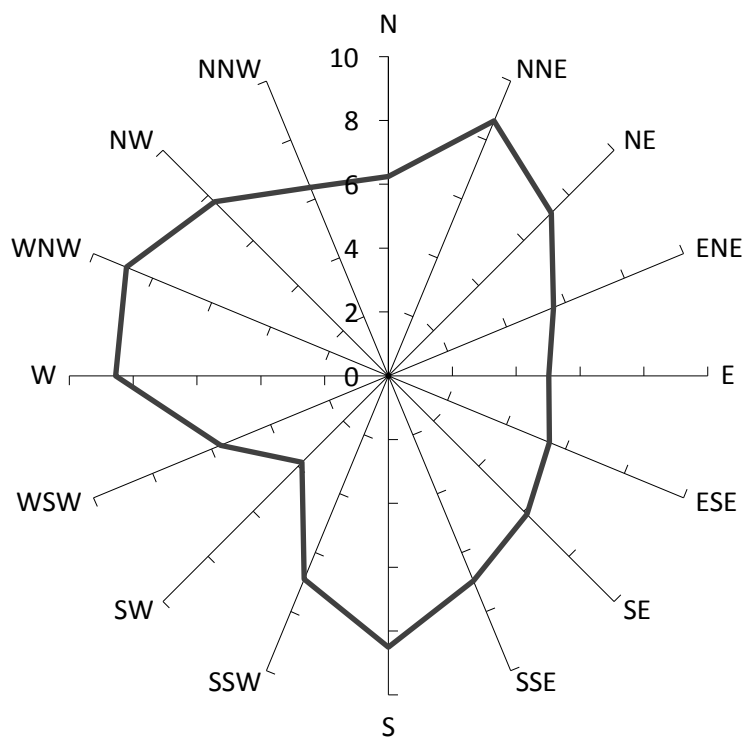


Desired Criterion

24m/s

Measured Wind Speeds at P42

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

11%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

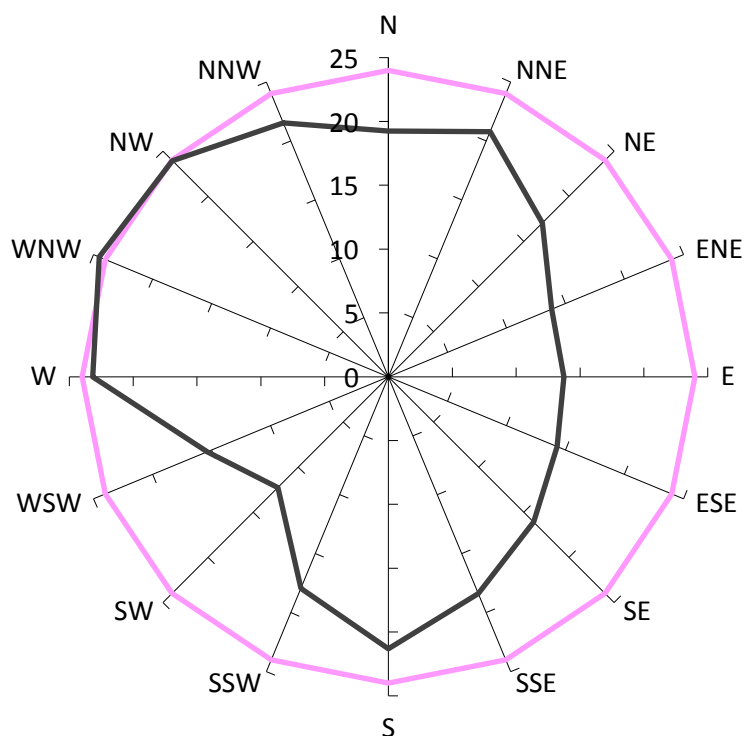
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

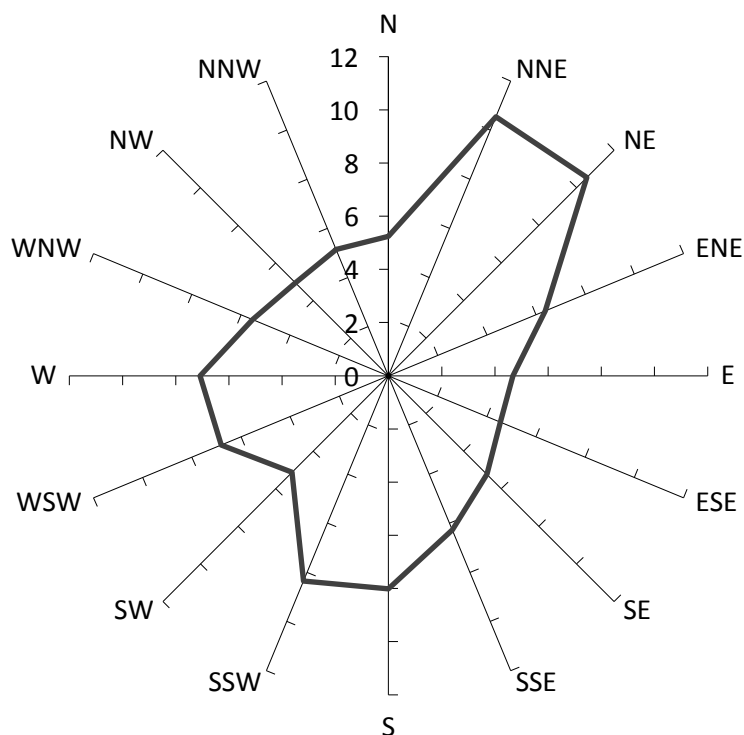


Desired Criterion

24m/s

Measured Wind Speeds at P43

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

16%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

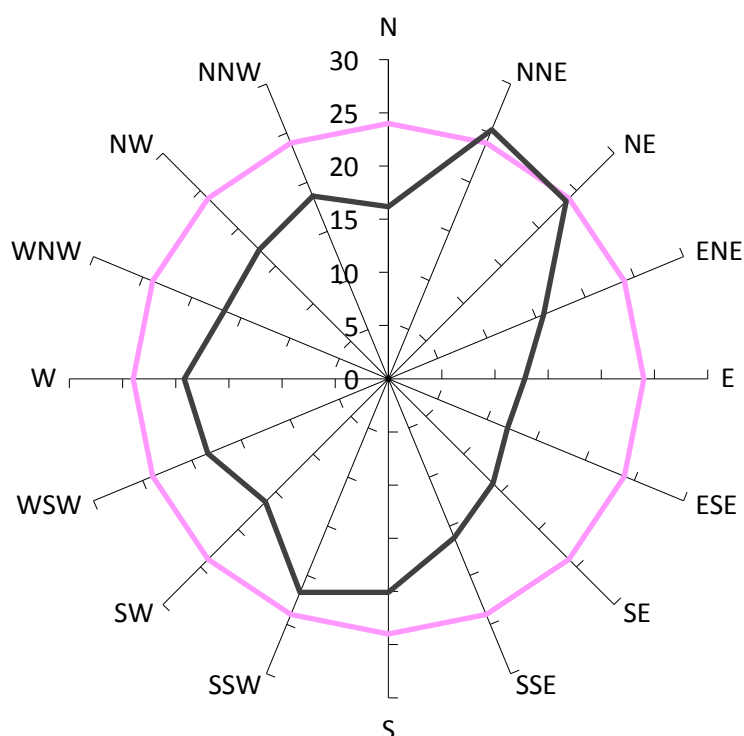
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

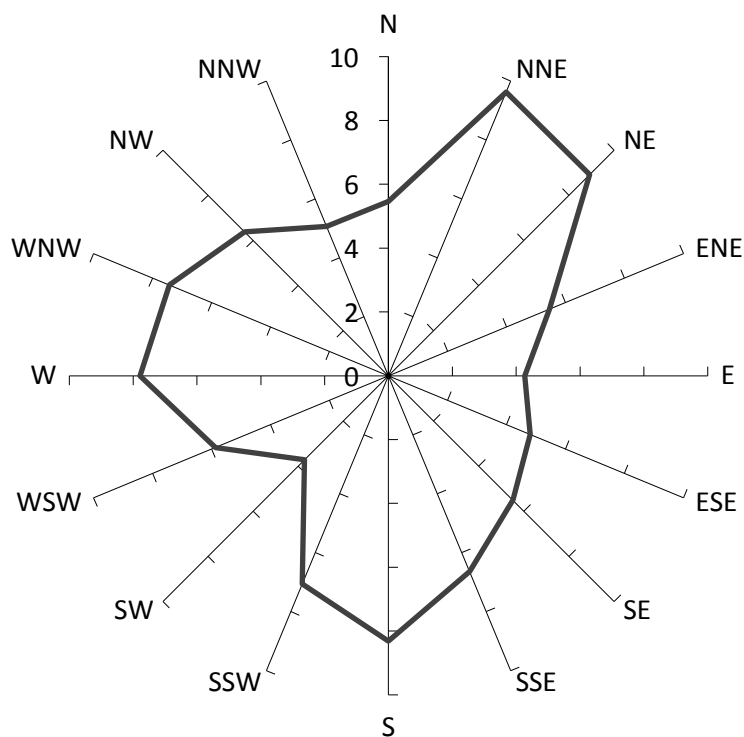


Desired Criterion

24m/s

Measured Wind Speeds at P44

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

11%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

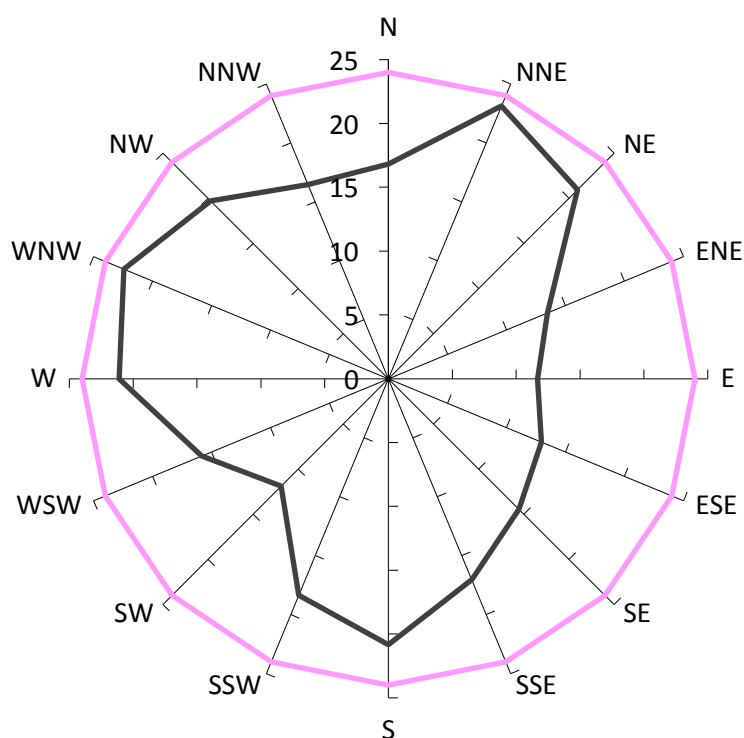
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

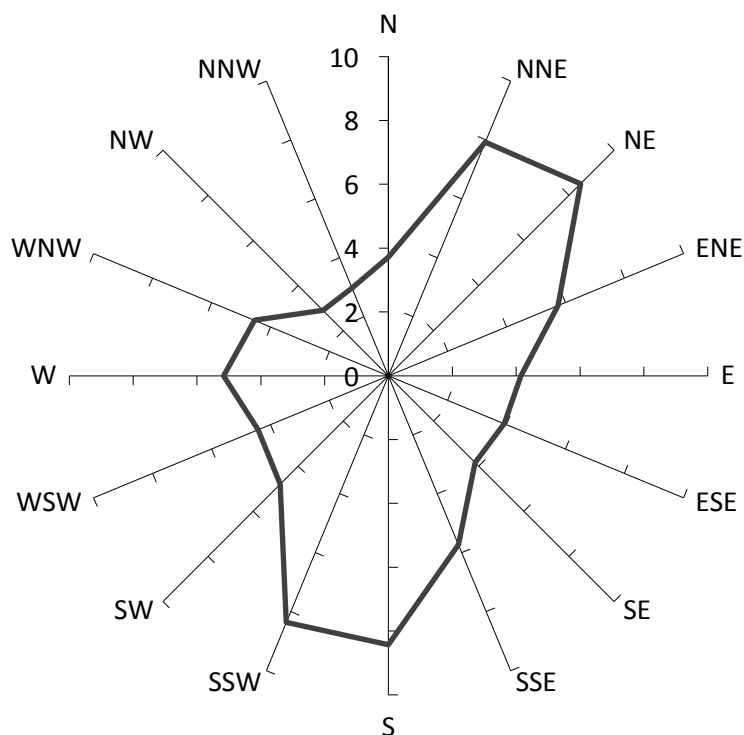


Desired Criterion

24m/s

Measured Wind Speeds at P45

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

6%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

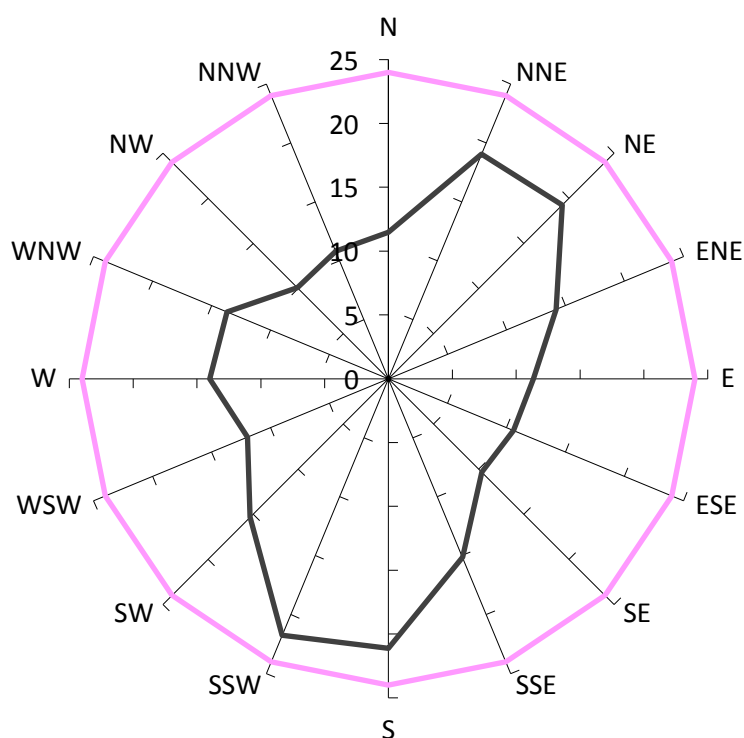
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

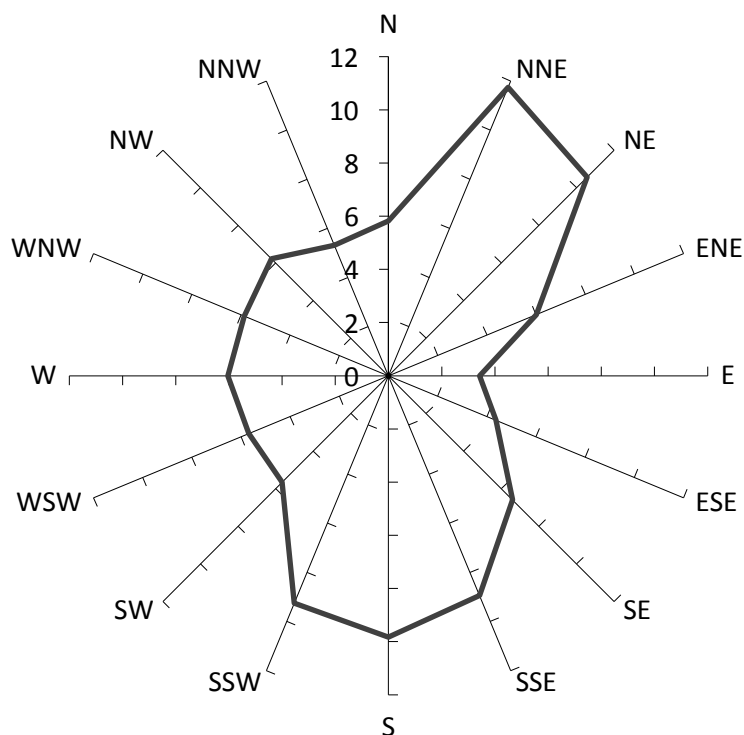


Desired Criterion

24m/s

Measured Wind Speeds at P46

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

22%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

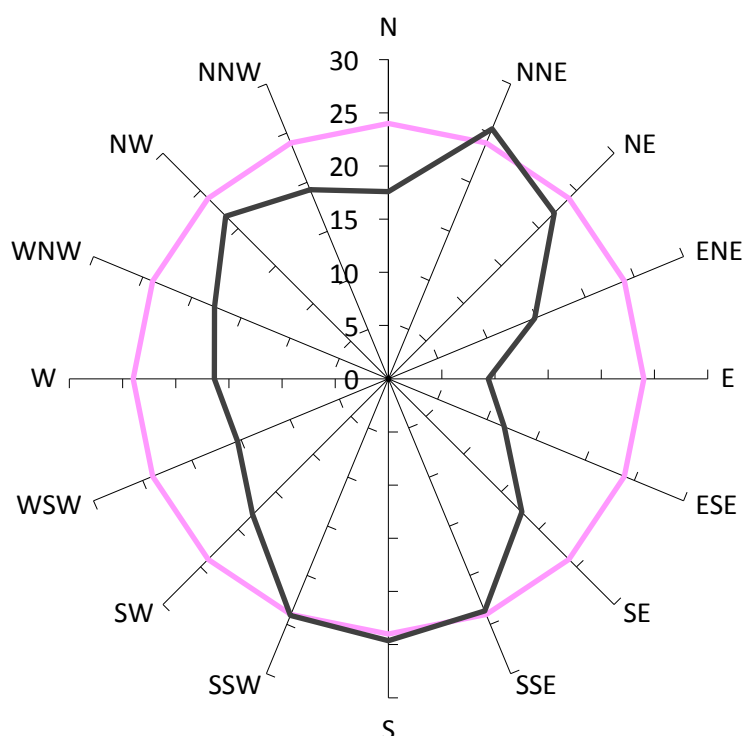
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

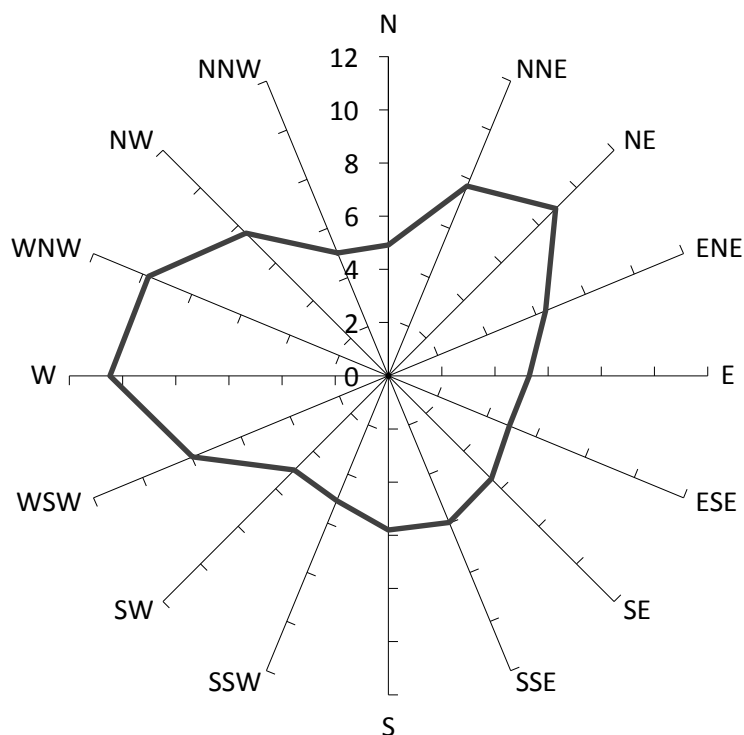


Desired Criterion

24m/s

Measured Wind Speeds at P47

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

12%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

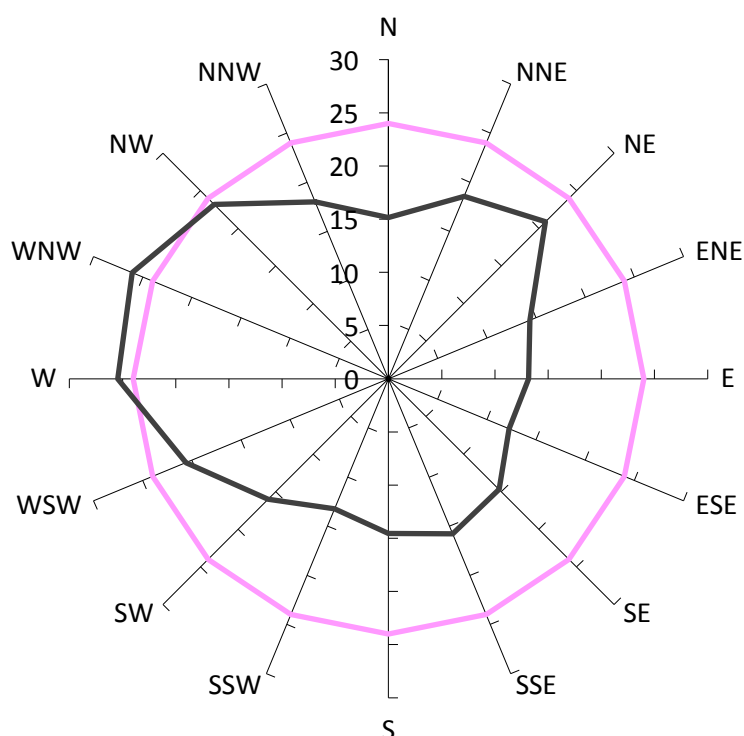
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

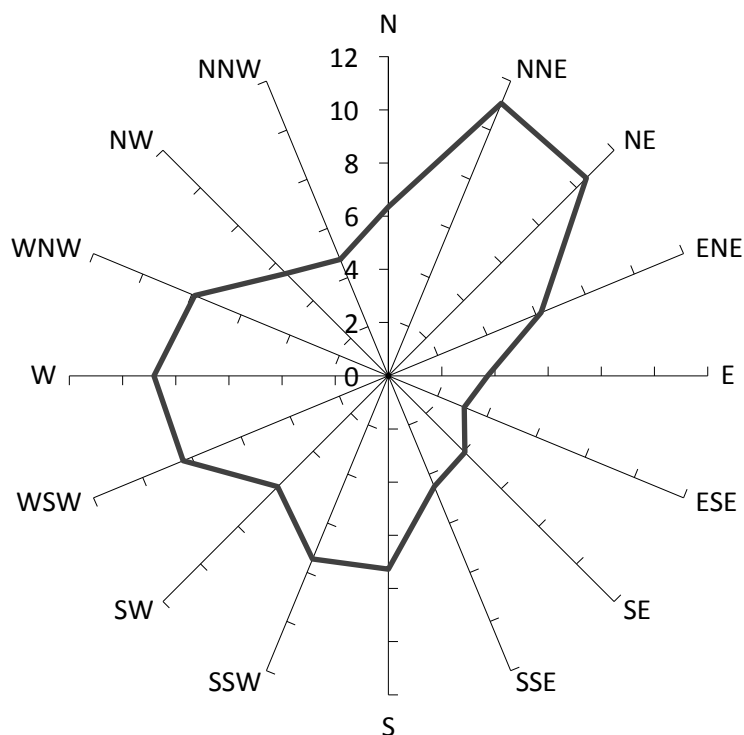


Desired Criterion

24m/s

Measured Wind Speeds at P48

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

18%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

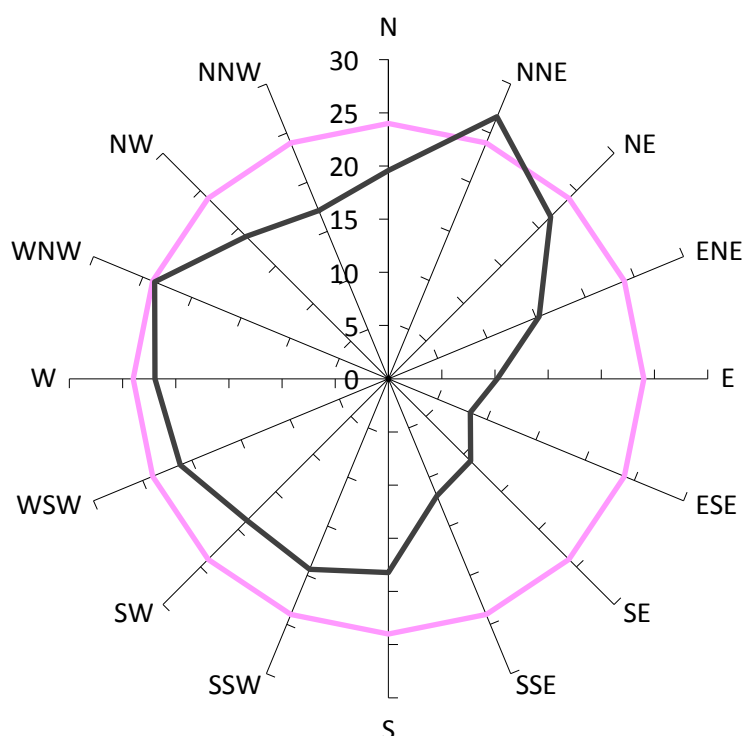
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

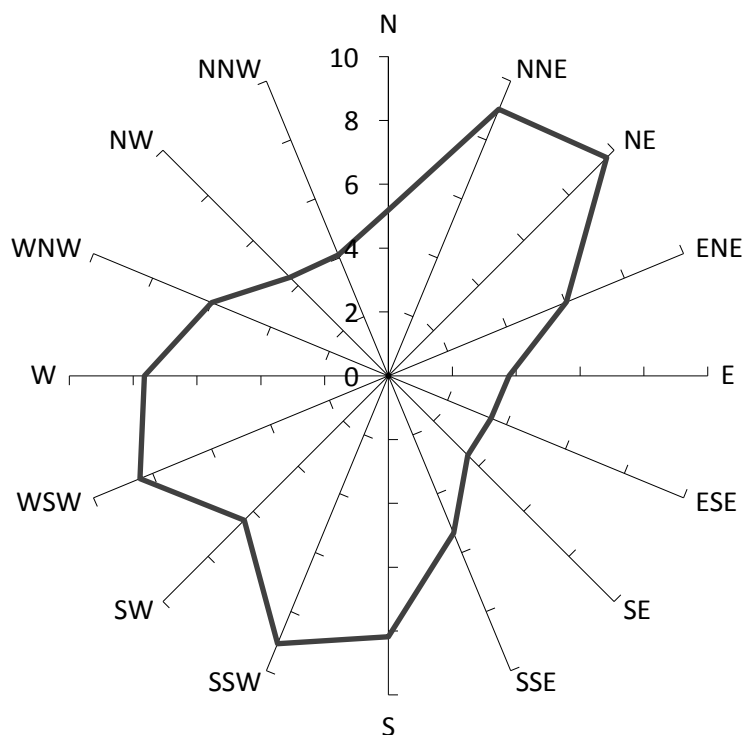


Desired Criterion

24m/s

Measured Wind Speeds at P49

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

13%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

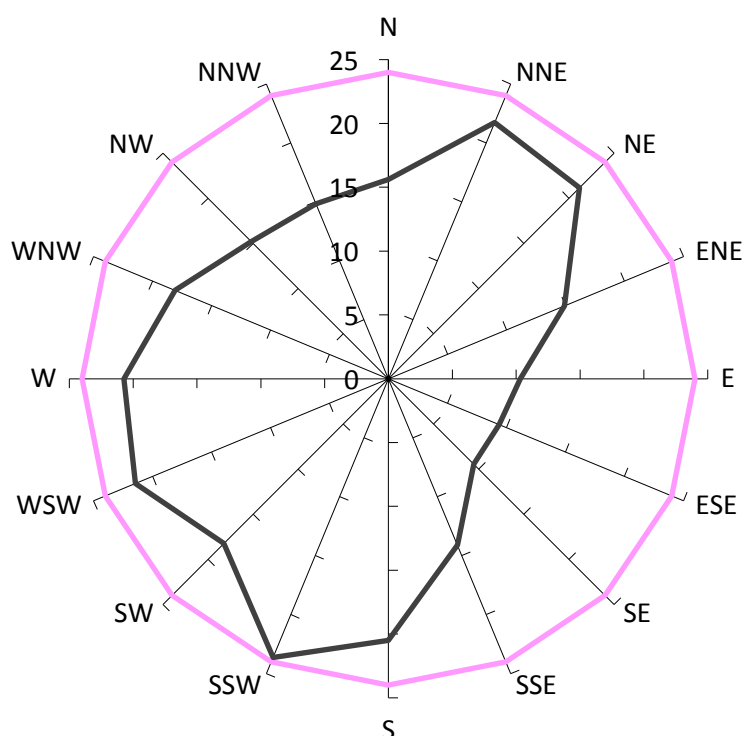
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

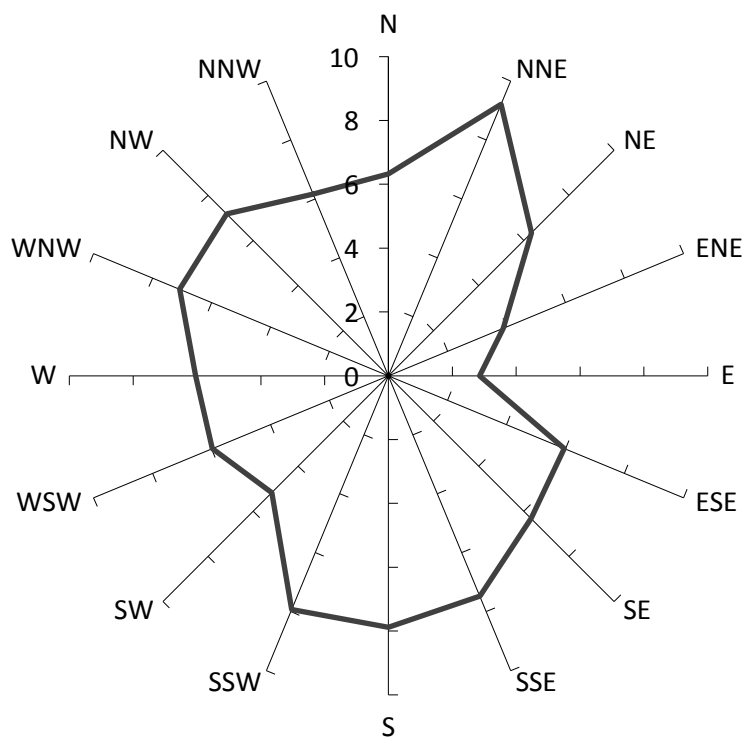


Desired Criterion

24m/s

Measured Wind Speeds at P50

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence
(existing site conditions)

9%

Probability of Criterion
Exceedence (initial test)

N/A

Probability of Criterion
Exceedence (final retest)

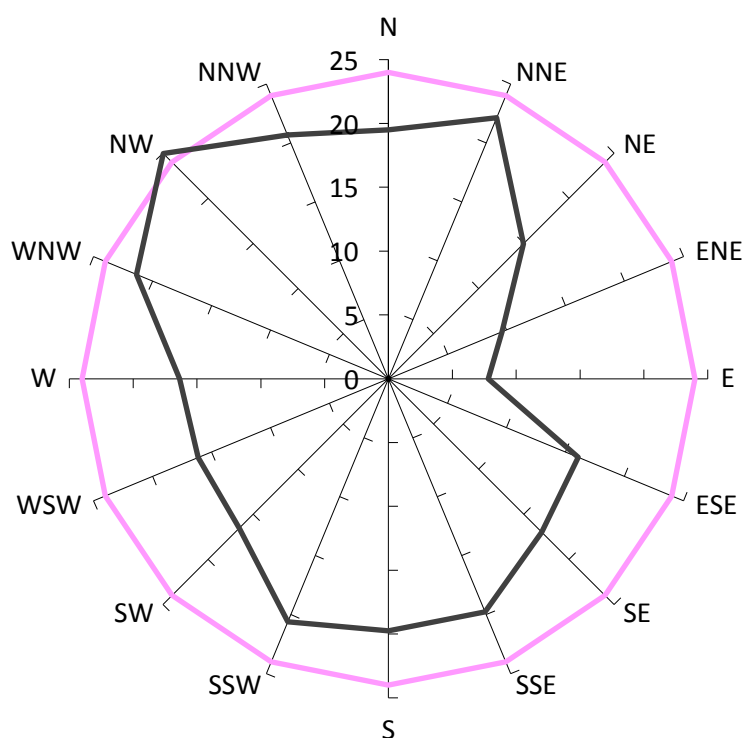
N/A

NOTE: The desired criterion is
exceeded if the probability of
exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

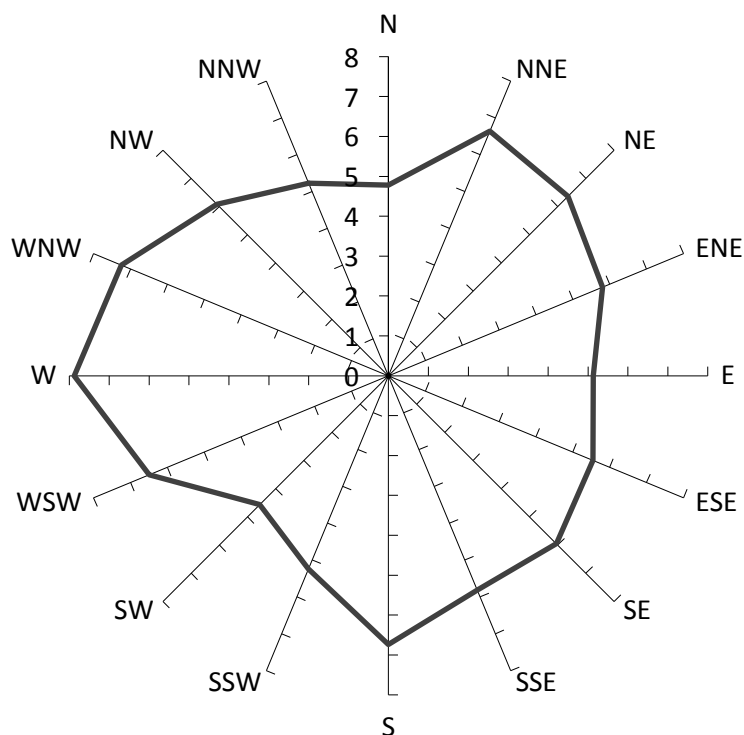


Desired Criterion

24m/s

Measured Wind Speeds at P51

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

4%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

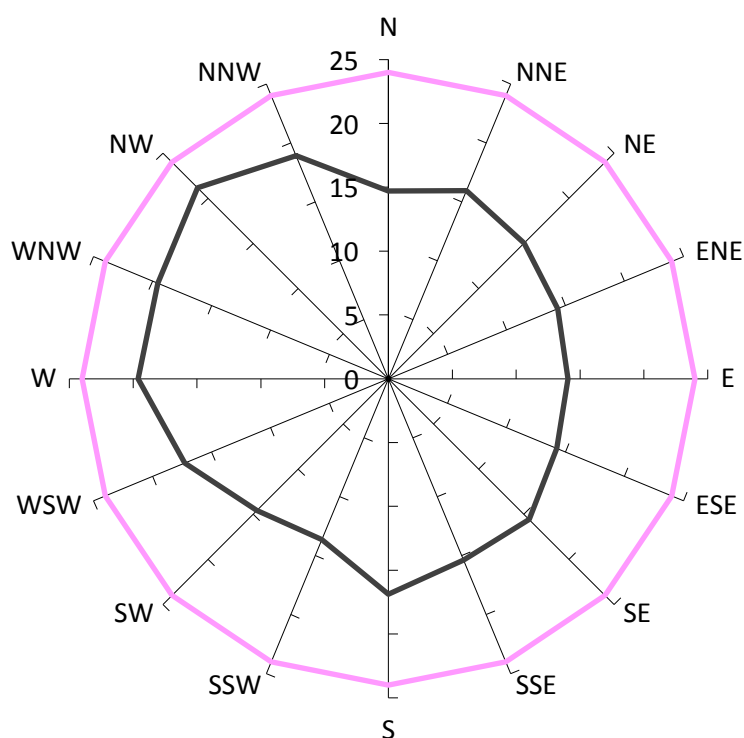
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

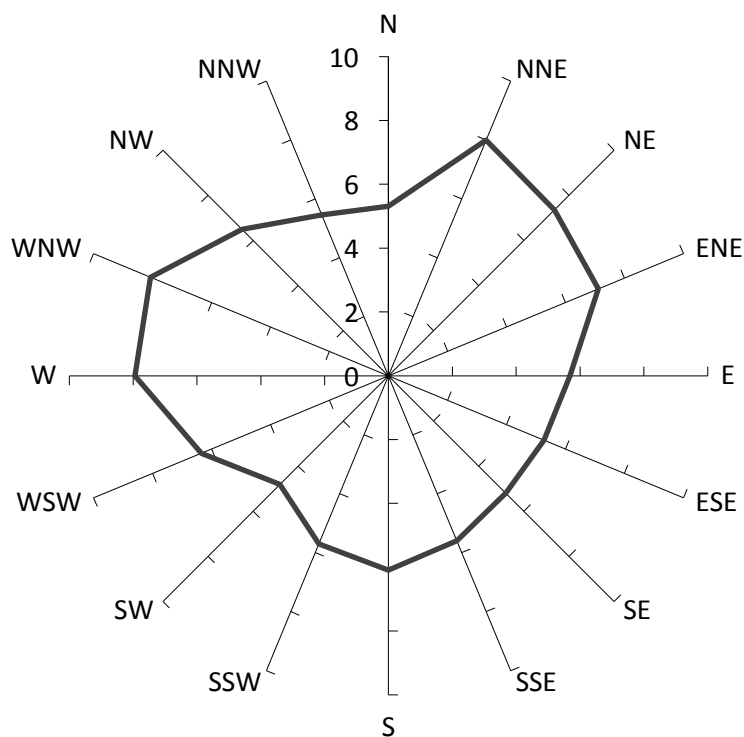


Desired Criterion

24m/s

Measured Wind Speeds at P52

Weekly Maximum GEM (m/s)



Desired Criterion

8m/s

Prob. of Criterion Exceedence (existing site conditions)

6%

Probability of Criterion Exceedence (initial test)

N/A

Probability of Criterion Exceedence (final retest)

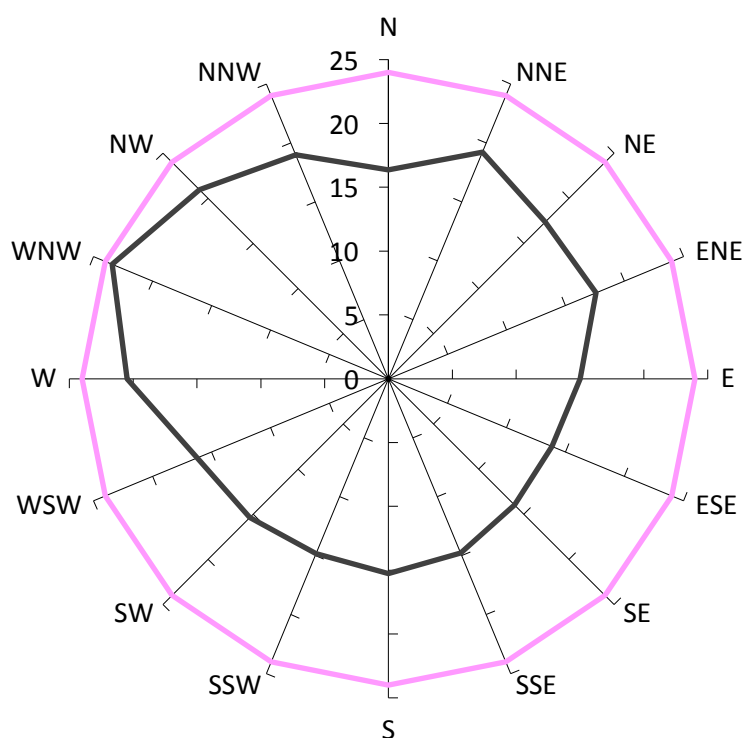
N/A

NOTE: The desired criterion is exceeded if the probability of exceedence is greater than 5%

Criterion.

With existing site conditions, no vegetation or other treatments.

Annual Maximum Gust (m/s)

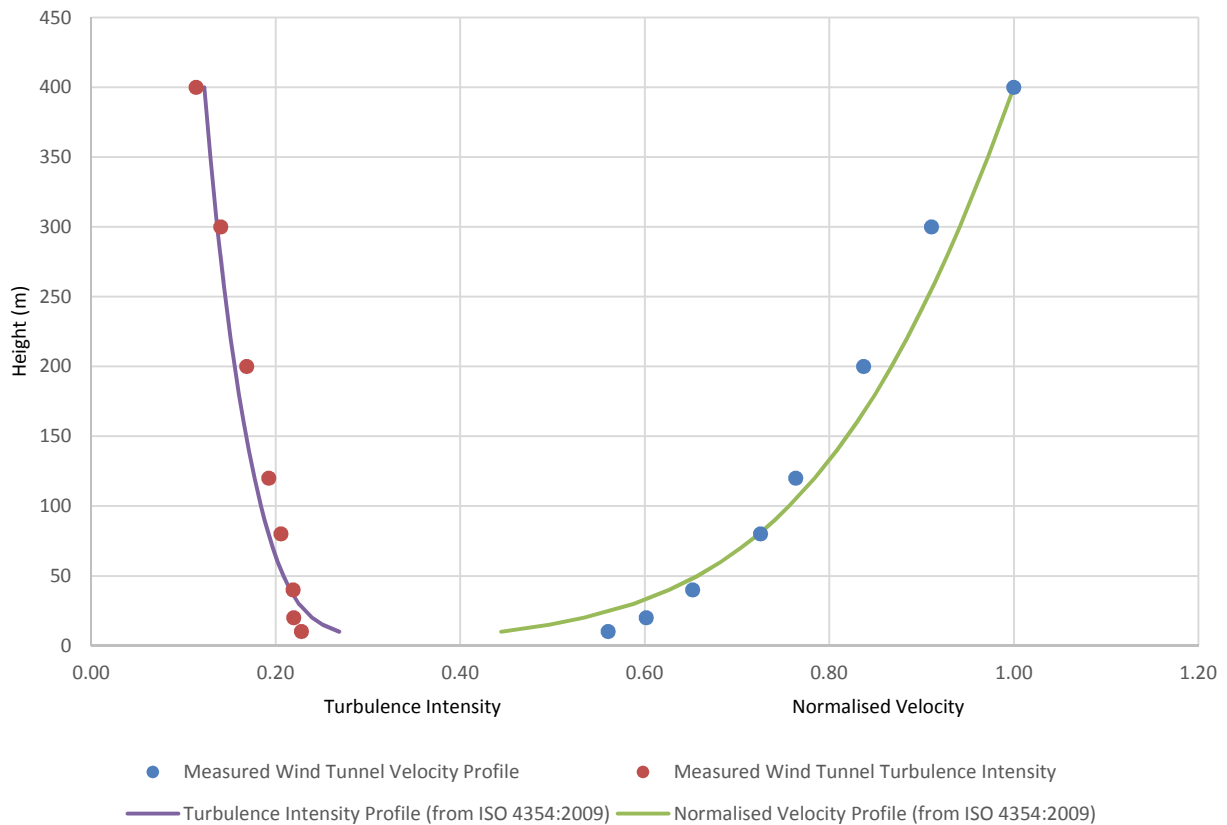


Desired Criterion

24m/s

APPENDIX B - VELOCITY AND TURBULENCE INTENSITY PROFILES

Mean Velocity and Turbulence Intensity for Suburban Terrain (TC3) at a 1:400 Scale



Longitudinal Spectra Density for Suburban Terrain (TC3) at a 1:400 Scale

