



25-27 LEEDS STREET, RHODES

Environmental Wind Tunnel Study

Billbergia Group

101/25 Angas Street
MEADOWBANK NSW 2114

Prepared by:

SLR Consulting Australia

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Basis of Report

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**Appendix A Seasonal Wind Roses for Bureau of Meteorology Met Stations at
Sydney (Kingsford Smith) Airport and Bankstown Airport**

Appendix B Wind Tunnel Test Data (Polar Plots) – BASELINE Scenario

Appendix C Wind Tunnel Test Data (Polar Plots) – PROPOSED Scenario

Appendix D Wind Tunnel Test Data (Polar Plots) – MITIGATION Scenario



1.0 INTRODUCTION

Billbergia Group has engaged SLR Consulting Australia Pty Ltd (SLR) to undertake a quantitative wind assessment of the proposed mixed-use development located at 25-27 Leeds Street, Rhodes. via an Environmental Wind Tunnel Study.

The assessment has been carried out via a Discrete Sensor Environmental Wind Tunnel Study whereby wind tunnel measurements were made to investigate wind conditions throughout and around the proposed development (simulated via a 1:400 scale model) at areas to be used by visitors and occupants of the development itself.

1.1 DEVELOPMENT – DESCRIPTION AND SITE CONTEXT

The site is bounded by Blaxland Road to the west, Paramatta River to the north, Leeds Street to the south and existing buildings to the east – refer **Figure 1**. The proposed multi-building residential development comprises 4 blocks. The surrounds comprise a mix of open-water (Parramatta River) to the northwest around to the northeast, commercial/industrial buildings to the east, residential dwellings to the southeast and south, and medium-rise residential towers to the southwest.

Figure 1 Project Site Location



Image: Courtesy Nearmap, November 2025



1.2 Development Description

The proposed multi-building mixed-use development comprises 4 buildings ranging in height from 10 to 26 storeys above ground – refer to **Figure 2** to **Figure 6**- comprises the following:

- Site-wide Basement-level parking
- Ground Floor (Level 01) for Retail, Units and Parking plus extensive landscaped areas
- Building “A” (southeast quadrant) – tiered levels with Roofs at L2, L3 and L13
- Building “B” (southeast quadrant – tiered levels with Roof at L11
- Building “C” (southwest quadrant) – tiered levels with Roof at L11
- Building “D” (southwest quadrant) – tiered levels with Roof at L12
- Building “E” (northwest quadrant) – Roof at L16
- Building “F” (northeast quadrant) – Roof at L26

Figure 2 Architectural Views of the Proposed Development – Ground Level

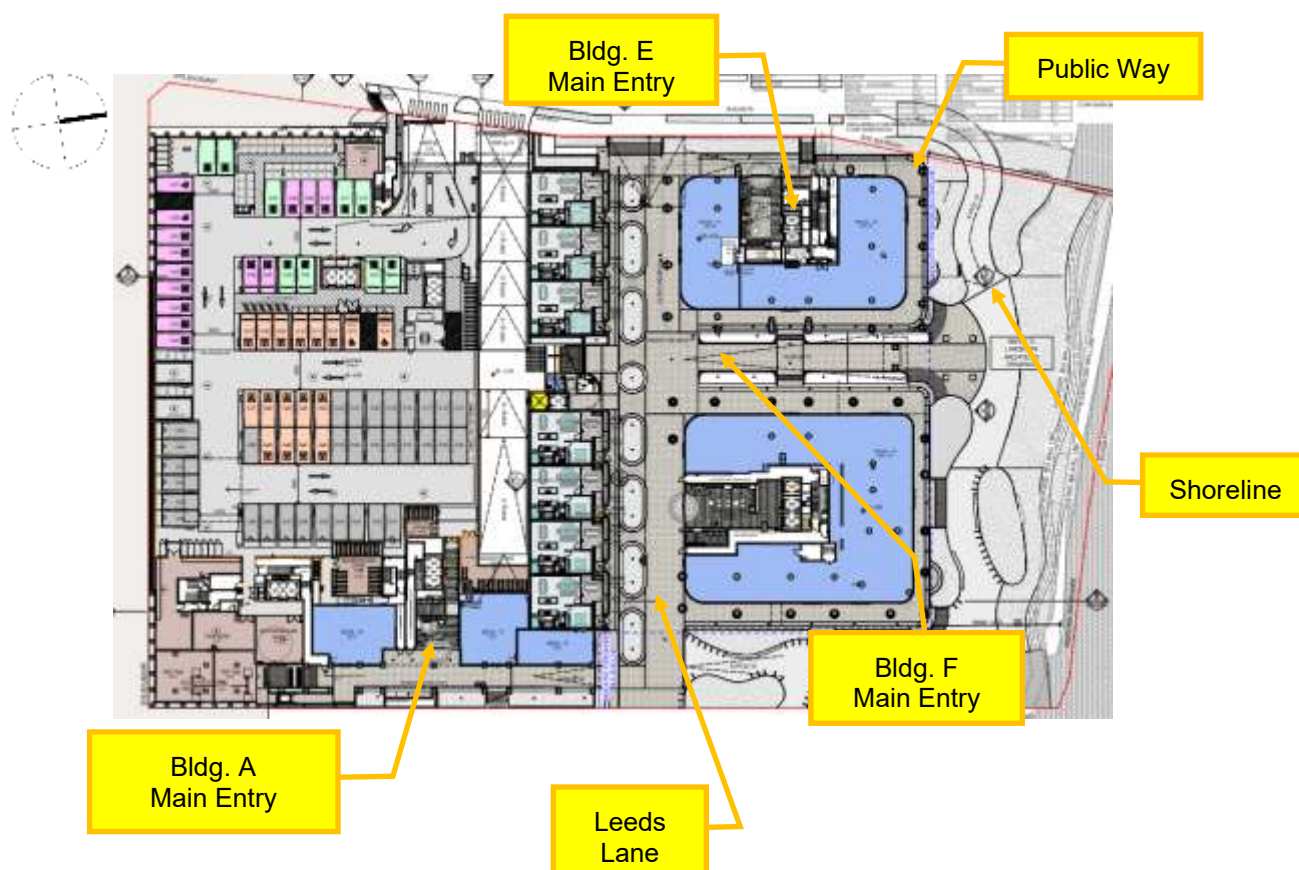


Figure 3 Architectural Views of the Proposed Development – Level 2



Figure 4 Architectural Views of the Proposed Development – Level 3



Figure 5 Architectural Views of the Proposed Development – Level 11

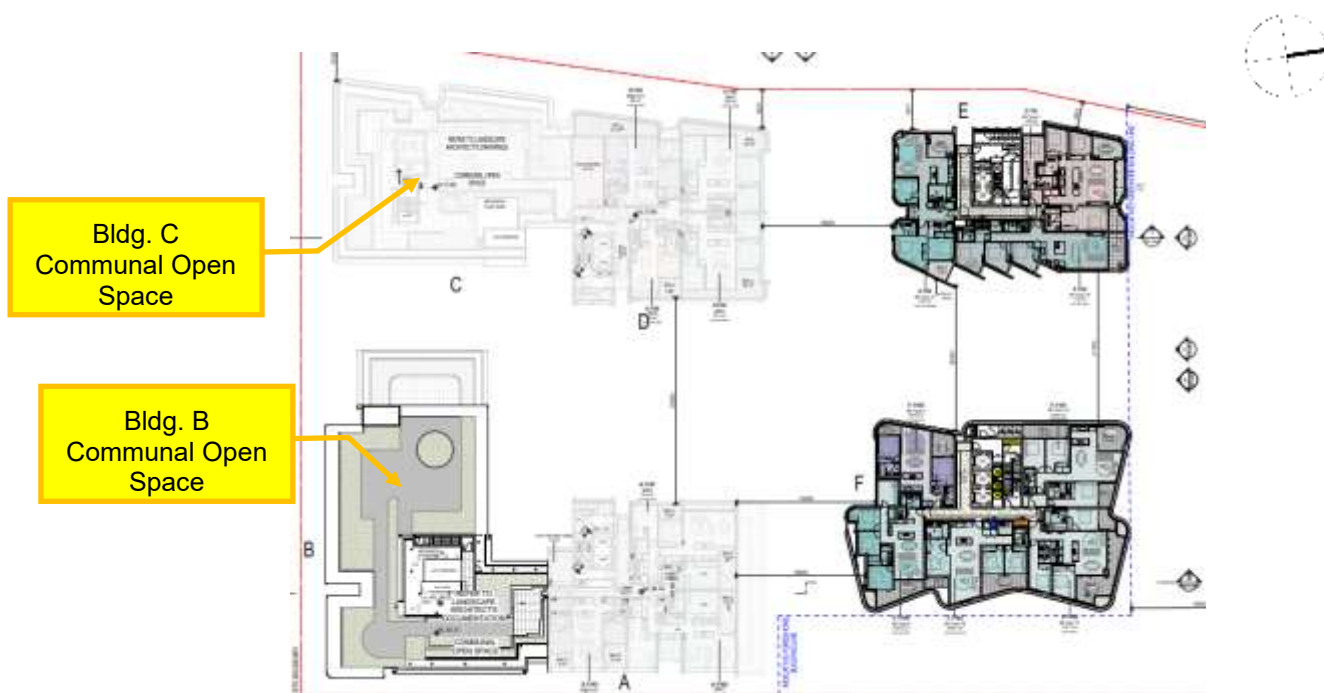
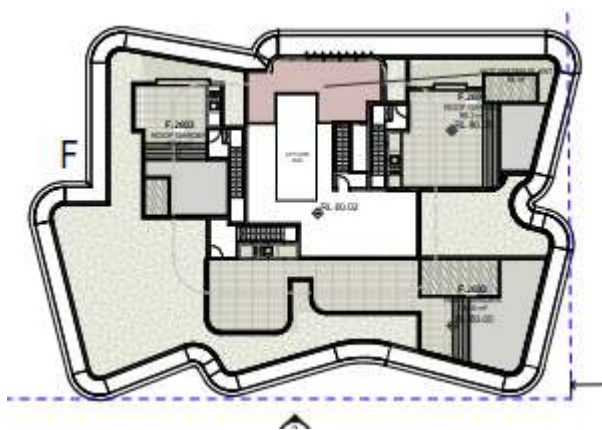


Figure 6 Architectural Views of the Proposed Development – Level 26 (Roof Building F)



1.3 Surrounding Built Environment

In terms of the surrounding terrain and topography (refer **Figure 7**):

“Near Field”

The “near-field” surrounds comprise a mix of open-water (Parramatta River) to the northwest around to the northeast, commercial/industrial buildings to the east, residential dwellings to the southeast and south, and medium-rise residential towers to the southwest.

“Far Field”

The “far-field” built environment comprises a similar mix of low-rise to medium-rise residential buildings, open stretches of water (east and west) and the more built-up areas of Rhodes and Wentworth Point.

Figure 7 Project Site Surrounds



Image: Courtesy Nearmap November 2025



2.0 SYDNEY'S WIND CLIMATE

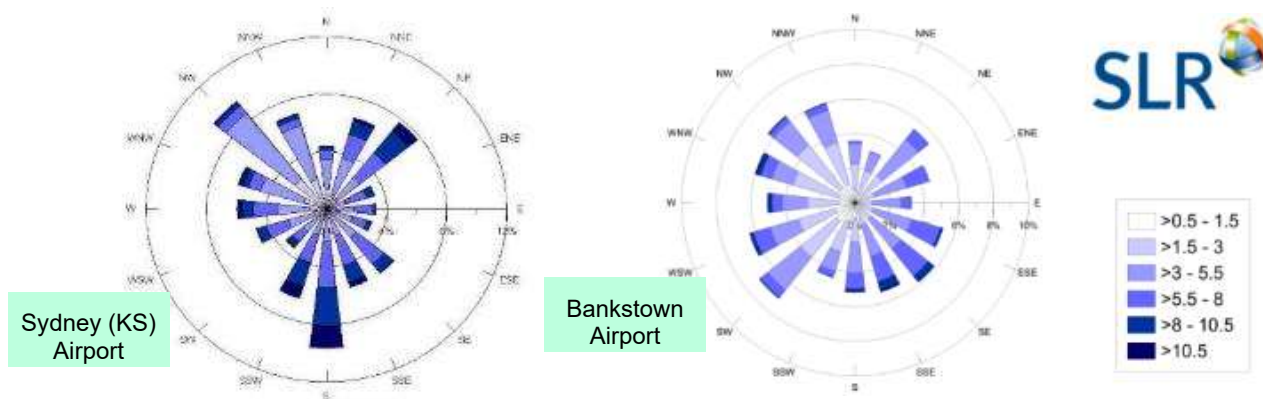
The data of interest in this study are the mean hourly wind speeds and largest gusts experienced throughout the year (especially higher, less frequent winds), how these winds vary with azimuth, and the seasonal break-up of winds into the primary Sydney Region wind seasons.

2.1 Annual and Seasonal Variations

Key characteristics of Sydney's Regional Wind Climate are illustrated in two representative wind roses shown in **Figure 8** taken from Bureau of Meteorology (BoM) data recorded during the period 1999-2017 at Sydney (Kingsford Smith) Airport and Bankstown Airport. A review of the associated seasonal wind roses (refer to **Appendix A**) shows that Sydney is affected by two primary wind seasons with relatively short (1-2 month) transition periods in between:

- Summer winds occur mainly from the northeast, southeast, and south. While northeast winds are the more common prevailing wind direction (occurring typically as offshore land-sea breezes), southeast and southerly winds generally provide the strongest gusts during summer. Both northeast winds (as sea breezes) and stronger southerly winds associated with "Southerly Busters" and "East Coast Lows" typically have a significantly greater impact along the coastline. Inland, these systems lose strength and have altered wind direction characteristics.
- Winter/Early Spring winds occur mainly from west quadrants and to a lesser extent from the south. West quadrant winds provide the strongest winds during winter and in fact for the whole year, particularly at locations away from the coast.

Figure 8 Annual Wind Roses for Sydney (KS) Airport and Bankstown Airport (BoM Data)



2.2 Wind Exposure at the Site – the “Local” Wind Environment

Close to the ground, the “regional” wind patterns described above are affected by the local terrain, topography and built environment, all of which influence the “local” wind environment.

- As noted in **Section 1.3**, the site is currently surrounded by commercial/industrial buildings (east), residential dwellings and medium-rise residential towers (southeast, southwest and south), as well as streetscapes marked by vegetation and trees, river (north, east and west) and modest changes in topography.



- The site will therefore receive minimal shielding for north and northwest winds, and moderate to reasonable wind shielding depending upon oncoming wind direction at lower levels with upper levels exposed to higher winds from a number of wind directions.

2.3 DESIGN WIND SPEEDS

SLR has carried out a detailed study of Sydney Basin wind speeds using continuous records of wind speed and direction measured at the Bureau of Meteorology's (BoM) Sydney weather stations. The above analysis is described in detail in ...

- SLR Technical Note: "9300-TN-CW&E-v2.0 Sydney Region Design Winds", March 2018.

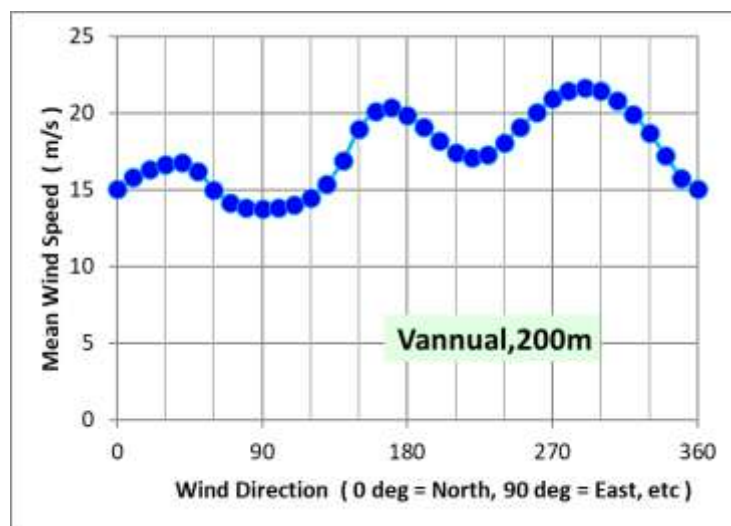
In particular, SLR has determined statistical wind information for locations not situated in close proximity (ie within say approximately a kilometre) of BoM weather stations. Particular emphasis was given to weather stations with a "clean" surrounding exposure, ie stations such as Sydney (Kingsford Smith) Airport and Bankstown Airport, which are relatively free of immediately surrounding obstacles such as buildings, vegetation, trees, etc, which would otherwise distort the winds seen by the weather station anemometer.

For the Project site, SLR has determined that local upper-level winds reflective of the weather systems experienced at the site would have characteristics closer to Bankstown Airport compared to Sydney (KS) Airport, given Rhodes's distance (18 km) inland from the coast compared to Bankstown Airport (25 km) and Sydney (KS) Airport (8 km).

2.4 Reference Height Annual Mean Wind Speeds

In the wind tunnel testing, the reference dynamic pressure used to record all wind speed data was measured at an equivalent (full-scale) height of 200 m above ground level (500 mm in the wind tunnel). Accordingly, conversion from wind tunnel speeds to full-scale speeds requires the determination of reference height design mean wind speeds for the site. These are shown in Figure 5 and have been based on the adopted Randwick wind model as described above. The winds shown have a once-per-year exceedance probability. The highest winds occur from the south and west to northwest quadrants with a secondary (more moderate) peak arising from summertime NE breezes.

Figure 9 Reference Height (200 m) Annual Recurrence Mean Wind Speed at Project Site



3.0 WIND ACCEPTABILITY CRITERIA

The choice of suitable criteria for evaluating the acceptability of particular ground level conditions has been the subject of international research over several decades.

3.1 Comfort and Safety Criteria

The criteria used in the evaluation of pedestrian level winds surrounding the proposed development are:

COMFORT: the “Lawson (2001)” criteria which couple the probability of exceeding winds at given statistical levels with wind speed magnitudes and associated impacts originally related to the Beaufort Wind Speed Land Scale – refer **Table 1**; and

SAFETY: the Melbourne (1978) criteria, based on the exceedance of annual peak gust wind speeds.

Table 1 Beaufort Wind Speed – LAND Scale

Beaufort Force	Hourly Average Wind Speed (m/s)	Description of Wind	Noticeable Wind Effect
0	< 0.45	Calm	Smoke rises vertically
1	0.45 to 1.55	Light air	Direction shown by smoke drift but not by wind vanes
2	1.55 to 3.35	Light breeze	Wind felt on face; leaves rustle; wind vanes begin to move
3	3.35 to 5.0	Gentle breeze	Leaves, small twigs in constant motion; Light flags extended
4	5.6 to 8.25	Moderate breeze	Raises dust and loose paper; small branches move
5	8.25 to 10.95	Fresh breeze	Small trees, in leaf, sway
6	10.95 to 14.10	Strong breeze	Large branches begin to move; telephone wires whistle Umbrellas used with difficulty
7	14.1 to 17.2	Moderate Gale	Whole trees in motion Inconvenience felt when walking against the wind.
8	17.2 to 20.8	Gale	Twigs break off trees; personal progress impeded
9	20.8 to 24.35	Strong/Severe Gale	Slight structural damage (chimney pots, slates removed)
10	24.35 to 28.4	Storm	Trees uprooted; considerable structural damage
11	28.4 to 32.4	Violent Storm	Widespread damage – unusual event
12	> 32.4	Hurricane	Devastation – only occurs in the tropics



“COMFORT” Criteria

As noted above, in relation to comfort, the Lawson (2001) criteria used in this report make use of the same Beaufort wind speed ranges to characterise issues of interest in terms of both pedestrian comfort and safety.

- The **Lawson (2001) Comfort** criteria relate a range of typical pedestrian activities such as purpose-walking, strolling, sitting, etc, to the local “GEM” wind speed which is exceeded on average 5% of the time, on an annual return period basis – refer **Table 2**.
- The “GEM” (Gust Equivalent Mean) wind speed used in the criteria is the maximum of the local mean wind speed or the local gust speed divided by 1.85.

Table 2 Lawson Wind Acceptability Criteria – COMFORT

Comfort Level	Beaufort Equivalent	“GEM” Wind Speed 5% Annual Exceedance	Description (see also Notes)
C5	1	2.5 m/sec	Dining
C4	2	4 m/sec	Sitting
C3	3	6 m/sec	Standing
C2	4	8 m/sec	Leisure Walking (Strolling)
C1	5	10 m/sec	Business (Purpose) Walking
CX	> 5	> 10 m/sec	Exceeds Comfort Criteria

Notes: C4 is suitable for promenades, popular recreation areas with seating, reading newspapers, etc
C3 is suitable for locations where pedestrians will likely be waiting for relatively short periods, eg at building entrances, at pedestrian crossings, bus stops, etc
C2 is suitable for activities such as window-shopping
C1 is suitable for footpaths used for purposeful pedestrian traffic only (eg not where shops might induce slower activities like window-shopping)
CX suggest winds whose force can be felt by the body (branches on trees would be visibly swaying) and where walking will start to become inconvenient or challenging for certain classes of pedestrians, eg the frail, pedestrians holding parcels, parents holding children, etc.

“SAFETY” Criteria

The safety acceptability criteria used in this report, currently referenced by many Australian Local Government Development Control Plans, are the so-called **Melbourne (1978) criteria**, summarised in **Table 3**.

Table 3 Melbourne (1978) Wind Acceptability Criteria – SAFETY

Type of Criteria	Gust Wind Speed Occurring Once Per Year	Activity Concerned
Safety	24 m/s	Knockdown in Isolated Areas
	23 m/s	Knockdown in Public Access Areas



3.2 Significance Criteria – Comfort

The significance criteria used by SLR in the assessment of “Comfort-related” wind effects at measurement locations surrounding the site are based on comparing the **wind-tunnel predicted** conditions at any particular location with the target usage at the same location (eg sitting, strolling, leisure walking, etc) as defined by the Lawson (2001) Comfort Criteria.

- The proposed development is deemed to have a “**Beneficial**” impact at any particular location if wind conditions are calmer than the levels associated with the target usage at that location.
- When wind conditions at any particular location, with the addition of the proposed development, are close to the levels associated with the target usage at that location, the impact is termed “**Negligible**”.
- The proposed development is deemed to have an “**Unfavourable**” impact at any particular location if wind conditions are higher (windier) than the levels associated with the target usage at that location.

The chosen significance criteria are shown **Table 4**.

- All “Unfavourable” impacts (whether minor, moderate or major) are considered to be “significant”, requiring consideration of mitigation for local conditions to become suitable for the intended use of the area.
- In considering mitigation under these such circumstances, “Baseline” wind conditions should also be considered if pre-existing conditions are already exceeding the target wind levels at the project site.

Table 4 Significance Criteria Related to Lawson Acceptability Criteria

Impact	Predicted Wind Microclimate
Beneficial – Major	Wind Conditions are 3-levels calmer than desired
Beneficial – Moderate	Wind Conditions are 2-levels calmer than desired
Beneficial – Minor	Wind Conditions are 1-level calmer than desired
Negligible	Wind Conditions are at the same level as desired
Unfavourable – Minor	Wind Conditions are 1-level windier than desired
Unfavourable – Moderate	Wind Conditions are 2-levels windier than desired
Unfavourable – Major	Wind Conditions are 3-levels windier than desired OR Wind Conditions are in the Lawson “CX” or “SX” category

3.3 Comments on the Application of the Acceptability Criteria

Approach for Areas Where Existing Wind Conditions Already Exceed Criteria

In many urban locations, either because of exposure to open upstream conditions or because of street “canyon” effects, etc, the relevant Comfort and Safety criteria may already be currently exceeded.

In such instances, a new development should:



- ideally not exacerbate existing adverse wind conditions; and
- wherever feasible and reasonable, ameliorate such conditions.

For this reason, in the assessment of wind tunnel predictions of wind conditions associated with a newly proposed development, it can be useful to compare the wind microclimate in the “Proposed” condition (ie with the proposed development) with the wind microclimate of the pre-existing “Baseline” condition – as has been done in the present study.

The probabilistic way in which the Comfort Criteria are defined indicates that the relevant activity may be unsuitable at a particular location for about 5% of the time (say around 18 days per year). For the rest of the time, the relevant activity may be suitable (given that winds will be lower than the prescribed acceptability level). Moreover, it is noted that the recommended limiting values for comfort-related wind conditions were generally derived from subjective assessments of wind acceptability. These have been found to vary considerably with the height, strength, age, etc, of the pedestrian concerned.

Accordingly, some latitude can be applied to the Comfort Criteria in particular taking into account the extent of windy conditions, eg some relaxation of the criteria may be acceptable for small areas under investigation which are used infrequently.

The safety criteria shown in **Table 3** reflect the potential for stronger winds to cause a loss of balance and even possible wind knock-down, especially for frail pedestrians. The criteria are accordingly significantly more stringent.

Mitigation Using Landscaping

The Australasian Wind Engineering Society (AWES) Guidelines for Pedestrian Wind Effects Criteria includes advice related to the use of landscaping (trees, shrubs, etc) for mitigation of adverse wind conditions.

In particular, the AWES Guideline notes the following:

- Trees planted in locations where the 23 m/s safety criterion is exceeded are likely to experience wind speeds every 5 years or so which will be sufficient to destroy or severely damage many trees.
- Trees placed in high wind areas therefore have the potential to shed limbs during windstorms, thereby causing a public danger and a public nuisance.
- Moreover, landscaping planted in high wind locations rarely matures to its normal full height necessary for the assumed wind mitigation it will provide.
- Finally, trees located on public footpaths become the responsibility of the local municipality. Their maintenance, replacement following damage, loss of limbs, etc, can become burdensome financially (assuming the Municipality is even aware of such damage) and cannot be guaranteed.

Accordingly, the AWES Guideline does not recommend the use of landscaping when seeking to mitigate wind conditions that equal or exceed the public safety 23 m/s criterion.



4.0 WIND TUNNEL TEST METHODOLOGY

4.1 Simulation of Natural Wind

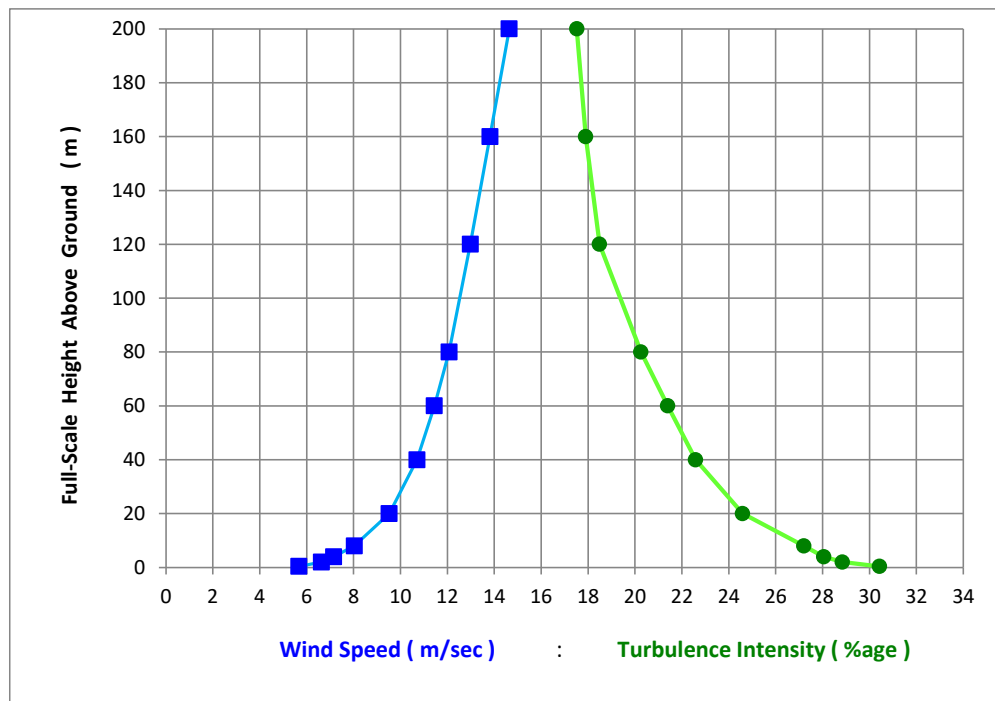
Similarity requirements between the wind tunnel model and prototype (ie full-scale) need to be fulfilled so that similitude in the flow conditions is satisfied. Usually all requirements cannot be satisfied, and compromises need to be made. In this type of wind tunnel test, it is possible to waive strict adherence to the full range of similarity parameters, eg the need to take into account buoyancy effects which are not relevant under strong wind conditions.

The wind tunnel test has been carried out using a geometric length scale of 1:300 for all dimensions (standard wind tunnel test scaling) and by scaling the boundary layer approach wind in the wind tunnel to the same scale as in the atmosphere.

The approach wind was modelled by matching terrain category conditions for all wind directions. In the wind tunnel, this is achieved by an almost 20-metre fetch of appropriate roughness elements.

The upstream profile conditions simulated in the present study is slightly more “urban” than a Suburban Terrain Category 3, associated with the presence of medium density, medium height surroundings. The variation of mean wind speed (blue curve) and turbulence intensity (green curve) is shown in **Figure 10**.

Figure 10 Wind Tunnel Test Profiles of Mean Wind and Turbulence Intensity

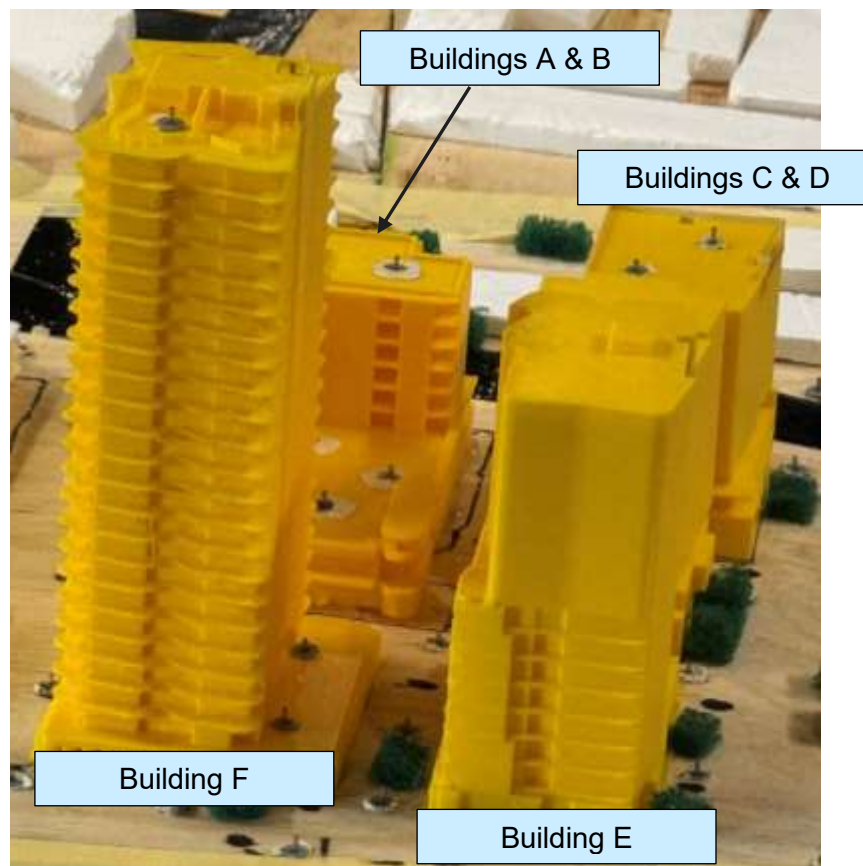


4.2 Proposed Development Models and Proximity Model

Development Models

A 1:400 scale model of the proposed development was built using 3D printing for testing purposes – refer **Figure 11**.

Figure 11 1:400 Scale Model of the Proposed Development



Proximity Model

To take into account the influence of the immediate surrounding physical environment, all neighbouring buildings and local topography within a diameter of almost 900 m around the site were included in the purpose-built 1:400 scale “proximity model” used for the test as shown in

The study has involved the testing of the following built environment “scenarios”:

- Scenario 1 – “**Baseline**” The existing built environment (as of June 2023),
- Scenario 2 – “**Proposed**” “Baseline” + Proposed Development
- Scenario 3 – “**Mitigation**” “Proposed” + Recommended wind mitigation treatments



Figure 12 1:400 Scale Proximity Model in Wind Tunnel - "Baseline" Scenario (Existing as June 2023)

View from South



Figure 13 1:400 Scale Proximity Model in Wind Tunnel - "Proposed" Scenario

View from South



Data Processing

Wind speed measurements were taken at 10° intervals: the 0° wind direction is from the north, with east at 90°, south at 180°, etc.

The wind speeds at the locations of interest are measured in the wind tunnel using Irwin sensors.

Wind speeds in the wind tunnel were measured at a height corresponding to approximately chest height (1.5 m) in full scale.

The sampling time for each measurement is 60 seconds.

Wind speed measurements are recorded as dimensionless ratios of the mean and gust ground level velocity to a mean reference wind speed at a (full-scale) height of 200 m above ground level.

The reader is referred to the publication referenced below for a full description of this technique and validation of Irwin sensor data using hot-wire anemometry.

LTR-LA-242 “A Simple Omni-Directional Sensor for Wind Tunnel Studies of Pedestrian Level Winds” (Irwin, National Aeronautical Establishment, Ottawa, Canada, May 1980)

The measured wind speeds are transformed using the directional wind speed information derived from the local wind climate to yield ground level wind speeds as a function of annual return period and directional mean reference wind speed – refer **Figure 14**. The measured ground level wind speeds thus incorporate both the building and terrain/topographical aspects of the location as well as the directional probability of wind speed for the Project Site. The results are computed on a probabilistic basis, enabling calculation of wind events which will occur at the probability levels relevant to the Lawson Comfort Criteria, ie 5% exceedance level on an annual basis, and the peak annual wind speed relevant to the Melbourne 23 m/s Safety Criterion, using the local Project Site statistical wind distribution.

4.3 Test Method – Sensor Locations

In the wind tunnel testing, Irwin wind sensors were positioned at the locations shown in **Figure 9**.

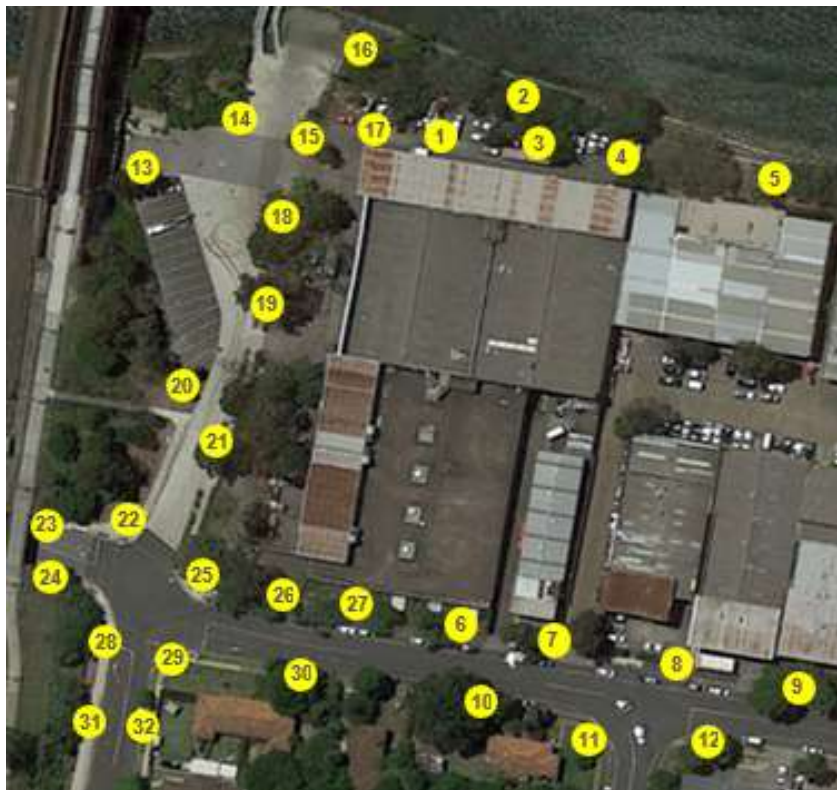
These locations were chosen as potentially susceptible to adverse wind conditions, eg near building corners, or represent locations of interest throughout the development, eg near primary building entrances and along footpaths.

- Locations 1- 32 were positioned at ground level locations surrounding the site and were measured for all two scenarios; “Baseline” and “Proposed” test scenarios.
- Locations 41-54 were located on the elevated communal open areas and hence they were only measured for “Proposed” test scenarios.



Figure 14 Sensor Locations

Ground Level Sensors (Baseline)



Ground Level Sensors (Proposed)

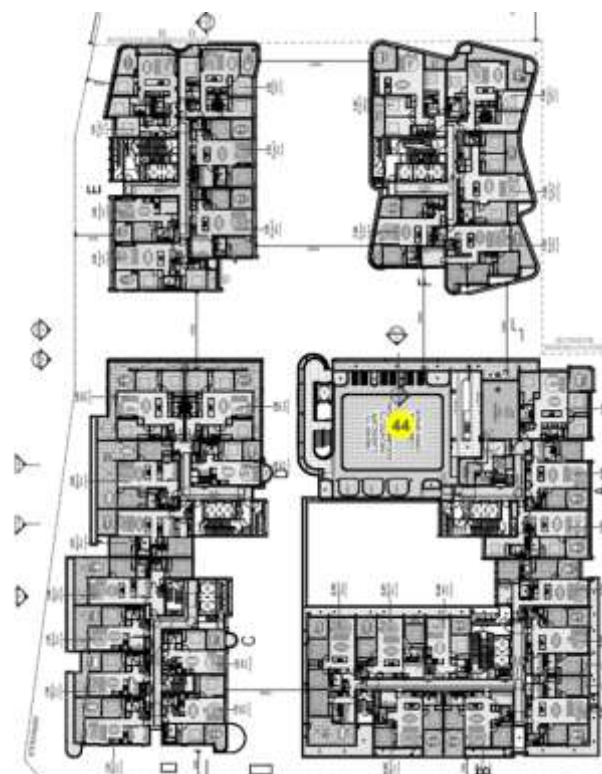


(Fig.14 cont'd)

Level 2

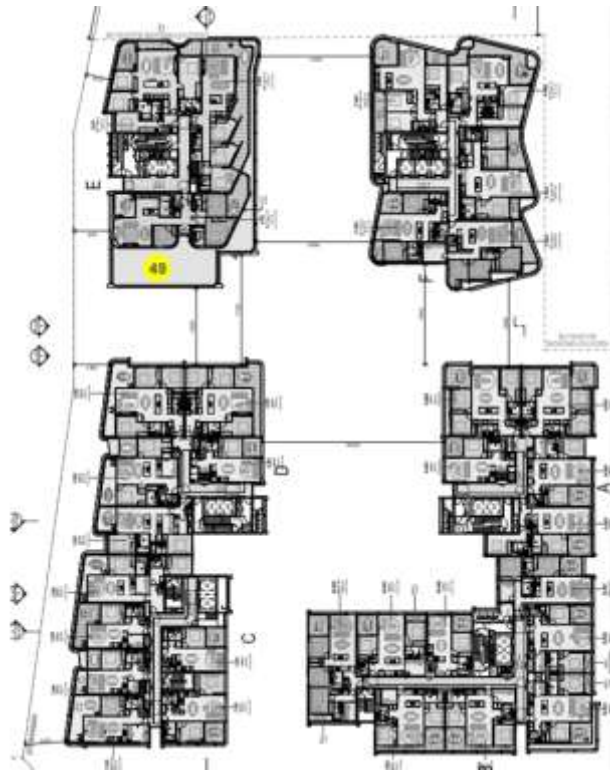


Level 3

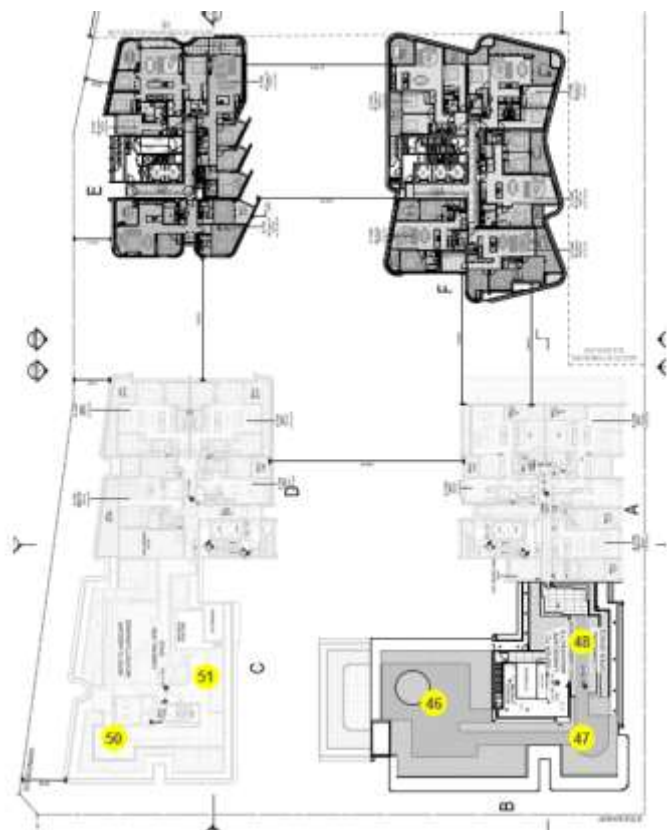


(Fig.14 cont'd)

Level 9

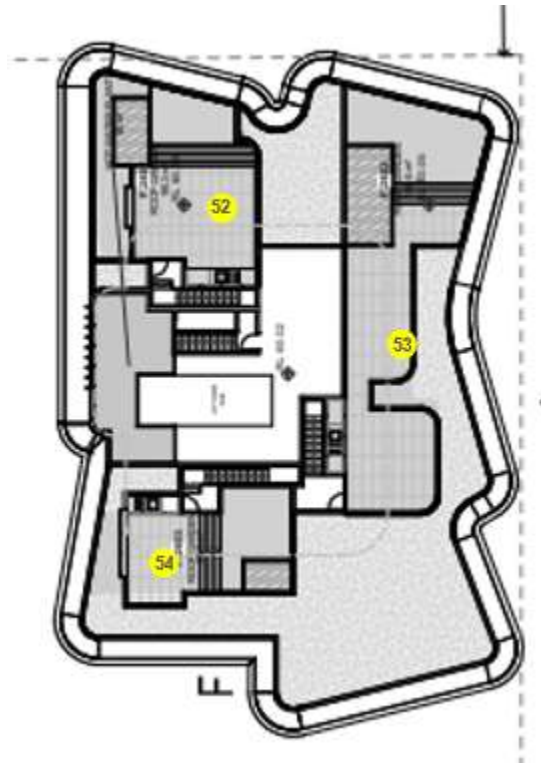


Level 11



(Fig.14 cont'd)

Level 26– Building F



4.4 Sample Test Result

An example of the test results and interpretation of these results is shown in **Figure 15** illustrating the peak annual mean and representative gust wind speeds at:

Sensor: **Location 1**
Location: midway along North Façade

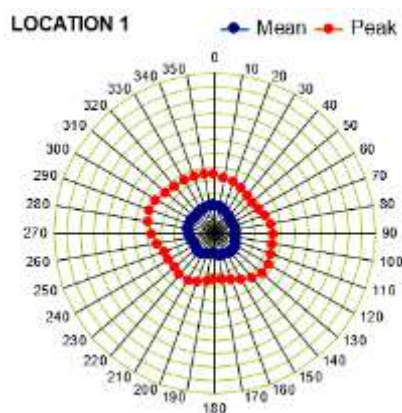
The polar diagram shows the output of the wind tunnel test results in terms of the ratio of local ground level wind speeds to the 200 m height reference mean wind speed:

Mean wind speed ratio: “navy blue” data points.
Gust wind speed ratio: “red” data points.

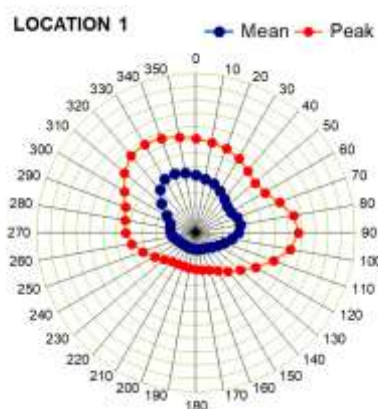
The polar diagram circumferential markings show the above ratios in “0.1” intervals.

Figure 15 Sample Polar Plot Test Result – Location 46

Scenario 1 – “Baseline”



Scenario 2- “Proposed”



Scenario 1 - “Baseline” Scenario

- Location 1 encounters a moderate increase in the speed of winds blowing from the northwest direction.

Scenario 2 - “Proposed” Scenario

- Location 1 experiences a substantial rise in the velocity of northerly winds as a result of non-shielding wind flows directed towards the northern side of the site and downwash winds off the northern façade of Buildings E and F.



4.5 Lawson (2001) and Melbourne (1978) Calculation Methodology

As described in previous sections, the wind tunnel results are processed as follows:

- The wind tunnel test data yield ratios of the local ground level wind speed (mean and peak gust) to the reference height (200 m full-scale) mean wind speed (refer **Figure 10**) in the wind tunnel.
- The local Project Site wind speed and wind direction probability distribution is then used to calculate the probability of occurrence of the "GEM" wind speeds at an annual exceedance level of 5% to compare to the Lawson (2001) Comfort Criteria and the peak annual gust to compare to the Melbourne (1978) 23 m/s Safety Criterion.

4.6 Wind Tunnel Test Data - All Scenarios

Appendices B, C and D present the relevant wind tunnel test result polar plots for all locations across all scenario test runs.

Note that the polar plots are the ratios of the local ground level wind speed (mean and peak gust) to the reference height (200 m full-scale) mean wind speed (refer **Figure 10**) in the wind tunnel, and do not take into account the directional "strength" characteristics of the Project site wind rose.

5.0 TEST RESULTS

5.1 Predicted Melbourne (1978) Safety Criteria Levels

The results of the combination of wind tunnel test results (local ground level wind speed ratios) with the wind speed and wind direction probability distribution (peak annual gust) relevant to safety yielded the following results:

- In the "Baseline" scenario, the **peak annual gust at ALL locations** around the site are below the 23 m/s safety criterion level,
- In the "Proposed" scenario, **peak annual gusts at ALL locations** around the site continue to remain below the 23 m/s safety criterion level.

5.2 Predicted Lawson Comfort Criteria Levels

The results of the combination of wind tunnel test results (local ground level wind speed ratios) with the wind speed and wind direction probability distribution (5% annual exceedance level) derived for the site compared to the Lawson Comfort criteria are shown in **Figure 16**.



Figure 16 Predicted Lawson Comfort Levels - “Baseline” Scenario – Surrounding Publica Domain



Figure 17 Predicted Lawson Comfort Levels - “Proposed” Scenario – Surrounding Publica Domain



Figure 18 Predicted Lawson Comfort Levels - “Proposed” Scenario –Level 2



Figure 19 Predicted Lawson Comfort Levels - “Proposed” Scenario –Level 3



Figure 20 Predicted Lawson Comfort Levels - “Proposed” Scenario –Level 9



Figure 21 Predicted Lawson Comfort Levels - “Proposed” Scenario –Level 11



Figure 22 Predicted Lawson Comfort Levels - “Proposed” Scenario –Level 26 (Bldg. F)



5.2.1 Impact of the Proposed Development on Existing Wind Conditions

Table 5 presents a comparison between the wind-tunnel predicted Lawson (2001) Comfort levels for the “Baseline”, “Proposed” and “Proposed + Mitigation” scenarios and the Target Comfort levels for the surrounding areas, as well as the locations within the proposed development and the elevated communal terrace areas.

“Baseline” Scenario

- As noted above, NO locations are predicted to experience winds which exceed the Safety Criterion,
- There are NO areas with the potential to experience winds which exceed the “CX” Comfort Criterion,
- Most locations surrounding the site fall “C2” (Walking) category, and some locations move to the “C3” (Standing) category due to limited shielding from the surrounding buildings itself.

“Proposed” Scenario

- As noted above, NO locations are predicted to experience winds which exceed the Safety Criterion,
- There are NO areas with the potential to experience winds which exceed the “CX” Comfort Criterion,
- All locations surrounding the site generally remain at the Lawson “C2” (Strolling) or “C3” (Standing) category; most locations undergo a moderate alteration in local wind speed by one Lawson Comfort Criteria level.

5.2.2 Impact of the Proposed Development Relative to Target Comfort Levels

It is noted that none of the landscaping proposed for the development was included in the “Proposed” built environment scenarios. Testing in their absence assists in confirming areas where wind mitigation may be needed and more importantly, using the polar plot information shown in **Appendices B, C and D**, revealing the wind directions of most concern, further assisting the decision making in relation to placement of specific landscaping elements.

“Proposed” Built Environment Scenario

- Lawson Comfort levels at most measurement locations comply with their “Target” Comfort level,
- Lawson Comfort Levels range from “C2” (suitable for leisure walking/strolling) to “C3” (suitable for sitting),
- There are NO areas with the potential to experience winds which exceed the 23 m/s Safety Criterion.

It will be recalled (refer **Section 3.2**) that all locations where the significance impact is “Unfavourable” leads to consideration of mitigation treatments (also taking into account the existing “Baseline” conditions).



Table 5 Assessment of Impacts – Wind Tunnel Predicted Comfort Level of “Baseline” and “Proposed” Scenarios Relative to Target Comfort Level

Location	Target	“Baseline”	“Proposed”	“Proposed” Impact (refer Table 4) Relative to Target Comfort Level
1	C2	C3	C3	Favourable Minor
2	C2	C3	C3	Favourable Minor
3	C2	C3	C2	Negligible
4	C2	C3	C3	Favourable Minor
5	C2	C3	C3	Favourable Minor
6	C3/C4	C3	C2	Unfavourable Minor/ Unfavourable Moderate
7	C2	C3	C2	Negligible
8	C3/C4	C3	C3	Negligible/ Unfavourable Minor
9	C2	C3	C3	Favourable Minor
10	C2	C3	C2	Negligible
11	C2	C3	C3	Favourable Moderate
12	C2	C3	C3	Favourable Minor
13	C2	C3	C3	Favourable Minor
14	C2	C3	C3	Favourable Minor
15	C2	C2	C3	Favourable Minor
16	C2	C3	C3	Favourable Minor
17	C2	C3	C3	Favourable Minor
18	C2	C3	C3	Favourable Minor
19	C2	C3	C2	Negligible
20	C2	C3	C2	Negligible
21	C2	C3	C3	Favourable Minor
22	C2	C3	C2	Negligible
23	C3	C3	C3	Negligible
24	C2	C3	C3	Favourable Minor
25	C2	C3	C2	Negligible
26	C3/C4	C3	C3	Negligible/ Unfavourable Minor
27	C2	C3	C3	Favourable Minor
28	C2	C3	C3	Favourable Minor
29	C2	C3	C3	Negligible
30	C2	C3	C3	Favourable Minor
31	C2	C3	C3	Favourable Minor
32	C2	C3	C3	Favourable Minor
33	C2		C3	Favourable Minor
34	C2		C3	Favourable Minor
35	C2		C2	Negligible
36	C2		C2	Negligible
37	C3/C4		C3	Negligible/ Unfavourable Minor
38	C3	Note 1	C2	Negligible
39	C3		C2	Negligible
40	C3/C4		C2	Unfavourable Minor / Unfavourable Moderate
41	C3/C4		C2	Unfavourable Minor / Unfavourable Moderate



Location	Target	“Baseline”	“Proposed”	“Proposed” Impact (refer Table 4) Relative to Target Comfort Level
42	C3/C4		C2	Unfavourable Minor / Unfavourable Moderate
43	C3/C4		C2	Unfavourable Minor / Unfavourable Moderate
44	C3/C4		C3	Negligible/ Unfavourable Minor
45	C3/C4		C3	Negligible/ Unfavourable Minor
46	C3/C4		C3	Negligible / Unfavourable Moderate
47	C3/C4		C3	Negligible / Unfavourable Moderate
48	C3/C4		C3	Negligible / Unfavourable Moderate
49	C3/C4		C2	Unfavourable Minor / Unfavourable Moderate
50	C3/C4		C3	Negligible / Unfavourable Moderate
51	C3/C4		C3	Negligible / Unfavourable Moderate
52	C3/C4		C3	Negligible/ Unfavourable Minor
53	C3/C4		C3	Negligible / Unfavourable Moderate
54	C3/C4		C3	Negligible / Unfavourable Moderate

Note 1 These are INTERNAL or ELEVATED Development locations and hence only included in the “Proposed” scenario.

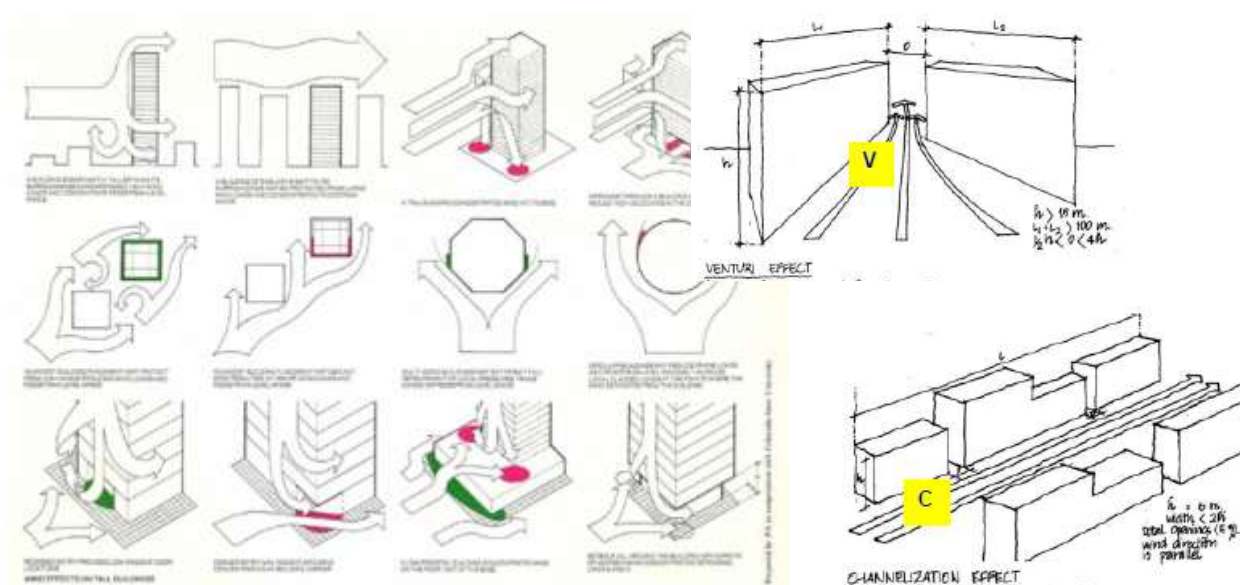
Note 2 All Unfavourable impacts are deemed “significant” and require consideration of wind mitigation.



6.0 WIND MITIGATION OPTIONS

Figure 23 shows some common wind impact flow patterns surrounding a new building development.

Figure 23 Common Built Environment Windflow Patterns



On the basis of the above, wind mitigation options generally fall into two categories:

- Windbreaks designed to mitigate **vertical or oblique** winds (eg downwash winds); and
- Windbreaks designed to mitigate **horizontal** winds (eg channelling/funnelling winds).

6.1 Windbreaks Suited to Mitigating Vertical/Oblique Winds

Wind mitigation options suited to ameliorating vertical/oblique wind conditions include:

- Horizontal (or near horizontal) Canopies, Awnings and Pergolas (solid or of moderate porosity) which are able to deflect winds approaching from above and redirect the wind away from ground level areas below.

6.2 Windbreaks Suited to Mitigating Horizontal Winds

Wind mitigation options suited to ameliorating horizontal wind conditions include:

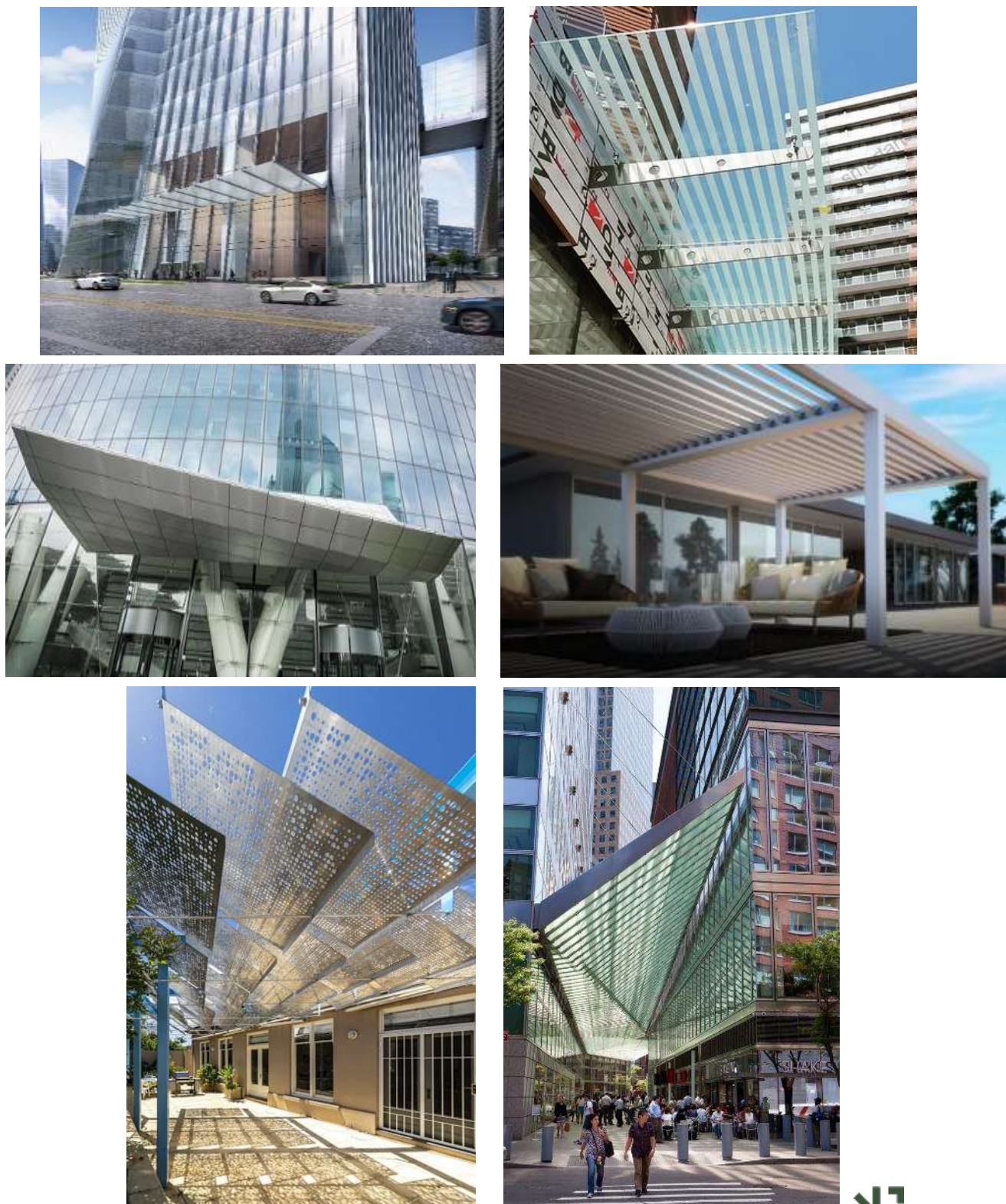
- Landscaping: trees, shrubs, vegetation, etc; and
- Sculptural screening (solid or of moderate porosity) – which can also be combined with landscaping.



6.3 Horizontal Windbreak Examples

Figure 24 shows typical examples of horizontal windbreak options typically found in urban built environments – they can be solid or porous, purely horizontal or with a slope aimed at deflecting oblique windflow.

Figure 24 Horizontal Windbreak Options



6.4 Vertical Windbreak Examples

Figure 25 shows examples of vertical windbreak options found in urban built environments – they can be solid or porous, involve landscaping (full or partial), timber, glazing, etc, and can provide a wide range of utilitarian functions beyond their wind mitigation capability (eg seating, advertising, etc).

Figure 25 Vertical Windbreak Options



7.0 MITIGATION AND TREATMENT RECOMMENDATIONS

Sections 4 and 5 provided guidance as to the areas where the adopted wind acceptability criteria had the potential to be exceeded and an indication as to the likely local optimum wind treatment strategy, eg whether the wind condition of interest is likely to arise from accelerating winds which require vertical windbreaks (such as landscaping) or downwash winds which require horizontal windbreaks (such as awnings, canopies).

By conducting an additional round of testing encompassing all sensor locations and spanning from 0° to 360°, the "Mitigation" scenario evaluated the effectiveness of proposed windbreak treatments, including landscaping (which was not included in the initial "Proposed" testing), along with supplementary wind mitigation measures.

7.1 Wind Mitigation Recommendations

The following features, already planned for the development, will significantly ameliorate local wind conditions.

Level 1 – refer Figure 26

- Maintain the proposed and existing trees/landscaping within and on the sides of the development to mitigate the impact of local wind speeds. Additionally, it is advisable to include additional trees in the open spaces at ground level to enhance wind mitigation. All proposed landscaping should consist of evergreen and densely foliated vegetation to ensure its effectiveness year-round.
- Sensor 6 initially recorded wind conditions corresponding to the walking comfort criterion. As this sensor is located in front of the Building B entrance, it was repositioned under the proposed setback in the mitigation scenario. Under this configuration, the sensor indicates wind conditions meeting the recommended standing comfort criterion. As such, maintain setbacks, awnings and colonnades to diminish wind speeds potentially caused by downwash and redirecting airflow on the pathways.
- The initial wind assessment identified Locations 35,36, 38, 39, and 40, where wind conditions met walking comfort levels but exceeded thresholds recommended for standing areas.
- To improve comfort levels, planter boxes with at least 1.5m high were introduced within Blaxland Lane and Leeds Lane between the relevant sensor locations. These elements provide effective horizontal wind shielding and help redirect wind channelling within the lanes, significantly improving local wind conditions and enabling these areas to comply with the standing comfort criterion.

Level 2 – refer Figure 27

- **Building F:** Sensors 41 and 42 show that the Level 2 communal space of Building F satisfies the walking comfort criterion. However, to achieve wind conditions suitable for standing or seated activities, it is recommended to increase the balustrade height to 1.8 m along the perimeter. This can be achieved by incorporating trees, planters, or other vegetation above the existing balustrade design.
- **Building B:** Sensor 43 meets the walking comfort criterion in the Level 2 communal open space of Building B. To further improve wind comfort in line with the standing or



seating criteria, it is recommended to introduce additional trees in this area and relocate any seating, so it is positioned beneath trees with a generous canopy.

Level 3 – refer Figure 28

- **Building A:** It is recommended to retain the proposed 1.8m high glazed balustrade around the outer edge of this area. To achieve wind conditions suitable for seated activities, it is recommended to incorporate horizontal wind windbreaks, such as cloth shades or umbrella, above the designated seating area.

Level 11 – refer Figure 29

- **Buildings B & C:** It is recommended to maintain the proposed 1.8m high vertical windbreak along the perimeter.

Level 26– refer Figure 31

- **Building F:** It is recommended to retain at least 1.8m high vertical windbreak along the outer edge of the open area on Level 26.

Elevate Private Balconies– refer Figure 30 and Figure 32

- It is recommended to keep solid balustrades along the outer edges of the private balconies.
- Adhere to the nested design featuring only a singular open aspect for elevated corner balconies.
- It is recommended to retain the proposed louver around the outer edge of selected elevated corner balconies.
- A sensor located on the Level 9 private terrace of Building E recorded walking comfort under the proposed balustrade height. Increasing the balustrade height to approximately 1.5 m at this location would improve conditions to standing comfort.
- For the corner balcony on Level 25 of Building F, which is exposed to multiple wind directions, it is recommended to block one end of the balcony, and increase the balustrade height along the full exposed edge to approximately 1.8 m. This approach would help reduce the risk of wind acceleration at the corner by limiting through-flow across the balcony and reducing the pressure equalisation driven by C_p differences between adjacent façades. By partially enclosing one end and providing a consistent increased balustrade height, the potential for corner acceleration, channelling effects, and localised gust amplification can be significantly reduced.



Figure 26 Wind Mitigation for the Development – Ground Floor (Level 1)

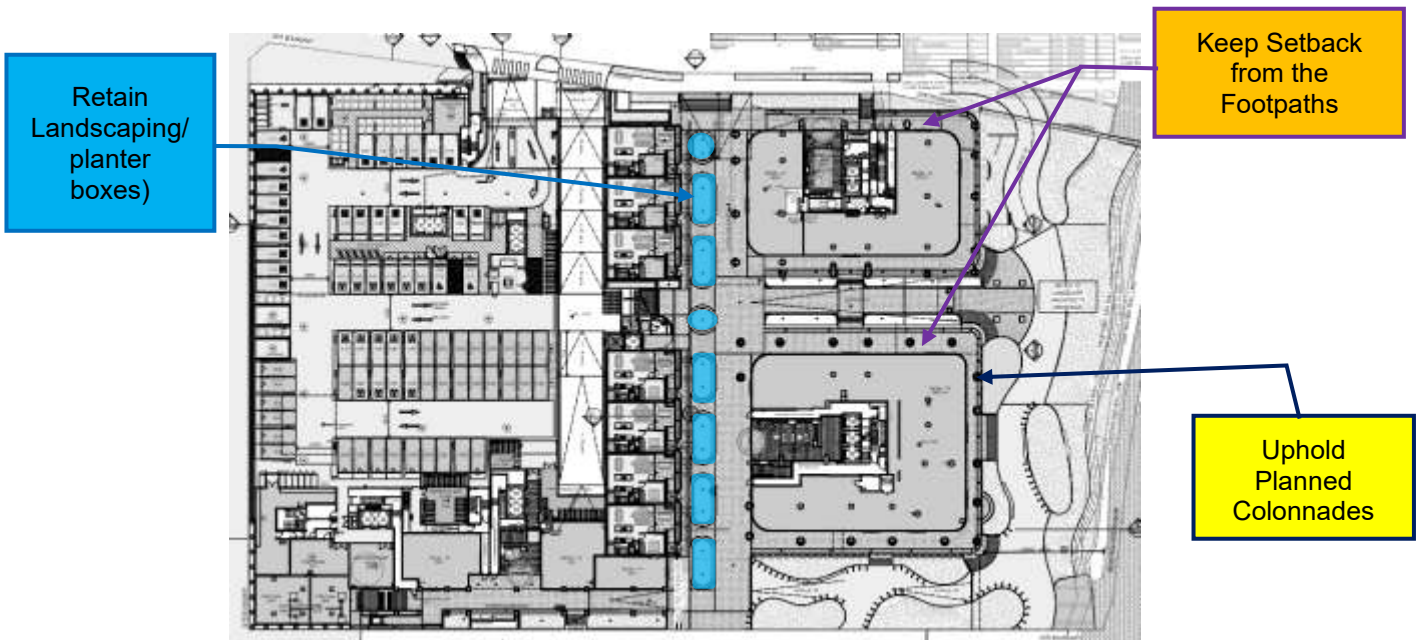


Figure 27 Wind Mitigation for the Development – Level 2

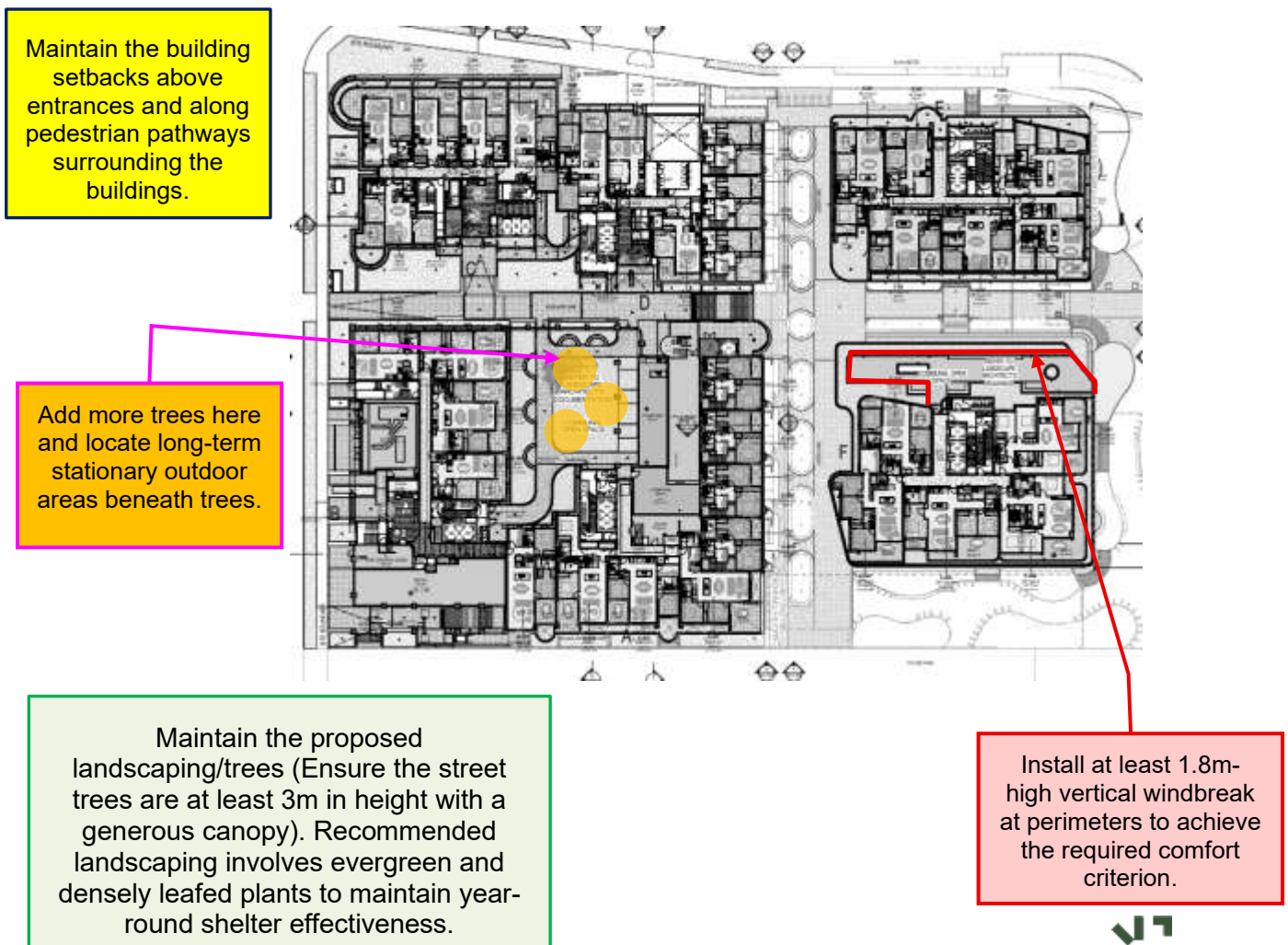


Figure 28 Wind Mitigation for the Development – Level 3



Figure 29 Wind Mitigation for the Development – Level 11

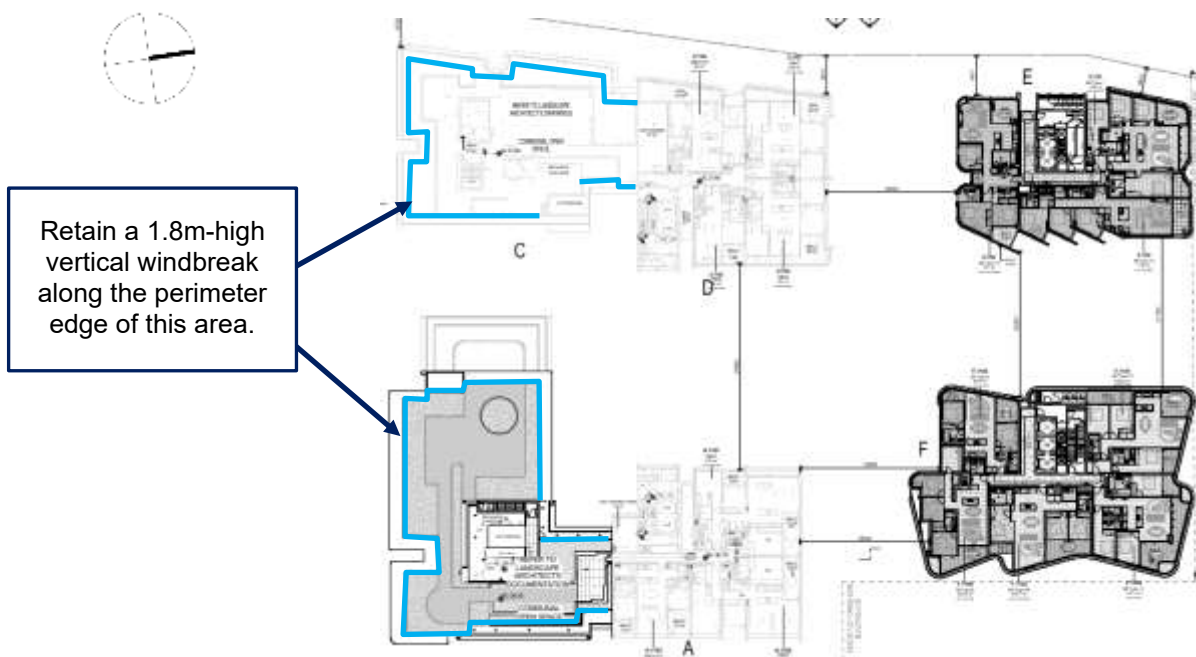


Figure 30 Balcony Wind Shielding Recommendations from Level 4 and up

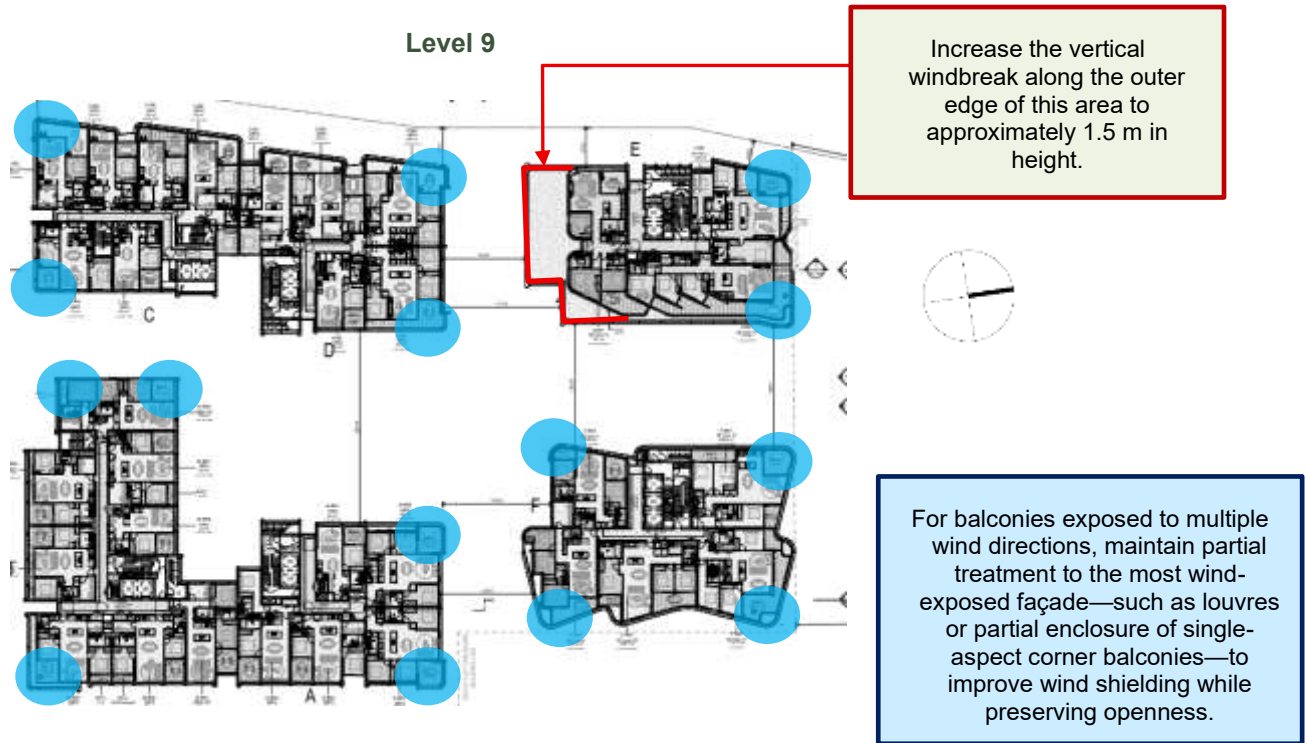


Figure 31 Wind Mitigation for the Development – Level 26 (Roof Building F)

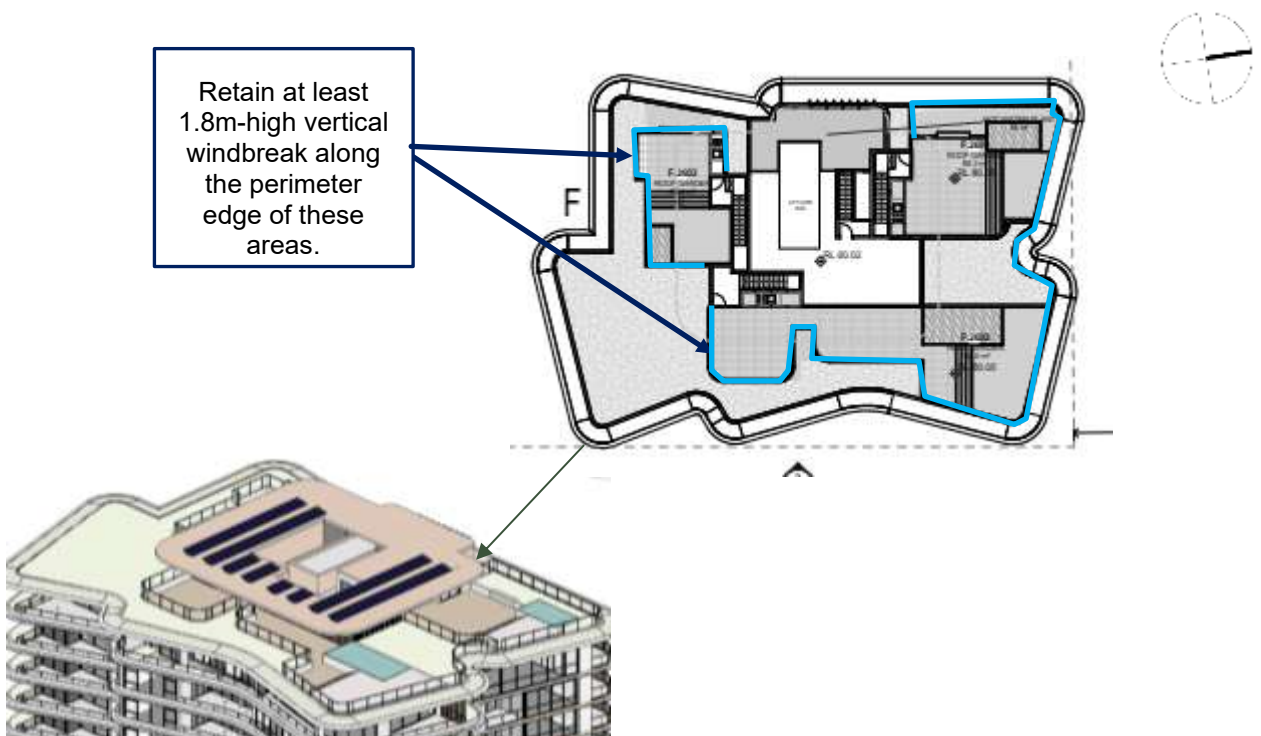
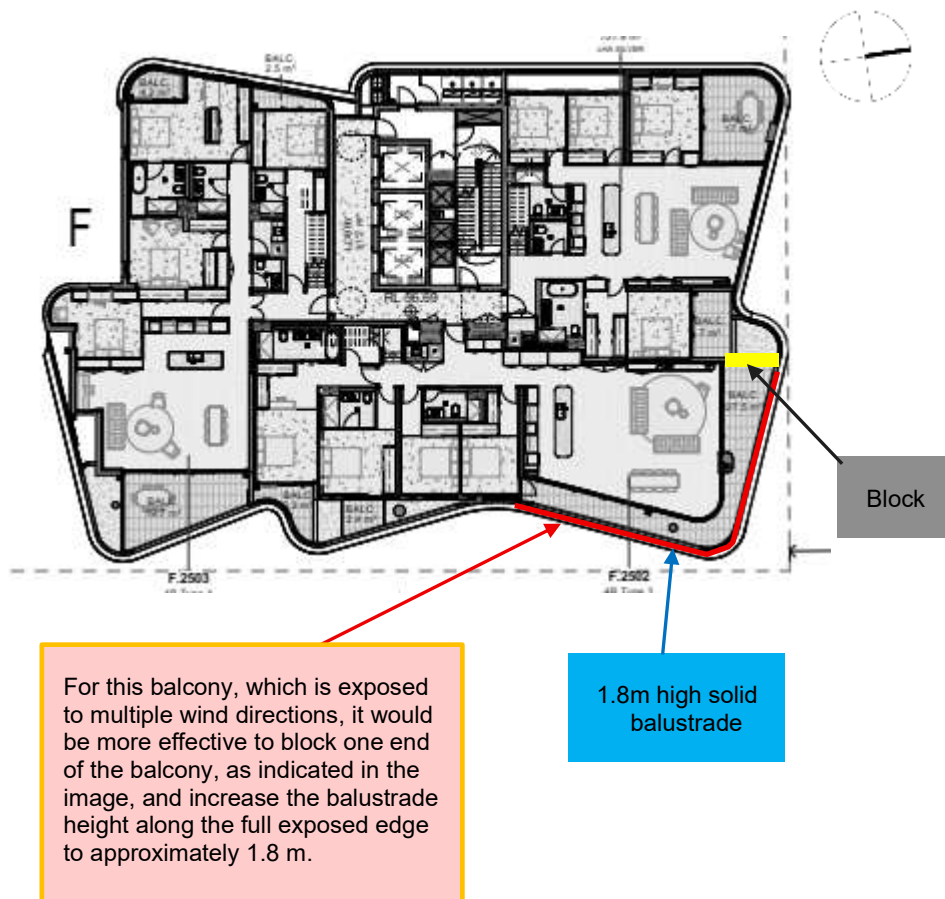


Figure 32 Balcony Wind Shielding Recommendations from Level 25 (Building F)



Mitigation” Outcome – Predicted Lawson Comfort Levels

The results of the combination of wind tunnel test results (local ground level wind speed ratios) with the wind speed and wind direction probability distribution (5% annual exceedance level) derived for the site compared to the Lawson Comfort criteria for the “Mitigation” scenario are shown in **Figure 33 to Figure 35**.

Figure 33 Predicted Lawson Comfort Levels – “Mitigation” Scenario – Surrounding Publica Domain



Figure 34 Predicted Lawson Comfort Levels – “Mitigation” Scenario – Level 2



Figure 35 Predicted Lawson Comfort Levels – “Mitigation” Scenario – Level 9 (Private Balcony (Building E))



8.0 Conclusion

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Billbergia Group to carry out a quantitative wind assessment using an environmental wind tunnel study for the proposed mixed-use development at 25-27 Leeds Street, Rhodes.

The site is bounded by Blaxland Road to the west, Paramatta River to the north, Leeds Street to the south and existing buildings to the east. The proposed multi-building residential development comprises 4 blocks ranging in height from 10 to 26 storeys above ground. The surrounds comprise a mix of open-water (Parramatta River) to the northwest around to the northeast, commercial/industrial buildings to the east, residential dwellings to the southeast and south, and medium-rise residential towers to the southwest.

Built Environment Scenarios Assessed

The study has involved the testing of three built environment “scenarios”:

- Scenario 1 – “**Baseline**” The existing built environment (as of June 2023),
- Scenario 2 – “**Proposed**” “Baseline” + Proposed Development
- Scenario 3 – “**Mitigation**” “Proposed” + Recommended wind mitigation treatments

Wind Acceptability Criteria

The criteria adopted for the present study are:

- “Comfort” Lawson (2001) Comfort Criteria; and
- “Safety” Melbourne (1978) 23 m/s Safety Criterion.

Project Site Wind Climate

On the basis of long-term wind records obtained from Bureau of Meteorology stations at Bankstown Airport and Sydney Kingsford Smith Airport, SLR has determined that Rhodes has local winds characteristics somewhat closer to Bankstown Airport than Sydney (KS) Airport, given the project site’s distance inland from the coast. Accordingly, key prevailing wind directions of interest are the northeast, southeast and south for summer and mainly west quadrant winds for winter.

“Baseline” (Existing) Wind Environment

Close to the ground, the “regional” wind patterns described above are affected by the local terrain, topography and built environment, all of which influence the “local” wind environment.

- The “near-field” surrounds comprise a mix of open-water (Parramatta River) to the northwest and the northeast, commercial/industrial buildings to the east, residential dwellings to the southeast and south, and medium-rise residential towers to the southwest.
- The “far-field” built environment comprises a similar mix of low-rise to medium-rise residential buildings, open stretches of water (east and west) and the more built-up areas of Rhodes and Wentworth Point.
- The terrain is gently undulating in the surrounding built environment, with only modest topographical variations influencing local wind speeds.



Based on the above:

- The site will therefore receive minimal shielding for winds from the northwest clockwise around to the northeast, and moderate to reasonable wind shielding for other wind directions at lower levels with upper levels exposed to higher winds from most wind directions.

“Proposed” Wind Environment

Wind conditions which have been identified as warranting consideration of mitigation in relation to the proposed development are:

Level 1 – refer Figure 26

- Retain the proposed and existing trees and landscaping within and along the sides of the development to mitigate local wind speeds. Additional trees are recommended within ground-level open spaces to further enhance wind mitigation. All landscaping should comprise evergreen, densely foliated species to ensure year-round effectiveness.
- Sensor 6 initially recorded wind conditions corresponding to the walking comfort criterion. As this sensor is located in front of the Building B entrance, it was repositioned beneath the proposed setback in the mitigation scenario. Under this configuration, wind conditions meet the recommended standing comfort criterion. Accordingly, the proposed setbacks, awnings, and colonnades should be retained to reduce downwash effects and redirect airflow away from surrounding pathways.
- The initial wind assessment identified Locations 35, 36, 38, 39, and 40 as experiencing wind conditions suitable for walking but exceeding the thresholds for standing comfort.
- To improve comfort in these areas, planter boxes with a minimum height of 1.5 m are recommended within Blaxland Lane and Leeds Lane between the relevant sensor locations. These elements provide effective horizontal wind shielding, reduce wind channelling, and enable compliance with the standing comfort criterion.

Level 2 – refer Figure 27

- Building F: Sensors 41 and 42 indicate that the Level 2 communal space satisfies the walking comfort criterion. To achieve wind conditions suitable for standing or seated activities, it is recommended to increase the balustrade height to 1.8 m along the perimeter. This may be achieved through the incorporation of trees, planters, or other vegetation above the existing balustrade.
- Building B: Sensor 43 meets the walking comfort criterion within the Level 2 communal open space. To improve wind conditions in line with standing or seating comfort criteria, additional trees are recommended, and seating should be repositioned beneath trees with a generous canopy.



Level 3 – refer Figure 28

- Building A: Retain the proposed 1.8 m high glazed balustrade along the outer edge of this area. To achieve wind conditions suitable for seated activities, incorporate horizontal windbreak elements—such as shade cloths or umbrellas—above designated seating areas.

Level 11 – refer Figure 29

- Buildings B and C: Maintain the proposed 1.8 m high vertical windbreak along the perimeter of the communal open space.

Level 26 – refer Figure 31

- Building F: Retain at least 1.8m m high vertical windbreak along the outer edge of the Level 26 open area.

Elevated Private Balconies – refer Figure 30 and Figure 32

- Retain solid balustrades along the outer edges of all private balconies.
- Maintain the nested balcony design with a single open aspect for elevated corner balconies.
- Retain the proposed louvres along the outer edges of selected elevated corner balconies.
- A sensor located on the Level 9 private terrace of Building E recorded walking comfort under the proposed balustrade height. Increasing the balustrade height to approximately 1.5 m at this location is expected to improve conditions to standing comfort.
- For the corner balcony on Level 25 of Building F, which is exposed to winds from multiple directions, it is recommended to screen one end of the balcony and increase the balustrade height along the full exposed edge to approximately 1.8 m. This configuration will help limit direct through-flow across the balcony and reduce pressure equalisation effects associated with C_p differentials between adjacent façades. By partially enclosing one end and providing a consistent increased balustrade height, the potential for corner acceleration, wind channelling, and localised gust amplification can be significantly reduced, thereby improving overall wind conditions for occupants

Summary

On the basis of the above, the overall effect of the proposed development on the local wind microclimate is predicted to be “not significant” (refer Section 3.2) and the proposed development should satisfy the nominated Wind Acceptability criteria for the project.



9.0 Feedback

At SLR, we are committed to delivering professional quality service to our clients. We are constantly looking for ways to improve the quality of our deliverables and our service to our clients. Client feedback is a valuable tool in helping us prioritise services and resources according to our client needs.

To achieve this, your feedback on the team's performance, deliverables and service are valuable and SLR welcome all feedback via <https://www.slrconsulting.com/en/feedback>.

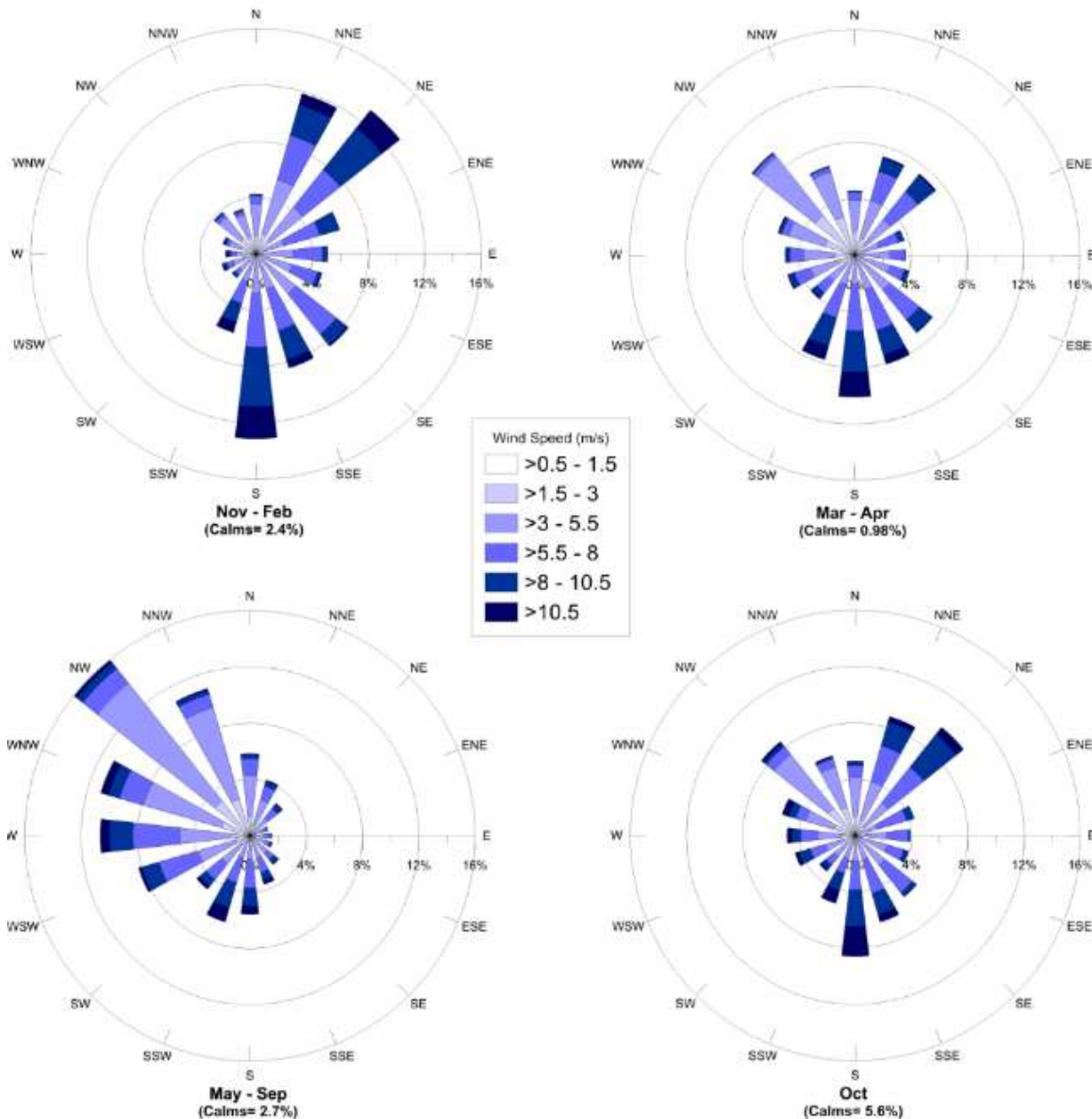
We recognise the value of your time and we will make a \$10 donation to our Charity Partner - Lifeline, for every completed form.



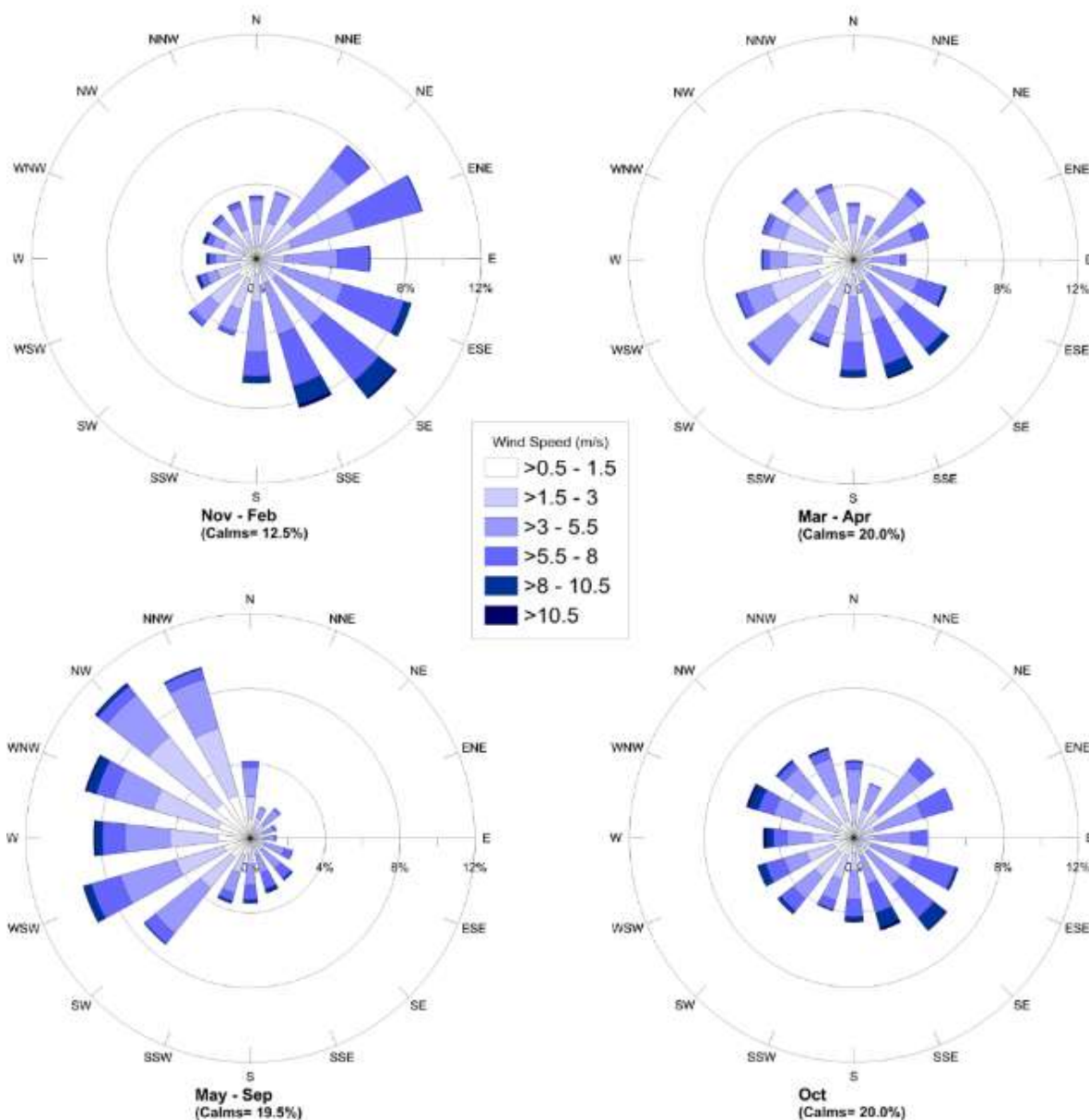
Appendix A Seasonal Wind Roses for Bureau of Meteorology Met Stations at Sydney (Kingsford Smith) Airport and Bankstown Airport



Sydney Airport AWS
(Observations)
1999-2017
600.09300



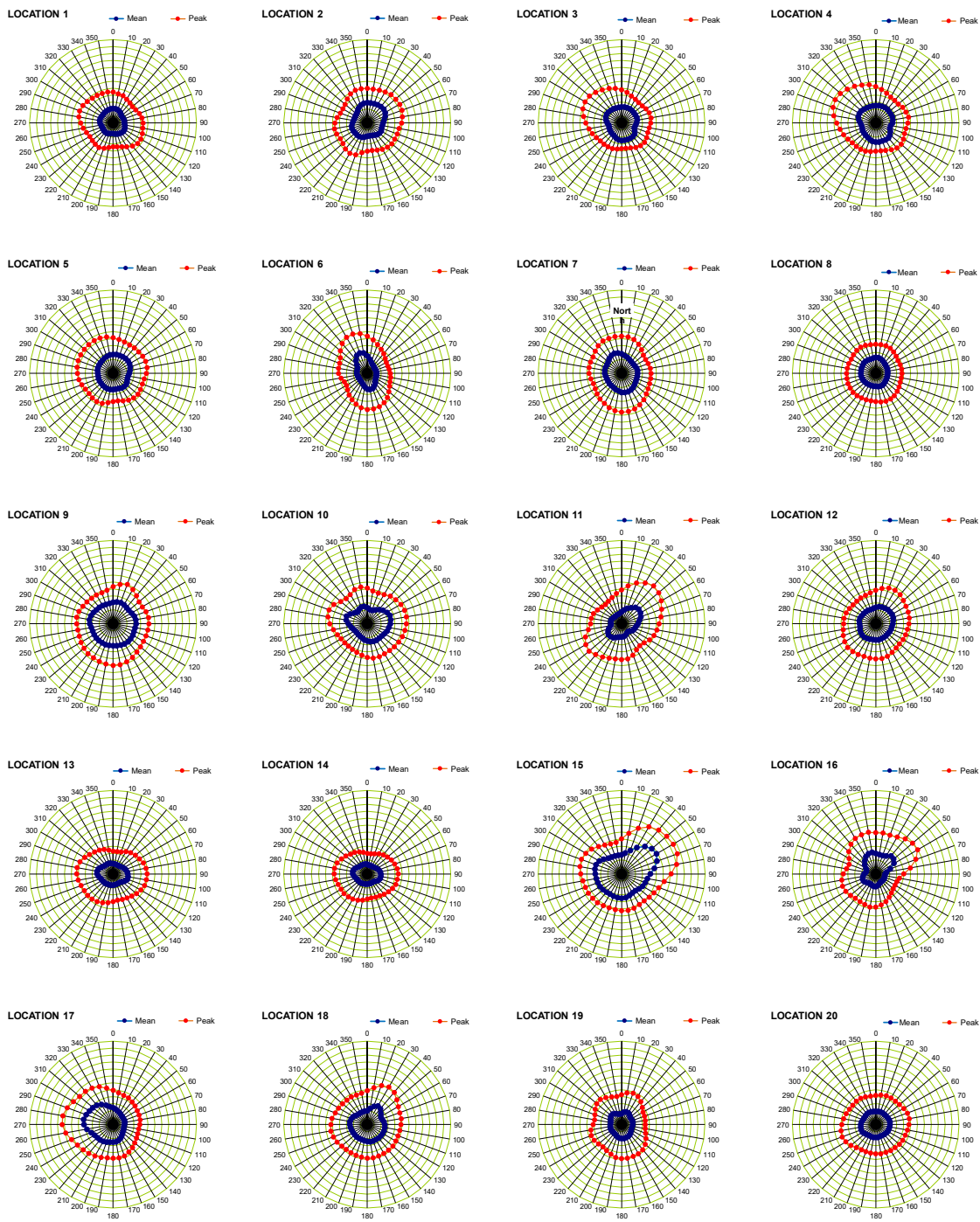
Bankstown Airport AWS
 (Observations)
 1999-2017
 600.09300

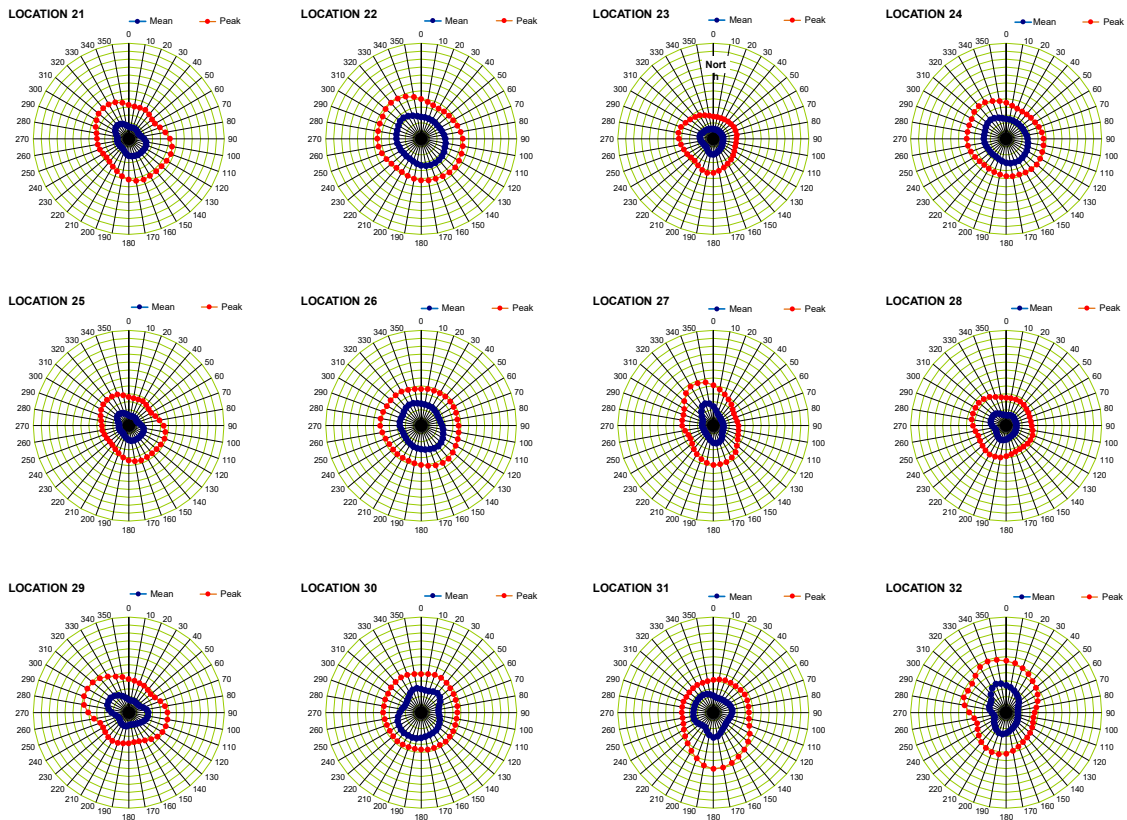


Appendix B Wind Tunnel Test Data (Polar Plots) – BASELINE Scenario

The polar diagram plots show the local (ground level) mean and peak gust wind speed as a ratio of the mean reference wind speed (at a full-scale height of 200 m). The polar diagram circumferential lines representing gradations in 0.1 intervals, ie 10% ratios.





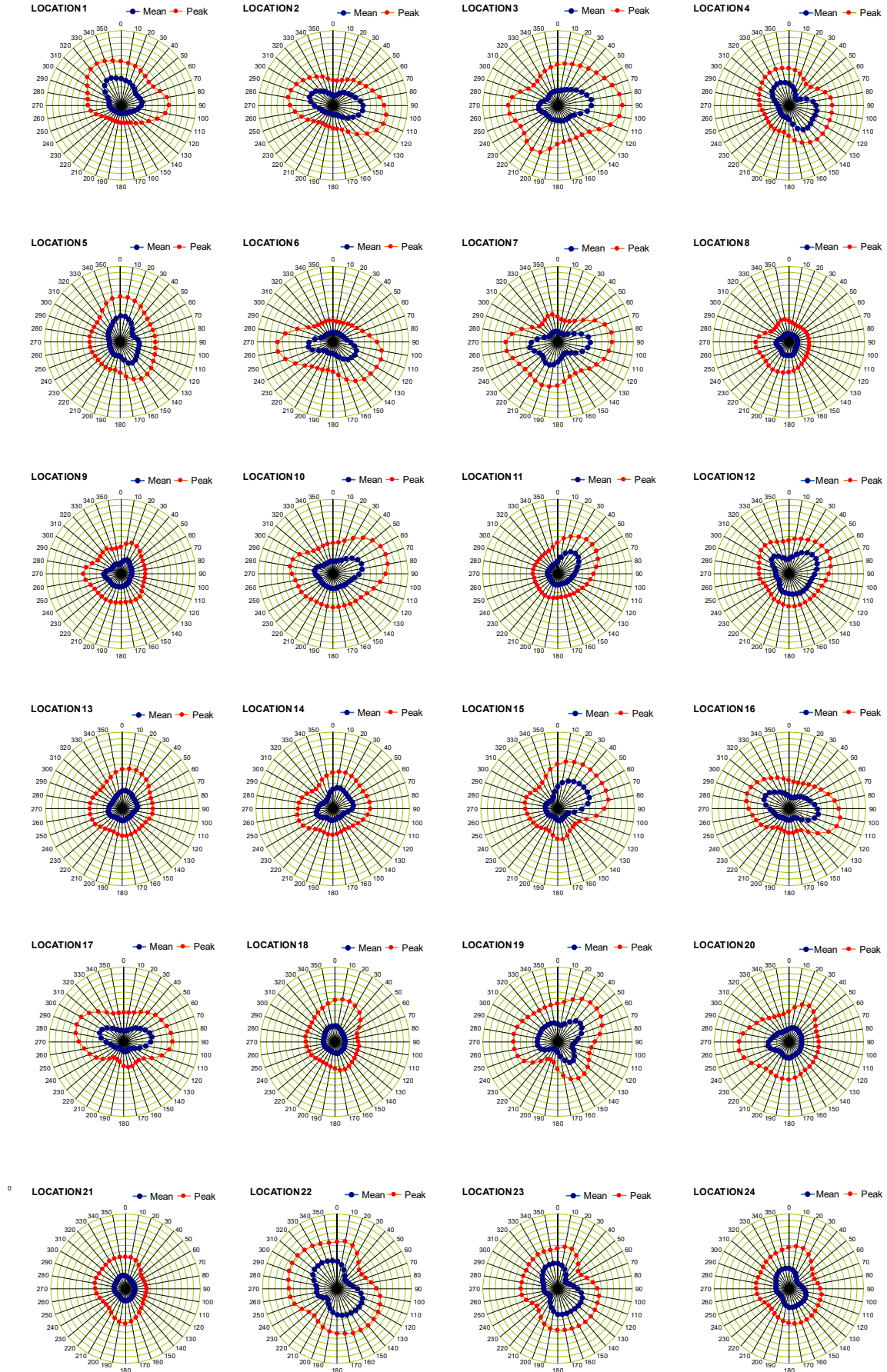


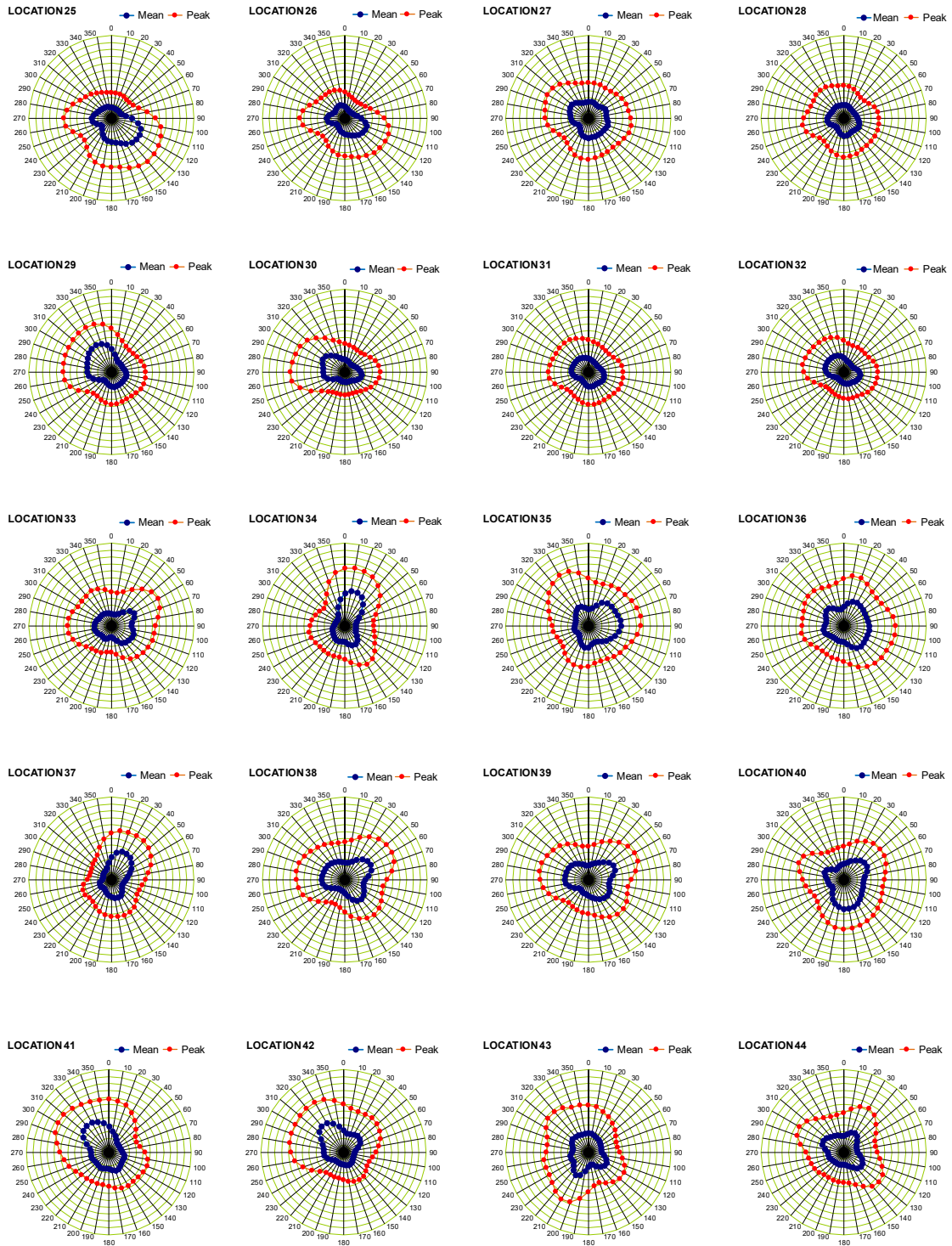
Appendix C

Wind Tunnel Test Data (Polar Plots) – PROPOSED Scenario

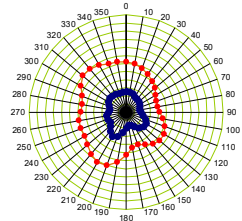
The polar diagram plots show the local (ground level) mean and peak gust wind speeds as a ratio of the mean reference wind speed (at a full-scale height of 200 m). The polar diagram circumferential lines representing gradations in 0.1 intervals, ie 10% ratios.



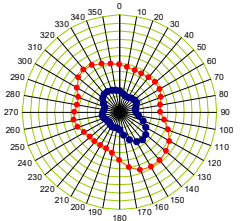




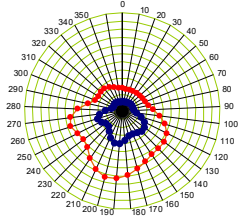
LOCATION 45 — Mean — Peak



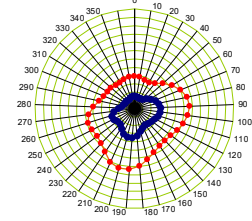
LOCATION 46 — Mean — Peak



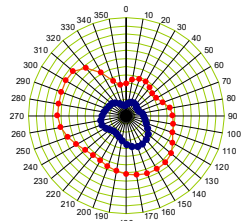
LOCATION 47 — Mean — Peak



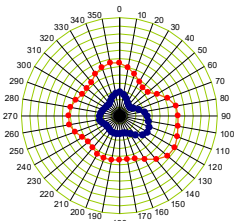
LOCATION 48 — Mean — Peak



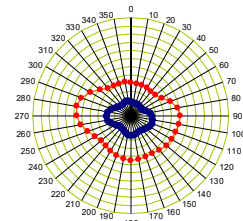
LOCATION 49 — Mean — Peak



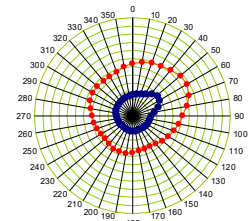
LOCATION 50 — Mean — Peak



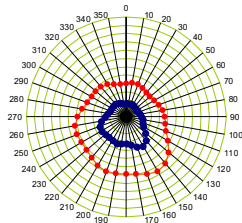
LOCATION 51 — Mean — Peak



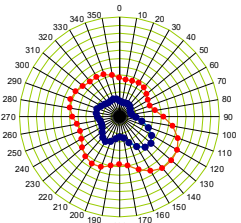
LOCATION 52 — Mean — Peak



LOCATION 53 — Mean — Peak



LOCATION 54 — Mean — Peak

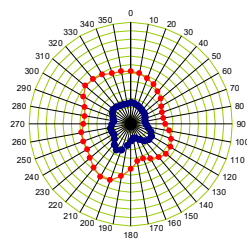


Appendix D Wind Tunnel Test Data (Polar Plots) – MITIGATION Scenario

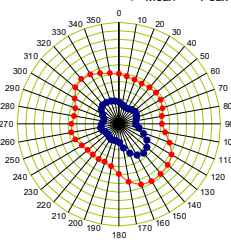
The polar diagram plots show the local (ground level) mean and peak gust wind speed as a ratio of the mean reference wind speed (at a full-scale height of 200 m). The polar diagram circumferential lines representing gradations in 0.1 intervals, ie 10% ratios.



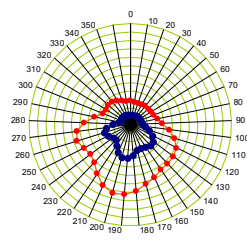
LOCATION 45



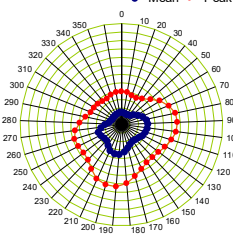
LOCATION 46



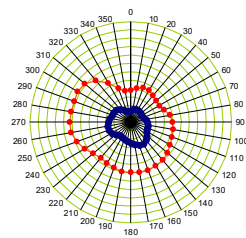
LOCATION 47



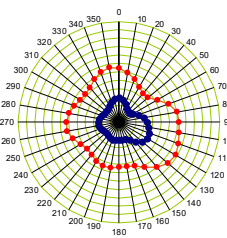
LOCATION 48



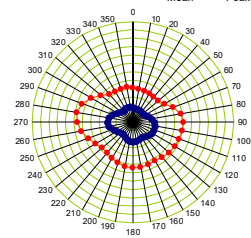
LOCATION 49



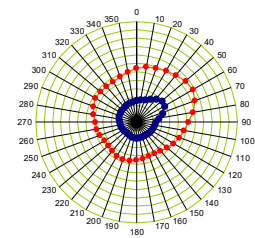
LOCATION 50



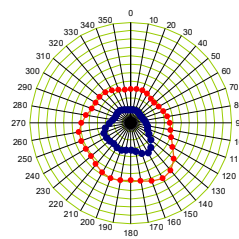
LOCATION 51



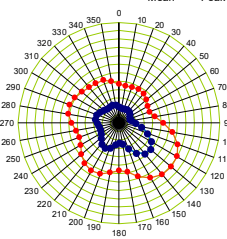
LOCATION 52

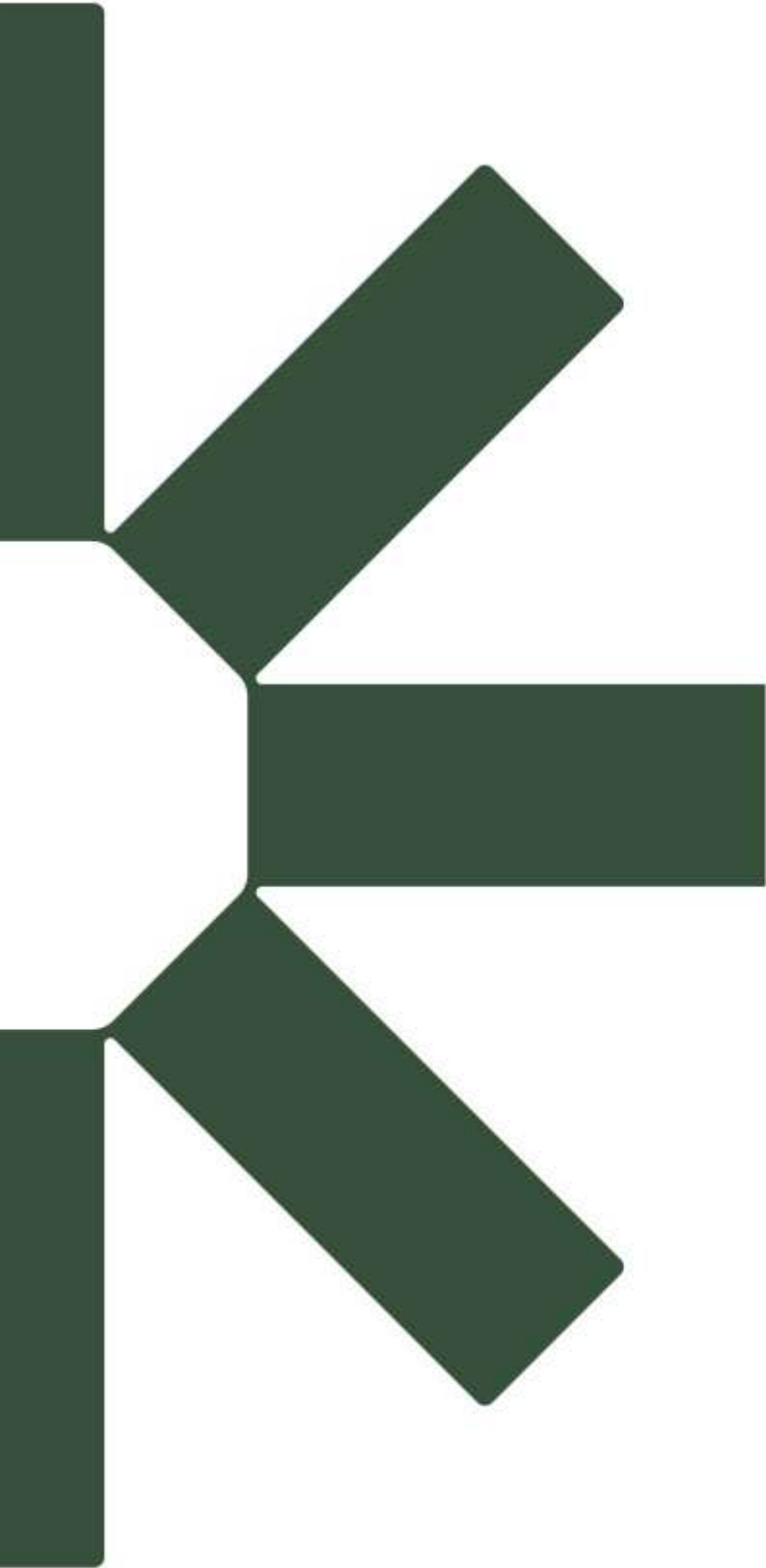


LOCATION 53



LOCATION 54





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