849, 853, AND 859 PACIFIC HIGHWAY AND 2 AND 8 WILSON STREET, CHATSWOOD

Environmental Wind Tunnel Study

Prepared for:

BB Wilson Property Pty Ltd
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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with BB Wilson Property Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.031413.00001-R01-v1.1	5 November 2024	Dr Farzin Ghanadi	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy

EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR) has been engaged by BB Wilson Property Pty Ltd to perform a quantitative wind assessment of the proposed development at 849, 853, and 859 Pacific Highway and 2 and 8 Wilson Street, Chatswood, via an Environmental Wind Tunnel Study. Following an initial wind tunnel test conducted in December 2023 (610.031413.00001-R01-v1.0-20231214), the design has now been revised to increase the height by 8 storeys. Consequently, an additional wind tunnel test has been conducted to evaluate the impact of these changes.

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.

The proposed mixed-use development, which comprises of two towers with 36 stories, is positioned amidst Pacific Hwy to the west, Wilson Street to the north/northeast, Railway to the east, and O'Brien Street to the south. in High-rise towers can be found to the south of the site, and in the more distant northwestern direction from this development lies Blue Gum Creek.

Chatswood Wind Climate

Using long-term wind records obtained from nearby Bureau of Meteorology stations at Bankstown Airport and Sydney Kingsford Smith Airport, SLR has determined that determined that Chatswood has local winds characteristics somewhat closer to Sydney (KS) Airport than Bankstown 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.

Built Environment Scenarios Assessed

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

- Scenario 1 – "Baseline" The existing built environment (as of Oct 2023)
- Scenario 2 – "Proposed" "Baseline" + Proposed Development

Wind Acceptability Criteria

The criteria adopted to the present study are:

- "Comfort" Lawson (2001) Comfort Criteria;
- "Safety" Melbourne (1978) 23 m/s Safety Criterion

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.

- As noted in Section 1.3, The site is partially shielded from the north, east, and west, as it is presently bordered by a combination of low to mid-rise residential structures on the west and north aspects of the proposed development. Conversely, the site experiences moderate shielding from the south, attributed to the presence of some high-rise buildings on the southern side of the development.

EXECUTIVE SUMMARY

- The terrain on the western side of the site undergoes significant elevation changes, impacting the nearby westerly wind patterns and speeds.

"Proposed" Wind Environment

Testing of the "Proposed" scenario (which incorporates a number of already planned windbreak treatments) yielded the follows areas of potential concern in relation to future wind impact:

- The residential Lobby B entry situated on the north side of the proposed development;
- The areas could potentially be designated as seating zones within the arcade;
- Communal open spaces located on levels 2,3, and 4;
- Private terraces.

Already Planned Wind Amelioration Treatments– refer Figure 19

The following treatments relevant to wind mitigation have already been incorporated in the current design scheme:

- Preserve the proposed or existing trees and landscaping along the sides of the development to help reduce local wind speeds. It is recommended that all trees and landscaping be evergreen with dense foliage to ensure year-round effectiveness - refer Figure 19A.

- Maintain the proposed setbacks, colonnades, and awnings at ground-level entrances to minimize wind speeds from downwash and to guide airflow along pedestrian pathways - refer Figure 19A.

- Retain the proposed planter boxes at ground level to counteract wind channelling effects in this area. Evergreen, densely foliated landscaping is recommended for continuous effectiveness throughout the year - refer Figure 19A.

- For the communal open spaces on Levels 2, 3, 4 keep the proposed solid vertical windbreak around the perimeter, along with the planned trees and landscaping. Evergreen, densely foliated trees and landscaping are recommended to ensure year-round effectiveness - refer Figure 19B & C.

- Keep the proposed solid balustrades around private balconies - refer Figure 19D & E.

With the wind mitigation strategies already in place, no further recommendations are required.

Overall Summary

On the basis of all of the above, the overall effect of the proposed development on the local wind microclimate, with the wind mitigation treatments recommended, is predicted to be "not significant" .

Accordingly, the proposed development should satisfy the nominated Wind Acceptability criteria for the project.

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been engaged by BB Wilson Property Pty Ltd to perform a quantitative wind assessment of the proposed development at 849, 853, and 859 Pacific Highway and 2 and 8 Wilson Street, Chatswood, via an Environmental Wind Tunnel Study. Following an initial wind tunnel test conducted in December 2023 (610.031413.00001-R01-v1.0-20231214), the design has now been revised to increase the height by 8 storeys. Consequently, an additional wind tunnel test has been conducted to evaluate the impact of these changes.

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 Location and Context of the Development Site

The proposed mixed-use development consists of two towers, each standing at 36 stories. It is situated between Pacific Hwy to the west, Wilson Street to the north/northeast, Railway to the east, and O'Brien Street to the south. To the south of the site, there are other high-rise towers, and in the further northwestern direction from this development, you'll find Blue Gum Creek- refer Figure 1.

Figure 1 Aerial View of Development Site

Image: Courtesy Nearmap, September 2024

1.2 Description of the Proposed Development

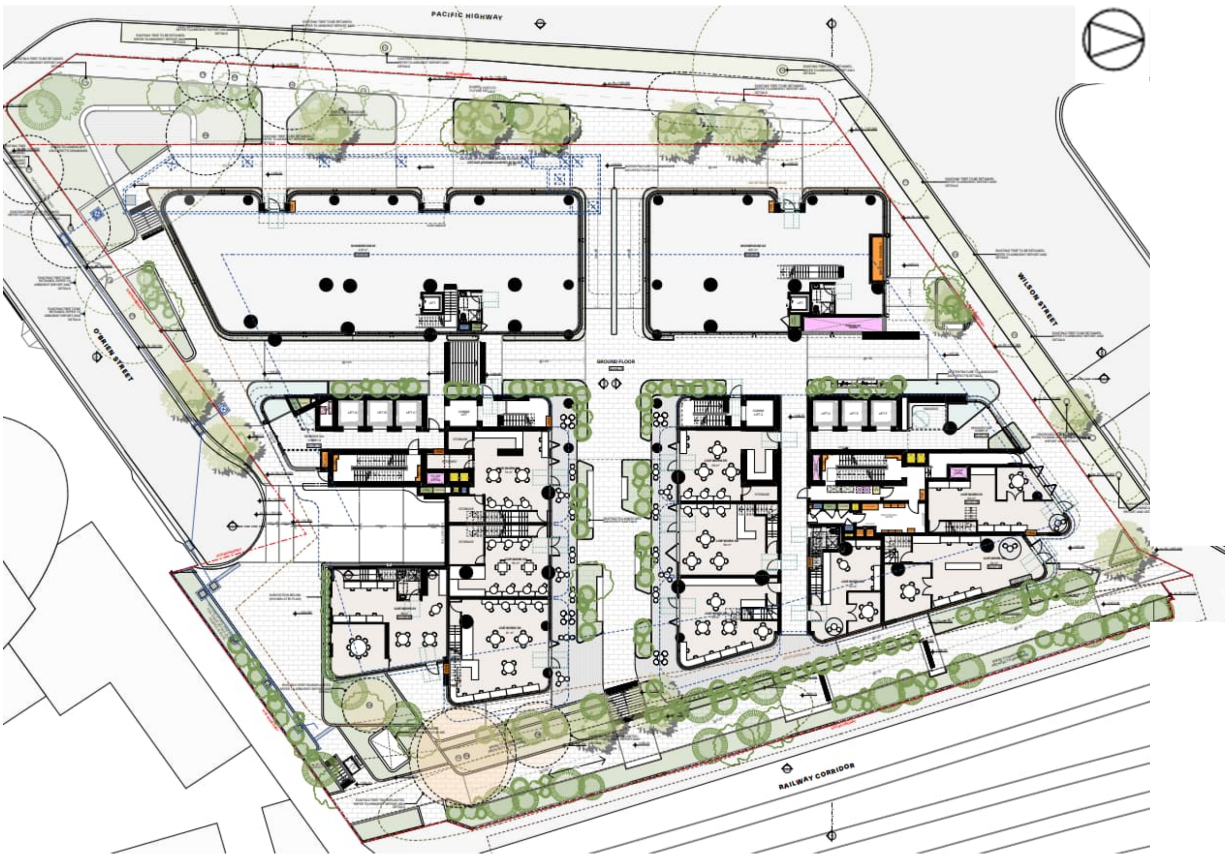
From the plans provided, the proposed development comprises the following features:

- 6 levels of basement with access from O'Brien Street
- Construction of a 36-storey mixed use development comprising:
  - Retail and commercial uses
  - Childcare centre
  - Two residential towers with 332 apartments including 308 residential apartments and 24 x live-work units
- Public domain works, including landscaping, street trees, and publicly accessible open spaces

Representative floor plans are shown in Figure 2.

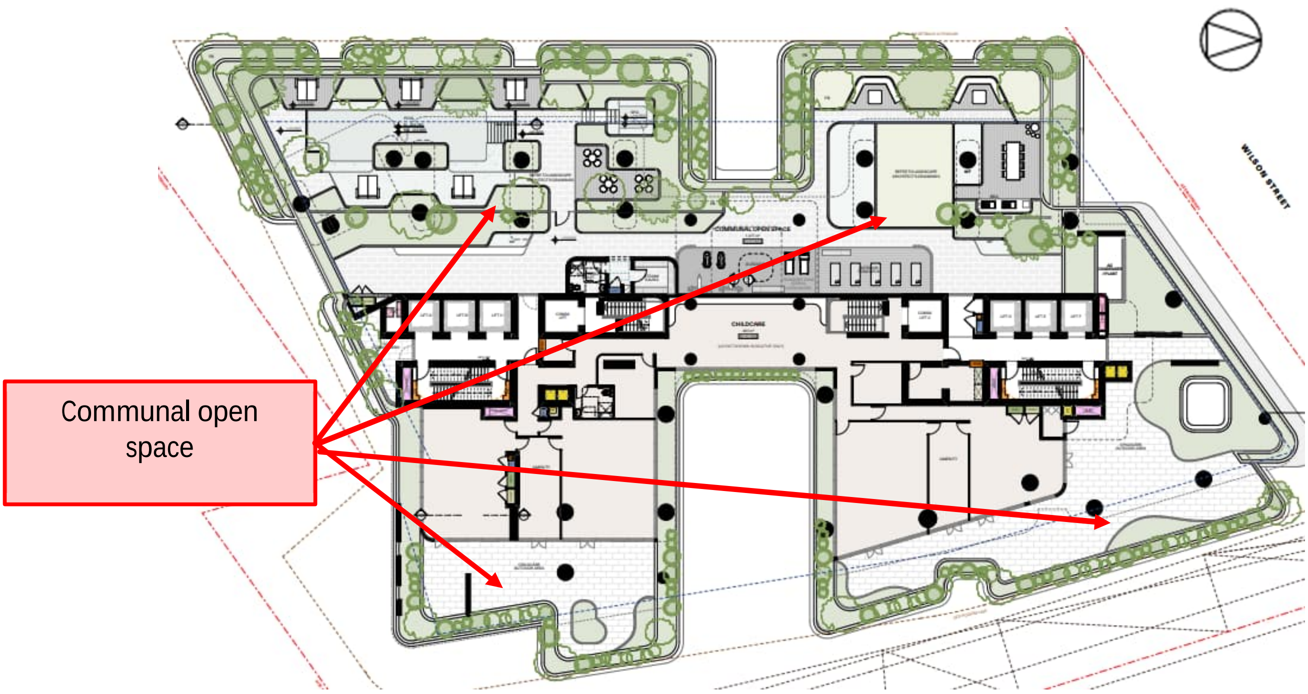
Figure 2 Architectural Views of the Proposed Development

Ground Level

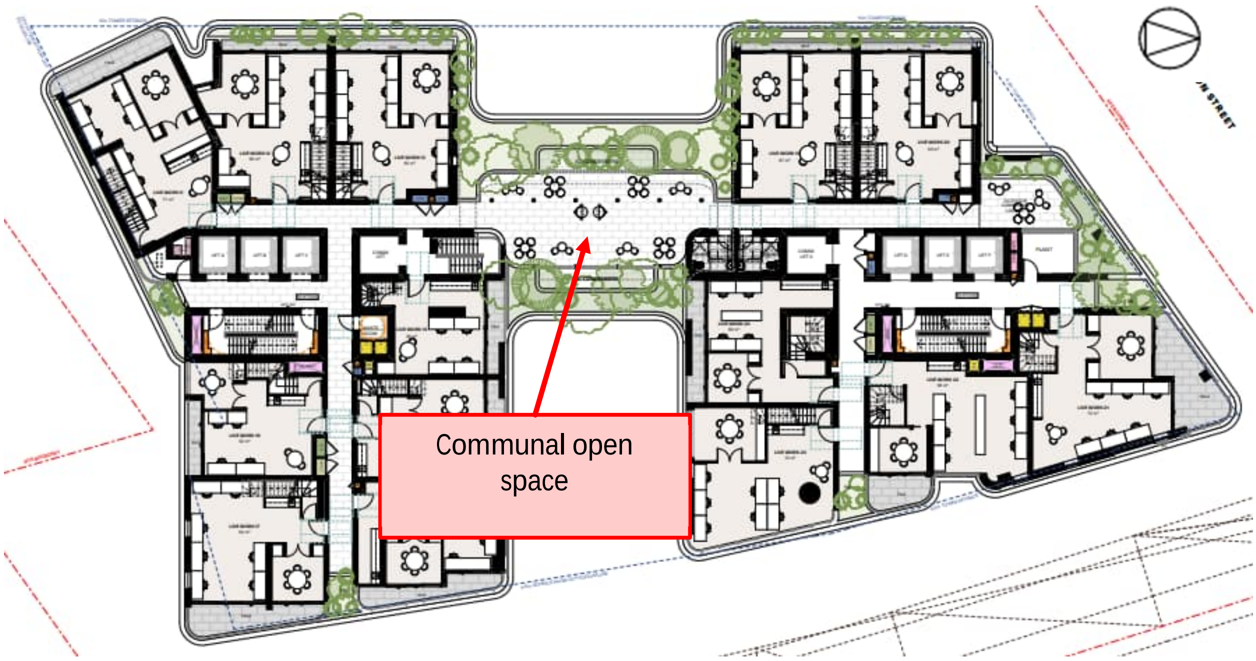


(Fig. 2 cont'd)

Level 2

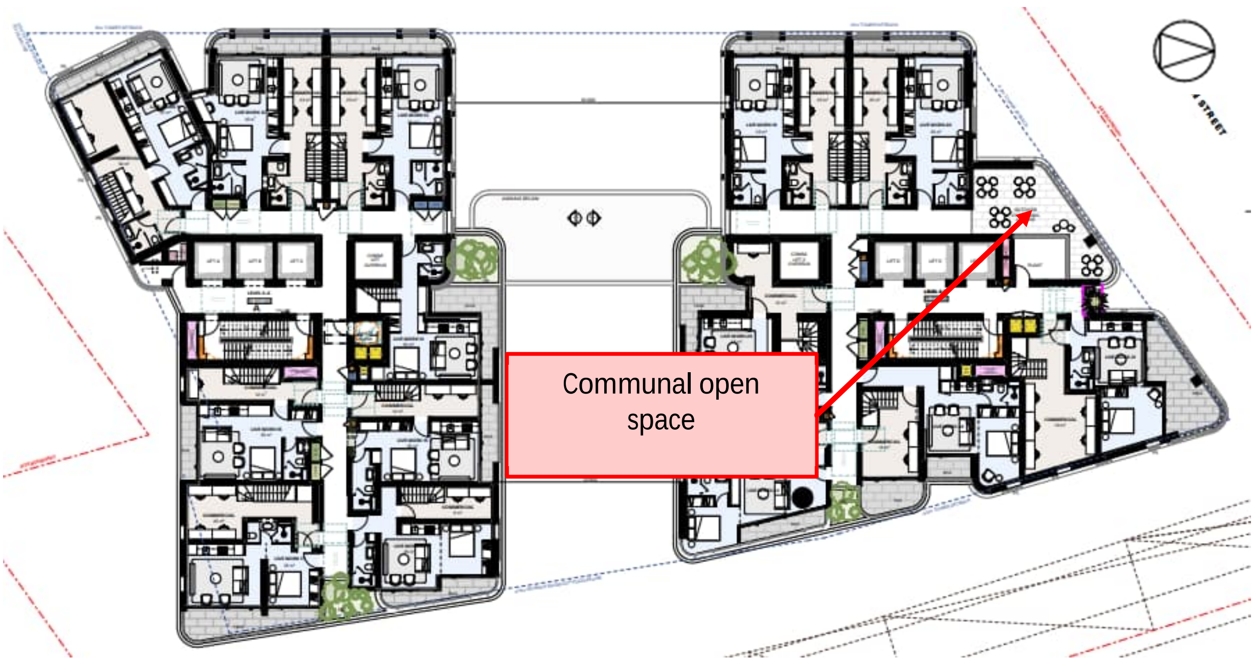


Level 3

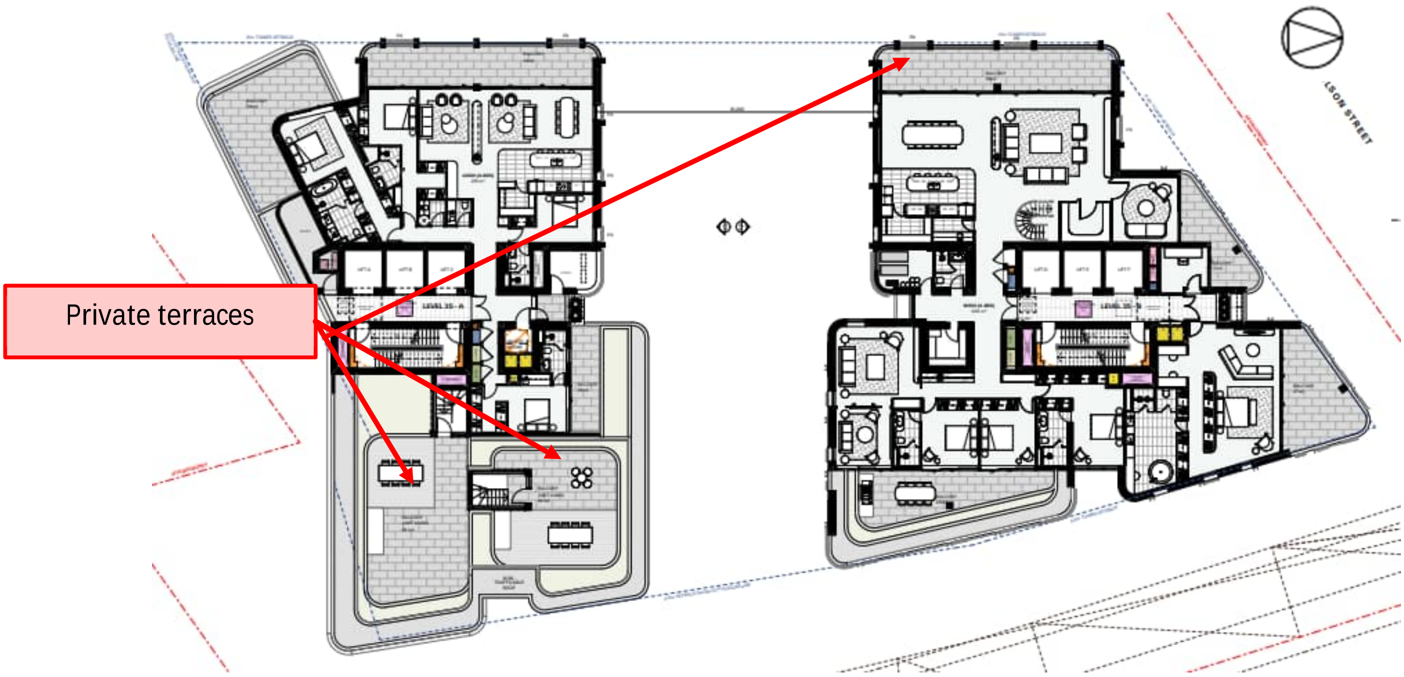


(Fig. 2 cont'd)

Level 4

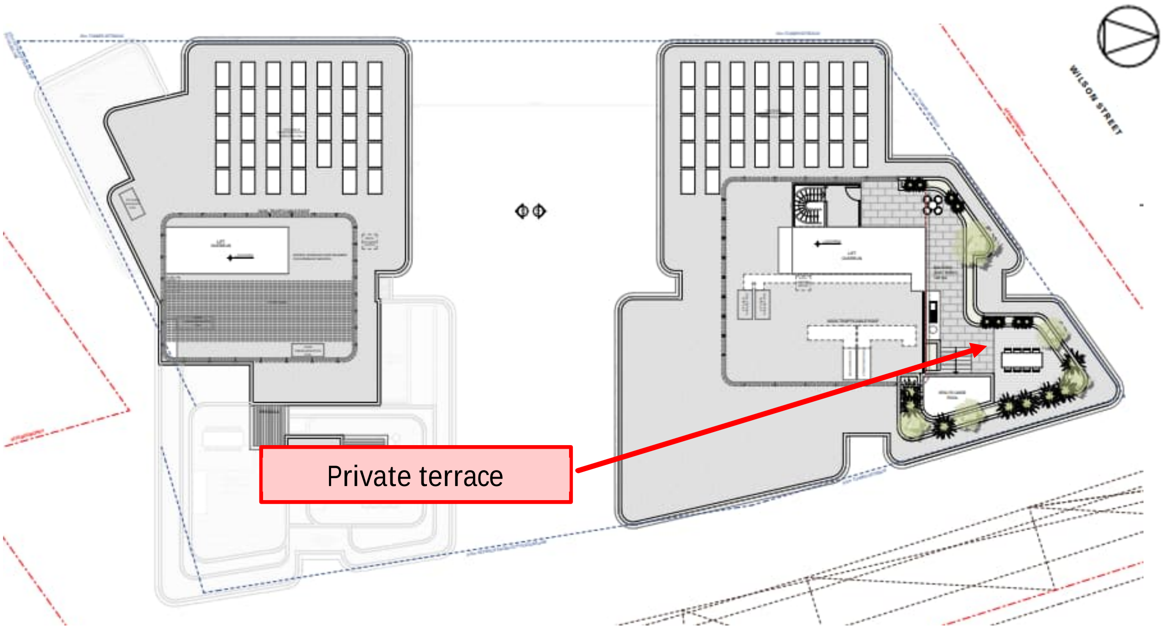


Level 35



(Fig. 2 cont'd)

Roof



1.3 Surrounds

In terms of the surrounding buildings:

- The railway is located immediately to the east of the site.
- Several high-rise residential buildings are situated in the south and southeast sides of the site.
- Low-rise developments are present on the west and north sides of the proposed development.
- Moving northwest, you'll find densely forested areas within Blue Gum Park.
- The terrain on the western side of the site undergoes significant elevation changes, impacting the nearby westerly wind patterns and speeds.

Figure 3 Surrounding Built Environment

Image: Courtesy Nearmap, September 2024

2 SYDNEY'S WIND CLIMATE

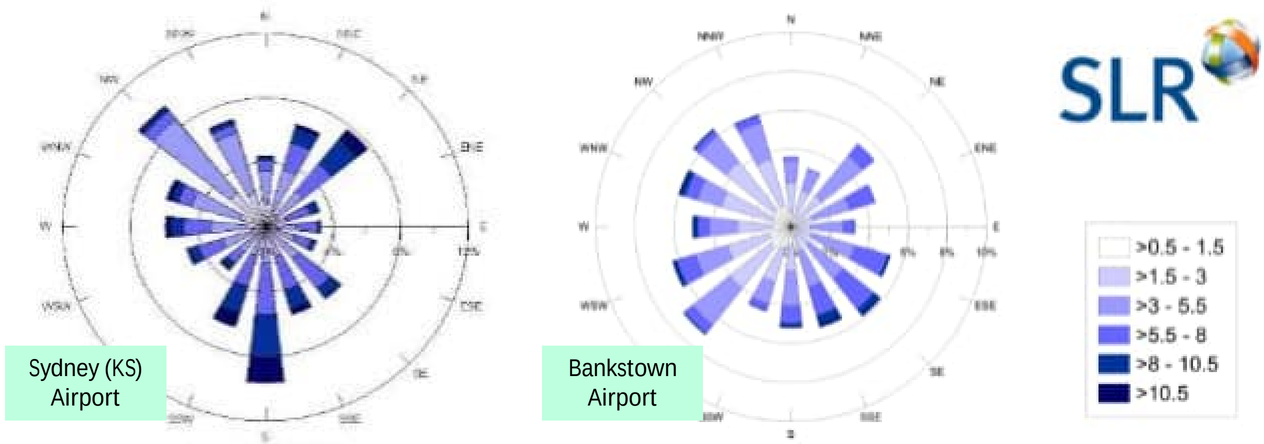
The data of interest in this study are the mean hourly wind speeds and largest gusts experienced throughout the year (especially higher, less frequent winds), how these winds vary with azimuth, and the seasonal break-up of winds into the primary Sydney Region wind seasons.

2.1 Annual and Seasonal Variations

Key characteristics of Sydney's Regional Wind Climate are illustrated in two representative wind roses shown in Figure 4, 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 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 4 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 current surroundings of the site consist of low to medium-rise buildings, ranging in height up to 4 stories, positioned in a clockwise direction from the west to the southeast. To the south, there are areas with high-rise towers.

- The site will therefore receive only modest wind shielding from north, west and east quadrants with increased sheltering (especially at lower levels) from other 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.

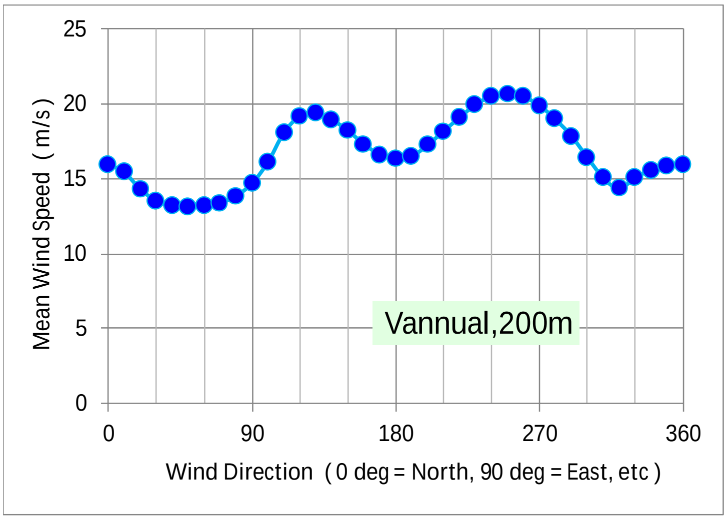
For Chatswood, SLR has determined that local upper-level winds reflective of the weather systems experienced at the site have characteristics in between Bankstown Airport than Sydney (KS) Airport, given the site's distance inland from the coast compared to Bankstown Airport and Sydney (KS) Airport (5 km).

Accordingly, the adopted Chatswood wind model has slightly lower strength characteristics from the northeast and south compared to Sydney (Kingsford Smith) Airport and correspondingly higher strengths from the southeast and southwest/northwest relative to Sydney (KS) Airport.

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 Chatswood wind model as described above. The winds shown have a once-per-year exceedance probability.

Figure 5 Reference Height (200 m) Annual Recurrence Mean Wind Speed at Project Site



3 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.

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.

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 WIND TUNNEL TEST METHODOLOGY

4.1 Simulation of Natural Wind

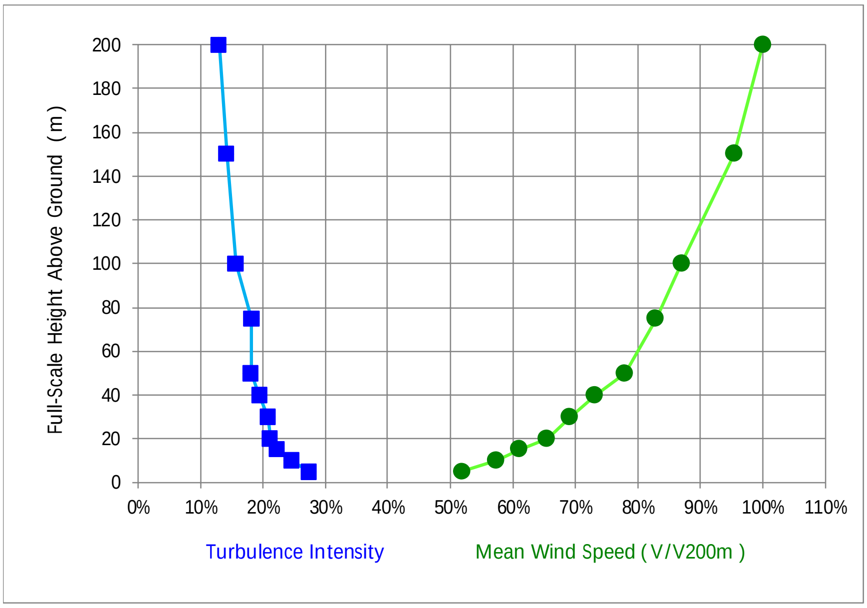
Similarity requirements between the wind tunnel model and prototype (ie full-scale) need to be fulfilled so that similitude in the flow conditions is satisfied. Usually all requirements cannot be satisfied, and compromises need to be made. In this type of wind tunnel test, it is possible to waive strict 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 1:400 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 Terrain Category 3 associated with medium density suburban surroundings. The variation of mean wind speed (blue curve) and turbulence intensity (green curve) is shown in Figure 6.

Figure 6 Wind Tunnel Test Profiles for Mean Wind and Turbulence Intensity



4.2 Proposed Development Model and Proximity Model

Development Model

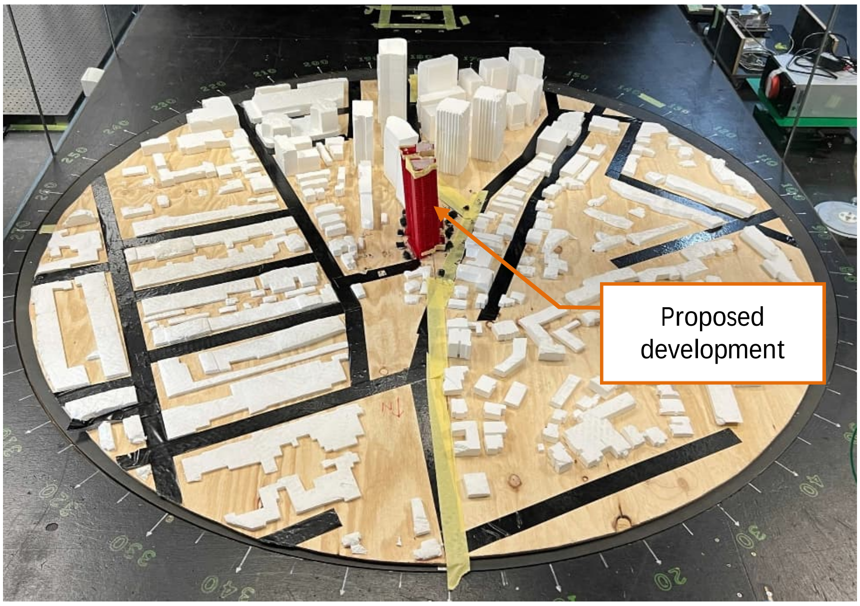
A 1:400 scale model of the proposed development was built for the testing. To take into account the influence of the immediate surrounding physical environment, all neighbouring buildings and local topography within a diameter of almost 900 m around the site were included in the purpose-built 1:400 scale "proximity model" used for the test as shown in Figure 7. The study has involved the testing of the following proposed scenario:

- Scenario 1 – "Baseline" The existing built environment (as of Oct 2023)
- Scenario 2 – "Proposed" "Baseline" + Proposed Development
- Scenario 3 – "Mitigation" "Proposed" + Recommended wind mitigation treatments

Figure 7 Proximity Model in Wind Tunnel

"Baseline" (existing) Model View from North

"Proposed" (Proposal) Model View from North



4.3 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 6. 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.

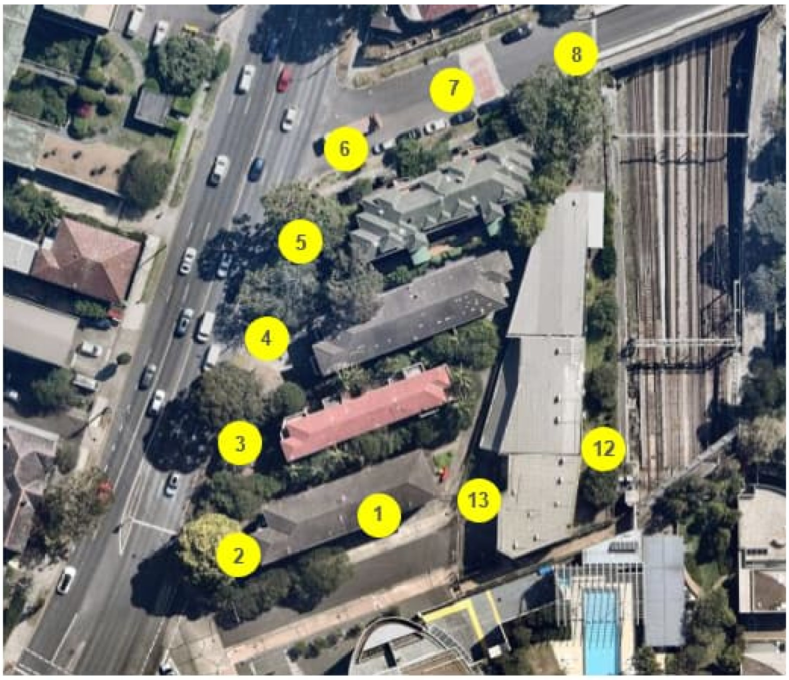
4.4 Test Method – Sensor Locations

In the wind tunnel testing, Irwin wind sensors were positioned at the locations shown in Figure 8. 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 1-18 are positioned at the Ground Level around the proposed development and within the arcade.
- Locations 18 to 34 have been strategically placed to assess the wind levels in the surrounding area, aiming to analyse the impact of the proposed development on the local wind patterns.
- Locations 35 to 41 are situated within the communal open terrace at Level 2.
- Locations 42 is situated within the communal open area at Level 3.
- Locations 43 to 46 are situated within the private terraces at Level 35 and Roof.

Figure 8 Sensor Locations on Ground Level

Baseline



Proposed

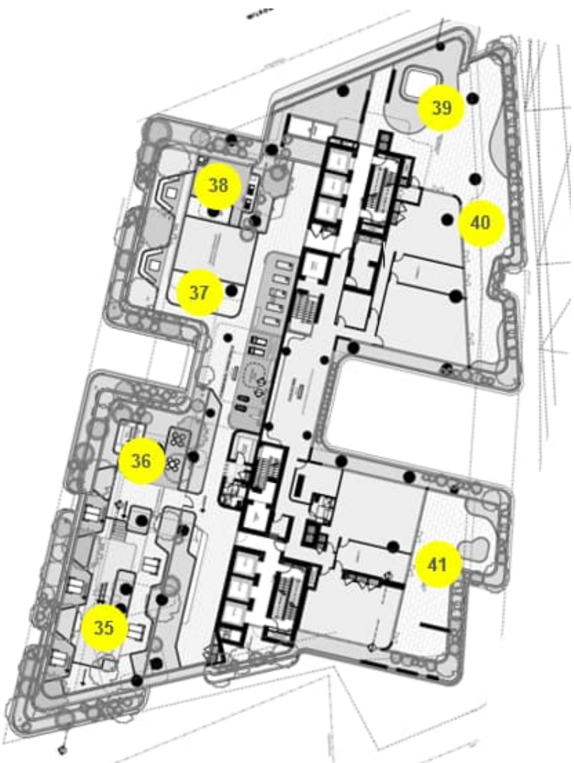


Figure 9 Sensor Locations on Surrounding area (Proposed and Baseline)

Figure 10 Sensor Locations on Level 2

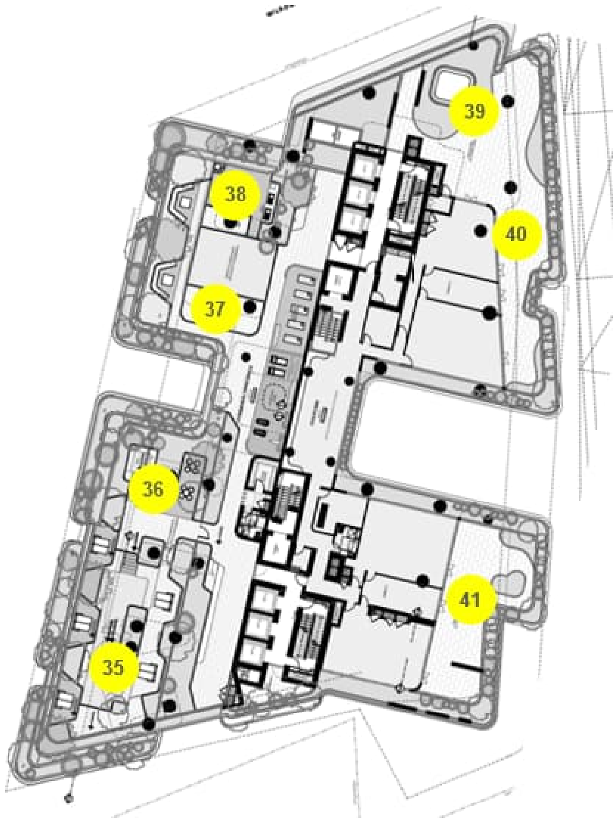


Figure 11 Sensor Location on Level 3

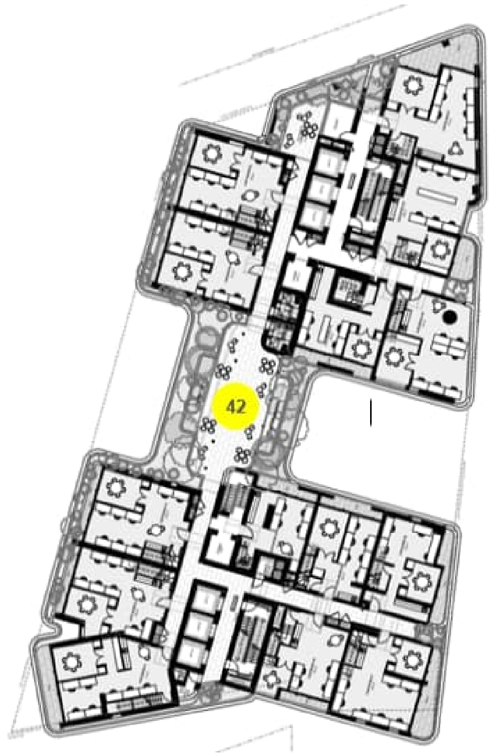


Figure 12 Sensor Locations on Level 35

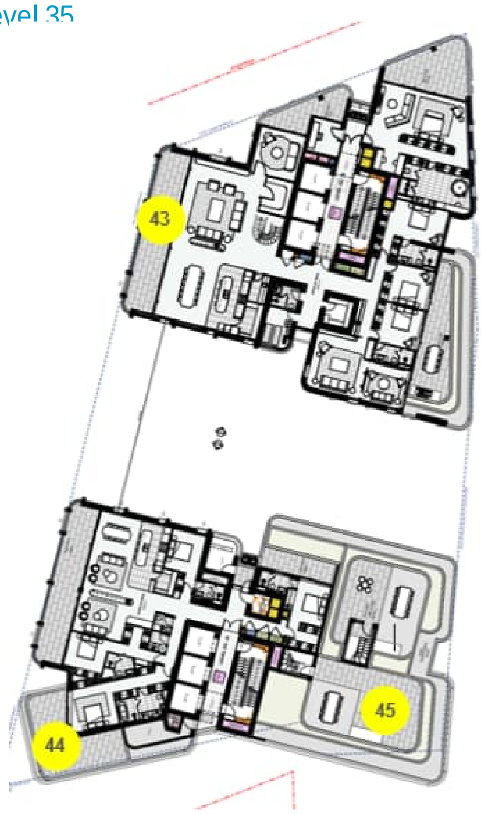
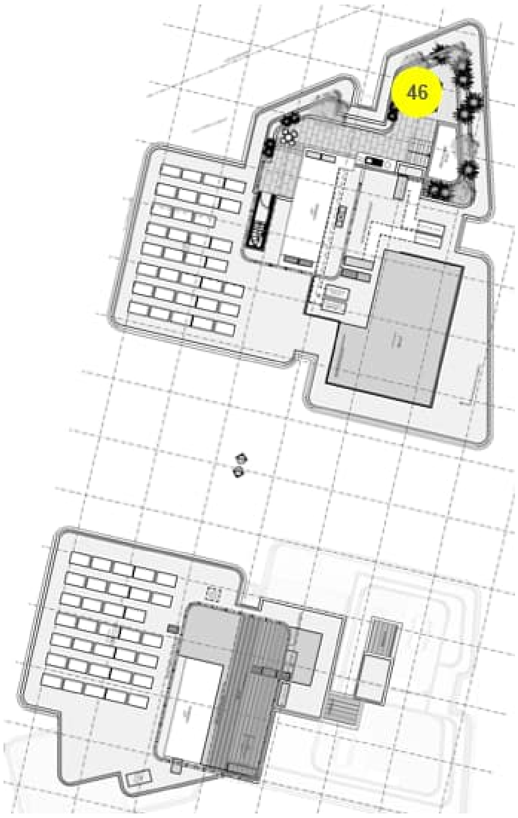


Figure 13 Sensor Locations on Roof



4.5 Sample Test Result

An example of the test results and interpretation of these results is shown in Figure 14, illustrating the peak annual mean and representative gust wind speeds at:

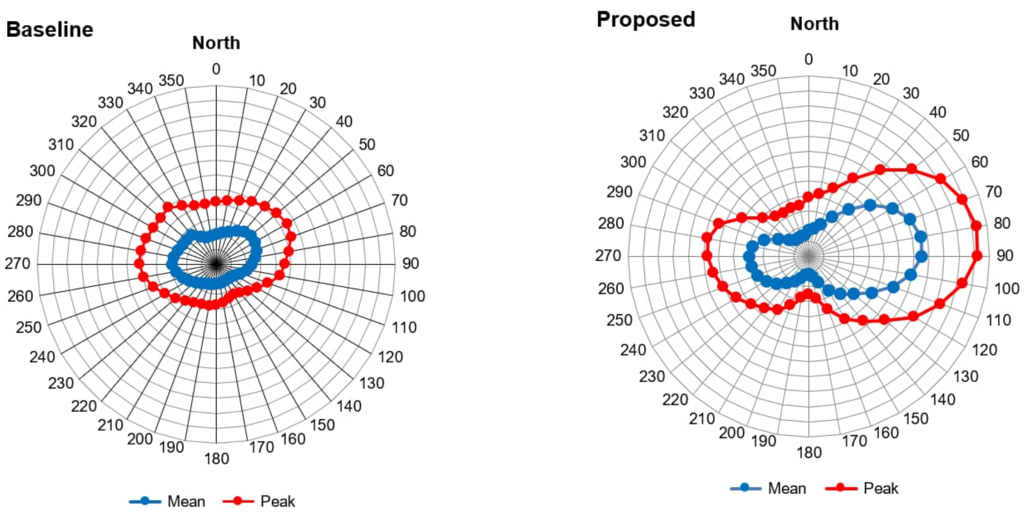
Sensor: Location 7
Location: At the ground level, situated on the north side of the development, in close proximity to the entrance of the arcade.

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 ratios in "0.1" intervals.

Figure 14 Sample Polar Plot Test Result – Location 7



Scenario 1 – "Baseline" Scenario

- Location 7 receives minimal shielding from the west and east due to the relatively open nature of the surroundings with low rise residential development and railway. As a result, existing winds at this location are higher from the east and west.

Scenario 2 – "Proposed" Scenario

- The introduction of the proposed development leads to an elevation in wind speed at location 7, attributed to corner acceleration, the downwash effect, and the channelling of wind along the north facade of the tower. Nevertheless, a significant decrease in southward winds is measured at this location due to the shielding effect generated by the proposed development. Consequently, the prevailing winds at Location 7 are expected to stem from the east and west.

5 TEST RESULTS

5.1 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 6) 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.

5.2 Wind Tunnel Test Data

Appendices B, C and D show the relevant wind tunnel test result polar plots for all locations for all “Baseline”, “Proposed”, and “Mitigation” Scenarios respectively.

The landscaping plans for both the current surroundings and the proposed development were incorporated into the "Proposed" scenario. The execution of tests aids in confirming areas where additional measures for wind mitigation might be necessary– refer Section 6.

5.3 Predicted Lawson Comfort Criteria Levels

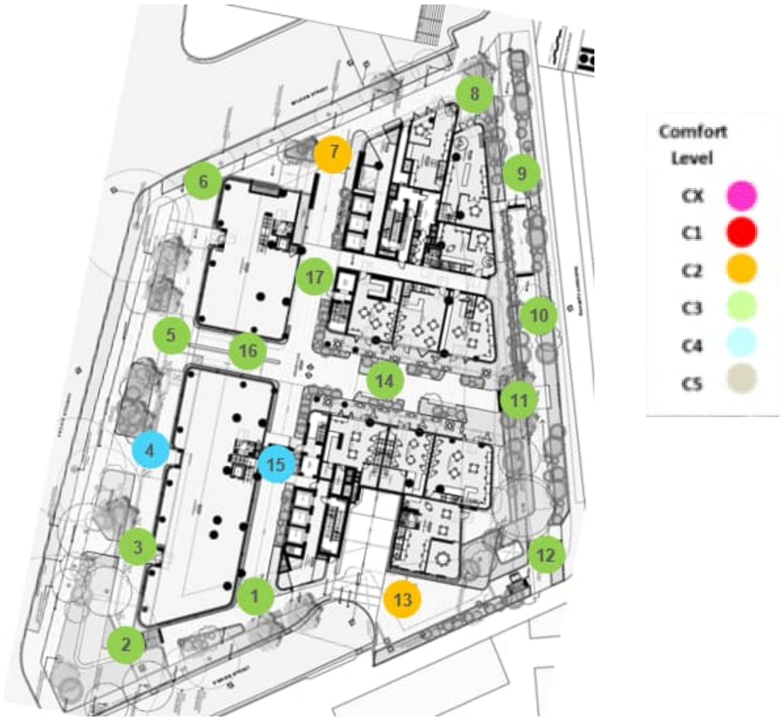
The results of the combination of wind tunnel test results (local ground level wind speed ratios) with the wind speed and wind direction probability distribution (5% annual exceedance level) derived for the site compared to the Lawson Comfort criteria are shown in Figure 15.

Figure 15 Predicted Lawson Comfort Levels “Baseline” and “Proposed” Scenarios

(Baseline)

(Fig.16 cont'd)

Ground level
(Proposed)



Surrounding
(proposed)

.

(Fig.16 cont'd)

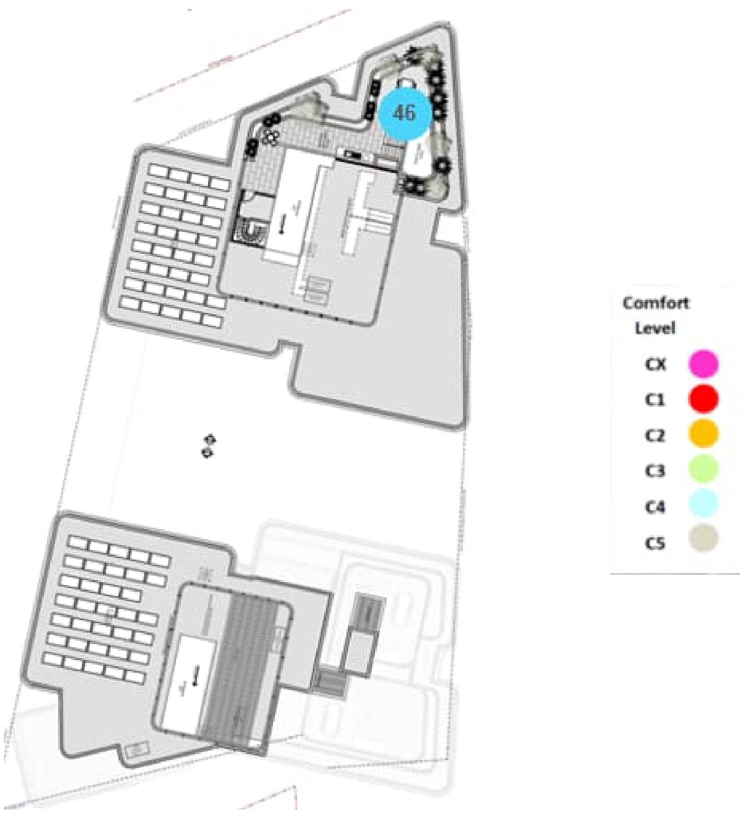
Level 2

Level 3

(Fig.16 cont'd)

Level 35

Roof



5.4 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 within and around the site are below the 23 m/s criterion level; and
- In the "Proposed" scenario, the peak annual gust at ALL locations within and around the site are below the 23 m/s criterion level.

5.5 Predicted Lawson Comfort Criteria Levels

The wind-tunnel predicted "Proposed" Lawson (2001) Comfort levels are compared to the Target Comfort levels for areas surrounding and within the proposed development in Table 5:

"Proposed" Built Environment Scenario

- 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.
- Ground level locations surrounding the site generally remain at the Lawson "C2" (Strolling) or "C3" (Standing) category, and some locations move to the "C4" (Sitting) category, due to shielding from the development itself. As such, Lawson Comfort levels at all surrounding ground level locations (1-34) comply with their "Target" Comfort level.
- Ground level locations within the site generally remain at the Lawson "C3" (Standing) or "C4" (Sitting) category.

It's important to highlight that the landscaping plans for both the current surroundings and the proposed development were incorporated into the "Proposed" built environment scenario. Conducting tests aids in verifying areas where additional wind mitigation measures might be necessary. Moreover, the polar plot information provided in Appendix C, showcasing critical wind directions, plays a vital role in guiding decision-making regarding the strategic placement of additional wind mitigation elements. In Section 7, the locations where a potentially "Unfavourable" impact is predicted for the "Proposed" scenario versus the Target Comfort levels were investigated further, incorporating a range of wind mitigation treatments.

Table 5 Assessment of Impacts of the Proposed Development – Baseline and Proposed Scenarios Results

Location	Target Comfort Level	Wind Tunnel Predicted Comfort Level – "Baseline"	Wind Tunnel Predicted Comfort Level – "Proposed"	"Proposed" Impact (refer Table 4) Relative to Target Comfort Level
1	C3	C3	C3	Favourable Minor
2	C2	C3	C3	Favourable Minor
3	C2	C2	C3	Favourable Minor
4	C2	C2	C4	Favourable Major
5	C2	C3	C3	Favourable Minor
6	C2	C3	C3	Favourable Minor
7	C2/C3	C3	C2	Negligible /Unfavourable Minor
8	C2	C3	C3	Favourable Minor
9	C2	Note 1	C3	Favourable Minor
10	C2		C3	Favourable Minor
11	C2		C3	Favourable Minor
12	C2	C3	C3	Favourable Minor
13	C2	C2	C2	Negligible
14	C3/C4	Note 1	C3	Negligible/ Unfavourable Minor
15	C3/C4		C4	Favourable Major/ Negligible
16	C3/C4		C3	Negligible/ Unfavourable Minor
17	C3/C4		C3	Negligible/ Unfavourable Minor
18	C2	C2	C3	Favourable Minor
19	C2	C3	C2	Negligible
20	C2	C3	C3	Favourable Minor
21	C2	C3	C3	Favourable Minor
22	C2	C3	C3	Favourable Minor
23	C2	C3	C3	Favourable Minor
24	C2	C3	C3	Favourable Minor
25	C2	C3	C4	Favourable Major
26	C2	C3	C3	Favourable Minor
27	C2	C4	C3	Favourable Minor
28	C2	C3	C3	Favourable Minor
29	C2	C3	C3	Favourable Minor
30	C2	C3	C2	Negligible
31	C2	C3	C2	Negligible
32	C2	C3	C2	Negligible
33	C2	C3	C3	Favourable Minor

Location	Target Comfort Level	Wind Tunnel Predicted Comfort Level – "Baseline"	Wind Tunnel Predicted Comfort Level – "Proposed"	"Proposed" Impact (refer Table 4) Relative to Target Comfort Level
34	C3	C3	C3	Negligible
35	C3	Note 1	C4	Favourable Minor
36	C4		C4	Negligible
37	C4		C4	Negligible
38	C4		C4	Negligible
39	C4		C4	Negligible
40	C4		C4	Negligible
41	C4		C4	Negligible
42	C4		C4	Negligible
43	C3		C3	Negligible
44	C3		C3	Negligible
45	C3		C3	Negligible
46	C3/C4		C4	Favourable Minor/Negligible

Note 1 Locations 9 to 11, 14 to 17 and 35 to 46 were not present in "Baseline" scenario.

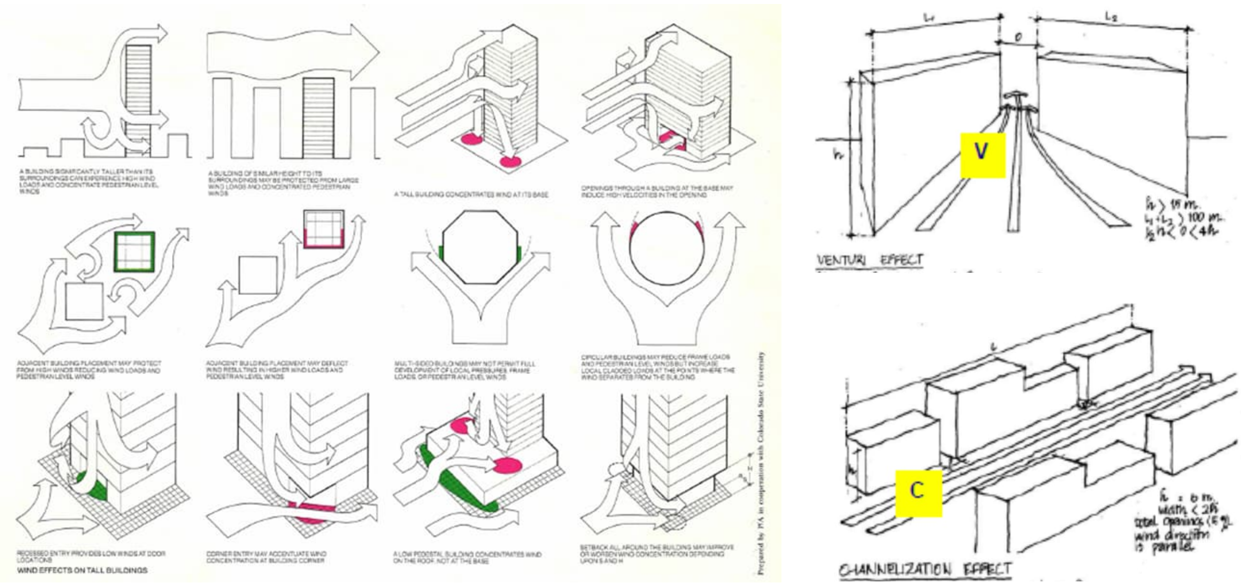
Note 2 All Unfavourable impacts are deemed "significant" and require consideration of wind mitigation.

It will be recalled (refer Section 3.2) that all locations where the significance impact is "Unfavourable" leads to consideration of mitigation treatments.

6 WIND MITIGATION OPTIONS

Figure 16 shows some common wind impact flow patterns surrounding a new building development.

Figure 16 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

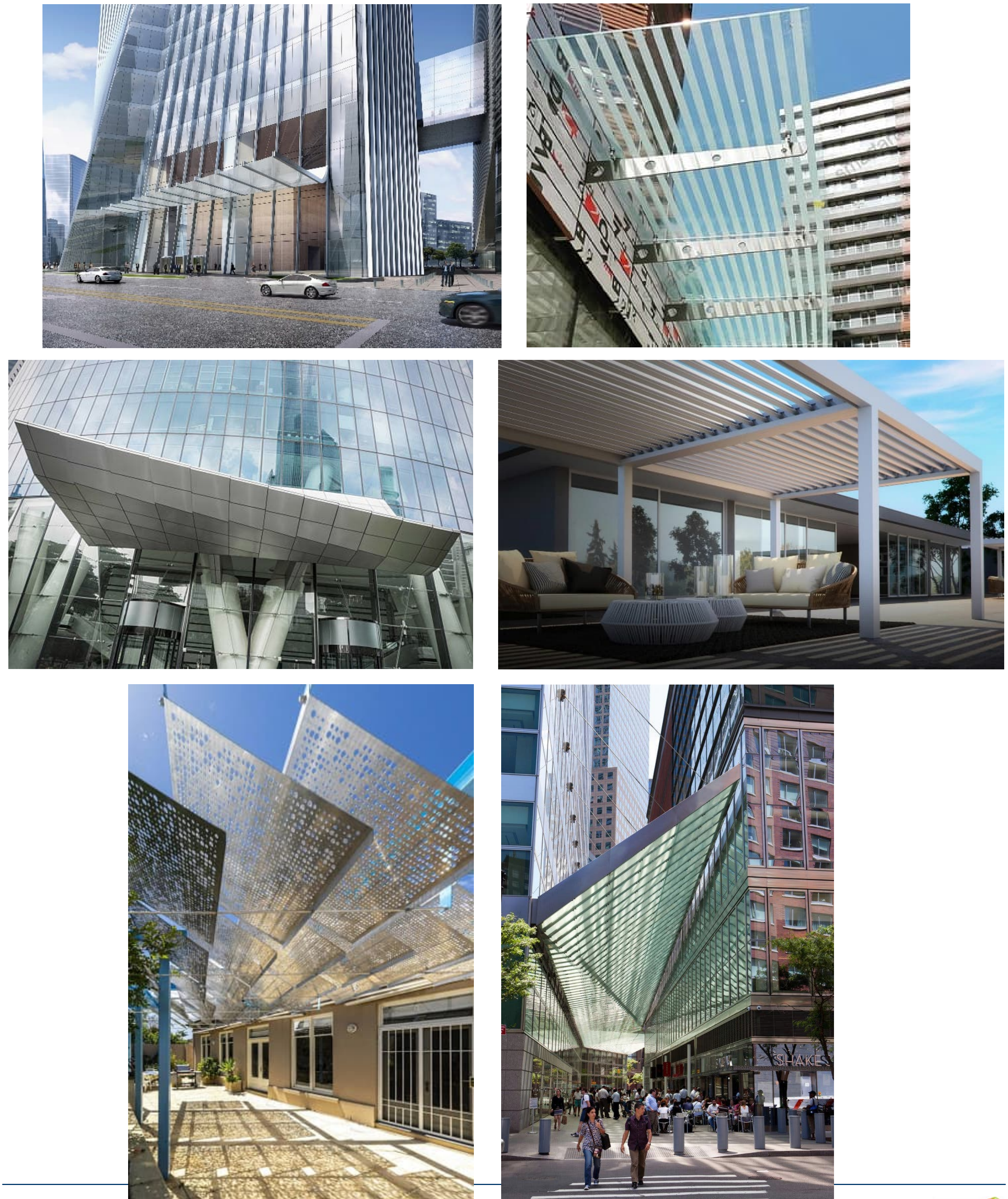
Wind mitigation options suited to ameliorating horizontal wind conditions include:

- 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 17 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 17 Horizontal Windbreak Options



6.4 Vertical Windbreak Examples

Figure 18 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 18 Vertical Windbreak Options

Landscaping

Solid

Multi-Function

Combination

7 MITIGATION AND TREATMENT RECOMMENDATIONS

Sections 5 and 6 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).

7.1 Wind Amelioration Treatments

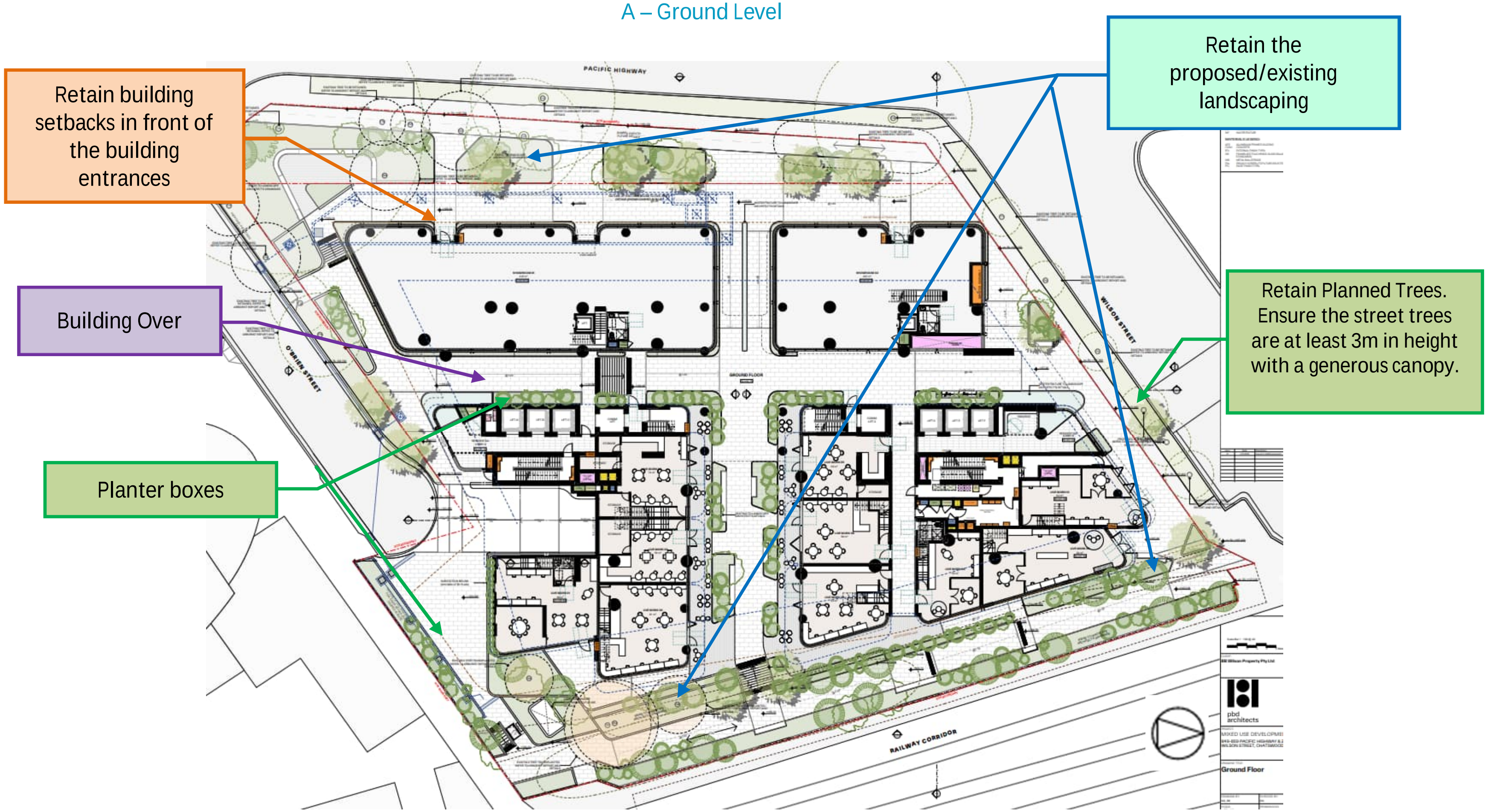
Following the implementation of wind mitigation measures in the development, the following recommendations have been made:

- Maintain the proposed/existing trees/landscaping on the sides of the development to mitigate the impact of local wind speeds. It is recommended that all trees/landscaping to be evergreen and densely foliating to maintain its effectiveness throughout the year – refer Figure 19A.
- Uphold the proposed setbacks, colonnades, and awnings at ground-level building entrances to reduce wind speeds from downwash and to redirect airflow along pedestrian pathways – refer Figure 19A.
- Keep the proposed planter boxes within the ground-level space to mitigate wind channelling effects in this area. Landscaping should be evergreen and densely foliated for continuous effectiveness throughout the year – refer Figure 19A.
- A combination of dense planting and fixed open screens or louvers is used to mitigate wind in the open breezeway corridors.
- For the communal open spaces on Levels 2,3 and 4, maintain the proposed solid vertical windbreak around the perimeter, along with the planned trees and landscaping. It is recommended that all trees and landscaping be evergreen and densely foliated to ensure effectiveness year-round – refer Figure 19 B & C.
- Retain the proposed solid balustrades around the private balconies – refer Figure 19 D & E.

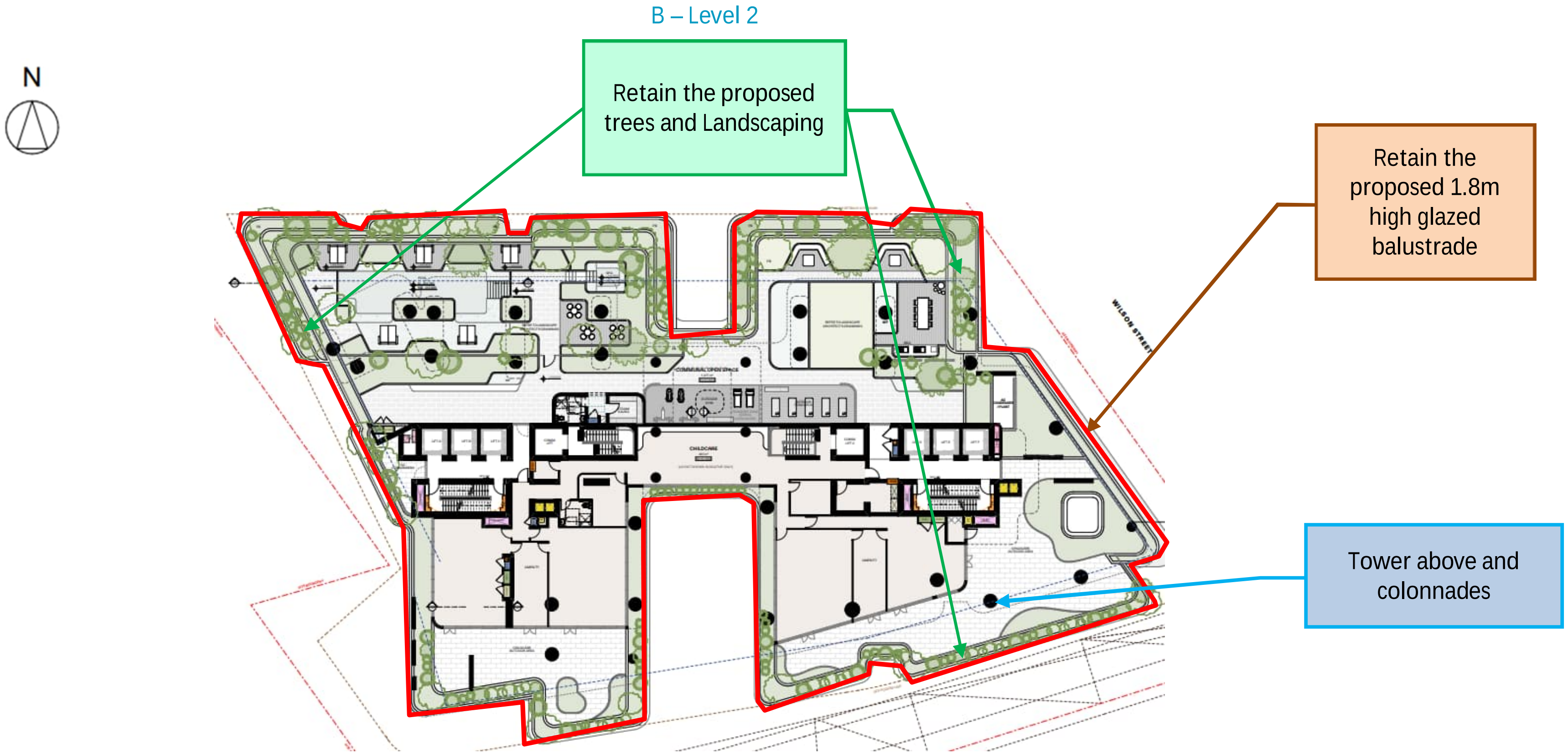
With the wind mitigation strategies already proposed, no additional recommendations are necessary.

Figure 19 Existing Landscaping and Already Planned Treatments Relevant to Wind Mitigation

A – Ground Level

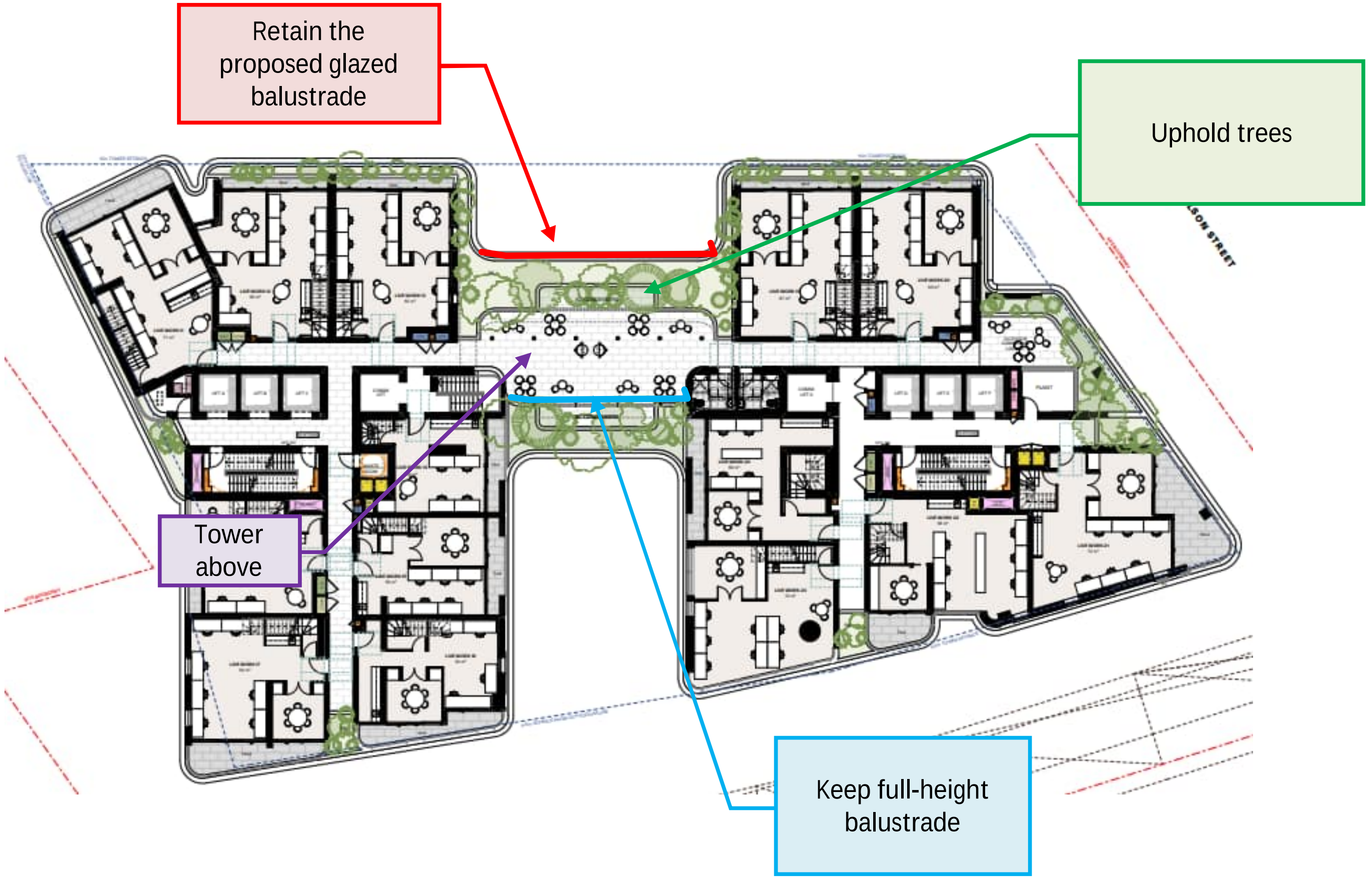


(Fig.20 cont'd)


B – Level 2
N
Retain the proposed trees and Landscaping
Retain the proposed 1.8m high glazed balustrade
Tower above and colonnades
WILSON STREET

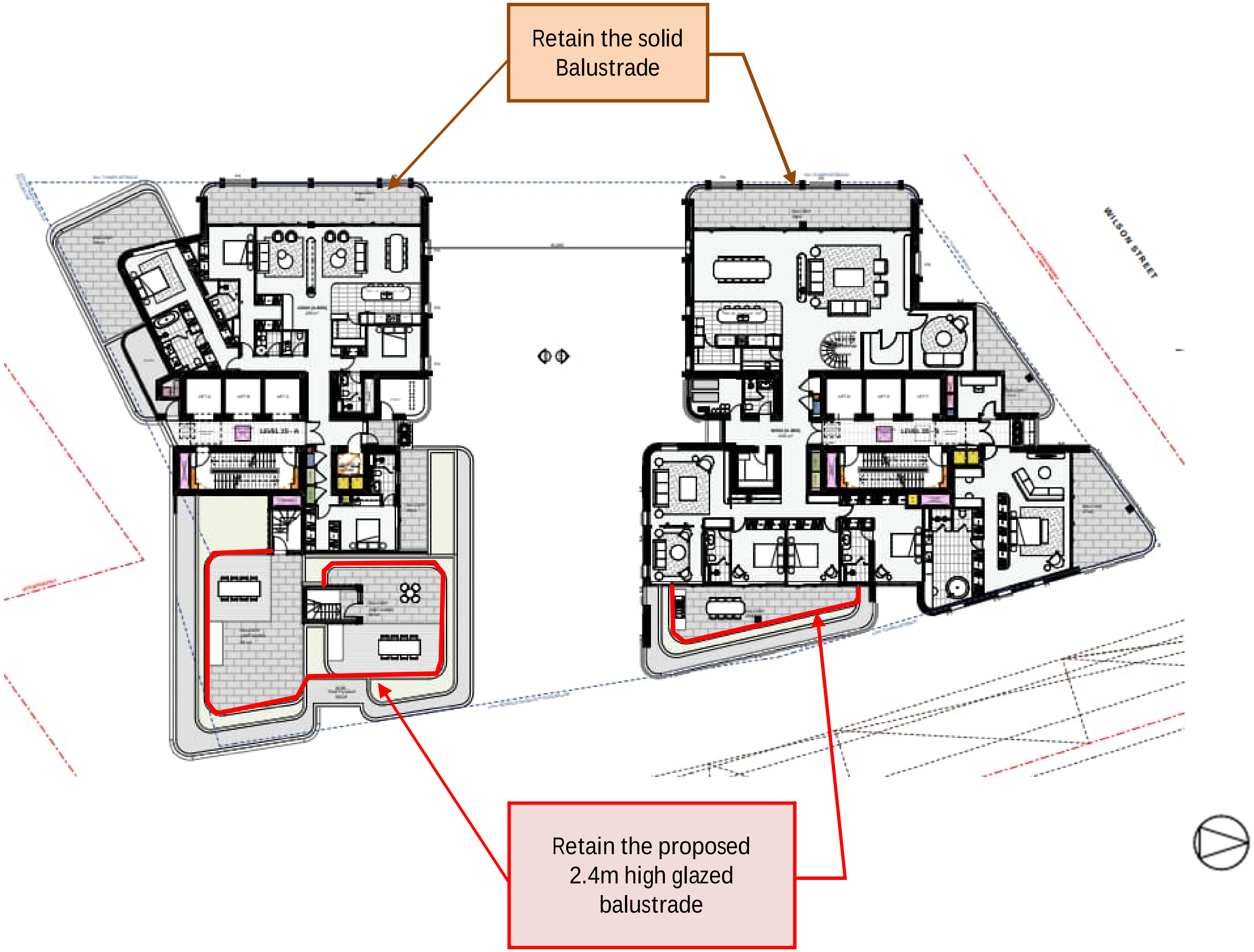
(Fig.20 cont'd)

C– Level 3



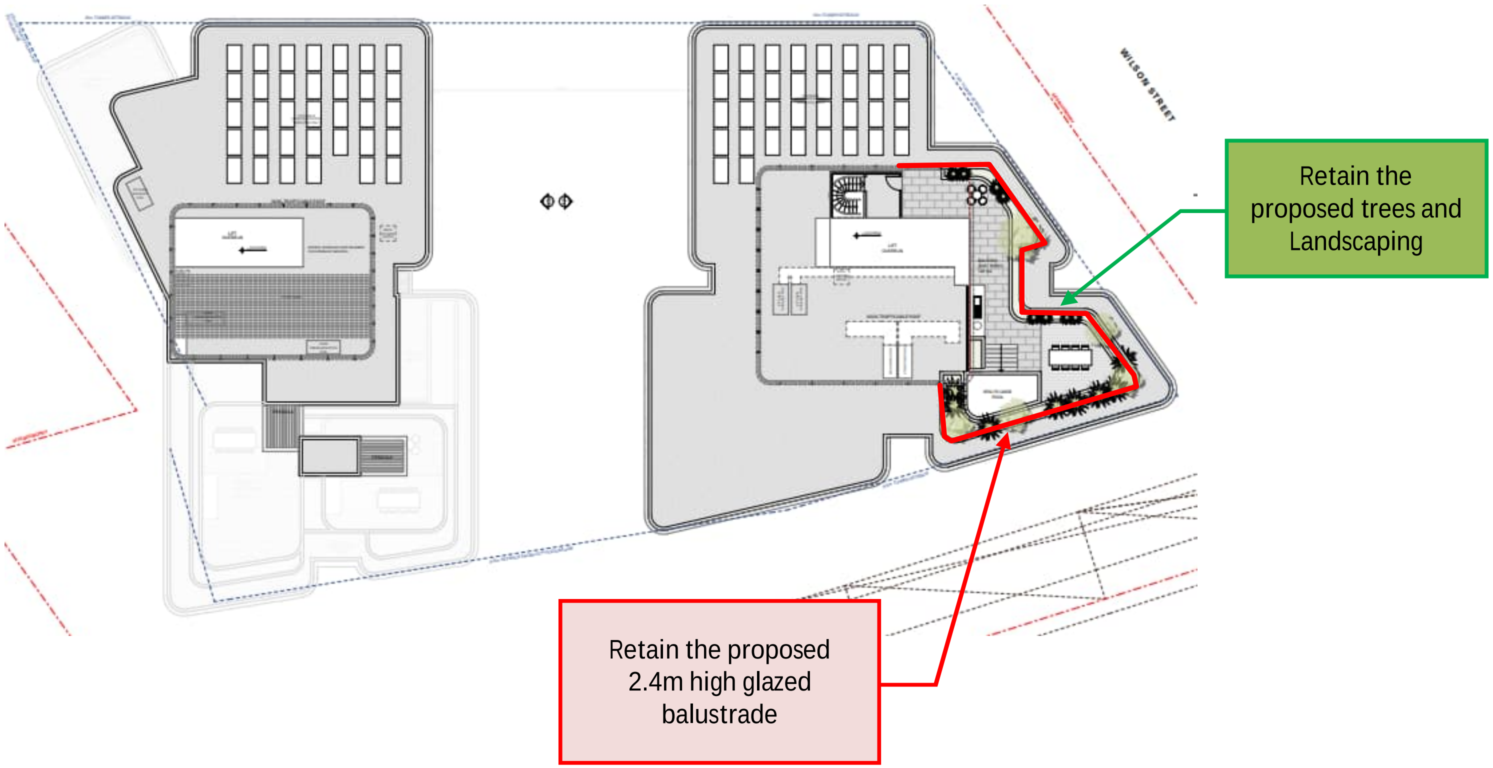
(Fig.20 cont'd)

D – Level 35



(Fig.20 cont'd)

E – Roof



8 Conclusion

SLR Consulting Australia Pty Ltd (SLR) has been engaged by BB Wilson Property Pty Ltd to perform a quantitative wind assessment of the proposed development at 849, 853, and 859 Pacific Highway and 2 and 8 Wilson Street, Chatswood, via an Environmental Wind Tunnel Study. Following an initial wind tunnel test conducted in December 2023 (610.031413.00001-R01-v1.0-20231214), the design has now been revised to increase the height by 8 storeys. Consequently, an additional wind tunnel test has been conducted to evaluate the impact of these changes.

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.

The proposed mixed-use development, which comprises of two towers with 36 stories, is positioned amidst Pacific Hwy to the west, Wilson Street to the north/northeast, Railway to the east, and O'Brien Street to the south. in High-rise towers can be found to the south of the site, and in the more distant northwestern direction from this development lies Blue Gum Creek.

Chatswood Wind Climate

Using long-term wind records obtained from nearby Bureau of Meteorology stations at Bankstown Airport and Sydney Kingsford Smith Airport, SLR has determined that determined that Chatswood has local winds characteristics somewhat closer to Sydney (KS) Airport than Bankstown 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.

Built Environment Scenarios Assessed

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

- Scenario 1 – "Baseline" The existing built environment (as of Oct 2023)
- Scenario 2 – "Proposed" "Baseline" + Proposed Development

Wind Acceptability Criteria

The criteria adopted to the present study are:

- "Comfort" Lawson (2001) Comfort Criteria;
- "Safety" Melbourne (1978) 23 m/s Safety Criterion

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.

- As noted in Section 1.3, The site is partially shielded from the north, east, and west, as it is presently bordered by a combination of low to mid-rise residential structures on the west and north aspects of the proposed development. Conversely, the site experiences moderate shielding from the south, attributed to the presence of some high-rise buildings on the southern side of the development.

- The terrain on the western side of the site undergoes significant elevation changes, impacting the nearby westerly wind patterns and speeds.

"Proposed" Wind Environment

Testing of the "Proposed" scenario (which incorporates a number of already planned windbreak treatments) yielded the follows areas of potential concern in relation to future wind impact:

- The residential Lobby B entry situated on the north side of the proposed development;
- The areas could potentially be designated as seating zones within the arcade;
- Communal open spaces located on levels 2,3, and 4;
- Private terraces.

Already Planned Wind Amelioration Treatments– refer Figure 19

The following treatments relevant to wind mitigation have already been incorporated in the current design scheme:

- Preserve the proposed or existing trees and landscaping along the sides of the development to help reduce local wind speeds. It is recommended that all trees and landscaping be evergreen with dense foliage to ensure year-round effectiveness - refer Figure 19A.

- Maintain the proposed setbacks, colonnades, and awnings at ground-level entrances to minimize wind speeds from downwash and to guide airflow along pedestrian pathways - refer Figure 19A.

- A combination of dense planting and fixed open screens/louvres is used to mitigate wind in the open breezeway corridors.

- Retain the proposed planter boxes at ground level to counteract wind channelling effects in this area. Evergreen, densely foliated landscaping is recommended for continuous effectiveness throughout the year - refer Figure 19A.

- For the communal open spaces on Levels 2, 3, and 4, keep the proposed solid vertical windbreak around the perimeter, along with the planned trees and landscaping. Evergreen, densely foliated trees and landscaping are recommended to ensure year-round effectiveness - refer Figure 19B & C.

- Keep the proposed solid balustrades around private balconies - refer Figure 19D & E.

With the wind mitigation strategies already in place, no further recommendations are required.

Overall Summary

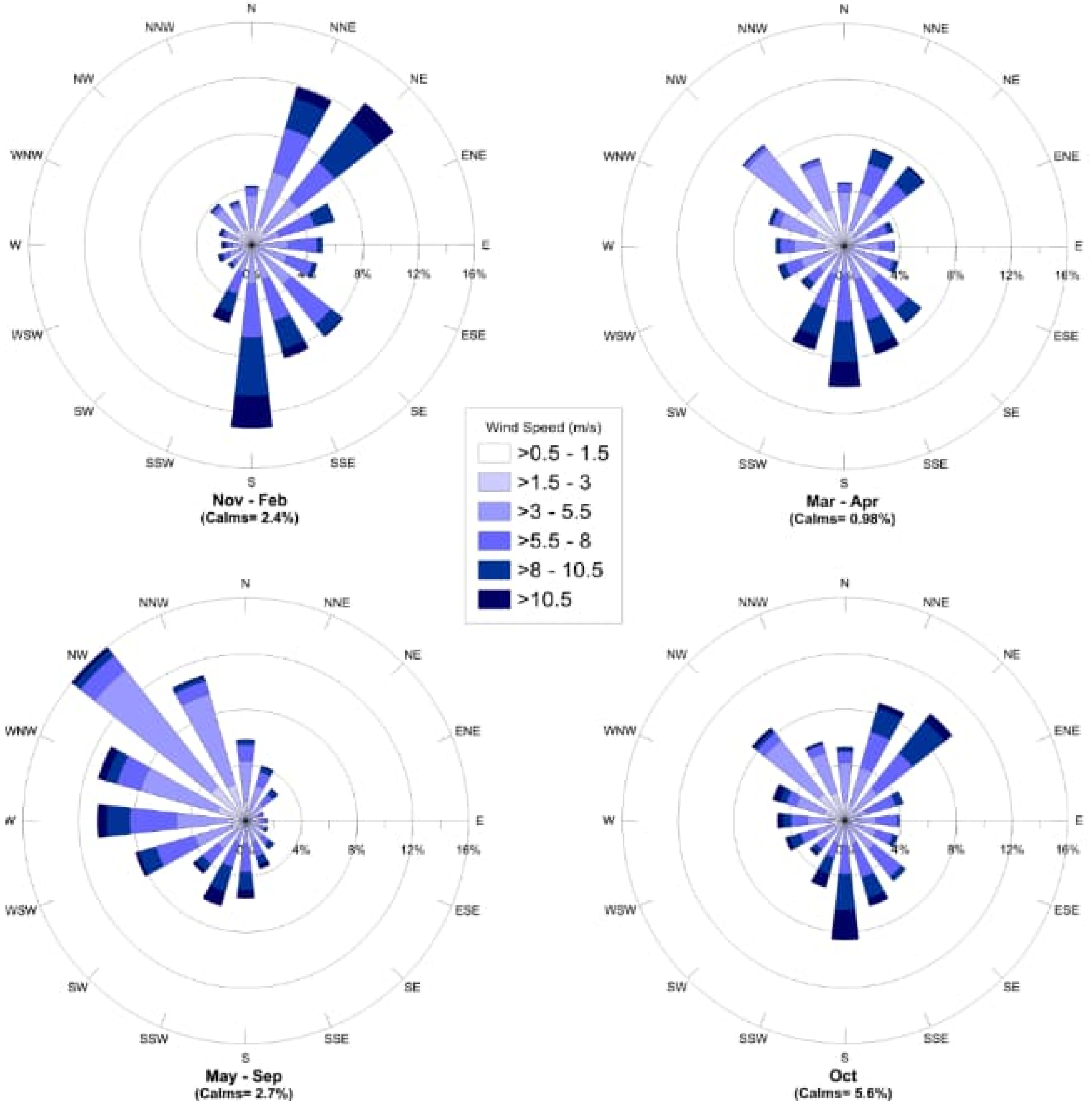
On the basis of all of the above, the overall effect of the proposed development on the local wind microclimate, with the wind mitigation treatments recommended, is predicted to be "not significant" .

Accordingly, the proposed development should satisfy the nominated Wind Acceptability criteria for the project.

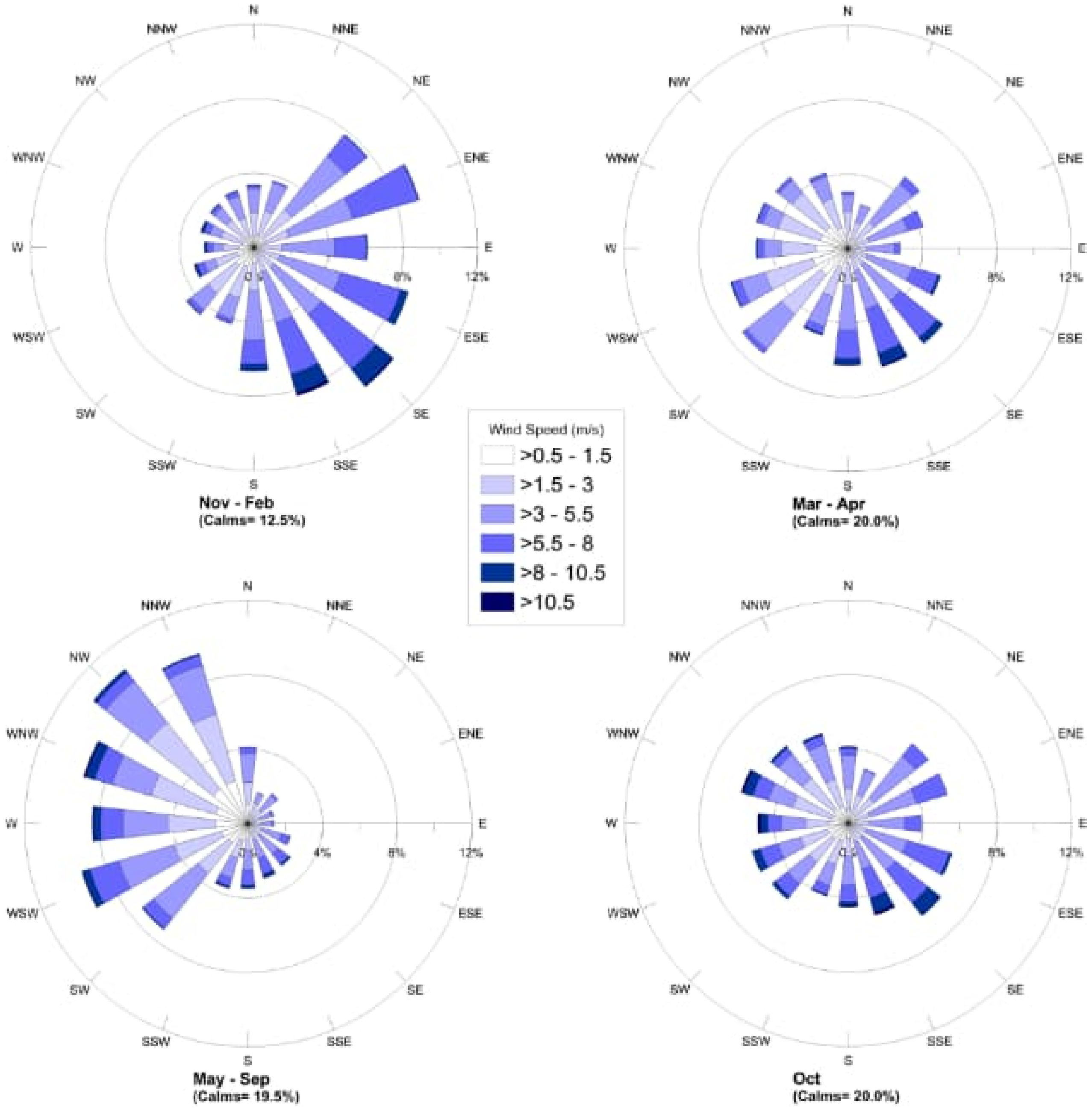
APPENDIX A

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



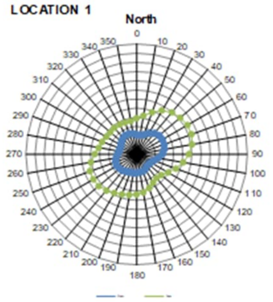
APPENDIX B

Wind Tunnel Test Data (Polar Plots) – Baseline Scenario

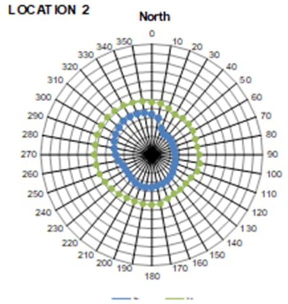
The polar diagram plots show the local (ground level) mean and peak gust wind speed as a ratio of the mean reference wind speed (at a full-scale height of 200 m).

The polar diagram circumferential lines representing gradations in 0.1 intervals, ie 10% ratios.

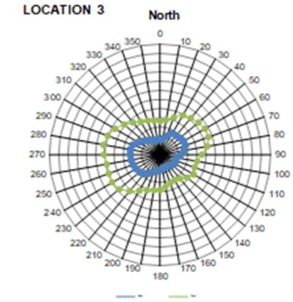
LOCATION 1



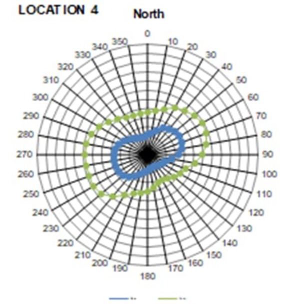
LOCATION 2



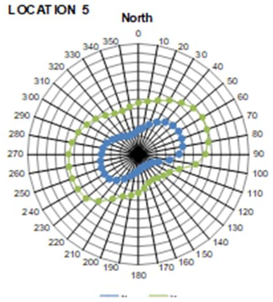
LOCATION 3



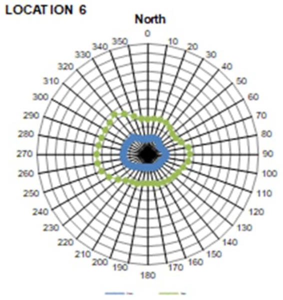
LOCATION 4



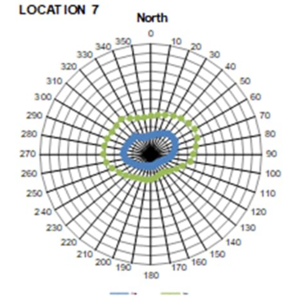
LOCATION 5



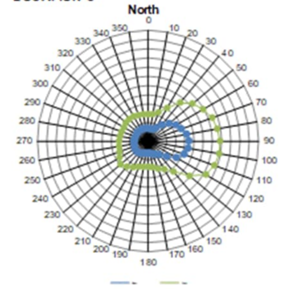
LOCATION 6



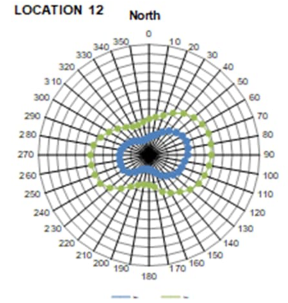
LOCATION 7



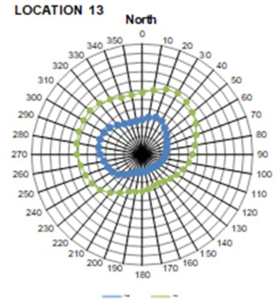
LOCATION 8



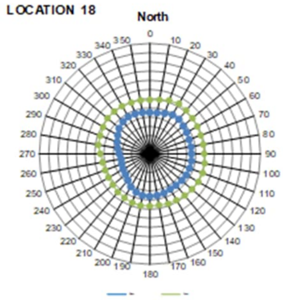
LOCATION 12



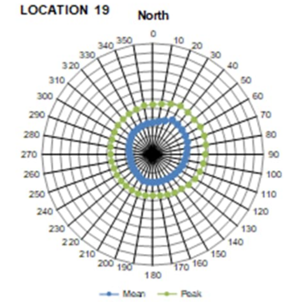
LOCATION 13



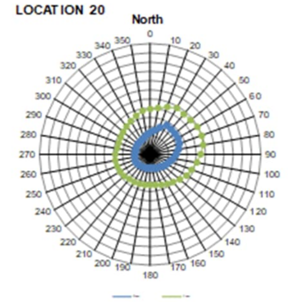
LOCATION 18



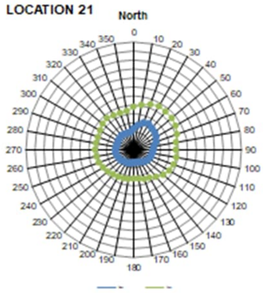
LOCATION 19



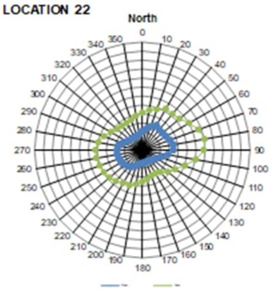
LOCATION 20



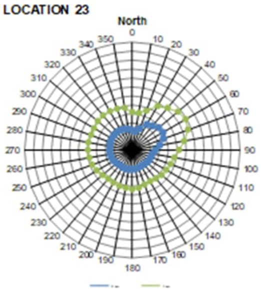
LOCATION 21



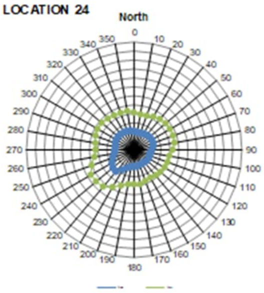
LOCATION 22



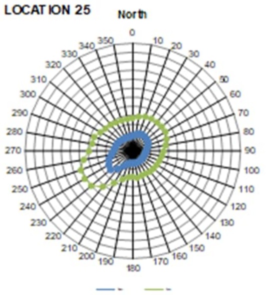
LOCATION 23



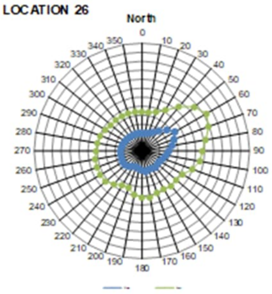
LOCATION 24



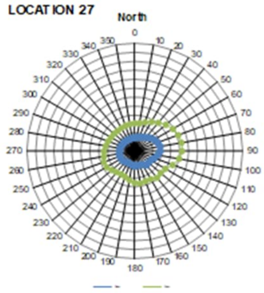
LOCATION 25



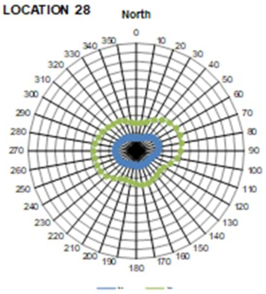
LOCATION 26



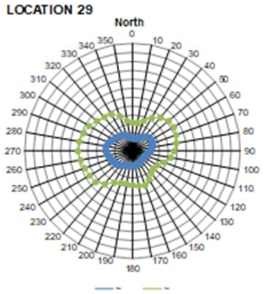
LOCATION 27



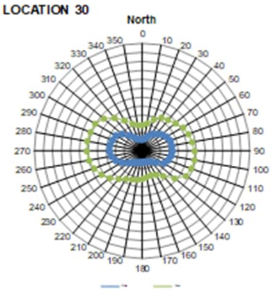
LOCATION 28



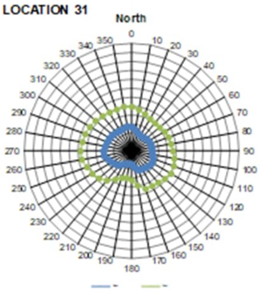
LOCATION 29



LOCATION 30



LOCATION 31



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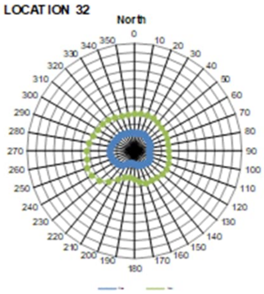

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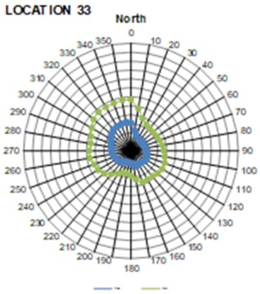

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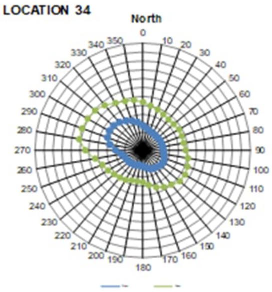

APPENDIX C

Wind Tunnel Test Data (Polar Plots) – Proposed 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.

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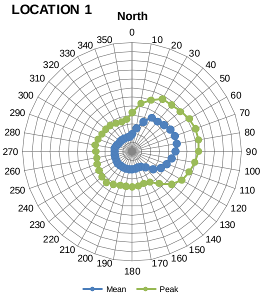

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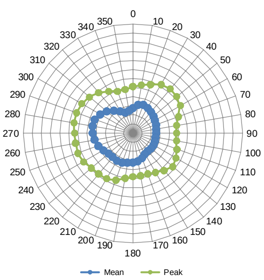

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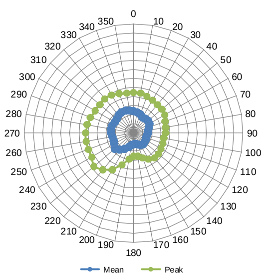

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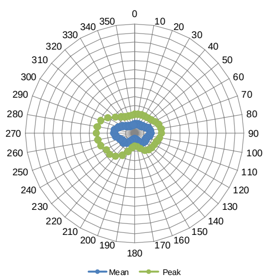

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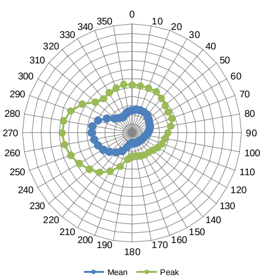

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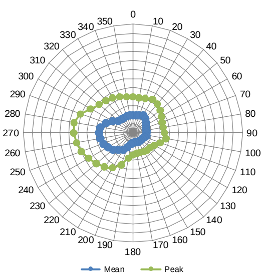

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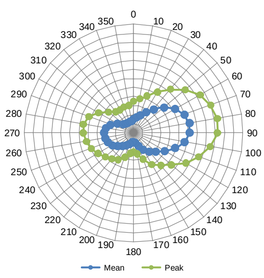

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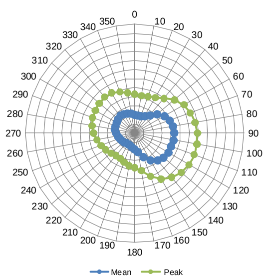

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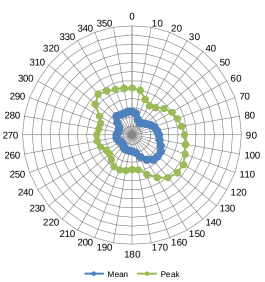

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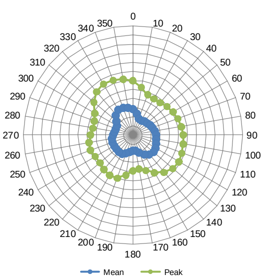

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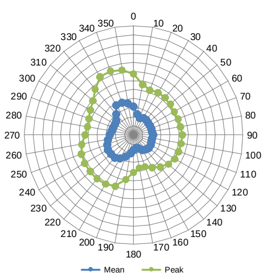

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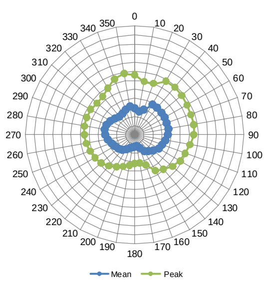

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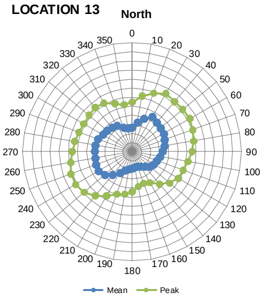

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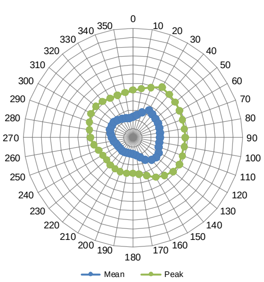

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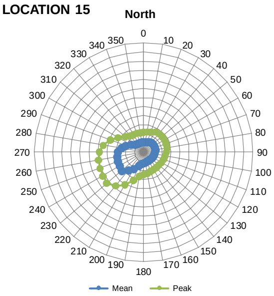

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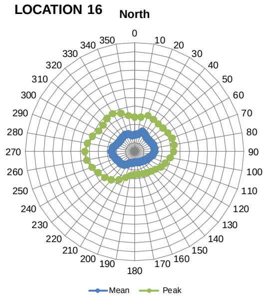

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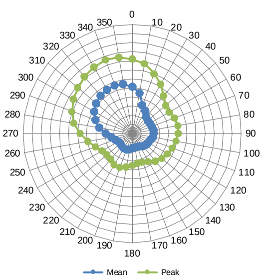

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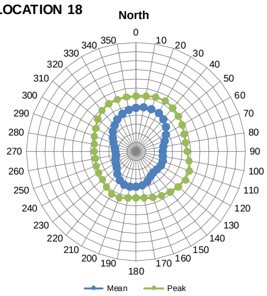

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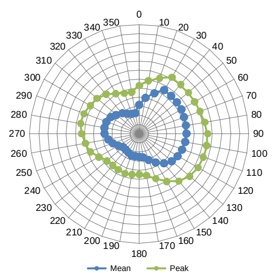

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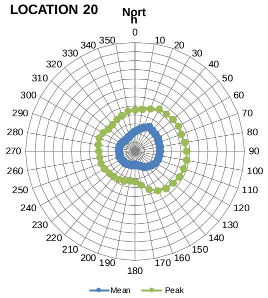

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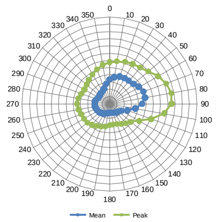

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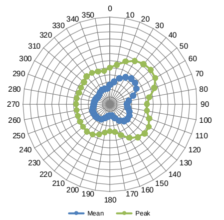

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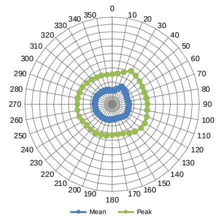

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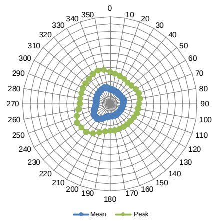

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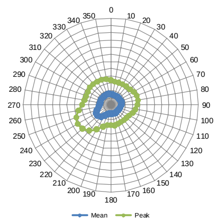

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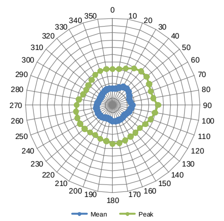

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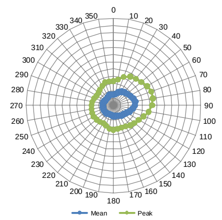

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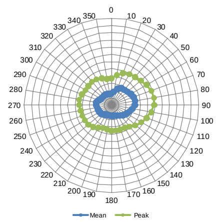

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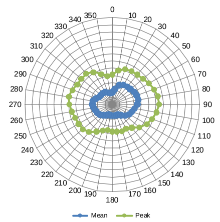

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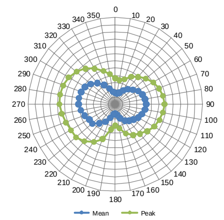

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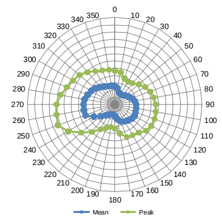

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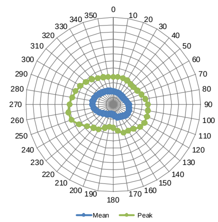

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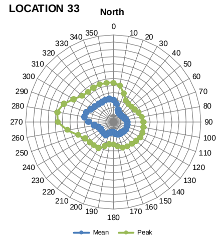

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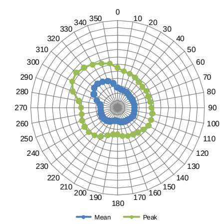

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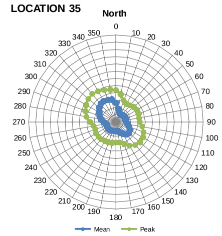

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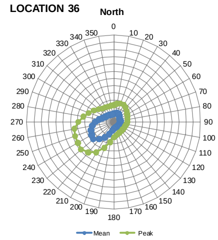

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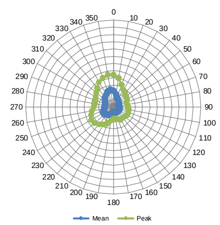

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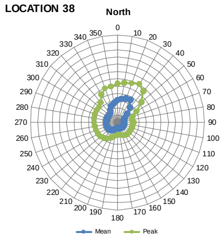

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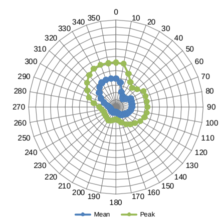

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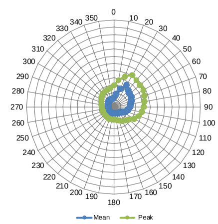

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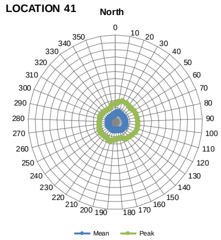

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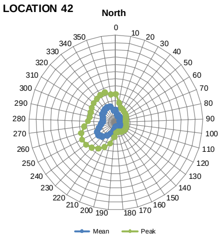

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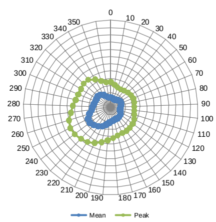

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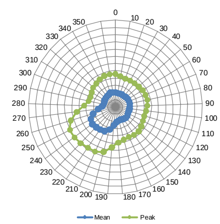

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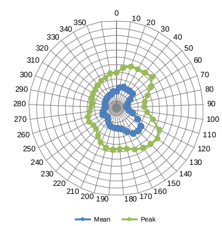

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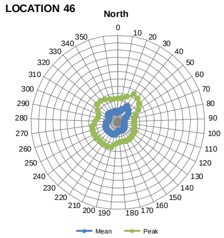

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