37 Archer Street, Chatswood

Environmental Wind Tunnel Study

HPG General Pty Ltd

Heritage House 256 Victoria Avenue,
Chatswood, NSW 2067 AU

Prepared by:

SLR Consulting Australia

SLR Project No.: 610.032216.00001

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Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
R01-v1.0	29 April 2025	Dr Farzin Ghanadi	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy
	Click to enter a date.			

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with HPG General 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.

Executive Summary

This quantitative wind assessment has been prepared by SLR Consulting Australia Pty Ltd (SLR) to accompany a detailed State Significant Development Application (SSDA) for the development of a mixed-use residential tower with infill affordable housing at 37 Archer Street, Chatswood NSW 2067. This assessment was performed through an Environmental Wind Tunnel Study, utilizing a Discrete Sensor approach. Wind tunnel measurements were conducted using a 1:400 scale model to evaluate wind conditions throughout and around the proposed development. This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-73277714).

The site consists of attached townhouses within a large rectangular lot. The legal description of the site is outlined in **Table 1** below.

Table 1 Legal Description

Property Address	Title Description
37 Archer Street, Chatswood NSW 2067	SP 38065
Project Site Area	2,201m^2

The proposed building is located on a site bordered by Archer Street to the west, Bertram Street to the east, and existing low-rise developments in the remaining directions. The surrounding area primarily consists of low-rise buildings to the east and south, while mid-rise buildings are present to the north and northwest. The site and its surroundings are generally flat, with no significant elevation changes.

Built Environment Scenarios Assessed

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

- Scenario 1 – **"Baseline"** The existing built environment
- 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

Using long-term wind records obtained from nearby Bureau of Meteorology stations at Bankstown Airport and Sydney Kingsford Smith Airport, SLR has determined that local upper-level winds reflective of the weather systems experienced at the site have characteristics similar to those of Sydney (Kingsford Smith) Airport, given the site's relatively close distance to the airport and similar distance inland.

"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.

- As noted in **Section 1.3**, the site is currently surrounded by a mix of typically low—to mid-rise buildings to all directions.
- The site will, therefore, receive low to moderate wind shielding depending upon oncoming wind direction at lower levels, with upper levels exposed to higher winds from a number of wind directions.

"Proposed" Wind Environment

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

- Building entries on Ground Level,
- Footpaths along the street surrounding the proposed development,
- The elevated public access areas

In terms of the future wind environment with the proposed Development, the following features of the development are noted as being of most significance:

Ground level – refer Figure 15

- The street trees along Bertram Street will be removed due to construction impacts, with replacement planting to be provided. However, the trees and landscaping along the surrounding footpaths, as proposed in the SSDA design, will help mitigate local wind effects. It is recommended that all new planting be evergreen and densely foliated to ensure year-round wind protection.
- As proposed in the SSDA design, the ground-level setbacks and entry awnings will assist in reducing wind speeds caused by downwash and help redirect airflow along pedestrian pathways.

Elevated communal open space

- The proposed vertical trees within the Level 1 courtyard, as detailed in the SSDA design, will improve wind conditions in this area to achieve the recommended standing comfort criterion. – refer **Figure 16.**
- As proposed in the SSDA design, the 3 m high glazed balustrades along the eastern and western edges of the Level 8 communal open space, together with shading over the eastern seating areas and the addition of tall trees, will contribute to meeting the recommended comfort criterion in this area – refer **Figure 17**.
- Wind assessments at Sensors 32 and 33 indicate that wind levels in the Level 8 communal open space exceeded seating comfort thresholds. Therefore, it is recommended to increase the height of the proposed windbreaks along the north and south sides of the communal open space to at least 1.8m to meet the required comfort criteria – refer **Figure 17**.
- As proposed in the SSDA design, the 3 m tall glazed balustrades on the eastern and western edges of the rooftop, along with the 2 m high glazed balustrade on the

southern edge, will support achieving the required standing comfort criteria in this area – refer **Figure 18.**

- Wind assessments from Sensors 35 and 36 show that while standing comfort criteria were met, seating comfort thresholds were exceeded in the northern part of the rooftop area. To address this, it is recommended to increase the height of the vertical windbreak along the northern edge to at least 3m. These windbreaks may consist of balustrades or a combination of walls and planters/trees of similar height, strategically positioned around the edge to enhance comfort – refer **Figure 18.**

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.

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1.0 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) was engaged by HPG General Pty Ltd to undertake a quantitative wind assessment for the proposed mixed-use development at 37 Archer Street, Chatswood, in support of a State Significant Development Application (SSDA) for a residential tower incorporating infill affordable housing. The assessment was carried out through an Environmental Wind Tunnel Study, using a Discrete Sensor approach. Wind tunnel testing was conducted on a 1:400 scale model to assess wind conditions within and surrounding the proposed development.

The application seeks consent for the demolition of existing structures on the site and the development of a residential apartments (including affordable housing), commercial office space, food and beverage uses and retail tenancies with servicing areas and parking contained within the building's basement. A publicly accessible through site-link is also proposed providing a direct connection between Archer and Bertram Streets and allowing opportunities for outdoor dining and passive recreation.

Specifically, the SSDA seeks development consent for:

- Demolition of existing buildings, structures and trees.
- Excavation of the site to a basement depth of RL RL71.85mm.
- Construction of a mixed-use building to 28 storeys (RL184.25m) comprising residential and commercial uses.

The development of 125 apartments (including 28 affordable housing units) with residential amenities and services, commercial office space, food and beverage tenancies and retail uses.

1.1 DEVELOPMENT – DESCRIPTION AND SITE CONTEXT

The proposed building is situated on a site bounded by Archer Street to the west, Bertram Street to the east, and existing low-rise developments in the remaining directions - refer **Figure 1**.

Figure 1 Project Site Location

Image: Courtesy Nearmap, January 2025

1.2 Development Description

The proposal is for a 28-storey building with 6-levels of basement below. The development contains the following uses:

- Residential apartments: A total of 125 apartments (including 28 affordable housing units) comprising 29 x 1 bed apartments, 55 x 2 bed apartments, 30 x 3 bed apartments and 11 x 4 bed apartments with recreational facilities at Level 8.
- Office tenancies: occupying levels 2 and 3.
- Retail tenancies: double storey retail units fronting Bertram Street.
- Food and beverage tenancies: ground level.
- Basement parking: 154 car spaces, 9 motorbike spaces, 28 bicycle spaces and end of trip facilities.
- Servicing and plant equipment.
- Publicly accessible landscaped through site link.
- The gross floor area (GFA) for the proposed development is described below:
- Total GFA: 14,230sqm
  - Residential GFA: 12,318sqm
  - Non-residential GFA: 1,912sqm

Affordable housing will be provided in the form of a monetary contribution and floorspace within the proposed development.

The purpose of the project is to provide a high-quality mixed-use development in an accessible location within the Chatswood CBD, providing new market and affordable housing opportunities complemented by commercial and retail uses within this well serviced location.

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 12 July 2024 and issued for the SSDA (SSD-73277714). Specifically, this report has been prepared to respond to the SEARs requirement issued below.

Table 2 SEARs Requirements

Item	Description of Requirement	Section Reference (this Report)
8. Trees and Landscaping	Assess the number, location, condition and significance of trees to be removed and retained and note any existing canopy coverage to be retained on-site. Provide a detailed site-wide landscape plan, that: details the proposed site planting, including location, number and species of plantings, heights of trees at maturity and proposed	Section 5.0

Item	Description of Requirement	Section Reference (this Report)
	canopy coverage (as a percentage of the site area). provides evidence that opportunities to retain significant trees have been explored and/or informs the plan. demonstrates how the proposed development would contribute to long term landscape setting in respect of the site and	

1.3 Surrounding Built Environment

The site is located at 37 Archer Street, Chatswood within the Willoughby Local Government Area (LGA). The site is legally described as SP 38065 and has an area of 2,201m2. The existing development includes two buildings (multi-unit housing) of up to three storeys in height which accommodate a total of 14 dwellings. The existing development includes an inground swimming pool fronting Archer Street and single level of basement parking which is accessed from Bertram Street. Pedestrian entries are available from Bertram and Archer Street. Vegetation within the site includes planter boxes through the central circulation spaces and established trees around the site's perimeter. Street trees, comprising native species, along the site's western frontage form part of an attractive and distinctive avenue of trees.

The site is situated on the southern edge of the Chatswood CBD. The immediately surrounding area has been zoned for more intensive development and is intended to support mixed use development including high density residential uses. The existing character of the area is evolving.

The urban context surrounding the site is characterised by a mix of residential, commercial, and retail uses. The surrounding locality is described below:

North: The site is bounded to the north by low scale residential development including townhouses and single dwelling properties. This land is zoned to support high-rise mixed use development including buildings with heights up to RL246.8m. Along Archer Street proposals for mixed use towers have been lodged for properties at 51-55 Archer Street and 57-61 Archer Street.

East: The site is bound to the east by Bertram Street which comprises a two-way local road and borders the western edge of the South Chatswood Heritage Conservation Area. A locally listed heritage item at 34 Neridah Street is situated directly opposite.

South: A development application for a 14-storey mixed use development has been lodged for 31-44 Archer Street which is situated immediately to the south of the site. This area provides a transition to low scale residential uses contained within the South Willoughby Conservation Area located on the southern side of Johnson Street. There is a locally significant heritage item at 27 Archer Street.

West: To the west the site is bound by Archer Street which comprises a four-lane classified road. Existing development on Archer Street comprises medium density residential towers of 7 storeys and higher. The area has been zoned for taller buildings of up to 90m. Further to the west is the Chatswood transport interchange and Pacific Highway, linking to the CBD and wider Greater Sydney region.

The site benefits from excellent access to public and active transport and is within walking distance of the Chatswood Interchange, which provides rail and metro connections to North Sydney, Macquarie Park, and the Sydney CBD. Bus services run along Archer Street and provide connections to Chatswood and Crows Nest.

Figure 2 Project Site Surrounds

Image: Courtesy Nearmap, January 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 3** 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 3 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 a mix of typically low to mid-rise buildings to all directions.
- The site will, therefore, receive low to moderate 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.

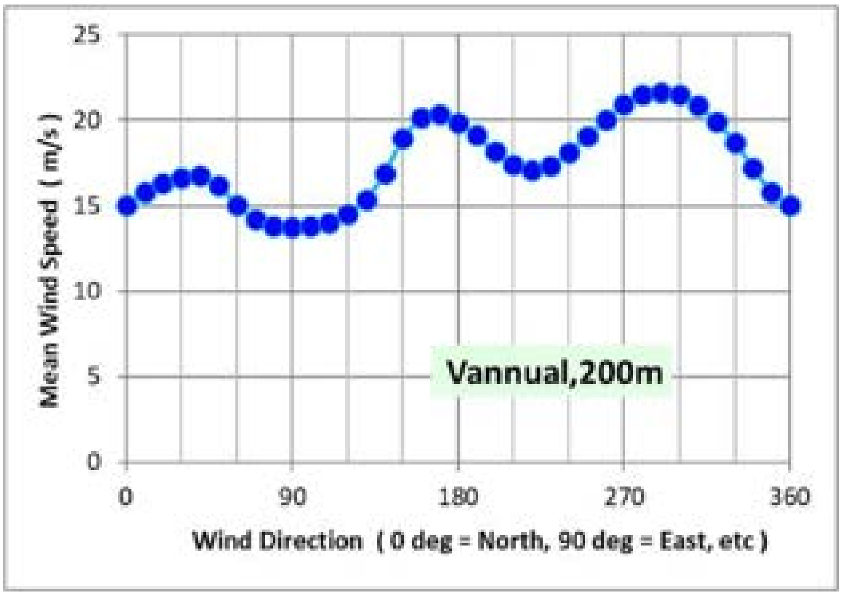
In particular, SLR has determined statistical wind information for locations not situated in close proximity (ie within say approximately a kilometre) of BoM weather stations. Particular emphasis was given to weather stations with a "clean" surrounding exposure, ie stations such as Sydney (Kingsford 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 4 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 3**; and

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

Table 3 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 4**.
- 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 4 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 5**.

Table 5 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 6**.

- 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 6 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 5** 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

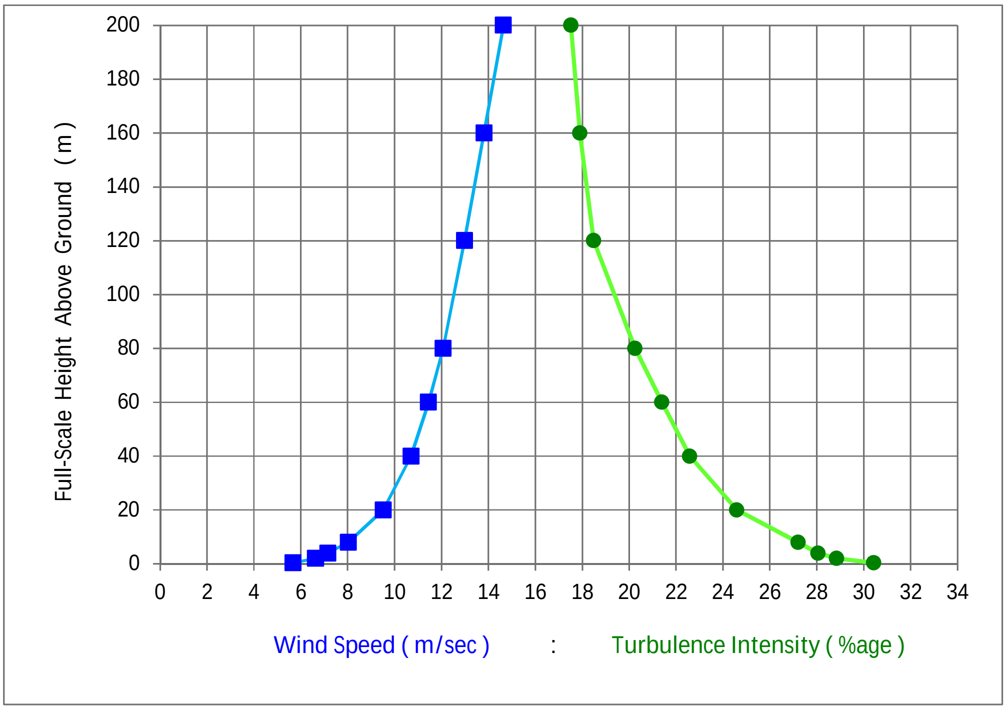
Similarity requirements between the wind tunnel model and prototype (ie full-scale) need to be fulfilled so that similitude in the flow conditions is satisfied. Usually all requirements cannot be satisfied, and compromises need to be made. In this type of wind tunnel test, it is possible to waive strict 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 1:400 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 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 5**.

Figure 5 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 based on the drawings received in December 2024, using 3D printing for testing purposes – refer **Figure 6.**

Figure 6 1:400 Scale Model of the Proposed Development (View from South)

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 **Figure 7**.

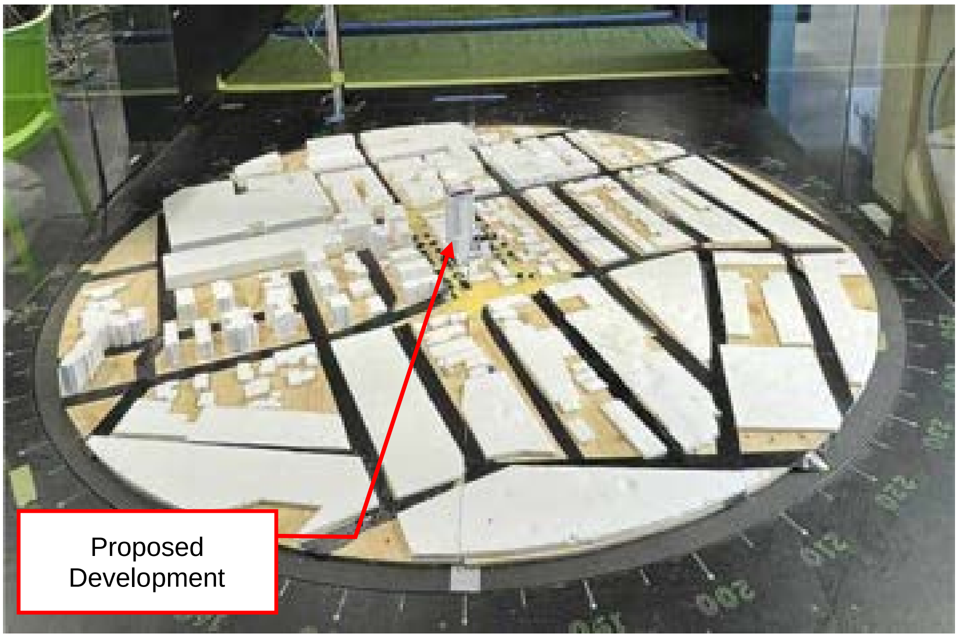
The study has involved the testing of the following built environment "scenarios":

- Scenario 1 – **"Baseline"** The existing built environment
- Scenario 2 – **"Proposed"** "Baseline" + Proposed Development
- Scenario 3 – "**Mitigation**" "Proposed" + Recommended wind mitigation treatments

Figure 7 1:400 Scale Proximity Model in Wind Tunnel

Scenario 1 – "Baseline" Scenario (Existing) – View from South

Scenario 2 – "Proposed" Scenario – View from South



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. 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

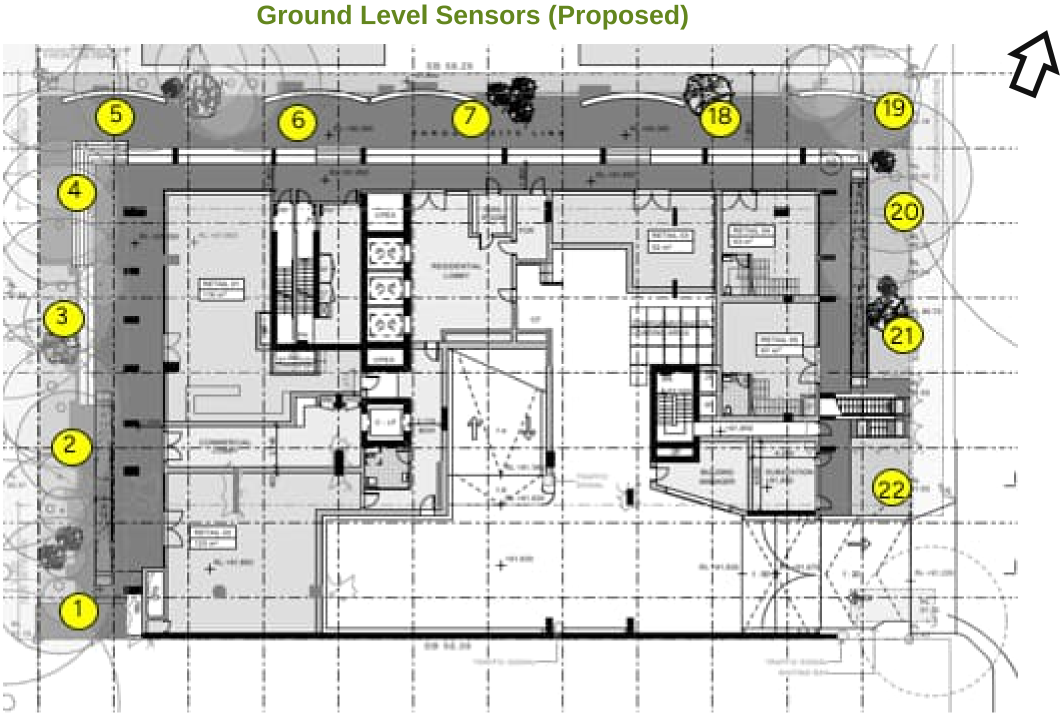
In the wind tunnel testing, Irwin wind sensors were positioned at the locations shown in **Figure 9**.

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 1-31 were positioned at ground level locations surrounding the site and were measured for all two scenarios; “Baseline” and “Proposed” test scenarios.
- Locations 32-39 were located on the elevated communal/private open areas and hence they were only measured for “Proposed” test scenarios.

Figure 8 Sensor Locations

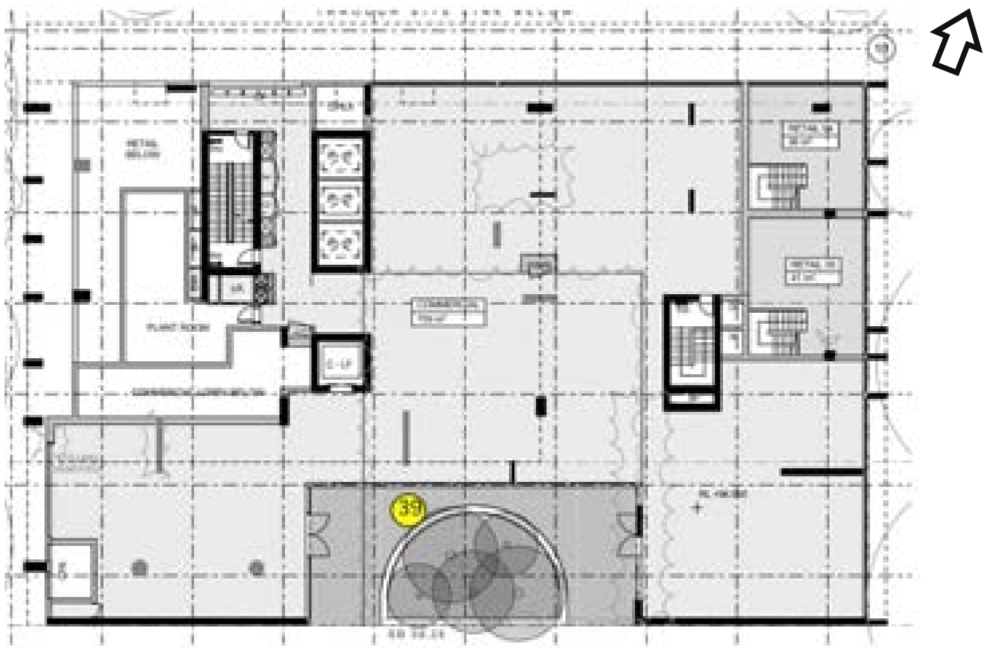
Ground Level Sensors (Proposed)



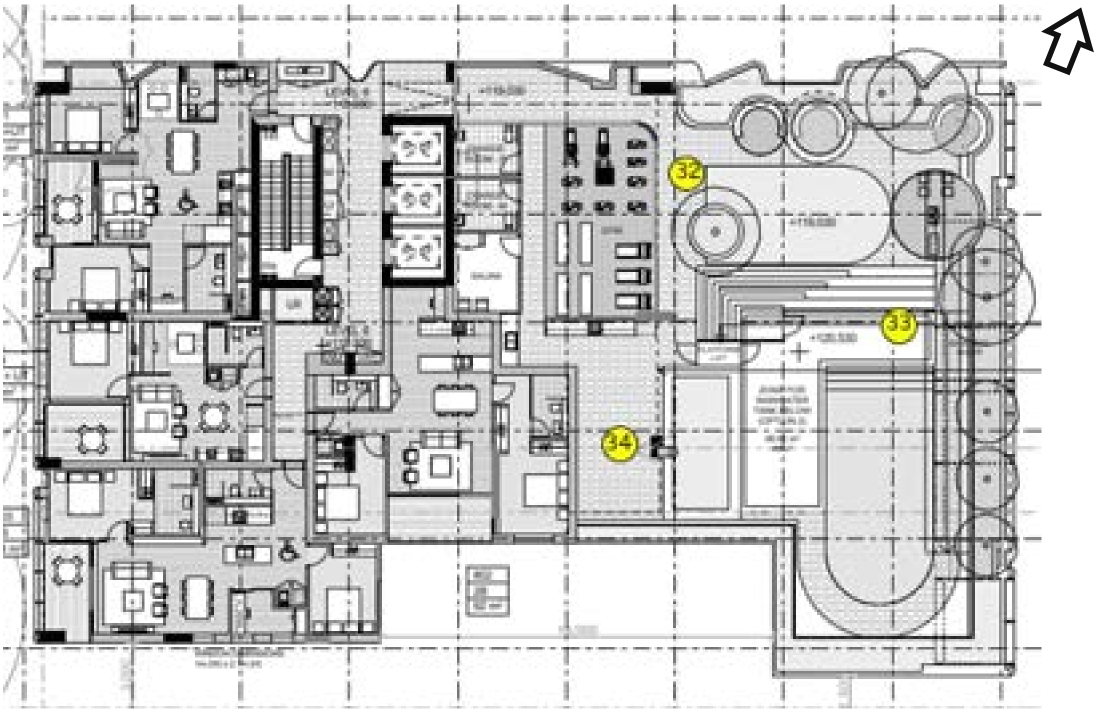
Surrounding Sensors (All Scenarios)

(Fig. 9 cont'd)

Courtyard (Level 1)

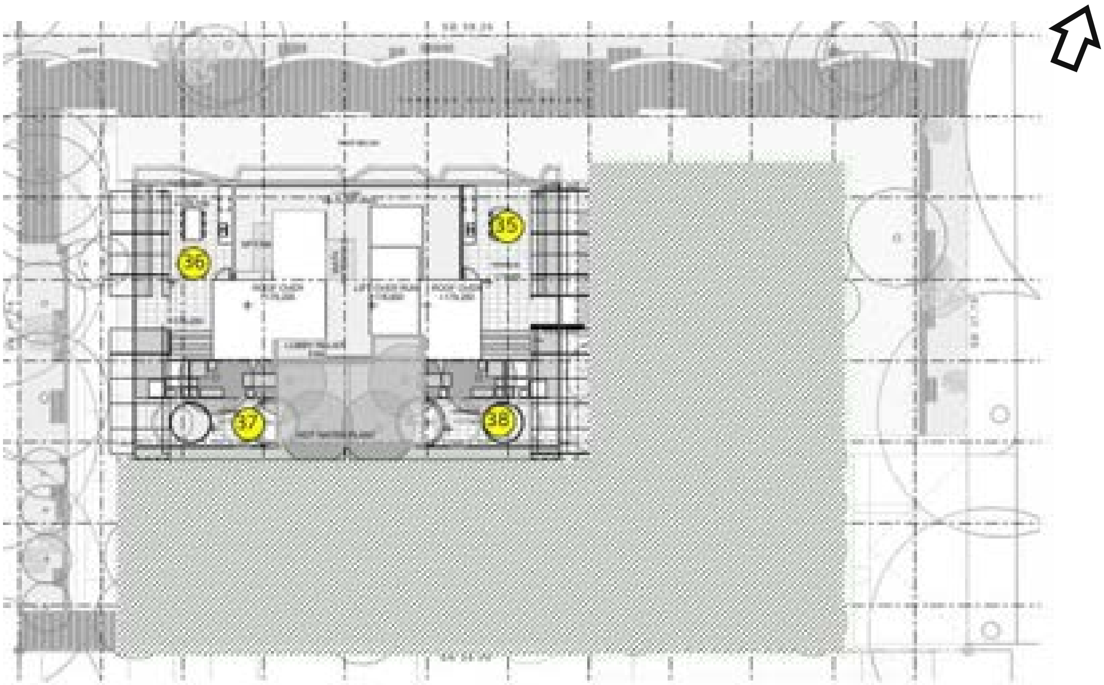


Elevated Communal Open Spaces (Level 8)



(Fig. 9 cont'd)

Elevated Private Open Spaces (Roof)



4.5 Sample Test Result

An example of the test results and interpretation of these results is shown in **Figure 9**, illustrating the peak annual mean and representative gust wind speeds at:

Sensor: **Location 5**
Location: Near the northwest corner of the proposed building

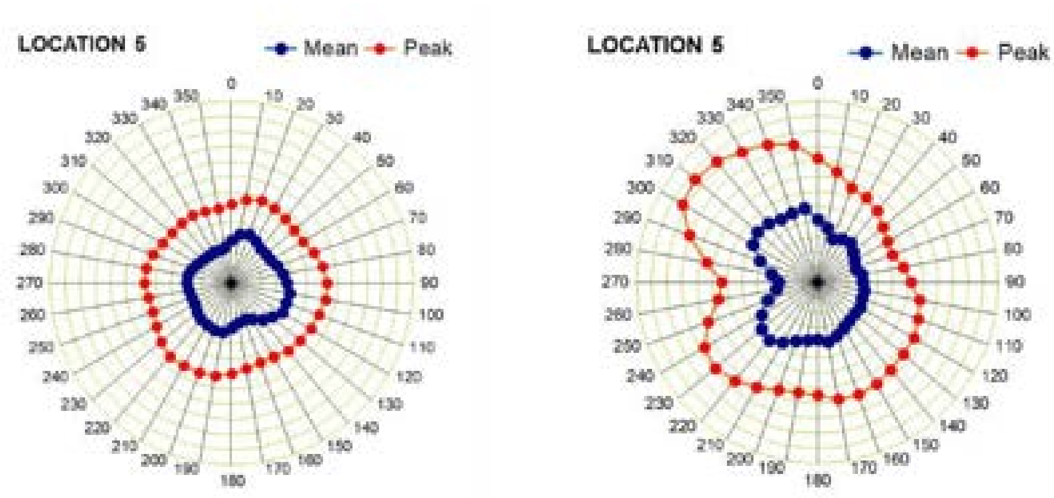
The polar diagram shows the output of the wind tunnel test results in terms of the ratio of local ground level wind speeds to the 200 m height reference mean wind speed:

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 9 Sample Polar Plot Test Result – Location 5

Scenario 1 – "Baseline" **Scenario 2- "Proposed"**



Scenario 1 - "Baseline" Scenario

- Due to the mid-rise development on the northwest side of the site, location 5 receives moderate shielding from the north and west at ground level. In contrast, the low-rise development on the north and south sides creates relatively open surroundings, which leads to slightly increased wind flow at location 5.

Scenario 2 - "Proposed" Scenario

- With the addition of the proposed development, Location 5 experiences increased wind conditions due to high-speed north-westerly and southerly winds, influenced by swirling effects and wind channelling. However, despite these changes, this location still meets the required comfort criteria.

4.6 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 5**) 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.

4.7 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 5**) 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:

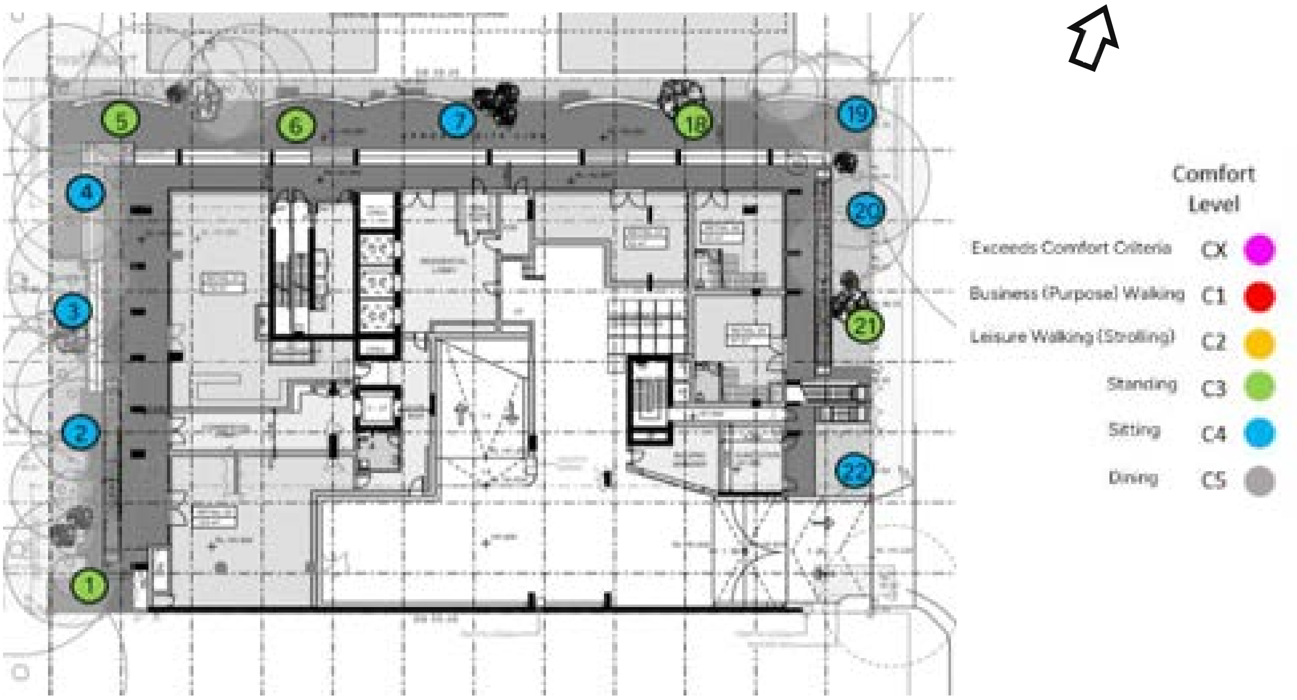
- In the “Baseline” scenario, the **peak annual gust at ALL locations** around the site are below the 23 m/s safety criterion level,
- In the “Proposed” scenario, **peak annual gusts at ALL locations** around the site continue to remain below the 23 m/s safety criterion level.

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 10** and **Figure 11**.

Figure 10 Predicted Lawson Comfort Levels - "Baseline" Scenario

Ground Level



Surrounding Area

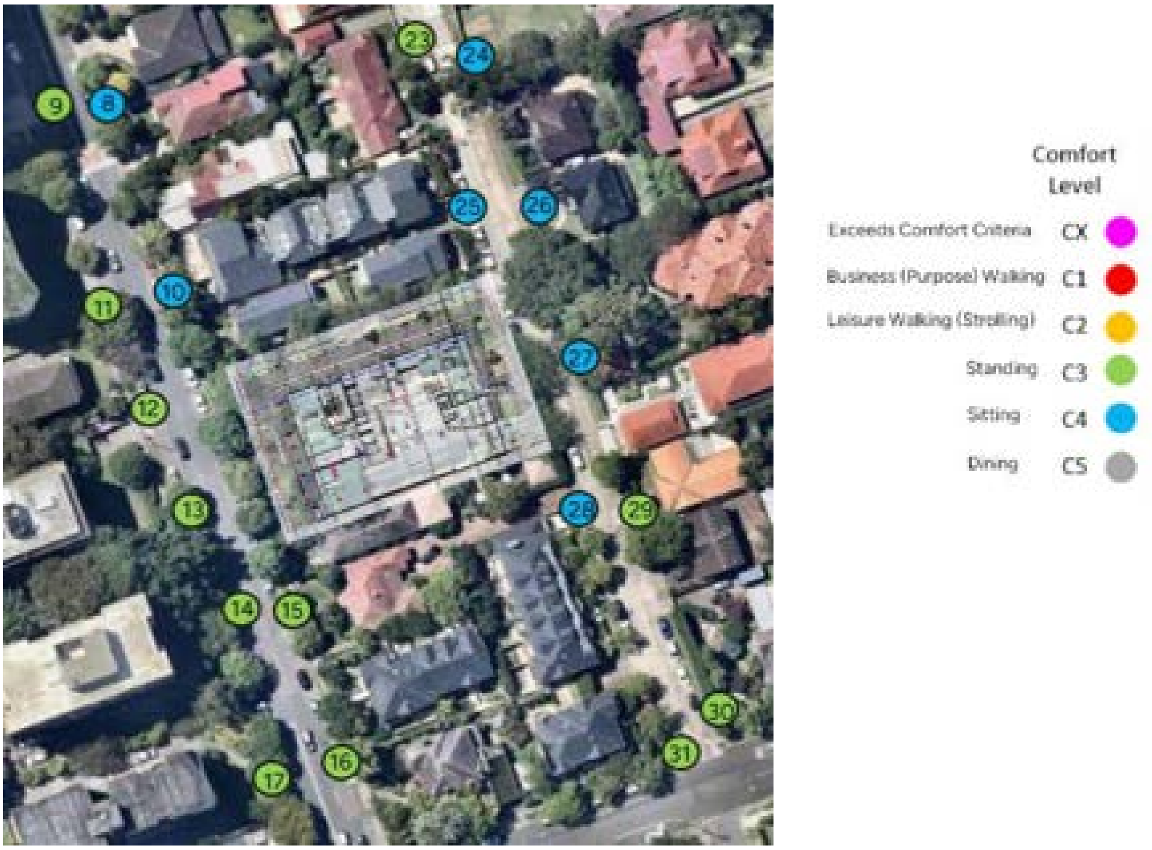
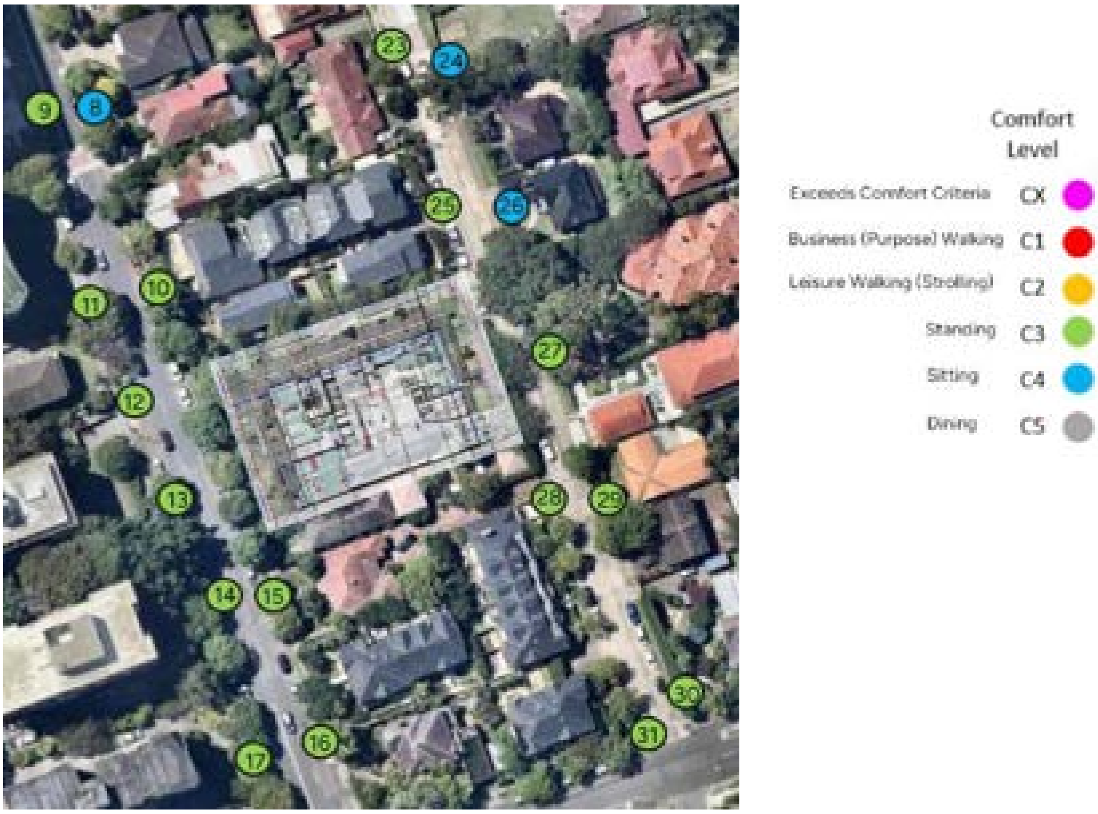


Figure 11 Predicted Lawson Comfort Levels - "Proposed" Scenario

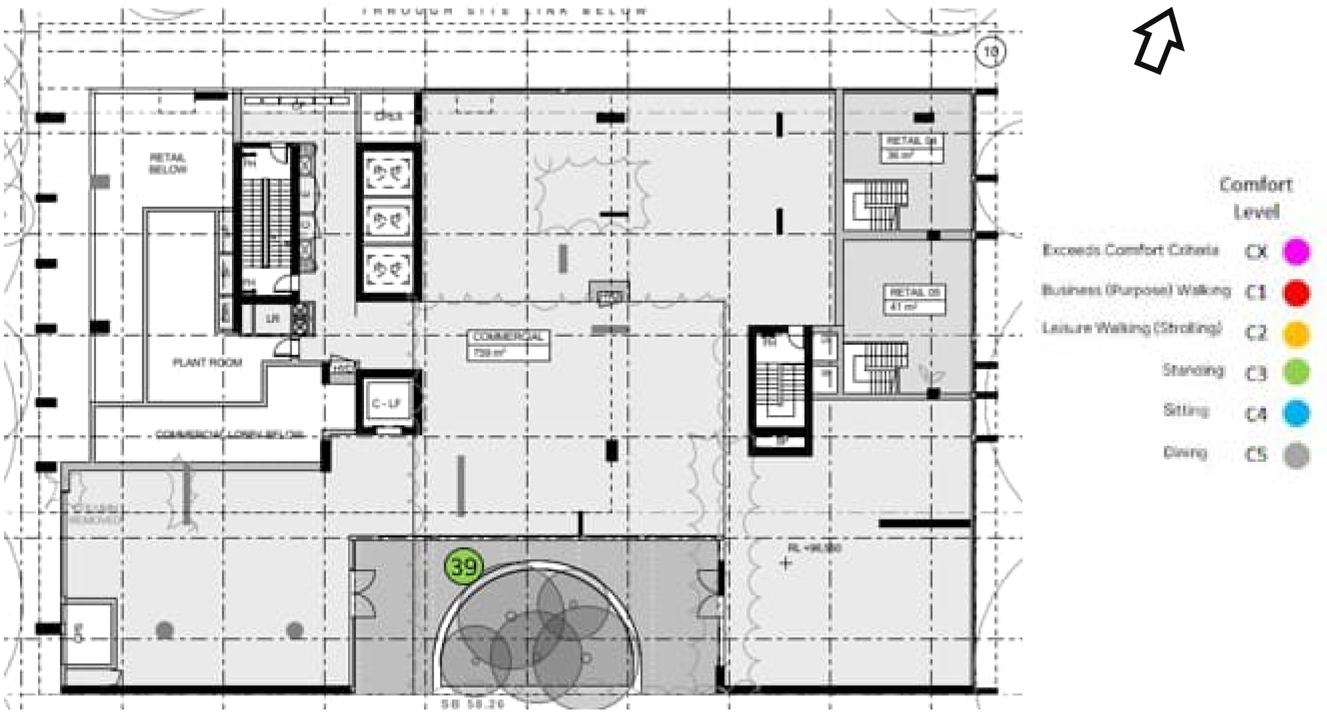
Ground Level

Surrounding Area

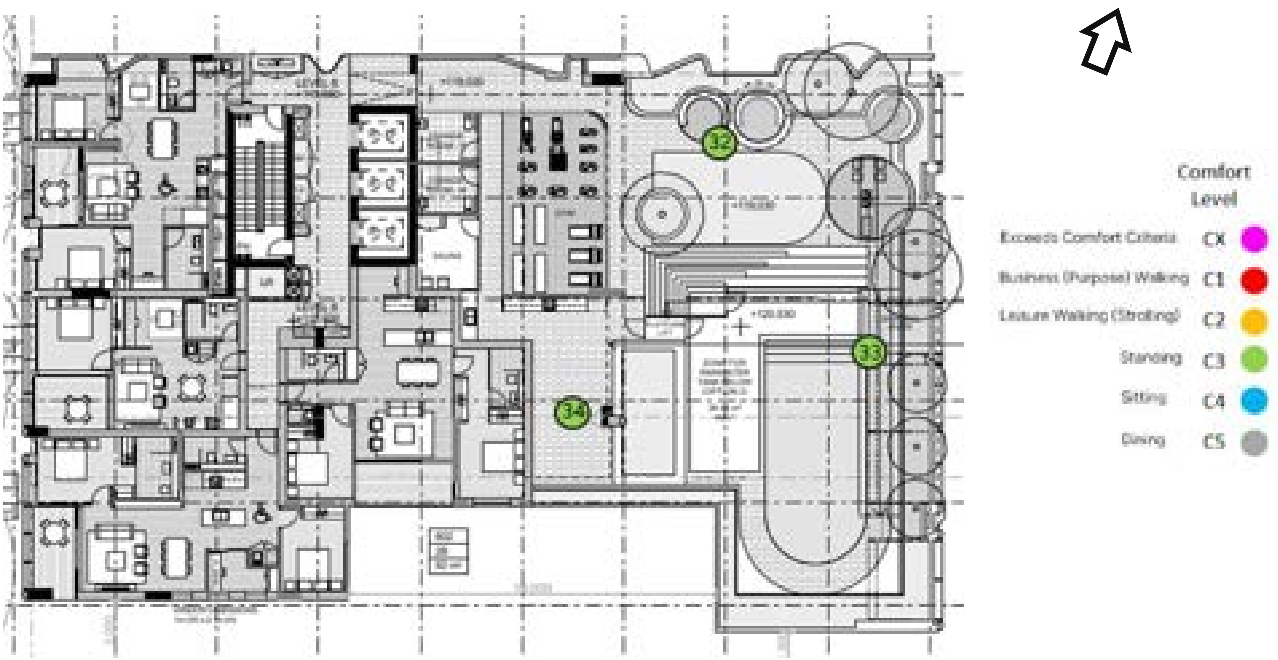


(Fig. 12 cont'd)

Courtyard (Level 1)

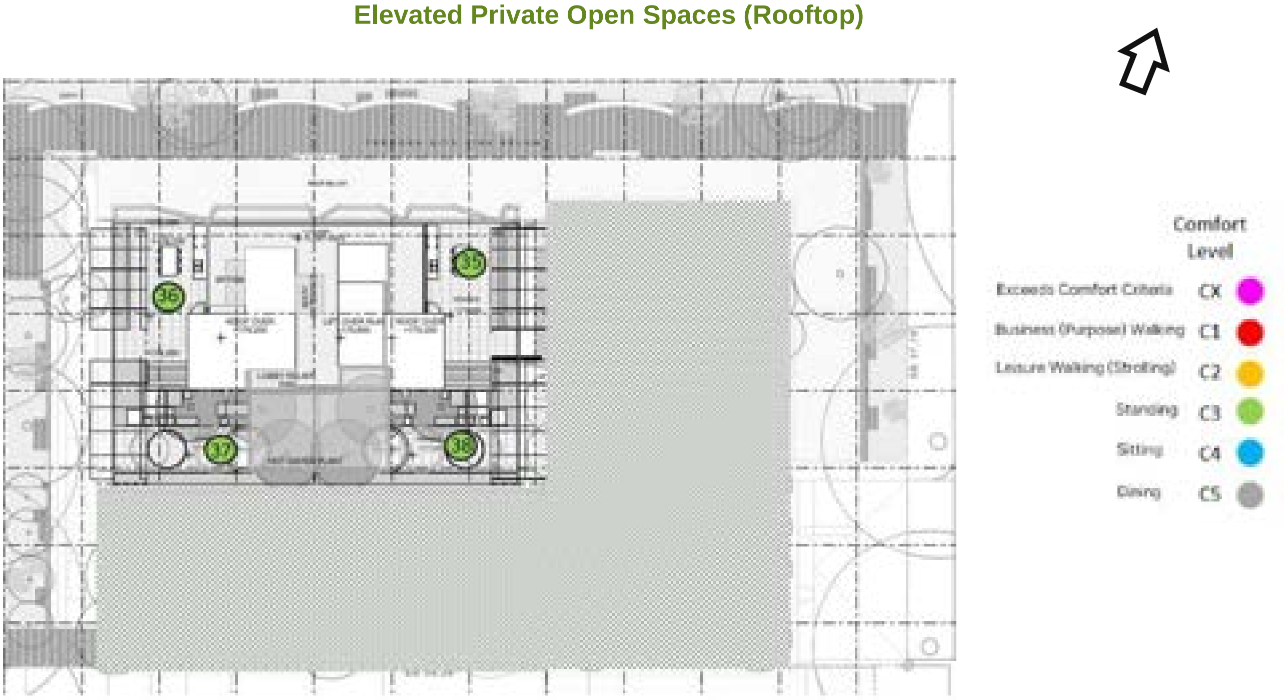


Elevated Communal Open Spaces (Level 8)



(Fig. 12 cont'd)

Elevated Private Open Spaces (Rooftop)



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 "C3" (Standing), and some locations move to the "C4" (Sitting) 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) to "C4" (Sitting) 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 "C4" (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 7 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	C2	Negligible
2	C3	C4	C3	Negligible
3	C2	C4	C3	Favourable Minor
4	C3	C4	C3	Negligible
5	C2	C3	C2	Negligible
6	C3	C3	C3	Negligible
7	C3	C4	C3	Negligible
8	C2	C4	C4	Favourable Moderate
9	C2	C3	C3	Favourable Minor
10	C2	C4	C3	Favourable Minor
11	C2	C3	C3	Favourable Minor
12	C2	C3	C2	Negligible
13	C2	C3	C3	Favourable Minor
14	C2	C3	C3	Favourable Minor
15	C2	C3	C3	Favourable Minor
16	C2	C3	C3	Favourable Minor
17	C2	C3	C4	Favourable Moderate
18	C2	C3	C3	Favourable Minor
19	C2	C4	C3	Favourable Minor
20	C2	C4	C4	Favourable Moderate
21	C2	C3	C3	Favourable Minor
22	C2	C4	C3	Favourable Minor
23	C2	C3	C3	Favourable Minor
24	C2	C4	C4	Favourable Moderate
25	C2	C4	C3	Favourable Minor
26	C2	C4	C4	Favourable Moderate
27	C2	C4	C3	Favourable Minor
28	C2	C4	C3	Favourable Minor
29	C2	C3	C3	Favourable Minor
30	C2	C3	C3	Favourable Minor
31	C2	C3	C3	Favourable Minor
32	C4	Note 1	C3	Unfavourable Minor
33	C4		C3	Unfavourable Minor
34	C3		C3	Negligible
35	C4		C3	Unfavourable Minor
36	C4		C3	Unfavourable Minor
37	C3		C3	Negligible
38	C3		C3	Negligible
39	C3		C3	Negligible

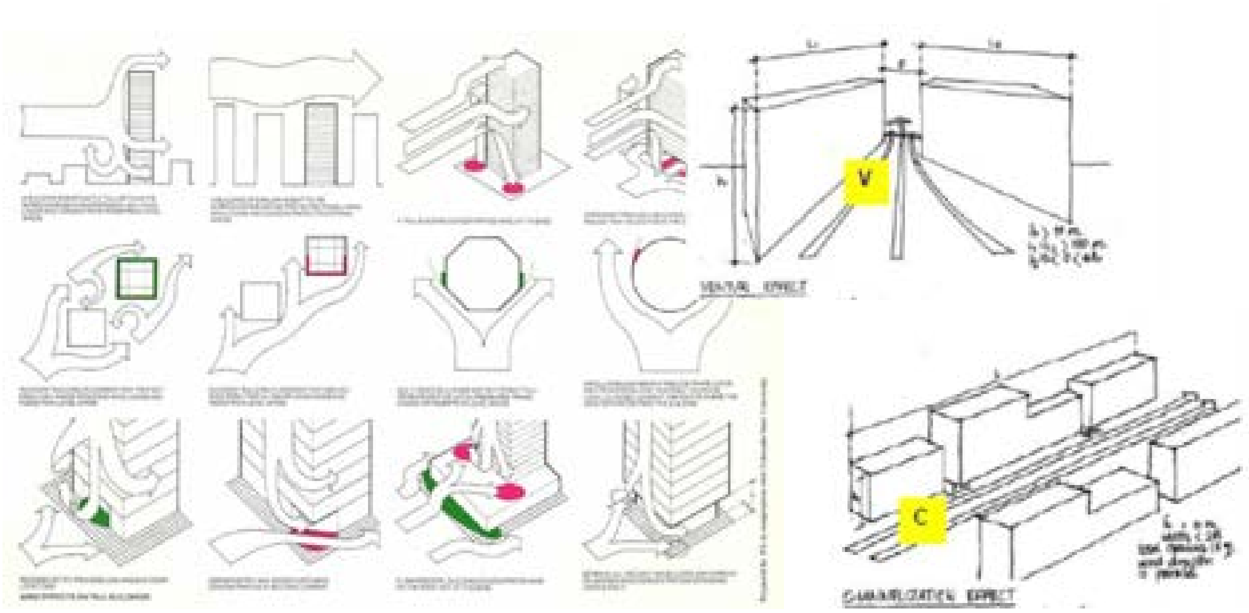
Note 1 These are ELEVATED Development locations and hence only included in the "Proposed" scenario.

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

6.0 WIND MITIGATION OPTIONS

Figure 12 shows some common wind impact flow patterns surrounding a new building development.

Figure 12 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

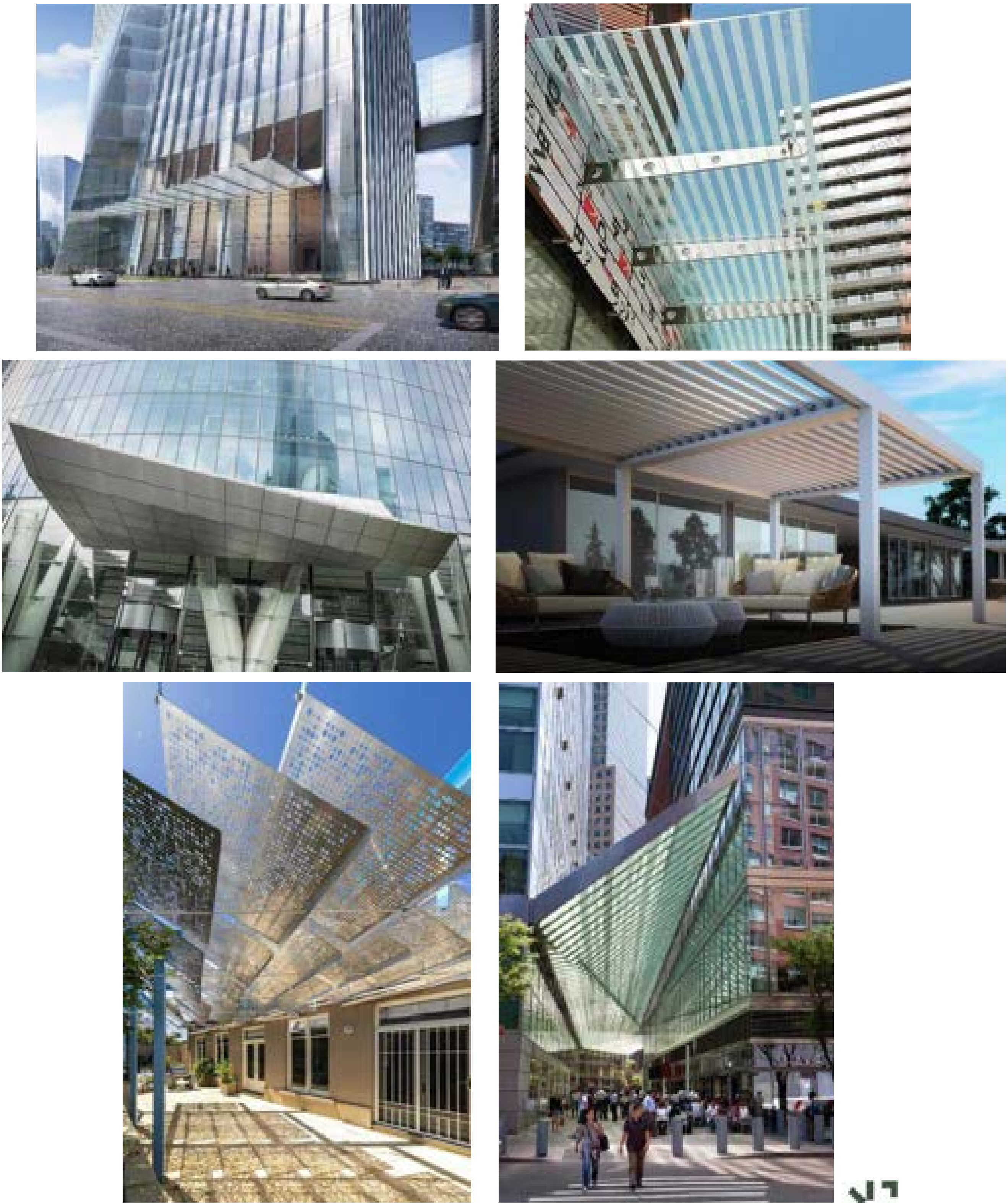
Wind mitigation options suited to ameliorating horizontal wind conditions include:

- 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 13 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 13 Horizontal Windbreak Options



6.4 Vertical Windbreak Examples

Figure 14 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).

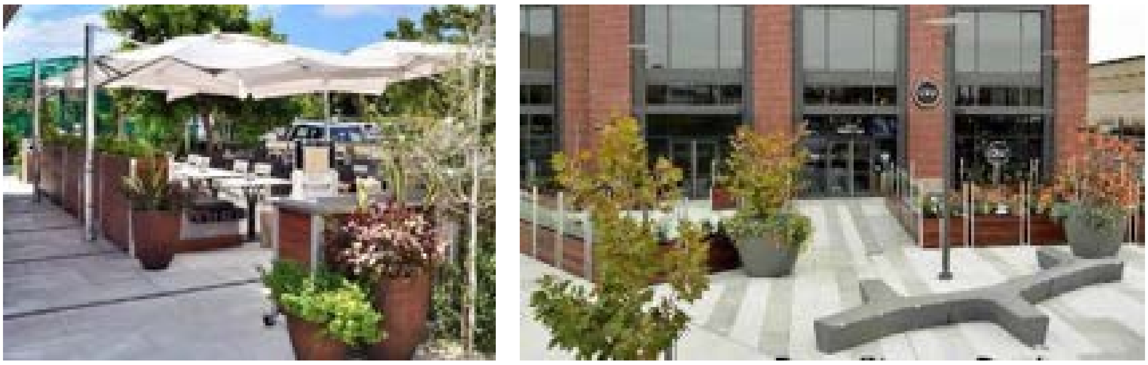
Figure 14 Vertical Windbreak Options

Landscaping

Solid

Multi-Function

Combination



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). Based on the Lawson Comfort and Safety Levels identified through the wind tunnel testing for the “Proposed”, scenario, wind mitigations are recommended for the following locations:

7.1 Wind Mitigation Recommendations

The following features, some of which have already been incorporated into the development, will significantly improve local wind conditions.

Ground Level – Figure 15

- The street trees on Bertram Street will be removed due to construction impacts and replacement planting will be provided. However, as outlined in the SSDA design the trees/landscaping along surrounding footpaths will mitigate the local wind speed effects. It is recommended that all trees and landscaping be evergreen and densely foliated to ensure year-round effectiveness.
- As proposed in the SSDA design, the setbacks and awnings at the ground-level building entries will help reduce wind speeds associated with downwash and assist in redirecting airflow along the pathways.

Elevated Communal Open Space

- The proposed vertical trees within the Level 1 courtyard, as outlined in the SSDA design, will enhance the wind conditions in this area to meet the recommended standing comfort criterion – refer **Figure 16.**
- As proposed in the SSDA design, the 3 m high glazed balustrades along the eastern and western edges of the communal open space on Level 8, along with shading over the seating areas on the eastern side and the inclusion of tall trees, will help achieve the recommended comfort criterion in this area – refer **Figure 17**.
- Wind levels at Sensors 32 and 33, located in the Level 8 communal open space, exceeded the recommended seating comfort thresholds. Therefore, it is recommended to increase the height of the proposed windbreaks along the north and south sides of the communal open space to at least 1.8m to meet the required comfort criteria – refer **Figure 17**.
- As proposed in the SSDA design, the 3 m tall glazed balustrades along the eastern and western outer edges of the rooftop, along with the 2 m high glazed balustrade along the southern edge, will help achieve the required standing comfort criteria in this area – refer **Figure 18.**
- Sensors 35 and 36 measured wind conditions in the northern part of the rooftop area, indicating that standing comfort criteria were met but exceeded the recommended seating comfort thresholds. Therefore, it is recommended to increase the height of the vertical windbreak along the northern edge of this area to at least 3m to achieve the required seating comfort criteria. Windbreaks can include a mix of balustrades or combinations of walls and planters/trees of similar height, positioned strategically around the edge – refer **Figure 18.**

Figure 15 Wind Mitigation as outlined in the SSDA design for the Development – Ground level

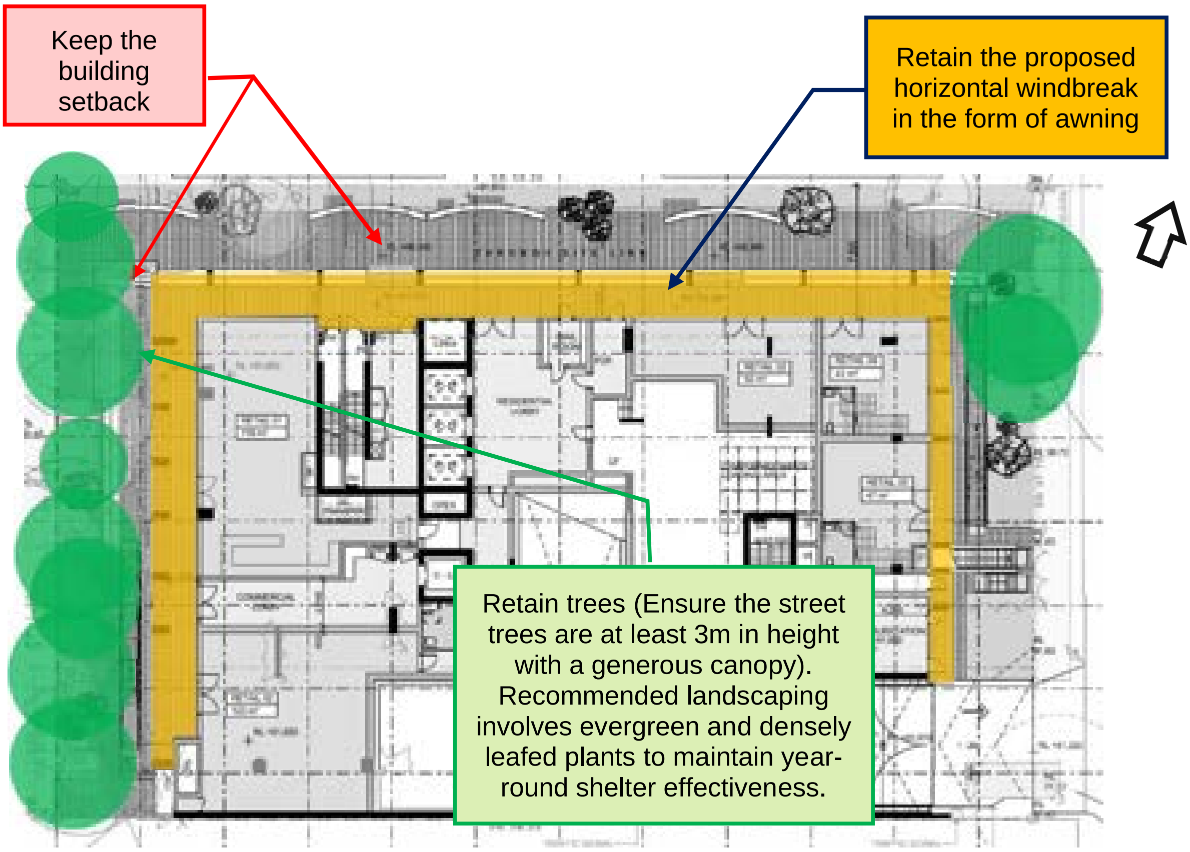


Figure 16 Wind Mitigation for the Development as outlined in the SSDA design – Level 1

Figure 17 Wind Mitigation for the Development as outlined in the SSDA design – Elevated Communal Open Space (Level 8)

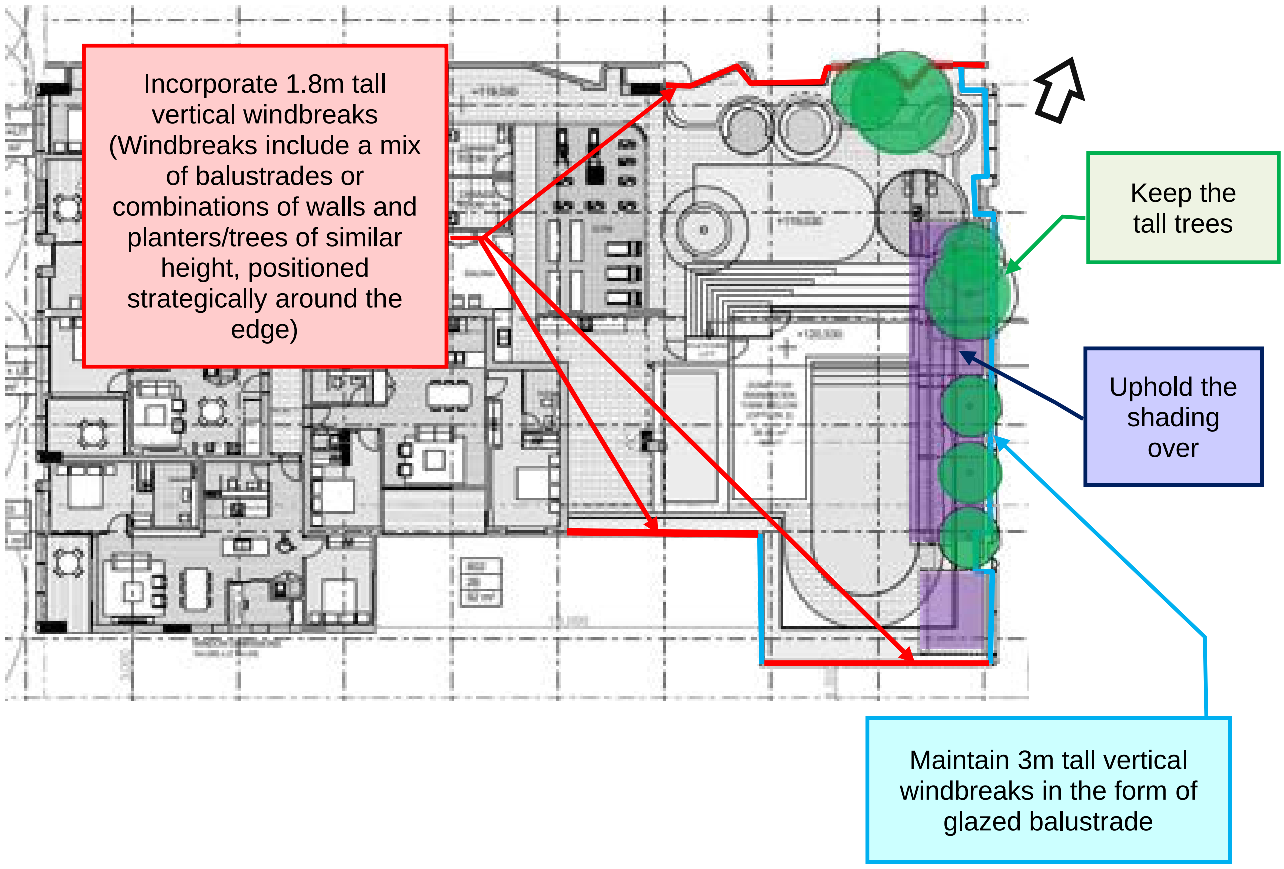
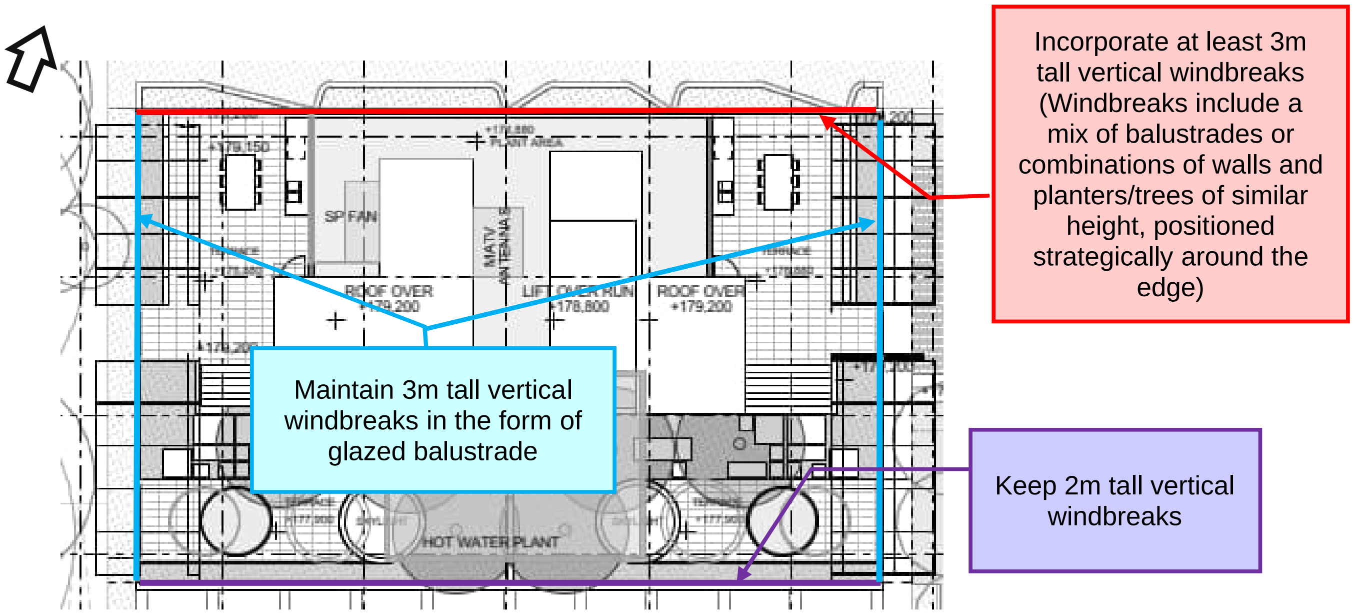


Figure 18 Wind Mitigation for the Development – Rooftop

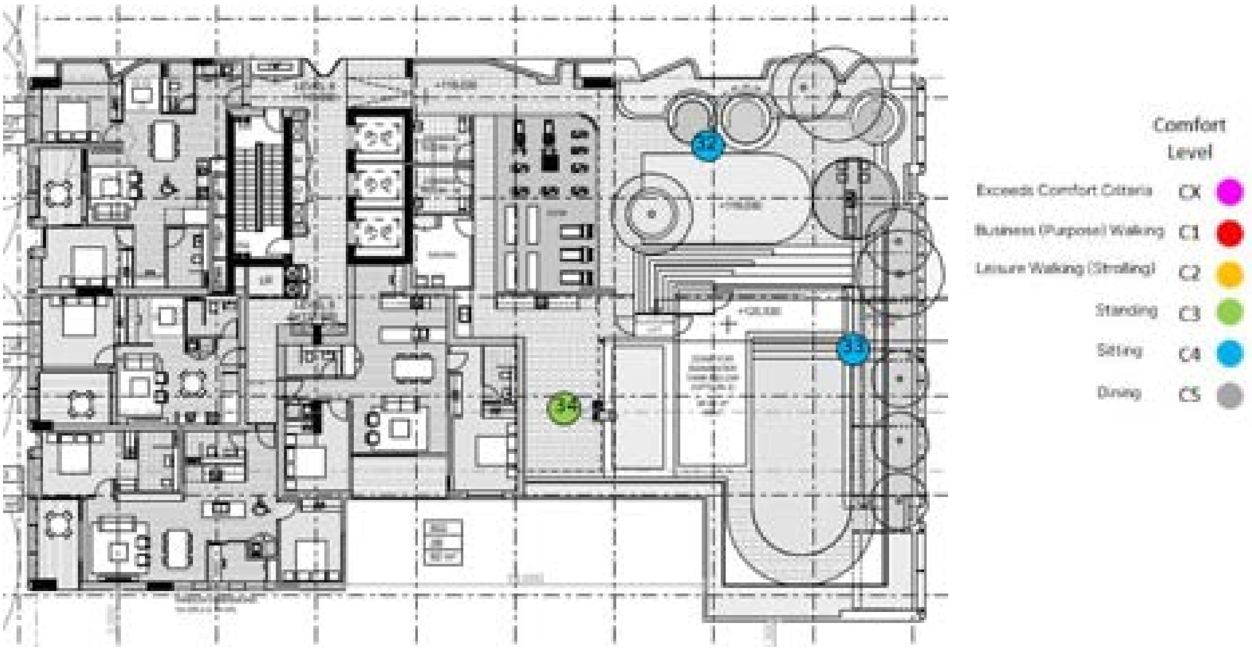


“Mitigation” Outcome – Predicted Lawson Comfort Levels

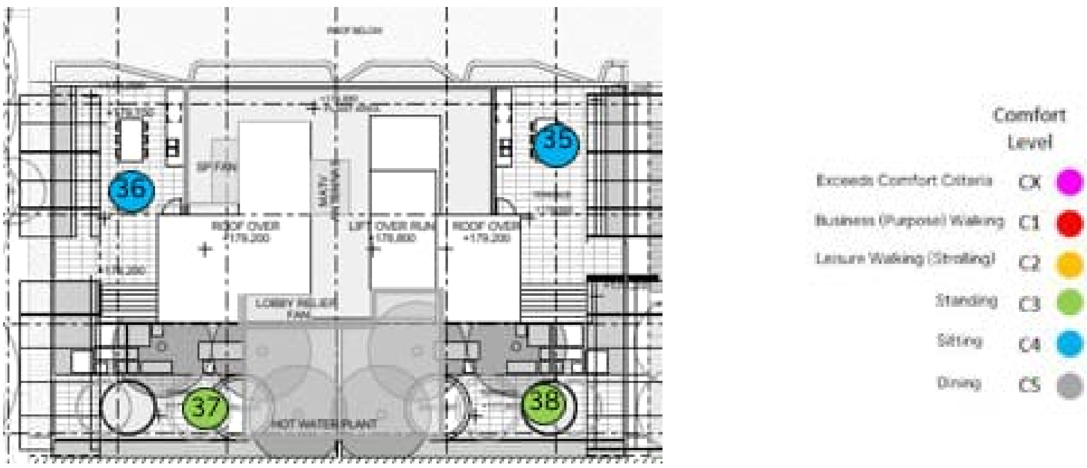
The results of the combination of wind tunnel test results (local ground level wind speed ratios) with the wind speed and wind direction probability distribution (5% annual exceedance level) derived for the site compared to the Lawson Comfort criteria for the “Mitigation” scenario are shown in **Figure 19**.

Figure 19 Predicted Lawson Comfort Levels – “Mitigation” Scenario

Level 8



Rooftop



8.0 Conclusion

This quantitative wind assessment has been prepared by SLR Consulting Australia Pty Ltd (SLR) to accompany a detailed State Significant Development Application (SSDA) for the development of a mixed-use residential tower with infill affordable housing at 37 Archer Street, Chatswood NSW 2067. This assessment was performed through an Environmental Wind Tunnel Study, utilizing a Discrete Sensor approach. Wind tunnel measurements were conducted using a 1:400 scale model to evaluate wind conditions throughout and around the proposed development. This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-73277714).

The site consists of attached townhouses within a large rectangular lot. The legal description of the site is outlined in **Table 1** below.

Table 8 Legal Description

Property Address	Title Description
37 Archer Street, Chatswood NSW 2067	SP 38065
Project Site Area	2,201m2

The proposed building is located on a site bordered by Archer Street to the west, Bertram Street to the east, and existing low-rise developments in the remaining directions. The surrounding area primarily consists of low-rise buildings to the east and south, while mid-rise buildings are present to the north and northwest. The site and its surroundings are generally flat, with no significant elevation changes.

Built Environment Scenarios Assessed

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

- Scenario 1 – **"Baseline"** The existing built environment
- 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

Using long-term wind records obtained from nearby Bureau of Meteorology stations at Bankstown Airport and Sydney Kingsford Smith Airport, SLR has determined that local upper-level winds reflective of the weather systems experienced at the site have characteristics similar to those of Sydney (Kingsford Smith) Airport, given the site's relatively close distance to the airport and similar distance inland.

“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.

- As noted in **Section 1.3**, the site is currently surrounded by a mix of typically low—to mid-rise buildings to all directions.
- The site will, therefore, receive low to moderate wind shielding depending upon oncoming wind direction at lower levels, with upper levels exposed to higher winds from a number of wind directions.

“Proposed” Wind Environment

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

- Building entries on Ground Level,
- Footpaths along the street surrounding the proposed development,
- The elevated public access areas

In terms of the future wind environment with the proposed Development, the following features of the development are noted as being of most significance:

<u>Ground level – refer Figure 15</u>

- The street trees along Bertram Street will be removed due to construction impacts, with replacement planting to be provided. However, the trees and landscaping along the surrounding footpaths, as proposed in the SSDA design, will help mitigate local wind effects. It is recommended that all new planting be evergreen and densely foliated to ensure year-round wind protection.
- As proposed in the SSDA design, the ground-level setbacks and entry awnings will assist in reducing wind speeds caused by downwash and help redirect airflow along pedestrian pathways.

<u>Elevated communal open space</u>

- The proposed vertical trees within the Level 1 courtyard, as detailed in the SSDA design, will improve wind conditions in this area to achieve the recommended standing comfort criterion. – refer **Figure 16.**
- As proposed in the SSDA design, the 3 m high glazed balustrades along the eastern and western edges of the Level 8 communal open space, together with shading over the eastern seating areas and the addition of tall trees, will contribute to meeting the recommended comfort criterion in this area – refer **Figure 17**.
- Wind assessments at Sensors 32 and 33 indicate that wind levels in the Level 8 communal open space exceeded seating comfort thresholds. Therefore, it is recommended to increase the height of the proposed windbreaks along the north and south sides of the communal open space to at least 1.8m to meet the required comfort criteria – refer **Figure 17**.
- As proposed in the SSDA design, the 3 m tall glazed balustrades on the eastern and western edges of the rooftop, along with the 2 m high glazed balustrade on the

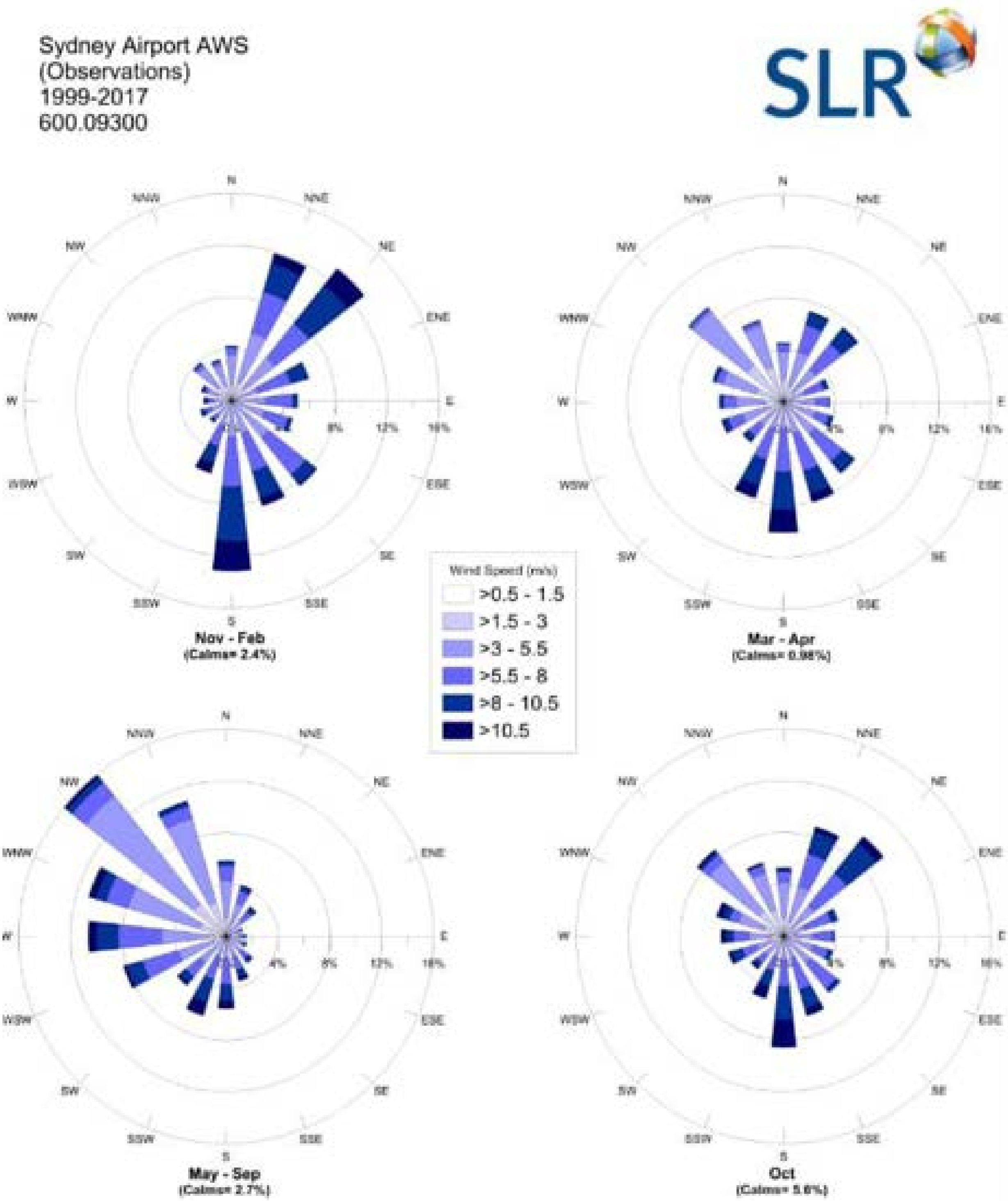
southern edge, will support achieving the required standing comfort criteria in this area – refer **Figure 18.**

- Wind assessments from Sensors 35 and 36 show that while standing comfort criteria were met, seating comfort thresholds were exceeded in the northern part of the rooftop area. To address this, it is recommended to increase the height of the vertical windbreak along the northern edge to at least 3m. These windbreaks may consist of balustrades or a combination of walls and planters/trees of similar height, strategically positioned around the edge to enhance comfort – refer **Figure 18.**

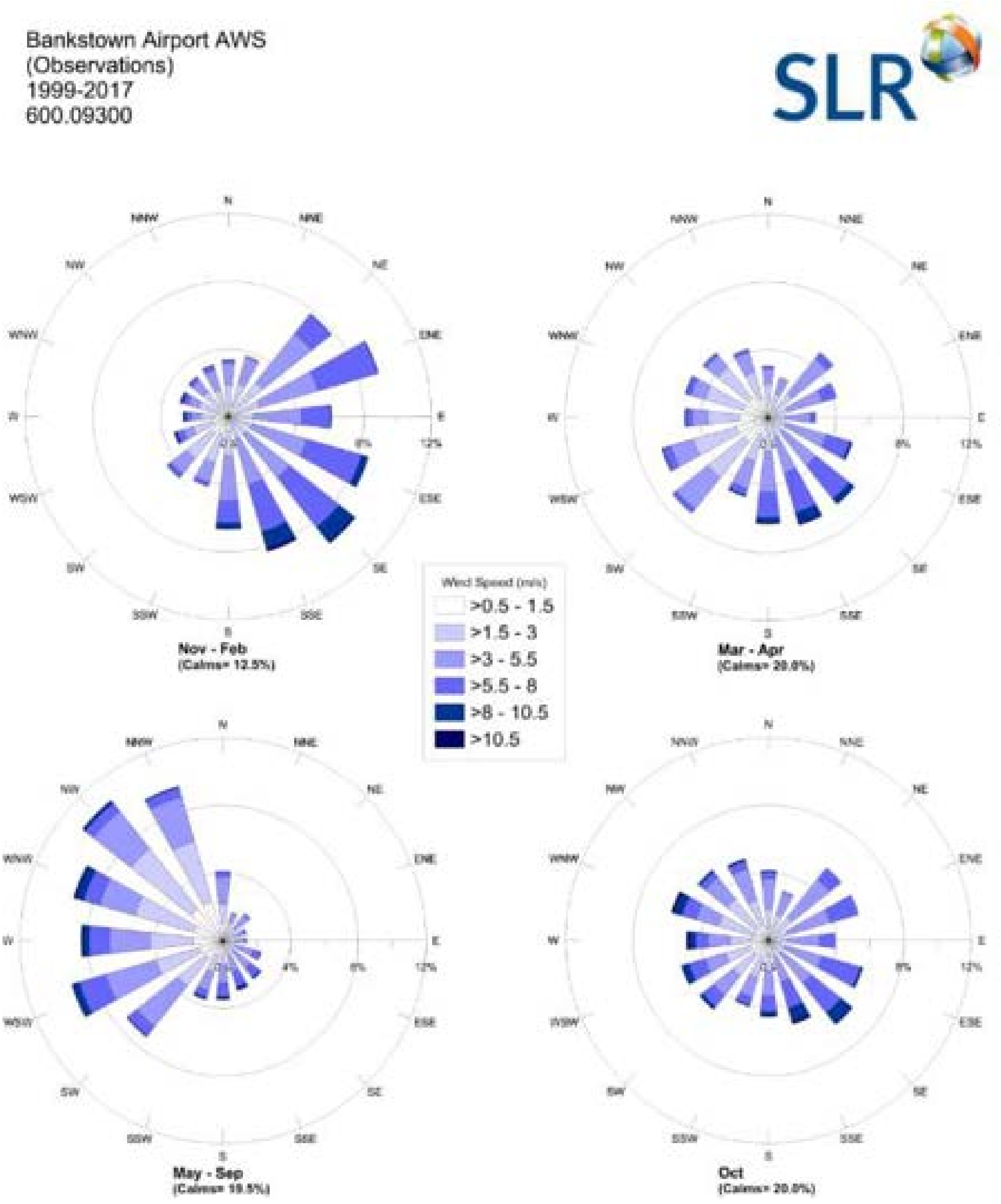
Summary

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.

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

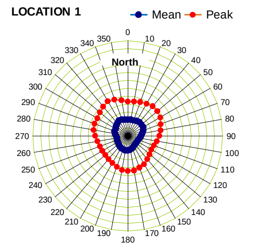

Sydney Airport AWS
(Observations)
1999-2017
600.09300
Wind Speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 5.5
>5.5 - 8
>8 - 10.5
>10.5
Nov - Feb
(Calms= 2.4%)
Mar - Apr
May - Sep
(Calms= 2.7%)
Oct

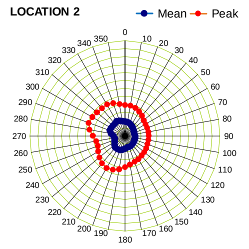

Bankstown Airport AWS
(Observations)
1999-2017
600.09300

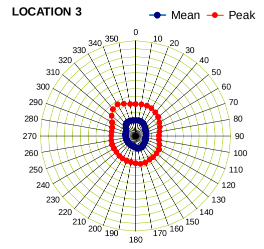

Bankstown Airport AWS
(Observations)
1999-2017
600.09300
SLR
Wind Speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 5.5
>5.5 - 8
>8 - 10.5
>10.5
Nov - Feb
(Calms= 12.5%)
Mar - Apr
(Calms= 20.0%)
May - Sep
(Calms= 19.5%)
Oct
(Calms= 20.0%)

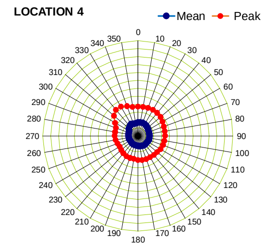
Appendix B Wind Tunnel Test Data (Polar Plots) – BASELINE Scenario

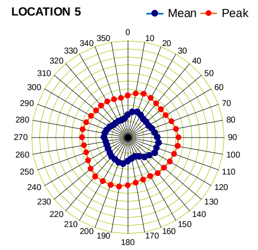
The polar diagram plots show the local (ground level) mean and peak gust wind speed as a ratio of the mean reference wind speed (at a full-scale height of 200 m).The polar diagram circumferential lines representing gradations in 0.1 intervals, ie 10% ratios.

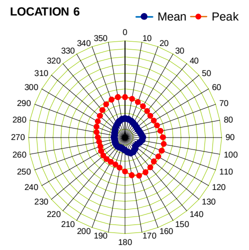

LOCATION 1
Mean
Peak
North

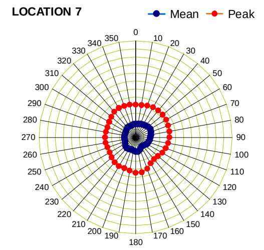

LOCATION 2
Mean
Peak

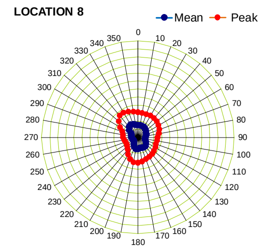

LOCATION 3
Mean
Peak

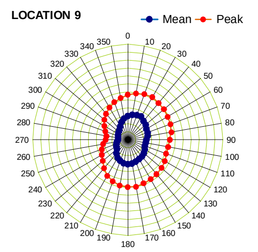

LOCATION 4
Mean
Peak

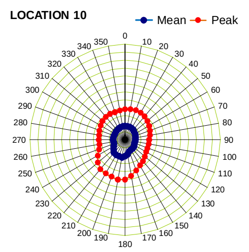

LOCATION 5
Mean
Peak

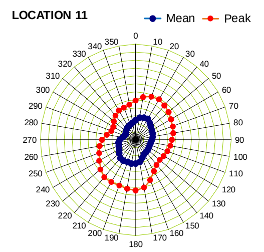

LOCATION 6
Mean
Peak

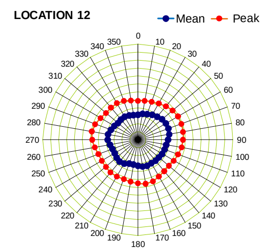

LOCATION 7
Mean
Peak

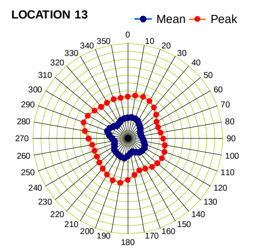

LOCATION 8
Mean
Peak


LOCATION 9
Mean
Peak


LOCATION 10
Mean
Peak


LOCATION 11
Mean
Peak


LOCATION 12
Mean
Peak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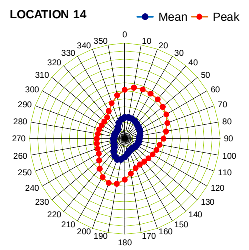
Mean
Peak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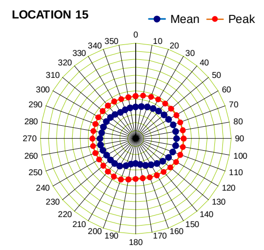
Mean
Peak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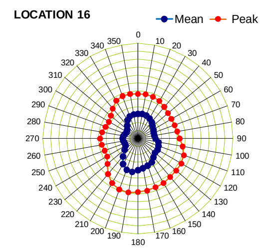
Mean
Peak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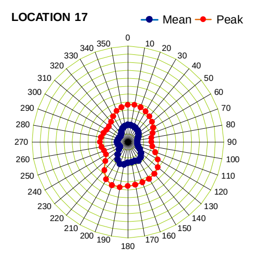
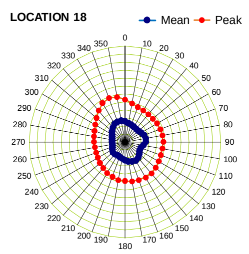
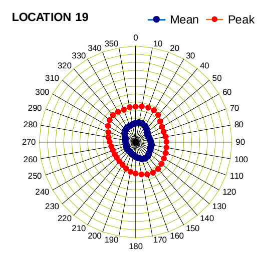
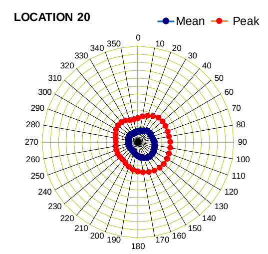
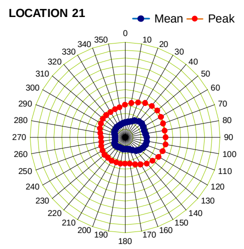
Mean
Peak

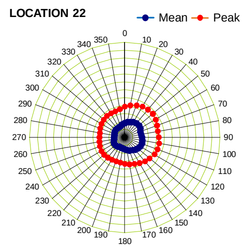

LOCATION 17
Mean
Peak

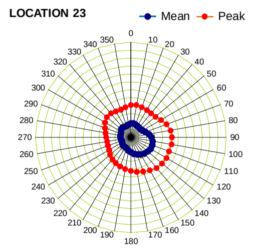

LOCATION 18
Mean
Peak

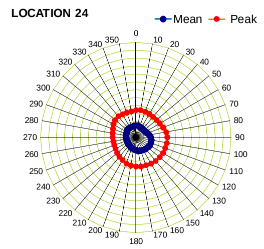

LOCATION 19
Mean
Peak

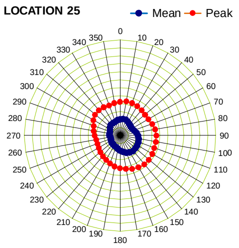

LOCATION 20
Mean
Peak

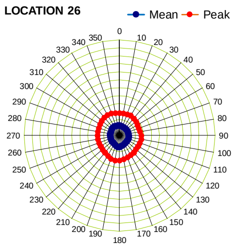

LOCATION 21
Mean
Peak

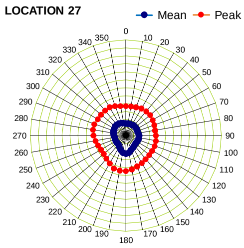

LOCATION 22
Mean
Peak

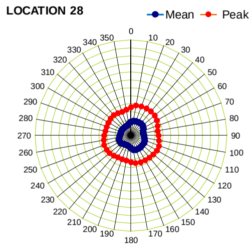

LOCATION 23
Mean
Peak

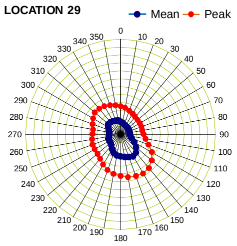

LOCATION 24
Mean
Peak

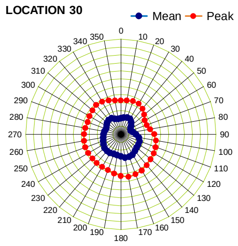

LOCATION 25
Mean
Peak

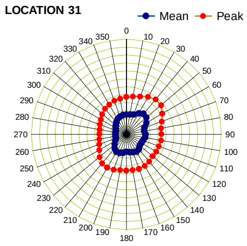

LOCATION 26
Mean
Peak


LOCATION 27
Mean
Peak


LOCATION 28
Mean
Peak


LOCATION 29
Mean
Peak

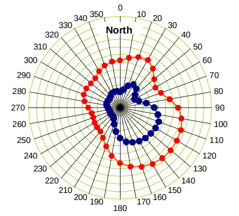

LOCATION 30
Mean
Peak


LOCATION 31
Mean
Peak

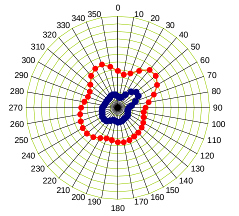
Appendix C Wind Tunnel Test Data (Polar Plots) – PROPOSED Scenario

The polar diagram plots show the local (ground level) mean and peak gust wind speedas 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.

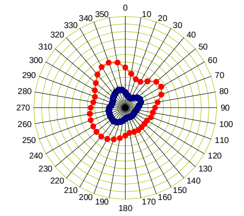
LOCATION 1



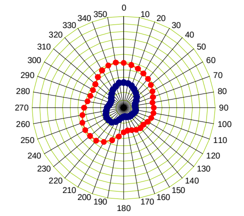
LOCATION 2



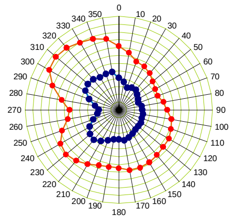
LOCATION 3



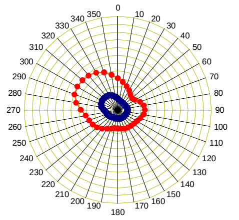
LOCATION 4



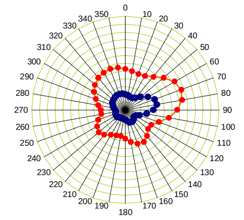
LOCATION 5



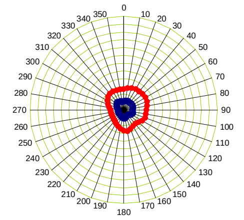
LOCATION 6



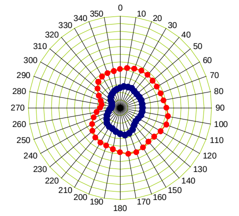
LOCATION 7



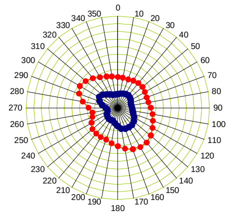
LOCATION 8



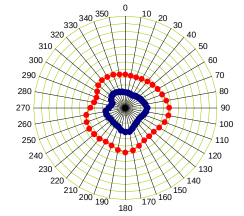
LOCATION 9



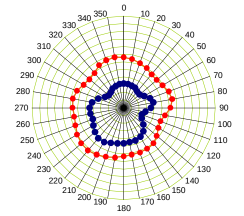
LOCATION 10



LOCATION 11



LOCATION 12



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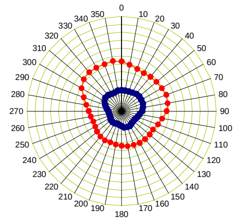
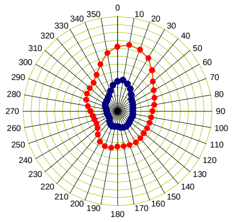
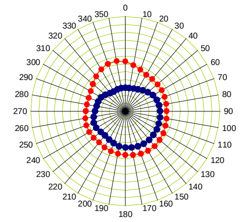


LOCATION 14



LOCATION 15



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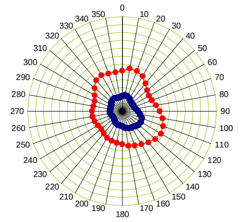

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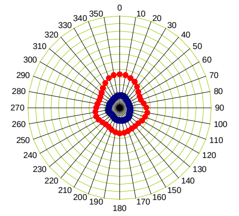

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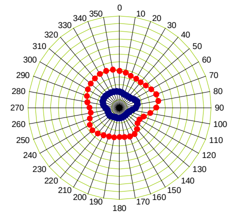

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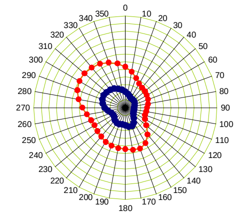

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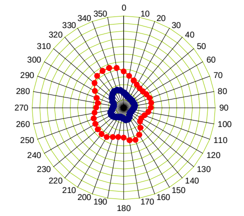
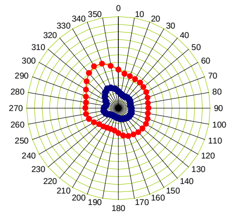


LOCATION 21



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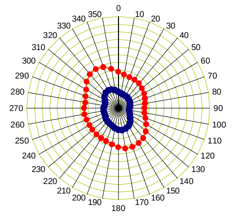

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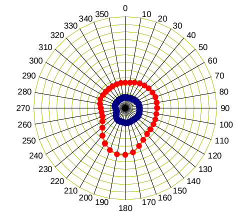

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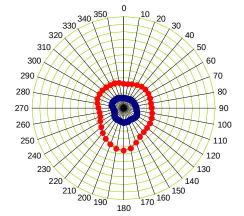
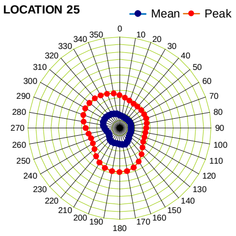
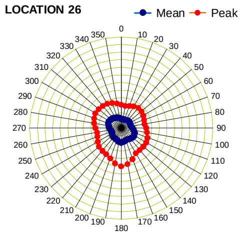
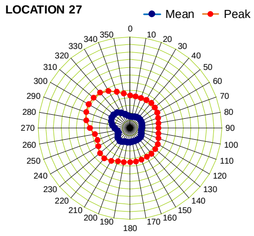
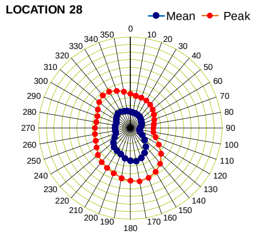
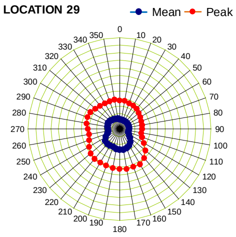



LOCATION 25
Mean
Peak


LOCATION 26
Mean
Peak


LOCATION 27
Mean
Peak


LOCATION 28
Mean
Peak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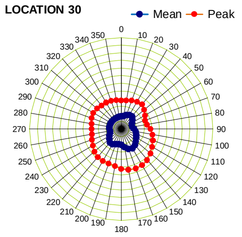
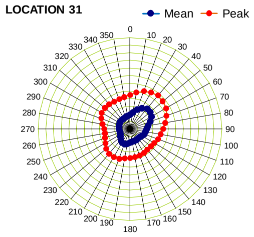
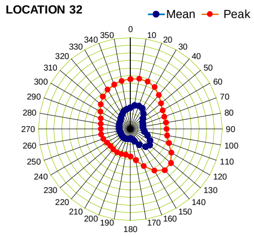
Mean
Peak


LOCATION 30
Mean
Peak


LOCATION 31
Mean
Peak


LOCATION 32
Mean
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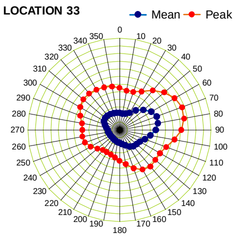
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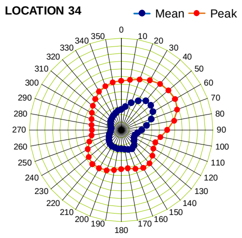
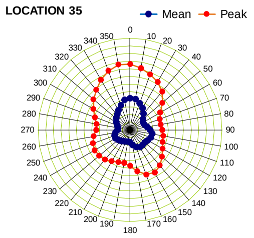
Mean
Peak


LOCATION 34
Mean
Peak


LOCATION 35
Mean
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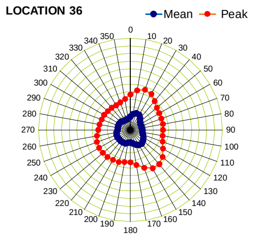
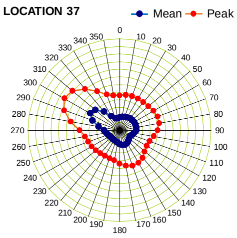
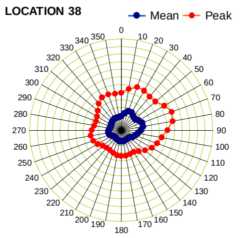
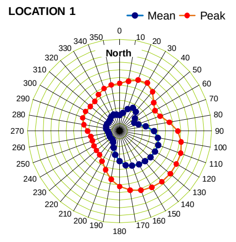

LOCATION 36
Mean
Peak

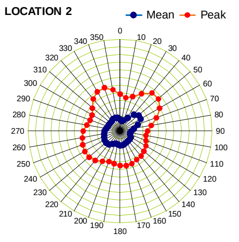

LOCATION 37
Mean
Peak

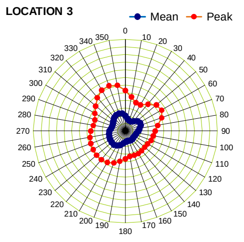

LOCATION 38
Mean
Peak

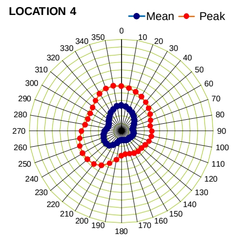
Appendix D Wind Tunnel Test Data (Polar Plots) – MITIGATION Scenario

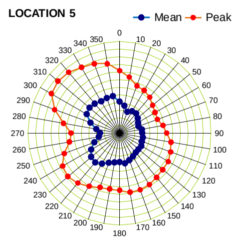
The polar diagram plots show the local (ground level) mean and peak gust wind speedas a ratio of the mean reference wind speed (at a full-scale height of 200 m).The polar diagram circumferential lines representing gradations in 0.1 intervals, ie 10% ratios.

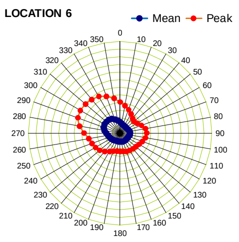

LOCATION 1
Mean
Peak
North

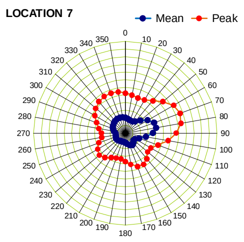

LOCATION 2
Mean
Peak

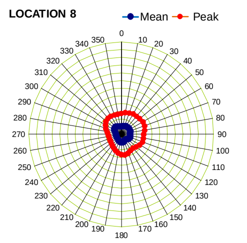

LOCATION 3
Mean
Peak

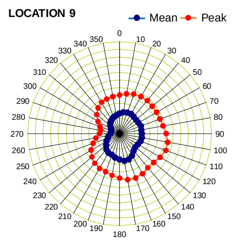

LOCATION 4
Mean
Peak

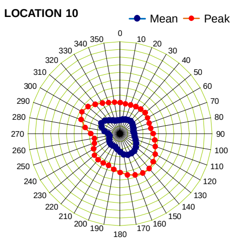

LOCATION 5
Mean
Peak

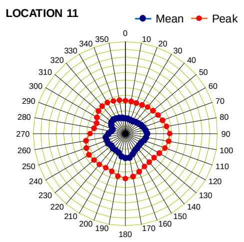

LOCATION 6
Mean
Peak

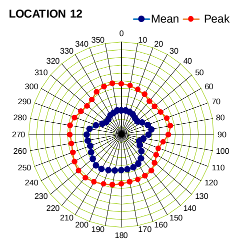

LOCATION 7
Mean
Peak

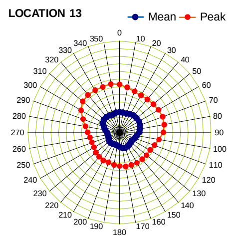

LOCATION 8
Mean
Peak


LOCATION 9
Mean
Peak


LOCATION 10
Mean
Peak


LOCATION 11
Mean
Peak


LOCATION 12
Mean
Peak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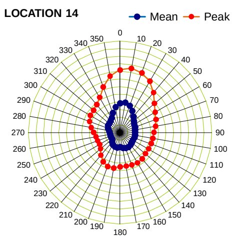
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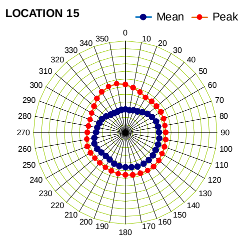
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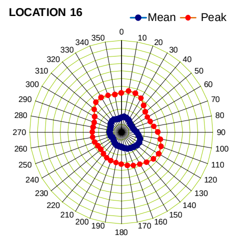
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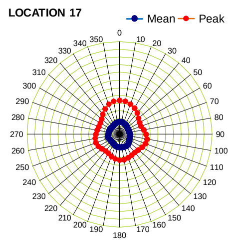
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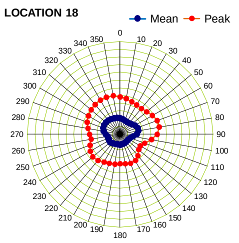
LOCATION 18
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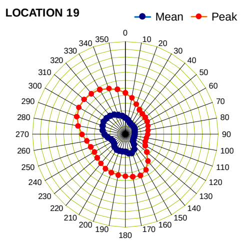
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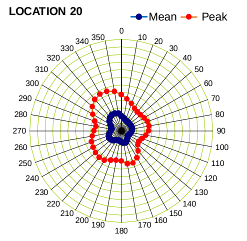
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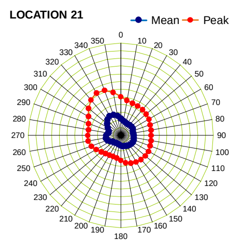
LOCATION 21
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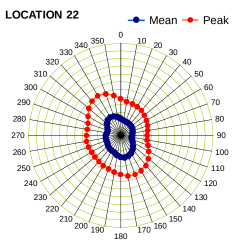
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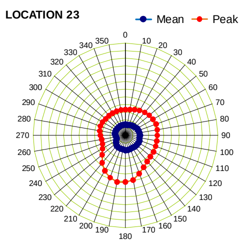
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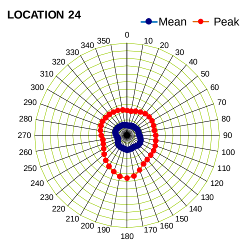
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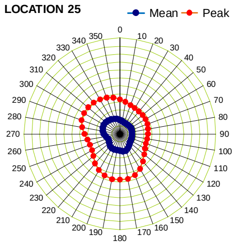
LOCATION 25
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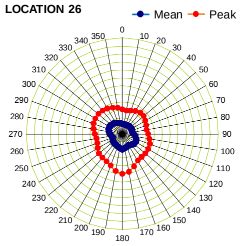
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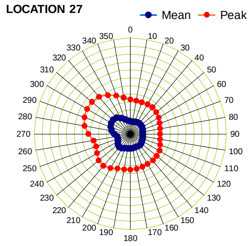
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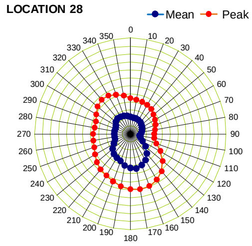
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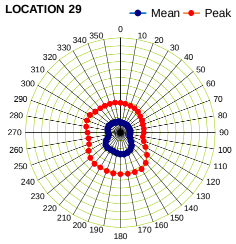
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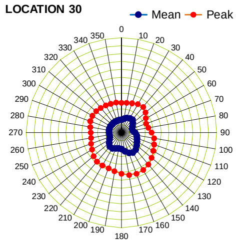
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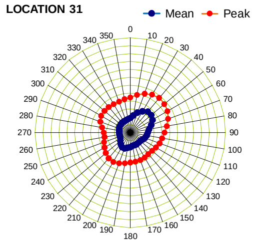
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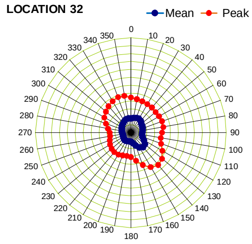
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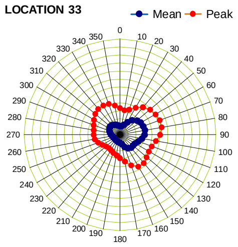
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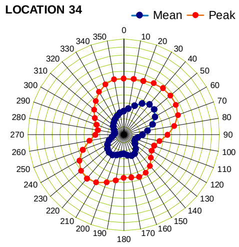
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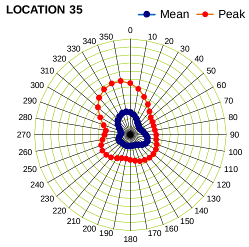
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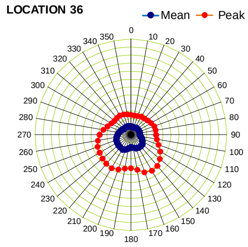
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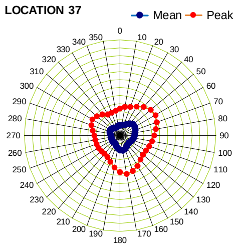
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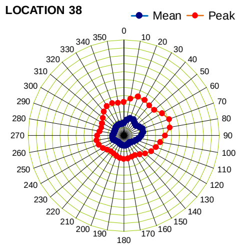
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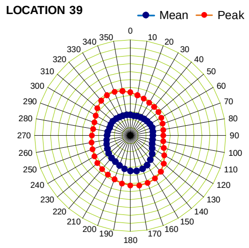
LOCATION 39
Mean
Peak

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