90-102 REGENT STREET, REDFERN

Environmental Wind Tunnel Test

Prepared for:

The Trust Company (Australia) Ltd ATF WH Regent Trust
c/o Allen Jack + Cottier
79 Myrtle Street
CHIPPENDALE NSW 2008

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with The Trust Company (Australia) Ltd ATF WH Regent Trust (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.

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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
610.18313-R12-v3.0	30 September 2020	Andy Huynh	Dr Peter Georgiou	Dr Neihad Al-Khalidy
610.18313-R12-v2.0	14 August 2020	Andy Huynh	Dr Peter Georgiou	Dr Neihad Al-Khalidy

EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Allen, Jack + Cottier, on behalf of The Trust Company (Australia) Ltd ATF WH Regent Trust, to assess the ground level wind environment around a proposed student village development located at 90-102 Regent Street, Redfern. The report is to be submitted to the Department of Planning in accordance with the application number: SSD-10382.

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

The assessment of the proposed development also included testing of the Redfern Centre Urban Design Principles "Compliant" design conforming to standard CoS set-back and building podium/height requirements.

There is no mention in the project SEARs of compliance with RWUDP. There is reference in the Project SEARs: Section 1 - "Key Issues" to consideration of the relevant provisions, goals and objectives in … *"Redfern Centre Urban Design Principles"*. There is also a direct reference to wind effects in the Project SEARs: Section 5 - "Amenity Issues" as follows:

> **5. Amenity**
> - Detail the impacts of the development on view loss, sunlight/overshadowing, wind impacts, reflectivity, visual and acoustic privacy to achieve a high level of environmental amenity.

With regarding to Regent Street, SLR notes that Regent Street is a highly trafficked thoroughfare.

The proposed development is bounded by Regent Street to the east, Marian Street to the north and William Lane to the west.

The proposal comprises of one level of basement car and bike parking; Ground Floor with building entry, common areas, retail and office units; Podium (Level 2) outdoor areas/terraces; student units; Levels 2-3 and 5-18 for student units; Roof Level.

Buildings surrounding the site are generally low and mid-rise, comprising a mix of commercial, retail and residential buildings (several of similar height to the proposed development). Gibbons Street Reserve lies to the west with Redfern train station to the north-northwest. There are a number of planned and approved future residential developments of similar height located immediately to the north, west and southwest of the proposed development, running between Gibbons Street and Regent Street. Sydney's CBD area lies to the north and the proposed SSD Waterloo Precinct development to the south-southeast.

Redfern Wind Climate

The study has developed a site-specific statistical wind climate model based on long-term wind records obtained from nearby Bureau of Meteorology stations at Sydney Kingsford Smith Airport and Bankstown Airport.

For Redfern, SLR has determined that local winds have characteristics very close to Sydney (KS) Airport compared to Bankstown Airport, given Redfern's proximity to Sydney (KS) Airport and similar distance inland from the coastline.

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Key prevailing wind directions of interest are the northeast, southeast and south for summer and mainly west quadrant winds for winter.

Wind Acceptability Criteria

The present study has adopted the so-called "Melbourne" criteria for assessment, currently referenced by many Australian Local Government Development Control Plans in relation to wind impact.

Built Environment Scenarios Assessed

The proximity models used in the present testing simulate the following built environment "scenarios":

- "Baseline" scenario: Existing built environment (as of April 2020);
- "Baseline-F" scenario: "Baseline" + future proposed 13-23 Gibbons Street development(SW of site).
- "Future-P" scenario: "Baseline-F" + future proposed development.
- "Future-C" scenario: "Baseline-F" + CoS "Compliant" design.
- "Mitigation" scenario: "Future-P" + proposed mitigation.

All of the above scenarios include the approved future developments lying to the immediate west of the site.

"Baseline" (Existing) Wind Environment

The "Baseline" scenario testing showed that. with the existing built environment, a number of pedestrian areas in surrounding thoroughfares were found to lie above the adopted 16 m/s walking comfort criterion but below the 23 m/s safety criterion, with the exception of Locations 19, 20 and 22, which lie on Marian Street, which just exceed the criterion. The latter condition arises from the channelling of westerly winds along Marian Street upstream of the proposed development site.

- Wind conditions predicted in the wind tunnel testing did not have the advantage of the mature and extensive vegetation and trees along footpath areas of interest (eg Gibbons Reserve, Regent Street, etc) – refer **Figure 15**. These would have an ameliorating (ie sheltering) effect, in some cases significant, on local wind speeds; and throughout the year, given that they generally comprise evergreen species. For example, Gibbons Reserve trees would have an ameliorative impact on Marian Street conditions for westerly winds.

"Future" Wind Environment – Surrounding Pedestrian Footpath Areas

The "Future" scenario testing showed that ground level locations surrounding the site continue to have the potential to experience wind speeds above the adopted 16 m/s walking comfort criterion.

- Locations 19, 20 and 22 are essentially unaffected by the addition of the propose development, similarly by the addition of the "Compliant" design building.

Future-Proposed versus Future-Compliant

- There were 3 ground level locations where the Future-Compliant Design peak annual gust was the same as the Future-Proposed Design.

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- There were 11 ground level locations where the Future-Compliant Design peak annual gust was lower than the Future-Proposed Design (differences typically around 1 m/s).
- There were 12 ground level locations where the Future-Compliant Design peak annual gust was higher than the Future-Proposed Design (differences typically around 1 m/s).
- Both the Future-Proposed and Future Compliant designs had a similar number of exceedances of the 16 m/sec walking comfort criterion.
- In most instances, these exceeedances, eg along Marian Street to the west of the site, also existed in the two "Baseline" test scenarios.

On the basis of the above, it is concluded that the "Future-Proposed" Design performs essentially idential, wind-wise, to the "Future-Compliant" Design.

Podium Areas

For many wind directions, the Podium (Level 2) is significantly sheltered by the proposed development itself and the adjacent similar height buildings to the immediate north and west. For some other restricted wind directions, the Podium has the potential to experience elevated wind conditions as windflow accelerates past the proposed development's eastern and southern façades and is directed downwards as downwash and accelerated shear flow.

- Wind conditions on the Podium were tested in the wind tunnel without the benefit of any of the landscaping already proposed for the Podium.
- The areas on the podium satisfy the 13m/s Standing-Waiting-Window Shopping criterion, with Location 30 satisfying the 10m/s outdoor dining criterion.
- It is also important to appreciate that, while the Podium has the potential to attract elevated winds from building floors above (downwash, etc), especially at the northwest corner, these winds are thereby prevented from generating the same impact at ground level locations immediately below. The Podium therefore plays a potentially important role in ameliorating ground level wind conditions in surrounding pedestrian areas.

Already Planned and Existing Wind Mitigation

The current round of wind tunnel testing did not include the following features, all of which would have had an ameliorating impact on local wind speeds:

- Landscaping proposed around the development site – refer **Figures 2 and 19A**;
- Vegetation and trees along Regent Street and the Gibbons Street Reserve – refer **Figure 15**;
- Tree planting and landscaping planned for the Level 2 Podium – refer **Figure 19B**.
- Existing vegetation and trees along Regent Street and the Gibbons Street Reserve - refer **Figure 17**;

The "Future-P" scenario testing did incorporate the proposed full perimeter awning along the development's northwest corner and northern and eastern façades - refer **Figure 2** and **Figure 19B&C**.

We recommend retention of the existing awnings protecting ground level footpaths and all of the trees and landscaping, existing and planned.

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- It is recommended that all "proposed" and "replacement" trees are evergreen and of similar foliage as the existing trees.

Podium – Level 2

The wind tunnel measurements have shown that:

- Locations 27 experience peak annual gust wind speeds of 6 m/s satisfying the 10 m/s sitting and dining criterion.
- Locations 28 and 30 experience peak annual gust wind speeds of 11m/s satisfying the 13 m/s standing criteria.
- Location 29 experience peak annual gust wind speeds of 12 m/s satisfying the 13 m/s standing criteria.

If areas were to be used for seating or for longer duration activities the 10 m/s sitting criterion should be satisfied. As a result, wind mitigation here should include both horizontal protection (eg awnings, canopies, etc) and vertical protection (balustrades, vertical screens, landscaping, etc).

The included tree planting on the Level 2 Podium would further mitigate adverse wind conditions in these areas and are expected to meet the 10 m/s sitting and dining comfort criterion – refer **Figure 19B**.

Similarly, the northern outdoor space is also expected to satisfy the 10 m/s sitting and dining criterion, with the included awning which extends to the proposed vertical screens as shown in **Figure 19C**.

We recommend retention of:

- The proposed awnings along the northern, eastern and western aspects of the terrace areas – refer **Figure 19C**.
- The proposed full height vertical screens on the Level 2 Podium – refer **Figure 19B**.
- The proposed tree planting on the Level 2 Podium – refer **Figure 19B**.

It is recommended that:

- Proposed landscaping around the podium level areas to be evergreen – refer **Figure 19B**.

"Mitigation" Scenario Testing

The "Mitigation" scenario demonstrates that all of the areas identified within the "Future-P" scenario as requiring consideration of windbreak treatment can successfully be addressed through a combination of:

- Vertical screening, especially ground level public access areas – including vertical screens, landscaping, etc;
- Awnings, canopies and pergolas (especially for internal development areas likely to be used for extended duration "sitting" type activities); and

Addition Wind Mitigation Recommendations – Rooftop Level

The proposed development's Roof Level currently shows no areas of public access on the development drawings. Accordingly, roof areas were not tested in the present DA phase assessment.

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It is almost certain, given the absence of nearby similar height buildings in some wind directions, that the Roof Level will experience elevated wind conditions, especially for stronger southerly and westerly winds, potentially requiring wind treatment beyond standard height (ie code-compliant) balustrades.

In accordance with AWES guidelines the preference is for vertical screening (solid/porous) as opposed to landscaping for higher wind locations.

If this area is to be ultimately used for public access usage (eg a Roof Garden), potential windbreak treatments might include a combination of both vertical screening (eg increased height solid balustrades, balustrades combined with planter boxes, etc) and horizontal screening to ensure all-year-round amenity, particularly for southerly and westerly winds.

Taking into account all of the above, it is believed that the proposed development
will comply with the adopted wind acceptability criteria
at all pedestrian and public access locations within and around the development.

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Allen, Jack + Cottier, on behalf of The Trust Company (Australia) Ltd ATF WH Regent Trust, to assess the ground level wind environment around a proposed student village development located at 90-102 Regent Street, Redfern. The report is to be submitted to the Department of Planning in accordance with the application number: SSD-10382.

In June 2020, an initial assessment was made via a Discrete Sensor Environmental Wind Tunnel Study whereby wind tunnel measurements were made to investigate wind conditions within 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 study was documented in:

- SLR Report 610.18313-R10-v1.0, *"90-102 Regent Street, Redfern – Environmental Wind Tunnel Test"*, June 2020.

Following design changes to the bulk envelope of the building, a second Environmental Wind Study was undertaken in August 2020, again via wind tunnel testing, using architectural drawings dated August 2020. This second study included the following additional aspects:

- The second round of testing included reassessment of points previously tested; and
- Testing of proposed mitigation treatments – these resulted in an improvement to several key ground level wind conditions.

There is no mention in the project SEARs of compliance with RWUDP. There is reference in the Project SEARs: Section 1 - "Key Issues" to consideration of the relevant provisions, goals and objectives in … *"Redfern Centre Urban Design Principles"*. There is also a direct reference to wind effects in the Project SEARs: Section 5 - "Amenity Issues" as follows:

> **5. Amenity**
> - Detail the impacts of the development on view loss, sunlight/overshadowing, wind impacts, reflectivity, visual and acoustic privacy to achieve a high level of environmental amenity.

With regarding to Regent Street, SLR notes that Regent Street is a highly trafficked thoroughfare.

1.1 Structure of the Report

The remainder of this report is structured as follows:

Section 2 … describes the proposed development and surrounds

Section 3 … describes Sydney's regional wind climate

Section 4 … presents the wind comfort and safety criteria used in the study

Section 5 … describes the local wind climate characteristics expected at the site

Section 6 … discusses the wind tunnel test methodology used in the study

Section 7 … presents the results of the testing

Section 8 … presents a summary of the results compared to the adopted acceptability criteria

Section 9 … discusses the wind mitigation recommendations for the development

2 DESCRIPTION OF THE PROPOSED DEVELOPMENT

2.1 Location of Development Site

The proposed development is bounded by Regent Street to the east, Marian Street to the north and William Lane to the west - refer **Figure 1**.

Figure 1 Satellite Image of the Proposed Development Site

Image Courtesy: Nearmap, April 2020

2.2 Proposed Development Description

The proposal comprises (refer **Figure 2**):

- One level of basement services bike parking;
- Ground Floor(Level 1) with building entry, common areas, retail and office units;
- Podium (Level 2) outdoor areas/terraces, student units;
- Levels 3-18 for student units; and
- Roof Level

Figure 2 Key Architectural Floor Plans of Interest and Representative Elevations

Ground Floor

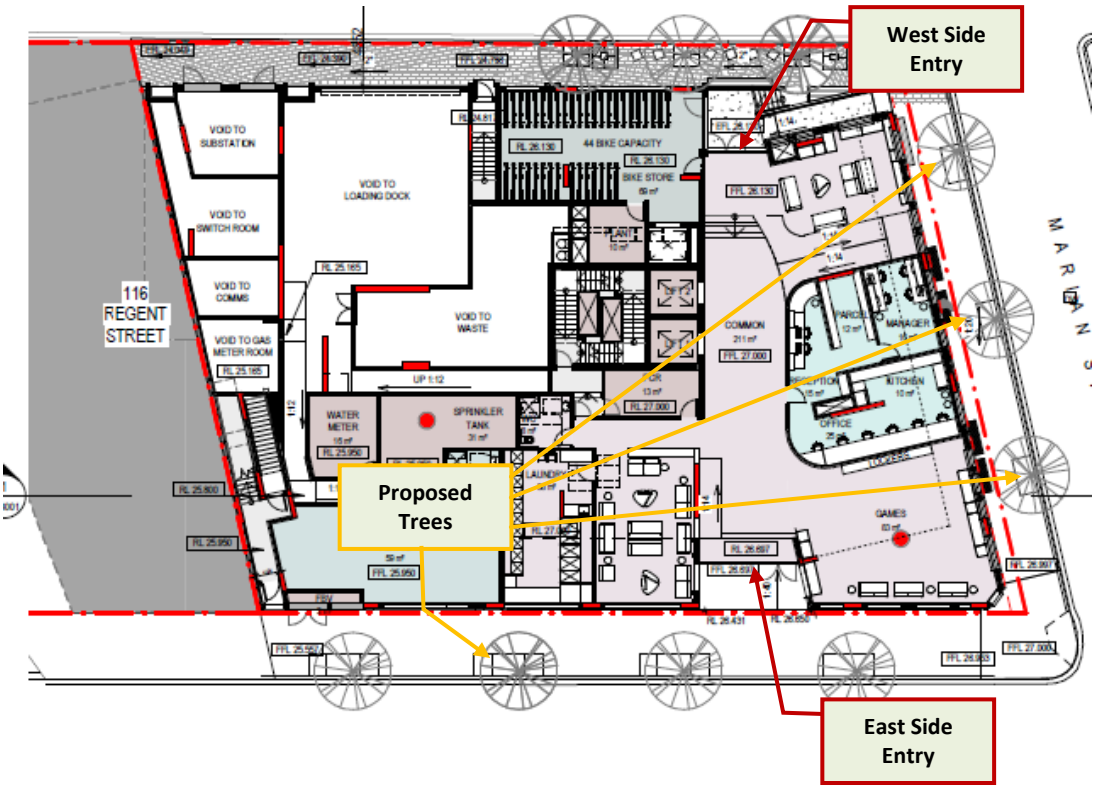
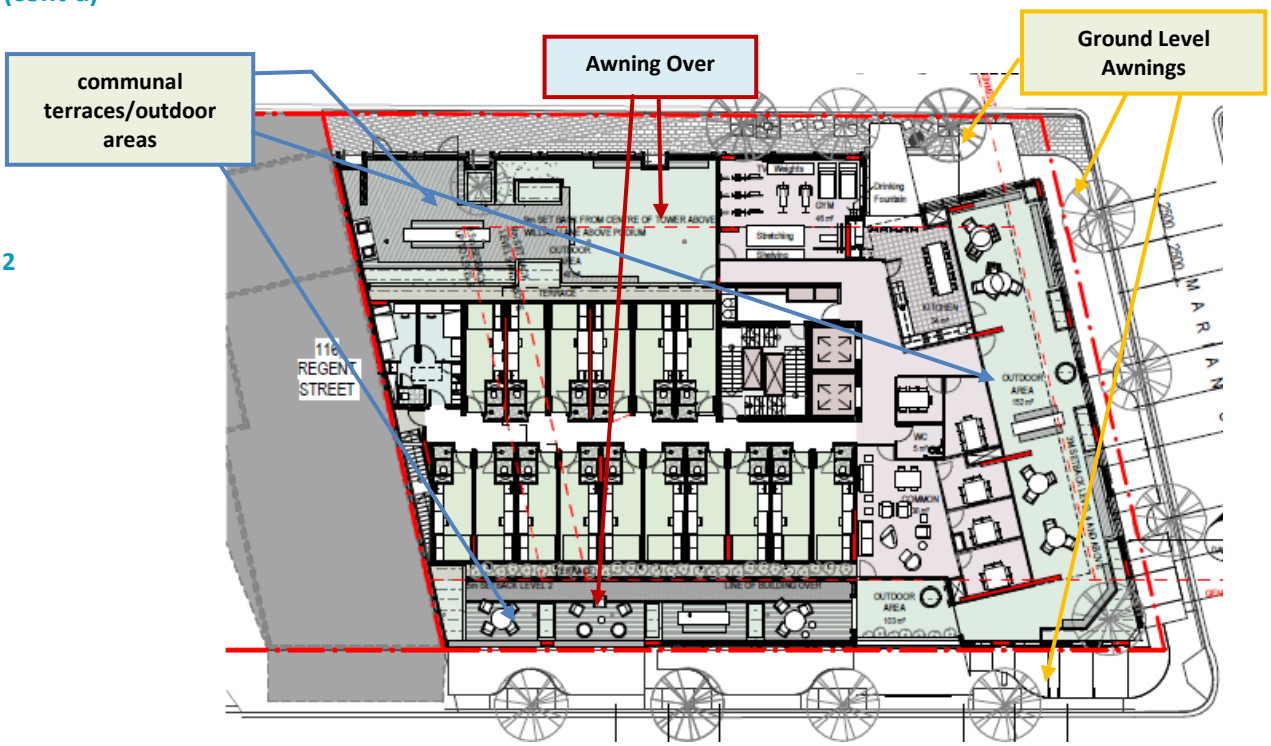
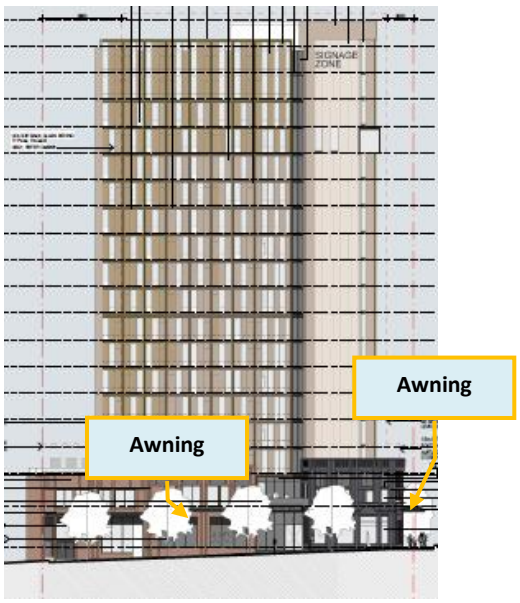


Fig.2 (cont'd)

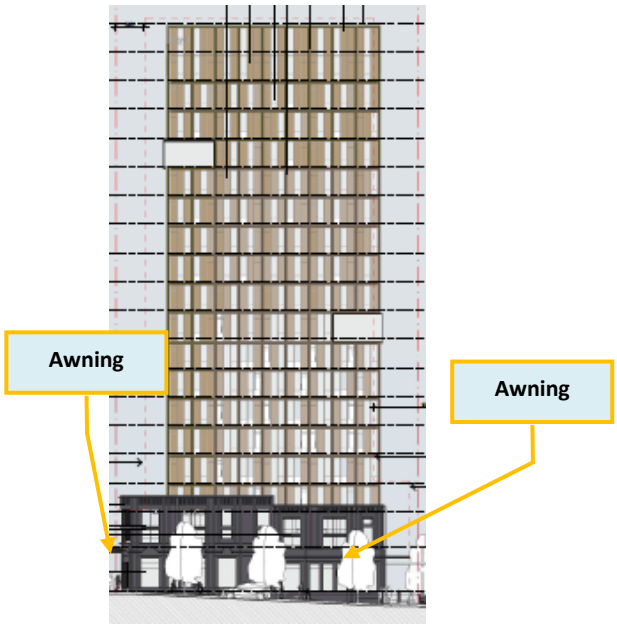
Level 2



East (Regent Street) Elevation

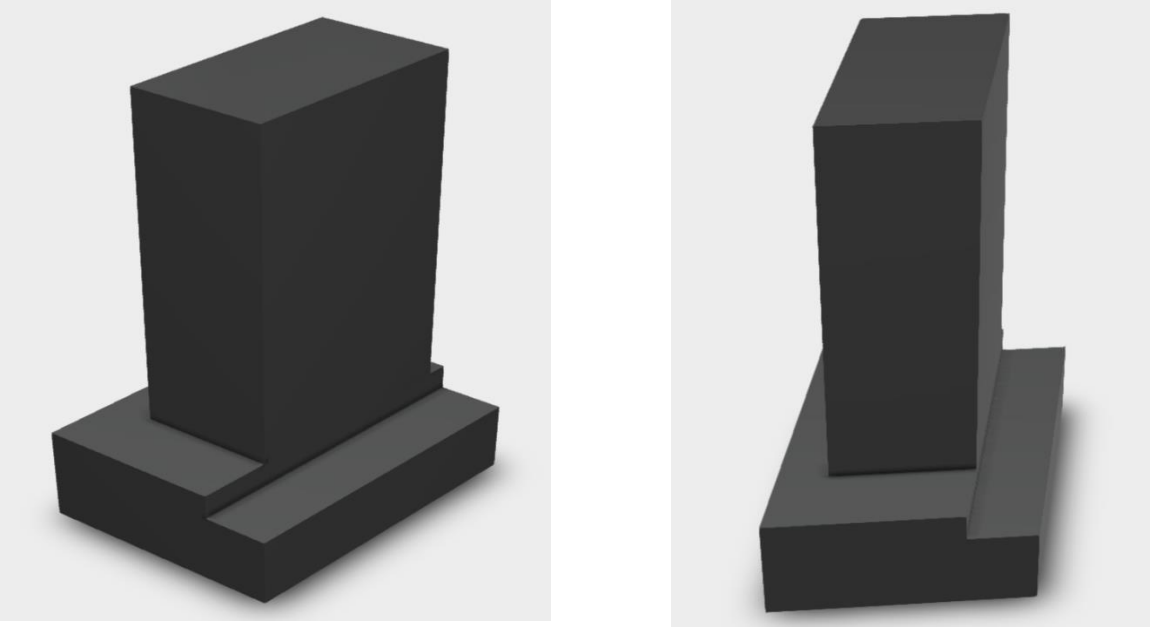


North (Marian Street) Elevation



The assessment of the proposed development also included testing of the Redfern Centre Urban Design Principles "Compliant" design conforming to standard CoS set-back and building podium/height requirements. This is shown in **Figure 3**.

Figure 3 Redfern Centre Urban Design Principles "Compliant" Design



2.3 The Surrounding Built Environment

In terms of surrounding buildings:

- Buildings surrounding site are generally low and mid-rise, comprising a mix of commercial, retail and residential buildings (several of similar height to the proposed development).
- Gibbons Street Reserve lies to the west with Redfern train station to the north-northwest.
- There are a number of planned and approved future residential developments of similar height located immediately to the north, west and southwest of the proposed development, running between Gibbons Street and Regent Street.
- Sydney's CBD area lies to the north and the proposed SSD Waterloo Precinct development to the south-southeast.

The terrain is undulating in the surrounding built environment, with no particularly significant topographical variations (ie hills, escarpments, etc) influencing local wind speeds.

These aspects are shown in representative views in **Photo 1**.

Photo 1 Representative Project Surrounds (Views towards Site, East and West of Site)

3 SYDNEY'S REGIONAL WIND CLIMATE

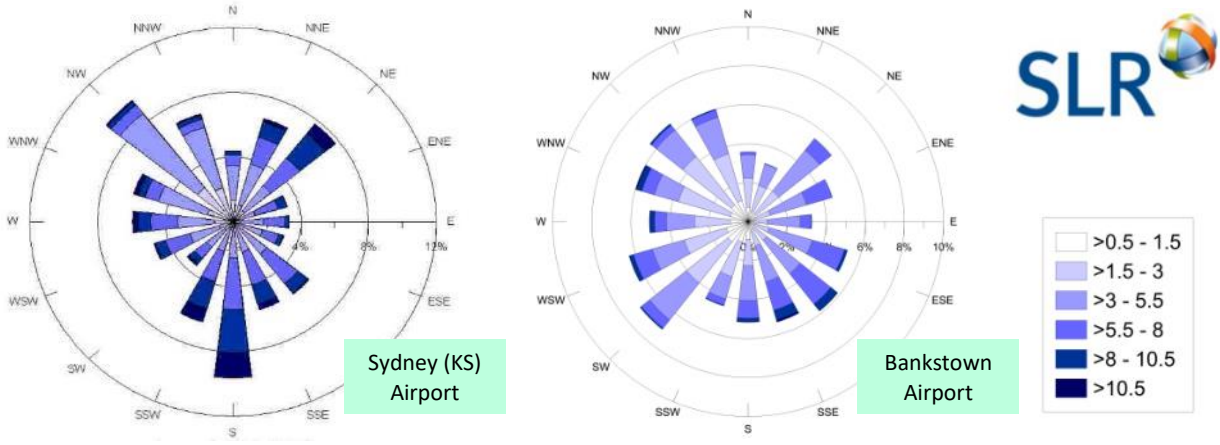
The data of interest in this study are the mean hourly wind speeds and largest gusts experienced throughout the year (especially higher, less frequent winds), how these winds vary with azimuth, and the seasonal break-up of winds into the primary Sydney Region wind seasons.

3.1 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. The associated seasonal wind roses (refer **Appendix A**) show that Sydney is affected by two primary wind seasons with 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. Northeast sea breeze winds 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)



3.2 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 low to mid-rise retail, commercial and residential buildings, with a number of these of similar height to the proposed development. The site will therefore receive moderate wind shielding depending upon oncoming wind direction at lower levels with upper levels exposed to higher winds from most wind directions.

4 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 recent decades.

4.1 The "Melbourne" Wind Criteria

One of the acceptability criteria developed from this research, and currently referenced by many Australian Local Government Development Control Plans, are the so-called "Melbourne" criteria, summarised in **Table 1**.

Table 1 Melbourne-Derived Wind Acceptability Criteria

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
Comfort	16 m/s	Comfortable Walking
	13 m/s	Standing, Waiting, Window Shopping
	10 m/s	Dining in Outdoor Restaurant

The following objectives relate to the above wind impact criteria:

- The general objective for pedestrian areas is for annual 3-second gust wind speeds to remain at or below the 16 m/s "walking comfort" criterion. Whilst this magnitude may appear somewhat arbitrary, its value represents a level of wind intensity above which the majority of the population would find unacceptable for comfortable walking on a regular basis.
- In many urban locations, either because of exposure to open coastal conditions or because of street "channelling" effects, etc, the 16 m/s criterion 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 recommended criteria for spaces designed for activities such as seating, outdoor dining, etc, are lower (ie more stringent) than for "walking comfort".

The **Table 1** criteria, especially for Comfort-type criteria, should not be viewed as *"hard"* numbers as the limiting values were generally derived from subjective assessments of wind acceptability. Such assessments have been found to vary with the height, strength, age, etc, of the pedestrian concerned.

A further factor for consideration is the extent of windy conditions, and some relaxation of the above criteria may be acceptable for small areas under investigation provided the general site satisfies the relevant criteria.

Finally, it is noted that the wind speed criteria in Table 1 are based on the maximum wind gust occurring (on average) once per year. Winds occurring more frequently, eg monthly winds, weekly winds, etc, would be of lesser magnitude. So, for example, a location with a maximum annual gust of 10 m/s would experience winds throughout the year of a much lower and hence generally mild nature, conducive to stationary activities (seating, dining, etc).

Mitigation Using Landscaping

The Australasian Wind Engineering Society (AWES) *Guidelines for Pedestrian Wind Effects Criteria* provides 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.
- Moreover, landscaping planted in high wind locations rarely matures to its normal full height assumed for wind mitigation and trees placed in high wind areas have the potential to shed limbs during windstorms, thereby causing a public danger and a public nuisance.
- 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.

5 DESIGN WIND SPEEDS

5.1 Methodology

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 objective of this study was to develop statistical wind information for locations not situated in close proximity (ie within say approximately a kilometre) of BoM weather stations.

The study is described in detail in …

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

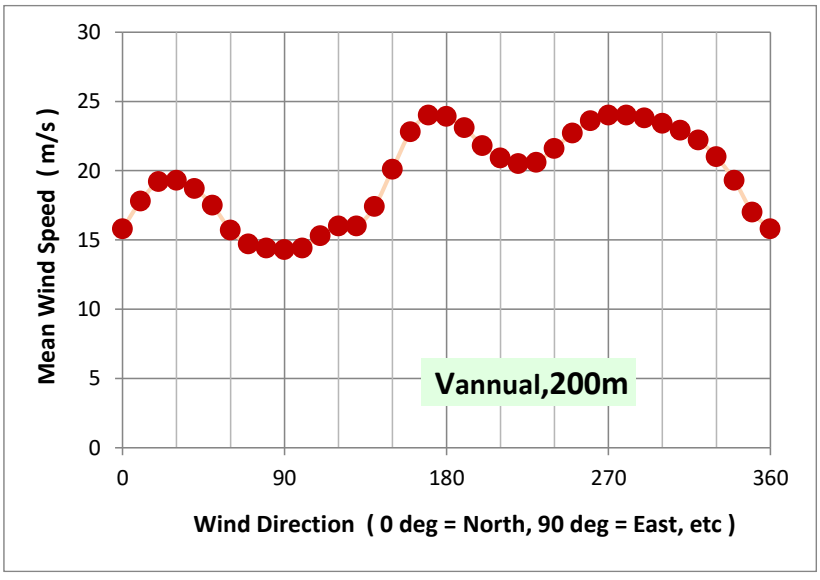
Wind records given particular emphasis were from weather stations with a "clean" surrounding exposure, eg stations such as Sydney (Kingsford Smith) Airport and Bankstown Airport, ie locations relatively free of immediately surrounding obstacles such as buildings, vegetation, trees, etc, which would otherwise distort the winds seen by the weather station anemometer.

For Redfern, SLR has determined that local winds have characteristics very close to Sydney (KS) Airport compared to Bankstown Airport, given Redfern's proximity to Sydney (KS) Airport and similar distance inland from the coastline. Key prevailing wind directions of interest are the northeast, southeast and south for summer and mainly west quadrant winds for winter.

5.2 Reference Height 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 Liverpool wind model as described above. The winds shown in **Figure 5** have a once-per-year exceedance probability.

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



6 WIND TUNNEL TEST METHODOLOGY

6.1 Simulation of Natural Wind

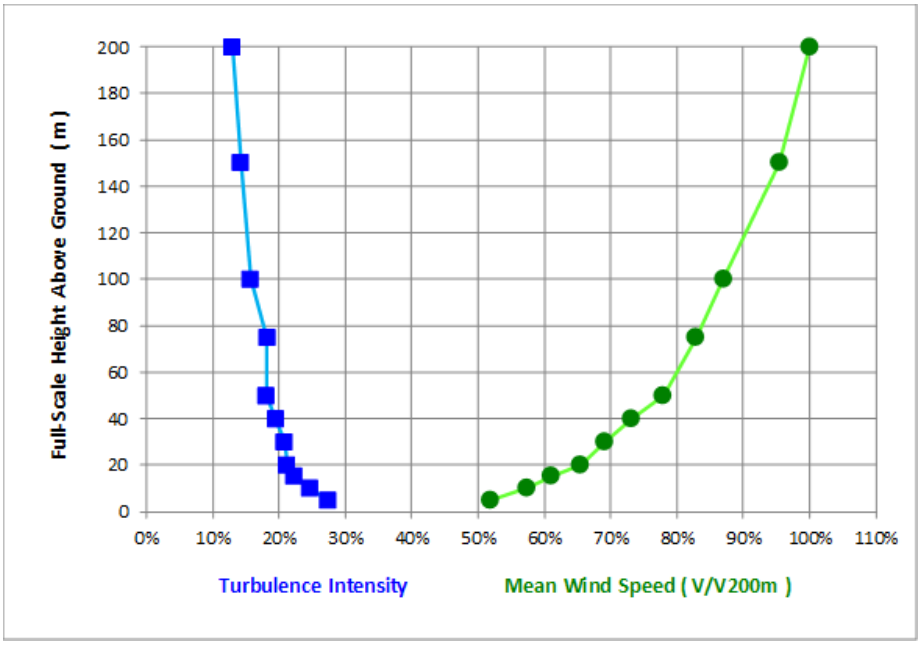
Similarity requirements between the wind tunnel model and prototype (ie full-scale) need to be fulfilled so that similitude in the flow conditions is satisfied. Usually all requirements cannot be satisfied and compromises need to be made. In this type of wind tunnel test it is possible to waive strict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

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



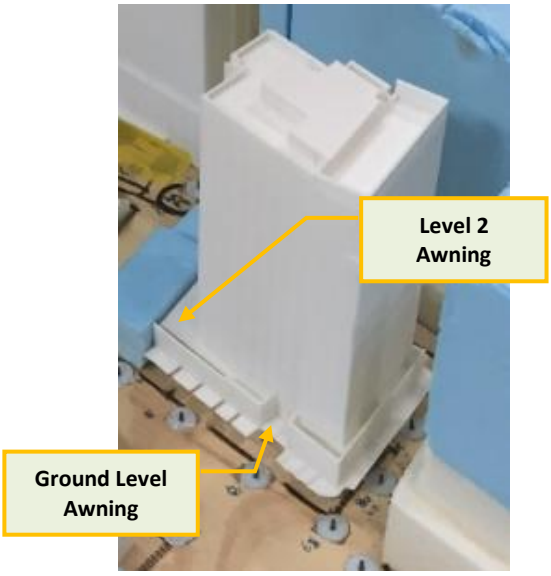
6.2 Development Models and Proximity Model

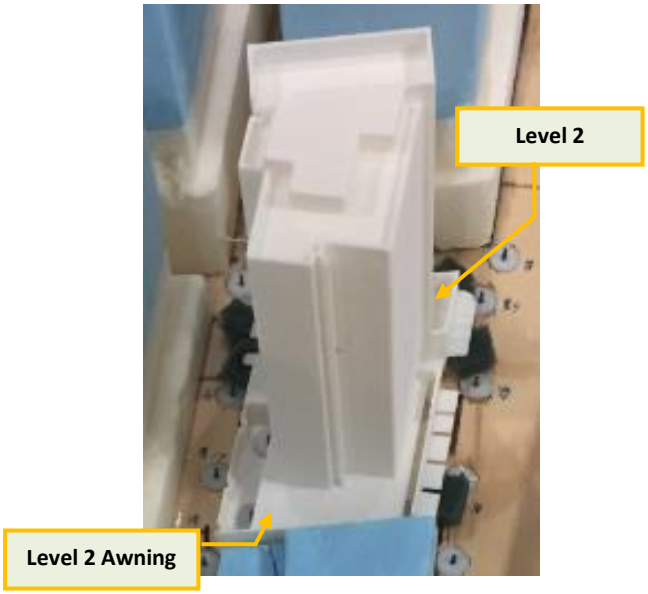
Development Models: August 2020 Latest Design & "Compliant" Design

Two 1:400 scale models of the proposed development were built (using 3D printing) for the testing – refer **Figure 7** - for the latest (August 2020) design and Redfern Centre Urban Design Principles "Compliant" design.

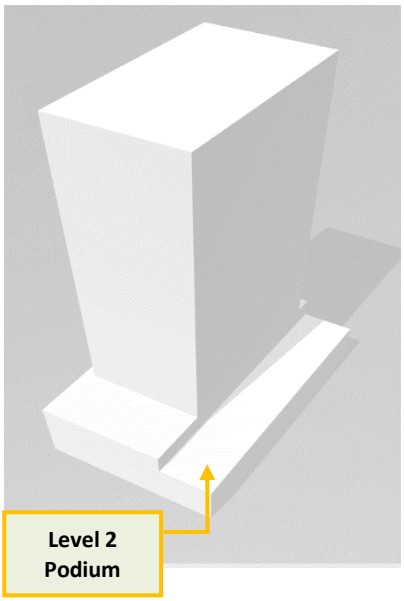
Figure 7 1:400 Scale Model of the Proposed Development

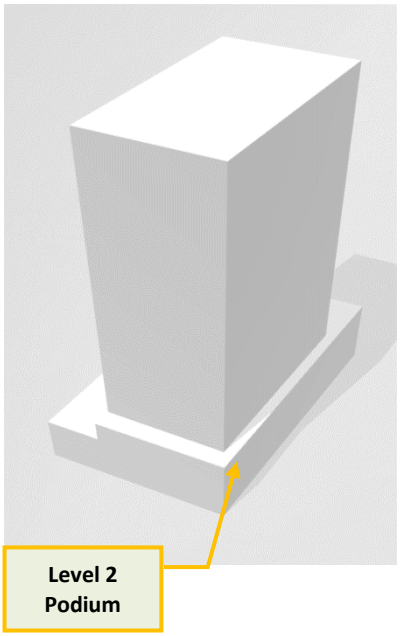
August 2020 Design





Redfern Centre Urban Design Principles "Compliant" Design





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 proximity models used in the present testing simulate the following built environment "scenarios":

- "Baseline" scenario: Existing built environment (as of April 2020);
- "Baseline-F" scenario: "Baseline" + future proposed 13-23 Gibbons Street development(SW of site).
- "Future-P" scenario: "Baseline-F" + future proposed development.
- "Future-C" scenario: "Baseline-F" + CoS "Compliant" design.
- "Mitigation" scenario: "Future-P" + proposed mitigation.

All of the above included the proposed and approved future developments immediately around the site – refer **Figure 8**.

Figure 8 Proximity Models Used in the Wind Tunnel Testing

"Baseline" Scenario (Existing)

View from South

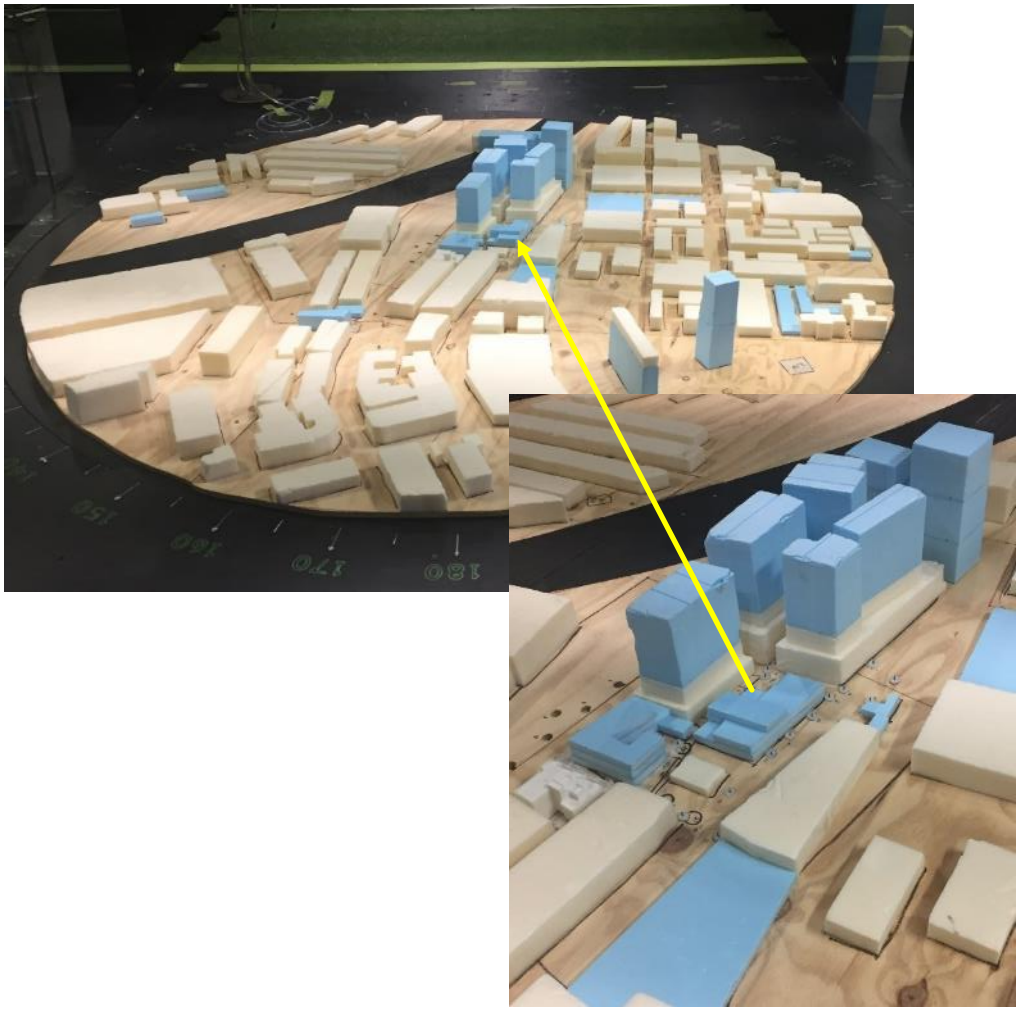
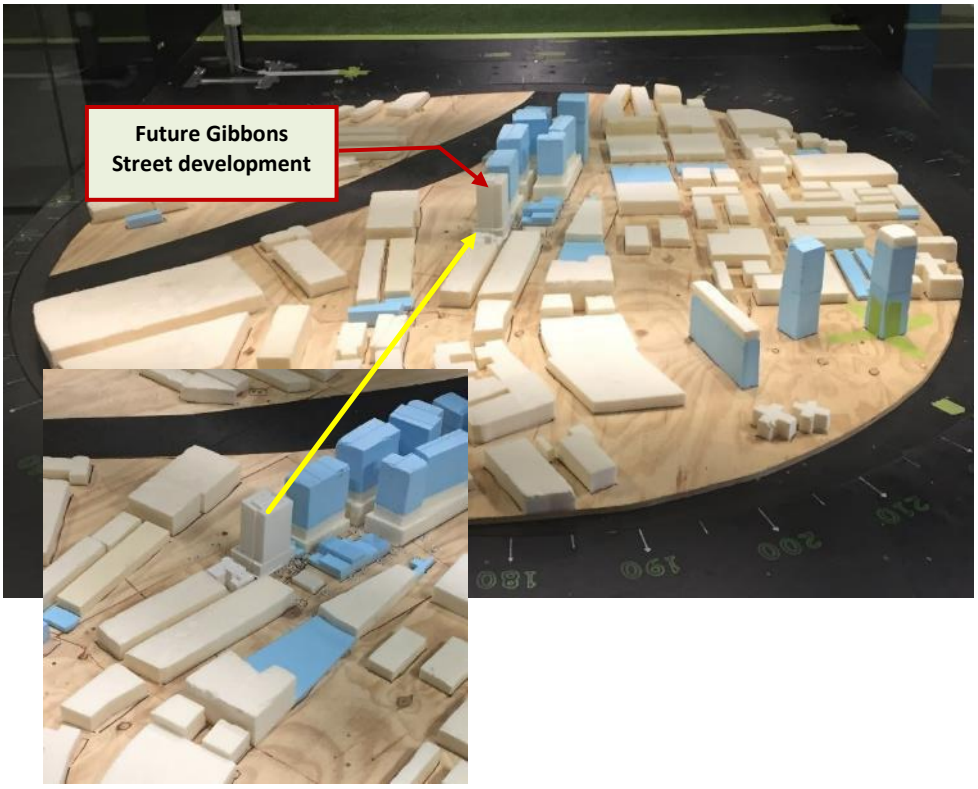
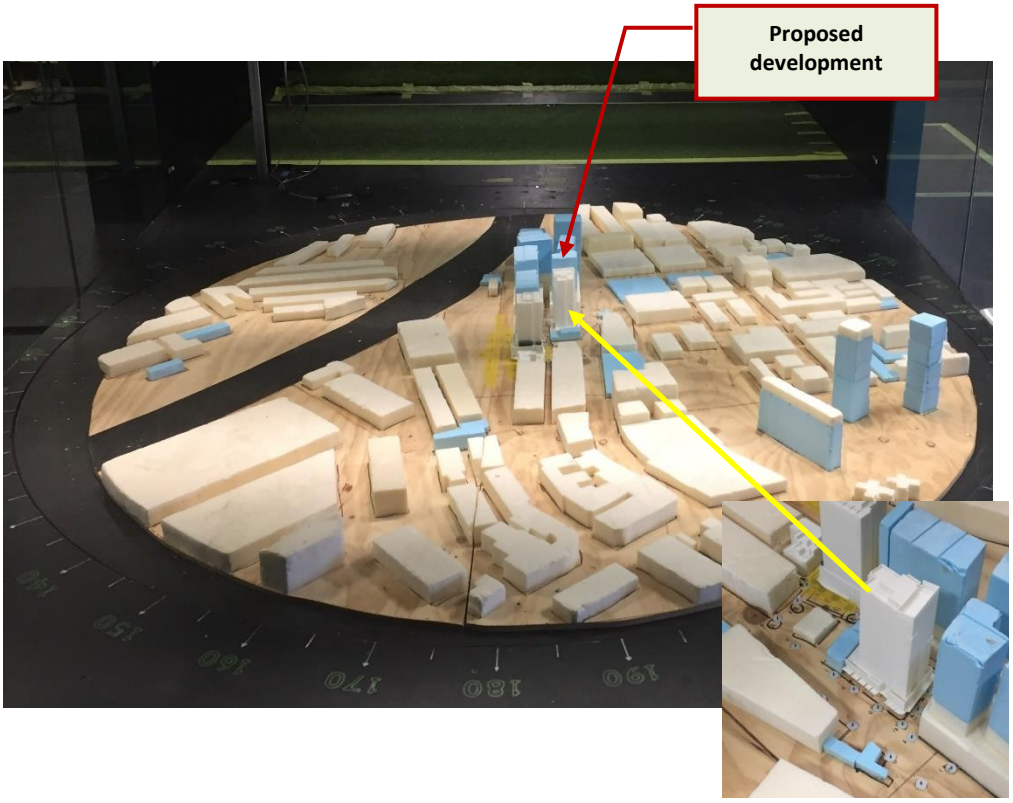


Fig.8 (cont'd)

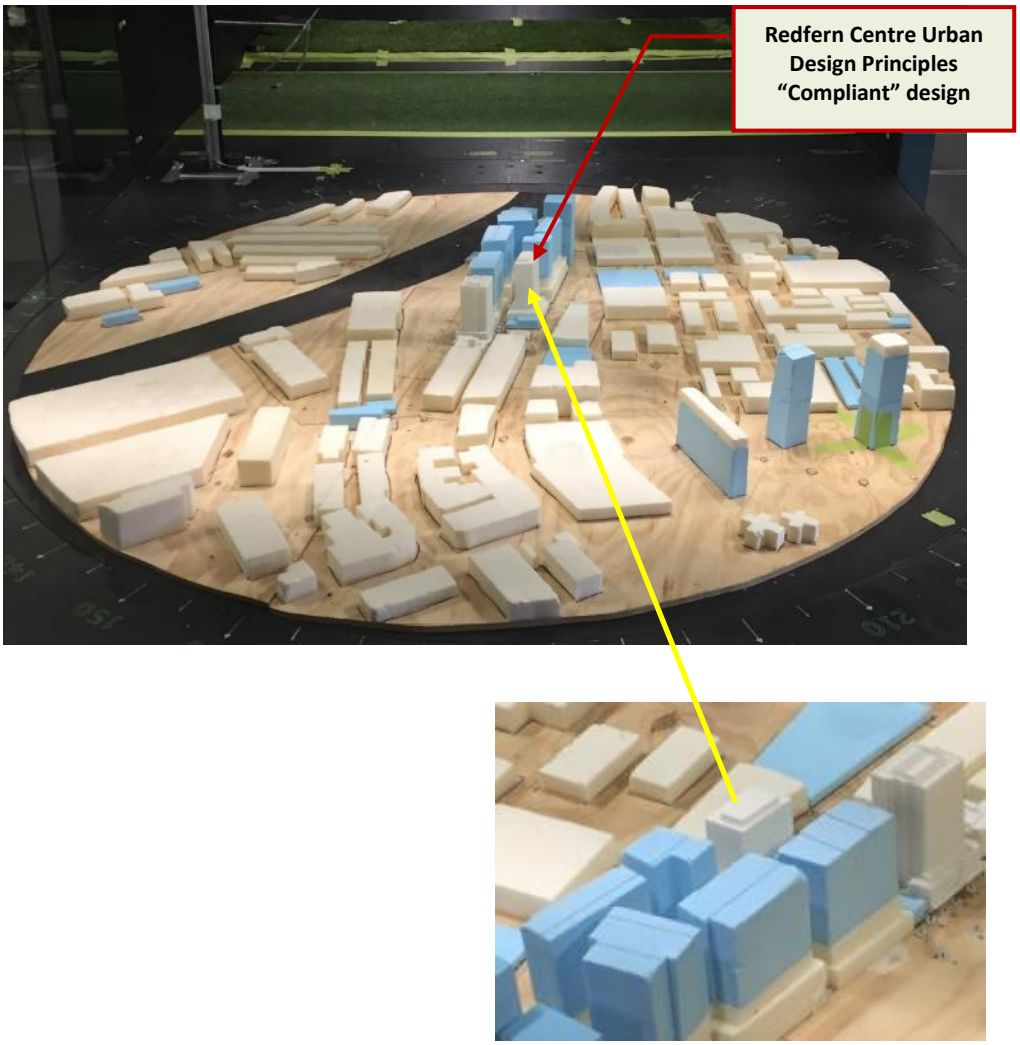
"Existing-F" Scenario (with Proposed Gibbons Street development)



"Future-P" Scenario



"Future-C" Scenario (Redfern Centre Urban Design Principles "Compliant" design)



6.3 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 wind tunnel output data is then processed using the directional wind speed information derived from the Redfern wind climate model to yield ground level wind speeds as a function of annual return period and directional mean reference wind speed – refer **Figure 5**.

The 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 site.

The results have been computed on an annual exceedance basis, to compare to the adopted wind acceptability criteria, using the local Project-Site statistical wind data – refer **Figure 5**.

6.4 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.

- The 26 Ground level sensors are shown in orange – these were measured for all scenarios;
- The 4 Level 2(Podium) sensors shown in blue were only measured for the "Future-P" scenario;

Figure 9 Wind Tunnel Test Sensor Locations

6.5 Sample Test Result

An example of the test results and interpretation of these results is shown in **Figure 10**, illustrating the peak annual mean and gust wind speeds at:

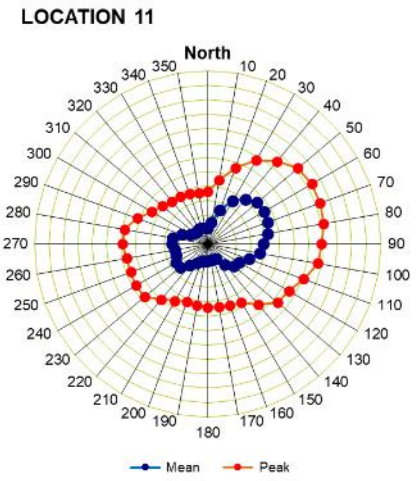
Sensor: **Location 11**
Location: Regent Street

The polar diagram shows the output of the wind tunnel test results in terms of the ratio of mean wind speed and gust wind speed to reference height mean wind speed (Ht=200m):

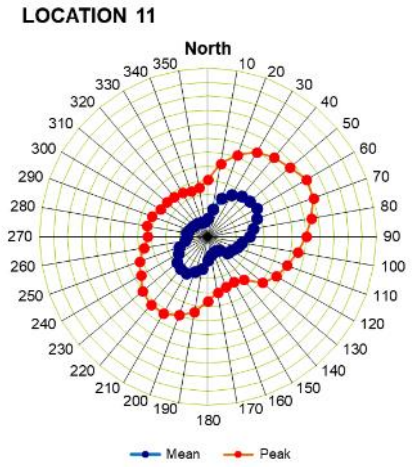
Mean wind speed: "navy blue" data points
Gust wind speed: "red" data points.

Figure 10 Sample Polar Plot Test Result – Location 11 – All Scenarios

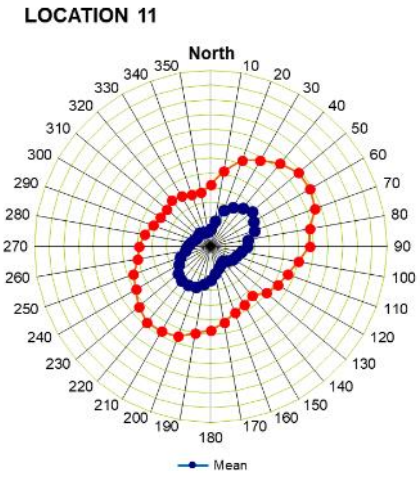
"Baseline" Scenario



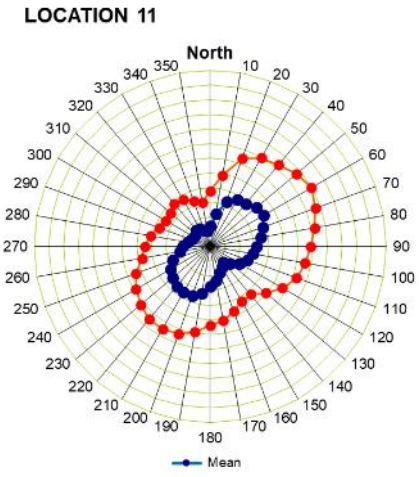
"Baseline-F" Scenario



"Future-P" Scenario



"Future-C" Scenario



For the **"Baseline"** scenario …

- Winds at Location 11 are strongest from the east and northeast, where winds from these directions can channel along Regent Street or approach the site over low height buildings.

For the **"Baseline+F"** scenario …

- Winds at Location 11 are strongest from the east and northeast, where winds from these directions can channel along Regent Street or approach the site over low height buildings.
- The addition of the future development to the southwest, winds increase from the southwest. These winds can accelerate around the future developments southern corner.

For the two **"Future"** scenarios …

- With the addition of the proposed development, winds at Location 11 are similar across both scenarios for the northeast and southwest, and slightly decrease from the west, where winds are shielded by the development itself.
- At Location 11, wind responses for the Redfern Centre Urban Design Principles "Compliant" design are virtually identical to the proposed design.

7 TEST RESULTS

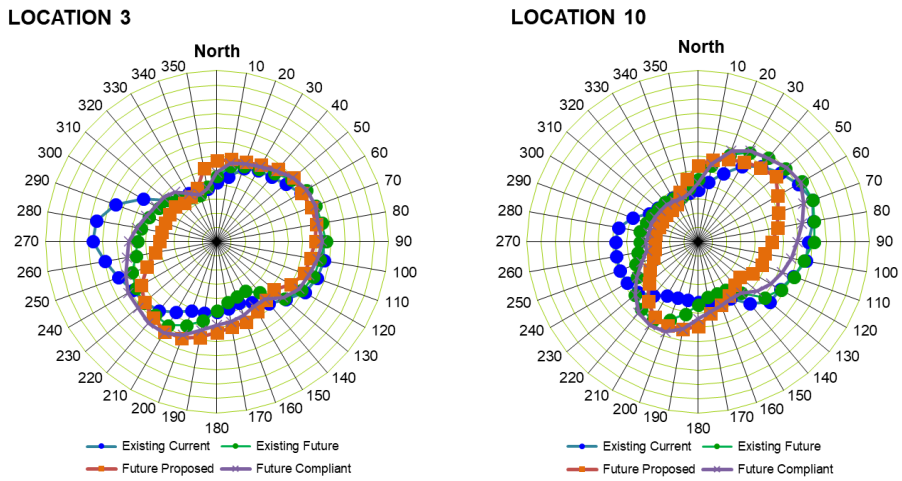
Appendices B, C, D and E shows the relevant wind tunnel test result polar plots respectively for all locations for the "Baseline" (existing built environment), "Baseline-F" (with the addition of the future proposed 13-23 Gibbons Street development), "Future-R" (with the proposal) and "Future-C" ("compliant") scenarios.

It should be noted that no landscaping was incorporated in the two "Baseline" and two "Future" proximity models. This is done to provide a clear insight as to the approach angles resulting in potential adverse wind conditions and the magnitude of such adverse conditions. This information can then be used to develop effective additional windbreak mitigation options such as additional vertical screening, canopies, awnings, etc.

7.1 Sensor Locations: Regent Street (east side) – (representative locations Fig.11)

- Winds along the eastern footpath of Regent Street are currently highest for directions where winds approach the relevant locations within minimal or modest upstream shielding, channelled along Marian Street and accelerating around the southern future development, eg from the northeast, west and southwest.
- The addition of the proposed development produces only slight changes in existing winds, eg slight decrease and increase in northeasterly winds for Locations 10 and 12.
- With the proposed development downstream for west to southwest winds, these remain unaffected.
- There is a modest decrease in westerly winds at locations opposite and immediately east of the site, reflecting increased sheltering from the proposed development – this occurs for both of the "Future" scenarios.

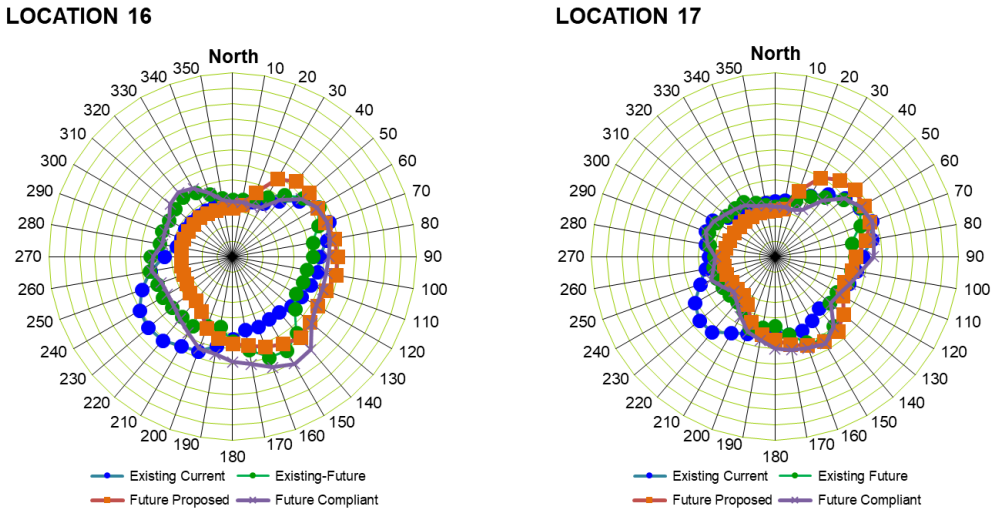
Figure 11 Peak Annual Gusts V/Vref: "Baseline" versus "Future" Scenarios Representative Location



7.2 Sensor Locations: William Lane (west side) - (representative locations Fig.12)

- Winds along William Lane in the vicinity of the development site are currently highest from the southwest and northeast, reflecting channelling of winds along this area. Winds from westelry and easterly quadrants are shielded by adjacent buildings.
- With the addition of the proposed development, winds decrease from the southwest, reflecting the shielding of the downward influenced winds of the proposed development's southern façade. William Lane remain the same or slightly increase from the northeast.
- Winds for the two future scenarios ("Proposed Design" and "Compliant Design") are similar for most of these locations, with slightly higher winds for northeasterly winds for the proposed development (Location 17).

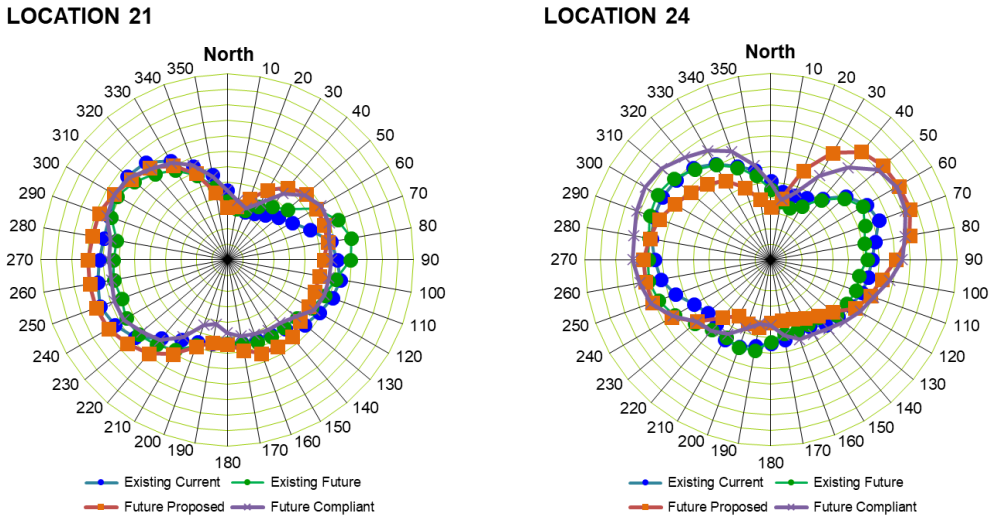
Figure 12 Peak Annual Gusts V/Vref: "Baseline" versus "Future" Scenarios Representative Locations



7.3 Sensor Locations: Marian Street (north side) - (representative locations Fig.13)

- Winds along Marian Street are currently highest for the west to northwest and northeast to east wind directions, channelled along Marian Street and accelerating around the northeastern corner of the development.
- With the addition of the proposed development, winds remain the same the majority of wind directions and increase slightly from the northeast.
- Winds for the two future scenarios ("Proposed Design" and "Compliant Design") remain the same, with the exception of Location 24 increasing modestly to the northeast.

Figure 13 Peak Annual Gusts V/Vref: "Baseline" versus "Future" Scenarios Representative Locations



7.4 "Future-P" Locations – Level 2 (Podium) Locations - (representative locations Fig.14)

- These are all "Future" scenario Podium locations (they do not exist in both "Baseline" and "Future-C scenarios).
- Winds on the Podium are highest from the south, and east where they occur as upstream winds and corner accelerations the development's eastern corner.

Figure 14 Peak Annual Gusts V/Vref: "Future" Scenario Representative Locations

8 OVERALL WIND IMPACT

Table 2 gives the peak annual gust wind speeds predicted to occur at the test sensor locations for the "Baseline" and "Future" built environment scenarios, relevant to assessment of the Melbourne Criteria.

Table 2 Predicted Peak Annual Gust Wind Speeds at all Sensor Locations

Sensor No and Location Description (ref Fig.9)	Peak Annual Gust (m/s)			
	BASELINE	BASELINE-F	FUTURE-P	FUTURE-C
1 Regent Street – east footpath, northeast of site	17.5	17.5	16.5	15.5
2 Regent Street – east footpath, east of site	16.5	16	15.0	16
3 Regent Street – east footpath, east of site	21	14.5	16.0	15.5
4 Regent Street – east footpath, east of site	20	14.5	17.0	15.5
5 Regent Street – east footpath, southeast of site	18	13	12.5	13
6 Regent Street – east footpath, southeast of site	16.5	14	13.0	13.5
7 Regent Street – west footpath, northeast of site	14.5	14.5	15.0	13.5
8 Regent Street – west footpath, northeast of site	19	17	18.0	16
9 Regent Street – west footpath, northeast corner of the development	16	17	15.0	20
10 Regent Street – west footpath, east of the facade	14	14.5	14.5	14.5
11 Regent Street – west footpath, east of the facade	14.5	13.5	15.5	14
12 Regent Street – west footpath, southeast corner of development	13.5	10.5	14.0	11.5
13 Regent Street – west footpath, southeast of the development site	12	14.5	14.5	15
14 William Lane – along development western facade	13.0	15.5	15.0	15.0
15 William Lane – along development western facade	12.5	14.5	13.0	14.0
16 William Lane – along development western facade	15.0	16.0	14.5	17.5
17 William Lane – along development western facade	13.5	13.5	14.0	15.0
18 William Lane – northwest of site	16.5	14.5	17.0	11.5
19 Marian Street – north footpath, northwest of site	23.5	24.0	23.0	24.0
20 Marian Street – north footpath, northwest of site	24.0	23.0	23.0	23.0
21 Marian Street – north footpath, northwest of site	20.0	19.0	21.5	19.5
22 Marian Street – along development northern facade	23.0	24.0	24.5	24.0
23 Marian Street – north footpath, north of site	20.0	19.5	16.5	20.0
24 Marian Street – along development northern façade	19.0	19.5	19.5	22.0
25 Marian Street – north footpath, north of site	16.5	15.5	14.0	16.5
26 Marian Street – along development northern façade	17.0	14.5	16.0	15.5
27 Podium (Level 2) – outdoor terrace area	*Refer Note 2*	*Refer Note 2*	5.5	*Refer Note 2*
28 Podium (Level 2) – outdoor terrace area			11.0	

Sensor No and Location Description (ref Fig.9)		Peak Annual Gust (m/s)			
		BASELINE	BASELINE-F	FUTURE-P	FUTURE-C
29	Podium (Level 2) – outdoor terrace area			12.0	
30	Podium (Level 2) – outdoor terrace area			11.0	

Note 1: Peak Gust Values rounded off to the nearest 0.5 m/s (the experimental error in results is ±0.5 m/s)

Note 2: Locations 1-26 are Ground Level and Level 2 (27-30) locations which only exist in the "Future-P" scenario

8.1 Wind Impact Relative to Intended Usage

There is no mention in the project SEARs of compliance with RWUDP. There is reference in the Project SEARs: Section 1 - "Key Issues" to consideration of the relevant provisions, goals and objectives in … *"Redfern Centre Urban Design Principles"*. There is also a direct reference to wind effects in the Project SEARs: Section 5 - "Amenity Issues" as follows:

> **5. Amenity**
> - Detail the impacts of the development on view loss, sunlight/overshadowing, wind impacts, reflectivity, visual and acoustic privacy to achieve a high level of environmental amenity.

With regarding to Regent Street, SLR notes that Regent Street is a highly trafficked thoroughfare.

Regarding the nearest major thoroughfares to the site, Regent Street and Gibbons Street, SLR notes that both are highly trafficked pedestrian areas. Furthermore, recent SLR Wind Studies in the area have shown that:

- In terms of its existing wind environment:
  - peak annual gusts along Marian Street currently range from 14 m/sec to 19.5 m/sec; and
  - peak annual gusts along Regent Street currently range from 12 m/sec to 21 m/sec.
- With the addition of the proposed development:
  - peak annual gusts along Regent Street (and Gibbons Street) experience both modest increases and decreases.

Given the above, SLR feels that the standard "Walking Comfort" criterion of 16 m/sec (peak annual gust) should be applied to both Gibbons Street and Regent Street, particularly in view of the existing conditions prevailing at the site.

Pedestrian Footpath Areas Surrounding the Site

Wind category objective: 16 m/s Walking Comfort criterion (recommended by SLR)

Ground level locations surrounding the site (Regent Street, Marian Street, William Lane) are predicted to experience both modest increases and decreases in wind speed for key prevailing wind directions (northeast, southeast, south and west).

- In terms of the Melbourne Criteria, a number of these locations currently experience peak annual gusts which lie above the 16 m/s walking comfort criterion, but well below the 23 m/s safety criterion, with the exception of Locations 19, 20 and 22, which just exceed the safety criterion for both "Baseline" scenarios ("Existing-Current" and "Existing-Future".

- In the "Future" scenarios, most of these locations remain above the 16 m/s walking comfort criterion, and continue to remain below the 23 m/s safety criterion. Locations 19, 20 and 22 continue to just fail the safety criterion and remain similar in magnitude.

Observation:

- Wind conditions predicted in the wind tunnel testing did not have the advantage of the mature and extensive vegetation and trees along some of the footpath areas of interest, in particular Gibbons Street and the Gibbons Street Reserve – refer **Figure 15**. These would have a significant ameliorating (ie sheltering) effect on local wind speeds (throughout the year if of evergreen species) for ALL of the test scenarios – "Existing-Current", "Existing-Future", "Future-Proposed" and "Future-Compliant".

Figure 15 Vegetation and Trees along Surrounding Footpath Areas

Future-Proposed versus Future-Compliant

- There were 3 ground level locations where the Future-Compliant Design peak annual gust was the same as the Future-Proposed Design.
- There were 11 ground level locations where the Future-Compliant Design peak annual gust was lower than the Future-Proposed Design (differences typically around 1 m/s).
- There were 12 ground level locations where the Future-Compliant Design peak annual gust was higher than the Future-Proposed Design (differences typically around 1 m/s).
- Both the Future-Proposed and Future Compliant designs had a simiular number of exceedances of the 16 m/sec walking comfort criterion.
- In most instances, these exceeedances, eg along Marian Street to the west of the site, also existed in the two "baseline" test scenarios.

On the basis of the above, it is concluded that the "Future-Proposed" Design performs essentially identical, wind-wise, to the "Future-Compliant" Design.

Podium Areas

Wind category objective: 13 m/s Standing-Waiting-Window Shopping criterion
Ideally 10 m/s Outdoor Dining criterion for seating areas intended for dining

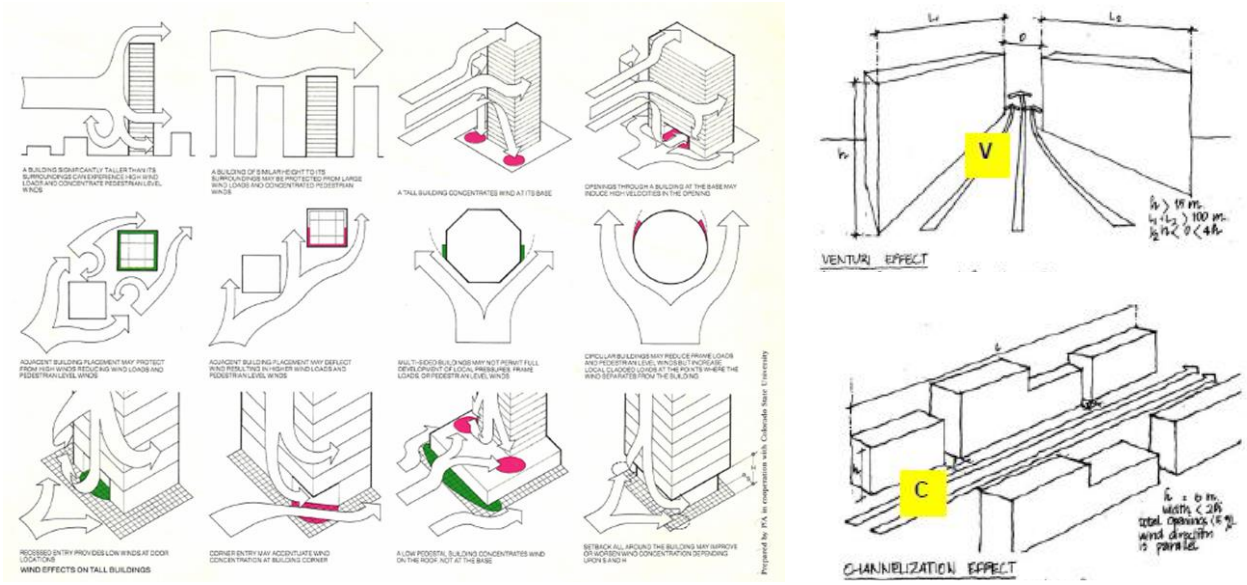
For many wind directions, the Podium (Level 2) is significantly sheltered by the proposed development itself and the adjacent similar height buildings to the immediate north and west. For some other restricted wind directions, the Podium has the potential to experience elevated wind conditions as windflow accelerates past the proposed development's eastern and southern façades and is directed downwards as downwash and accelerated shear flow.

- Wind conditions on the Podium were tested in the wind tunnel without the benefit of any of the landscaping already proposed for the Podium.
- The areas on the podium satisfy the 13m/s Standing-Waiting-Window Shopping criterion, with Location 27 satisfying the 10m/s outdoor dining criterion.
- It is also important to appreciate that, while the Podium has the potential to attract elevated winds from building floors above (downwash, etc), especially at the northwest corner, these winds are thereby prevented from generating the same impact at ground level locations immediately below. The Podium therefore plays a potentially important role in ameliorating ground level wind conditions in surrounding pedestrian areas.

9 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; and
- Windbreaks designed to mitigate **horizontal** winds; and

9.1 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 which are able to deflect winds approaching from above and redirect the wind away from grounds level areas below.

9.2 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 porous) – which can also be combined with landscaping.

9.3 Horizontal Windbreak Examples

Figure 17 shows typical examples of horizontal windbreak options typically found in urban built environments – they can be soild or porous, purely horizontal or with a slope aimed at deflecting oblique windflow.

Figure 17 Horizontal Windbreak Options






9.4 Vertical Windbreak Examples

Figure 18 shows examples of vertical windbreak options found in urban built environments – they can be soild 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

10 MITIGATION TREATMENT RECOMMENDATIONS

Sections 7 and 8 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 mainly horizontal winds which require vertical windbreaks (refer **Figure 18**)or mainly vertical downwash winds which require horizontal windbreaks (refer **Figure 19**).

The wind conditions of potential concern in relation to the proposed development revealed by the wind tunnel study are:

- Selected footpath areas along Regent Street, William Lane and Marian Street; and
- The outdoor terraces of Podium (Level 2) – Locations 27 to 30.

10.1 Existing and Planned Wind Amelioration

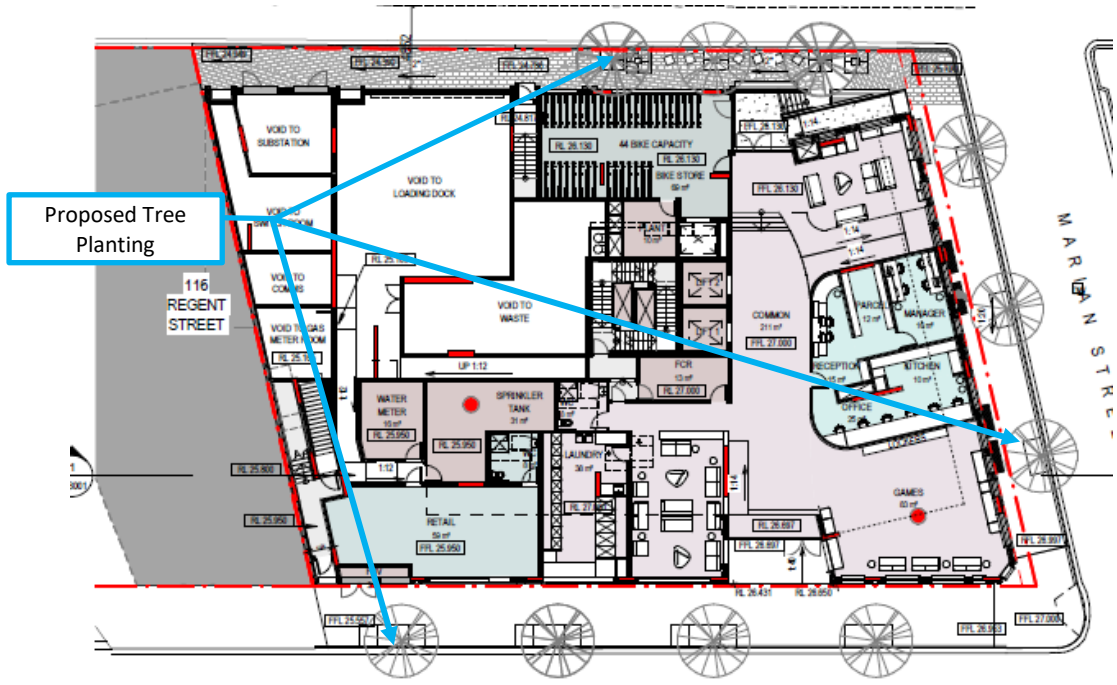
It has been noted that the current round of wind tunnel testing did not include the following features, all of which would have had an ameliorating impact on local wind speeds:

- Landscaping proposed around the development site – refer **Figures 2 and 19A**;
- Vegetation and trees along Regent Street and the Gibbons Street Reserve – refer **Figure 15**;
- Tree planting and landscaping planned for the Level 2 Podium – refer **Figure 19B**.

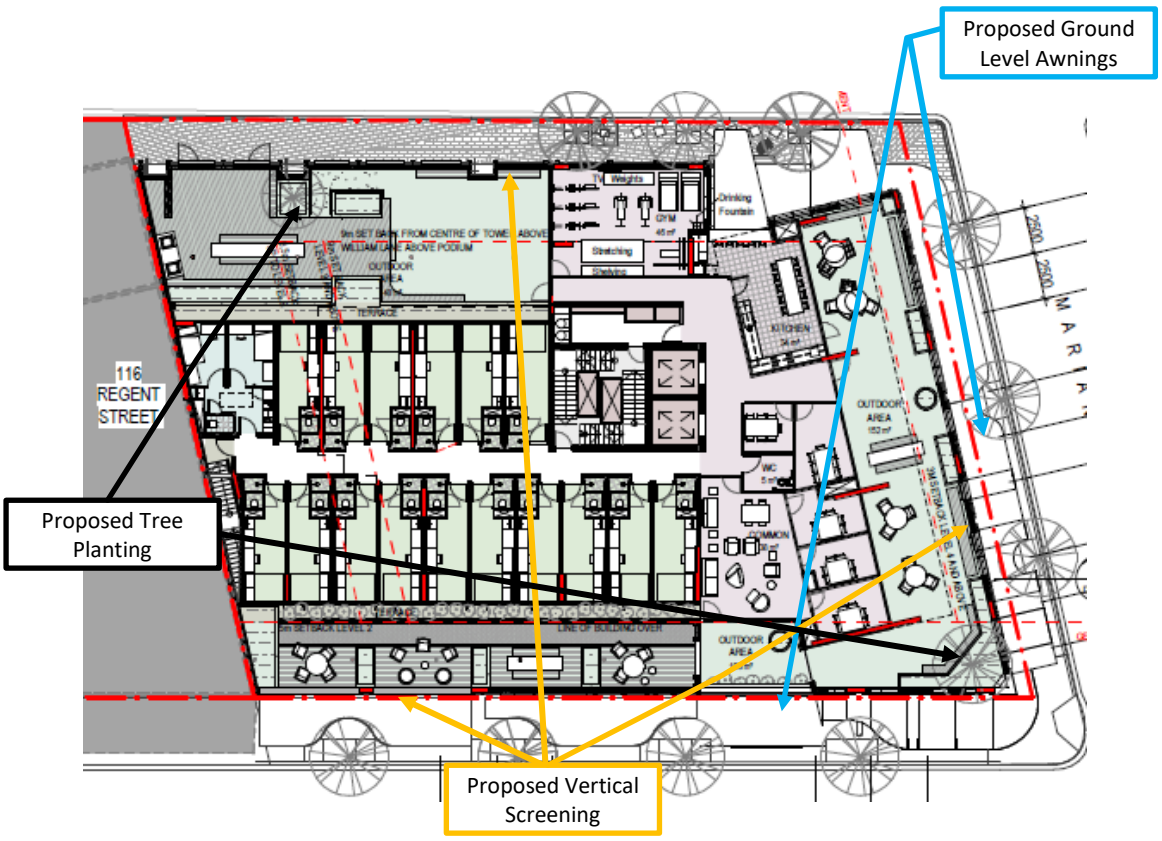
The above features are shown in architectural drawings in **Figure 19**.

Figure 19 Plan View of Project Site Treatments

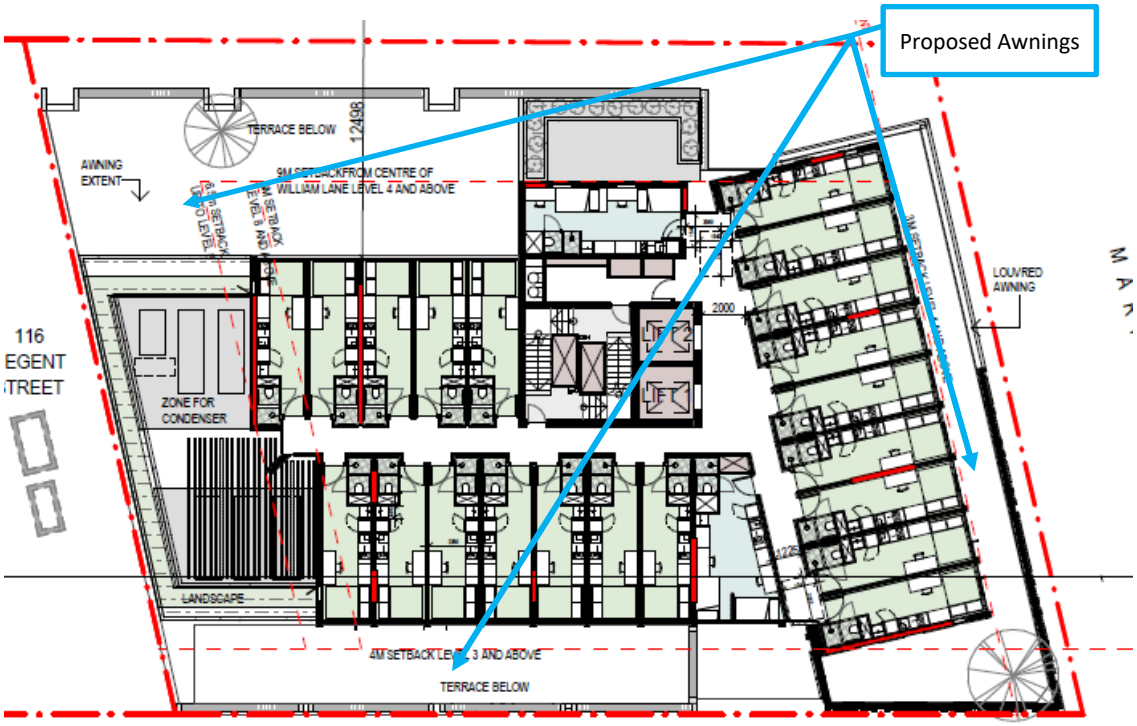
A. Ground Level Plan View



B. Level 2 Plan View



C. Level 3



10.2 Additional Wind Mitigation Recommendations

Pedestrian Areas Surrounding the Site

Current plans for the proposed development incorporate additional landscaping along Regent Street and Marian Street and included a full perimeter awning along the development's northwest corner and northern and eastern façades - refer **Figure 2** and **Figure 19A**.

The wind tunnel testing showed that potentially high localised winds occur at selected ground level locations along both Regent Street and Marian Street for both "Baseline" and "Future" scenarios.

- It has been noted that these results were obtained in the absence of existing trees and landscaping
- Further, the "Future" results did not include the planned additional trees along Regent Street and Marian Street.

We recommend retention of the existing awnings protecting ground level footpaths and all of the trees and landscaping, existing and planned.

- It is recommended that all "proposed" and "replacement" trees are evergreen and of similar foliage as the existing trees.

Podium – Level 2

The wind tunnel measurements have shown that:

- Locations 37 experience peak annual gust wind speeds of 6 m/s satisfying the 10 m/s sitting and dining criterion.
- Locations 28 and 30 experience peak annual gust wind speeds of 11m/s satisfying the 13 m/s standing criteria.
- Location 31 experience peak annual gust wind speeds of 12 m/s satisfying the 13 m/s standing criteria.

If areas were to be used for seating or for longer duration activities the 10 m/s sitting criterion should be satisfied. As a result, wind mitigation here should include both horizontal protection (eg awnings, canopies, etc) and vertical protection (balustrades, vertical screens, landscaping, etc).

The included tree planting on the Level 2 Podium would further mitigate adverse wind conditions in these areas and are expected to meet the 10 m/s sitting and dining comfort criterion – refer **Figure 19B**.

Similarly, the northern outdoor space is also expected to satisfy the 10 m/s sitting and dining criterion, with the included awning which extends to the proposed vertical screens as shown in **Figure 19C**.

We recommend retention of:

- The proposed awnings along the northern, eastern and western aspects of the terrace areas – refer **Figure 19C**.
- The proposed full height vertical screens on the Level 2 Podium – refer **Figure 19B**.
- The proposed tree planting on the Level 2 Podium – refer **Figure 19B**.

It is recommended that:

- Proposed landscaping around the podium level areas to be evergreen – refer **Figure 19B**.

10.3 "Future-Proposed" versus "Future-Compliant" Design

On the basis of the test results at all ground level locations it has been concluded that:

- On average, the "Future-Proposed" Design performs essentially identical, wind-wise, to the "Future-Compliant" Design; and
- Variations (both up and down) between the two Future scenarios ("Proposed" and "Compliant") are minor – typically ±1 m/s.

11 ADDITIONAL TESTING – "MITIGATION" SCENARIO

The proposed windbreak treatments were assessed by carrying out a further round of wind tunnel testing – 0° to 360°, all sensor locations – with treatments at the locations indicated in **Section 6.4**.

- This testing has been termed the … "Mitigation" built scenario

The dimensionless polar plot ratios of ground level wind speed to reference height wind speed for the "Mitigation" scenario are shown in **Appendix D**.

Discussion of Results – Ground Level

The two "Future" scenarios indicated peak annual gust wind speeds within this area – Locations 1 to 26 - slightly windier than the Target levels for these areas. Accordingly, a "scaled" level of additional windbreak treatment was added to the model in the "Mitigation" scenario:

- Vertical screening (ie trees, shrubs, screens, etc) surrounding the immediate development site– refer to **Figure 20**.

The impact of these treatments can be seen in **Table 3** and **Figure 21**, where:

- Winds decrease for Locations 3 to 5, 8 to 11 and 13 along Regent Street;
- Winds decrease for Locations 14 to 18 along William Lane;
- Winds decrease for Locations 19, 21 to 24 and 26 along Marian Street ;and
- No Change for Locations 1, 7, 14 and 20.

The following is noted:

- In relation to locations within Gibbons Street Reserve (Nos.1-5) and Gibbons Street locations to the west of the site, the wind directions which influence the overall peak annual gusts are from the west quadrants. The proposed development has essentially no impact on these locations for westerly winds, as can be seen from the test results.
- In relation to Marian Street and Regent Street footpath winds immediately surrounding the site, vertical windbreaks (ie trees, shrubs, screens, etc) have a highly localised impact.

It should also be noted that wind tunnel testing in the "Mitigation" scenario had utilised vertical screening to treat the horizontal oncoming northwesterly to westerly and easterly winds. If landscaping is chosen for such vertical screening. SLR recommends that any such landscaping be of evergreen in nature in order to mitigate winds effectively all year round.

Peak annual gust wind speeds are shown in **Table 3**, outlining the effectiveness on the Locations surrounding the immediate development site.

Along Regent Street there was no change regarding winds with the inclusion of the mitigations surrounding the immediate site for Locations 1 to 6 and 7 to 9. The dominant winds in these areas are from the northeast which are upstream of the site. Similarly, this is also shown for westerly winds along Marian Street for Locations 22 to 25.

Additionally, with the inclusion of the proposed vertical screening immediately surrounding the site there is a decrease in the peak annual gust wind speeds within suitable levels for comfortable walking activity at several locations.

Finally, it is noted that the existing trees located in Gibbons Reserve would provide further wind mitigation for the horizontal winds experienced along Gibbons Street and Marian Street.

Table 3 Predicted Peak Annual Gust Wind Speeds for Locations 1 to 28

Sensor No and Location Description (ref Fig.9)		FUTURE-P	MITIGATION
1	Regent Street – east footpath, northeast of site	16.5	16.5
2	Regent Street – east footpath, east of site	15.0	16.0
3	Regent Street – east footpath, east of site	16.0	15.0
4	Regent Street – east footpath, east of site	17.0	16.0
5	Regent Street – east footpath, southeast of site	12.5	12.0
6	Regent Street – east footpath, southeast of site	13.0	13.5
7	Regent Street – west footpath, northeast of site	15.0	15.0
8	Regent Street – west footpath, northeast of site	18.0	16.0
9	Regent Street – west footpath, northeast corner of the development	15.0	10.5
10	Regent Street – west footpath, east of the facade	14.5	9.5
11	Regent Street – west footpath, east of the facade	15.5	8.5
12	Regent Street – west footpath, southeast corner of development	14.0	15.0
13	Regent Street – west footpath, southeast of the development site	14.5	14.0
14	William Lane – along development western facade	15.0	15.0
15	William Lane – along development western facade	13.0	12.0
16	William Lane – along development western facade	14.5	13.5
17	William Lane – along development western facade	14.0	8.5
18	William Lane – northwest of site	17.0	11.5
19	Marian Street – north footpath, northwest of site	23.0	22.5
20	Marian Street – north footpath, northwest of site	23.0	23.0
21	Marian Street – north footpath, northwest of site	21.5	20.0
22	Marian Street – along development northern facade	24.5	24.0
23	Marian Street – north footpath, north of site	16.5	10.0
24	Marian Street – along development northern façade	19.5	7.5
25	Marian Street – north footpath, north of site	14.0	14.5
26	Marian Street – along development northern façade	16.0	12.5

Figure 20 Treatments Implemented at Ground Level

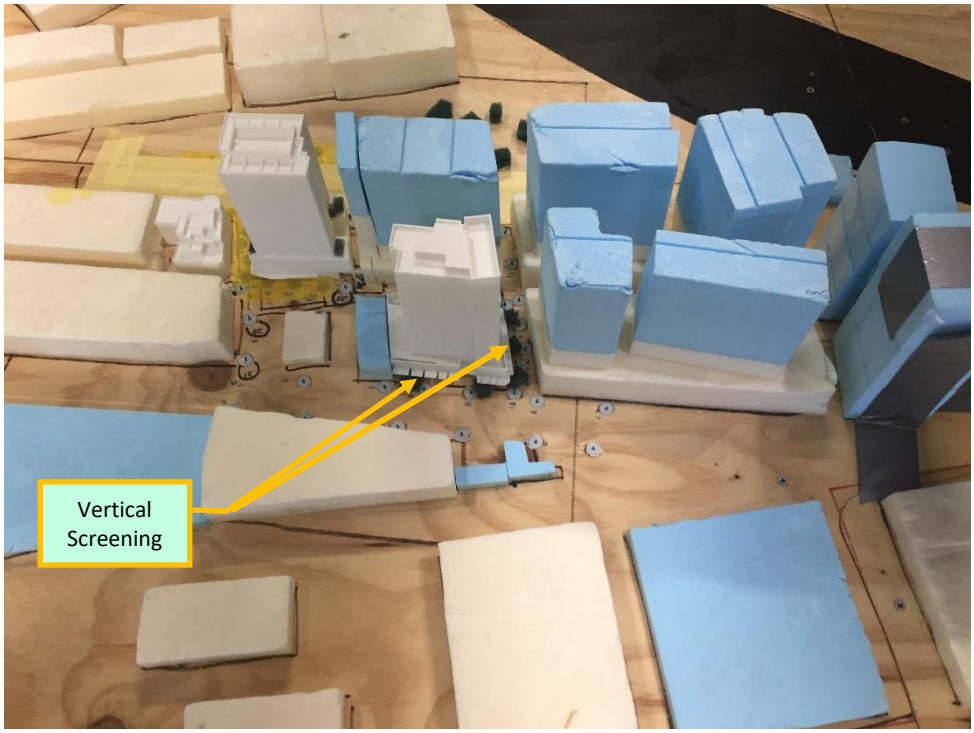
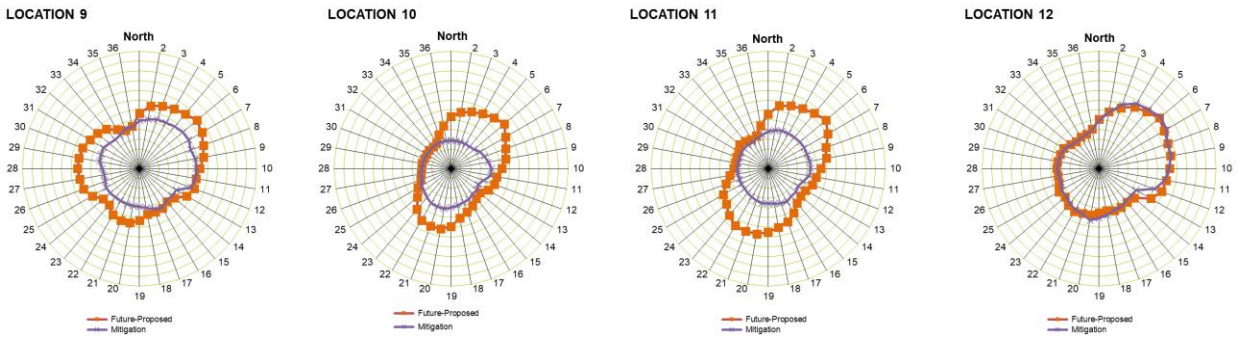


Figure 21 Sample Polar Plot Wind Tunnel Test Results: Locations 9-12

"Future-P" (orange) and "Mitigation" (purple) comparison



12 RESULTS SUMMARY

12.1 "Future-P" versus "Future-C" Design

On the basis of the test results at all ground level locaions it has been concluded that

- On average, the "Future-Revised" Design performs comparably, wind-wise, to the "Future-Compliant" Design; and
- Taking into account predicted wind speed increases and decreases, the "Future-Proposed" Design performs overall marginally better than the "Future-Compliant" Design.

12.2 Mitigation Scenario Testing

The "Mitigation" scenario demonstrates that all of the areas identified within the "Future-P" scenario as requiring consideration of windbreak treatment can successfully be addressed through a combination of:

- Vertical screening, especially ground level public access areas – including vertical screens, landscaping, etc;
- Awnings, canopies and pergolas (especially for internal development areas likely to be used for extended duration "sitting" type activities); and

12.3 Areas Not Assessed Via Wind Tunnel Testing

The proposed development's Roof Level currently shows no areas of public access on the development drawings. Accordingly, roof areas were not tested in the present DA phase assessment.

It is almost certain, given the absence of nearby similar height buildings in some wind directions, that the Roof Level will experience elevated wind conditions, especially for stronger southerly and westerly winds, potentially requiring wind treatment beyond standard height (ie code-compliant) balustrades.

In accordance with AWES guidelines the preference is for vertical screening (solid/porous) as opposed to landscaping for higher wind locations.

If this area is to be ultimately used for public access usage (eg a Roof Garden), potential windbreak treatments might include a combination of both vertical screening (eg increased height solid balustrades, balustrades combined with planter boxes, etc) and horizontal screening to ensure all-year-round amenity, particularly for southerly and westerly winds.

Taking into account all of the above, it is believed that the proposed development
will comply with the adopted wind acceptability criteria
at all pedestrian and public access locations within and around the development.

13 CLOSURE

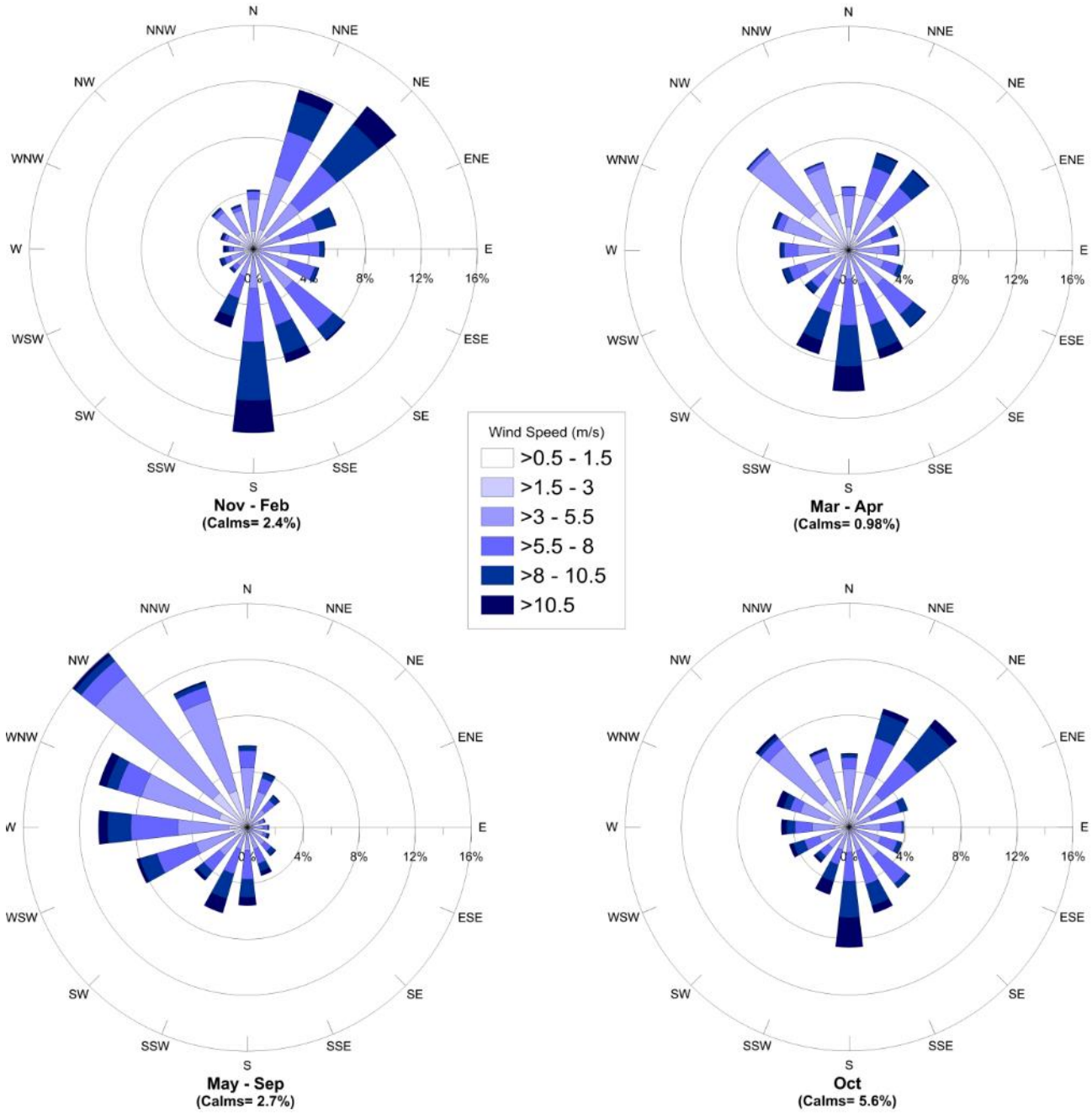
This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of The Trust Company (Australia) Ltd ATF WH Regent Trust. 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 Consulting.

APPENDIX A

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

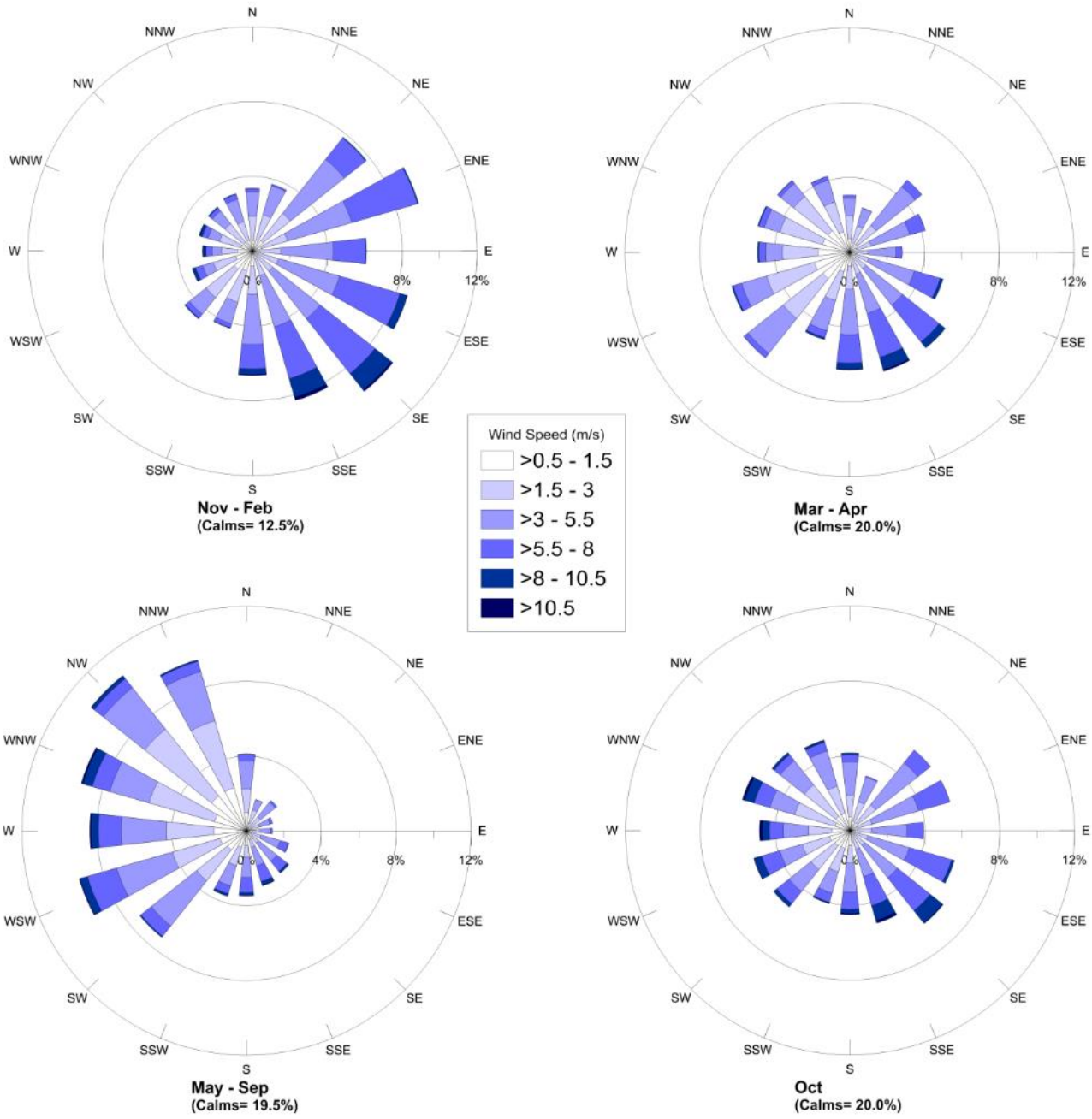
Sydney Airport AWS
(Observations)
1999-2017
600.09300



APPENDIX A

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

Bankstown Airport AWS
(Observations)
1999-2017
600.09300



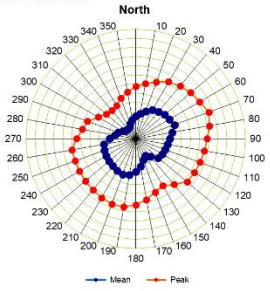
APPENDIX B

Wind Tunnel Test Results: BASELINE Scenario

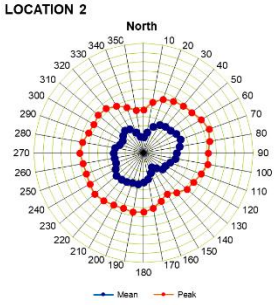
Polar Plots: Ratio of Ground Level Wind Speed to Reference Wind Speed

Existing-Current

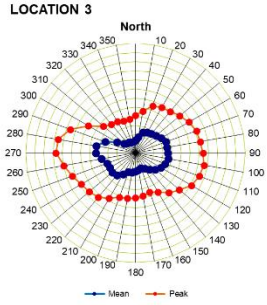
LOCATION 1



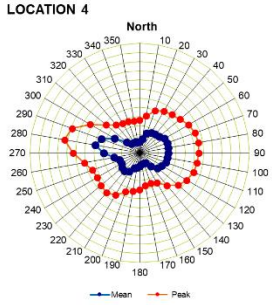
LOCATION 2



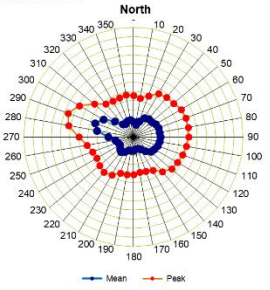
LOCATION 3



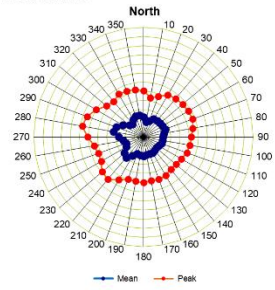
LOCATION 4



LOCATION 5



LOCATION 6



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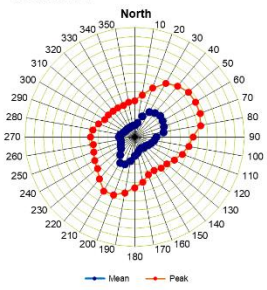

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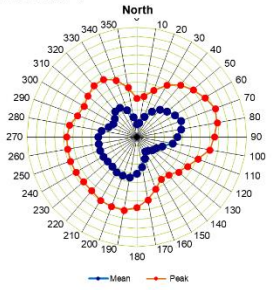

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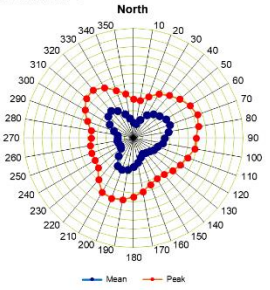

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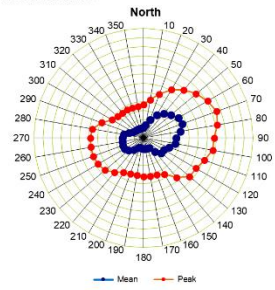

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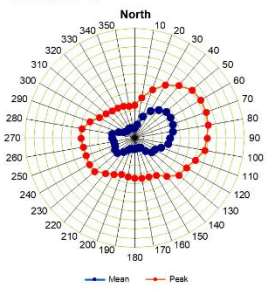

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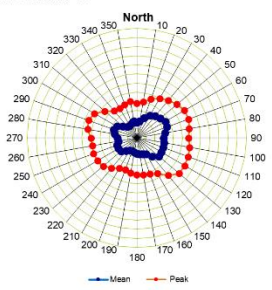

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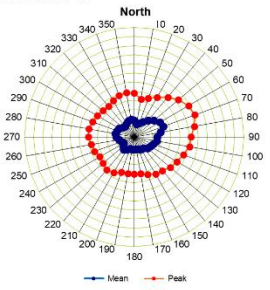
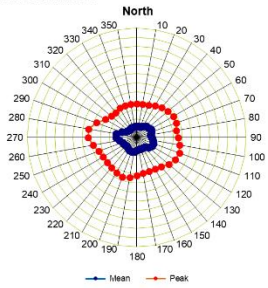


APPENDIX B

Wind Tunnel Test Results: BASELINE Scenario

Polar Plots: Ratio of Ground Level Wind Speed to Reference Wind Speed

LOCATION 14



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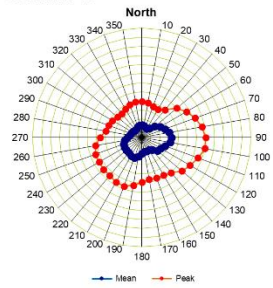

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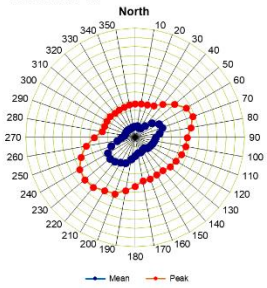

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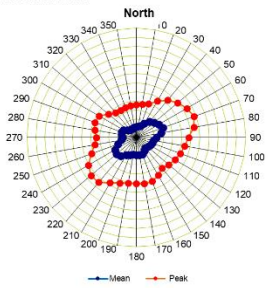

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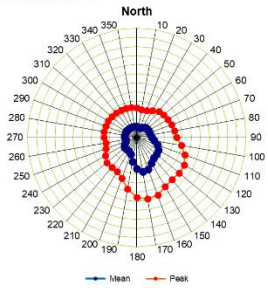

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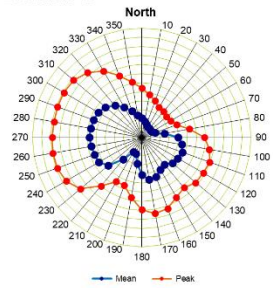

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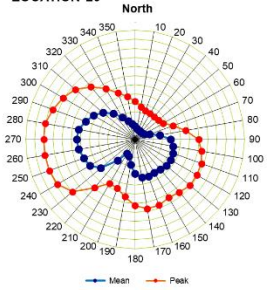

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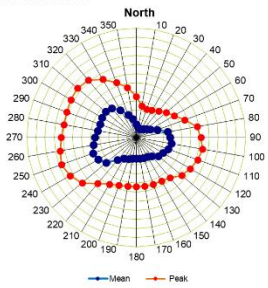

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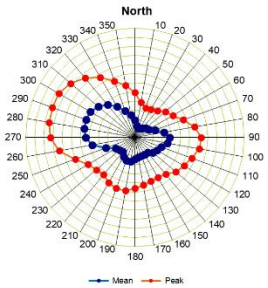

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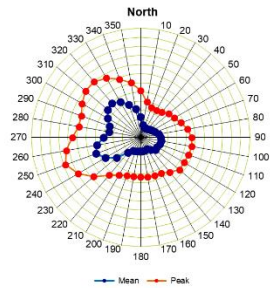

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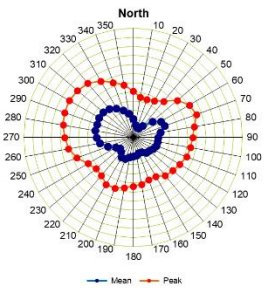

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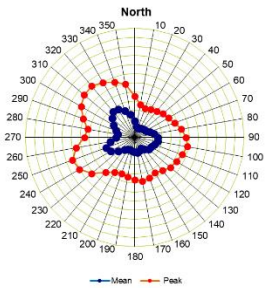

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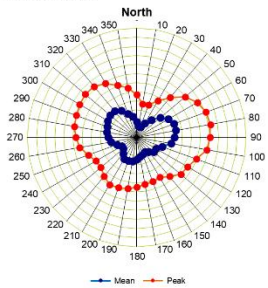


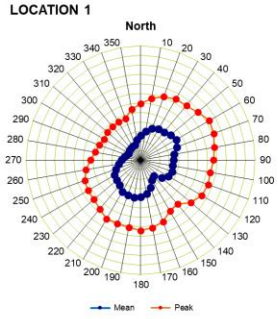
APPENDIX B

Wind Tunnel Test Results: BASELINE Scenario

Polar Plots: Ratio of Ground Level Wind Speed to Reference Wind Speed

Existing-Future

LOCATION 1



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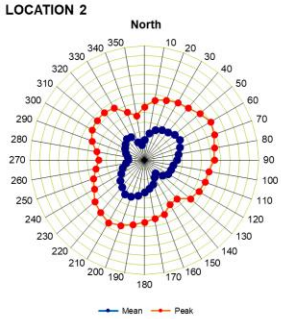

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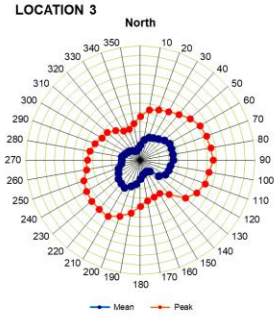

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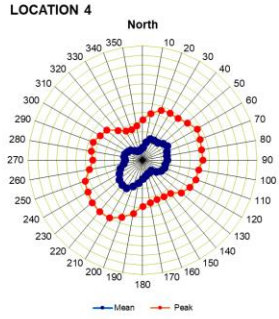

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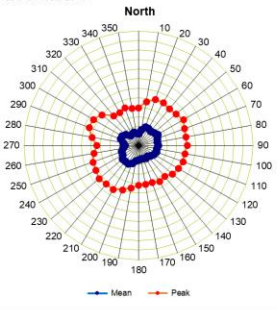

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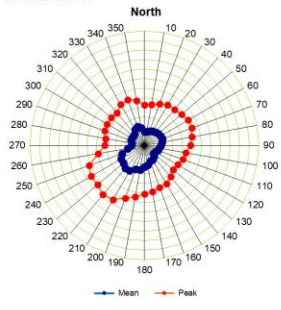

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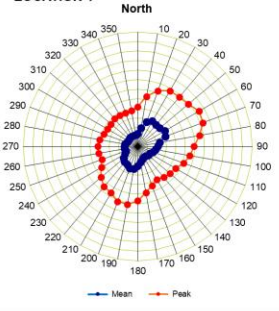

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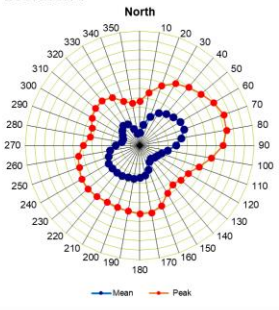

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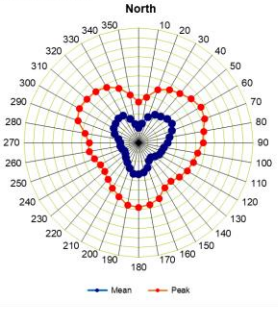

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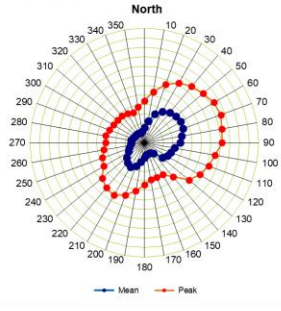

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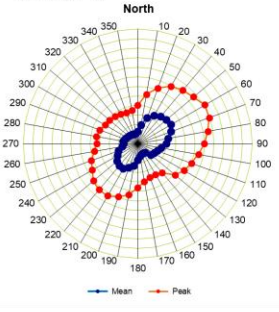

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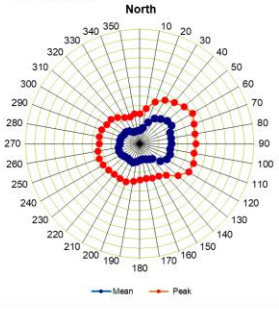

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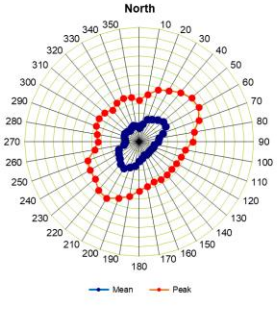
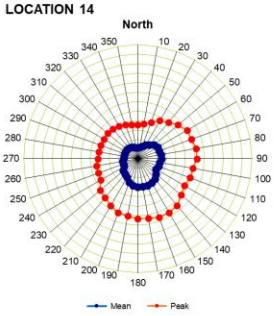


APPENDIX B

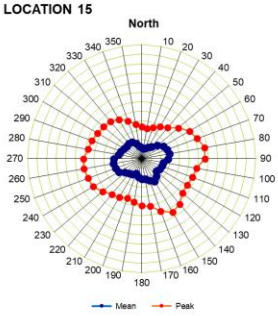
Wind Tunnel Test Results: BASELINE Scenario

Polar Plots: Ratio of Ground Level Wind Speed to Reference Wind Speed

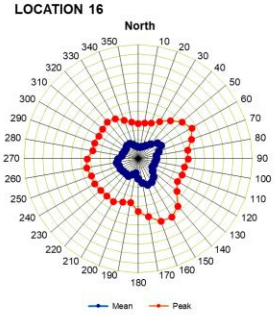
LOCATION 14



LOCATION 15



LOCATION 16



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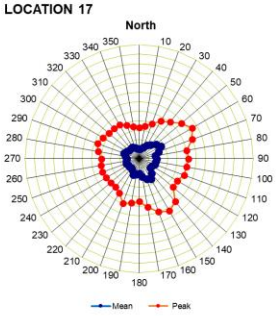

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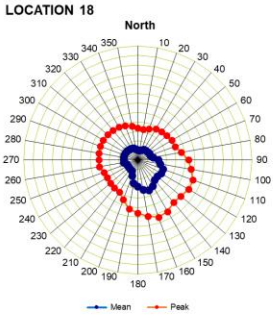

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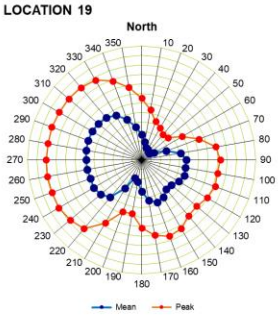

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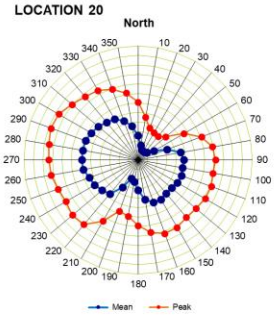
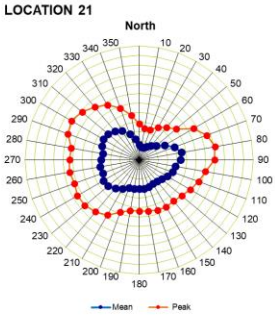
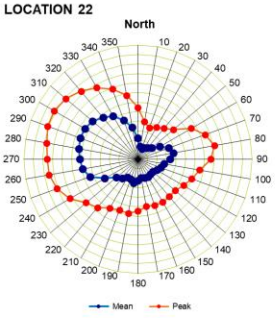


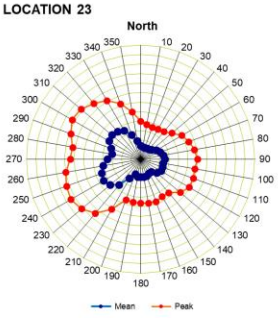
LOCATION 21



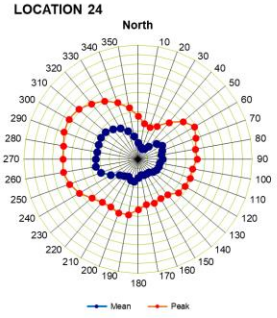
LOCATION 22



LOCATION 23



LOCATION 24



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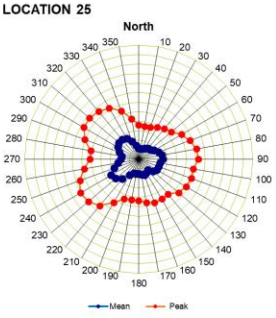

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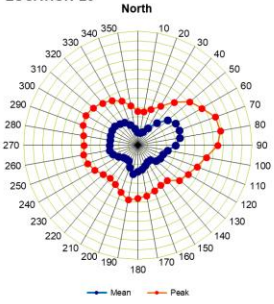


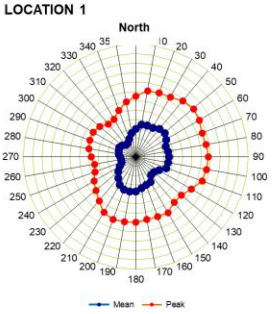
APPENDIX C

Wind Tunnel Test Results: FUTURE Scenario

Polar Plots: Ratio of Ground Level Wind Speed to Reference Wind Speed

Future-Proposed Design

LOCATION 1



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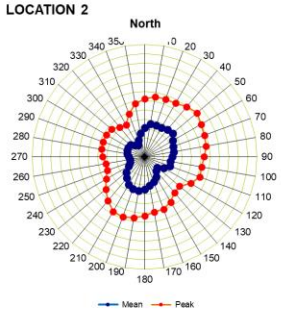

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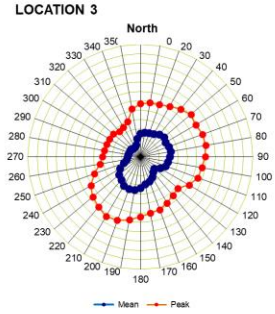

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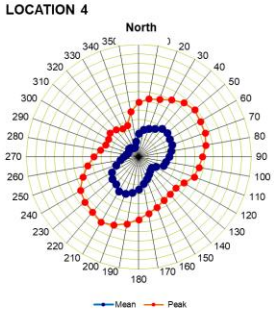

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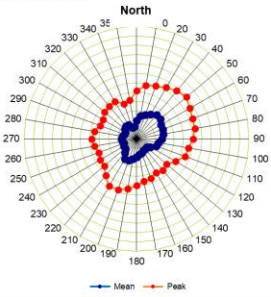

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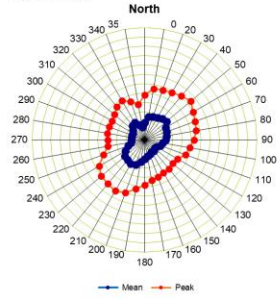

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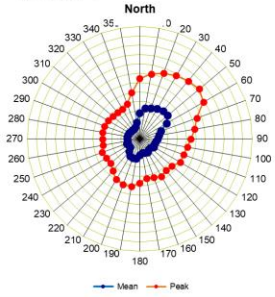

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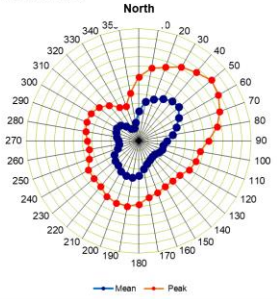

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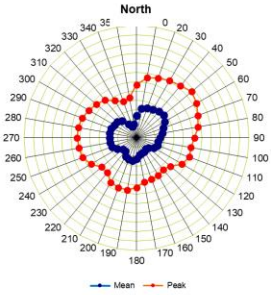

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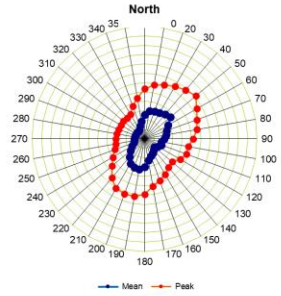

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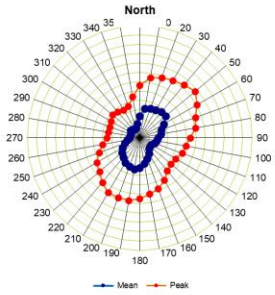

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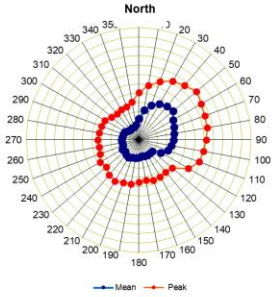

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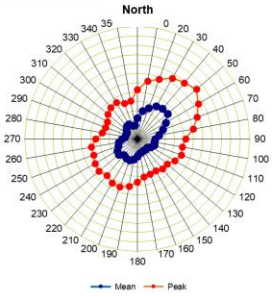
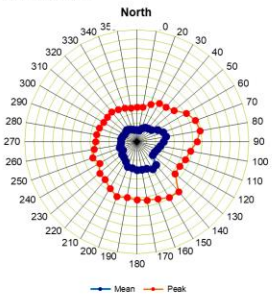


APPENDIX C

Wind Tunnel Test Results: FUTURE Scenario

Polar Plots: Ratio of Ground Level Wind Speed to Reference Wind Speed

LOCATION 14



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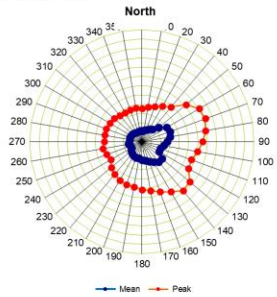

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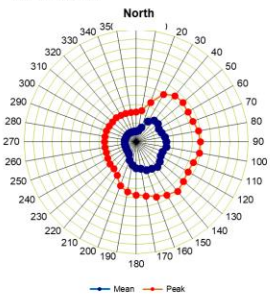

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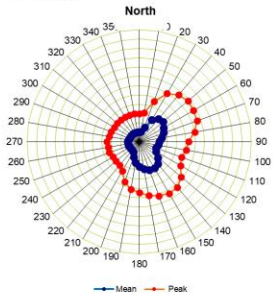

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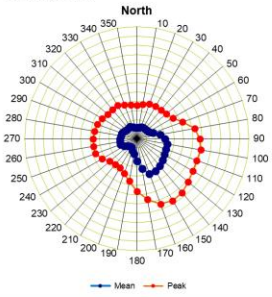

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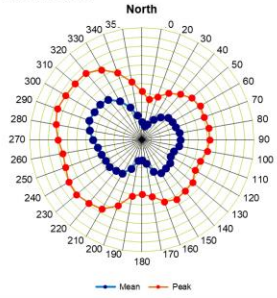

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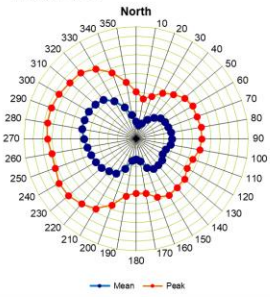

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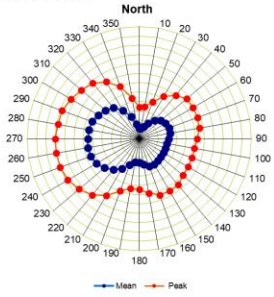

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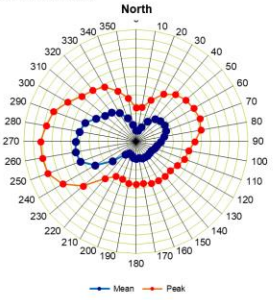

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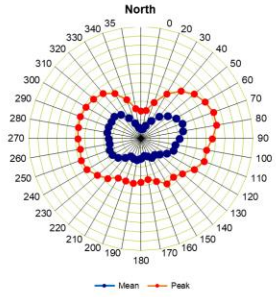

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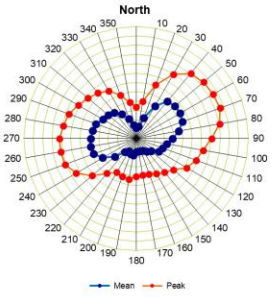

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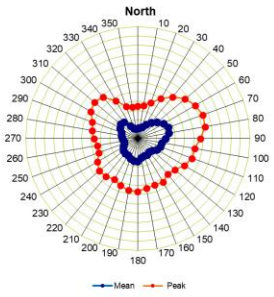

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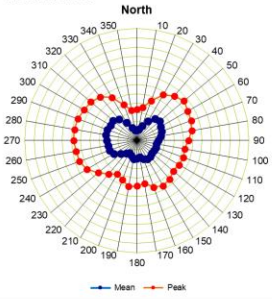

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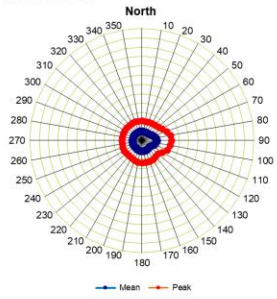

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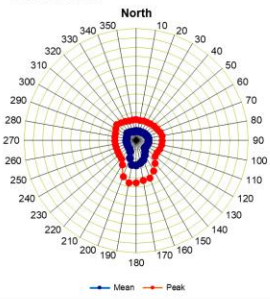

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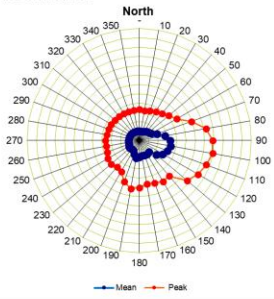

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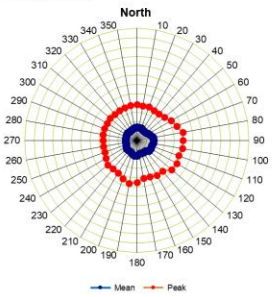


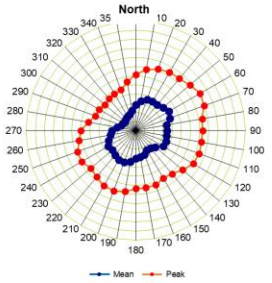
APPENDIX C

Wind Tunnel Test Results: FUTURE Scenario

Polar Plots: Ratio of Ground Level Wind Speed to Reference Wind Speed

Future-Compliant Design

LOCATION 1



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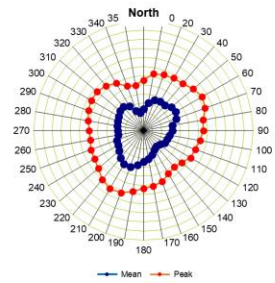

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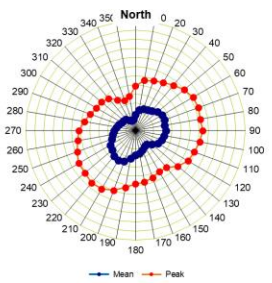

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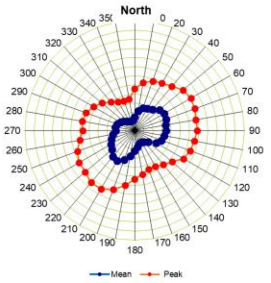

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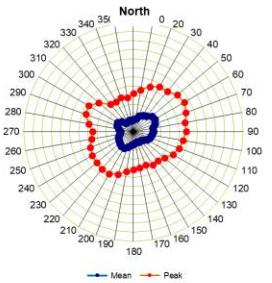
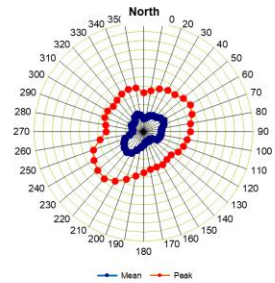
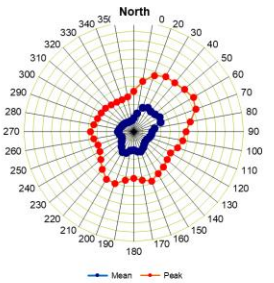


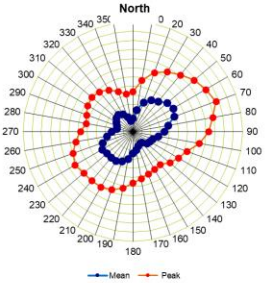
LOCATION 6



LOCATION 7



LOCATION 8



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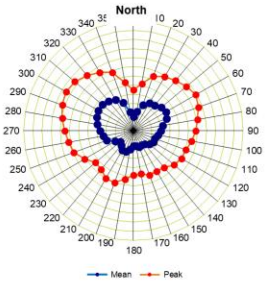
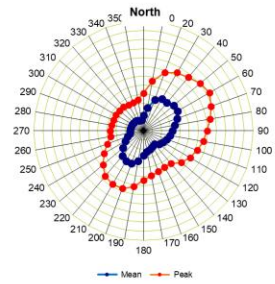


LOCATION 10



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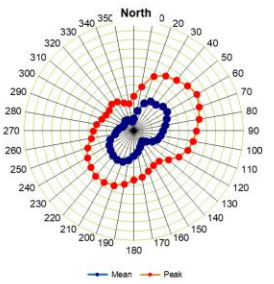

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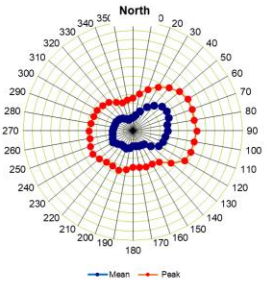

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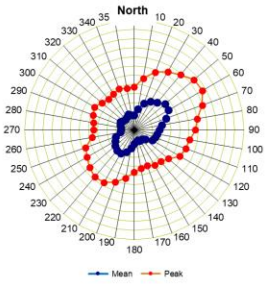
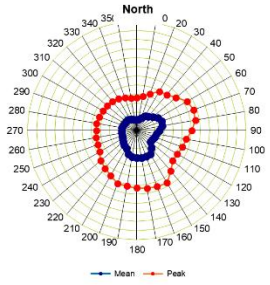


APPENDIX C

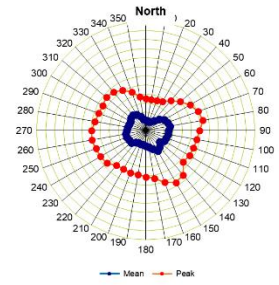
Wind Tunnel Test Results: FUTURE Scenario

Polar Plots: Ratio of Ground Level Wind Speed to Reference Wind Speed

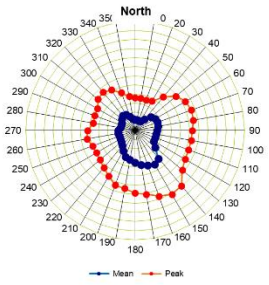
LOCATION 14



LOCATION 15



LOCATION 16



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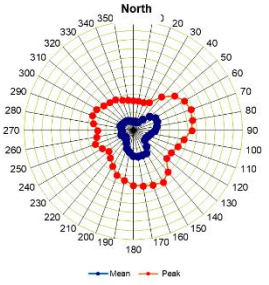

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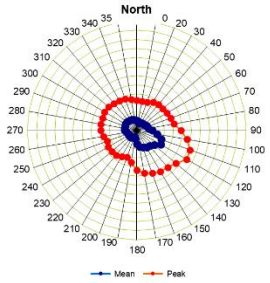

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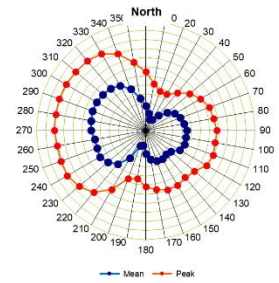

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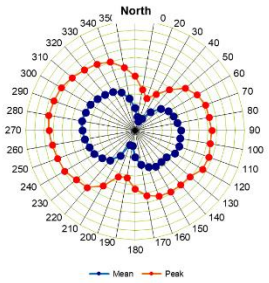

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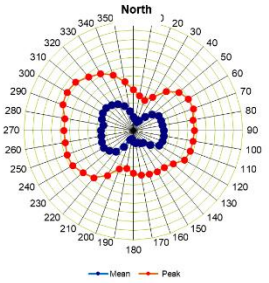

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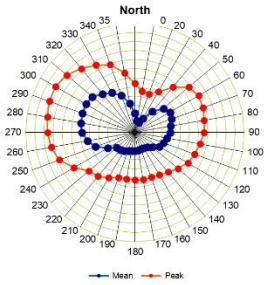
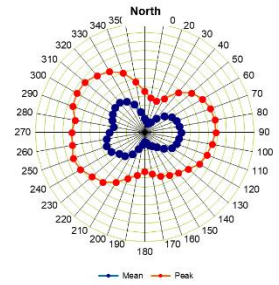


LOCATION 23



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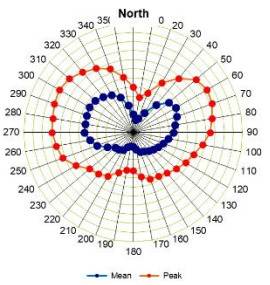

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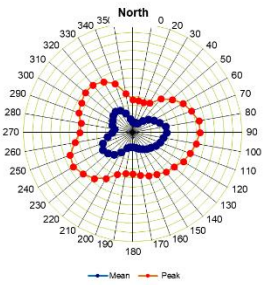

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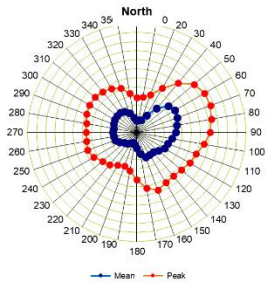


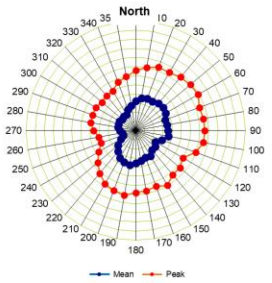
APPENDIX C

Wind Tunnel Test Results: FUTURE Scenario

Polar Plots: Ratio of Ground Level Wind Speed to Reference Wind Speed

MITIGATION

LOCATION 1



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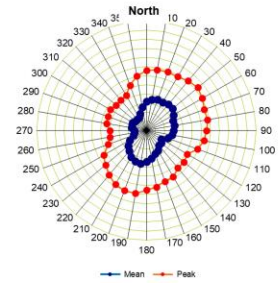

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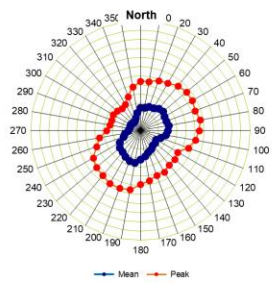

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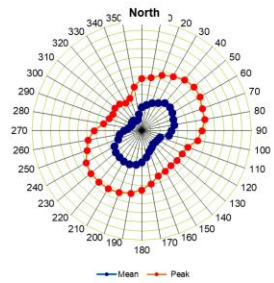

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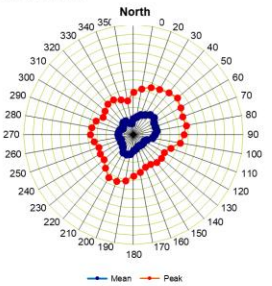

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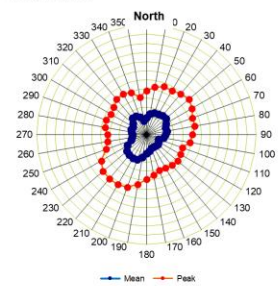

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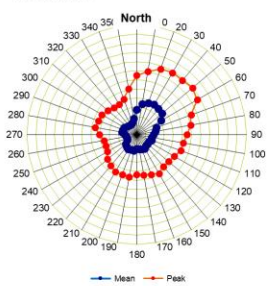

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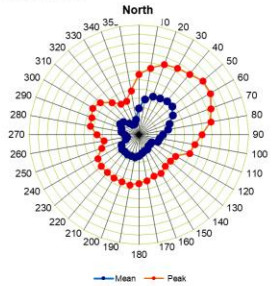

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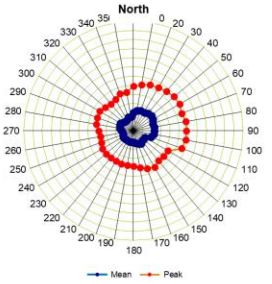

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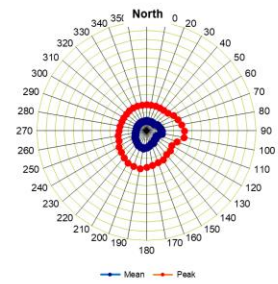

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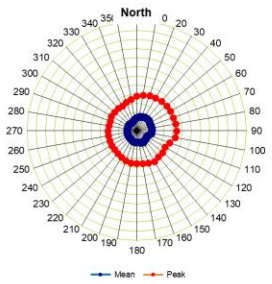

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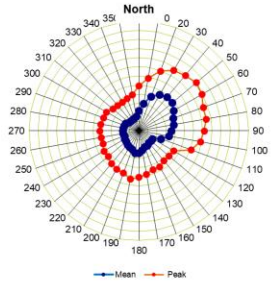

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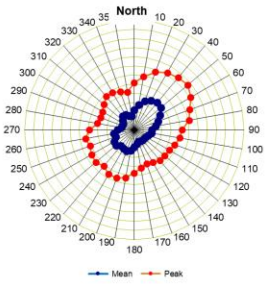
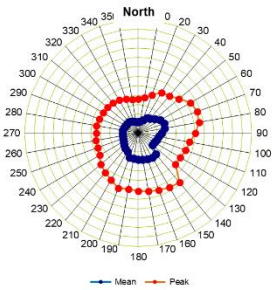


APPENDIX C

Wind Tunnel Test Results: FUTURE Scenario

Polar Plots: Ratio of Ground Level Wind Speed to Reference Wind Speed

LOCATION 14



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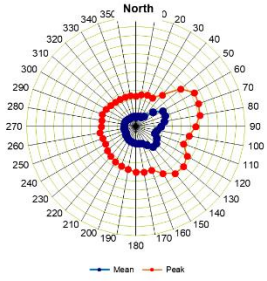

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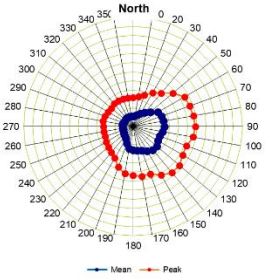

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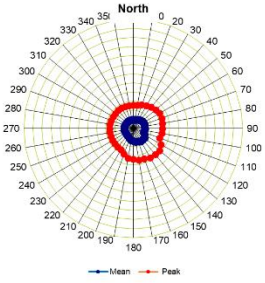

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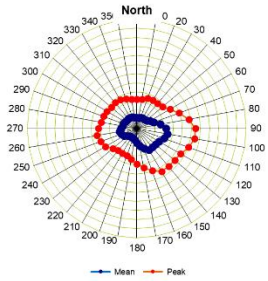

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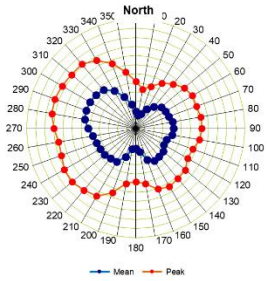

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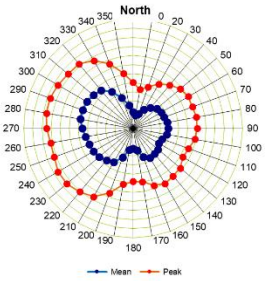

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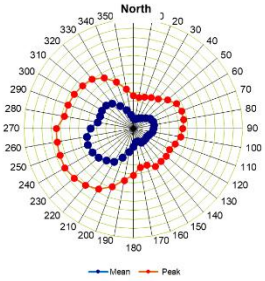

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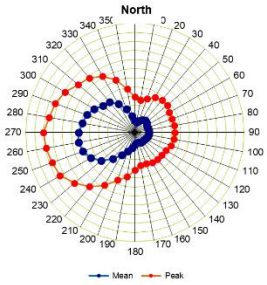

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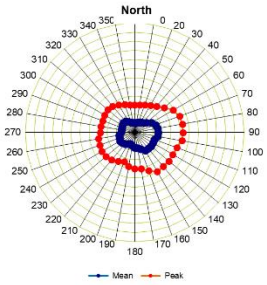

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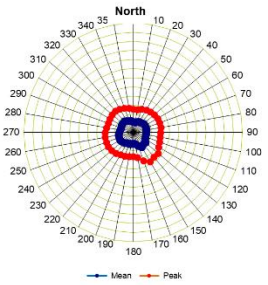

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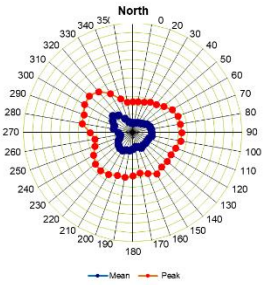

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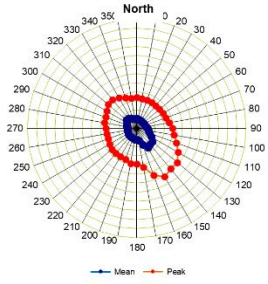

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