



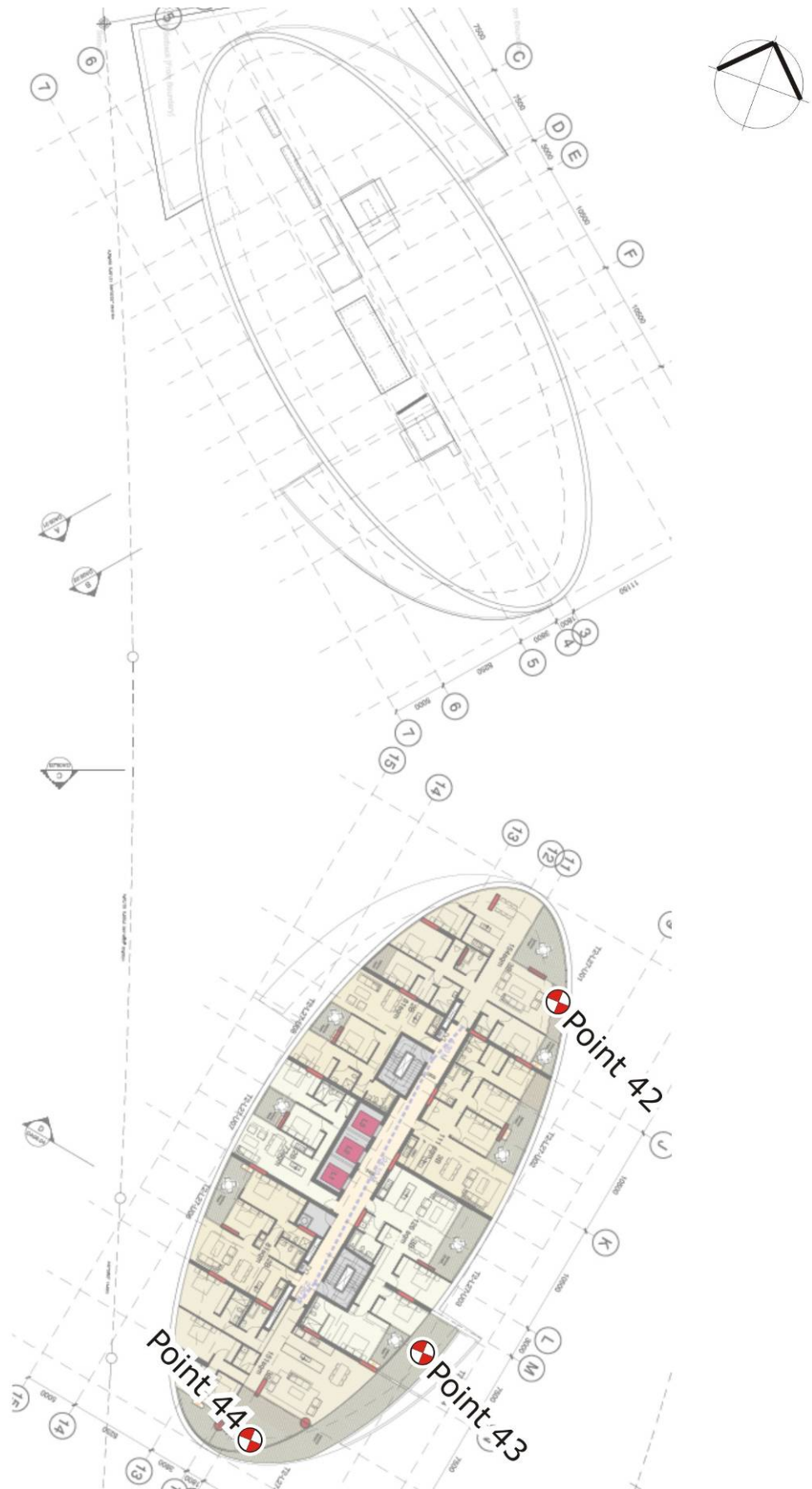
**Figure 6d: Study Point Location
(Level 22)**



**Figure 6e: Study Point Locations
(Level 23)**



**Figure 6f: Study Point Locations
(Level 24)**



**Figure 6g: Study Point Locations
(Level 27)**

8.0 Environmental Wind Speed Criteria

The acceptability of wind in any area is dependent upon its use. For example, people walking or window-shopping will tolerate higher wind speeds than those seated at an outdoor restaurant. The following table developed by Penwarden (1975) is a modified version of the Beaufort Scale, and describes the effects of various wind intensities on people. Note that the applicability column related to wind conditions occurring frequently (approximately once per week on average). Higher ranges of wind speeds can be tolerated for rarer events.

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

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

Lawson (1973) quotes that Beaufort 4 wind speeds (6 to 8m/s means) would be acceptable if it is not exceeded for more than 4% of the time; and a Beaufort 6 (11 to 14m/s means) as being unacceptable if it is exceeded more than 2% of the time.

8.1 Davenport's Criteria for Mean Wind Speeds

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

Table 5: Criteria by Davenport (1972)

Classification	Human Activities	95 Percentile Maximum Mean (once per week)
Walking Fast	Acceptable for walking, main public accessways	$10 \text{ m/s} > u > 7.5 \text{ m/s}$
Strolling, Skating	Slow walking, etc.	$7.5 \text{ m/s} > u > 5.5 \text{ m/s}$
Short Exposure Activities	Generally acceptable for walking & short duration stationary activities such as window-shopping, standing or sitting in plazas.	$5.5 \text{ m/s} > u > 3.5 \text{ m/s}$
Long Exposure Activities	Generally acceptable for long duration stationary activities such as in outdoor restaurants & theatres and in parks.	$3.5 \text{ m/s} > u$

8.2 Lawson's Criteria for Mean Wind Speeds

Later, Lawson (1975) came up with a set of criteria very similar to those of Davenport's. These are presented in Tables 6a and 6b, below.

Table 6a: Safety Criteria by Lawson (1975)

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

Table 6b: Comfort Criteria by Lawson (1975)

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

8.3 Melbourne's Criteria for Peak Wind Speeds

Melbourne (1978) introduced a set of criteria for the assessment of environmental wind conditions. These criteria were developed for temperatures in the range from 10°C to 30°C and for people suitably dressed for outside temperature conditions. These criteria are based on peak gust wind speeds. Melbourne's criteria are outlined in Table 7 below. This set of criteria tends to be more conservative than criteria suggested by other researchers such as those indicated in Figure 7.

Table 7: Criteria by Melbourne (1978)

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

8.4 Comparison of the Various Wind Speed Criteria

The criteria mentioned in Table 7, as well as other criteria, are compared on a probabilistic basis in Figure 7, below.

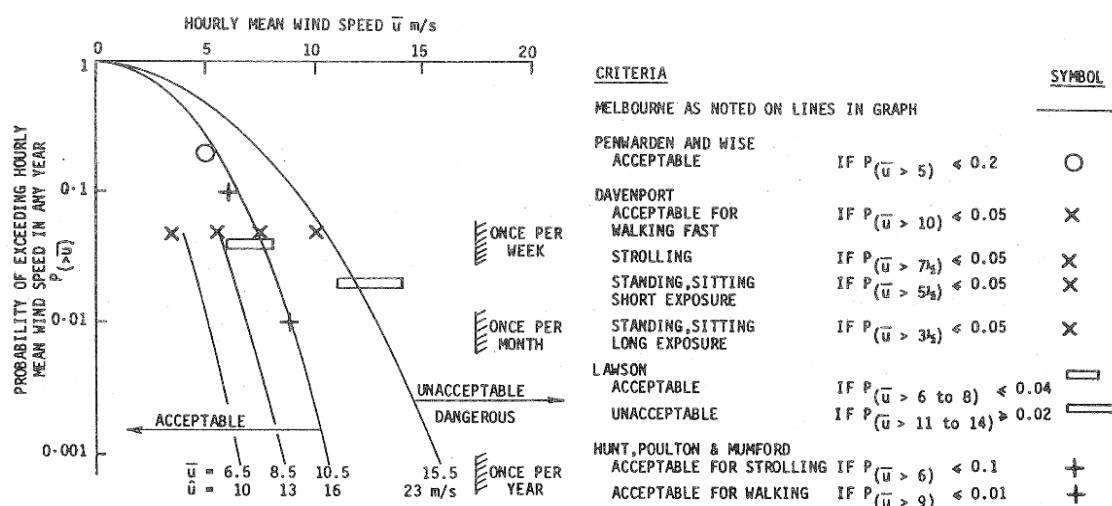


Figure 7: Comparison of Various Mean and Gust Wind Environment Criteria, assuming 15% turbulence and a Gust Factor of 1.5 (after Melbourne, 1978)

However, a comparative study presented by Ratcliff and Peterka (1990) based on measurements taken from a total of 246 locations in various urban situations tends to indicate that the criteria suggested by Melbourne (1978) can be considerably more conservative than the other criteria set out above. The results are indicated in Figure 8. This agrees with our own observations (Rofail, 2007). This discrepancy in the criteria by Melbourne is due to the assumption of a fixed 15% turbulence intensity for all areas, which in our experience tends to be at the lower end of the range of turbulence intensities.

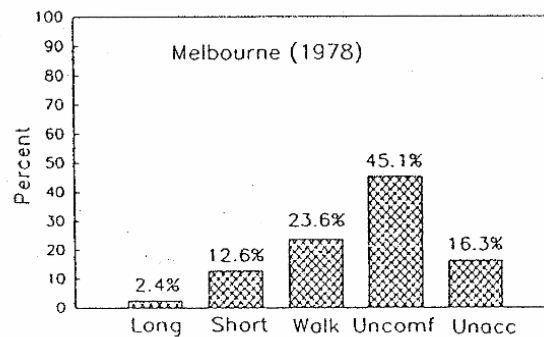
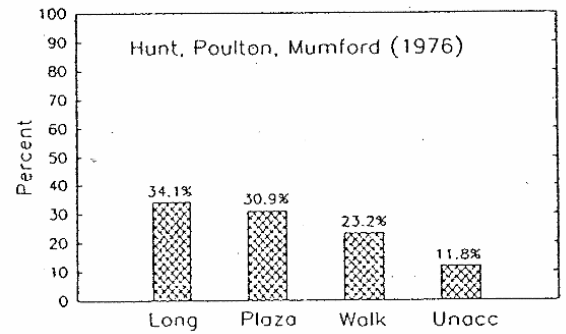
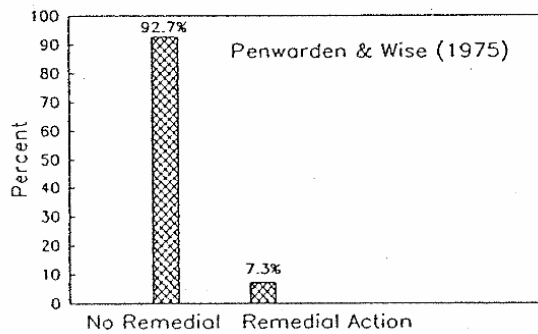
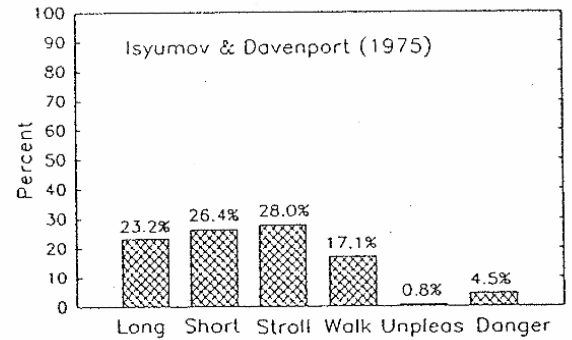
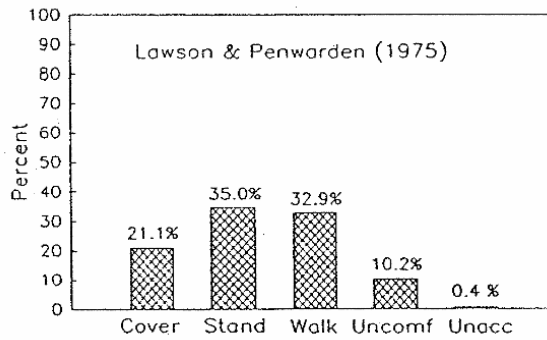


Figure 8: Distribution of Pedestrian Wind Comfort over Five Criteria for 246 locations examined in the Wind Tunnel (after Ratcliff & Peterka, 1990)

8.5 Wind Speed Criteria Used for This Study

For this study, the measured wind conditions for the various critical outdoor trafficable areas of the subject development are compared against two sets of criteria. For comfort, the aforementioned Davenport (1972) criteria are used in conjunction with a weekly maximum Gust Equivalent Mean (GEM) wind speed (defined below). The safety limit criterion by Melbourne (1972) of 23m/s for the annual maximum peak wind speeds is also used. Note that the abovementioned Davenport (1972) criteria is used in conjunction with a Gust Equivalent Mean (GEM) wind speed (defined below) as this has proven over time, and through field observations, to be the most reliable indicator of pedestrian comfort. The most reliable source of data for field observation results are obtained when undertaking remedial wind environment studies. Note that the safety limit criterion by Melbourne (1978) of 23m/s for annual maximum peak wind speeds is also applied to all areas.

The basic criteria for a range of outdoor activities are described as follows:

- **Long Exposure:** 3.5m/s weekly maximum GEM wind speeds
- **Short Exposure:** 5.5m/s weekly maximum GEM wind speeds
- **Comfortable Walking:** 7.5m/s weekly maximum GEM wind speeds
- **Fast Walking:** 10.0m/s weekly maximum GEM wind speeds
- **Safety Limit:** 23.0m/s annual maximum gust wind speeds

Note that the criteria above for the weekly maximum GEM wind speeds are based on the Davenport (1972) criteria, but converted for weekly wind speeds.

Notes:

- The GEM is defined as the maximum of the following:
 - o Mean wind speed
 - o Gust wind speed divided by a gust factor of 1.85
- The gust wind speed is defined as 3.5 standard deviations from the mean.
- Long Exposure applies typically to outdoor dining areas in restaurants, amphitheatres, etc.
- Short Exposure applies typically to areas where short duration stationary activities are involved (less than 1 hour). This includes window shopping, waiting and drop-off areas.
- Comfortable Walking applies typically to areas used mainly for pedestrian thoroughfares. This also includes private swimming pools and communal areas.
- Fast walking applies typically to car parks, laneways, infrequently used public pedestrian thoroughfares and parks, balconies, private terraces etc.
- In all areas, the wind conditions are also checked against the safety limit.

9.0 Results of Study

For this study a total of 44 study points were selected for detailed analysis. This included 18 study points on the ground level areas within and around the site, 16 study points on the podium rooftop area and, 12 study points on private balconies at various levels up the buildings. The locations of the various study points tested for this study are shown in Figures 6a to 6g.

The wind conditions at each study point location were measured in the wind tunnel. The initial tests were performed without the effect of any forms of wind ameliorating devices such as balustrades, screens, canopies, etc that are not already shown in the architectural drawings. Furthermore, the effect of vegetation was also not included in the initial testing. Where wind speeds exceed the appropriate wind speed criterion for a certain area, treatments are generally tested to confirm their effectiveness, unless the effect is certain, in which case in-principle recommendations are given.

The results of the measured wind conditions at each of the various study points were determined for the weekly maximum GEM wind speeds and the annual maximum peak wind speeds using the procedure as detailed in Section 7.0 of this report. These were then compared against the pedestrian wind comfort criteria outlined in Section 8.5 of this report. Plots of results of the local directional wind speeds for the various test locations, as derived from the wind tunnel tests, are presented in Appendix A.

9.1 Ground Level Pedestrian Areas

The Study Points

Test Points 1 to 18 were used to monitor the ground level wind conditions along the various pedestrian walkways in and around the proposed development. The location of these study points are summarised as follows:

- Point 1 is located to the north of the proposed development, along the footpath to Australia Avenue.
- Points 2 to 4 are located along the median strip within Australia Avenue.
- Points 5 to 7 are located on the northern boundary of the proposed development.
- Points 7 and 9 to 11 are located along the western boundary, of the proposed development.
- Points 8 and 12 are located in front of the north-western and south-western entrances to the development.
- Points 13 to 16 are located on the south-western corner of the podium.
- Points 17 and 18 are located on the southern boundary of the proposed development.

The locations of these points are also shown in Figure 6a.

Applicable Criteria

The various pedestrian footpaths around the site are used primarily as pedestrian thoroughfares. The appropriate wind comfort criterion for this type of use is the comfortable walking criterion of 7.5m/s for the weekly maximum GEM wind speeds.

Points 5 and 6 are not expected to have significant pedestrian activity. For these points the wind conditions only need to meet the fast walking criterion.

Points 8, 10 and 12 are located at entrances to the podium area and are considered to be potential meeting points. For this reason the short-exposure criterion has been applied to these points.

For the remaining ground level points, the appropriate criterion is the comfortable walking criterion.

Note that the safety limit criterion of 23m/s for the annual maximum peak wind speeds should also be satisfied for all ground level areas.

Results and Recommendations

The results of the study indicate that the wind conditions around the proposed development at Points 2, 3, 4, 8, 9 and 10 satisfy the desired comfort and safety criteria without the inclusion of any vegetation. It should be noted that the effect of the existing tree planting along the western side of Australia Avenue and along the median strip were not taken into account however they would serve to improve the wind environment at Points 2, 3 and 4.

Initial tests indicate that Point 1 experiences high wind speeds from the north-east and the south-south-west quadrants. Retests were undertaken on Point 1 with the following treatment scheme:

- Add various trees and shrubs around the north-western corner of the site (including the proposed vegetation for Stage 1).

The results of the retests indicate that with the tree layout depicted in Figure 9a, was effective in mitigating the adverse wind conditions at Point 1. This Test Point will now satisfy the comfortable walking and safety criteria and be acceptable for its intended use.

Initial tests indicate that Point 5 will potentially experience high wind speeds from the north-west to the south-south-west. Retests were undertaken with the inclusion of a number of trees proposed as part of the Stage 1 development, north of the subject development as shown in Figure 9a. The wind conditions were improved by means of the proposed trees. However they still do not satisfy the safety criterion. The inclusion of an impermeable screen or dense shrubs at least 2.5m high extending from the north-eastern corner as depicted in Figure 9a is expected to stagnate the flow around Point 5 and bring wind conditions to meet the safety limit.

Initial tests indicate that Point 6 experienced high wind speeds from the north-west to the south and Point 7 experienced high wind speeds from the north-east and south-south-west quadrants. Retests were undertaken for Points 6 and 7 with the following treatment scheme:

- Add 4 trees to the north-west corner of the development.

- Plant low level shrubs around the north-west corner of the proposed development.

The results of the retests indicate that the treatment layout depicted in Figure 9a produced wind speeds at Points 6 and 7 that were marginally acceptable for an area of low pedestrian activity. Any additional trees are required to bring Point 7 to meet the comfortable walking and safety criteria. This can be achieved by the following:

- Tree planting along the footpath along the northern section of the Australia Ave boundary of the site as shown in Figure 9a.

Initial tests indicate that Points 11 to 16 experienced high winds from the south and west. Retests were undertaken on Points 12, 14 and 15 with the following treatment scheme:

- Add trees to the south-west corner of the proposed development

The results of the retests indicate that the tree layout depicted in Figure 9a was effective in mitigating adverse wind conditions at Points 12, 14 and 15. They will now satisfy the comfortable walking and safety criteria and be acceptable for its intended use. Points 11, 13 and 16 are given a pass in-principle due to their close proximity to the other points and to the proposed trees.

Initial tests indicate that Point 17 will experience high winds from the north-east and west-south-west quadrants. Retests were undertaken with the following treatment scheme.

- Add trees/shrubs to the south-eastern corner of Tower 2.
- Add trees to the south-west corner of the proposed development.
- Plant trees along the southern boundary of the proposed development.

The results of the retest indicate that the treatment layout depicted in Figure 9a was effective in mitigating adverse wind conditions at Point 17. It will now satisfy the comfortable walking and safety criteria and be acceptable for its intended use.

Initial tests indicated that Point 18 experienced high winds from the south-south-west and south. Retests were undertaken with the following treatment scheme.

- Incorporate scattered planting to the south of the site.
- Plant trees along the southern boundary of the proposed development.
- Provide dense shrubs at least 2.5m high along the eastern side of the southern boundary of the proposed development.

The results of the retests indicate that the treatment layout depicted in Figure 9a was effective in mitigating the adverse wind conditions at Point 18. With the inclusion of the above treatments, this Test Point will now satisfy the recommended wind comfort criterion and be acceptable for its intended use

9.2 Podium Areas

The Study Points

Test Points 19 to 32 were used to monitor wind conditions for the outdoor trafficable areas on the roof of the podium. The location of the various study points are summarised as follows:

- Points 19 to 22 are located along eastern side of Tower 1.
- Points 23 to 25 are located on the southern side of Tower 1,
- Points 26 to 28 are located on the northern side of Tower 2.
- Points 29 to 32 are located along the eastern side of Tower 2.

The locations of these points are also shown in Figure 6b.

Applicable Criteria

The various trafficable areas will be used for pedestrians to walk around the top of the Podium rooftop. The appropriate wind comfort criterion for this type of use is the comfortable walking criterion of 7.5m/s for the weekly maximum GEM wind speeds. Note that the safety limit criterion of 23m/s for the annual maximum peak wind speeds should also be satisfied.

Results and Recommendations

The results of the study indicate that the wind conditions around the proposed development at Points 19, 20, 25, 26 and 28 satisfy the desired comfort and safety criteria without the inclusion of any vegetation.

Initial tests indicated that Point 21 and 22 experienced high winds from the south and north-north-east and Point 29 experienced high winds from the south and the north-north-west. Retests were undertaken on Points 21, 22 and 29 with the following treatment scheme.

- Add 2 trees to the east of Tower 1 somewhat in line with the minor axis of the building.
- Scatter trees between the two towers.

Retests were undertaken on Point 21 as above with the addition of a 4m awning extending from the southern side of Tower 1.

The results of the retests indicate that the treatment layout depicted in Figure 9b was effective in mitigating the adverse wind conditions at Points 21, 22 and 29. With the inclusion of the above treatments, these Test Points will now satisfy the recommended wind comfort criteria and be acceptable for its intended use

Initial tests indicated that Points 23, 24 and 27 experienced high winds from the south, west and north-east. Retests were undertaken on Points 24 and 27 with the following treatment scheme:

- Scatter trees between the two towers.
- Add a row of trees to the west of the site.

Retests were undertaken on Point 23 as above with the addition of a 4m awning extending from the southern side of Tower 1.

The results of the retests indicate that the treatment layout depicted in Figure 9b was effective in mitigating the adverse wind conditions at

Points 27. With the inclusion of the above treatments, this Test Point will now satisfy the recommended wind comfort criteria and be acceptable for its intended use. The wind conditions at Points 23 and 24 with the above treatment scheme are considered marginally acceptable.

Initial tests indicate that Point 30 experienced high winds from the south-south-east and the north-north-east. Retests were undertaken on Point 30 with the following treatment scheme:

- Add 4 trees to the east of Tower 2.
- Add 2 trees to the north-east of Tower 2.
- Scatter trees between the two towers.

The results of the retests indicate that the treatment layout depicted in Figure 9b was effective in mitigating the adverse wind conditions at Points 30. With the inclusion of the above treatments, this Test Point will now satisfy the recommended wind comfort criteria and be acceptable for its intended use.

Initial tests indicated that Points 31 and 32 experienced high winds from the south. With the inclusion of densely foliating shrubs along the southern boundary of the podium and 4 densely foliating trees to the north of Point 31, depicted in Figure 9b, the wind conditions at those points are expected to satisfy the appropriate wind criteria. These points are therefore given an in-principle pass.

9.3 Private Balconies on Level 12

The Study Points

Test Points 33 to 35 were used to monitor the wind conditions on the Private balconies connected to unit 1 on Level 12 of Tower 1. The location of these study points are summarised as follows:

- Points 33 and 34 are located on the balcony on the western side of Tower 1.
- Point 35 is located on the balcony on the eastern side of Tower 1.

The locations of these points are also shown in Figure 6c.

Note that although there are a lot of outdoor balconies throughout the proposed development. The majority of these balconies are either located within recesses into the overall building form, or protected by full-height blade walls and/or privacy screens on either side. Each of these cases leaves only one side of the balcony exposed to wind and the wind will be effectively stagnated. Hence wind conditions for all untested private balconies of the proposed development are expected to be ideal.

Applicable Criteria

Private balconies are generally used infrequently, and the wind criterion typically applied to these is the safety limit of 23m/s for the annual maximum gust wind speeds. Note that, as with any situation involving elevated outdoor areas, it should be noted that the use of loose glass-tops and other light-weight sheets or covers (including loose BBQ lids) is not appropriate. Lightweight furniture is not recommended, unless it is securely attached to the balcony floor slab.

Results and Recommendations

Initial tests indicated that Point 33 experienced high winds from the south and Point 34 experienced high winds from the south-western and north-north-eastern quadrants. Retests were undertaken on Point 34 only, as it was the more critical of the two points. Retests were undertaken with the effect of 2m impermeable screen on the southern and northern edges of the balcony and 1.2m impermeable balustrade along the western edge of the balcony.

The results of the tests indicate that the wind speeds from the south-south-west were still above the safety criterion. It is expected that following treatment will mitigate this wind effect:

- 1.2m impermeable balustrade along the western edge of the balcony
- 2.5m high screen along the southern, northern and eastern edges
- A canopy over the northern section of this terrace as shown in Figure 9c

The above treatments will improve the wind conditions at Points 33 and 34 such that they would satisfy the safety criterion.

Initial tests indicate that Point 35 experienced high winds from the west and north-east. Retests were undertaken on Point 35 with the following treatment scheme.

- 1.2m impermeable balustrade along the northern side of the balcony.

The results of the retests indicate that the treatment layout depicted in Figure 9c was effective in mitigating the adverse wind conditions at Point 35. With the inclusion of the aforementioned treatments, this test point will satisfy the recommended wind safety criteria and be acceptable for its intended use

9.4 Private Balconies on Level 22

The Study Points

Test Point 36 was used to monitor the wind conditions on the Private balcony connected to unit 6 on Level 22 of Tower 1. The location of this study point is summarised as follows:

- Point 36 is located on the southern tip of Tower 1.

The location of this point is also shown in Figure 6d.

Applicable Criteria

Private balconies are generally used infrequently, and the wind criterion typically applied to these is the safety limit of 23m/s for the annual maximum gust wind speeds. Note that, as with any situation involving elevated outdoor areas, it should be noted that the use of loose glass-tops and other light-weight sheets or covers (including loose BBQ lids) is not appropriate. Lightweight furniture is not recommended, unless it is securely attached to the balcony floor slab.

Results and Recommendations

Initial tests indicated that Point 36 experienced high winds from the south and north-east. A full height screen along the southern edge of the balcony, to the extent shown in Figure 9d is proposed. Any retests with the aforementioned treatments would produce potentially spurious results since the only probe access to the study point is from its windward side. Therefore Point 36 is given an in-principle pass for the treatment option shown in Figure 9d.

With the inclusion of the aforementioned treatment, this Test Point should be acceptable for its intended use.

9.5 Private Balconies on Level 23

The Study Points

Test Points 37 to 39 are used to monitor the wind conditions on the Private balconies of various units on Level 23 of Tower 1 respectively. The location of these study points are summarised as follows:

- Point 37 is located on the private balcony of Unit 3.
- Point 38 is located on the private balcony to Unit 7
- Point 39 is located on the private balcony to Unit 8

The locations of these points are also shown in Figure 6e.

Applicable Criteria

Private balconies are generally used infrequently, and the wind criterion typically applied to these is the safety limit of 23m/s for the annual maximum gust wind speeds. Note that, as with any situation involving elevated outdoor areas, it should be noted that the use of loose glass-tops and other light-weight sheets or covers (including loose BBQ lids) is not appropriate. Lightweight furniture is not recommended, unless it is securely attached to the balcony floor slab.

Results and Recommendations

The results of the study indicate that the wind conditions at Point 39 satisfy the desired safety criteria without the inclusion of any treatments.

Initial tests indicate that Point 38 will experience high winds from the southern and western quadrants. Retests were undertaken on Point 38 with the following treatment scheme.

- Full height impermeable screen extending from the south-eastern tip to divide that balcony area as depicted in Figure 9e.
- Full height impermeable screen along the south eastern aspect of the balcony to at least the extent depicted in Figure 9e.

The results of the retests indicate that the treatment layout depicted in Figure 9e was effective in mitigating the adverse wind conditions at Point 38. With the inclusion of the aforementioned treatments, this Test Point will satisfy the recommended wind safety criteria and be acceptable for its intended use.

Initial tests indicate that Point 37 will experience high winds from the north-east and north-west. A full height screen or set of operable

louvers along the southern boundary of the balcony, along with a 1.2m impermeable balustrade along the eastern boundary of the balcony is proposed. Any retests with the aforementioned treatments would produce potentially spurious results since the only probe access to the study point is from its windward side. Therefore Point 37 is given an in-principle pass for the treatment option shown in Figure 9e. With the inclusion of the aforementioned treatments, the wind climate at this test point should be acceptable for its intended use.

9.6 Private Balconies on Level 24

The Study Points

Test Points 40 and 41 were used to monitor the wind conditions on the Private balconies of two units on Level 24 of Tower 2 respectively. The location of these study points are summarised as follows:

- Point 40 is located on the private balcony of unit 11.
- Point 41 is located on the private balcony to unit 1.

The locations of these points are also shown in Figure 6f.

Applicable Criteria

Private balconies are generally used infrequently, and the wind criterion typically applied to these is the safety limit of 23m/s for the annual maximum gust wind speeds. Note that, as with any situation involving elevated outdoor areas, it should be noted that the use of loose glass-tops and other light-weight sheets or covers (including loose BBQ lids) is not appropriate. Lightweight furniture is not recommended, unless it is securely attached to the balcony floor slab.

Results and Recommendations

The results of the study indicate that the wind conditions at Point 40 satisfy the desired safety criteria without the inclusion of any treatments.

Initial tests indicated that Point 41 experienced high winds from the north and west. Retests were undertaken on Point 41 with the following treatment scheme.

- 1.2m impermeable balustrade along the perimeter of the balcony.
- Full height inter-tenancy screen to the south of the point

The results of the retests indicate that with the treatment layout depicted in Figure 9f was effective in mitigating the adverse wind conditions at Point 41. With the inclusion of the aforementioned treatments, this Test Point will satisfy the recommended wind safety criteria and be acceptable for its intended use.

9.7 Private Balconies on Level 27

The Study Points

Test Points 42, 43 and 44 were used to monitor the wind conditions on the Private balconies of two units on Level 27 of Tower 2 respectively. The location of these study points are summarised as follows:

- Point 42 is located on the private balcony of unit 1.
- Point 43 is located on the private balcony to unit 3.
- Point 44 is located on the private balcony to unit 4.

The locations of these points are also shown in Figure 6g.

Applicable Criteria

Private balconies are generally used infrequently, and the wind criterion typically applied to these is the safety limit of 23m/s for the annual maximum gust wind speeds. Note that, as with any situation involving elevated outdoor areas, it should be noted that the use of loose glass-tops and other light-weight sheets or covers (including loose BBQ lids) is not appropriate. Lightweight furniture is not recommended, unless it is securely attached to the balcony floor slab.

Results and Recommendations

Initial tests indicate that Point 42 will experience high winds from the north-north-east. It is expected that the addition of a 1.2m impermeable balustrade will improve the wind conditions at Point 42 such that they would satisfy the safety criterion.

Initial tests indicate that Point 43 will experience high winds from the south. It is expected that the addition of a full height impermeable screen to the northern edge of the balcony, to at least the extent shown in Figure 9g, will improve the wind conditions at Point 43 such that they would satisfy the safety criterion.

Initial tests indicate that Point 44 will experience high winds from the west around to the east-south-east. It is expected that the addition of a full height impermeable screen to at least the extent shown in Figure 9g, will improve the wind conditions at Point 44 such that they would satisfy the safety criterion.

With the inclusion of the aforementioned treatments, these Test Points should be acceptable for their intended use.



Figure 9a: Recommended Minimum Planting Layout of Trees for the Ground Level Areas of the Development Site

-  Densely foliating trees, capable of growing to at least 4m tall with 4m wide canopy
-  4m wide awning
-  2-3m high densely foliating shrubs



Figure 9b: Recommended Minimum extent of Awning and Planting Layout of Trees for the Podium Areas



Figure 9c: Recommended Treatments for Level 12



Figure 9d: Recommended Treatments for Level 22



Figure 9e: Recommended Treatments for Level 23





10.0 Conclusion

A detailed investigation has been undertaken into the wind environment impact in relation to the proposed development located known as Australia Towers, Sydney Olympic Park. The results of the study indicate that wind conditions for most of the outdoor areas within and around the development site will satisfy the appropriate wind comfort and safety criteria. The following treatments have been recommended for the areas exposed to strong winds:

- Strategic planting of trees and shrubs for ground level pedestrian areas, particularly at the north-western and southern-western corners of the development.
- Several trees and shrubs are also recommended for the podium.
- A 4m wide awning is recommended around the southern end of Tower 1.
- 2.5m impermeable screens are recommended for the northern and southern boundaries of the north-western balcony of unit 1 on Level 12 of Tower 1. Furthermore, a canopy is to be connected to the northern screen.
- A full height impermeable screen is recommended for the southern edge of the southern balcony of Unit 6 on Level 22 in Tower 1
- A full height impermeable screen extending from the south-eastern tip of Tower 1, to divide the southern balcony of Unit 7 on Level 23 in Tower 1 in addition to a full-height perimeter screen along the south-eastern aspect of that southern balcony.
- Full height louver panel (as per other floors) or impermeable screen along the south-eastern edge of the balcony of Unit 3 on Level 23 in Tower 1.
- A full height privacy screen along the boundary between the balconies for Units 1 and 11 on Level 24 of Tower 2.
- A full height impermeable screen along the south western section of the boundary of the balcony for Unit 4 on Level 27 of Tower 2.
- Full height louver panel (as per the other floors) or impermeable screen along the northern edge of the balcony for Unit 3 on Level 27 of Tower 2.
- It is generally recommended to have 1.2m impermeable balustrades for the various balconies.

To be effective in wind mitigation, the abovementioned trees should be densely foliating and of an evergreen species. They should also be capable of growing to the heights and widths specified in the relevant figures in the report.

Wind conditions for most of the private balconies and terraces within the development are expected to be ideal since they are either recessed or protected by full-height blade walls, louver panels and/or privacy screens on either side. However, as with any situation involving high-rise outdoor areas, it should be noted that the use of loose glass-tops and other light-weight sheets or covers (including loose BBQ lids) is not appropriate. Lightweight furniture is not recommended, unless it is securely attached to the balcony floor slab.

With the inclusion of the abovementioned treatments to the proposed development, wind conditions for all outdoor trafficable areas within and around the development will satisfy the recommended wind comfort and safety criteria.

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Appendix A

Plots of Wind Tunnel Results