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WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report

Wind Tunnel Tests for:

1 CARRINGTON STREET

Sydney, Australia

Prepared for:

Sovereign Wynyard Centre Pty Ltd

Level 22, 135 King Street
Sydney
NSW 2000

Prepared by:

Christian Rohr, Engineer
Graeme Wood, Ph.D., Director

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CPP
Unit 2, 500 Princes Highway
St. Peters, NSW 2044, Australia
info-syd@cppwind.com
www.cppwind.com

EXECUTIVE SUMMARY

A wind tunnel study of the proposed development at 1 Carrington Street, to be located in Sydney, was conducted to assess pedestrian wind comfort at ground level. A model of the project was fabricated to a 1:400 scale and centred on a turntable in the wind tunnel. Replicas of surrounding buildings within a 570 m radius were constructed and placed on the turntable.

The wind tunnel testing was performed in the natural boundary layer wind tunnel of Cermak Peterka Petersen Pty. Ltd., St Peters. Measurements of wind speeds likely to be experienced by pedestrians were made with a hot-film anemometer. Approach boundary layers representative of the environment surrounding the proposed development were established in the test section of the wind tunnel. The approach wind flow had appropriate turbulence characteristics corresponding to Terrain Category 3 as defined in Standards Australia (2011). The pedestrian wind environment was investigated at 21 locations for 16 wind directions each in accordance with Australasian Wind Engineering Society (2001). These points were tested in the proposed configuration and to determine the effect of mitigation measures where necessary. The measurements were combined with wind statistics to produce results of wind speed versus the percentage of time that wind speed is exceeded for each location.

The street level wind environment has been found to be similar to typical wind conditions in the surrounding area. All locations in the public domain were found to pass the distress criterion.

The through-site links are expected to be suitable for their intended uses as a main pedestrian accessway.

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LIST OF SYMBOLS

D	Characteristic dimension (building height, width, etc.) (m)
n	Mean velocity profile power law exponent
T_u	Turbulence intensity, U_{stdev}/U
U	Local mean velocity (m/s)
U_{ref}	Reference velocity at reference height z_{ref} (m/s)
U_{pk}	Peak wind speed in pedestrian studies (m/s)
U_{stdev}	Standard deviation of fluctuating velocity (m/s)
z	Height above surface (m)
ν	Kinematic viscosity of approach flow (m^2/s)
$\sigma(\ )$	Standard deviation of $(\ ),=(\ )'_{\mathrm{rms}}$
ρ	Density of approach flow (kg/m^3)
$(\ )_{\mathrm{max}}$	Maximum value during data record
$(\ )_{\mathrm{min}}$	Minimum value during data record
$(\ )_{\mathrm{mean}}$	Mean value during data record
$(\ )_{\mathrm{stdev}}$	Standard deviation

1. INTRODUCTION

Pedestrian acceptability of footpaths, entrances, plazas, and terraces is often an important design parameter of interest to the development approvals body, building owner, and architect. Assessment of the acceptability of the pedestrian level wind environment is desirable during the project design phase so that modifications can be made, if necessary, to create wind conditions suitable for the intended use of the space.

Analytical methods such as computational fluid dynamics (CFD) are not capable, except in very simple geometries, to estimate wind pressures, frame loads, or windiness in pedestrian areas.

Techniques have been developed which permit boundary layer wind tunnel modelling of buildings to determine wind velocities in pedestrian areas. The wind tunnel testing was performed in the natural boundary layer wind tunnel of Cermak Peterka Petersen Pty. Ltd., St Peters. This report includes wind tunnel test procedures, test results, and a discussion of results. Table 1 summarises the model configurations, test methods, and data acquisition parameters used. All the data collection was performed in accordance with Australasian Wind Engineering Society (2001), and American Society of Civil Engineers (1999, 2010).

Table 1: Configurations for data acquisition

Configuration A	
Geometry:	Proposed 1 Carrington Street development with existing surrounding buildings and landscape, as shown in Figure 4.
Pedestrian Velocities:	Pedestrian wind conditions measured at 21 locations for 16 wind directions in 22.5° increments from 0° (north).

2. THE WIND TUNNEL TEST

Modelling of the aerodynamic flow around structures requires special consideration of flow conditions to obtain similitude between the model and the prototype. A detailed discussion of the similarity requirements and their wind tunnel implementation can be found in Cermak (1971, 1975, 1976). In general, the requirements are that the model and prototype be geometrically similar, that the approach mean velocity and turbulence characteristics at the model building site have a vertical profile shape similar to the full-scale flow, and that the Reynolds number for the model and prototype be equal. Due to modelling constraints the Reynolds number cannot be made equal and Australasian Wind Engineering Society Quality Assurance Manual (2001) suggests a minimum Reynolds number of 50,000, based on minimum model width and wind velocity at the top of the model; in this study the modelled Reynolds number was over 50,000.

The wind tunnel test was performed in the boundary layer wind tunnel shown in Figure 1. The wind tunnel test section is 3.0 m wide, by 2.4 m high with a porous slatted roof for passive blockage correction. This wind tunnel has a 21 m long test section, the floor of which is covered with roughness elements, preceded by a vorticity generating fence and spires The spires, barrier, and roughness elements were designed to provide a modelled atmospheric boundary layer approximately 1.2 m thick with a mean velocity and turbulence intensity profile similar to that expected to occur in the region approaching the modelled area. The approach wind characteristics used for the model test are shown in Figure 2 and are explained more fully in Section 4.1.1.

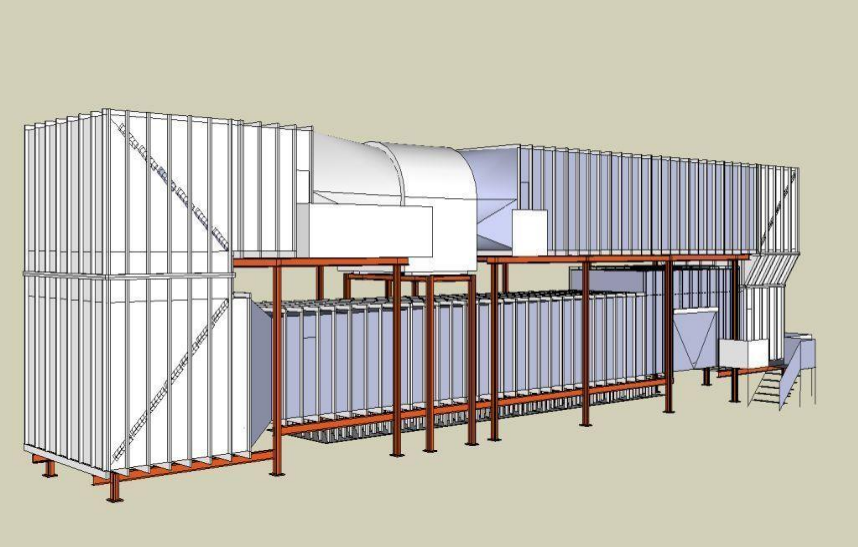

Figure 1: Schematic of the closed circuit wind tunnel

A model of the proposed development and surrounds to a radius of 570 m was constructed at a scale of 1:400, which was consistent with the modelled atmospheric flow, permitted a reasonable test model size with an adequate portion of the adjoining environment to be included in a proximity model, and was within wind tunnel blockage limitations. Significant variations in the building surface were formed into the model. The models were mounted on the turntable located near the downstream end of the wind tunnel test section, Figure 3. The turntable permitted rotation of the modelled area for examination of velocities from any approach wind direction. Additional photos of the testing are included in Appendix 1.

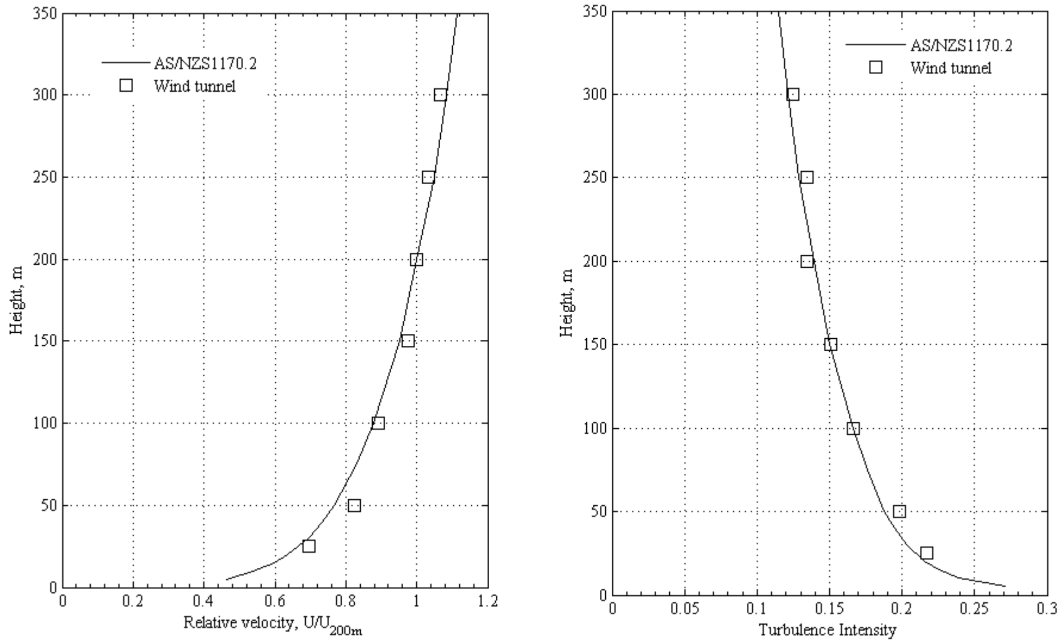

Figure 2: Mean velocity and turbulence profiles approaching the model, terrain category 3

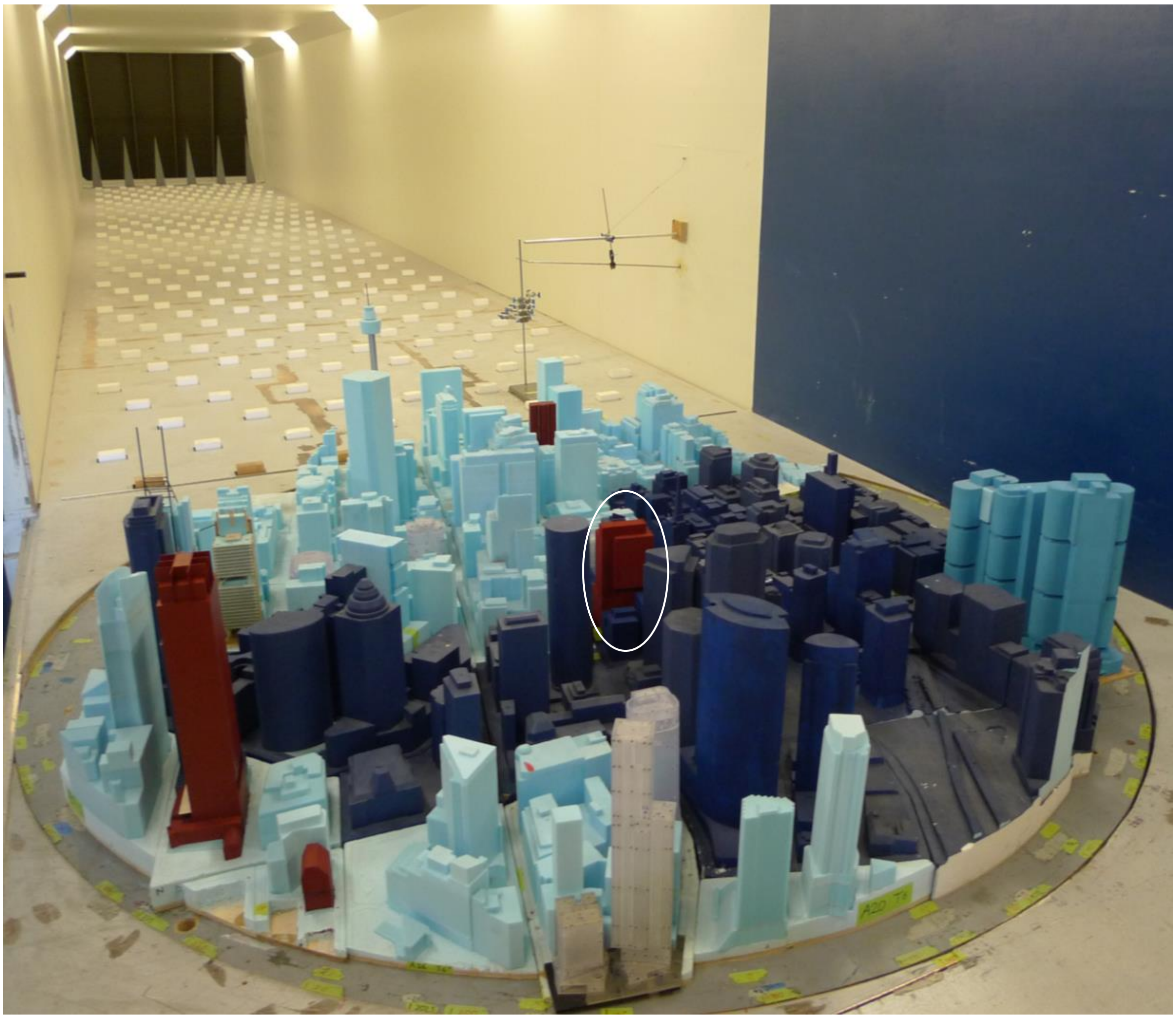

Figure 3: Photograph of the 1 Carrington Street model in the CPP wind tunnel

3. ENVIRONMENTAL WIND CRITERIA

Over the years, a number of researchers have added to the knowledge of wind effects on pedestrians by suggesting criteria for comfort and safety. Because pedestrians will tolerate higher wind speeds for a smaller period of time than for lower wind speeds, these criteria provide a means of evaluating the overall acceptability of a pedestrian location. A location can further be evaluated for its intended use, such as for an outdoor café or a footpath. One of the most widely accepted set of criteria was developed by Lawson (1990), which is described in Table 2.

Table 2: The Lawson comfort criteria

Comfort (maximum of mean or gust equivalent mean (GEM^{+}) wind speed exceeded 5% of the time)	
< 4 m/s	Pedestrian Sitting (considered to be of long duration)
4 - 6 m/s	Pedestrian Standing (or sitting for a short time or exposure)
6 - 8 m/s	Pedestrian Walking
8 - 10 m/s	Business Walking (objective walking from A to B or for cycling)
> 10 m/s	Uncomfortable
Distress (maximum of mean or GEM wind speed exceeded 0.022% of the time)	
<15 m/s	not to be exceeded more than two times per year (or one time per season) for general access area
<20 m/s	not to be exceeded more than two times per year (or one time per season) where only able bodied people would be expected; frail or cyclists would not be expected

Note: $^{+}$ The gust equivalent mean (GEM) is the peak 3 s gust wind speed divided by 1.85.

Lawson's criteria have categories for discomfort, based on wind speeds exceeded five percent of the time, allowing planners to judge the usability of locations for various intended purposes ranging from "business walking" to "pedestrian sitting". The level and severity of these comfort categories can vary based on individual preference, so calibration to the local wind environment is recommended when evaluating the Lawson ratings. The criteria also include a distress rating, for safety assessment, which is based on occasional (once or twice per year) wind speeds[1]. In both cases, the wind speed used is the larger of a mean or gust equivalent-mean (GEM) wind speed. The GEM is defined as the peak gust wind speed divided by 1.85; this is intended to account for locations where the gustiness is the dominant characteristic of the wind. Assessment using the Lawson criteria provides a similar classification as using the once per annum gust, which was the basis of the City of Sydney (2011) DCP, however provides additional information regarding the serviceability wind climate. The current City of Sydney

[1] The rating of "uncomfortable" in Table 2 is the word of the acceptance criteria author and may not apply directly to any particular project. High wind areas are certainly not uncomfortable all the time, just on windier days. The word uncomfortable, in our understanding, refers to acceptability of the site by pedestrians for typical pedestrian use; i.e., on the windiest days, pedestrians will not find the areas "acceptable" for walking and will tend to avoid such areas if possible. The distress rating fail indicates some unspecified potential for causing injury to a less stable individual who might be blown over. The likelihood of such events is not well described in the literature and is likely to be strongly affected by individual differences, presence of water, blowing dust or particulates, and other variables in addition to the wind speed.

(2012) DCP specifies wind effects not to exceed 10 m/s, as the area is classified as an ‘active frontage’. From discussions with Council this is a once per annum gust wind speed similar to the 2004 DCP, but is meant to be interpreted as a comfort level criterion to promote outdoor café style activities and is not a distress requirement.

4. DATA ACQUISITION AND RESULTS

4.1 Velocities

Velocity profile measurements were taken to verify that appropriate boundary layer flow approaching the site was established and to determine the likely pedestrian level wind climate around the test site. Pedestrian wind measurements and analysis are described in Section 4.1.2. All velocity measurements were made with hot-film anemometers, which were calibrated against a Pitot-static tube in the wind tunnel. The calibration data were described by a King's Law relationship (King, 1914)

4.1.1 Velocity Profiles

Mean velocity and turbulence intensity profiles for the boundary layer flow approaching the model are shown in Figure 2. Turbulence intensities are related to the local mean wind speed. These profiles have the form as derived from Standards Australia (2011) and are appropriate for the approach conditions.

4.1.2 Pedestrian Winds

The proposed development is situated on the block bounded by Carrington, George, Margaret, and Wynyard Streets, Sydney. There is an existing vehicular laneway joining Margaret and Wynyard Streets. The proposed development includes a pedestrian through site link connecting George and Carrington Streets, along with direct access to Wynyard Train Station. It is understood that the main entrances to the proposed commercial office tower development will be from Carrington Street and George Street.

The proposed commercial office tower has frontage of approximately 50 m on Carrington and George Streets. The proposed development consists of an essentially prismatic tower with a square shaped plan form rising approximately 125 m above George Street level.

The proposed development is surrounded by many medium to high-rise buildings, including Suncorp Tower, Australia Square, Angel Place, and the MLC Centre. Topography surrounding the site is relatively flat in the north-south direction, but drops significantly from York Street to the east and west.

Wind speed measurements were recorded at 21 locations to evaluate pedestrian comfort in and around the project site, Figure 4 and Figure 5. The points were tested for the configurations described in Table 1. Velocity measurements were made at the model scale equivalent of 1.5 to 2.1 m above the surface for 16 wind directions at 22.5° intervals. Locations were chosen to determine the degree of pedestrian comfort at the building corners where relatively severe conditions frequently are found, near building entrances, on adjacent pavements with heavy pedestrian traffic, and in open plaza areas. Three comparative pedestrian positions, located in a familiar or relatively undisturbed area near the project site, were tested for reference purposes, Figure 4.

The hot-film signal was sampled by for a period corresponding to one hour in prototype. All velocity data were digitally filtered to obtain the two to three second running mean wind speed at each point; this is the minimum size of a gust affecting a pedestrian and the gust duration on which the wind criteria are based. These local wind speeds, U, were normalised by the tunnel reference velocity, U_{ref}. Mean and turbulence statistics were calculated and used to calculate the normalised effective peak gust using $\frac{U_{pk}}{U_{ref}} = \frac{\overline{U} + 3 \cdot U_{stdev}}{U_{ref}}$.

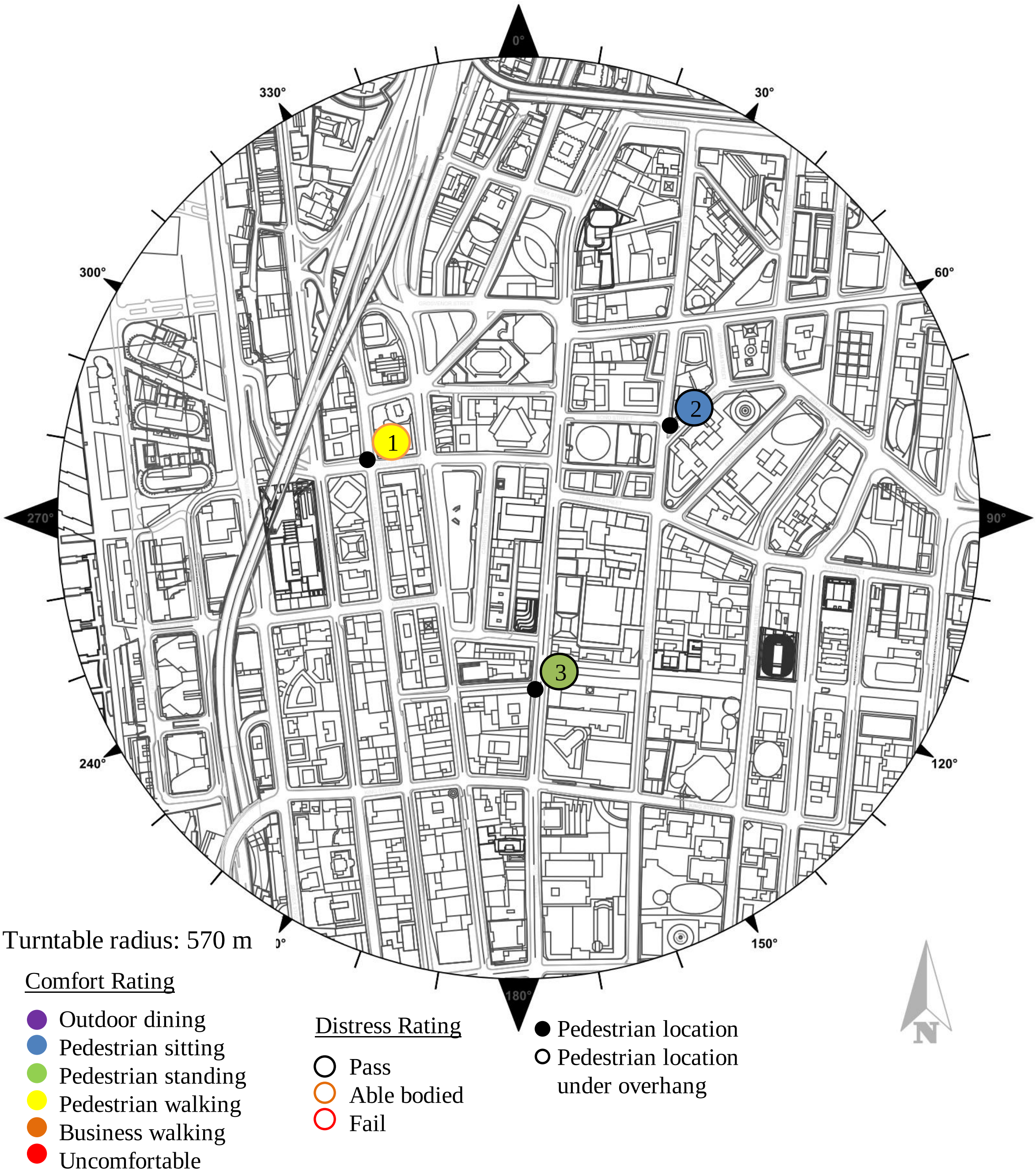

Figure 4: Site layout and remote pedestrian wind speed measurement locations with comfort/distress rating

Figure 5: Pedestrian wind speed measurement locations with comfort/distress ratings

The mean and gust equivalent mean velocities relative to the free stream wind tunnel reference velocity at a full-scale elevation of 200 m are plotted in polar form in Appendix 2. The graphs show velocity magnitude and the approach wind direction for which that velocity was measured. The polar plots aid in visualisation of the effects of the nearby structures or topography, the relative significance of various wind azimuths, and whether the mean or gust wind speed is of greater importance.

To enable a quantitative assessment of the wind environment, the wind tunnel data were combined with wind frequency and direction information measured by the Bureau of Meteorology at a standard height of 10 m at Sydney Airport from 1995 to 2012, Figure 6. From these data, directional criterion lines for the Lawson rating wind speeds have been calculated and included on the polar plots in Appendix 2; this gives additional information regarding directional sensitivity at each location.

The criteria of Lawson consider the integration of the velocity measurements with local wind climate statistical data summarized in Figure 6 to rate each location. From the cumulative wind speed distributions for each location, the percentage of time each of the Lawson comfort rating wind speeds are exceeded are presented in tabular form under the polar plots in Appendix 2. In addition to the rating wind speeds, the percentage of time that 2 m/s is exceeded is also reported. This has been provided as it has found that the limiting wind speed for long-term stationary activities such as fine outdoor dining should be about 2 to 2.5 m/s rather than 4 m/s. Interpretation of these wind levels can be aided by the description of the effects of wind of various magnitudes on people. The earliest quantitative description of wind effects was established by Sir Francis Beaufort in 1806, for use at sea; the Beaufort scale is reproduced in Table 3 including qualitative descriptions of wind effects.

The tables in Appendix 2 also give the wind speed exceeded 5% and 0.022% for direct comparison with the Lawson criteria and the associated Lawson ratings for both mean and GEM wind speeds. A colour coded summary assessment of pedestrian comfort and safety with respect to the Lawson criteria is presented in Figure 4 and Figure 5 for each test location. Because some pedestrian wind measurement positions are purposely chosen at sites where large velocities of small spatial extent may exist, the general wind environment about the structure may be less severe than one might infer from an analysis only of Figure 4 and Figure 5. The implications of the results are discussed in Section 5.

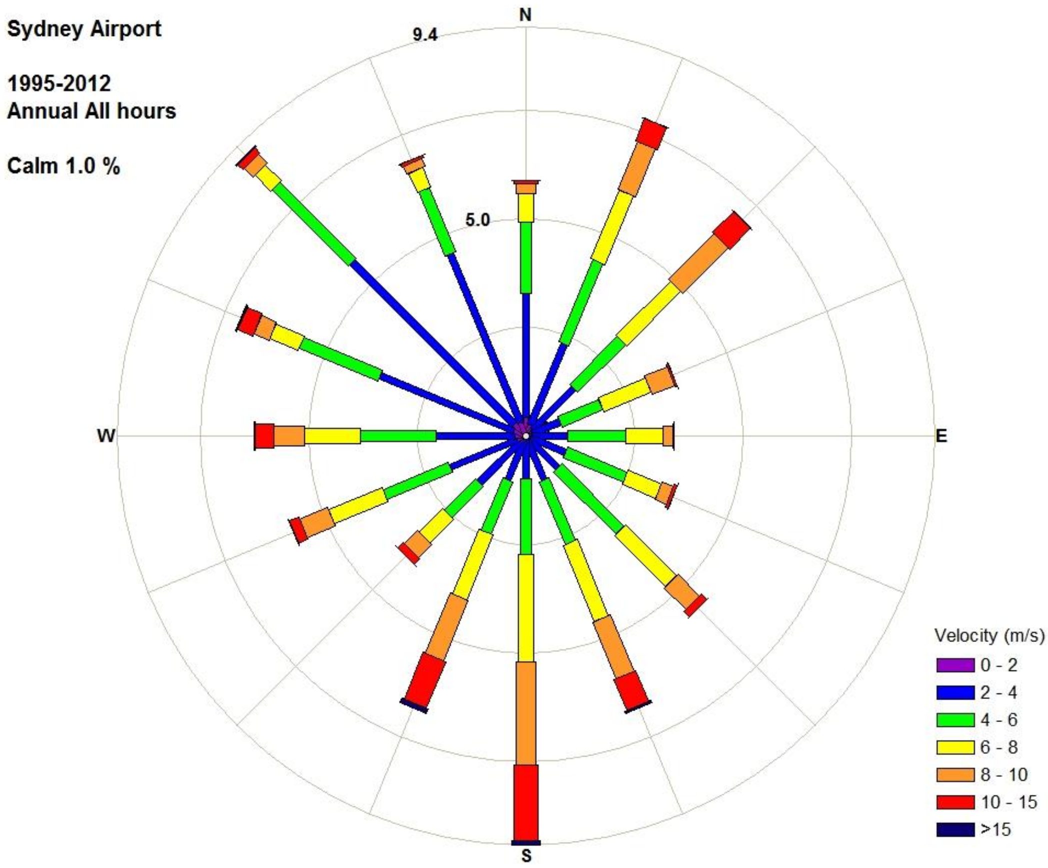

Figure 6: Wind rose of direction and speed for Sydney Airport

Table 3: Summary of wind effects on people, Penwarden (1973)

Description	Beaufort Number	Speed (m/s)	Effects
Calm, light air	0, 1	0–2	Calm, no noticeable wind.
Light breeze	2	2–3	Wind felt on face.
Gentle breeze	3	3–5	Wind extends light flag. Hair is disturbed. Clothing flaps
Moderate breeze	4	5–8	Raises dust, dry soil, and loose paper. Hair disarranged.
Fresh breeze	5	8–11	Force of wind felt on body. Drifting snow becomes airborne. Limit of agreeable wind on land.
Strong breeze	6	11–14	Umbrellas used with difficulty. Hair blown straight. Difficult to walk steadily. Wind noise on ears unpleasant. Windborne snow above head height (blizzard).
Near gale	7	14–17	Inconvenience felt when walking.
Gale	8	17–21	Generally impedes progress. Great difficulty with balance in gusts.
Strong gale	9	21–24	People blown over by gusts.

5. DISCUSSION

The wind climatology chart of Figure 6 indicates that the most frequent strong winds are from the south, and to a lesser extent, the west and north-east. The development is located in a section of the city with an irregular street pattern that is not aligned to the prevailing wind directions and is therefore beneficial in reducing the local wind speed. The topography and surrounding building layout relative to the prevailing strong winds is also beneficial in reducing the local wind speed at ground level. Individual locations around the development are more susceptible to winds from different directions, depending on the relative location of the point tested to the geometry of development. The influence of wind direction on the suitability of a location for an intended purpose can be ascertained from the graphs in Appendix 2.

The primary conclusions of the pedestrian study can be understood by reviewing the colour coded images of Figure 4 and Figure 5, which depict the locations selected for investigation of pedestrian wind comfort around the site along with the Lawson criteria rating for both comfort and distress in the various configurations. Note that testing was performed without planned trees, or other plantings to provide a worst case assessment; heavy streetscape planting typically reduces the wind speeds by less than 10%. The central colour indicates the comfort rating for the location, and the colour of the outer ring indicates whether the location passes the distress criterion. Mitigation measures are likely to be required for red locations, and may be necessary for other locations depending on the intended use of the space. Although conditions may be classified acceptable there may be certain wind directions that cause regular strong events, these can be determined by an inspection of the plots in Appendix 2.

It is evident from Figure 5 that the wind environment around the proposed development is generally satisfactory for pedestrian sitting or standing. The general wind amenity of the site is similar to wind conditions remote from the site investigated at locations 1 to 3, which are suitable for pedestrian walking to sitting, Figure 4, depending on the CBD location. These surrounding locations give a general indication of the surrounding wind climate and can be used for comparison with the wind environment in and around the development. Existing conditions at Location 1 on the corner of Clarence and Margaret Streets are shown to marginally exceed the distress criterion for winds from the south-west quadrant.

Locations 4 to 10 are positioned along George Street. Conditions in this area are primarily driven by channelling of winds from the north-east and south along George Street. Locations 4 and 5 to the north of the development were both found to be suitable for pedestrian sitting. Locations 6 to 8 are positioned along the eastern face of the development. Location 6 is at the entrance to the through site link to Wynyard Park and is rated as suitable for pedestrian standing. Wind conditions here are expected to be gusty when the wind is from the north. An inspection of the polar plot for this location in Appendix 2 shows that the wind amenity will be best when the wind is from the east and west, indicating that it is unlikely that a strong cross-flow will develop through the east-west link under moderate conditions. Locations 7 and 8 are rated as suitable for pedestrian sitting, falling just below the criteria for pedestrian standing. The polar plots for all three locations are typical of channelled flow along George Street, along with the influence of relatively minor downwash from the proposed development. Downwash is reduced for the proposed development by its position in the middle of a block with lower structures to the north and south that assist in redirecting the downwash from reaching ground level. Winds from the north are channelled onto the proposed development by the influence of Australia Square and Sixty Margaret Street, leading to downwash impinging on George Street from location 6 to between locations 9 and 10. Locations 9 and 10 are further south along George Street and are classified as suitable for pedestrian standing. Locations 4-10 pass the distress criterion.

Locations 11 to 16 are positioned along Carrington Street and all pass the distress criterion. The south-west corner of Wynyard Park (location 11) is rated as suitable for pedestrian sitting, with stronger conditions expected when the wind is from the west. The topography slopes steeply down to sea-level along Erskine and Margaret Streets which tend to accelerate winds from the west. There is less potential for channelling flow along Carrington Street due its short length. Location 12 is classified as suitable for pedestrian sitting, with similar conditions to location 11. Wind conditions deteriorate slightly from location 13 to the north, due to winds from the south-west accelerating along the obstruction created by the building façade line along Carrington Street. Locations 13 to 16 are rated as suitable for pedestrian standing. Location 14.1 is positioned under the western entrance to the through site link and shows that wind conditions are classified as suitable for pedestrian sitting activities. The Lawson criteria are intended for evaluating comfort in external spaces. For semi-internal spaces pedestrians may perceive the environment as more windy. Regardless wind conditions inside the building are not expected to be severe for the current configuration. All these locations pass the distress criterion.

Location 17 in the middle of Wynyard Park is rated as suitable for pedestrian standing activities and is estimated as suitable for pedestrian sitting approximately 90 % of the time. This location is governed by winds from the south-west quadrant where lower rise buildings are located. It is considered that the proposed building massing would have a minimal beneficial effect on the wind conditions in Wynyard Park for these wind directions. Location 18 is on the corner of Margaret and York Streets and while rated as pedestrian standing is windy during winds from the north-west, due to the topography rising along Margaret Street from the west. Both these locations pass the distress criterion.

Locations 19 and 20 are on Wynyard Lane, adjacent to the north and south sides of the proposed development respectively. Measurements show these locations as relatively calm and suitable for pedestrian sitting or outdoor dining, however the geometry for the north-south laneway through the site was not available at the time of testing. Winds from the north and south will generate airflow through the link, but conditions are expected to be acceptable given its intended use as service vehicle accessway.

6. CONCLUSIONS

A wind tunnel investigation of the pedestrian level wind environment around the proposed development at 1 Carrington Street has been conducted. The street level wind environment was found to be similar to typical street level wind conditions in the surrounding area and classified as suitable for pedestrian standing or sitting from a comfort perspective.

The through-site links are expected to be suitable for their intended uses as a main pedestrian accessway.

All locations in the public domain were found to pass the distress criterion.

7. REFERENCES

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Appendix 1: Additional Photographs of the Wind Tunnel Model

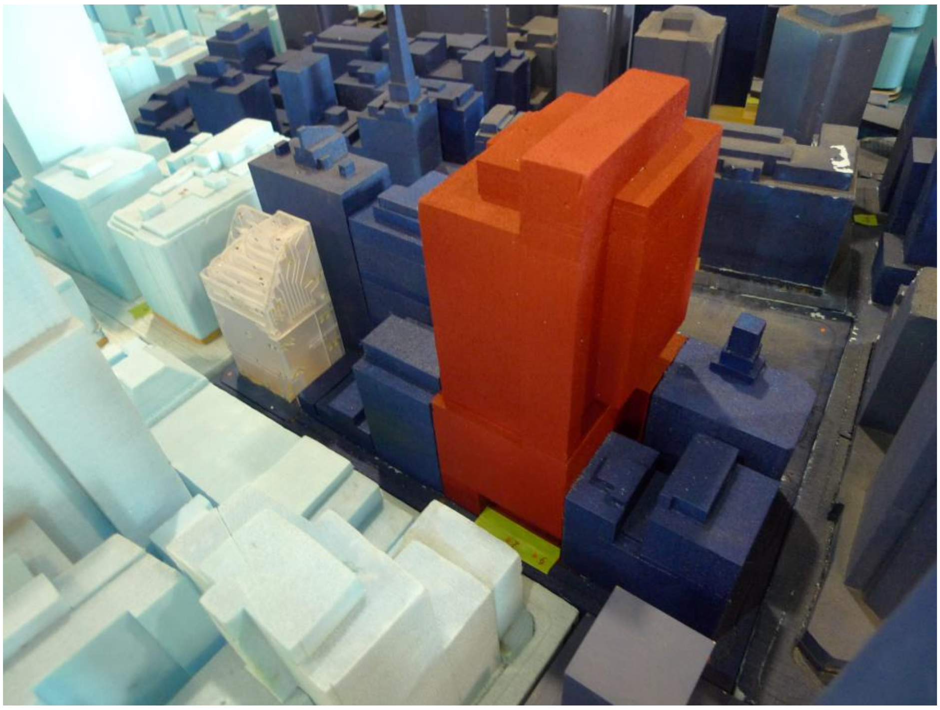


Figure 7: The CPP wind tunnel model viewed from the east

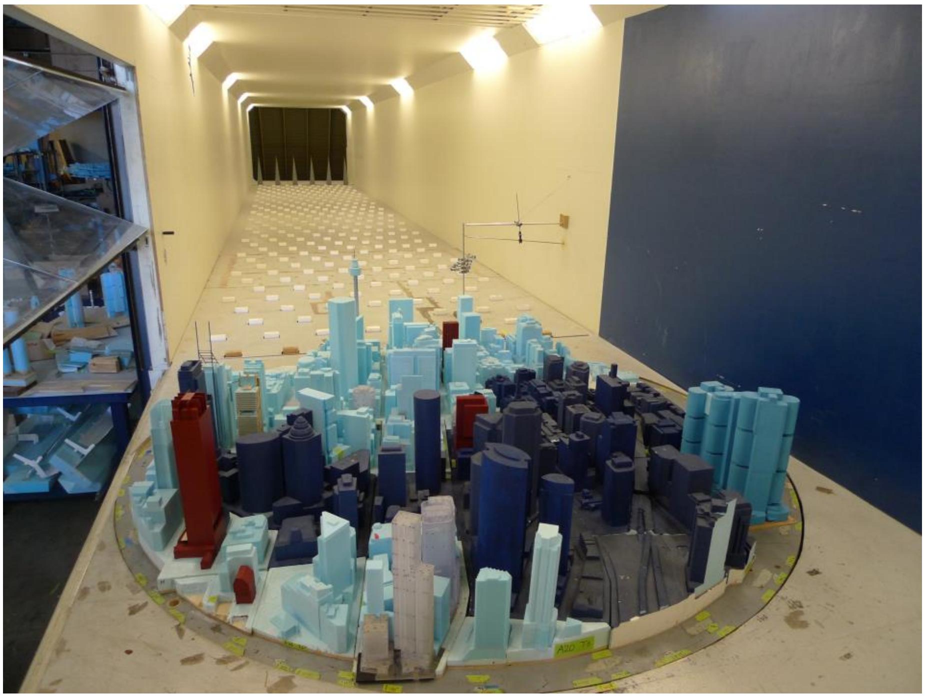
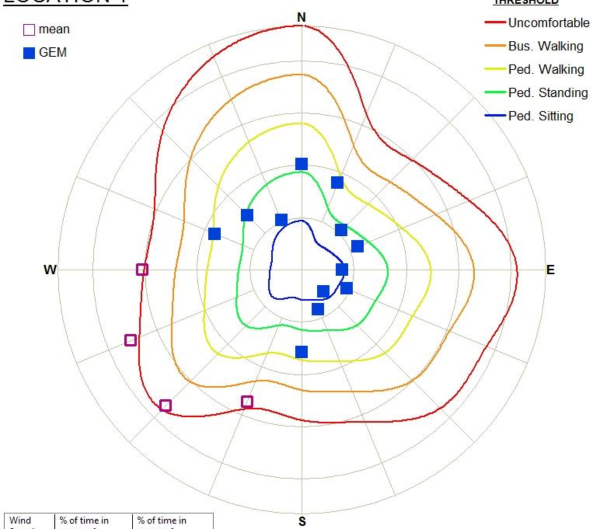


Figure 8: The model and surrounds viewed from the north

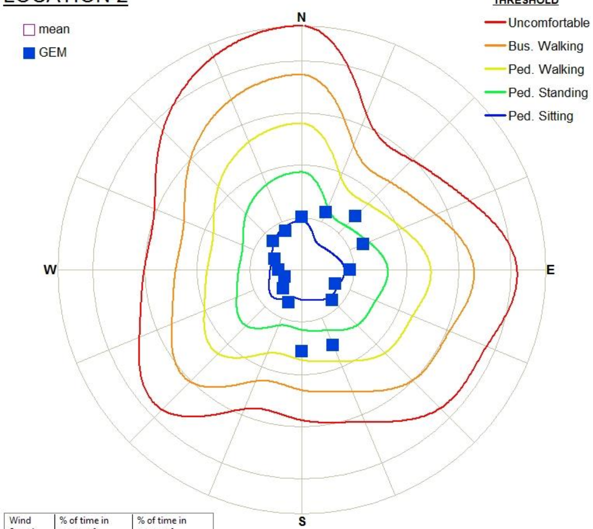
Appendix 2: Directional Wind Results

LOCATION 1



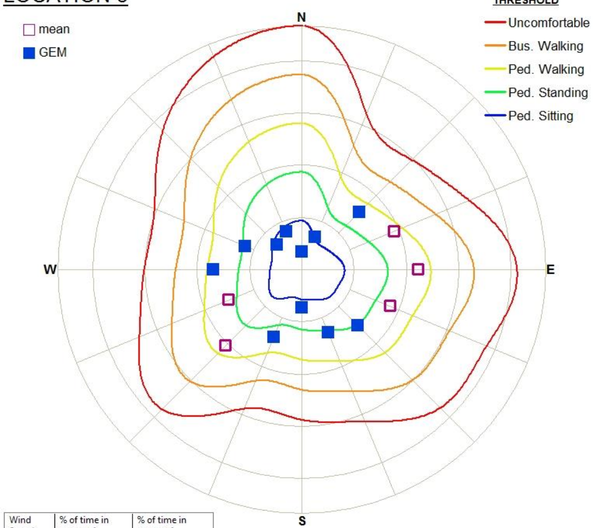
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	43.5	51.5
4.0	18.7	17.9
6.0	9.1	5.1
8.0	3.5	1.1
10.0	1.1	0.2
7.3	**5.0**	Ped Walking
15.6	**0.022**	Able Body
6.0	Ped Standing	**5.0**
12.2	Pass	**0.022**

LOCATION 2



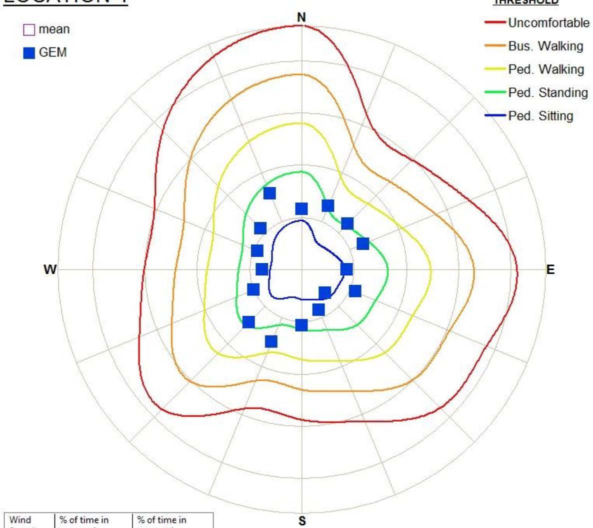
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	20.6	26.5
4.0	1.8	5.2
6.0	0.0	0.3
8.0	0.0	0.0
10.0	0.0	0.0
3.3	**5.0**	Ped Sitting
6.2	**0.022**	Pass
4.0	Ped Sitting	**5.0**
7.5	Pass	**0.022**

LOCATION 3



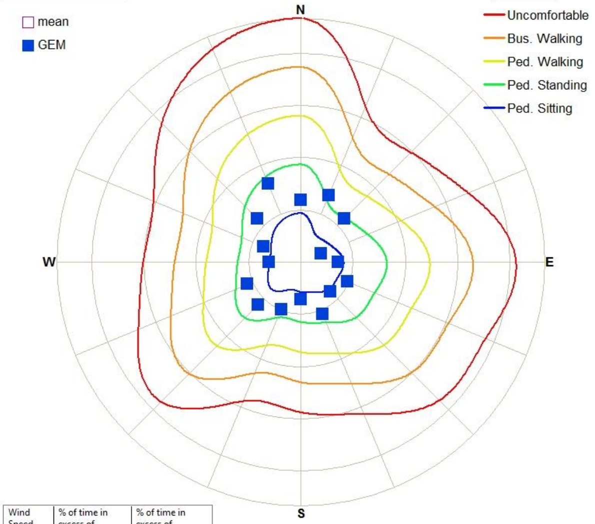
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	34.6	40.7
4.0	7.2	7.9
6.0	0.6	0.6
8.0	0.0	0.0
10.0	0.0	0.0
4.3	**5.0**	Ped Standing
8.2	**0.022**	Pass
4.4	Ped Standing	**5.0**
8.1	Pass	**0.022**

LOCATION 4



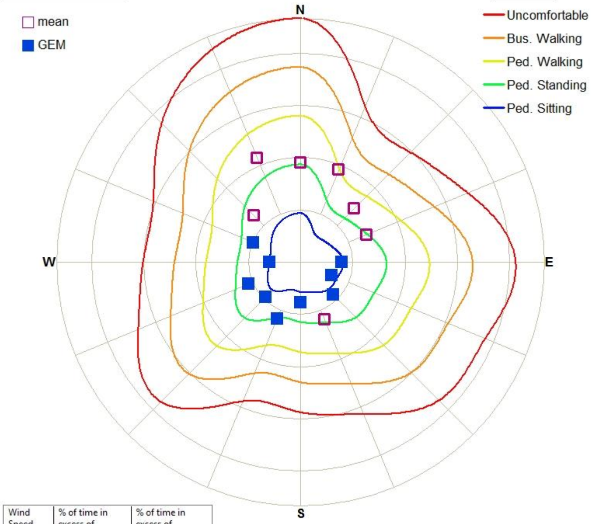
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	18.3	33.9
4.0	0.8	3.2
6.0	0.0	0.1
8.0	0.0	0.0
10.0	0.0	0.0
2.9	**5.0**	Ped Sitting
6.0	**0.022**	Pass
3.7	Ped Sitting	**5.0**
7.2	Pass	**0.022**

LOCATION 5



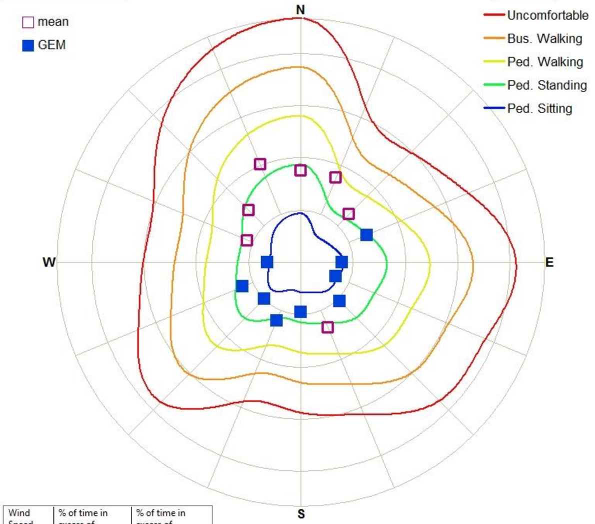
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	11.1	26.6
4.0	0.4	1.7
6.0	0.0	0.0
8.0	0.0	0.0
10.0	0.0	0.0
2.5	**5.0**	Ped Sitting
5.2	**0.022**	Pass
3.3	Ped Sitting	**5.0**
6.3	Pass	**0.022**

LOCATION 6



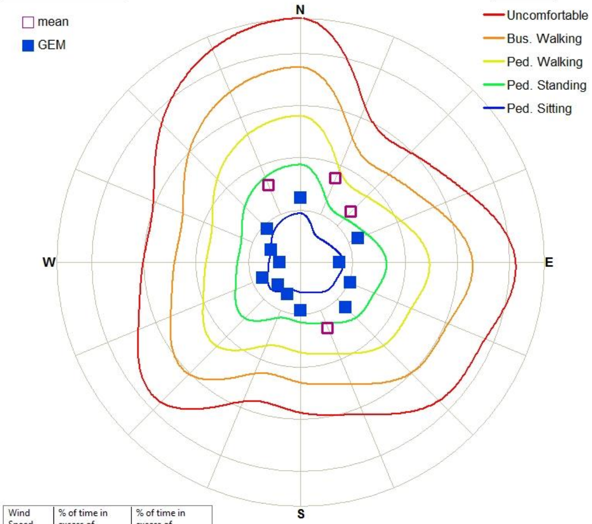
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	34.3	34.6
4.0	5.4	3.8
6.0	0.6	0.1
8.0	0.0	0.0
10.0	0.0	0.0
4.0	**5.0**	Ped Standing
8.0	**0.022**	Pass
3.7	Ped Sitting	**5.0**
7.0	Pass	**0.022**

LOCATION 7



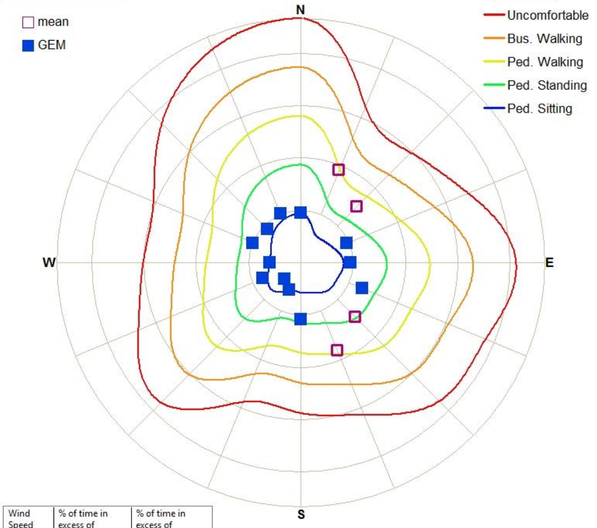
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	36.2	38.7
4.0	4.8	4.2
6.0	0.4	0.1
8.0	0.0	0.0
10.0	0.0	0.0
3.9	**5.0**	Ped Sitting
7.7	**0.022**	Pass
3.8	Ped Sitting	**5.0**
7.0	Pass	**0.022**

LOCATION 8



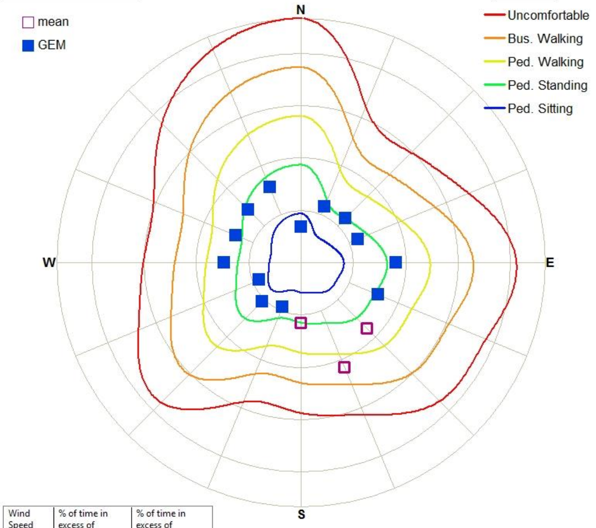
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	24.5	28.8
4.0	3.4	3.0
6.0	0.2	0.1
8.0	0.0	0.0
10.0	0.0	0.0
3.6	**5.0**	Ped Sitting
6.8	**0.022**	Pass
3.5	Ped Sitting	**5.0**
6.4	Pass	**0.022**

LOCATION 9



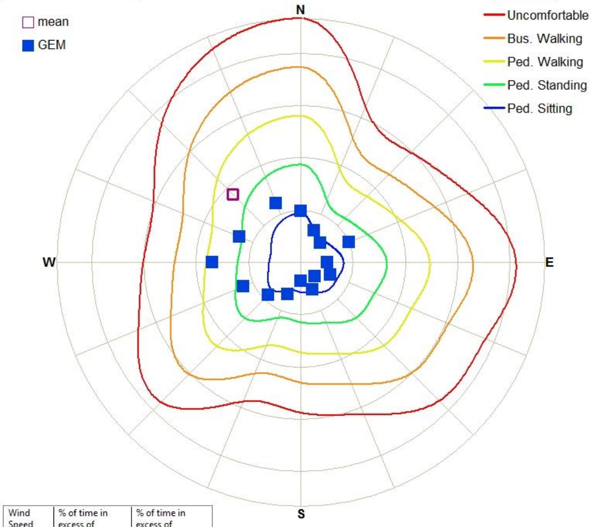
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	27.4	31.9
4.0	6.1	5.3
6.0	0.7	0.3
8.0	0.0	0.0
10.0	0.0	0.0
4.2	**5.0**	Ped Standing
8.1	**0.022**	Pass
4.0	Ped Standing	**5.0**
7.8	Pass	**0.022**

LOCATION 10



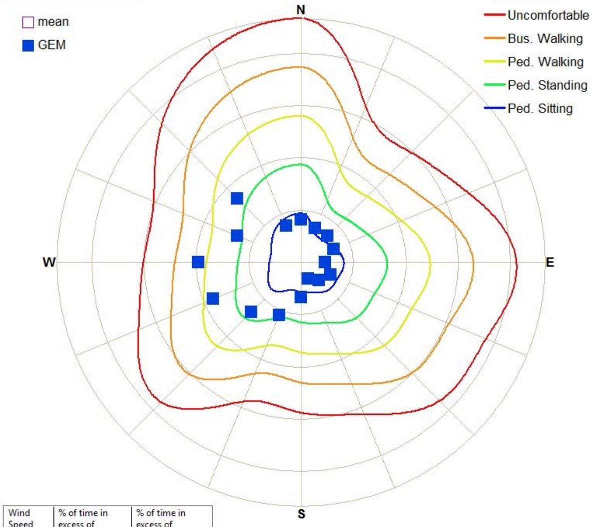
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	36.7	44.7
4.0	6.6	6.1
6.0	1.0	0.5
8.0	0.1	0.0
10.0	0.0	0.0
4.2	**5.0**	Ped Standing
9.5	**0.022**	Pass
4.2	Ped Standing	**5.0**
8.4	Pass	**0.022**

LOCATION 11



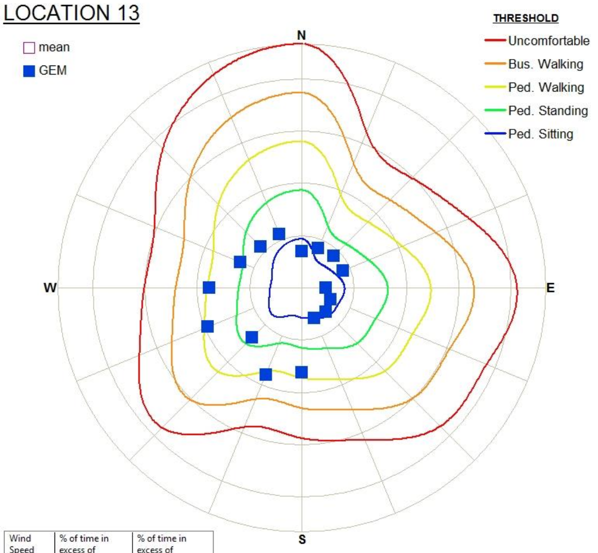
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	13.9	19.0
4.0	2.0	2.7
6.0	0.3	0.4
8.0	0.1	0.1
10.0	0.0	0.0
3.0	**5.0**	Ped Sitting
8.7	**0.022**	Pass
3.2	Ped Sitting	**5.0**
8.8	Pass	**0.022**

LOCATION 12



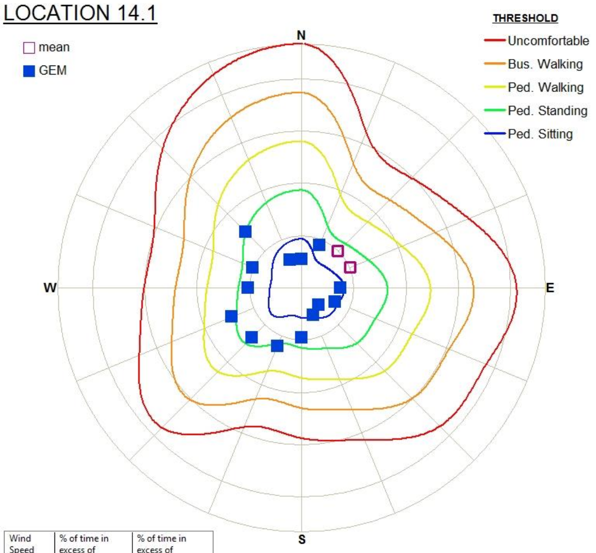
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	16.1	25.0
4.0	3.3	4.9
6.0	0.5	0.9
8.0	0.0	0.1
10.0	0.0	0.0
3.5	**5.0**	Ped Sitting
8.7	**0.022**	Pass
3.9	Ped Sitting	**5.0**
9.4	Pass	**0.022**

LOCATION 13



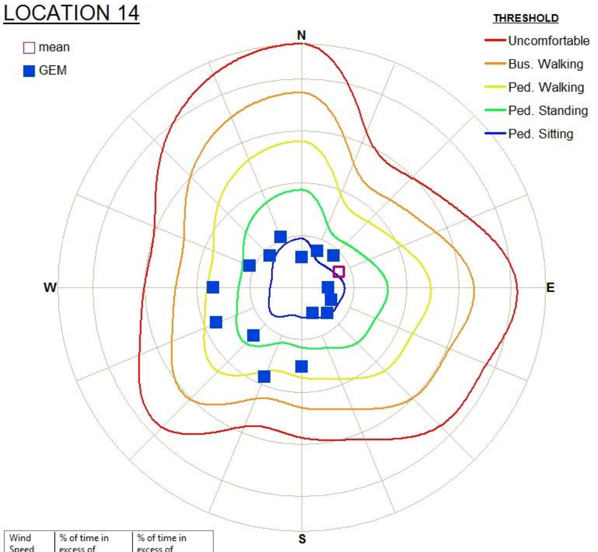
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	24.7	33.1
4.0	4.3	9.5
6.0	0.4	1.3
8.0	0.0	0.1
10.0	0.0	0.0
3.9	**5.0**	Ped Sitting
7.8	**0.022**	Pass
4.7	Ped Standing	**5.0**
9.1	Pass	**0.022**

LOCATION 14.1



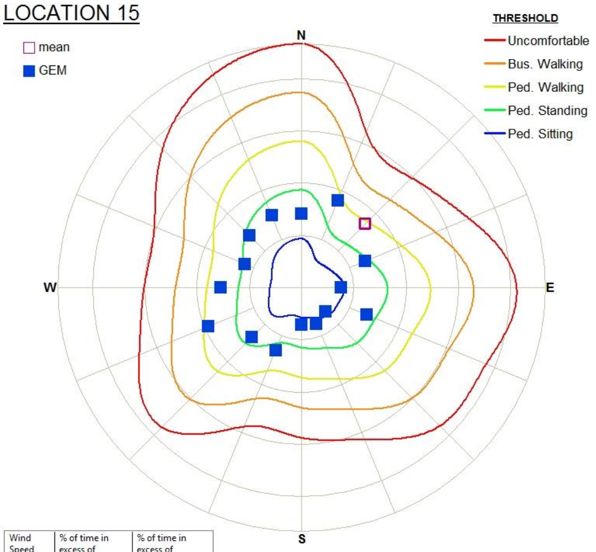
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	20.1	26.1
4.0	1.0	1.8
6.0	0.1	0.1
8.0	0.0	0.0
10.0	0.0	0.0
2.9	**5.0**	Ped Sitting
7.1	**0.022**	Pass
3.2	Ped Sitting	**5.0**
7.3	Pass	**0.022**

LOCATION 14



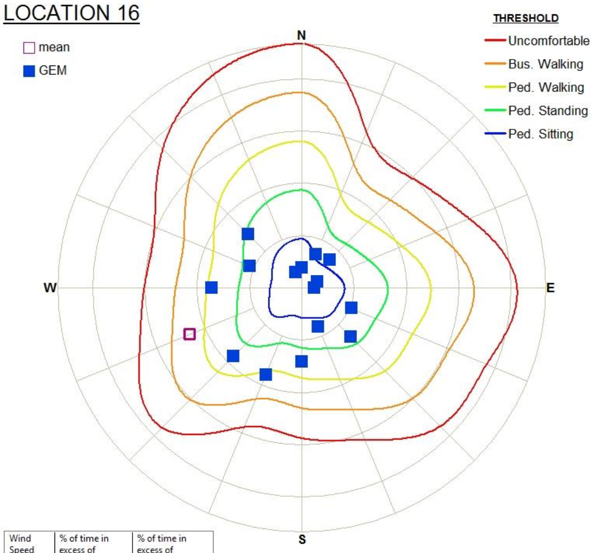
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	24.8	30.2
4.0	4.8	7.8
6.0	0.4	1.0
8.0	0.0	0.1
10.0	0.0	0.0
3.9	**5.0**	Ped Sitting
7.8	**0.022**	Pass
4.4	Ped Standing	**5.0**
9.0	Pass	**0.022**

LOCATION 15



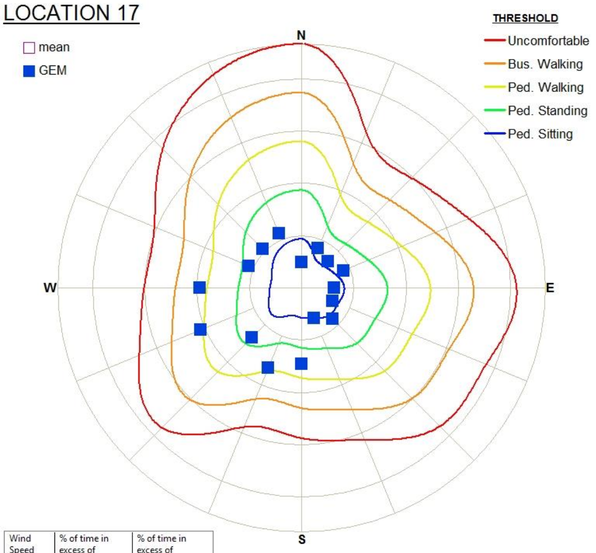
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	28.5	39.1
4.0	5.5	8.4
6.0	0.4	0.9
8.0	0.0	0.0
10.0	0.0	0.0
4.1	**5.0**	Ped Standing
7.5	**0.022**	Pass
4.5	Ped Standing	**5.0**
8.3	Pass	**0.022**

LOCATION 16



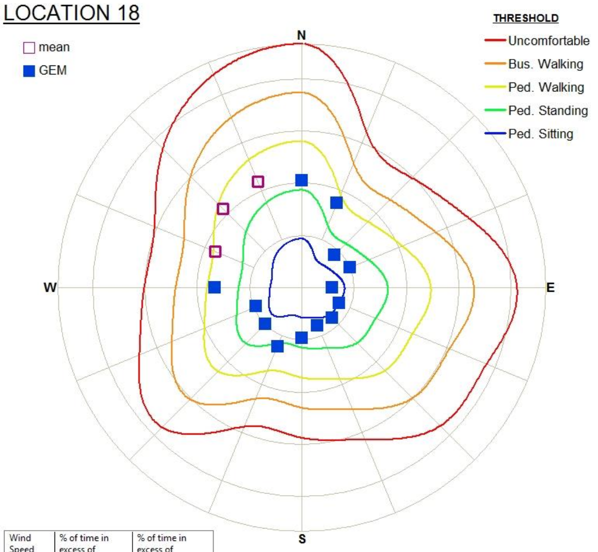
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	27.8	35.7
4.0	6.6	9.2
6.0	1.0	1.3
8.0	0.1	0.2
10.0	0.0	0.0
4.3	**5.0**	Ped Standing
9.6	**0.022**	Pass
4.7	Ped Standing	**5.0**
9.6	Pass	**0.022**

LOCATION 17



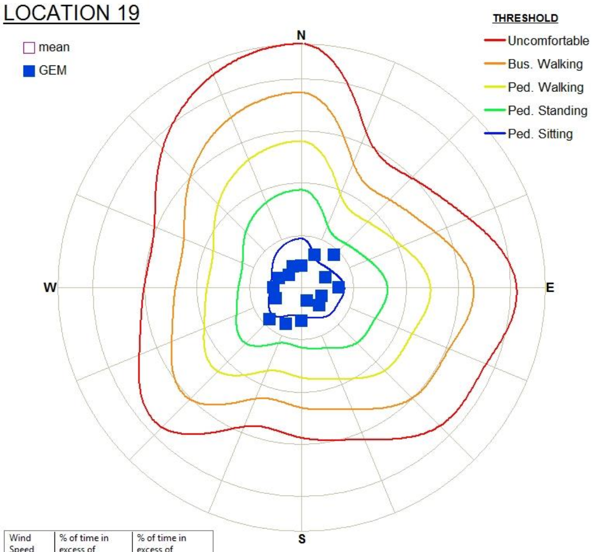
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	22.6	31.6
4.0	3.0	8.4
6.0	0.3	1.2
8.0	0.0	0.1
10.0	0.0	0.0
3.5	**5.0**	Ped Sitting
7.7	**0.022**	Pass
4.5	Ped Standing	**5.0**
9.4	Pass	**0.022**

LOCATION 18



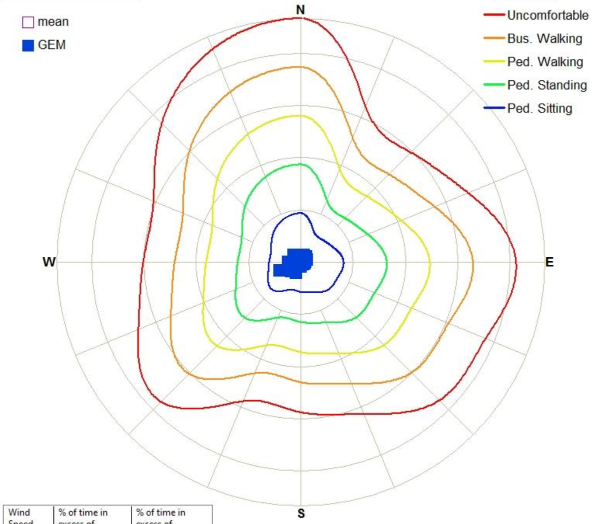
Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	32.2	42.9
4.0	4.7	6.3
6.0	1.0	0.9
8.0	0.2	0.1
10.0	0.0	0.0
3.9	**5.0**	Ped Sitting
10.2	**0.022**	Pass
4.2	Ped Standing	**5.0**
9.0	Pass	**0.022**

LOCATION 19



Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	2.7	6.2
4.0	0.0	0.0
6.0	0.0	0.0
8.0	0.0	0.0
10.0	0.0	0.0
1.7	**5.0**	Outdoor Dining
3.6	**0.022**	Pass
2.1	Ped Sitting	**5.0**
3.9	Pass	**0.022**

LOCATION 20



Wind Speed (m/s)	% of time in excess of Mean	% of time in excess of GEM
2.0	0.0	0.0
4.0	0.0	0.0
6.0	0.0	0.0
8.0	0.0	0.0
10.0	0.0	0.0
0.4	**5.0**	Outdoor Dining
1.3	**0.022**	Pass
0.7	Outdoor Dining	**5.0**
1.8	Pass	**0.022**