Pedestrian Wind Environment Statement

for the proposed Concept Plan of the

Riverwood North Residential Renewal Project

November 16, 2010

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Document Control

Revision Number	Date	Revision History	Prepared By (initials)	Reviewed & Authorised By (initials)
0	09/11/2010	Initial	AB	
1	16/11/2010	Updated Figure 3.	AB	

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Table of Contents

1.0 Introduction

This report is in relation to the proposed Concept Plan of the Riverwood North Residential Renewal Project, and presents an opinion on the likely impact of the proposed building massing of the design on the local wind environment to the critical outdoor areas within and around the site.

The effect of wind activity within and around the proposed Concept Plan is examined for the three predominant wind directions for the Sydney region; north-easterly, southerly and westerly winds. The analysis of the wind effects relating to the proposal was carried out in the context of the local wind climate, building morphology and land topography.

The conclusions of this report are drawn from our extensive experience in this field and are based on an examination of the architectural drawings which have been prepared by the project architect Turner + Associates, dated October 20, 2010. No wind tunnel tests have been undertaken for the subject Concept Plan. As such, this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection. Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects.

2.0 Regional Wind Climate for Sydney

The Sydney region is governed by three principle wind directions, and these can potentially affect the subject development. These winds prevail from the north-east, south and west. A summary of the principal time of occurrence of these winds throughout the year is presented in Table 1 below. This summary is based on an analysis of wind rose data obtained by the Bureau of Meteorology from Kingsford Smith Airport between 1939 and 2000. The wind roses are attached in the appendix of this report.

Table 1: Principal Time of Occurrence of Winds for Sydney

Month(s)	Prevailing Wind Direction		
	North-Easterly	Southerly	Westerly
January through to March	X	X	
April		X	X
May through to August			X
September		X	X
October through to December	X	X	

A directional plot of the annual and weekly recurrence winds for the Sydney region is shown in Figure 1 below. The frequency of occurrence of these winds is also shown in Figure 1. This plot has been produced based on an analysis of recorded wind speed data obtained from Kingsford Smith Airport from 1939 to 2008.

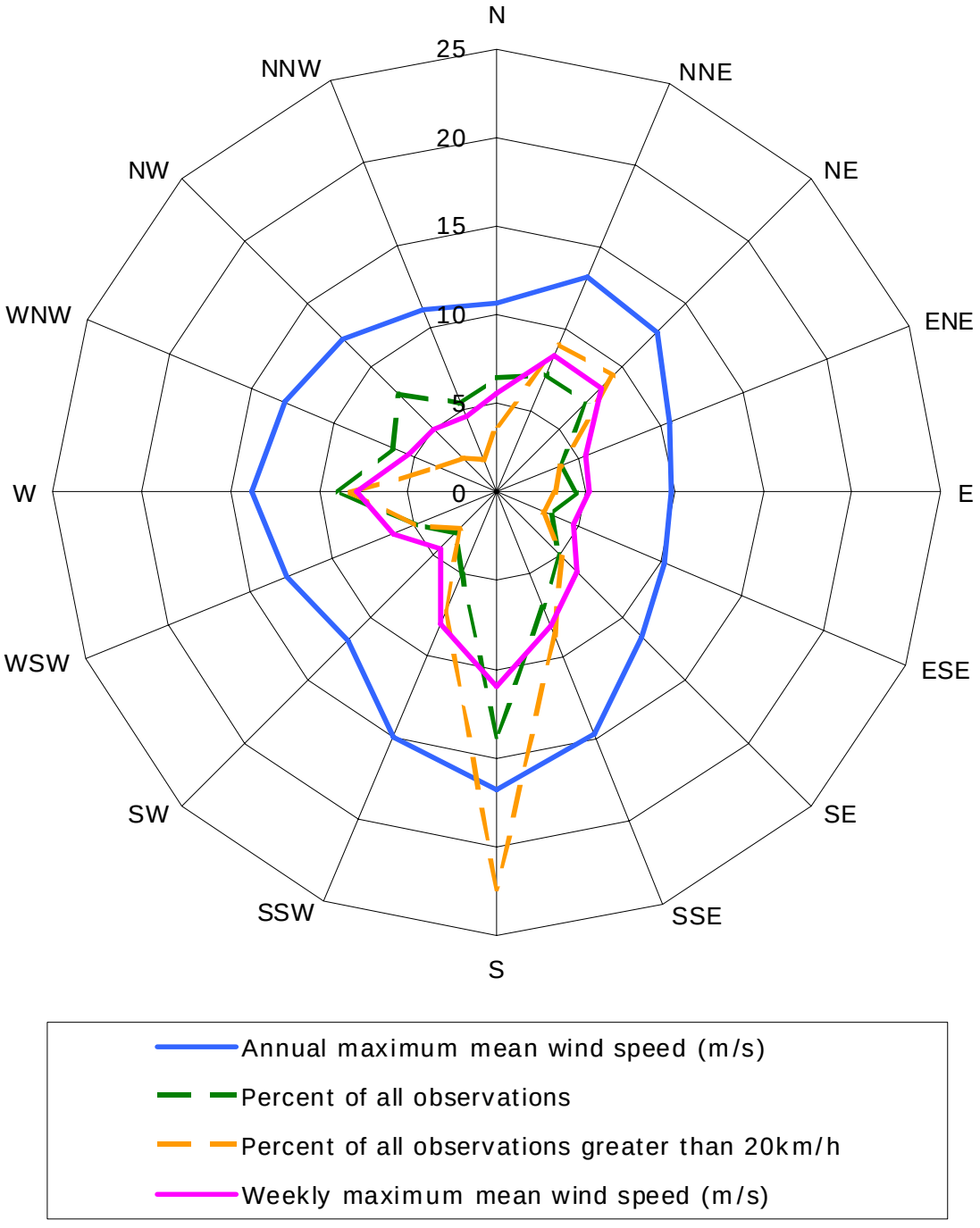


Figure 1: Annual and Weekly Recurrence Mean Wind Speeds, and Frequencies of Occurrence, for the Sydney Region (based on 10 minute mean observations from Kingsford Smith Airport from 1939 to 2008, corrected to open terrain at 10m)

3.0 Wind Effects on People

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), describes the effects of various wind intensities on people. Note that the applicability column relates to the indicated wind conditions occurring frequently (exceeded approximately once per week on average). Higher ranges of wind speeds can be tolerated for rarer events.

Table 2: Summary of Wind Effects on People (after Penwarden, 1975)

Type of Winds	Gust Speed (m/s)	Effects	Applicability
Calm, light air	0 - 1.5	Calm, no noticeable wind.	Generally acceptable for Stationary, long exposure activities such as in outdoor restaurants, landscaped gardens and open air theatres.
Light breeze	1.6 - 3.3	Wind felt on face.	
Gentle breeze	3.4 - 5.4	Hair is disturbed, Clothing flaps.	
Moderate breeze	5.5 - 7.9	Raises dust, dry soil and loose paper. Hair disarranged.	Generally acceptable for walking & stationary, short exposure activities such as window shopping, standing or sitting in plazas.
Fresh breeze	8.0 - 10.7	Force of wind felt on body.	Acceptable as a main pedestrian thoroughfare
Strong breeze	10.8 - 13.8	Umbrellas used with difficulty, Hair blown straight, Difficult to walk steadily, Wind noise on ears unpleasant.	Acceptable for areas where there is little pedestrian activity or for fast walking.
Near gale	13.9 - 17.1	Inconvenience felt when walking.	
Gale	17.2 -20.7	Generally impedes progress, Great difficulty with balance.	Unacceptable as a public accessway.
Strong gale	20.8 - 24.4	People blown over by gusts.	Completely unacceptable.

4.0 Description of the Concept Plan and Surroundings

The proposed site is bound by Kentucky Road and Washington Avenue to the south and west. Further to the east is the Riverwood Community Centre and Belmore Road, and further to the north is parklands, a community garden, and the M5 Motorway. Aerial views of the existing site area are shown in Figures 2a to 2c on the following pages.

The proposal is for ten multi-dwelling residential buildings, with details as described in Table 3. Since these are to be residential buildings, it is expected that private balconies for the adjoining apartments will be located on most aspects of each building. Terraces may also be located on some rooftop areas. Open landscaped areas, gardens, and parkland are proposed within the site. New streets are also proposed within the site, and it is anticipated that some of these will be shared for vehicular and pedestrian movement. Many trees are proposed within and around the site, mostly lining the various streets within the site, and also scatted throughout the parks, gardens, and other open areas.

The site plan of the proposed Concept Plan is shown in Figure 3. Also included on this figure is the height of each proposed building, shown as the number of stories above ground.

Table 3: Description of the Various Buildings of the Concept Plan

Phase	Stage	Description
01	01	2 residential buildings located along Washington Avenue. Building A has a height ranging from 5 to 6 stories above ground, and Building B has a height ranging from 6 to 8 stories above ground.
01	02	1 residential building (Building C) located at the eastern end of the site, with a height of 4 stories above ground.
02	01	2 residential buildings located along Washington Avenue. Building A has a height ranging from 6 to 9 stories above ground, and Building B has a height of 5 stories above ground.
02	02	1 residential building (Building A) located within the north-eastern area of the site, with a height of 6 stories above ground.
02	03	2 residential buildings located within the northern area of the site. Building A has a height ranging from 5 to 8 stories above ground, and Building B has a height of 2 stories above ground.
02	04	2 residential buildings located at the north-western end of the site. Building A has a height ranging from 6 to 8 stories above ground. Building B has a height of 6 stories above ground.

Figure 2a: Aerial View of the Existing Site (top-down view)

Figure 2b: Aerial View of the Existing Site (view from the east, facing west)

Figure 2c: Aerial View of the Existing Site (view from the south, facing north)

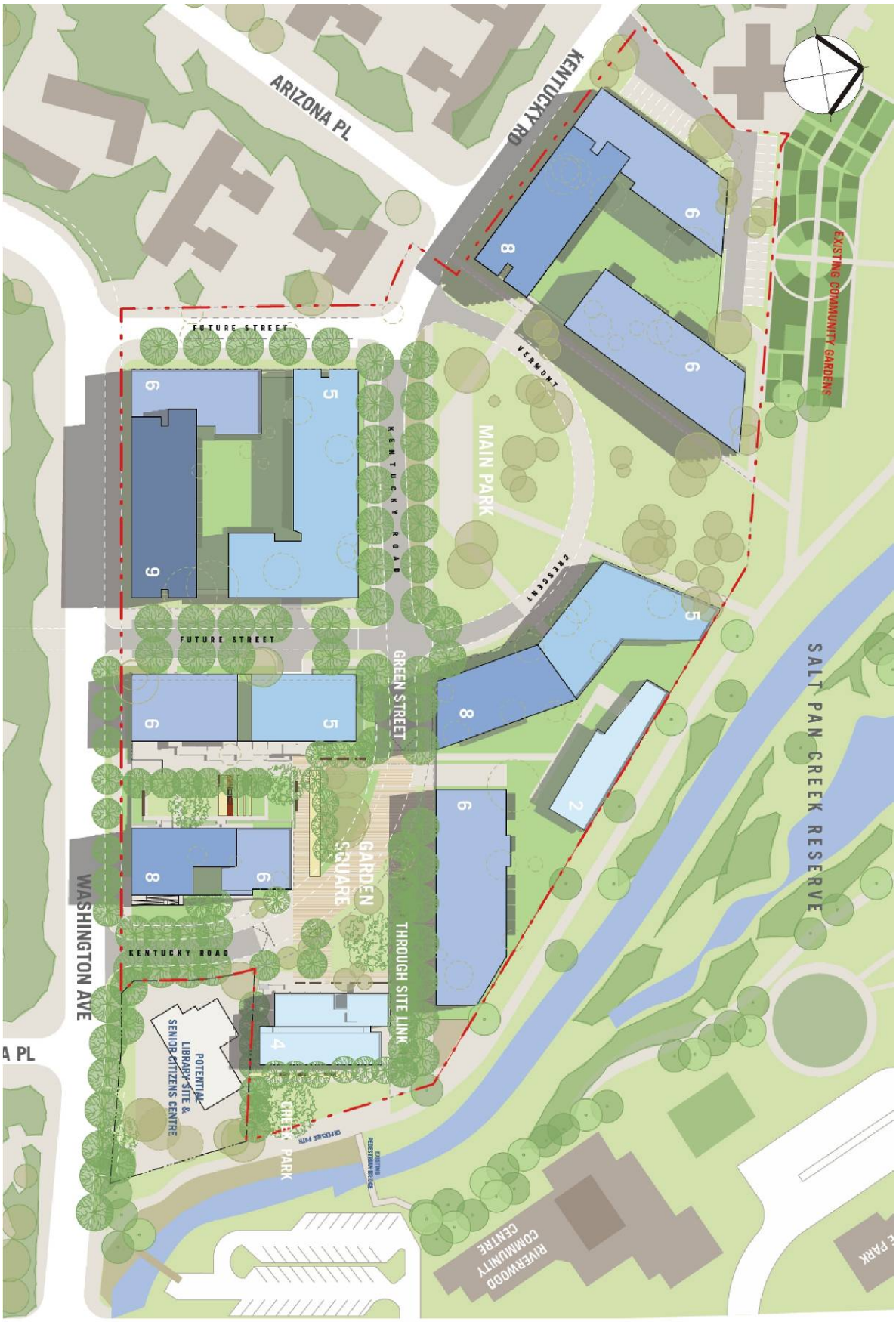


Figure 3: Proposed Site Plan of the Concept Plan

5.0 Results of the Analysis

For each of the three predominant wind directions for the Sydney region, the interaction between the wind and the building morphology in the area was considered. Important features taken into account include the distances between the proposed building forms, their overall heights and bulk, as well as the landform. Note that only the potentially critical wind effects are discussed in this report.

5.1 Wind Conditions for the Ground Level Areas

Adverse ground level winds for a development site tend occur when there are gaps between buildings that are aligned with a prevailing wind direction for the region, or when there is minimal up-wind obstructions to assist in providing shielding. Other less-common causes of adverse ground level winds may also include downwashed winds from smooth tower facades, or acceleration of winds due to topography effects.

The expected wind effects for the various critical ground level areas of the site are discussed in the following sub-sections of this report for the three predominant wind directions for the Sydney region; north-easterly, southerly, and westerly winds.

5.1.1 North-Easterly Winds

North-easterly winds occur most frequently during the warmer months of the year for the Sydney region. They are typically not as strong as the southerly winds, and are usually welcomed within outdoor areas since they typically occur when it can be quite warm during the summer.

For the proposed Concept Plan, the areas where there are gaps between the buildings that are aligned with the north-easterly winds are all shielded and/or stagnated by the other buildings of the proposal, or by the significant amount of proposed tree planting. These areas are described as follows:

- The central area of Stage 04 of Phase 02 is open to the prevailing north-easterly winds, however the 8-storey component of Building A will provide effective stagnation to these winds, and provide adequate wind conditions to this area.
- The area between Stages 03 and 04 of Phase 02, to the north of the Main Park, is open to the prevailing north-easterly winds. However, there are many trees proposed in this area of the site, and these will be effective in mitigating adverse wind effects.
- The areas in the gaps between the buildings of Stages 02 and 03 of Phase 02 will benefit from the overlapping layout of these buildings, and hence adverse wind effects are not expected for these locations.
- The pedestrian footpath areas either side of Stage 01 of Phase 1 will benefit from the shielding provided by the many proposed trees lining the streets, and also from the shielding provided by the Stage 02 and 03 buildings of Phase 02 to the north.

The proposed Concept Plan is not expected to have any significant impact onto the wind conditions for the pedestrian footpath around the northern site boundary. Hence wind conditions are expected to be similar to the existing conditions for that footpath. The addition of trees along the northern site boundary is expected to further enhance wind conditions.

5.1.2 Southerly Winds

As shown in Figure 1 of this report, the southerly winds are by far the most frequent wind for the Sydney region, and are also the strongest.

For the proposed Concept Plan, the areas where there are gaps between the buildings that are aligned with the southerly winds are all shielded and/or stagnated by the other buildings of the proposal, or by the significant amount of proposed tree planting. These areas are described as follows:

- The pedestrian footpath areas either side of Stage 01 of Phase 1 and Stage 01 of Phase 03 will benefit from the shielding provided by the many proposed trees lining the streets.
- The areas in the gaps between the buildings of Stages 02 and 03 of Phase 02 will benefit from the overlapping layout of these buildings, and hence adverse wind effects are not expected for these locations.
- The area between Stages 03 and 04 of Phase 02, to the north of the Main Park, is relatively well shielded from the prevailing southerly winds by the many proposed trees in that area, and by the up-wind buildings of Stage 01 of Phase 02.

The proposed Concept Plan is not expected to have any significant impact onto the wind conditions for the pedestrian footpaths along the southern site boundary (along Washington Avenue and Kentucky Road). With the inclusion of the proposed trees along these footpaths it is expected that adequate wind conditions will be achieved.

5.1.3 Westerly Winds

Westerly winds occur most frequently during the winter season for the Sydney region. Although they are typically not as strong as the southerly winds, they are usually a cold wind since they occur during the winter, and hence can be a cause for discomfort for outdoor areas.

For the proposed Concept Plan, the areas where there are gaps between the buildings that are aligned with the westerly winds are all shielded and/or stagnated by the other buildings of the proposal, or by the significant amount of proposed tree planting. These areas are described as follows:

- The pedestrian footpaths along Kentucky Road, Green Street, the Garden Square Area, and the Through Site Link, will benefit from the shielding provided by the many proposed trees along these areas. Adverse winds are not expected with the inclusion of these trees.

- The pedestrian footpath along the southern site boundary of Washington Avenue will also benefit from the shielding provided by the many proposed trees along this footpath. Adverse winds are not expected with the inclusion of these trees.
- Wind conditions for the ground level areas around the western end of Stage 04 of Phase 02 are expected to be adequate due to the shielding provided by the proposed trees located at the corners of Building A.

Ground level winds around the western areas of the site are generally well shielded by the various neighbouring buildings and trees to the west of the subject site.

Note that for trees to be effective in mitigating adverse westerly winds in the Sydney region, which tend to occur most frequently during the winter season, the selected species should be evergreen.

5.2 Wind Conditions for the Private Balconies and Terraces

Wind tends to be accelerated around the corners of a building. Adverse winds on private balconies are most easily avoided by ensuring that there are no large balconies protruding from the corner of a building.

Wind conditions on any single-aspect balconies will be ideal due to the stagnation provided by the building. If balconies are located near the corner of a building it is recommended that a full-height screen be used on the side of the balcony area (which will effectively transform the balcony into a single-aspect balcony), which will provide shielding from the accelerated winds travelling around the corner of the building. Impermeable balustrades may also be necessary to provide additional shielding for some of the balcony or terrace areas, particularly if there are to be rooftop terraces.

Rooftop terrace areas are exposed to prevailing winds and up-wash effects from the building façade below. If these types of areas are to be included in the development, it may be necessary to set-back the trafficable edge of the terrace area from the edge of the building to avoid adverse up-wash effects. In addition to using impermeable balustrades for rooftop terraces, and if the area is relatively large and exposed to adverse winds, scattered vegetation and/or awnings/canopies may also be necessary to assist with wind mitigation.

Note that, as with any situation involving high-rise outdoor areas, 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.

It is recommended that wind conditions for the private balconies and terraces be investigated at a more detailed design stage, once the locations of the balconies and terraces of each building are determined.

6.0 Conclusions

An analysis of the wind environment impact with respect to the three principal wind directions for the Sydney region has been completed for the proposed Concept Plan of the Riverwood North Residential Renewal Project. The conclusions of this report are drawn from our extensive experience in this field and are based on an examination of the architectural drawings which have been prepared by the project architect Turner + Associates, dated October 20, 2010. No wind tunnel tests have been undertaken for the subject Concept Plan. As such, this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection. Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects.

The results of this study indicate that generally the proposed alignment and placement of the buildings of the Concept Plan will not likely cause any adverse wind effects. The significant amount of proposed trees within and around the site will also be effective in mitigating adverse winds. To provide adequate wind conditions for the outdoor trafficable areas within and around the site, the following recommendations are made:

- The species of trees selected for the footpaths along Kentucky Road, Green Street, the Through Site Link, and along Washington Avenue, should be of an evergreen and moderately well-foliating variety. The requirement for an evergreen species of tree is important for these areas since they could otherwise be exposed to the westerly winds, which tend to occur most frequently during the winter season for the Sydney region.
- The inclusion of the remaining proposed trees within and around the site will also assist in mitigating adverse winds.
- Private balconies should not be designed to be protruding from the corner of a building, where winds tend to be accelerated. If balconies are located near the corner of a building, it may be necessary to include a full-height screen along the side of the balcony (which will effectively transform the balcony into a single-aspect balcony). Impermeable balustrades may also be necessary for some of the private balconies.
- Care should be taken in the location of rooftop terrace areas, if these are to be part of the design. These types of areas are exposed to the prevailing winds and possibly even up-washed winds from the building façade below. A combination of impermeable balustrades, scattered vegetation and awnings/canopies may be necessary to mitigate adverse winds for these types of areas.
- As with any situation involving high-rise outdoor areas, 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.

It is recommended that wind conditions for the private balconies and terraces be investigated at a more detailed design stage, once the locations of the balconies and terraces of each building are determined.

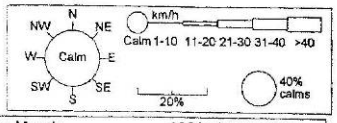
With the inclusion of the abovementioned treatments and design principles, it is not expected that adverse wind conditions will be experienced within the various trafficable outdoor areas within or around the site.

Appendix

Wind Roses for the
Sydney Region

Wind Roses using available data between 1939 and 2000 for SYDNEY AIRPORT AMO

Site Number 066037 • Locality: SYDNEY AIRPORT • Opened Jan 1929 • Still Open
Latitude 33°56'28"S • Longitude 151°10'21"E • Elevation 6m



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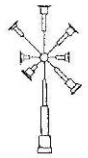
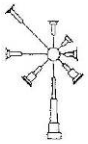
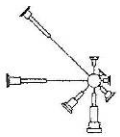
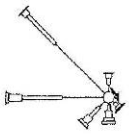
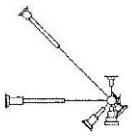
		
9 am April 1834 observations	**9 am May 1866 observations**	**9 am June 1806 observations**
		
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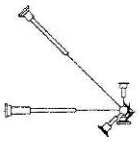
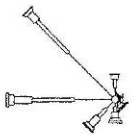
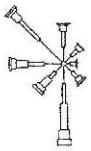
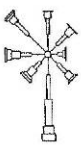
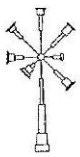
		
9 am October 1901 observations	**9 am November 1835 observations**	**9 am December 1906 observations**
		

Wind Roses using available data between 1939 and 2000 for SYDNEY AIRPORT AMO

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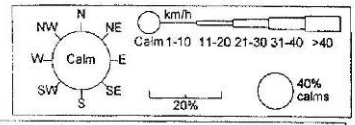

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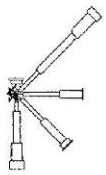

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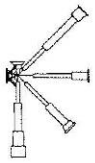

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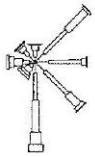

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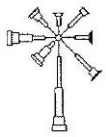

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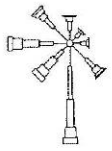

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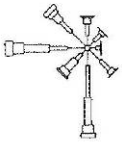

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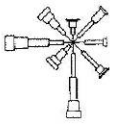

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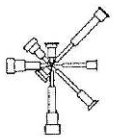

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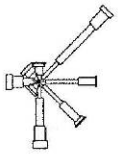

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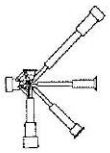

3 pm December 1906 observations