global environmental solutions

330 Church, Parramatta

"Waterfront Apartments"

Qualitative Environmental Wind Report

Report Number 610.12667-R2

30 May 2013

Meriton Apartment Pty Ltd
Level 11, 528 Kent Street
SYDNEY NSW 2000

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330 Church, Parramatta

"Waterfront Apartments"

Qualitative Environmental Wind Report

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been engaged Meriton Apartments Pty Ltd (Meriton) to assess the environmental impact of a proposed new development at 330 Church Street, Parramatta also known as the “Riverfront Apartments” with respect to the wind environment in and around the site.

1.1 Development Site

The site is bounded on the west by Church Street and on the north by the Parramatta River. The surrounding area contains a mixture of low to high rise buildings

Figure 1 Site Location

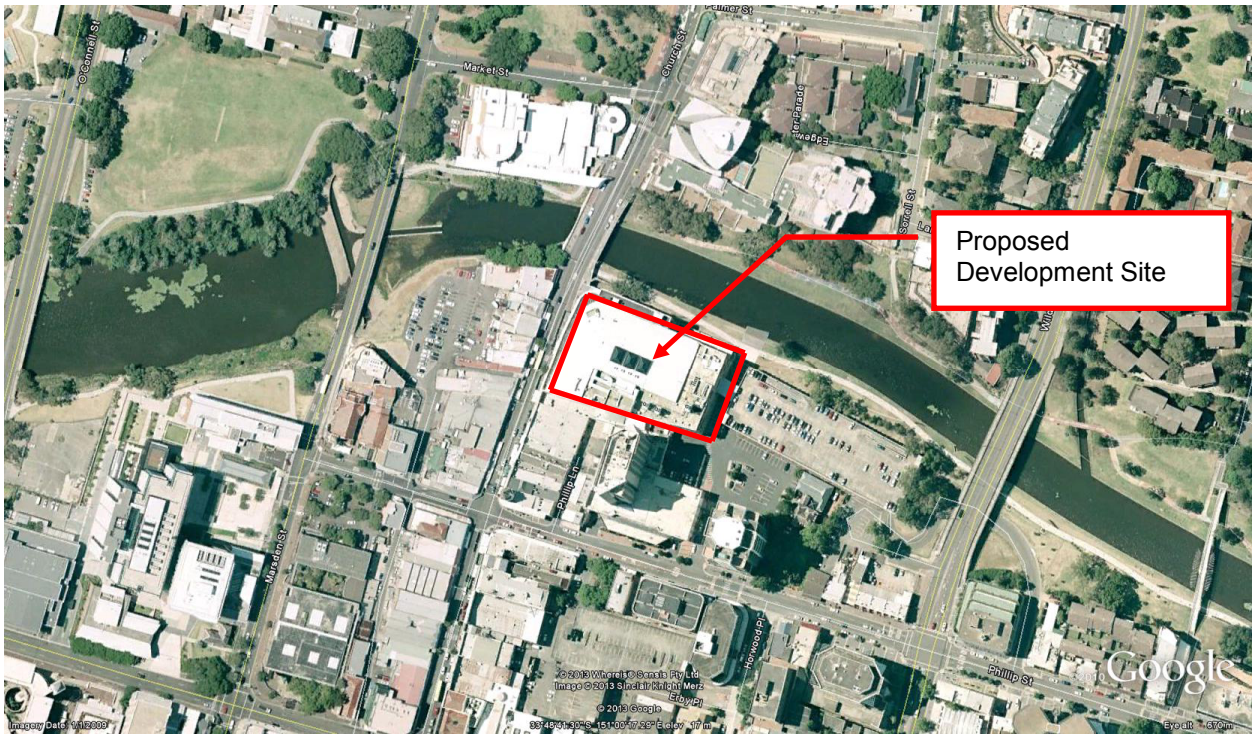


Image: Google

1.2 Proposed Development Description

The proposed development consists of two towers over a podium section with a maximum height of 55 storeys. There are a total of 644 dwellings in the development. The following breakdown has been made using the latest plans provided by Meriton.

- 378 residential apartments accessible from the western core
- 266 serviced apartments accessible from the eastern core

2 SYDNEY'S WIND CLIMATE

The data of interest in this study are the annual extreme, mean hourly wind speeds and largest gusts experienced throughout the year, how these winds vary with azimuth, and the seasonal break-up of winds into the primary Sydney wind seasons.

2.1 Seasonal Winds

In relation to key characteristics of the Sydney Region Wind Climate (refer wind roses provided in **Appendix A**) relevant to the wind impact assessment of the proposed development, we note that Sydney is affected by two primary wind seasons:

- Summer winds occur mainly from the northeast, southeast and south.
  - While northeast winds are the more common prevailing wind direction (occurring typically as offshore land-sea breezes), southeast and south winds generally provide the strongest gusts during summer.
- Winter/Early Spring winds occur mainly from the west and the south.
  - West quadrant winds (southwest to northwest) provide the strongest winds during winter and in fact for the whole year.

2.2 Wind Exposure at the Site – the "Local" Wind Environment

Close to the ground, the "regional" wind patterns described above are affected by the local terrain and topography.

- The development site receives reasonable shielding at lower levels from the low to mid-rise developments surrounding the development site.
- The site is somewhat more exposed to winds from the west quadrant due to the Waterloo Oval located on the west of Elizabeth Street

3 WIND ACCEPTABILITY CRITERIA

3.1 Standard Local Government Criteria

The choice of suitable criteria for evaluating the acceptability of particular ground level conditions has been the subject of relatively recent research. The acceptability criteria that have been developed from this research and currently referenced by most Australian Local Government Development Control Plans have been summarised below in **Table 1**.

Table 1 Standard Local Government Wind Acceptability Criteria

Type of Criteria	Limiting Gust Wind Speed Occurring Once Per Year	Activity Concerned
Safety	24 m/s	Knockdown in Isolated Areas
	23 m/s	Knockdown in Public Access Areas
Comfort	**16 m/s**	**Comfortable Walking**
	13 m/s	Standing, Waiting, Window Shopping
	10 m/s	**Dining in Outdoor Restaurant**

The primary objectives relating to the above wind impact criteria are as follows:

- The general objective is for annual 3-second gust wind speeds to remain at or below the so-called 16 m/sec "Walking Comfort" criterion. Whilst this magnitude may appear somewhat arbitrary, its value represents a level of wind intensity which the majority of the population would find unacceptable for comfortable walking on a regular basis at any particular location.
- In many urban locations, either because of exposure to open water conditions or because of street "canyon" effects, etc., the 16 m/sec "Walking Comfort" level may already be currently exceeded. In such instances a new development should ideally not exacerbate existing adverse wind conditions and, wherever feasible and reasonable, ameliorate such conditions.
- It can be seen in **Table 1** that the recommended limiting wind speeds for spaces designed for activities such as seating, outdoor dining, etc., are lower than for "walking comfort".

3.2 Application of Standard Council Wind Criteria

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

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

Finally, it is noted that the limiting wind speed criteria in **Table 1** are based on the maximum wind gust occurring (on average) once per year. Winds at all other times, i.e. monthly winds, weekly winds, etc., would be of lesser magnitude. So for example, a location with a maximum annual gust of 10 m/sec would experience winds throughout the year of a generally very mild nature, conducive to stationary activities (seating, dining, etc.).

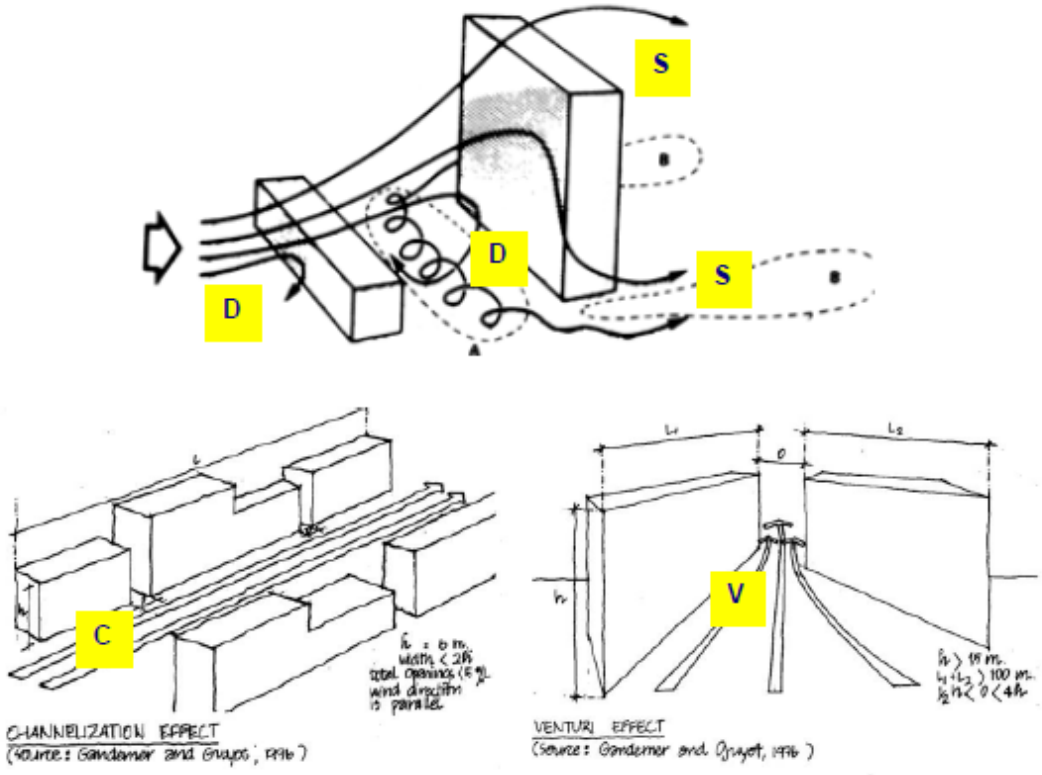
4 BUILDING-WIND INTERACTION – SOME GENERAL OBSERVATIONS

The impact of wind flowing past buildings has well known general impacts at ground level – refer **Figure 2**:

- **Downwash winds "D"** are the winds which impact on the windward face of a building and are then deflected downwards to ground level in a vertical direction
- Accelerating **Shearflow winds "S"** are the winds which experience an acceleration as they pass by the building edges and roof as the wind flow moves around and past the building

In general, the taller the building, the more pronounced the impact on ground level winds. Local building details can also influence winds in the immediate vicinity; egg building undercrofts are often associated with local acceleration of winds.

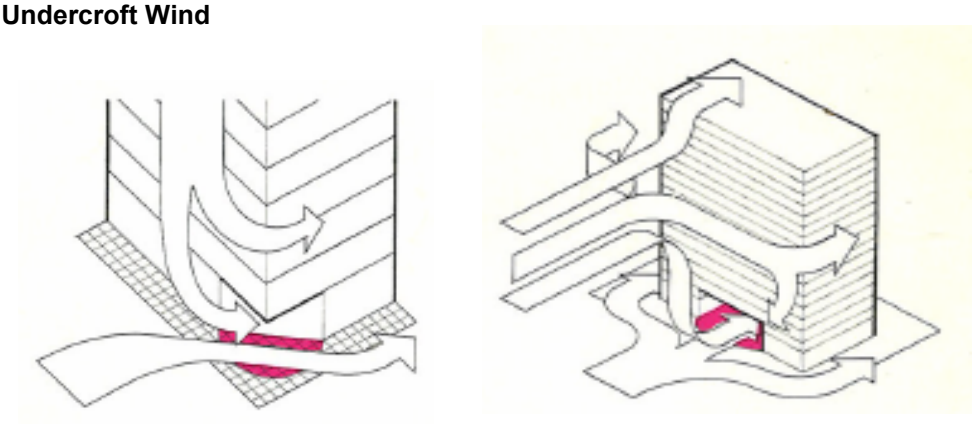
Figure 2 Wind flow Patterns Past Regular Shaped Buildings



The grouping of buildings can also have an impact on resulting pedestrian winds – refer **Figure 2**:

- **Canyon Effect winds "C"** result when there are rows of parallel buildings (especially taller ones) where the gaps in between line up with prevailing wind directions.
- **Venturi Effect winds "V"** result when wind flow is forced to pass between two converging buildings or groups of buildings with a resulting increase in flow.
- **"Undercroft"** effect is a well-known adverse building-wind characteristic as depicted in the generic building wind effect diagrams shown in **Figure 3**. The winds are induced towards the negative pressure area within the undercroft, creating concentrated adverse wind flow through undercrofts.

Figure 3 Undercroft Wind



Building Undercrofts (left) and Building Cross-Façade Openings (right) can induce concentrated adverse wind flow past and through a building.

5 WIND IMPACT OF THE PROPOSED DEVELOPMENT

5.1 Existing Winds – Wind Impact and Effects

Existing street level wind conditions in the vicinity of the site are likely close to or exceeding the 16 m/s *"walking comfort"* criterion for some prevailing wind directions given the orientation of the site and the spacing of upstream shielding afforded to the site by surrounding buildings. In particular adverse winds of more than 16 m/s are likely to be present along Church Street due to the streets alignments in the same directions as the prevailing winds (south) in Sydney.

Northeast Winds

There is some shielding available to the north and northeast provided by a couple of medium and high rise buildings as well as low level residential buildings. This is also helped by the pedestrian areas on the north side of the site being lower than other surrounding areas. In addition, northeast winds are generally mild and the potential therefore for exceedance of the 16 m/sec criterion along the pedestrian pathways at the site is small, i.e. occurrences, if any, are likely to be very infrequent. There may be the potential for northeast winds to accelerate between the site and the multilevel car park to the east

South Quadrant (Southeast to Southwest) Winds

There is potential for stronger wind conditions (i.e. exceeding the 16 m/sec criterion) to occur from the south clockwise around to the southwest. Reasonable shielding is provided by the proposed development and other upstream buildings to immediate north to the site. Again there is the potential for winds to accelerate between the site and the car park. There is also the potential for canyoning effects to occur along Church Street in south south-westerly winds.

Westerly Winds

To the west, which provides the highest winds affecting the Sydney region, the proposed development site may be affected by strong winds due to a reduced amount of shielding in that direction. While the footpath along Church Street will receive shielding from the buildings on the other side of the street and the walkway between the site and the car park will be shielded by the site itself the exposed path between the site and the river is likely to receive strong winds from this direction

Existing upper level wind conditions at the site are likely to approach and exceed the 16 m/sec *"walking comfort"* criterion for stronger prevailing wind directions (e.g. west) given the absence of surrounding buildings of significant height. There is some upper level shielding the immediate south of the site and also to the north on the other side of the river.

5.2 Future Winds – Predicted Wind flow Patterns

The following sections analyse the expected impacts of the proposed development on the pedestrian wind environment in the adjacent streetscape.

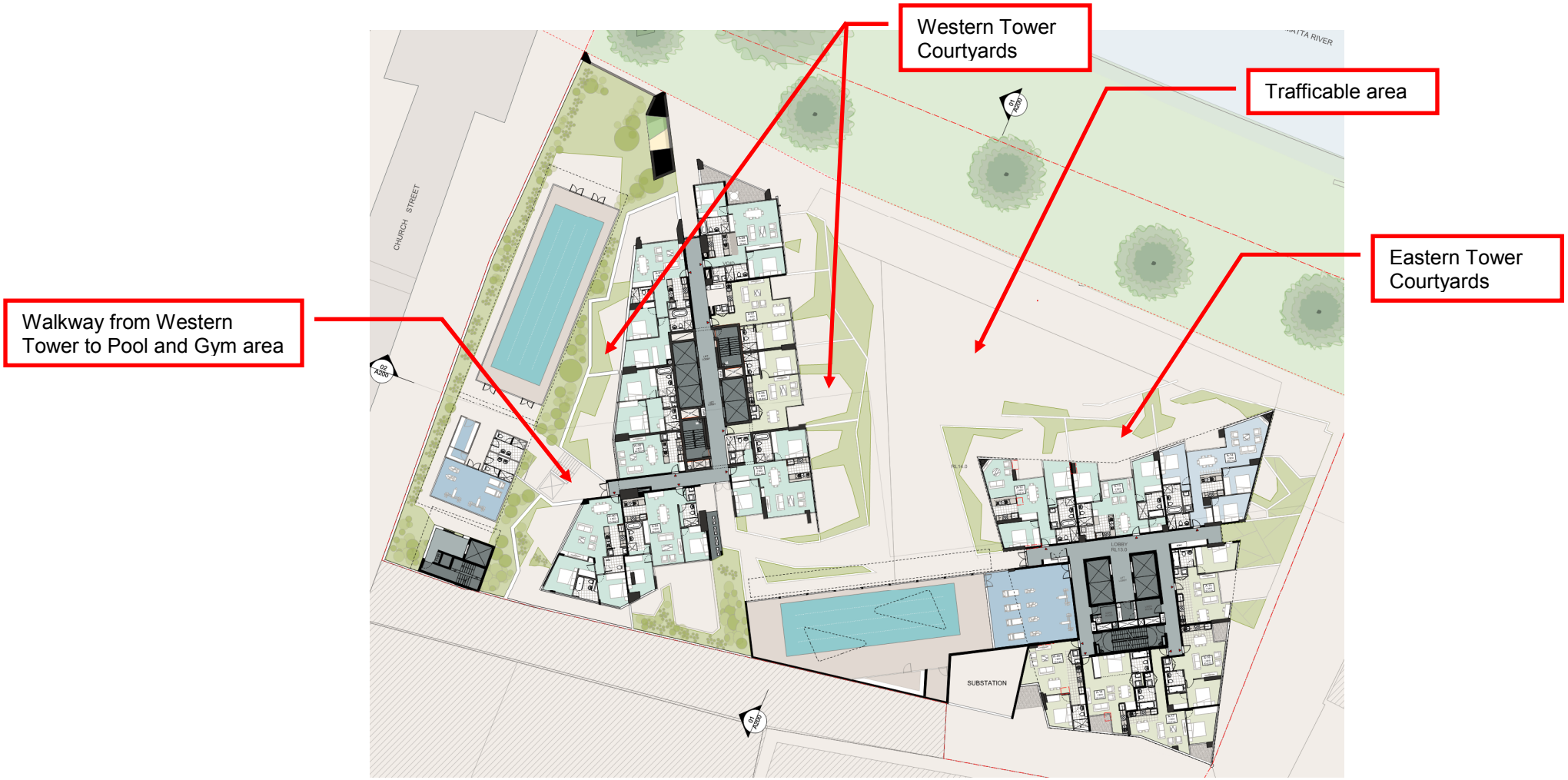
The wind impact of the proposed development is described by examining the impact of prevailing wind conditions on all public access areas of interest within and external to the development.

This analysis is made on the basis of our best engineering judgement and on the experience gained from model scale wind tunnel testing of a range of developments and in this case the wind tunnel testing conducted by "Windtech" and detailed in their report (WB055-03F01(rev0)) dated 15th November 2011

Areas of interest (i.e. surrounding footpaths, primary entry points, internal public access areas, seating and dining areas, etc.) are identified in Figure 4.

Figure 4 Street Level – Points of Interest

Figure 5 Podium Level – Areas of Interest



5.3 Northeast Winds

Location	Wind Impact
Pedestrian Footpath along Church Street	Potential impact here should be **less than 16 m/s** for most areas and **close to or exceeding 16 m/s** at the northwest corner, affected by: • Shielding from the proposed development and upstream buildings • Accelerations past the northwest corner and through the undercroft.
Pedestrian footpath along north side of site	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from upstream buildings and the relative height difference of the walkway and riverfront area to the buildings on the north side of the river. • The Windtech report indicates that some points near the river edge may **exceed 16 m/s**.
Eastern footpath between site and car park	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from upstream buildings and vegetation.
Outdoor eating areas on Church Street	Potential impact here should be **less than 10 m/s**, affected by: • Shielding from the proposed development and upstream buildings.
Outdoor eating areas at the northeast corner	Potential impact here should **exceed 10 m/s**, affected by: • Area more exposed to northeast winds.
Pedestrian walkthrough	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from the proposed development and upstream buildings.
Western core entrance	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from upstream buildings. • Indications from the Windtech report.
Eastern core entrance	Potential impact here could be **close to or exceeding 16 m/s** , affected by: • Accelerations around the southeast corner and through the undercroft. • Shielding from existing vegetation and upstream buildings • Revolving door will stop any wind entering the lobby
Podium courtyards	Potential impact here could be **close to or exceeding 10 m/s** for courtyards facing the northeast and **less than 10 m/s** for others, affected by: • Downwash from the towers. • Reduced shielding from existing vegetation and upstream buildings
Walkway from western tower to pool and gym	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from the western tower.
Upper balconies	Potential impact here should **exceed 10 m/s**, affected by: • Stronger upper level winds • Reduced shielding at upper levels.
Trafficable podium area	Potential impact here could be **close 16 m/s**, affected by: • Shielding from the upstream buildings • Channelling between the towers.

5.4 South and Southeast winds

Location	Wind Impact
Pedestrian Footpath along Church Street	Potential impact here should **close to or exceeding 16 m/s**, affected by: • Channelling along Church Street • Some upstream shielding. •
Pedestrian footpath along north side of site	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from upstream buildings and the relative height difference of the walkway and riverfront area to the site. • The Windtech report indicates that some points near the river edge may **exceed 16 m/s**.
Eastern footpath between site and car park	Potential impact here could be **close to 16 m/s**, affected by: • Shielding from upstream buildings and vegetation. • Channelling between site and car park
Outdoor eating areas on Church Street	Potential impact here should be **exceed 10 m/s**, affected by: • Channelling along Church Street and accelerations through the undercroft • Some upstream shielding.
Outdoor eating areas at the northeast corner	Potential impact here could **close to or exceeding 10 m/s**, affected by: • Shielding from the development itself. • Accelerations around the northeast corner and through the undercroft
Pedestrian walkthrough	Potential impact here could be **close to 16 m/s**, affected by: • Accelerations along the through façade opening, although the Windtech report indicates the gust speeds should be around 10 m/s.
Western core entrance	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from the site and upstream buildings.
Eastern core entrance	Potential impact here could be **close to or exceeding 16 m/s** , affected by: • Accelerations around the southeast corner and through the undercroft. • Shielding from upstream buildings • Downwash from the south side of the eastern tower • Revolving door will stop any wind entering the lobby
Podium courtyards	Potential impact here could be **close to or exceeding 10 m/s** for courtyards facing the south and **less than 10 m/s** for others, affected by: • Downwash from the towers. • Reduced shielding from existing vegetation and upstream buildings
Walkway from western tower to pool and gym	Potential impact here could be **close to or exceeding 16 m/s**, affected by: • Accelerations around the southwest corner of the western tower.

Location	Wind Impact
Upper balconies	Potential impact here should **exceed 10 m/s**, affected by: • Stronger upper level winds • Reduced shielding at upper levels. • Strong seasonal winds from this direction
Trafficable podium area	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from the upstream buildings • Shielding from the east tower pool building.

5.5 Westerly Winds

Location	Wind Impact
Pedestrian Footpath along Church Street	Potential impact here should be **less than 16 m/s** for most areas and **close to or exceeding 16 m/s** at the northwest corner, affected by: • Shielding from upstream buildings on the opposite side of Church Street • Accelerations past the northwest corner and through the undercroft. • Shielding from the awnings along Church Street
Pedestrian footpath along north side of site	Potential impact here could be **close to or exceeding 16 m/s**, affected by: • Lack of upstream shielding. • Limited shielding provided by the development
Eastern footpath between site and car park	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from upstream buildings and the development itself.
Outdoor eating areas on Church Street	Potential impact here could be **close to or exceeding 16 m/s**, affected by: • Shielding from the proposed development and upstream buildings.
Outdoor eating areas at the northeast corner	Potential impact here should **exceed 10 m/s**, affected by: • Shielding from upstream buildings on the opposite side of Church Street • Higher seasonal wind speeds from this direction
Pedestrian walkthrough	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from the proposed development and upstream buildings.
Western core entrance	Potential impact here should be **less than 16 m/s**, affected by: • Setback of the entrance from the main building facade.
Eastern core entrance	Potential impact here should be **less than 16 m/s**, affected by: • Accelerations around the southeast corner and through the undercroft. • Good shielding from the development and upstream buildings
Podium courtyards	Potential impact here could be **close to or exceeding 10 m/s** for courtyards facing the west and **less than 10 m/s** for others, affected by: • Downwash from the western tower on to west facing courtyards. • The western tower should provide good shielding to courtyards in the eastern tower
Walkway from western tower to pool and gym	Potential impact here could be **close to or exceeding 16 m/s**, affected by:

Location	Wind Impact
	• Shielding from the gym building. • Strong seasonal winds from this direction • Downwash from the western tower
Upper balconies	Potential impact here should **exceed 10 m/s**, affected by: • Stronger upper level winds • Reduced shielding at upper levels.
Trafficable podium area	Potential impact here should be **less than 16 m/s**, affected by: • Shielding from the western tower.

6 WIND AMELIORATION RECOMMENDATIONS

On the basis of the expected wind impacts outlined in previous four sections, recommendations for wind break features are made in areas where winds are expected to

- Approach or exceed 10 m/s or 16 m/s depending on the designed use for that area

These wind mitigation recommendations are summarised in **Table 2**.

Table 2 Recommended Wind Mitigation

Location of Interest	Wind Impact Potential	Windbreak Treatment/Recommendation
Pedestrian Footpath along Church Street	**High** Winds likely to exceed16 m/s from the south (**this is an existing condition**). Winds at the northwest corner likely to exceed for all directions	**Mitigation Recommended** Landscaping, art wall or a glazed screen is recommended for the northwest corner of the site, however this may not be possible due its location within the surrounding streetscape and the wind speeds should not be higher than existing conditions.
Pedestrian footpath along north side of site	**Moderate to High** Winds likely to approach 16m/s for west winds (**this is an existing condition**) Winds for other directions will be below 16 m/s.	**Mitigation Recommended** An increase in vegetation is shown in the current plans which should reduce the wind speeds in that area. Also the Windtech report shows speeds in this area being below 16 m/s. Wind speeds should not be higher than existing conditions.
Eastern footpath between site and car park	**Moderate to High** Winds likely to exceed 16m/s for southerly winds (**this is an existing condition**) Winds for other directions will be below 16 m/s.	**Mitigation Recommended** Area is outside the site boundary. Wind speeds should not exceed the existing conditions

Location of Interest	Wind Impact Potential	Windbreak Treatment/Recommendation
Outdoor eating areas on Church Street	**High** Winds likely to exceed 10m/s for west and southerly winds	**Mitigation Required** At present it has not been determined if outdoor dining will take place in these areas. Transparent pull-up/pull-down screens should be included in areas where outdoor dining will take place.
Outdoor eating areas at the northeast corner	**Moderate to High** Winds likely to exceed 10m/s for westerly and northeast winds	**Mitigation Required** A 1.5 m transparent screen will be required on the western side of the seating area.
Pedestrian walkthrough	**Low** Winds for all directions should be below 16 m/s.	**No Mitigation Required** Windtech report indicates peak speeds around 10m/s in this area.
Western core entrance	**Low** Winds for all directions will be below 16 m/s.	**No Mitigation Required**
Eastern core entrance	**Moderate** Winds likely to exceed 16m/s for southerly and northeast winds	**Mitigation Required** Some additional vegetation around this area could help to reduce the wind speeds. Wind speeds should not be higher than existing conditions. A revolving door is already provided in the design
Podium courtyards	**Moderate to High** Downwash winds likely to exceed 10m/s for westerly and northeast winds on to some courtyards in the western tower	**Mitigation Required** A 1.2 m awning should be added to level six of the western tower to reduce downwash on to the courtyards below.
Walkway from western tower to pool and gym	**Moderate to High** Winds likely to exceed 16m/s for westerly and southerly winds	**Mitigation Required** A covered walkway could be added to connect the buildings and mitigate any downwash. A planter box should be added at the southern boundary.
Upper balconies	**High** Stronger upper level winds are likely to exceed 10m/s for all directions	**Mitigation Recommended** Certain balconies from level 7 up may be uncomfortable during certain wind conditions; residents should use discretion as to the use of the balcony during high wind conditions.
Trafficable podium area	**Moderate** Winds may exceed 16m/s for northeast winds	**Mitigation Required** A 1.2 m transparent glazed screen should be constructed on the northern edge of the podium. An awning should be added over the western tower podium entrance

Figure 6 Street Level Mitigation

Figure 7 Podium Level Mitigation

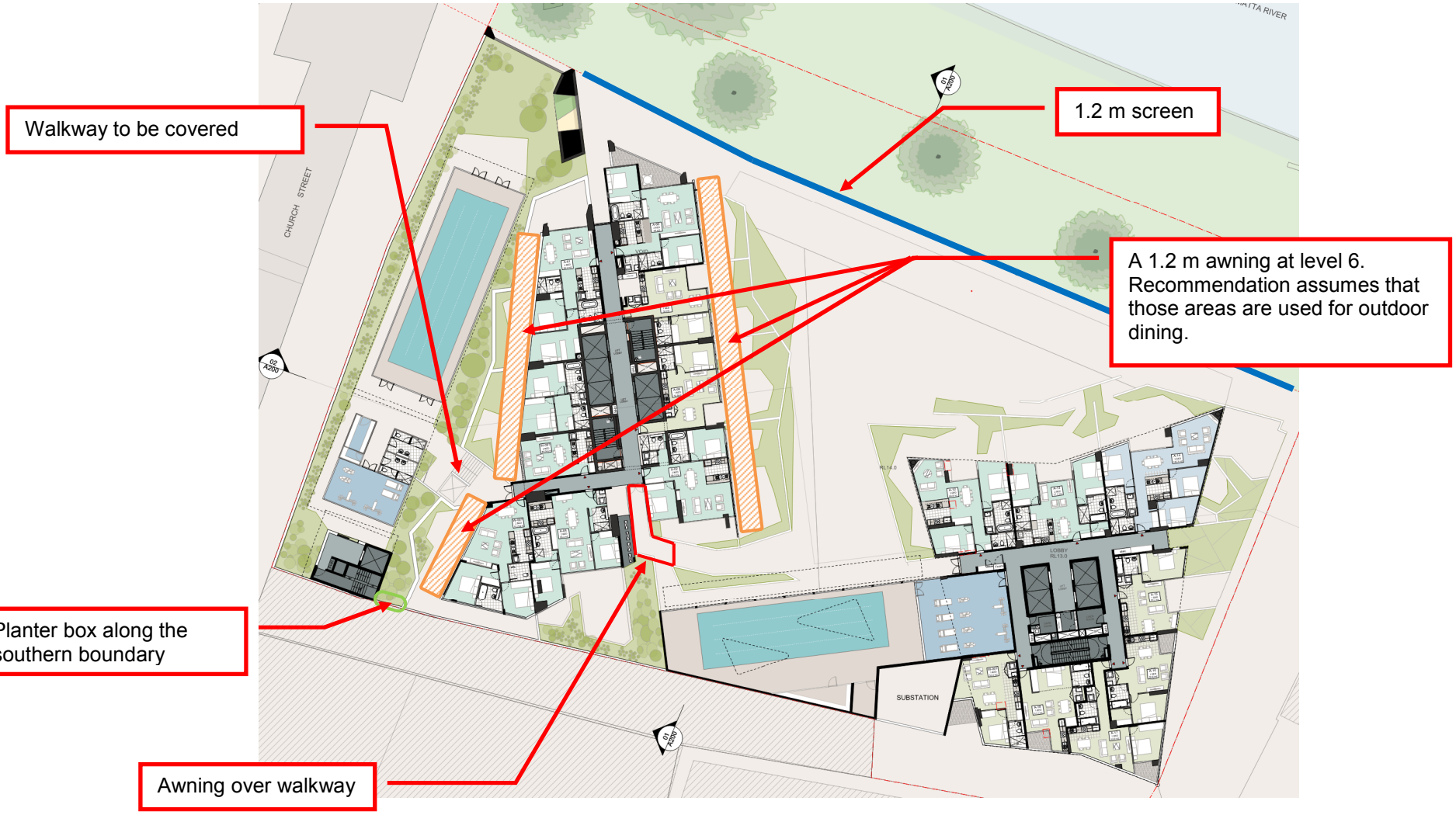


Figure 8 Upper Level Balcony Mitigation

7 CONCLUSION

SLR has been engaged by Meriton to undertake a qualitative wind impact assessment of proposed new development at 330 Church Street, Parramatta also known as the “Riverfront Apartments” with respect to the wind environment in and around the site.

Sydney’s Prevailing Winds

The Sydney wind climate is characterised by dominant (prevailing) north-easterly, westerly and southerly winds. While northeast winds are the more common prevailing wind direction (occurring typically as offshore land-sea breezes), southeast and south winds generally provide the strongest gusts during summer. West quadrant winds (southwest to northwest) provide the strongest winds for the whole year.

Existing Wind Environment

Existing street level wind conditions in the vicinity of the site are likely close to or exceeding the 16 m/s *“walking comfort”* criterion for some prevailing wind directions given the orientation of the site and the spacing of upstream shielding afforded to the site by surrounding buildings. In particular adverse winds of more than 16 m/s are likely to be present along Church Street due to the streets alignments in the same directions as the prevailing winds (south) in Sydney.

FUTURE Wind Environment

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

- Pedestrian footpaths surrounding the site are subjected winds close to or exceeding the 16 m/s criterion. Some of these are existing wind conditions and mitigation may be possible with additional landscaping.
- Outdoor eating area will require transparent screens and canopies to reduce the wind speeds in those areas (Refer **Figure 7**).
- The significant height of the towers may result in adverse downwash on the podium level courtyards. Canopies have been recommended the counteract this.
- Some corner Balconies from level 10 and up (Refer **Figure 8**) will occupationally experience stronger upper level winds and subjected winds may exceed the dining criterion. SLR recommends providing movable screens or a suitable practical alternative to protect the relevant balcony areas. The practical wind treatment will be investigated during the detailed design stage of the project.

Accordingly, it has been predicted that ground levels wind speeds within
all public access areas surrounding the development
should remain at their present levels or be reduced
with the addition of the proposed development and its wind mitigation treatments.

The above analysis has been made on the basis of our best engineering judgment and on the experience gained from scale model wind tunnel testing or computational fluid dynamics analysis of a range of developments. Further analysis could be carried out using Computational fluid dynamics to assess specific locations around the site during the detailed design stage of the project.

SYDNEY WIND ROSES