641-655A PACIFIC HIGHWAY

CHATSWOOD, NSW

PEDESTRIAN WIND ASSESSMENT

PROJECT # 2203553
MARCH 10, 2022

SUBMITTED TO

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1. INTRODUCTION

RWDI Australia Pty Ltd (RWDI) was retained to conduct a qualitative assessment of the pedestrian wind conditions expected on and around the proposed development located at 641-655A Pacific Highway in Chatswood, NSW. The development site is located to the south of the Chatswood CBD, approximately 8km to the northwest of the Sydney CBD, and is bound by the Pacific Highway to the west and Gordon Avenue to the south (Image 1). The existing Hammond Laneway forms the eastern and northern boundary to the site. The project site is generally surrounded by low-rise residential buildings in all directions.

The proposed development consists of two 26-storey residential towers. Commercial tenancies are planned on the lower levels and communal open spaces are located at the connected podium. Image 2 shows the illustrative masterplan of the development site.

The key outdoor pedestrian accessible areas of interest associated with the development include the pedestrian footpaths around the site, the Bowling Club to the east of the site and other nearby pedestrian accessible areas. It is understood that, since the release of Willoughby Council strategy for Chatswood CBD, several planning proposals for nearby developments have been submitted for future buildings. However, the current assessment only takes into account the proposed development within its existing surrounding context.

This qualitative wind assessment has been prepared to accompany a Planning Proposal for the proposed development. Additional quantitative analysis through wind tunnel testing and CFD modelling are planned during the detailed DA stage.

Image 1: Aerial View of the Existing Site and Surroundings Source: Nearmap

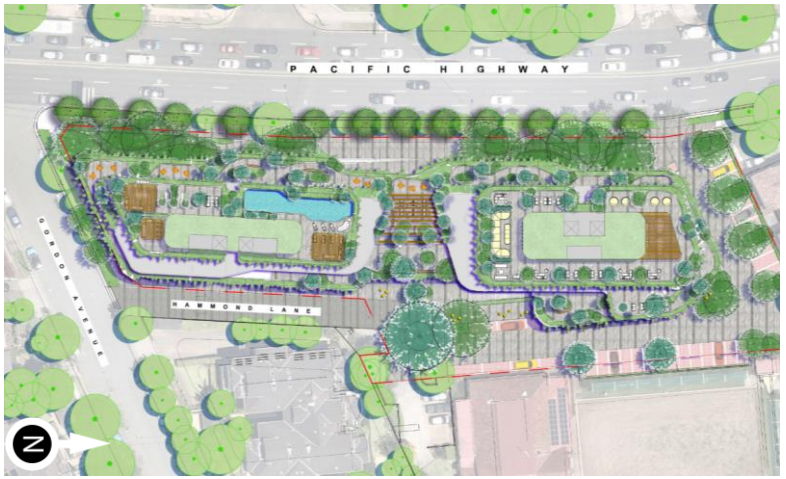

Image 2: Illustrative Masterplan of the Development Site

2. METHODOLOGY

Predicting wind speeds and occurrence frequencies around a building is a complex process and involves the combined assessment of building geometry, orientation, position and height of surrounding buildings, upstream terrain and the local wind climate. Over the years, RWDI has conducted thousands of wind-tunnel model studies and CFD assessments on pedestrian wind conditions around buildings, yielding a broad knowledge base of potential flow behaviour. In some situations, this knowledge and experience, together with literature, allow for a reliable, consistent and efficient desktop estimation of pedestrian wind conditions without wind-tunnel testing. This approach provides a screening-level estimation of potential wind conditions and offers conceptual wind control measures to improve wind comfort, where deemed necessary.

In order to quantify and confirm the predicted conditions and refine the conceptual wind control measures, physical scale model tests in a boundary-layer wind tunnel are planned for the detailed design stage of the development.

RWDI's assessment is based on the following:

- A review of the regional long-term meteorological data;
- Drawings and design reports of the development site received by RWDI in February / March 2022.
- Use of RWDI's proprietary software (*WindEstimator*[1]) for providing a screening-level numerical estimation of potential wind conditions around generalised building forms;
- Wind-tunnel studies and desktop assessments undertaken by the team for projects in the region;
- Our engineering judgement, experience, and expert knowledge of wind flows around buildings[2, 3]; and,
- RWDI Criteria for pedestrian wind comfort and safety.

Note that other microclimate issues such as those relating to cladding and structural wind loads, door operability, building air quality, noise, vibration, etc. are not part of the scope of this assessment.

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1. H. Wu, C.J. Williams, H.A. Baker and W.F. Waechter (2004), "Knowledge-based Desk-Top Analysis of Pedestrian Wind Conditions", ASCE Structure Congress 2004, Nashville, Tennessee.
2. H. Wu and F. Kriksic (2012). "Designing for Pedestrian Comfort in Response to Local Climate", Journal of Wind Engineering and Industrial Aerodynamics, vol.104-106, pp.397-407.
3. C.J. Williams, H. Wu, W.F. Waechter and H.A. Baker (1999), "Experience with Remedial Solutions to Control Pedestrian Wind Problems", 10th International Conference on Wind Engineering, Copenhagen, Denmark.

3. METEOROLOGICAL DATA

Meteorological data recorded at Sydney International Airport from 1998 to 2019 were used as a reference for wind conditions in the area. The distributions of wind frequency and directionality for the summer (November through April) and winter (May through October) seasons are shown in Image 3.

The records indicate that winds from the northeast and the southern sectors are predominant during the summer season. Wind from the west and northwest directions are predominant in the winter season and can have an impact on the perceived outdoor thermal comfort of a space.

Strong winds of a mean speed greater than 30 km/h measured at the airport (at an anemometer height of 10 m) occur more often in the summers than in the winters. During both seasons, strong winds from the southerly directions are predominant. These winds could potentially be the source of uncomfortable / unsafe wind conditions, depending on the site exposure or development design. The analysis has accounted for this and all winds directions.

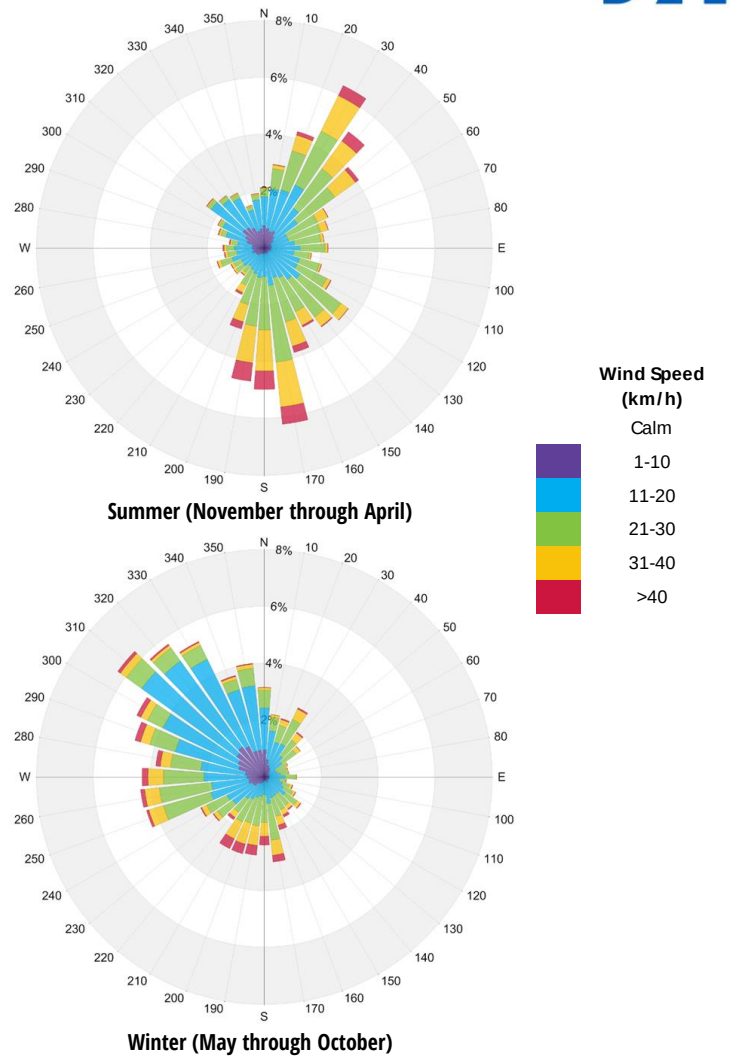


Image 3: Directional Distribution of Winds Approaching Sydney International Airport - Recorded from 1998-2019

4. RWDI PEDESTRIAN WIND CRITERIA

The RWDI pedestrian wind comfort criteria are used in the current study. These criteria have been developed by RWDI through research and consulting practice since 1974. They have also been widely accepted by municipal authorities, building designers and the city planning community. The Australasian Wind Engineering Society (AWES) recommended safety criterion is also utilised. The criteria are as follows:

4.1 Safety Criterion

Pedestrian safety is associated with excessive gusts that can adversely affect a pedestrian's balance and footing. If strong winds that can affect a person's balance (83 km/h) occur more than 0.1% of the time or 9 hours per year, the wind conditions are considered severe.

4.2 Pedestrian Comfort Criteria

Wind comfort can be categorized by typical pedestrian activities:

Sitting (≤ 10 km/h): Calm or light breezes desired for outdoor seating areas where one can read a paper without having it blown away.

Standing (≤ 14 km/h): Gentle breezes suitable for main building entrances and bus stops.

Strolling (≤ 17 km/h): Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park.

Walking (≤ 20 km/h): Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.

Uncomfortable: The comfort category for walking is not met.

Wind conditions are considered suitable for sitting, standing, strolling or walking if the associated mean wind speeds are expected for at least 80% of the time. Wind control measures are typically required at locations where winds are rated as uncomfortable or if these exceed the wind safety criterion.

Note that these wind speeds are assessed at the pedestrian height (i.e., 1.5 m above grade or the concerned floor level), typically lower than those recorded in the airport (10 m height and open terrain).

These criteria for wind forces represent average wind tolerance. They are sometimes subjective and regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. can also affect people's perception of the wind climate.

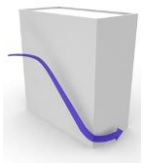
For the current development, wind speeds comfortable for walking or strolling are appropriate for sidewalks; lower wind speeds comfortable for standing are required for building entrances and bus-stops where pedestrians may linger, and calm wind speeds suitable for sitting are desired in areas where passive activities are anticipated, such as the outdoor dining and amenity terraces.

5. RESULTS AND DISCUSSION

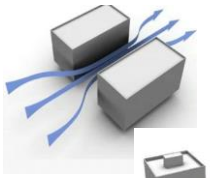
5.1 General Wind Flow around Buildings

In our discussion of wind conditions on and around the proposed development, reference may be made to the following generalised wind flows (see Image 4). If these building / wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and uncomfortable or potentially unsafe conditions.

Downwashing
Tall buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level. This is often the main cause for wind accelerations around large buildings at the pedestrian level.



Corner Acceleration
Winds approach at an oblique angle to a tall façade and are deflected down causing a localised increase in the wind activity or corner acceleration around the exposed building corner(s) at pedestrian level.



Channelling
When two buildings are situated side by side or an underpass is created, wind flow tends to accelerate through the space due to channeling effect caused by the narrow gap.

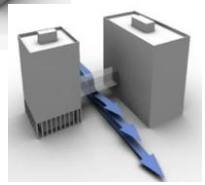


Image 4: General wind flow around buildings

Design details such as setting back a tower from the edges of a podium, deep canopies close to ground level, wind screens / tall trees with dense landscaping, etc. (Image 5) can help reduce high wind activity. The choice and effectiveness of these measures would depend on the exposure and orientation of the site with respect to the prevailing wind directions and the size and massing of the proposed buildings.

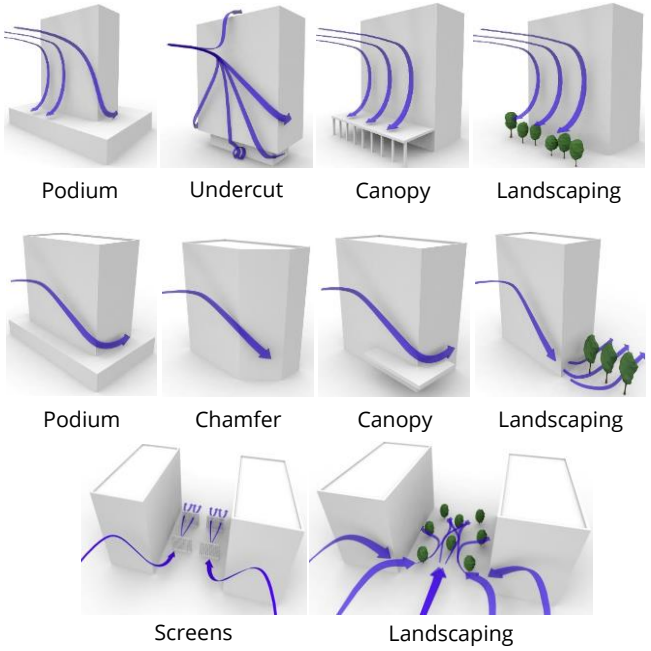


Image 5: Examples of Common Wind Control Measures

5. RESULTS AND DISCUSSION

5.2 Existing Site Conditions

The existing site consists of three-storey residential buildings and is surrounded by suburban terrain in all directions. The typical height of the neighbourhood buildings is between 1-3 storeys. Therefore, no significant structures exist close to the site that will considerably alter the local microclimate. The existing street trees are also expected to further diffuse the winds leading to conditions that are generally expected to be suitable for passive use throughout the year. Wind conditions exceeding the safety criterion are also not expected.

5.3 Proposed Site Conditions

5.3.1 Ground Level

The proposed design takes advantage of several positive features that are likely to reduce the overall impact of high winds. These include the narrow form of the buildings to the southerly winds, the use of curved corners, strategic location of canopies and other landscaping features, and the setbacks to the towers along the western aspect. The redirected westerly winds can, however, wrap around the corners of the buildings and impact the northern carpark and the street fronts along Gordon Avenue (Image 6 and7). Proposed vegetation and existing vegetation along the Pacific Highway, the norther carpark and the adjoining streets is expected to enhance ground level wind conditions around the site. These measures are also expected to protect the Bowling Club to the east of the site.

5.3.2 Lower-Level Outdoor Spaces

The westerly winds can also influence any outdoor amenities planned atop the podium between the two towers. This is primarily due to these winter winds downwashing off the façade of the buildings and then channeling between the towers, as shown in Images 6 and 7, creating localised regions of high wind activity. Similarly, the north-easterly sector winds may wrap around the northern tower and funnel between the buildings. The space between the towers is expected to be significantly influenced by the regional winds with conditions. The use of the indicated canopy / trellis structure between the buildings and vegetation to baffle the winds is expected to improve wind conditions (see Image 2 for the indicative landscaping). Other measures such as wind screening and use of additional canopies is recommended for the seating areas to ensure a comfortable wind amenity is achieved. These measures will be further refined during the detailed design stage of the project.

The outdoor spaces on Level 2 along the western front are exposed to wind accelerations around the corners. Inclusion of taller balustrades (1.5-2m) and dense vegetation can significantly improve conditions within these spaces. Partitioning these areas with full-height screening can also achieve a similar impact. On the other hand, the communal terraces located at the north-eastern corner of the development at Levels 1 and 2 are generally shielded from the prevailing regional winds. The north-easterly summer winds, after passing over Chatswood CBD, would also be welcomed in these spaces due to their cooling effect. The exposure to the westerly winds, noted in Image 7, can be resolved through a 1.5m high perimeter balustrade and the indicated landscaping elements interspersed within the terrace.

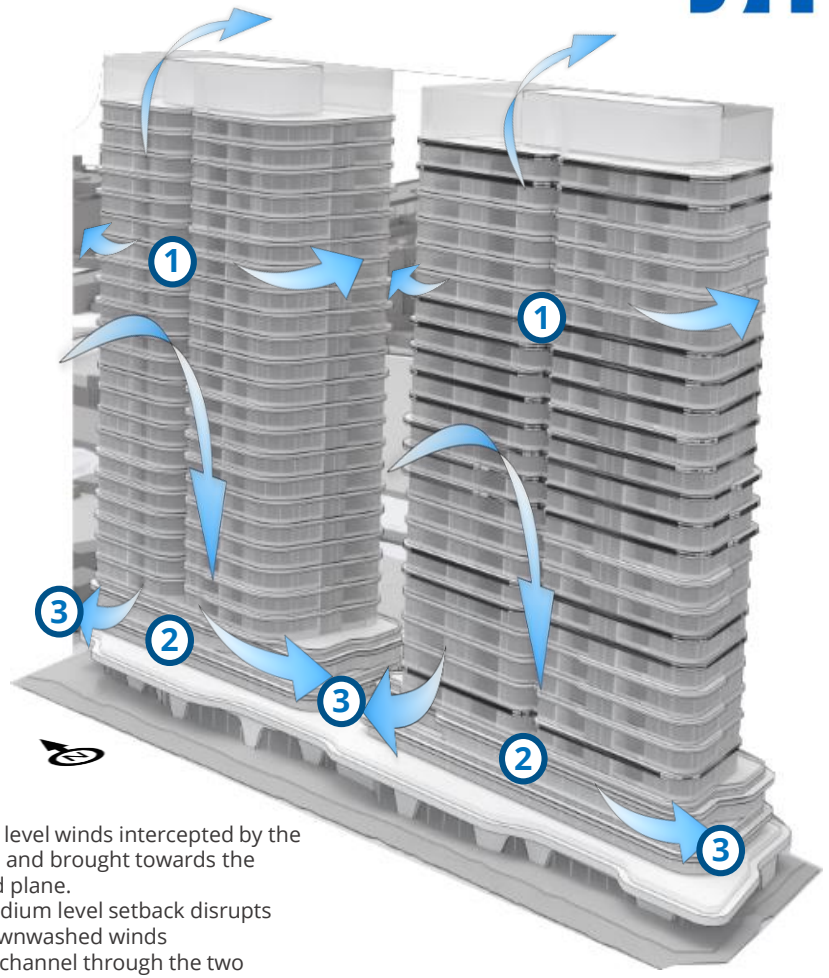
5. RESULTS AND DISCUSSION

5.3.3 Private Balconies

The design of the proposed residential buildings indicates that the private balconies are inset within the building form and are, therefore, shielded from prevailing wind effects. These are expected to be comfortable for intended use. It is be noted that corner balconies are exposed to winds accelerating around these spaces and can often lead to high wind activity. Use of screening / louvres along one of the corners can mitigate this wind effects (Image 8).

5.3.4 Rooftop Terraces

The rooftop terraces are generally exposed to all prevailing regional winds. The westerly and southerly winds can upwash off the tower façade and reattach within the terraces creating high wind activity. Therefore, it is recommended to incorporate a 1.5-2m high perimeter screening around the terraces. Additionally, the use of centralised canopies / trellis elements are recommended within the terraces to mitigate wind reattachment. Additional screening and vegetation, particularly around any seating areas, is also recommended to help buffer wind activity and to ensure comfortable wind conditions within these spaces.



1. Higher level winds intercepted by the towers and brought towards the ground plane.
2. The podium level setback disrupts the downwashed winds
3. Winds channel through the two buildings or accelerate around corners creating a localised region of high wind activity

Image 6: Expected Wind Flow Patterns for the Westerly Sector Winds

5. RESULTS AND DISCUSSION

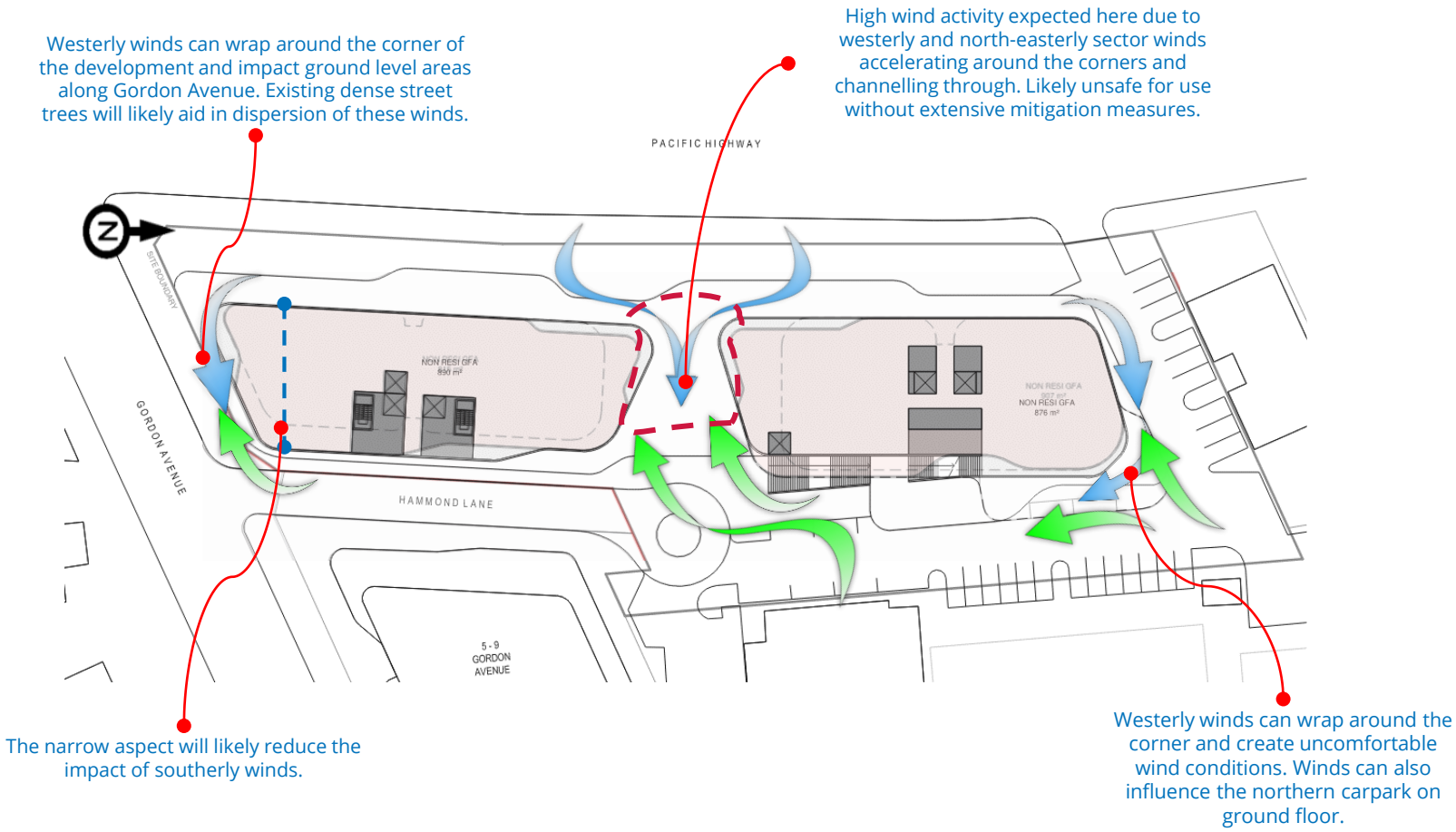


Image 7: Planar View of the Development (Overlay of Levels 1 and 2) - Expected Wind Flow Patterns and Wind Activity

5. RESULTS AND DISCUSSION

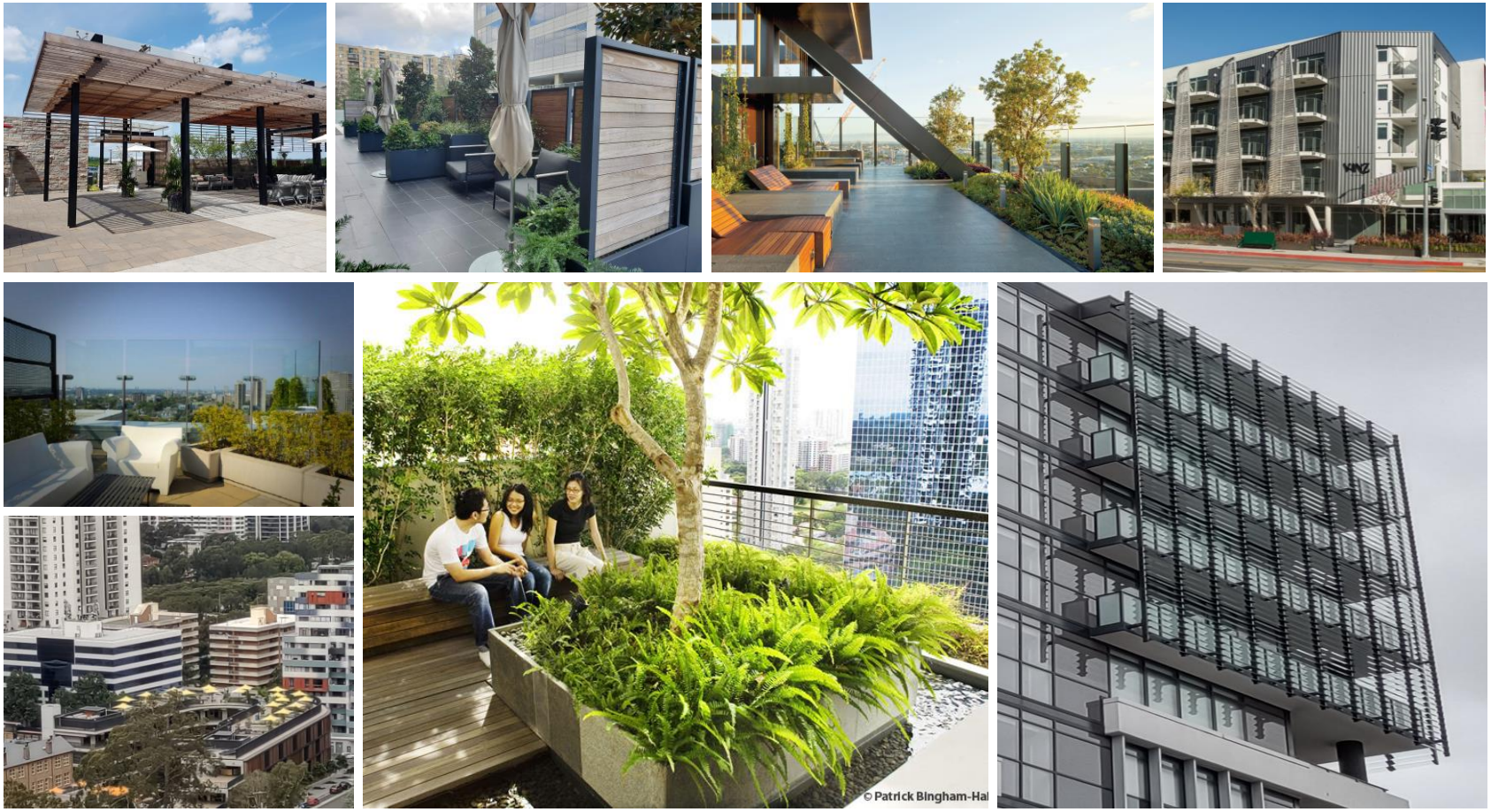


Image 8: Examples of Wind Control Measures

6. SUMMARY

Wind conditions in and around the proposed development located at 641-655A Pacific Highway in Chatswood are discussed in this report. The qualitative assessment is based on the review of local wind climate, the current design of the proposed precinct, impact of the surrounding buildings and our experience with wind tunnel testing of similar buildings within the region. The assessment has been prepared to accompany the Planning Proposal for the proposed development.

The proposed development takes advantage of several positive design features that are expected to improve wind conditions on the ground level. These include deep setbacks along the western aspect and the narrow form of the development to the southerly winds as well as the strategic use of landscaping features around the development. These elements are expected to considerably improve the local wind conditions within and around the development site. Additional insight has also been provided for key wind effects associated with the design of the development. These will be quantified, and the control measures further refined, using wind tunnel testing and CFD analysis during the detailed design stage of the development.

7. APPLICABILITY OF ASSESSMENT

The assessment discussed in this report pertain to the proposed development in accordance with the information received in February / March 2022. In the event of any significant changes to the design, construction or operation of the building or addition of surroundings in the future, RWDI could provide an assessment of their impact wind conditions discussed in this report. It is the responsibility of others to contact RWDI to initiate this process.

Statement of Limitations

This report entitled Pedestrian Wind Assessment, dated March 10, 2022 was prepared by RWDI Australia Pty Ltd ("RWDI"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final stages of the project to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project. The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.