14-16 MARSHALL AVENUE, 5-9 HOLDSWORTH AVENUE & 2-10 BERRY ROAD

ST LEONARDS, NSW

PEDESTRIAN WIND ASSESSMENT

PROJECT # 2103338

APRIL 19, 2023

SUBMITTED TO

Costas Haramis
Development Coordinator
costasharamis@modernco.com.au
T: +61 2 9058 3300

SUBMITTED BY

Aman Choudhry, PhD, MIEAust
Senior Microclimate Engineer
aman.choudhry@rwdi.com
T: +61 2 8000 9855

Henry Kuo, BE(Aero), DipPM, MIEAust
Project Manager
henry.kuo@rwdi.com
T: +61 2 8000 9856

Michael Pieterse,
M.A.Sc., CPEng., P.Eng., RPEN
Senior Project Manager | Associate Principal
michael.pieterse@rwdi.com
T: +61 455 545 527

Modern Construction & Development
12/82 Elizabeth St,
Sydney, NSW 2000

RWDI Australia Pty Ltd.
ABN 86 641 303 871

rwdi.com

1. INTRODUCTION

This Pedestrian Wind Report has been prepared by RWDI on behalf of Modern Construction & Development (Proponent) and in support of a development application submitted to Lane Cove Council (Council) for construction of a mixed-use development comprising of 10 allotments with a total site area of 5,874sqm. The site is known as Areas 13,14 and 15 within the St Leonards South Precinct, and is bound by Marshall Avenue to the north, Holdsworth Avenue to the east and Berry Road to the west.

This development proposal seeks consent for the demolition of all existing buildings and structures on site and the construction of three separate 10 to 11 storeys residential flat buildings development, in accordance with the broader development within the St Leonards South Precinct.

More specifically, the proposed works are described as follows:

- Construction of three residential buildings comprising:
  - A consolidated basement car park comprising four levels and one part basement level;
  - Vehicular access via Holdsworth Avenue (from Area 14).
  - Significant landscaping integrated throughout the site with a focus on the central green spine.

A key component of the development is to incorporate the desired future character of the St Leonards South Precinct and emphasis on the unique context of the locality through architectural expression and landscaping.

The proposed development is aligned with Council's vision for the St Leonards South Precinct and will create a landmark development within this corner site to celebrate the gateway entrance to the St Leonards South Precinct.

2. BACKGROUND

The site forms part of the Council led St Leonards South Planning Proposal followed by the amendments to the LEP, DCP and implementation of a new Landscape Master Plan (LMP). The intent of the amendments is to allow for higher density residential development in the area. The LEP amendments were gazetted in October 2020 and came into effect on 1 November 2020.

The new planning framework is also supported by a site specific DCP and a LMP which were adopted by Council on 19 October 2020. These documents are intended to supplement the LEP controls to provide more detailed built form and landscape guidelines.

2.1 Pre-Lodgement Discussions

The proposal for the development of Area's 13, 14 & 15 has led to multiple preliminary discussions with Lane Cove Council. The Proponent has been consulting extensively with Lane Cove Council throughout the Planning Proposal phase, and in addition met with senior planning staff in November 2020 to seek clarity on a range of matters while the design review structure was being finalised.

Post gazettal of the LEP and as part of the pre-DA process, the applicant met with Council and the Design Excellence Panel (DEP) on multiple occasions. Preliminary design schemes were presented at these meetings.

On 19 August 2022, Lane Cove Council issued a Letter to the Applicant providing detailed comments on the proposal. The correspondence generally accepted the design responses with one amendment pertaining to the southern setback controls for Levels 5-10 of buildings in Areas 14 & 15.

3. SITE LOCATION

The subject site is located at 2-10 Berry Road, 5-9 Holdsworth Avenue and 14-16 Marshall Avenue, St Leonards. The site comprises 10 allotments with a total site area of 5,874sqm. It is acknowledged that the Proponent owns all lots forming part of the site.

The site is known as Areas 13, 14 and 15 within the St Leonards South Precinct and in the Lane Cove Local Government Area (LGA). St Leonards is located 6km north of the Sydney CBD. The subject site is in proximity and highly accessible to the commercial centres of North Sydney, Chatswood and Macquarie Park. The site is located within convenient walking distance to St Leonards rail station and the future metro station.

The surrounding development has undergone significant transition, from low density dwellings to medium and high density residential and mixed use. The desired future character for St Leonards South Precinct is for a liveable, walkable, connected, safe area which helps build upon the transit, commercial and residential opportunities of St Leonards. This transition is being supported by current development activity, recent approvals and further planned development.

Address	Lot and Deposited Plan
14 Marshall Avenue	Lot 2 in DP7259
16 Marshall Avenue	Lot 1 in DP7259
2 Berry Road	Lot 38 in DP7259
4 Berry Road	Lot 37 in DP7259
6 Berry Road	Lot 36 in DP7259
8 Berry Road (*to be acquired from neighbour)	Lot 35 in DP7259
10 Berry Road (*to be acquired from neighbour)	Lot 34 in DP7259
5 Holdsworth Avenue	Lot 7 in DP7259
7 Holdsworth Avenue	Lot 8 in DP7259
9 Holdsworth Avenue	Lot 9 in DP7259

3. SITE LOCATION

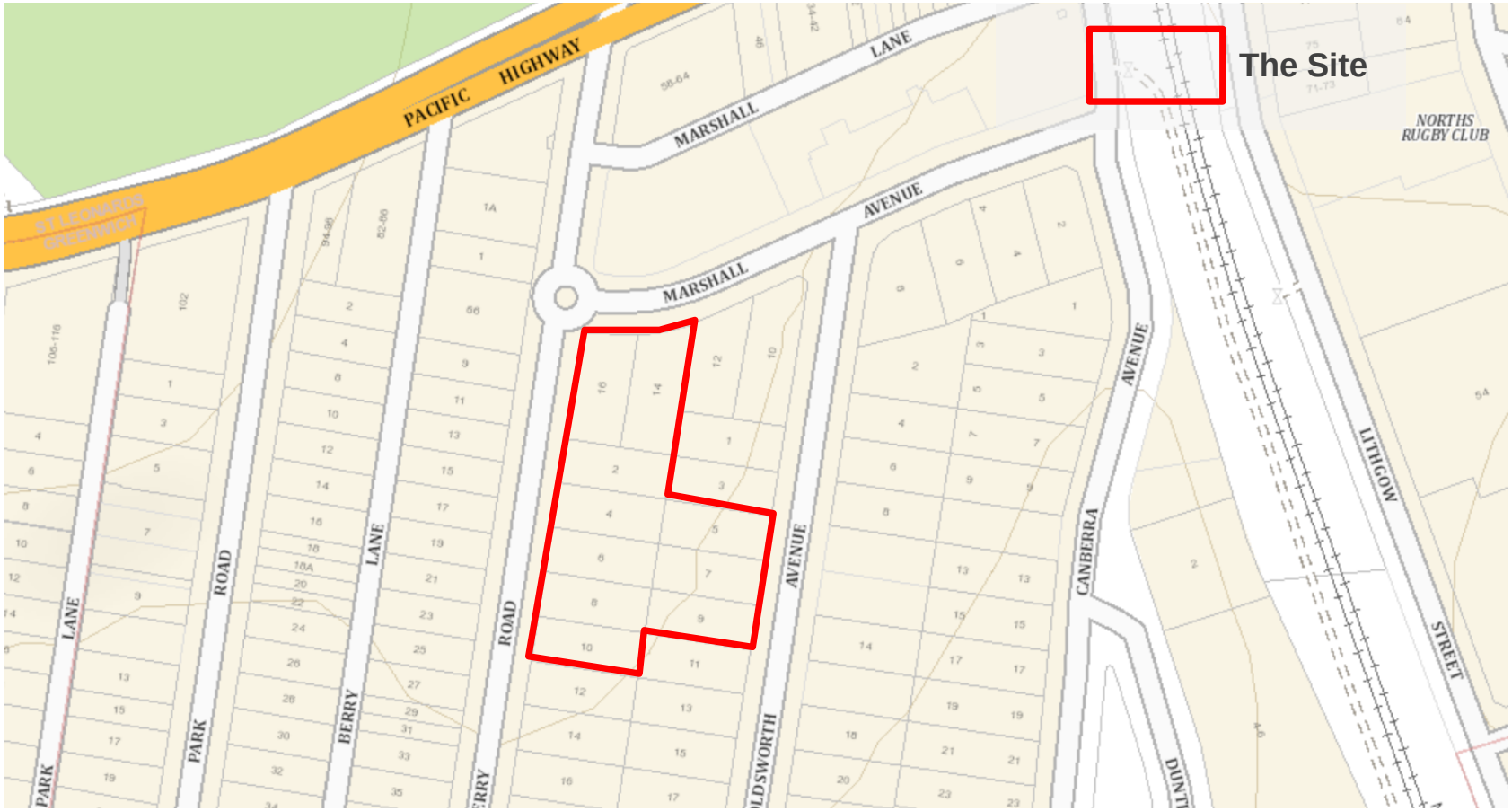


Image 1: The Site

3. SITE LOCATION

Image 2: Proposed St Leonards Masterplan Aerial View
Source: A+ Design, 2020

4. 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. This knowledge and experience, together with literature, allows for a reliable, consistent and efficient desktop estimation of pedestrian wind conditions without wind-tunnel testing or detailed CFD studies.

This qualitative 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 or to refine any of the suggested conceptual wind control measures, physical scale model tests in a boundary-layer wind tunnel would be required.

RWDI's assessment is based on the following:

- A review of the regional long-term meteorological data;
- Architectural drawing set received by RWDI 12 April 2023.
- Wind-tunnel studies, CFD simulations, and desktop assessments undertaken by the microclimate team for projects in the region;
- Our engineering judgement, experience, and expert knowledge of wind flows around buildings[1, 2]; and,
- RWDI Criteria for pedestrian wind comfort.
  NB: The Wind Standards for St Leonards – Section 6.2 of Lane Cove Development Control Plan are outdated and based on gust wind speeds, rather than the Gust Equivalent Mean wind speeds, as is standard industry practice.

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.

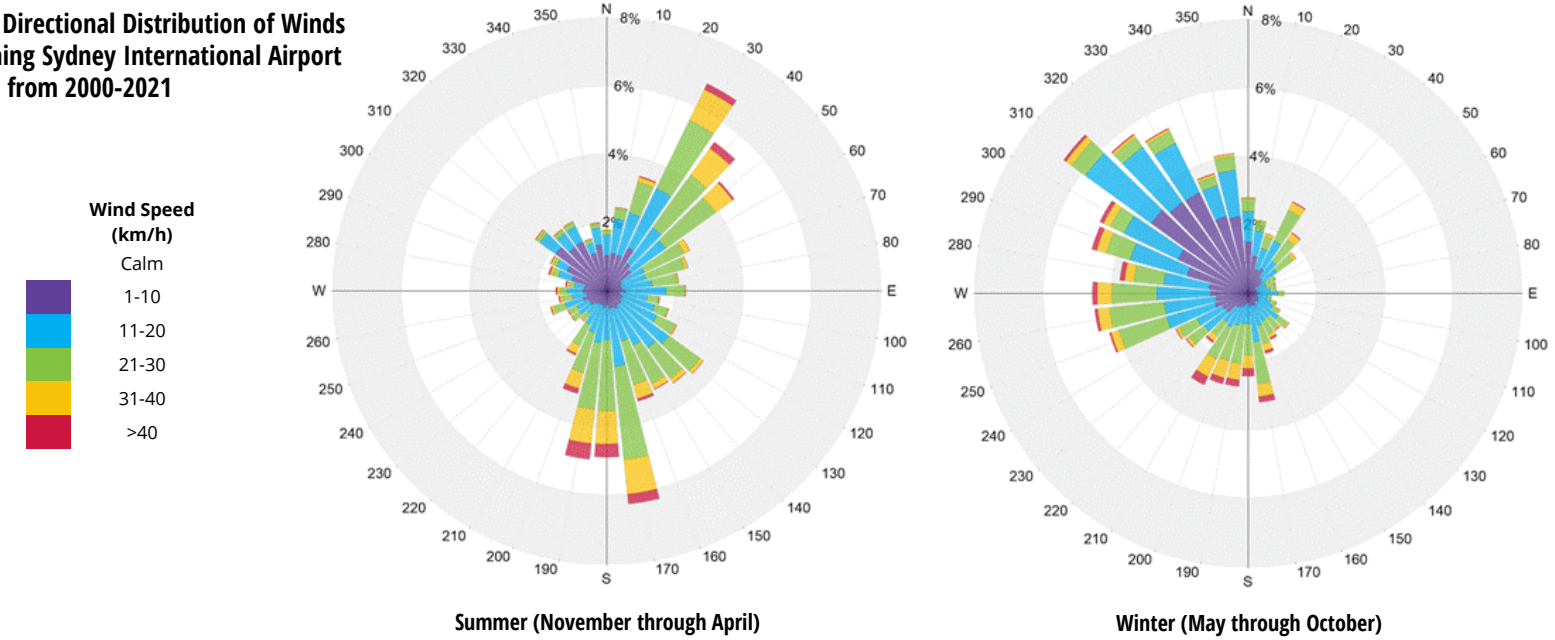
1. H. Wu and F. Kriksic (2012). "Designing for Pedestrian Comfort in Response to Local Climate", Journal of Wind Engineering and Industrial Aerodynamics, vol.104-106, pp.397-407.
2. C.J. Williams, H. Wu, W.F. Waechter and H.A. Baker (1999), "Experience with Remedial Solutions to Control Pedestrian Wind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

5. METEOROLOGICAL DATA

Meteorological data recorded at Sydney International Airport from 2001 to 2021 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 2000-2021



6. RWDI PEDESTRIAN WIND CRITERIA

6.1 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. These generally coincide with areas of high wind activity noted in the report.

6.2 Pedestrian Comfort Criteria

The RWDI pedestrian wind comfort criteria, depicted in Image 4, are used in the current study. These criteria have been developed by RWDI through research and consulting practice since 1974 and have also been widely accepted by municipal authorities, building designers and the city planning community worldwide. These are categorised based on typical / intended pedestrian activities.

Note that wind conditions are assessed at a typical pedestrian chest height and are considered suitable for the intended use of the space if the associated mean winds are expected for at least 80% of the time. Wind control measures are typically required at locations where the occurrence frequencies of wind speeds exceed the threshold values for specific pedestrian activities.

Furthermore, note that these criteria for wind forces represent average wind tolerance. These are sometimes subjective with regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. also affecting people's perception of the wind climate. For a full assessment of comfort, it is recommended that a thermal comfort study be undertaken.

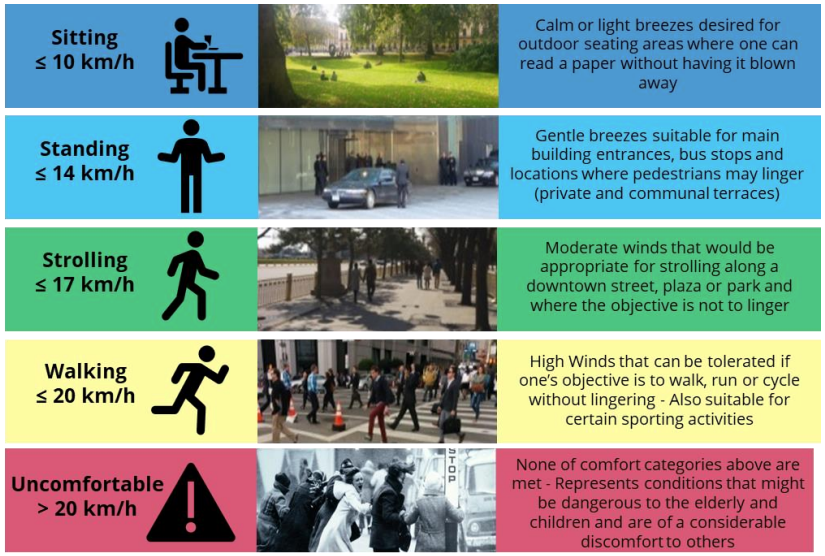


Image 4: RWDI Pedestrian Wind Comfort Criteria

7. RESULTS AND DISCUSSION

7.1 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 5). If these building / wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and uncomfortable or potentially unsafe conditions. Design details such as setting back a tower from the edges of a podium for a prevailing wind direction, deep canopies close to ground level, wind screens / tall trees with dense landscaping, etc. 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.

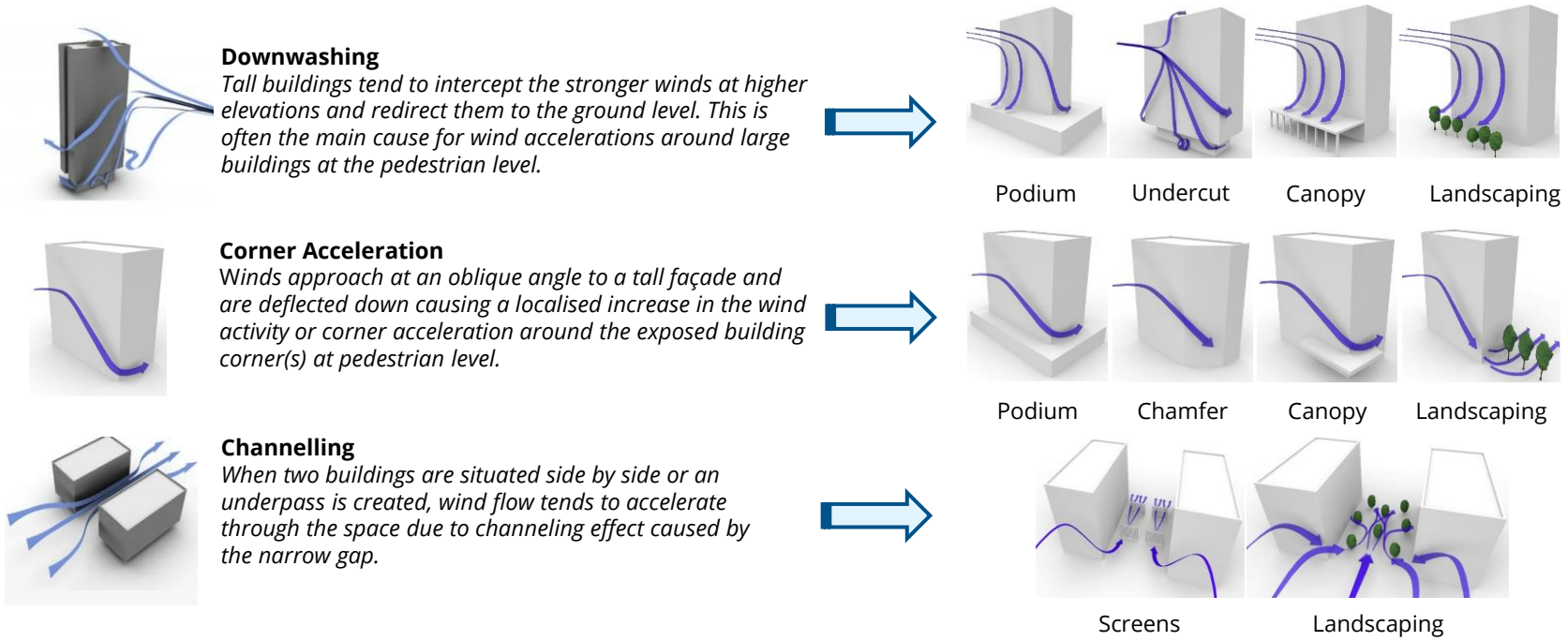


Image 5: General Wind Flow around Buildings with Examples of Common Wind Measures

7. RESULTS AND DISCUSSION

7.2 Existing Site Conditions

The existing site is currently occupied by a low-rise residential buildings that blend in with the neighbouring surrounding area. As a result, these buildings are unlikely to have a significant impact on the local winds. Instead, the overall impact will be determined by factors such as the alignment of the streets with prevailing winds and local topography. Specifically, Berry Road and Holdsworth Avenue are likely to channel southerly winds, and the steep rise along Berry Road will increase wind speeds along the road. Nonetheless, wind conditions around the site are expected to be comfortable for passive use in winters and active use in summers. The inclusion of existing street trees is expected to make the conditions even calmer.

7.3 Proposed Site Conditions

Image 6 displays the exposure of the development site to regional prevailing winds. The proposed development with three separate residential buildings, each consisting of 10 to 11 storeys, is taller than the surrounding buildings to the south and west. The open exposure to the winds from these directions as well as the orientation and design of the buildings can result in increased wind activity around the site. The image while the site is somewhat protected from prevailing northeasterly winds due to high-rise buildings in St Leonards, wind exposure to these other directions remains a significant consideration.

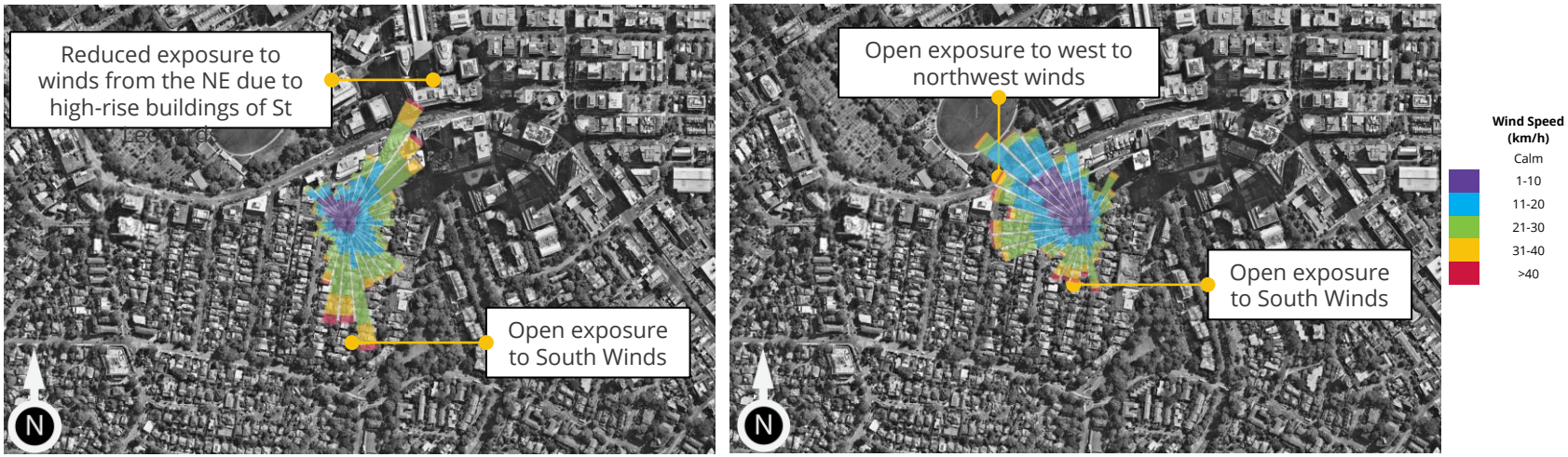


Image 6: Exposure of Site to Regional Prevailing Winds
Left: Summer | Right: Winter

7.3.1 Ground Level

The proposed development includes several positive design features that will likely reduce the wind activity within the public domain on the local ground level. These include the setbacks in Areas 13 and 15 along the western aspect, the inclusion of trellises along the southern aspect of Areas 14 and 15, and the inclusion of dense landscaping within the communal open space between the towers and the pedestrian link at the south end of the site. Key wind interactions and expected wind conditions are shown in Image 7 and are noted below:

- The proposed individual entrances to the buildings are located along the central communal green space. These are recessed into the building form and surrounded by dense landscaping. Wind conditions within and around these entrances are expected to be comfortable for passive use throughout the year.
- Although the awnings along the southern sides of Areas 14 and 15, as well as the dense landscaping within the communal space and pedestrian link, will help reduce the impact of southerly winds, the open design and early end of these elements will likely result in increased wind speeds towards the southern end of the communal space.
- The wide front along Berry Road (made up of Areas 13 and 15) will redirect significant volumes of wind towards the ground plane, leading to high activity at the exposed corners of the buildings. Additionally, the awnings and trees at the southern end of Area 15 may create a channel for winds to duck underneath. The open lobby space between the two buildings is also likely to channel westerly winds, leading to potentially uncomfortable conditions in winter and suitable conditions for active use in summer due to channelling of winds from the northeast.
- Wind conditions within the communal space and the pedestrian link are expected to be calm due to the high levels of shielding provided by the proposed buildings and Area 12 site as well as the dense landscaping within the Green Zone.

7.3.2 Private Balconies

Most private balconies in the proposed buildings have a single aspect design and are recessed, resulting in comfortable wind conditions for passive use throughout the year. However, balconies at the corners will likely experience strong wind conditions due to acceleration of prevailing winds around exposed corners, with no adjacent shielding to mitigate the effect. This condition may extend throughout the height of the tower, with the channelling between Areas 13 and 15 exacerbating conditions above Level 9. Additionally, Level 8 balconies will likely have uncomfortable wind conditions due to redirected westerly winds downwashing and accelerating around corners

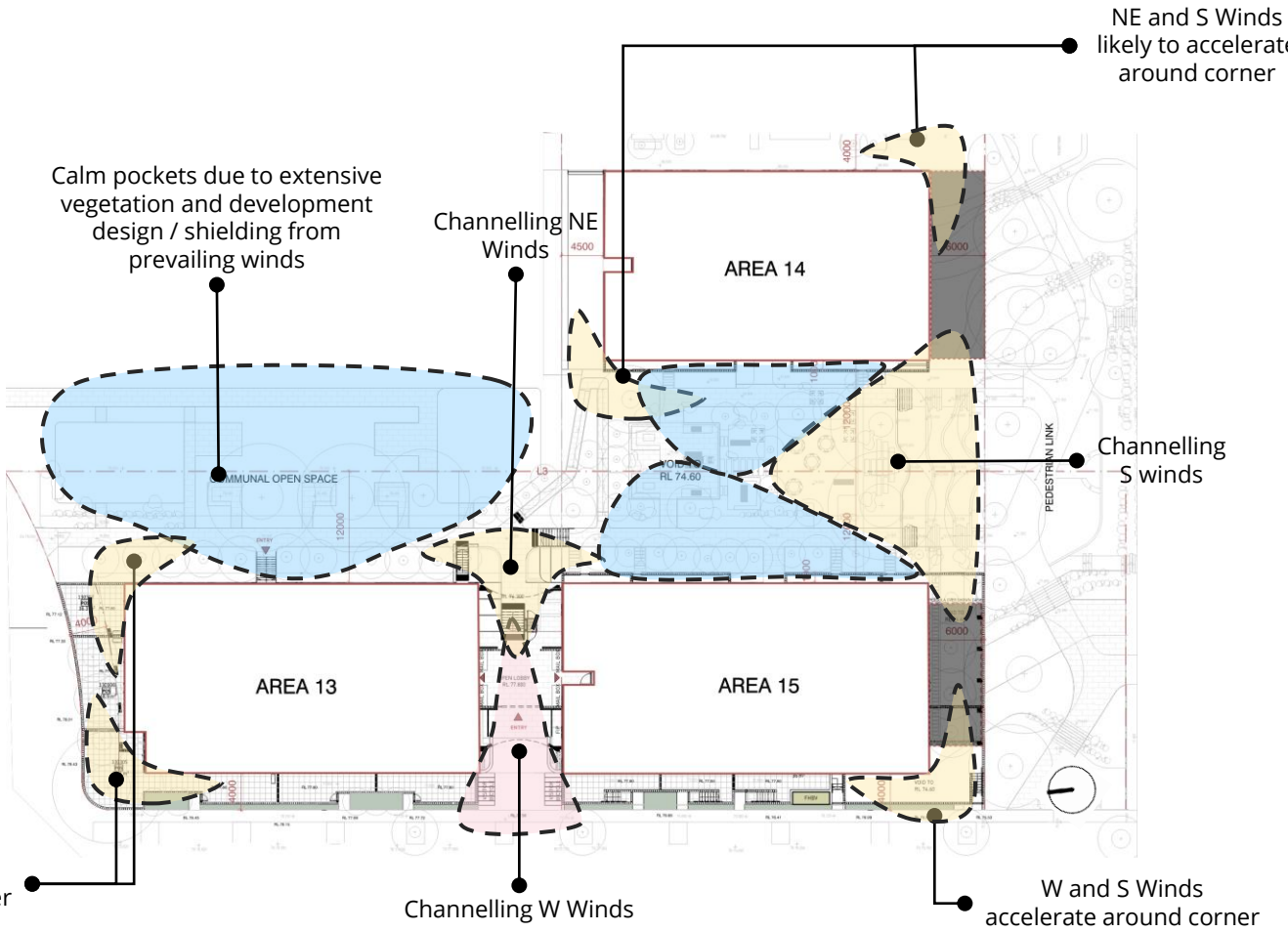
7. RESULTS AND DISCUSSION

Image 7: Expected Wind Comfort Conditions at Local Ground Levels

A — Generally calm. Well-sheltered areas suitable for any use.

B — Moderate to high wind activity. Likely to be suitable for active use. Too windy for comfortable amenity use unless mitigation measures are implemented.

C — Windy with potential for localised strong winds. Likely to be uncomfortable during the windier times of the year



7.3.3 Rooftop Terrace

The communal terrace on the roof of Area 13 incorporates a 1.8m high perimeter screen that is expected to provide significant protection from regional winds for areas closer to the screens. The lift overrun and plant rooms located at the northeast corner of the terrace will also provide some protection from northeast winds. Landscaping elements such as trees and planters on the terrace will further reduce wind movement. However, note that winds from the roof of Area 15 can reattach within and may slightly increase wind activity in the southern part of the terrace.

5.4 Design Advice and Recommendations

Based on the discussions provided, the following design advice and wind control measures can be incorporated in the design to ensure comfortable wind amenity is achieved around the site (examples shown in Image 8):

- It is understood that the development site will be landscaped with numerous trees and shrubs within the communal spaces. Plantings with large crowns and dense foliage, complemented with underplanting to prevent wind flows from accelerating under the crowns, will help reduce wind activity immediately around these areas. Localised landscaping in the form of tree clusters at the corners of the buildings is recommended to reduce corner wind acceleration effects.
- The awnings along the southern aspect of Areas 14 and 15 should have a maximum porosity of 50% to be effective in reducing the impacts of downwashing winds. Trees should be situated strategically at the ends of these trellises to diffuse the winds further before these reattach on the ground level.
- It is recommended to retain the awning over the through-site link between Areas 13 and 15. This awning should be located at approximately Level 4 to allow the downwashed winds to flow above the trafficable area, and extend from the edge of the slab above by at least 2m on the western aspect.
- Trellises (1.5m deep and maximum porosity of 50%) are recommended along the western aspect of Level 8 corner terraces (Apartments 130805 and 150802). Alternatively, the corner balcony for Apartment 130805 can be partitioned further using 1.8m high screen. Similarly, screening with a height of 1.8m can be included at the corner southern corner of the terrace for Apartment 150802.
- While the balconies are expected to be safe for use, the comfort of corner balconies can be further improved through screening, landscaping and other such measures.

These mitigation strategies can be further developed at a more detailed design stage.

5. RESULTS AND DISCUSSION

Image 8: Examples of Wind Control Measures

6. SUMMARY

Wind conditions on and around the proposed development located at 2-10 Berry Road, 5-9 Holdsworth Avenue and 14-16 Marshall Avenue in St Leonards, NSW are discussed in this report. The qualitative assessment is based on the review of local wind climate and the current design of the proposed development. The impact of the surrounding buildings and the local land topography has also been considered. The assessment is based on our experience with wind tunnel testing and CFD analysis of similar buildings within the region.

The proposed development includes several positive design features including the setbacks along the western aspect, awnings along southern aspects, inset balconies and entrances, and dense landscaping on ground level and within the rooftop communal space. These elements, along with the location of the site, are expected to allow majority of the areas in and around the proposed development to be suitable and safe for intended pedestrian use. However, high wind activity is anticipated at localised spots, particularly at exposed corners on the ground level and within the open lobby space between Areas 13 and 15. Channelling is also expected between Areas 14 and 15, albeit the overall of is likely to be smaller due to dense landscaping included here. Wind control measures have, therefore, been discussed in the report and are expected to improve the wind conditions of these areas. Design advice has also been provided to further improve wind comfort amenity for private balconies. These strategies can be considered at a more detailed design stage.

This qualitative approach provides a screening-level estimation of potential wind conditions around the site and offers conceptual wind control measures and design advice suitable for early design of buildings. However, predicting outdoor wind conditions around a site is a complex process that involves the combined assessment of building geometry and orientation, position and height of surrounding buildings, upstream terrain, and the local wind climate. To quantify and confirm the predicted conditions discussed in the report, wind tunnel testing and/or computational fluid dynamics (CFD) can be undertaken at a more detailed design stage to assess the high wind areas discussed in the report, such as the channels between the various buildings. The conceptual wind control measures can be further refined through wind tunnel testing and CFD.

7. APPLICABILITY OF ASSESSMENT

The assessment discussed in this report pertains to the proposed development in accordance with the drawings and information received in April 2023. 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 on the 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 '*2-10 Berry Road Pedestrian Wind Assessment*', dated 19 April 2023, 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.