524-542 PACIFIC HIGHWAY
ST LEONARDS, NSW

WIND MICROCLIMATE DESIGN REVIEW
PROJECT # 2204821
SEPTEMBER 21, 2023

SUBMITTED TO

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DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
A	Initial	23/09/2022	AMC	JG/KMP
B	Update for minor comments	26/09/2022	AMC	JG
C	Detailed recommendations included in report	26/10/2022	AMC	JG
D	DA set review and comments, standard consultant text, SEARs included	14/09/2023	AMC	JG
E	Final	21/09/23	AMC	JG

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1. INTRODUCTION

This Wind Microclimate Design Review is submitted to the Department of Planning and Environment (DPE) in support of a concurrent State Led Rezoning and State Significant Development Application (SSDA) for a new mixed-use development, comprising build-to-rent housing, commercial and retail land uses at the Telstra Exchange Site at 524-542 Pacific Highway, St Leonards (the site).

The proposed development will specifically comprise the following:

- Site preparation and excavation.
- Retention and integration of the existing Telstra Exchange Building;
- Construction of a new 42-storey mixed-use development, comprising:
  - 21,472m2 of build-to-rent housing across 31 storeys, including 272 dwellings;
  - 3,840m2 of non-residential space within an 8 storey podium used for the purposes of short stay accommodation, including;
  - 721 m2 of Key Worker Housing across 1 level, within the podium, delivering a total 10 dwellings to be managed as part of the build to rent development
  - 2,014m2 of community amenity facilities throughout the building.
- Residential lobby accessed via Christie Street and separate commercial use lobby accessed via Pacific Highway;
- Podium car parking and loading area with vehicular access via Christie Street, comprising a 48 space car stacker;
- Associated landscaping and public domain works; and
- Augmentation of, and connection to, existing utilities services as required.

It is noted that to facilitate the abovementioned development, amendments to the Lane Cove Local Environmental Plan 2013 are proposed via a concurrent State Led Rezoning to rezone the site from B3 Commercial Core to B4 Mixed Use and to increase the maximum building height of 72m to 155m. The maximum FSR of the site will remain as per existing at 17.1:1.

This Wind Microclimate Design Review addresses the following relevant Secretary's Environmental Assessment Requirements (SEARs) set out in the Table 1 below.

SEARs	Response
5 Environment Amenity Assess amenity impacts on the surrounding locality, including lighting impacts, reflectivity, solar access, visual privacy, visual amenity, view loss and view sharing, overshadowing and **wind impacts**. A high level of environmental amenity for any surrounding residential or other sensitive land uses must be demonstrated.	Section 6

In addition to the SEAR's, this Wind Microclimate Design Review has also been prepared in accordance with the Study Requirements (IRF22/649) issued in March 2022 by the DPE in collaboration with other government agencies.

2. PROJECT DETAILS

The project site is bound by the Pacific Highway along its northern boundary and by Christie Street along its western boundary. The proposed development sits within a high-rise precinct with the Landmark Residential Tower abutting the eastern boundary. The project site is situated approximately 4km to the northwest of the Sydney CBD. The location of the site within its broader existing context is shown in Image 1. The proposed development is a 42-storey tower that will replace the existing low-rise structure on the site. Elevations of the proposed building are shown in Image 2. This desk-based report discusses the potential impacts of the proposed massing of the tower on the local wind microclimate. The findings of the report are informed by Computational Fluid Dynamics (CFD) simulations for the prevailing wind directions that show the likely wind flow patterns around the proposed tower massing. Conceptual wind control measures and design alterations are also suggested, where necessary, to alleviate any adverse wind conditions.

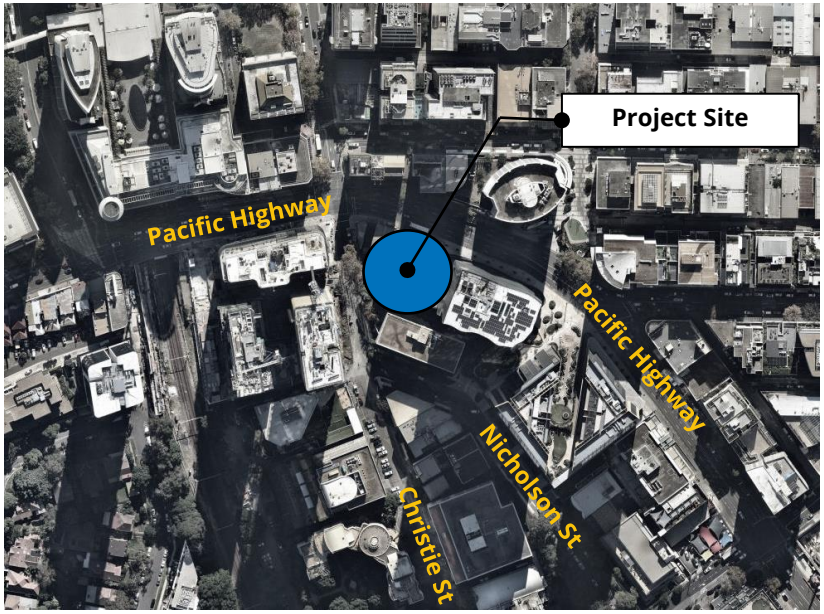


Image 1: Aerial View of the Existing Site and Surroundings
Source: Nearmap

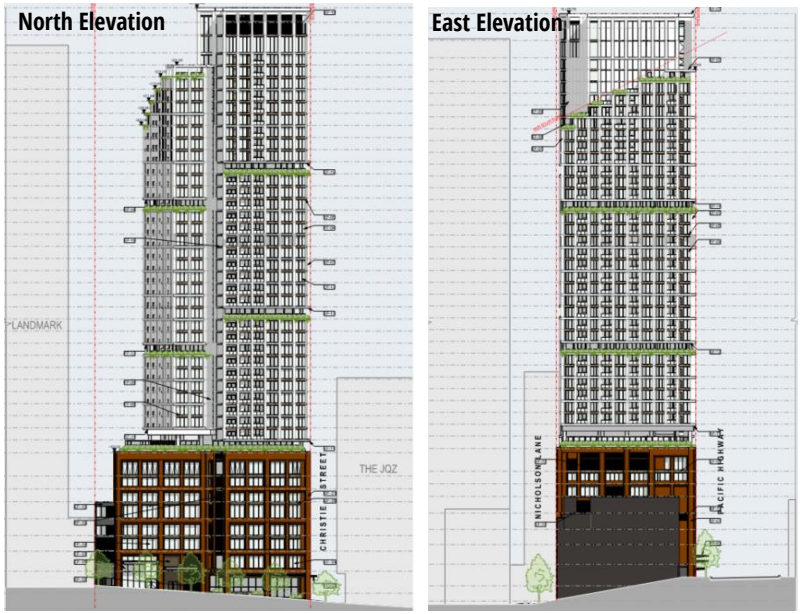


Image 2: Elevations of the Proposed Development

3. BACKGROUND AND METHODOLOGY

3.1 Objectives and Scope

The objective of this assessment is to provide an evaluation of the wind comfort conditions around the proposed development site. Predicting outdoor wind conditions is a complex process that involves the combined assessment of building geometry, orientation, position and height of surrounding buildings, upstream terrain and the local wind climate. Computational Fluid Dynamics is a useful tool for this as it not only combines the impact of these various parameters but can also provide a visual reference for the merits of a particular design of the building.

This analysis was, therefore, based on the following:

- A review of the regional long-term meteorological data.
- Use of the Orbital Stack Direct, an in-house CFD tool, to provide numerical estimation of potential wind conditions around the site for the prevailing winds. The simulation models have been based on the drawings and information received by RWDI between August and September 2022.
- Review of DA Set received by RWDI in September 2023.
- Our engineering judgement, experience, and expert knowledge of wind flows around buildings including wind tunnel studies undertaken for similar projects in the region.

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.

3.2 CFD in Urban Wind Modelling

CFD is a computational tool that can be used to simulate wind in the urban realm. For modelling winds around buildings, CFD techniques are used to generate a virtual wind tunnel where flows around the site, surroundings, and the study building are simulated at full scale. The computational domain that covers the site and surroundings is divided into millions of small cells where calculations are performed, which allows for the prediction of wind conditions across the entire study domain. CFD excels as a tool for wind modeling that can be used to provide early design advice, comparing different design and site scenarios, resolving complex flow physics, and helping diagnose problematic wind conditions.

High speed gust conditions causing safety issues are infrequent but deserve special attention due to their potential impact on pedestrian safety. The computational modelling method used in the current assessment does not directly quantify the transient behavior of wind gusts. As such, the effect of gusts, i.e., wind safety, was not considered in this assessment. In order to directly quantify the transient behavior of wind, and refine any conceptual mitigation measures, physical scale-model tests in a boundary-layer wind tunnel or more detailed transient computational modelling would be required.

3. BACKGROUND AND METHODOLOGY

3.3 Simulation Model

Wind flows were simulated using Orbital Stack, an in-house computational fluid dynamics (CFD) tool that has been validated using RWDI's historical wind tunnel test data and experience. Simulation have been carried out using the models of the project building and the existing surrounding context (shown in Image 3). For the purposes of this computational study, the 3D models were simplified to include only the necessary elements that are likely to affect the local wind flows in the area and around the site. Note that this study only focusses on the final SDRP4 configuration of the study building. The evolution of the massing based on previous wind assessments can be seen in Image 4. Note that RWDI have also reviewed the latest DA set received in September 2023. It is noted that the overall form of the development remains similar to the models used for the CFD study.

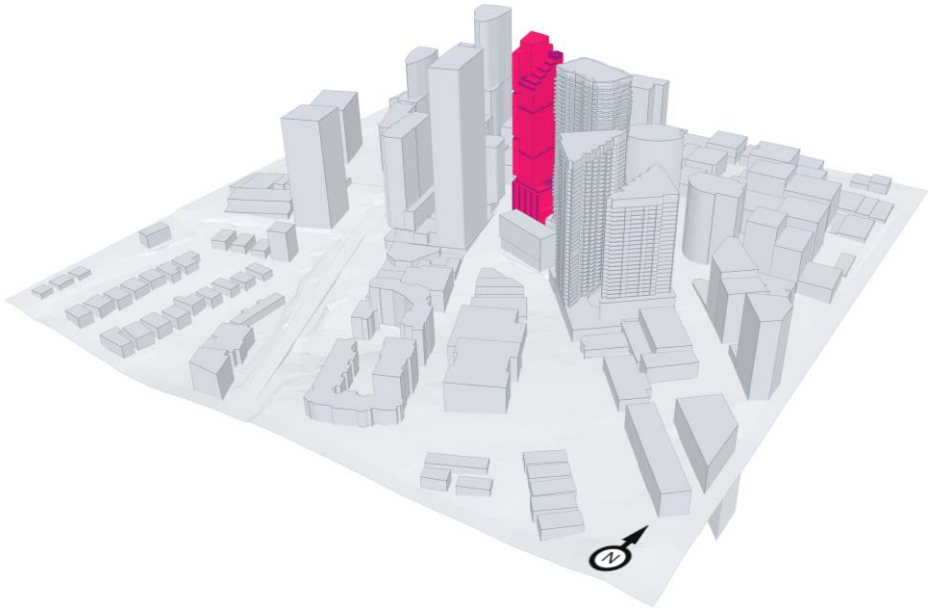


Image 3: Computer Model of the Proposed Development and Surrounding Context

3.4 Methodology

Select predominant wind directions were simulated accounting for the effects of the atmospheric boundary layer and terrain. The wind field was assumed to be steady in time and, as such, the transient effects of strong wind gusts and vortex shedding was not included. Turbulence was modeled in the wind simulations by a Reynolds Averaged Navier-Stokes (RANS) approach using the k-epsilon (RNG) turbulence closure. These results were combined with the meteorological data to determine the qualitative variation of wind speeds in the areas of concern (i.e., 1.5 m above local grade). These conditions were then assessed against the wind criteria for pedestrian comfort and the spaces were categorised accordingly.

3. BACKGROUND AND METHODOLOGY

Base Scheme

SDRP3 Scheme
- Strategic shaping with cuts
- Awnings along street front

SDRP4 Scheme
- Strategic shaping with cuts
- Awning positioned strategically to reduce wind exposure
- Strategic recesses and shelters along the northwest corner
- Podium articulation
- Localised measures introduced

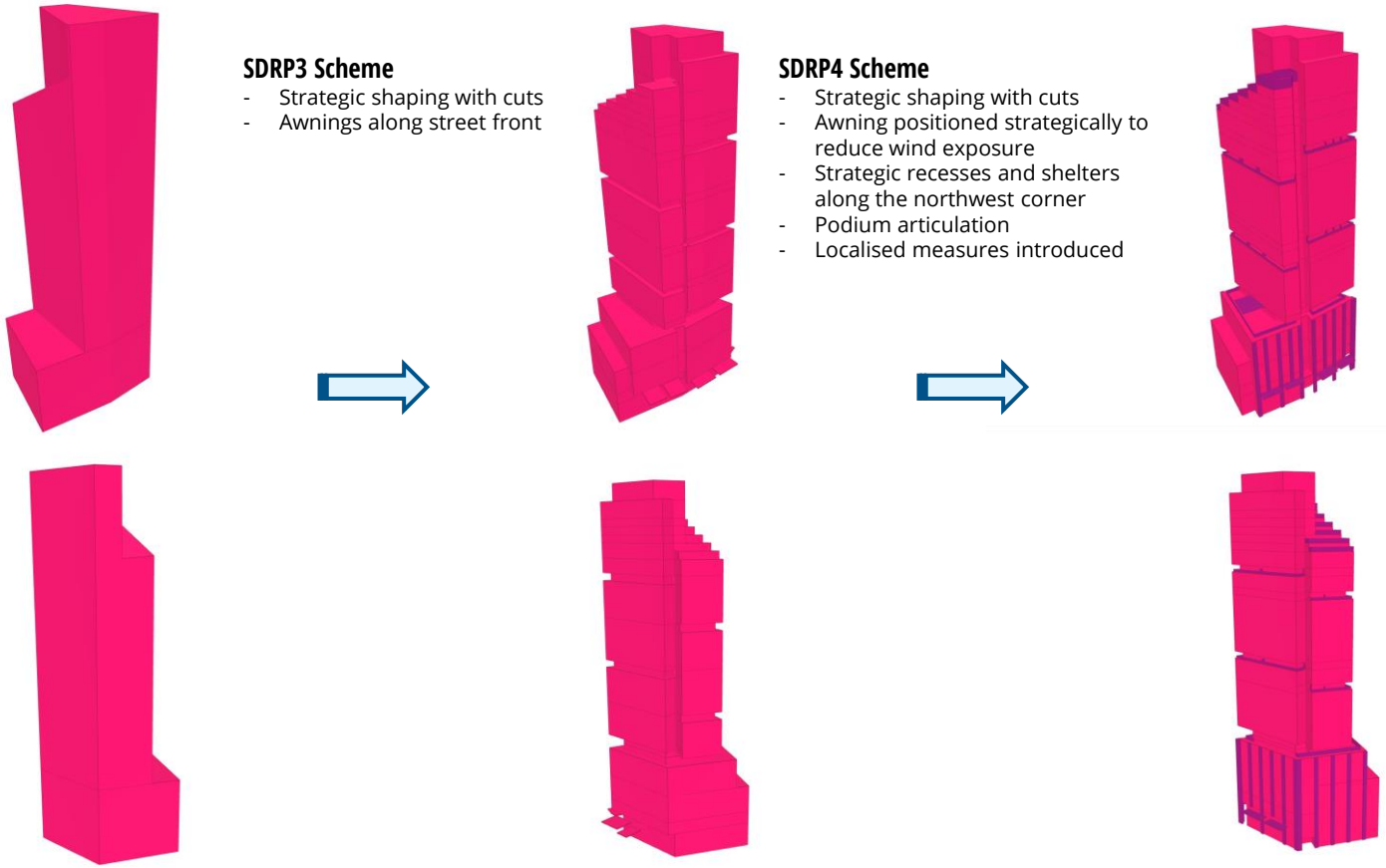


Image 4: Evolution of the Building Envelope in response to Wind Studies

3.5 Factors Affecting Wind Flows

In our discussion of wind conditions in 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 foliage, 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.

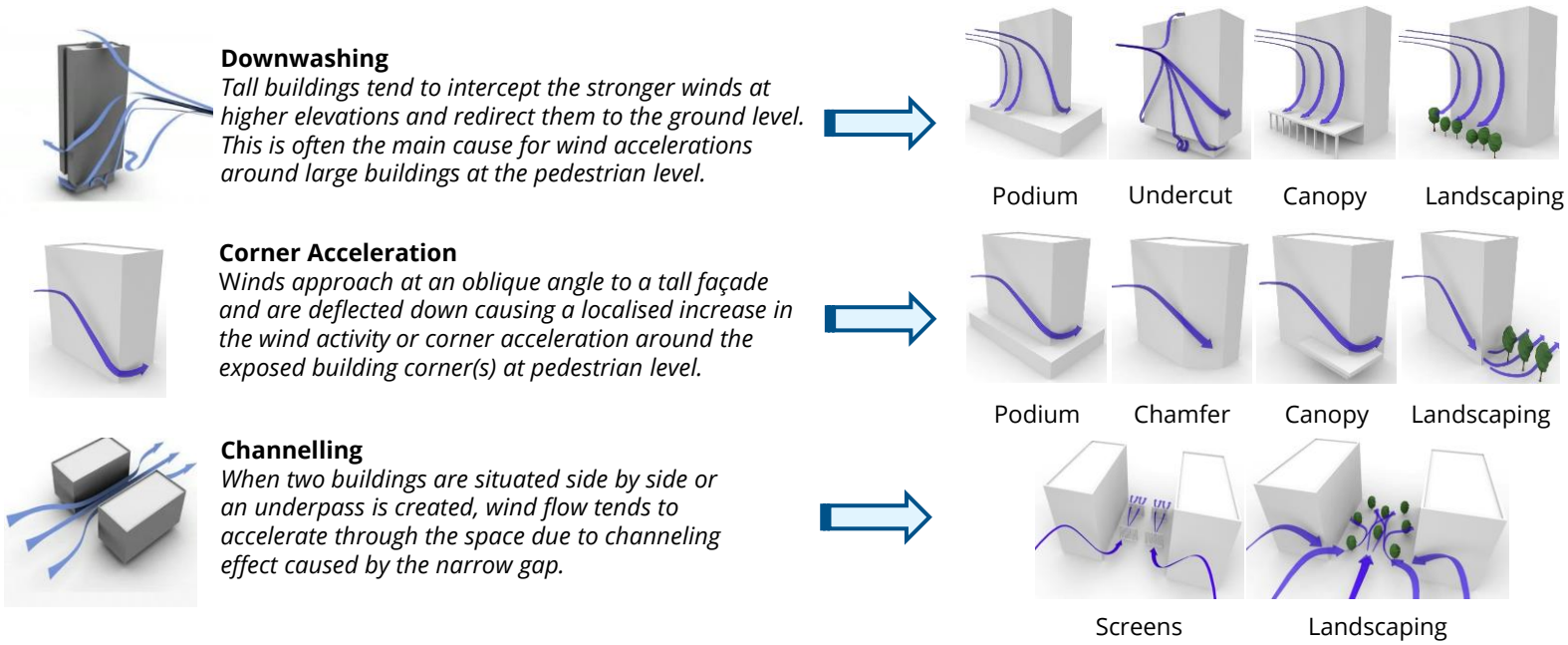


Image 5: General Wind Flow around Buildings with Examples of Common Wind Measures

4. METEOROLOGICAL DATA

Meteorological data recorded at Sydney International Airport from 2000 to 2021 (inclusive) 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 6. 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.

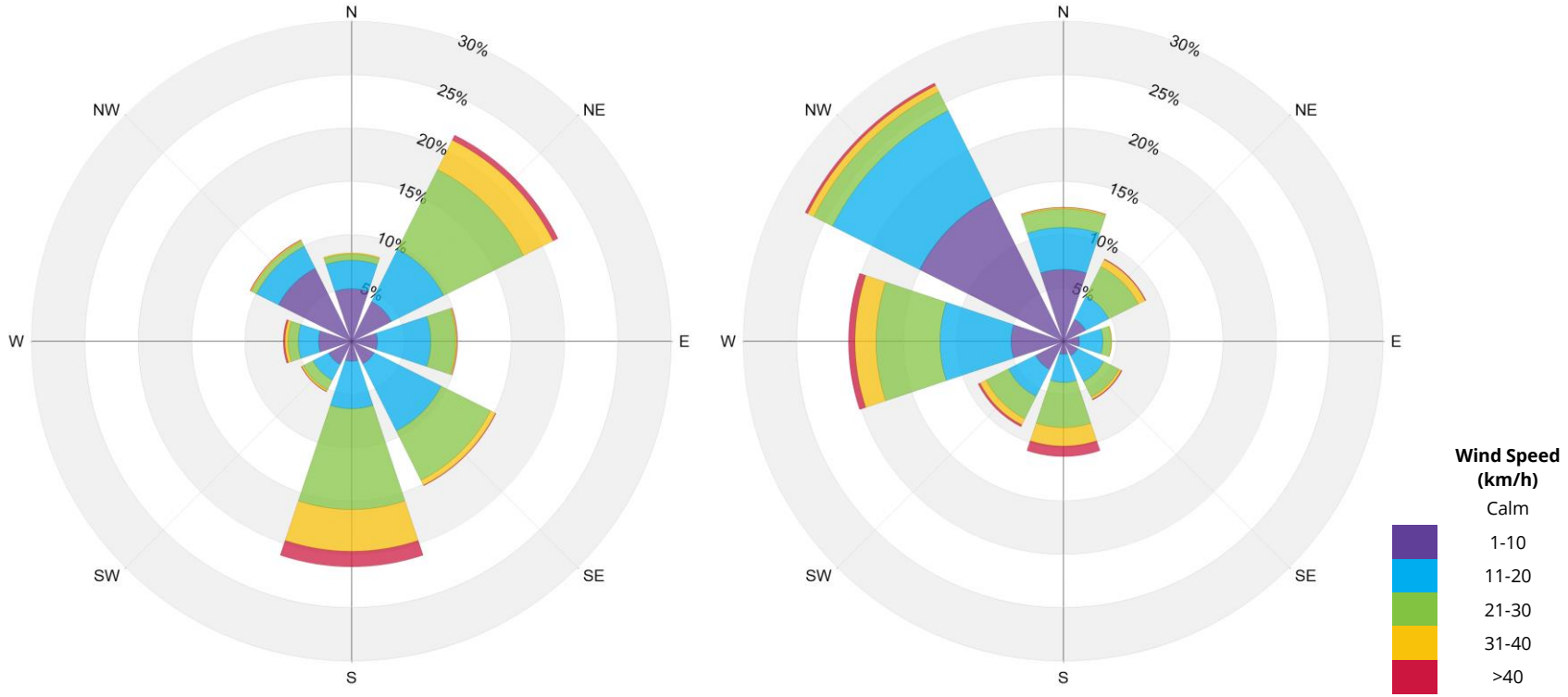


Image 6: Directional Distribution of Winds Approaching Sydney International Airport
Recorded from 2000-2021

5. PEDESTRIAN WIND CRITERIA

An abridged version of the RWDI pedestrian wind comfort criteria are used in the current study (Image 7). The wind comfort levels are categorised based on typical/intended pedestrian activity and are expressed in terms of their suitability for various levels of human activity. The categorisation is based on conservative average wind speeds; higher the activity level, higher the wind speed one can typically tolerate while engaged in the activity. These criteria for wind forces represent average wind tolerance and can be subjective with regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. also impacting and individual's perception of the wind climate.

Professional judgement incorporating RWDI's experience of a large number of similar projects both within Australia and internationally has been applied, informed by the CFD results, to identify areas within and around the Proposed Development that are likely to have instances of strong winds. Mitigation measures, in the form of landscaping and architectural elements, can be applied to improve pedestrian comfort conditions and to reduce the frequency of, or even eliminate, any strong winds. Note the wind safety conditions are assessed qualitatively using the available information from the CFD studies.

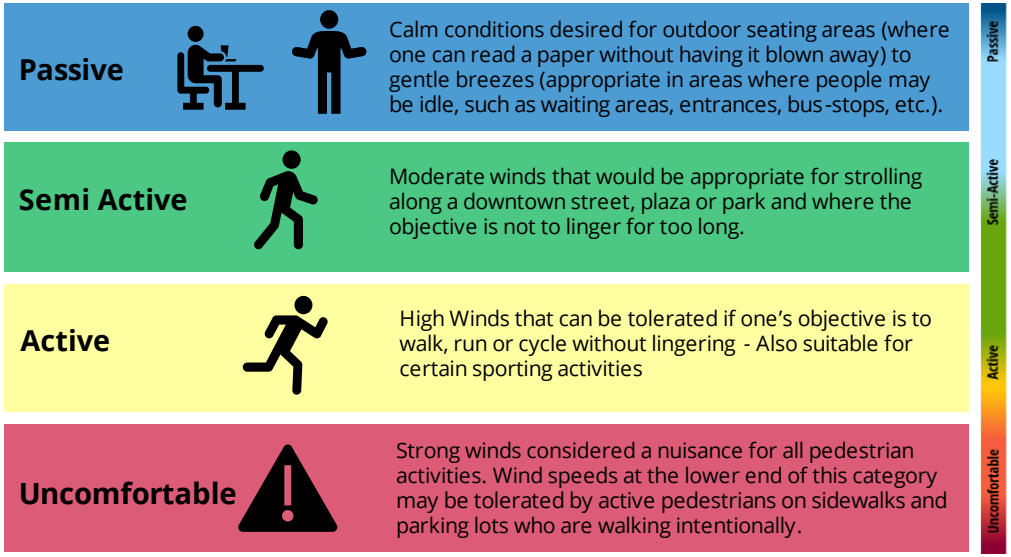


Image 7: Pedestrian Wind Comfort Criteria and Scale

6. RESULTS AND DISCUSSIONS

The following pages present the results of the pedestrian wind comfort study for the site. Pedestrian wind comfort results are presented for the averaged seasonal or annual wind conditions. The full set of results, including the statistical average wind speeds (or ventilation potential) around the sites which indicate areas that may be more stagnant/breezy, streamlines for flow visualisation, etc. can be accessed via the OrbitalStack platform at: 524-542 Pacific Highway, St Leonards | OrbitalStack

Please contact support@orbitalstack.com for further assistance to access the results.

Wind comfort results are presented as colour contours based on the criteria discussed in Section 5. The contours represent the conditions predicted at a horizontal plane approximately at 1.5 m above the local surfaces.

6.1 Ground Level and Public Domain

The predicted wind comfort conditions on the ground level around the proposed development site are presented in Images 8. The comfort contours are presented for the summer and winter seasons calculated based on an abridged RWDI criteria. Note that any instances of uncomfortable wind conditions correspond to regions where high wind activity will generally be observed consistently. Such areas might also correspond to unsafe wind conditions.

Most areas along the Pacific Highway and Nicholson Street fronts of the development are noted to be suitable for passive use throughout the year. This is primarily due to positive design elements that have been introduced strategically throughout the design process to reduce wind impacts around the site. These include elements such as the cuts within the building façade, podium articulation, the strategic placement of awnings, and the northwest corner cut creating shelter from high winds within the public domain. Wind conditions suitable for semi-active standing to strolling use are noted along Christie Street during winters which is suitable for the intended use of the space. However, the street front will likely be exposed to strong northeasterly and southerly sector winds during the summers. This is caused by the deflection of the northeast winds by the neighbouring Landmark Tower and of the southerly winds due to the proposed development, as shown in Image .

It is understood that landscaping in the form of dense trees will be incorporated at the southwest corner of the building. These are expected to significantly reduce the wind movement around the corner of the proposed building. Therefore, wind conditions along Christie Street with the inclusion of these elements are expected to be suitable for the intended active use of the space.

6. RESULTS AND DISCUSSIONS

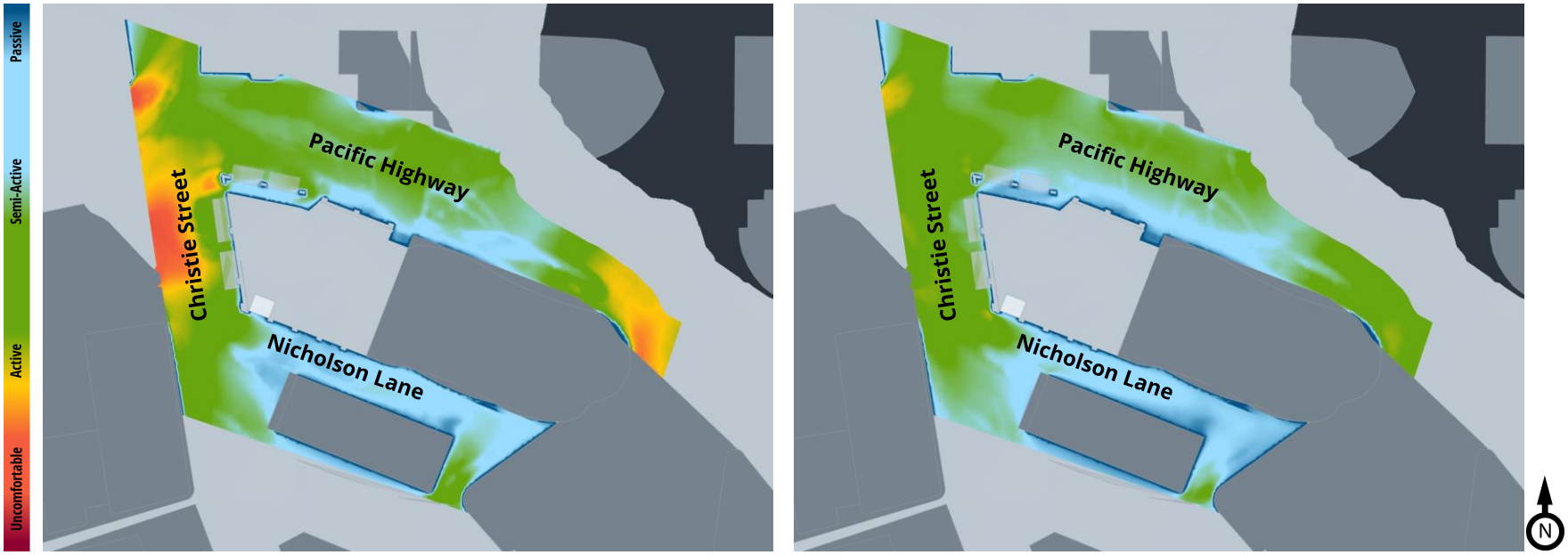
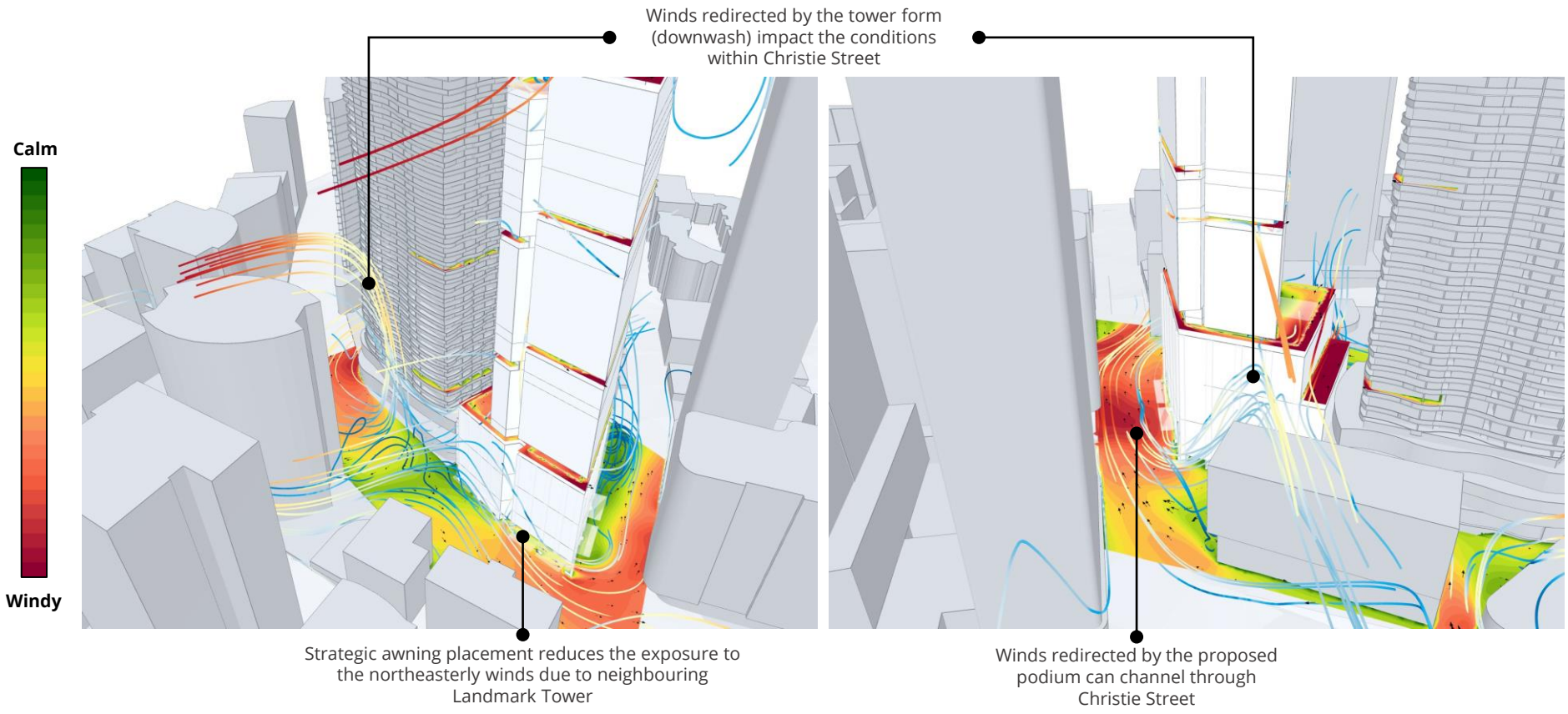


Image 8: Expected Wind Comfort Conditions on the Ground Level Areas
(Left: Summer | Right: Winter)

6. RESULTS AND DISCUSSIONS

Image 9: Interaction of Prevailing Winds
Relative Wind Intensity Indicated for the Simulated Direction
Winds from 30° sector (Left) and 180° sector (right)



Note: Relative wind speeds and contours shown here are for informational purposes only and are not representative of the overall wind conditions at the site. The wind comfort conditions are evaluated using the probability of occurrence for all wind directions.

6. RESULTS AND DISCUSSIONS

6.2 Podium and Rooftop Terraces

The expected wind comfort conditions on the podium and rooftop terraces are presented in Image 10 for the summer and winter seasons. Most upper-level areas are generally exposed to strong winds. Wind comfort levels range between semi-active use to uncomfortable.

Wind conditions within the podium terrace were generally dictated by the channelling winds moving between the proposed development and the Landmark Tower. The stepped podium design assists in breaking up these winds compared to the base scheme with the centrally located awning and perimeter screening also assisting in mitigating the overall wind impact. It is understood that the design of the terrace has since evolved further with additional canopies at the north and south ends of the podium and wind screens incorporated along the northern and southern boundaries (DA Set received in Sept 2023).

The rooftop terraces, located on Levels 36-40, are exposed to strong regional winds due to their elevation. Wind conditions are generally noted to be uncomfortable within these spaces during summers with most areas suitable for active use during winters. The design of these terraces has also evolved further, as noted in the latest DA Set (received in Sept 2023). The terraces have been pulled back from the southern edge with dense landscaping incorporated to reduce the exposure to southerly winds.

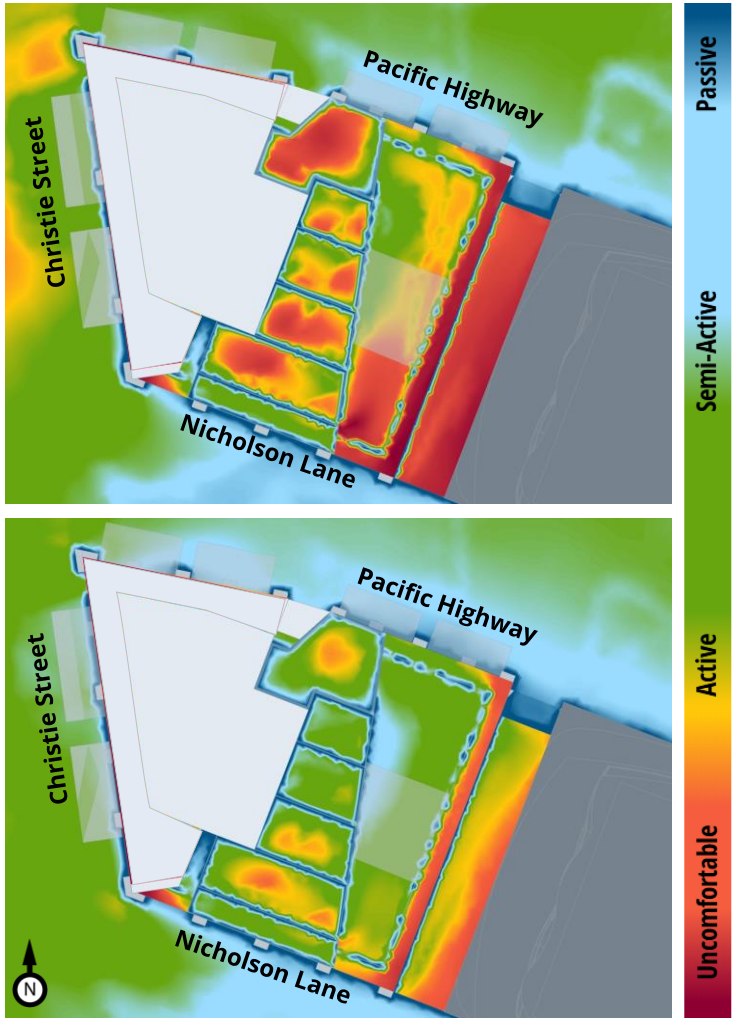


Image 10: Wind Comfort Conditions on Podium and Rooftop Terraces
(Top: Summer | Bottom: Winter)

6.3 Amenity (Levels 17, 20, 29, 32)

The predicted wind comfort conditions on the various amenity levels are presented in Images 11. The comfort contours are presented for the annual scenario. The cuts in the tower form for the amenity levels have the added benefit of reducing the impact of winds deflected by the tower form towards the ground plane. Higher wind activity is, however, expected due to the elevated exposure of these spaces. Winds can rapidly accelerate around the corners and create localised strong wind effects that can impact the comfort and safety of patrons using the spaces. The SDRP4 Scheme introduces wind screens distributed within the terrace spaces to create pockets of useable spaces, as shown in Image 11 within the terrace. The latest drawings (received in Sept 2023) show additional segmentation of the terraces that will likely further improve conditions within these spaces.

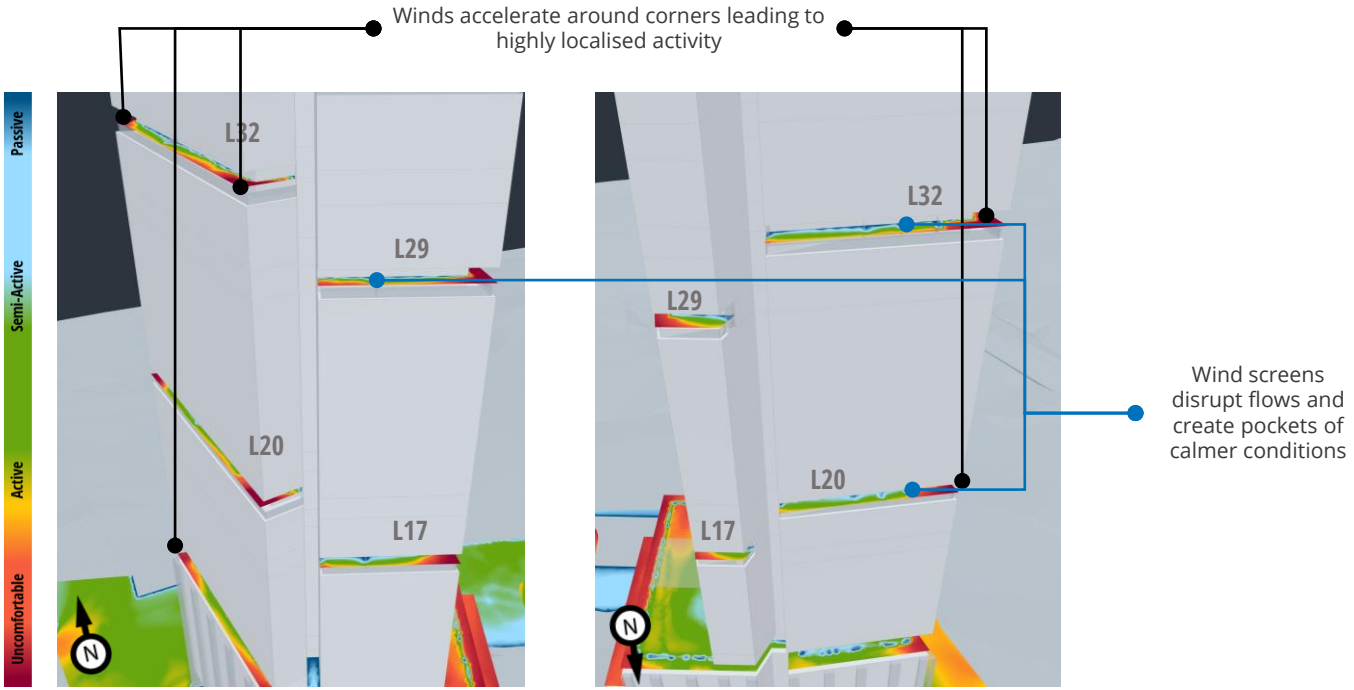


Image 11: Expected Annual Wind Comfort Conditions on the Amenity Levels

7. DESING ADVICE AND RECOMMENDATIONS

Based on the results of the CFD assessment, the following design recommendations are suggested for the proposed development site to improve wind conditions :

- Dense landscaping tends to reduce wind speeds downwind of their location to a large extent and can be used upwind of areas where reduced wind activity is desired. It is understood that the southwest corner will be planted out with a cluster of dense trees. This is likely to considerably improve wind conditions along Christie Street and should be retained.
- It is understood that the design of the podium terrace has evolved in response to this wind assessment. The terrace is now pulled back from the edges and incorporates two stand-alone canopies situated strategically to respond to both the northeasterly winds and the southerly winds. The terrace also incorporates 1800 mm screening around the perimeter. These are positive design features and are likely to considerably reduce the wind exposure within the terrace.
- The design of the amenity levels located on Levels 17, 20, 29 and 32 have also been updated. Additional partition screenings are introduced to provide buffer to the wind movement. This is useful to create more useable space within the terrace. Increasing the height of the balustrades to a minimum of 1500mm can provide direct shelter from winds. Additional screening should be considered near the corners where localised wind accelerations are observed. Alternatively, incorporating full-height porous screening around the corner edges can also assist in reducing wind exposure at the corners. Landscaping in the form of a cluster of planter boxes at the corners of the terraces are also recommended to improve wind comfort conditions further.
- The design of the rooftop terraces located between Level 36-40 has also evolved as part of this assessment. The terraces are now pulled back from the southern edge and incorporate dense landscape buffer around the perimeter. Additional canopy/trellis elements could also be considered to further reduce the likelihood of winds reattaching within these spaces. However, this is subject to further assessments to be carried out during the detailed design stages of the project.

8. SUMMARY AND LIMITATIONS

Wind conditions around the proposed development located at 524-542 Pacific Highway in St Leonards, NSW are discussed in this report. The desk-based review is based on the CFD analysis of the proposed SDRP4 massing of the tower and the existing surrounding context for the prevailing winds of the region. The DA set received in September 2023 has also been reviewed and it is noted that the overall form of the tower remains consistent. Note that additional information such as ventilation potential and contours for wind etc. can be viewed online through the OrbitalStack platform. The findings of the report should be assessed based on the limitations listed below:

1. The analysis presented was based on the historical climate conditions for the region.
2. It is noted that the conditions presented herein depict statistical conditions for certain seasons. It would be prudent to be reminded that specific seasonal trends (e.g., a heatwave) would be expected to result in ambient conditions which could create longer durations of uncomfortable conditions. For a full assessment of comfort, thermal comfort studies can be undertaken
3. The effect of climate change (i.e., forward predictions of trends in meteorological conditions) has not been considered in the analysis. However, the use of the latest meteorological information should give some indication.
4. The CFD simulations were conducted using a steady-state analysis. This means that the wind speed predictions represent an 'average' of the expected conditions within and around the development. As such, RWDI would expect the comfort conditions to be more dynamic in reality than the 'static' images presented herein.
5. Gusts are an important part of the overall wind microclimate that can impact safety, and these have not been considered in the current assessment. A more detailed assessment would be required using either a boundary-layer wind tunnel or more detailed transient computational modelling to evaluate the gust response of the development as the design evolves.

9. APPLICABILITY OF ASSESSMENT

The assessment discussed in this report pertains to the CFD simulations of the proposed development in accordance with the drawings and information received between August and September 2022. The DA set received in September 2023 has also been reviewed and commentary has been provided. 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 *'524-542 Pacific Highway Wind Microclimate Design Review',* dated 21 September 2023, was prepared by RWDI ("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 utilise 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.