IGLU UNSW
KENSINGTON, NSW

WIND DESIGN REVIEW
PROJECT # 2204899
APRIL 24, 2024

SUBMITTED TO

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DOCUMENT CONTROL

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1	Final	04/03/2024	AMC	JG
2	Section added for review of latest updates post RCC meetings	18/04/2024	AMC	JG
3	Review of Revised DA Set (removal of L3 terrace, review of rooftop terrace)	24/04/2024	AMC	JG

NOTE

RWDI

RWDI is a team of highly specialised consulting engineers and scientists working to improve the built environment through three core areas of practice: building performance, climate engineering and environmental engineering. More information is available at www.rwdi.com.

QUALITY ASSURANCE

RWDI Australia Pty Ltd operates a Quality Management System which complies with the requirements of AS/NZS ISO 9001:2015. This management system has been externally certified by SAI Global and Licence No. QEC 13457 has been issued for the following scope: The provision of consultancy services in acoustic engineering, air quality and wind engineering; and the sale, service, support and installation of acoustic monitoring and related systems and technologies.

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1. INTRODUCTION

RWDI Australia Pty Ltd (RWDI) was retained to undertake a pedestrian wind assessment of the proposed IGLU at UNSW development located at 215B Anzac Parade in Kensington, NSW. The project site is bound by Anzac Parade to the east with Day Avenue located to the south and Doncaster Avenue to the west. The National Institute of Dramatic Arts is located to the north of the site. The project encompasses five buildings with a mix of typologies, designated as Buildings A through E. A central Eat Street is planned to run through the site between Buildings A & B, offering opportunity for street activation through retail. The proposed masterplan and 3D model of the development are is shown in Images 1a & 1b, respectively.

This desk-based report discusses the potential impacts of the proposed massing of the precinct buildings 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.

Design review has also been carried out for the latest updates to the building massing (WIP Set dated 12 April 2024). These include a shift in the massing of the towers to the south, increasing the gap with the neighbouring NIDA, and a reduction in the height of Buildings A and B by 5 and 4 levels, respectively. The design review is informed by previous wind tunnel tests and CFD simulations.

Image 1a: Proposed Masterplan Site

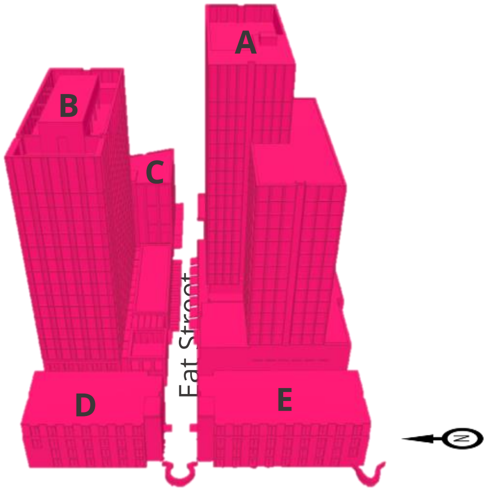


Image 1b: 3D Model of the Proposed Development

2. BACKGROUND AND METHODOLOGY

2.1 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 (Dated 14 Feb 2024).
- Review of WIP drawings received by RWDI in April 2024.
- 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.

2.2 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.

2. BACKGROUND AND METHODOLOGY

2.3 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. Simulations have been carried out for the proposed configuration of site using massing models of the various buildings within the precinct (Images 2a and 2b). 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. Landscaping and other smaller architectural and accessory features were not included in the computer model.

2.4 Methodology

Select predominant wind directions were simulated accounting for the effects of the atmospheric boundary layer and terrain impacts. 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 directly. 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 then combined with the meteorological data to determine the qualitative variation of wind speeds in the areas of concern (i.e., 1.5m above local grade). These conditions were then assessed against the wind criteria for pedestrian comfort and, the spaces were categorised accordingly.

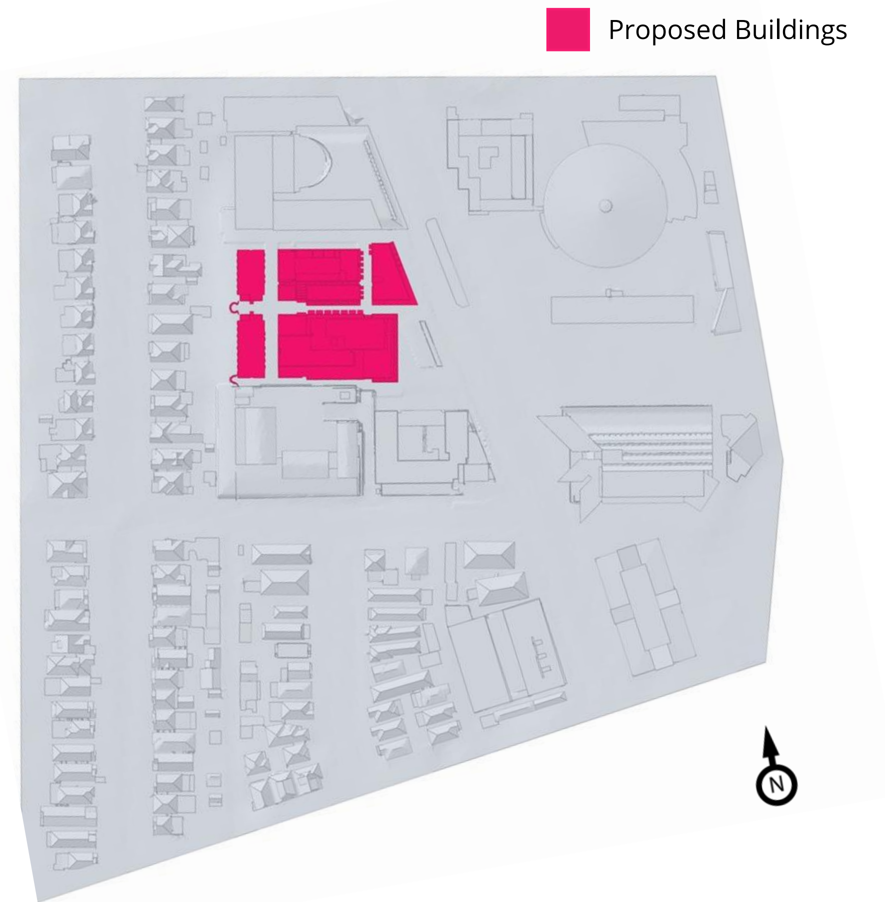


Image 2a: Computer Model of the Proposed Development and Surrounding Context
(Top-down View)

2. BACKGROUND AND METHODOLOGY

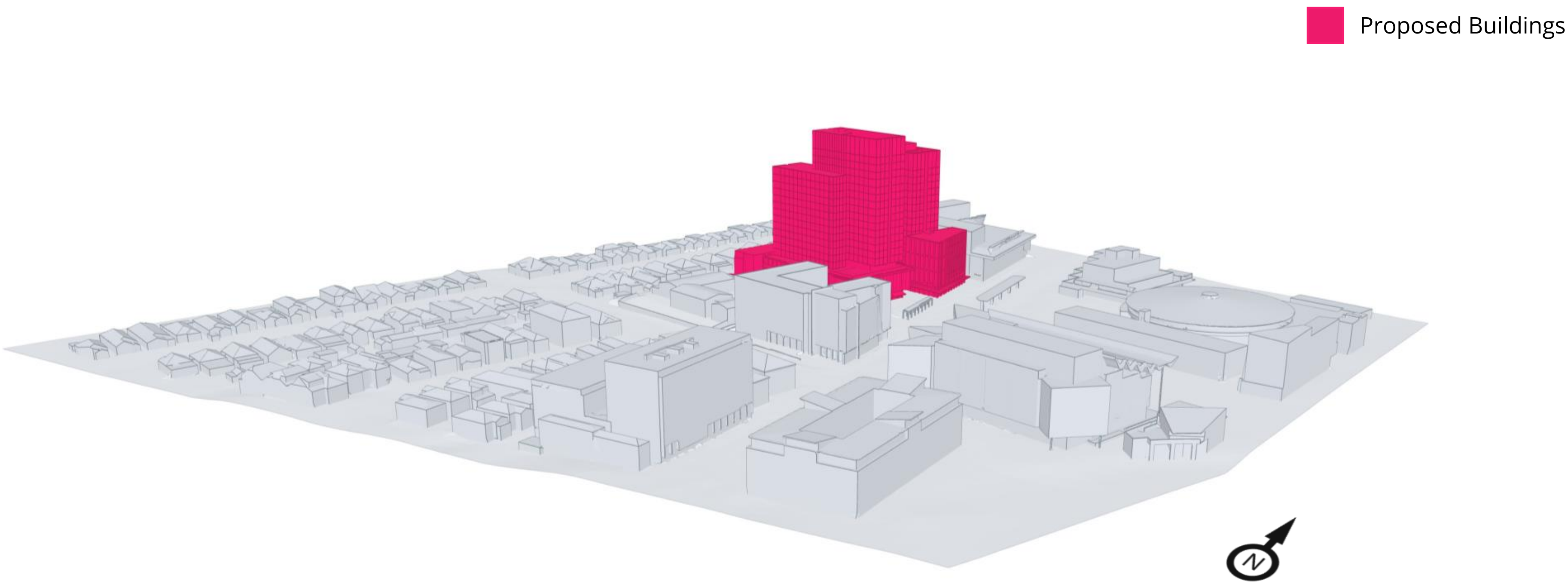


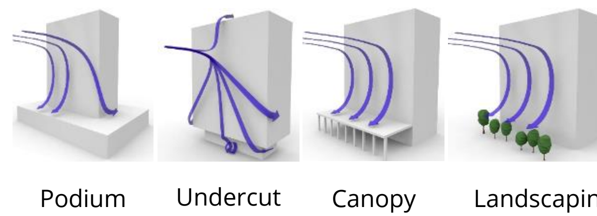
Image 2b: Computer Model of the Proposed Development and Surrounding Context
(Iso View)

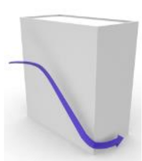
2. BACKGROUND AND METHODOLOGY

2.5 Factors Affecting Wind Flows

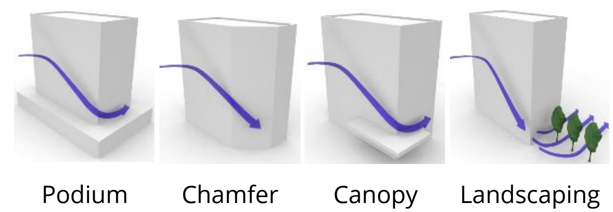
In our discussion of wind conditions in and around the proposed development, reference may be made to the following generalised wind flows (see Image 3). If these building / wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and uncomfortable or potentially 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.

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.

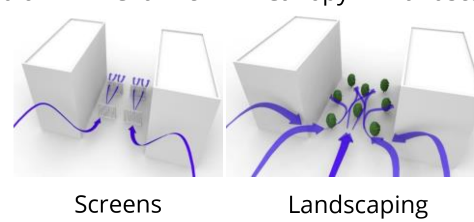
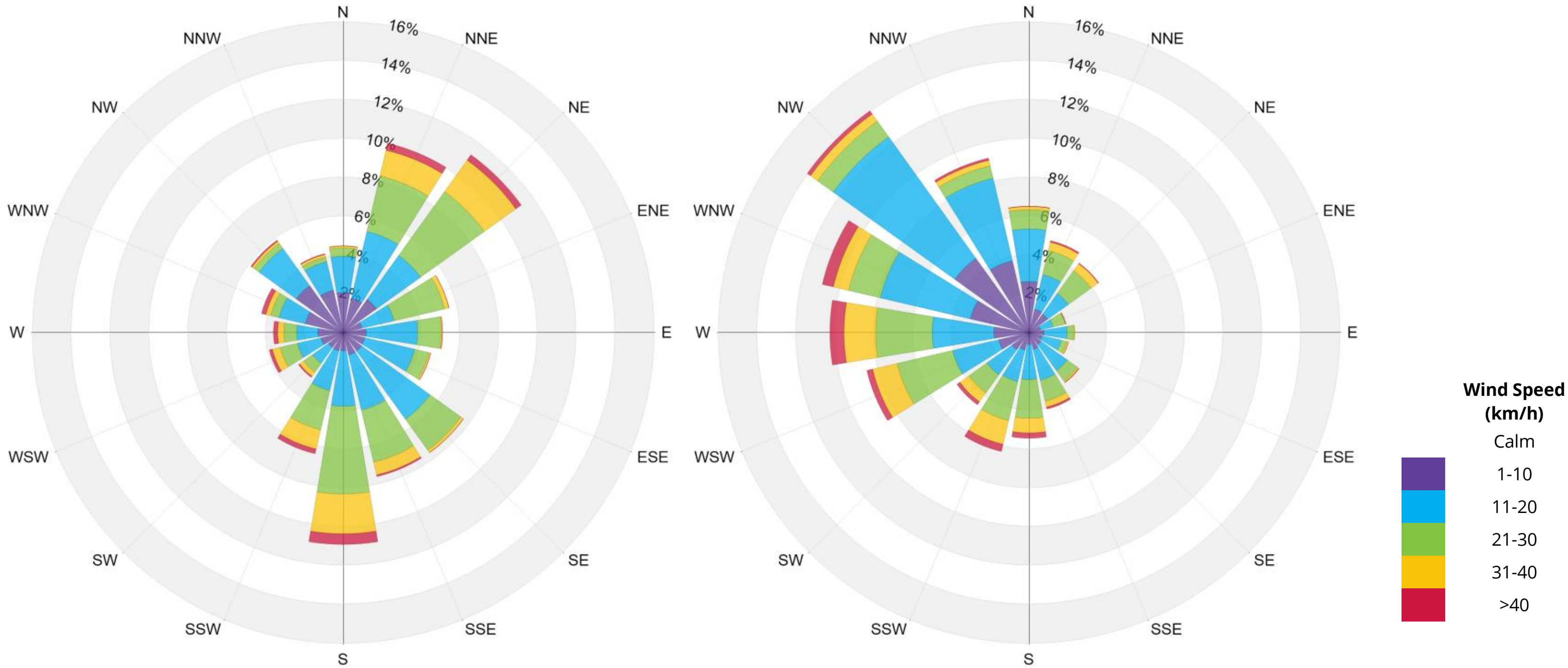


Image 3: General Wind Flow around Buildings with Examples of Common Wind Measures

3. METEOROLOGICAL DATA

Meteorological data recorded at Sydney International Airport from 2002 to 2022 (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 4, measured at the station at an anemometer height of 10m. The records indicate that winds from the northeast and the southern sectors are predominant during the summer season. Winds from the west and northwest directions are common in the winter season and can have an impact on the perceived outdoor thermal comfort of a space.



Summer (Nov - Apr)

Winter (May - Oct)

Image 4: Directional Distribution of Winds Approaching Sydney International Airport
Recorded from 2002-2022

4. PEDESTRIAN WIND CRITERIA

An abridged version of the RWDI pedestrian wind comfort criteria are used in the current study (Image 5). 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.

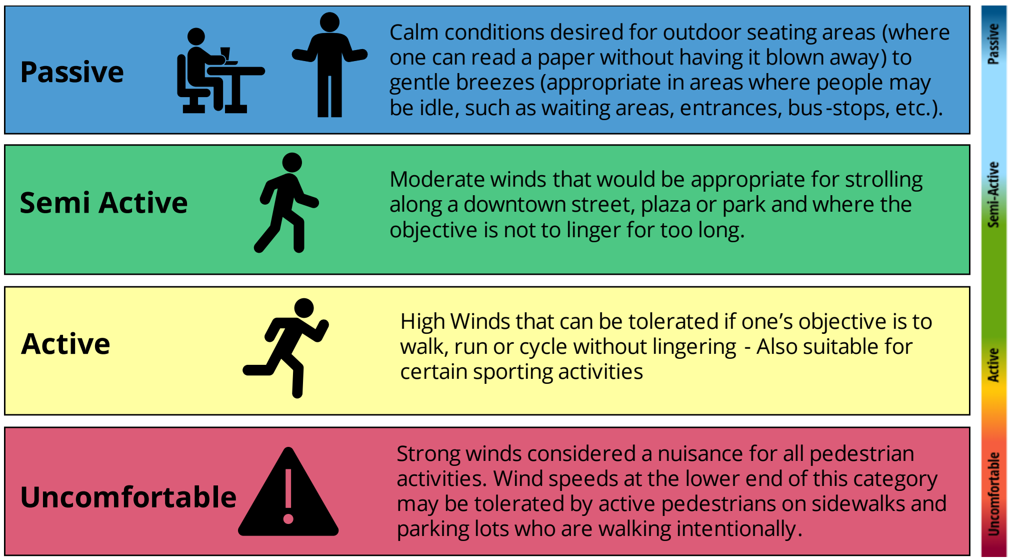


Image 5: Pedestrian Wind Comfort Criteria and Scale

5. 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: IGLU UNSW | 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 4. The contours represent the conditions predicted at a horizontal plane approximately at 1.5m above the local surfaces.

5.1 Ground Level and Public Domain

The predicted wind comfort conditions on the ground level and public domain areas around the proposed development site are presented in Images 6a and 6b for the summer and winter seasons. Note that landscaping has not been included in the current round of simulations to present a conservative estimate of the site wind conditions.

A summary of the wind comfort conditions is noted below:

- Wind comfort conditions around the majority of the precinct are noted to be comfortable for semi-active to active use throughout year. Note that these are conservative estimates of the winds considering the lack of vegetation around the site will impact outdoor comfort.
- The western sections of Eat Street, areas spanning between Buildings B & C and Buildings D and E, and the outdoor seating spaces positioned along the eastern perimeters of Buildings A and C (covered areas) are noted to be comfortable for passive use throughout the year.
- Wind conditions around entrances are expected to be comfortable for intended use. Note that the southwest entry to the ground level arcade might experience slightly windier conditions.
- Strong winds are likely to occur at the southeast corner of Building A throughout the year. This is primarily due to the channelling of southerly winds through the space after being redirected by Building A, as indicated in Images 7a to 7c.
- Wind accelerations are likely to occur at the southwest corner of Building A and the northwest corner of Building B. These winds can impact overall comfort of these space with conditions likely to be suitable for active use.
- Westerly winter winds are likely to channel between Buildings A & B and between Building A & the Postgraduate Village building (Image 7c). These winds can impact the comfort of areas situated between the various buildings.

5. RESULTS AND DISCUSSIONS

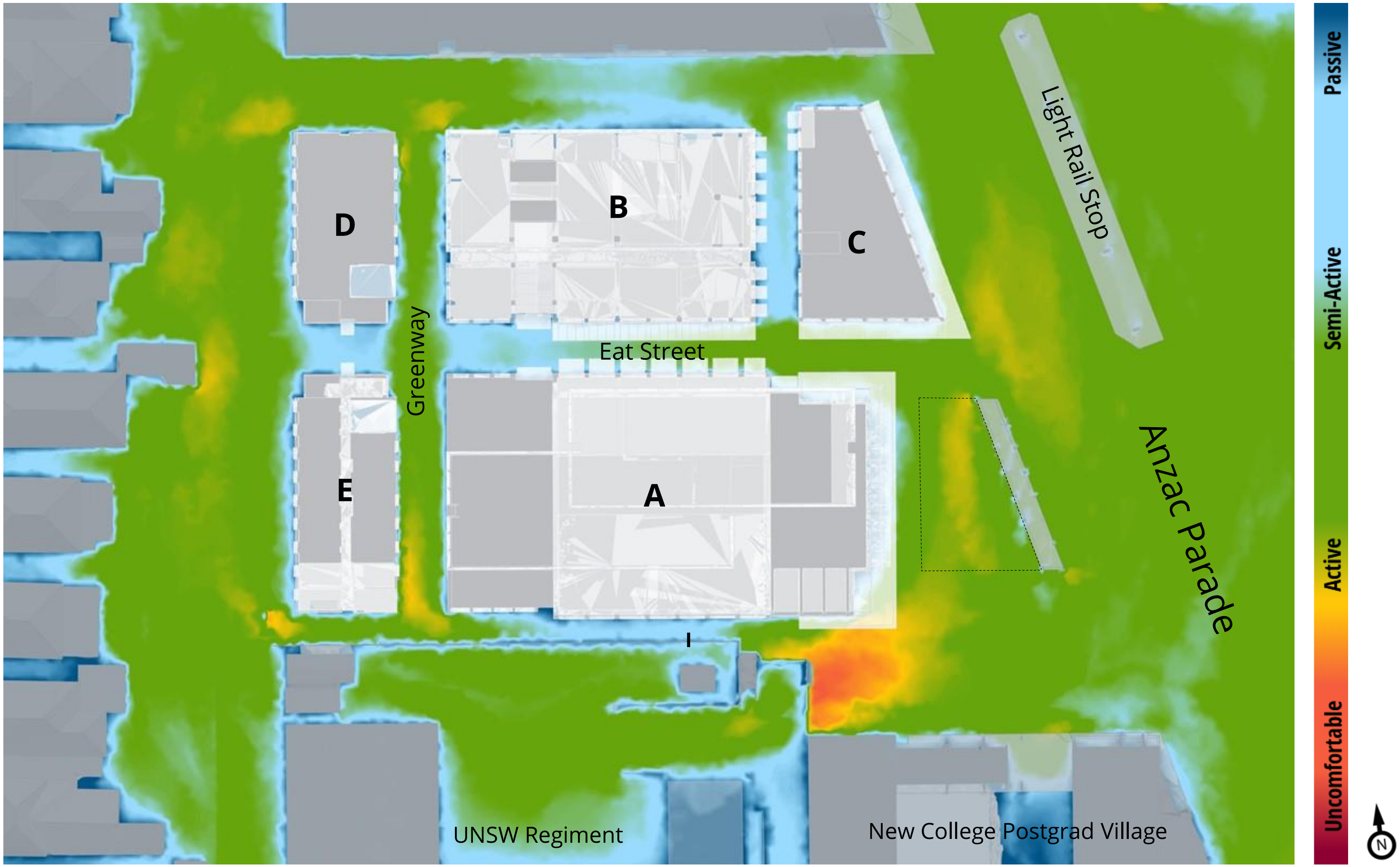


Image 6a: Expected Wind Comfort Conditions on the Ground and Public Domain during Summers

5. RESULTS AND DISCUSSIONS

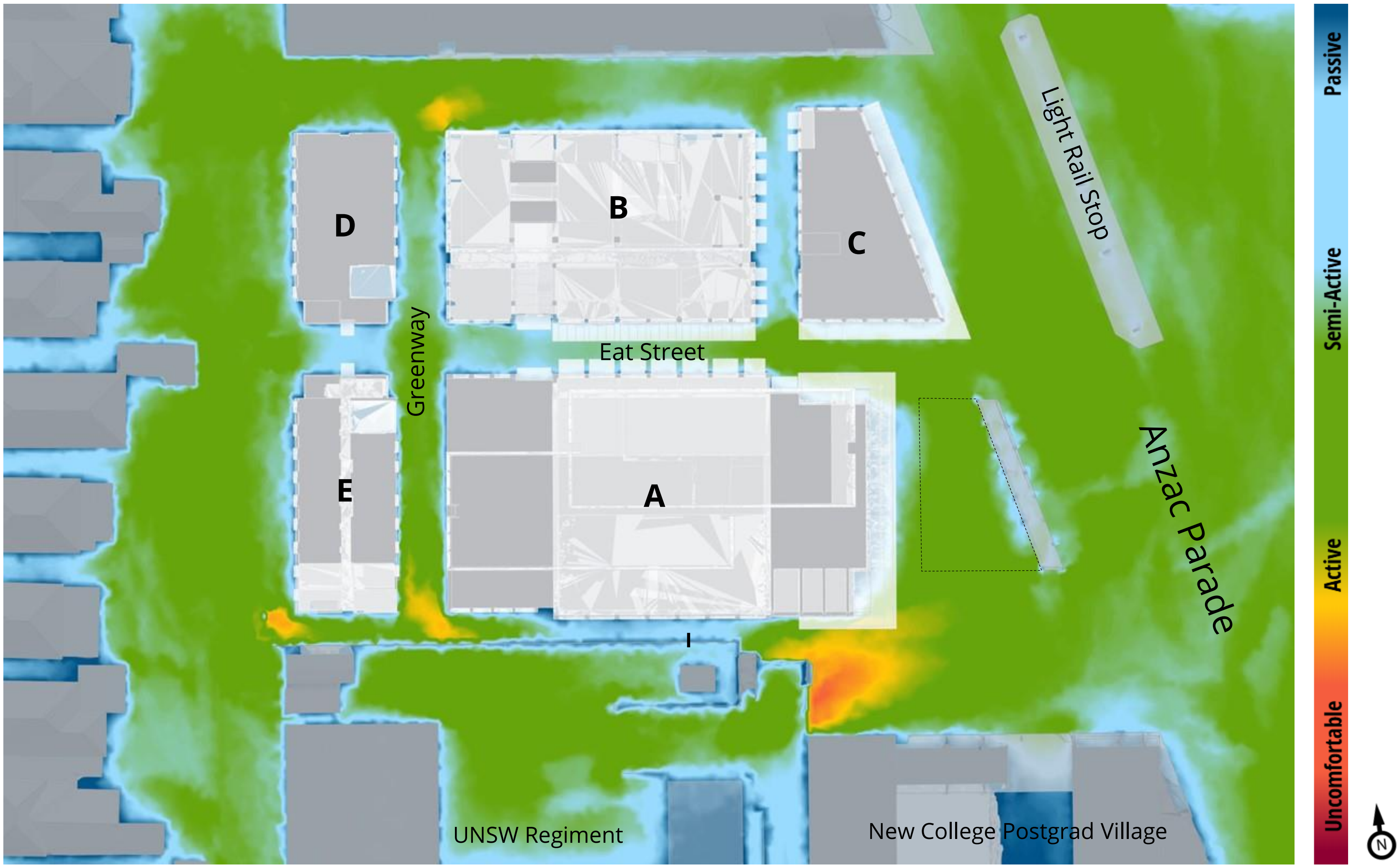
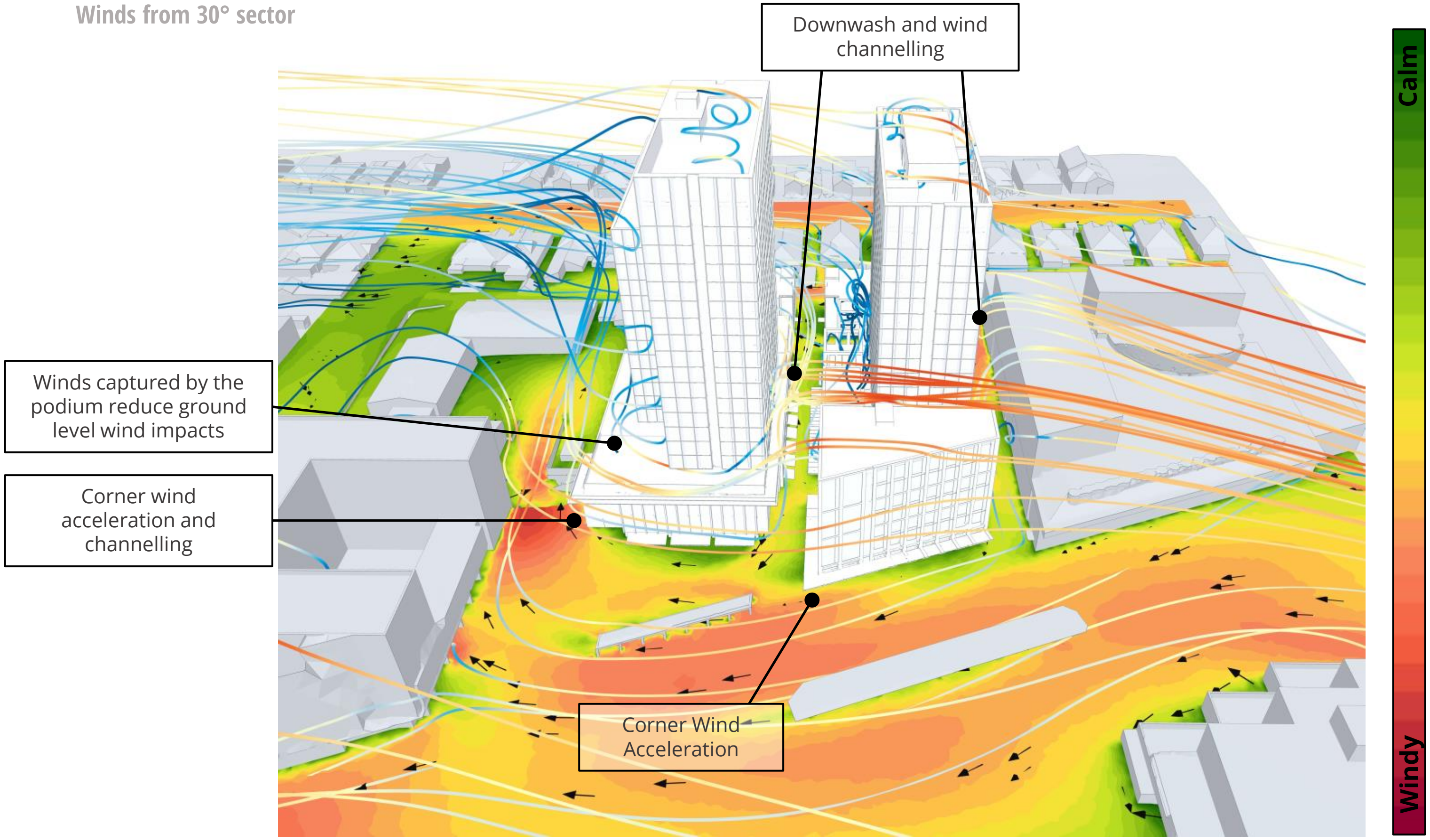


Image 6b: Expected Wind Comfort Conditions on the Ground and Public Domain during Winters

5. RESULTS AND DISCUSSIONS

Image 7a: Interaction of Prevailing Winds with Proposed Massing

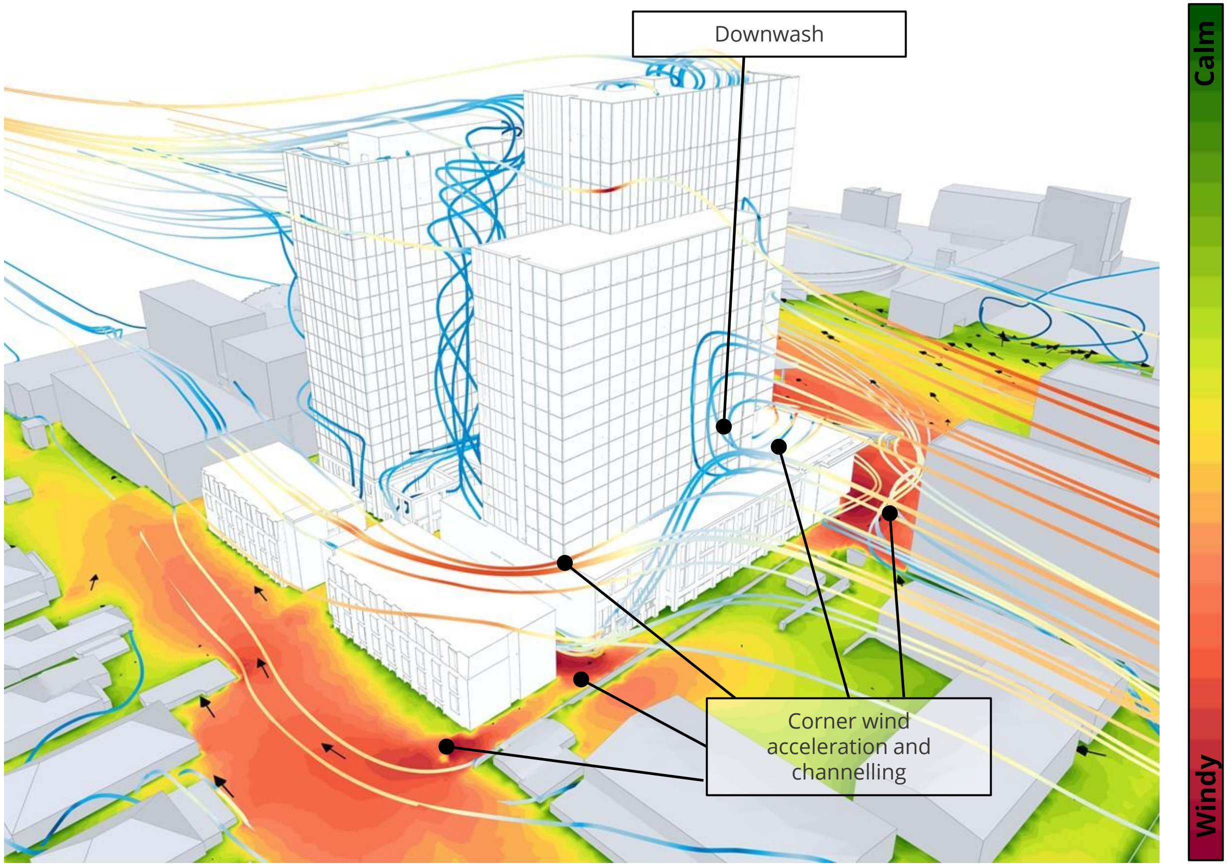
Winds from 30° sector



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 through a combined assessment for all wind directions and are shown in Images 6a and 6b.

5. RESULTS AND DISCUSSIONS

Image 7b: Interaction of Prevailing Winds with Proposed Massing
Winds from 190° sector

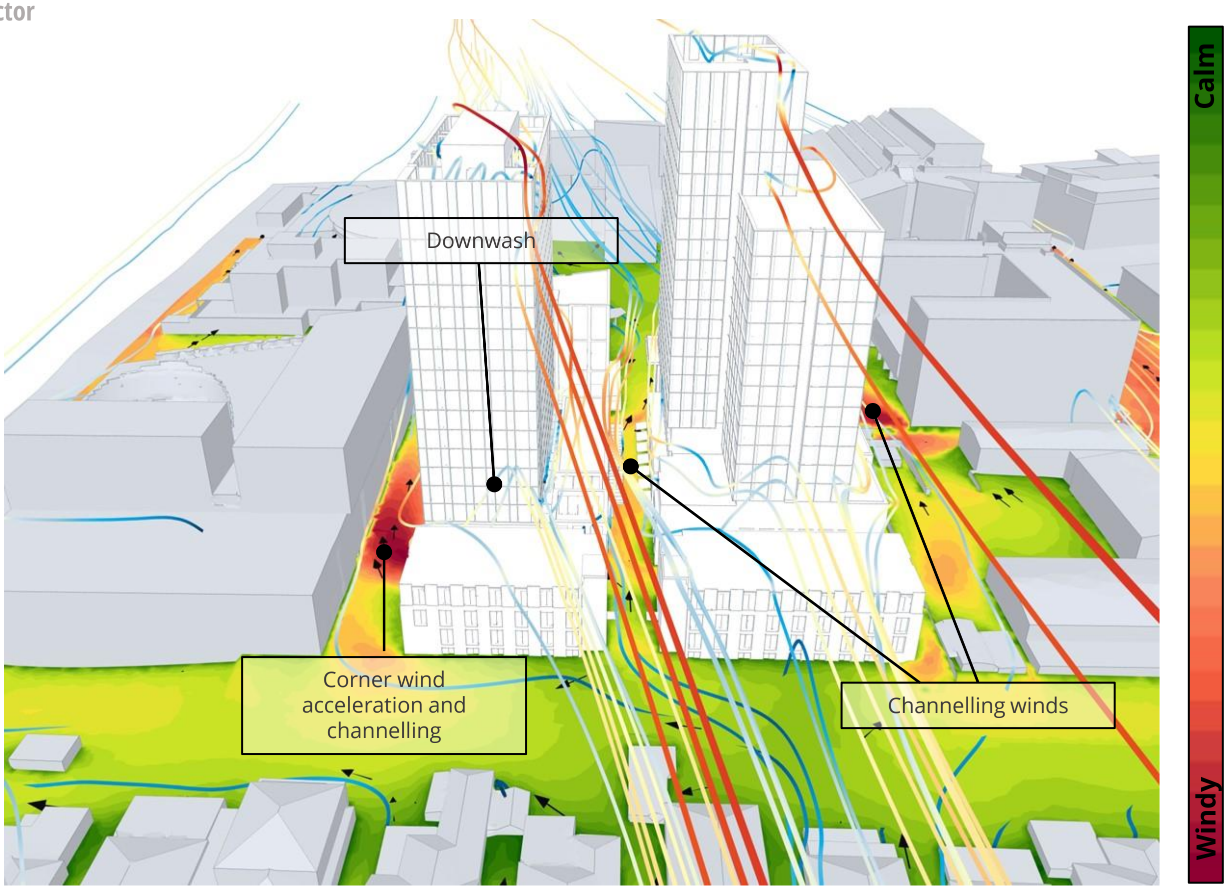


Note: Relative wind speeds and contours shown here are for informational purposes only and are not representative of the overall wind conditions at the site. The wind comfort conditions are evaluated through a combined assessment for all wind directions and are shown in Images 6a and 6b.

5. RESULTS AND DISCUSSIONS

Image 7c: Interaction of Prevailing Winds with Proposed Massing

Winds from 270° sector



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 through a combined assessment for all wind directions and are shown in Images 6a and 6b.

5. RESULTS AND DISCUSSIONS

5.2 Upper-Level Areas

The predicted annual wind comfort conditions for the upper-level communal terraces are visually presented in Image 8 using sectional views. Key observations are noted below:

- The wind conditions are expected to be comfortable for passive use within all communal open spaces on Level 01 of Buildings B and C throughout the year.
- Wind conditions are expected to be suitable for active use within most of the podium-top spaces of Buildings A and B. Note that stronger wind effects are observed around the perimeter of Building A podium roof (Level 03).
- The covered rooftop areas of Building B are observed to be comfortable for passive use throughout the year. Spaces to the north and south of the covered area are prone to wind reattachment and are, therefore, expected to be comfortable for active use.
- Wind conditions are typically severe on other rooftop spaces that are more exposed to prevailing winds.

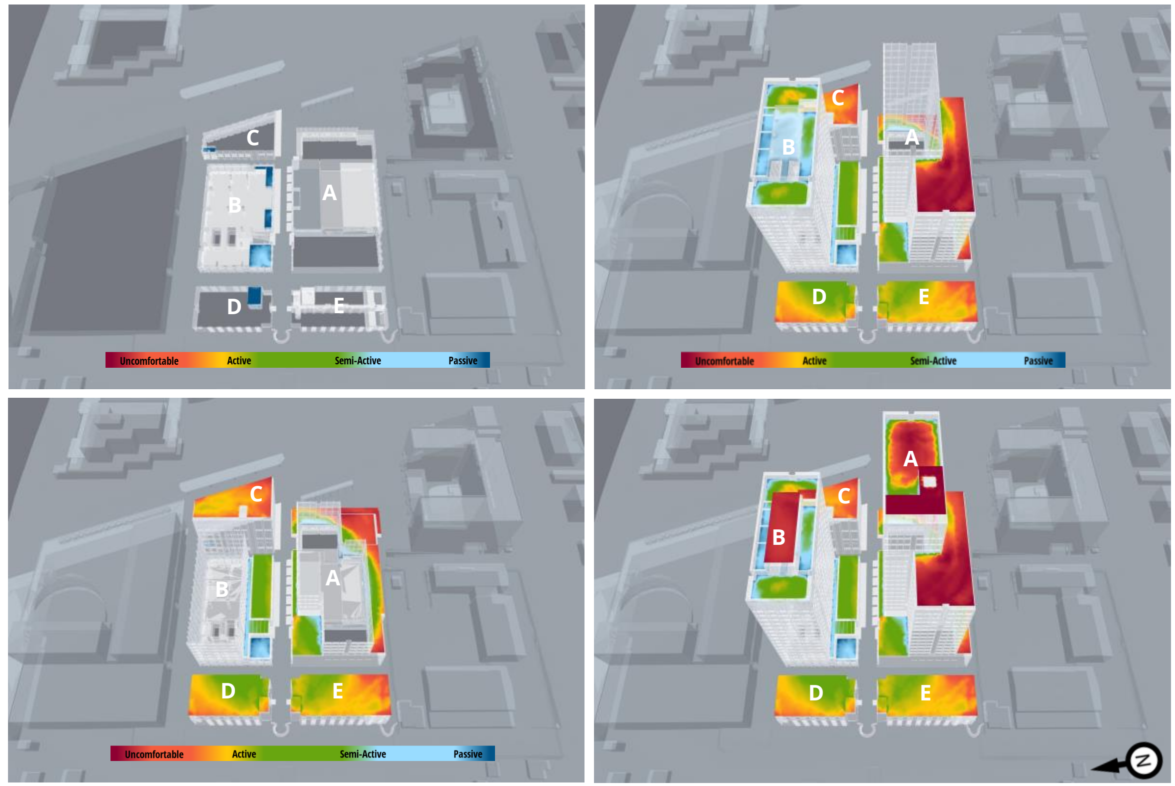


Image 8: Expected Annual Wind Comfort Conditions on Upper-Level Communal Terraces

5. RESULTS AND DISCUSSIONS

5.3 Review of Updated Drawings

RWDI has conducted an assessment of the most recent drawings submitted by Bates Smart (Revised DA - dated April 19, 2024). The overall building forms are similar to the simulated models and hence the primary wind dynamics will not change significantly. However, the following key items, indicated in Image 9, can have an impact on the local wind conditions :

- The overall height of Building A has been reduced by 5 levels which is expected to reduce the impact of downwash winds. However, the southward shift of the building diminishes the level of protection afforded by the podium to areas exposed to southerly winds while increasing the level of protection from the northeast and westerly winds. Therefore, wind conditions within the southern parts of the Greenway are likely to be impacted by the southerly winds whereas areas along Eat Street and to the southeast of the Building A are likely to improve. Overall, wind conditions along Greenway are expected to be suitable for active strolling to walking use with areas closer to the southwest corner of Building A are likely to be impacted by stronger winds leading to uncomfortable conditions. The southeast corner of Building A is likely to experience relatively similar conditions as those discussed in Section 5.1.
- Building B has undergone a reduction in height by 4 levels, accompanied by a tower massing shift above the podium. These adjustments are not expected to significantly affect overall conditions around the site, especially when considered alongside the massing shift of Building A. However, the decreased height of Building B is likely to mitigate wind channeling impacts within Eat Street. As a result, wind impacts within Eat Street are anticipated to be favorable, with larger areas expected to be suitable for passive sitting to standing use throughout the year than those indicated in Image 6a and 6b.
- The podium terrace on Level 3 of Building A has been omitted from the latest drawings. Hence, no further measures are required.
- The rooftop terrace of Building B is expected to experience less severe winds as a result of the reduction in height. Consequently, wind conditions on the rooftop terrace are likely to range from passive sitting to standing use in most areas to active strolling use depending on the presence of overhead cover.
- The rooftop terrace of Building A will likely be vulnerable to strong wind effects. These winds are caused by upwash and subsequent reattachment within the space. Overall, wind impacts are anticipated to resemble those depicted in Image 8 and are likely to be uncomfortable without mitigation measures. However, note that the simulated design does not include any overhead cover which, similar to Building B, would have provided cover to the areas and reduce the risk of reattachment .

5. RESULTS AND DISCUSSIONS

Site Plans

Sectional Views

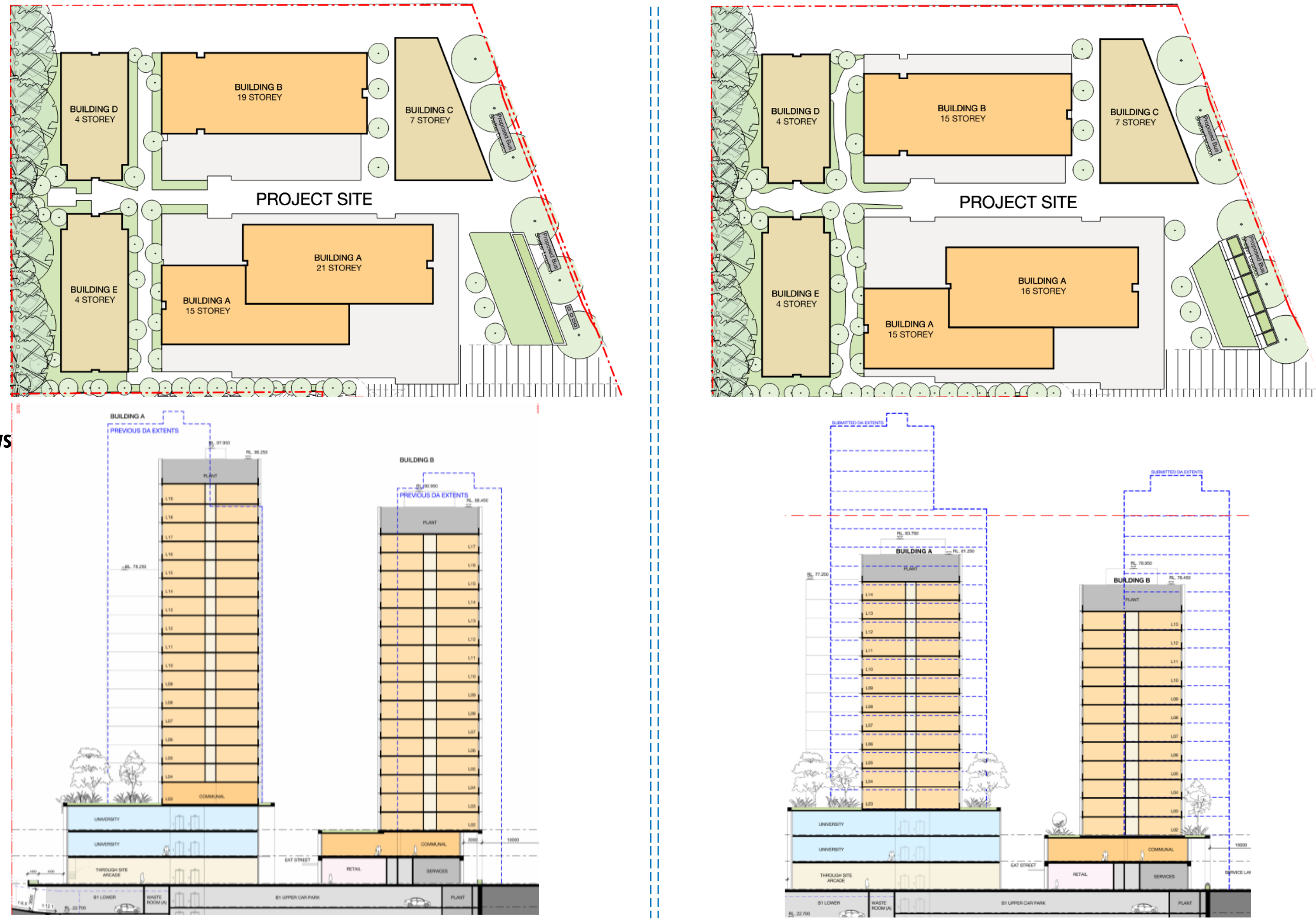


Image 9: Key Massing Changes

Left: Current Simulation Drawings| Right: Updated Drawings

6. DESING ADVICE AND RECOMMENDATIONS

Based on the anticipated wind flows around the site and review of the latest drawings, the following design recommendations and strategies for wind control can be explored to enhance the wind conditions further around the site:

- It is understood that the development site will be landscaped with numerous trees and shrubs, as depicted in Image 10. Dense landscaping tends to reduce wind speeds around and downwind of their location. Landscaping can also be evolved to reduce pedestrian movement near the corners of a building or within areas where high wind activity is expected through non-trafficable green zones (e.g., southern corners of Building A).
- The wind comfort maps provide an opportunity to refine the placement of outdoor seating spaces around the site. These should be situated in areas that are comfortable for passive use throughout the year. If outdoor seating is planned outside these areas, additional wind mitigation elements such as localised screens or planters can be employed to improve wind comfort conditions.
- It is recommended to incorporate 2-3 m tall porous vertical screens (50% porosity) between Building A and the Postgrad Village building to mitigate the impact of channelling winds. The position of the screen is indicated in Image 11.
- Landscape buffer in the form of planters is recommended to the south of the arcade entry at the southwest corner of Building A (see Image 11).
- Localised canopy / trellis cover (maximum porosity of between 30-50%) is recommended along the southern parts of Greenway to mitigate potential impacts of southerly winds due to the proposed shift in the Building A massing. The position of the canopy is noted in Image 11.
- Note that any outdoor seating areas at the base of the two buildings within Greenway will also benefit from local canopies and from localised screening (east-west aligned) to mitigate the impact of westerly winds and improve comfort for the intended use of these areas .
- The yoga terrace on Level 2 of Building A will likely benefit from an overhead canopy or trellis to reduce impact of winds redirected by the building above. This measure will assist with thermal comfort conditions during winters. However, this is not strictly necessary given the active use of the space.
- The landscape design for the rooftop terrace of Building A, as depicted in Image 10, includes an overhead cover above the proposed central areas. Additionally, seating nooks positioned closer to the edge will benefit from direct shelter provided by high perimeter screening and dense landscaping. While central areas may experience slightly higher winds due to wind reattachment, the overall conditions are likely to be comfortable for the intended active use of these space (similar to the open areas of Building B). Hence, the design is poised to create comfortable conditions conducive to the diverse array of activities envisioned for the space.

6. DESING ADVICE AND RECOMMENDATIONS

Ground Level

Building A – Level 15 Rooftop

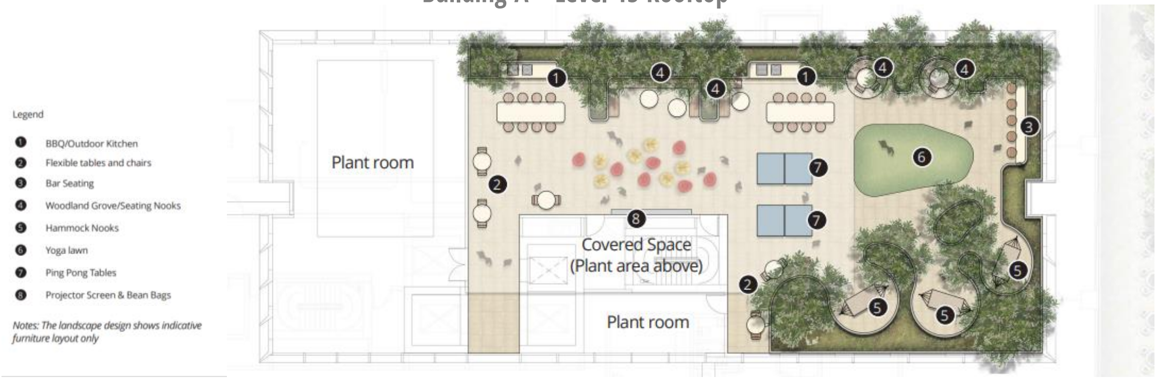
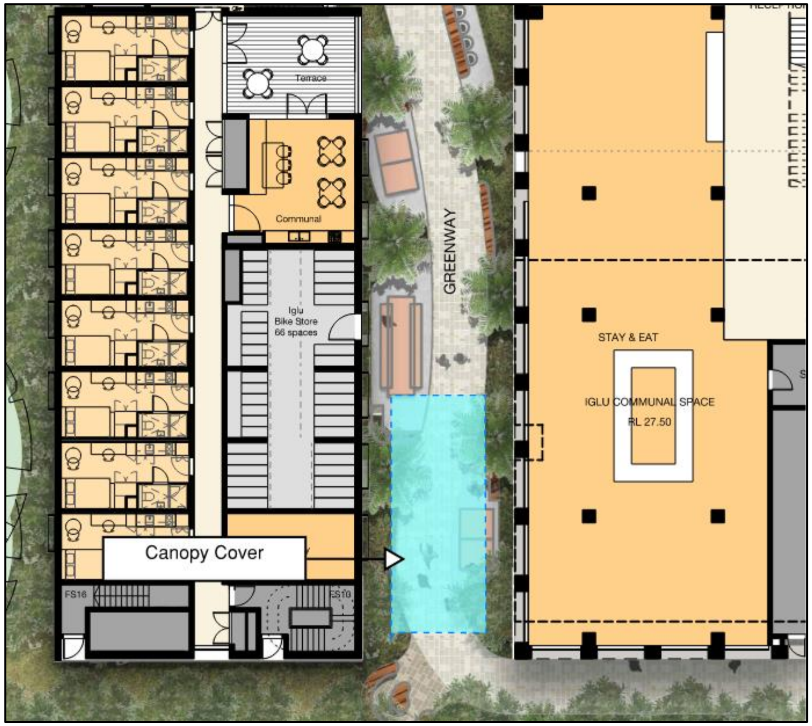


Image 10: General Landscape Layout

6. DESING ADVICE AND RECOMMENDATIONS

Southwest Corner of Building A



Southeast Corner of Building A

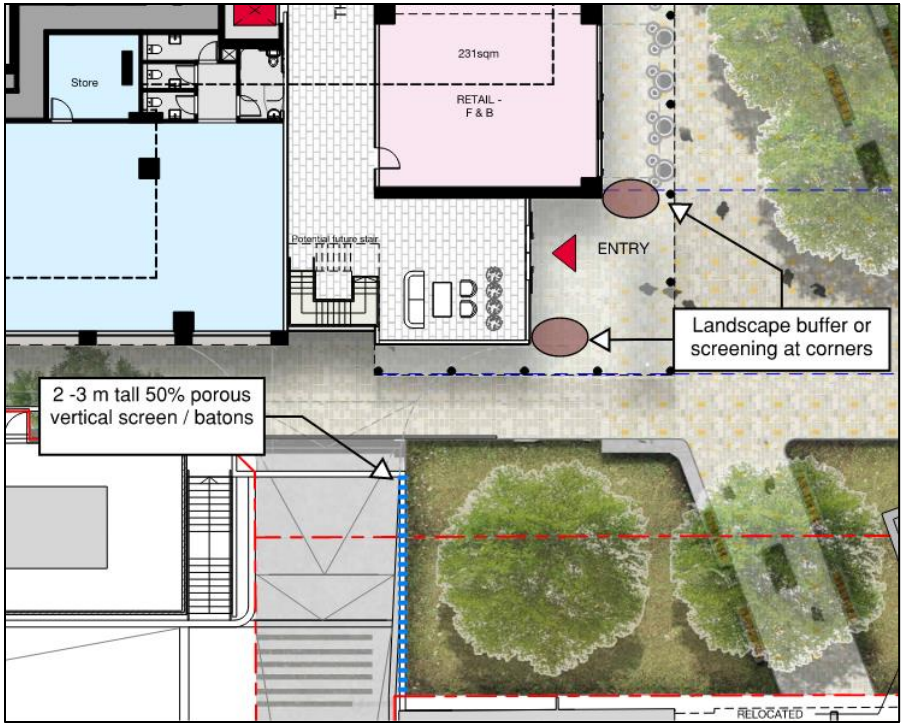


Image 11: Wind Mitigation Strategy

7. SUMMARY AND LIMITATIONS

Wind conditions around the proposed IGLU at UNSW development located at 215B Anzac Parade in Kensington, NSW are discussed in this report. The desk-based review is based on the CFD analysis of the proposed buildings within the existing surrounding context for the prevailing winds of the region. 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.

8. 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 by RWDI, dated 14 Feb 2024. The Revised DA set (dated 19 April 2024) has also been qualitatively reviewed as part of the report. 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 '*IGLU UNSW Wind Design Review*', dated 24th of April 2024, 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.