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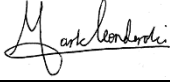

## **Wollongong Developments No.8 Pty Ltd**

**221-291 Crown Street, 216-238 Keira Street and 86-90  
Burelli Street, Wollongong**

## **Pedestrian Wind Comfort - Computational Wind Engineering**

30N-24-0405-TRP-101414-5

31 July 2025

<b>Job Title:</b>	221-291 Crown Street, 216-238 Keira Street and 86-90 Burelli Street, Wollongong		
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## Executive Summary

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (**SSD-76440958**).

The 3D model was developed based on drawings and Revit model supplied by **DKO Architects** in **February 2025**. The proposed development and surrounding buildings covering a circular area of approximately 500m radius were modelled at a full-scale. The approaching mean wind speed and turbulent intensity of Terrain Category (TC) 1 and 3 Atmospheric Boundary Layer (ABL) profiles were modelled based on Australian Standard ASNZ 1170.2:2021.

Wind speeds simulated for 16 wind directions are combined with the local wind climate to determine mean wind speed exceeded **5%** of the time for the wind comfort and gust wind speed at **once per year (0.1%)** for the wind safety.

Updated drawings (Architectural and Landscaping) were provided in **July 2025**. A comparative analysis was conducted with the finding of the Computational Wind Engineering (CWE) study are summarised as follows:

### The proposed design of the development:

- fulfils the recommended criterion for **Safety** at all interest areas;
- fulfils the recommended criterion for **Walking** at all footpath and access areas;
- fulfils the recommended criterion for **Standing** at all building entrances;
- fulfils the recommended criterion for **Walking** at the Level 3 terrace; and
- fulfils the recommended criterion for **Walking** at the Level 4 terrace.

The proposed development would not cause a significant adverse impact on the adjacent areas.

As a general statement, common to all new developments, educating occupants about wind conditions at high level terraces/balconies during high-wind events and tying down loose furniture are highly recommended.

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## 1 Introduction

This pedestrian level wind comfort report has been prepared by Vipac Engineers & Scientists on behalf of Wollongong Developments No.8 Pty Ltd ('the Applicant') supports a State Significant Development Application (SSDA) for an Infill Affordable Housing Development, SSD-76440958, for the site at 221-291 Crown Street, 216-238 Keira Street and 86-90 Burelli Street, Wollongong (the site).

Specifically, consent is sought for the following development in this SSDA:

- Demolition of existing structures on the site, retention of heritage facades, tree removal and site excavation for new basement.
- Construction of a new mixed-use development consisting of:
  - Four residential towers, ranging from 16 to 38 storeys and comprising 546 apartments including:
    - Approx. 414 market apartments.
    - Approx. 132 affordable apartments.
    - Residential lobbies and podium.
    - Communal open space.
  - A 10-storey commercial office building, an 8-storey hotel comprising 166 rooms, and numerous retail tenancies (including a supermarket) consisting of:
    - 10,009 sqm of commercial GFA.
    - 8,793 sqm of hotel GFA.
    - 3,781 sqm of retail GFA.
    - 1,510 sqm of retail supermarket GFA.
- Car, motorcycle and bicycle parking for residents, workers and visitors across two basement levels, mezzanine, lower ground and levels 1 and 2 including:
  - 774 car parking spaces, including:
    - 547 residential spaces (including accessible spaces).
    - 49 residential visitor spaces.
    - 63 commercial/retail/residential visitor spaces.
    - 25 commercial/retail (staff) spaces.
    - 10 hotel (staff only) spaces.
    - 80 retail (supermarket) spaces.
  - Five (5) loading bays.
  - 320 bicycle parking spaces.
  - 47 motorcycle parking spaces.
- New public open space including a new public plaza.
- Associated landscaping and public domain works.

The report details the analysis and results obtained from the CFD simulations of the development in February 2025. CFD simulations solves the governing equations of fluid flow for a wide range of applications. It can provide both insight and quantitative assessments to areas such as wind flow in an urban/open environment. For the proposed development located in windy locations, having data obtained from CFD enables to predict the wind conditions at any location which reduces risks that would otherwise be persist. Vipac has carried out many winds related studies using computational and experimental approaches on developments of similar shapes, size, and exposure to that of the proposed development. These serves as a valid reference for the prediction and analysis of wind effects.

The simulations were carried out for 16 wind directions using a full-scale model of the proposed development, surroundings, and variable topography surface. Some pictures of the CFD modelling are shown in Figure 5 to Figure 9. In the analysis, only the proposed development with the existing surroundings were modelled in the CFD simulations.

Drawings of the proposed development were supplied to Vipac by **DKO Architects** in **February 2025**. Updated plans were provided in **July 2025**. A list of drawings supplied is provided in Appendix B of this report.

## **1.1 Site Description**

The site is situated at 221-291 Crown Street, 216-238 Keira Street and 86-90 Burelli Street, Wollongong, within the Wollongong Local Government Area (LGA).

The site forms part of the Wollongong City Centre Precinct, as identified in the Wollongong Local Environmental Plan 2009 (WLEP). It is well located, being approximately 280m from Wollongong Train Station which provides services within Wollongong and to the Sydney CBD. It is adjacent to Wollongong Central shopping centre, a major regional retail hub. The site has ample access to public open space being less than 50m from MacCabe Park.

The site comprises a significant landholding of approximately 13,088m<sup>2</sup> with frontages to Crown Street, Keira Street, Burelli Street and Atchison Street. The site is owned by Wollongong Developments No.8 Pty Ltd.

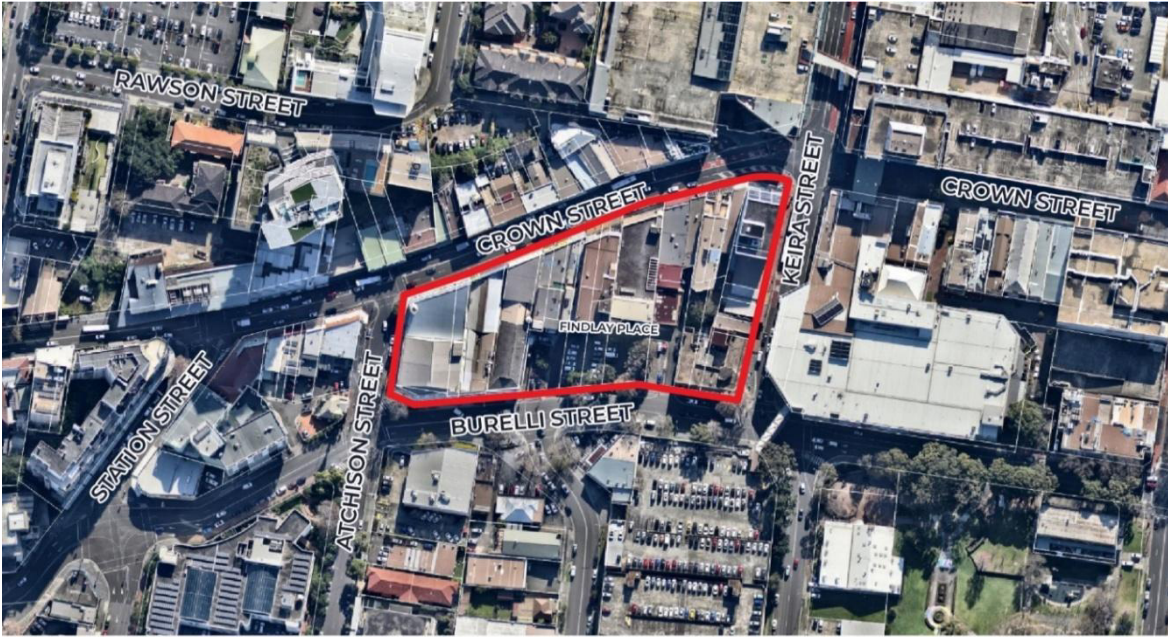
An aerial of the site is shown in Figure 1.


A section view of the proposed development, and the ground level plan of the proposed development are shown in Figure 2, and Figure 3, respectively. Assumed terrain categories for wind speed estimation are shown in Figure 4.

The site area and legal description is recorded in Table 1.

*Table 1: Site Description*

Legal Description	Address
Lot 1 in DP 112417	216-222 Keira Street
Lot 100 in DP 774957	226-230 Keira Street
Lot 9 in DP 551157	232-234 Keira Street
Lot 8 in DP 546125	236-238 Keira Street
Lot 1 in DP 88455	86 Burelli Street
Lot 4 in DP 17979	
Lot 5 in DP 17979	
Lot B in DP 395330	90 Burelli Street
Lot 1 in DP 220513	221-229 Crown Street
Lot 3 in DP 17979	231 Crown Street
Lot 2 in DP 17979	233-235 Crown Street
Lot 1 in DP 17979	
Lot 7 in DP 878243	237-241 Crown Street
Lot 1 in DP 1135333	243-251 Crown Street
Lot 1 in DP 226374	253-259 Crown Street
Lot 1 in DP 183348	
Lot 2 in DP 226374	
Lot 3 in DP 319452	261 Crown Street
Lot 2 in DP 319452	269-271 Crown Street
Lot 1 in DP 319452	
Lot 2 in DP 181570	273-279 Crown Street
Lot 1 in DP 1116034	
Lot 1 in DP 82673	281-291 Crown Street
Lot 1 in DP 117019	
Lot 1 in DP 927806	281-291 Burelli Street
Lot 1 in DP 1198873	
Lot 1 in DP 1087986	



 The Site

 NOT TO SCALE

Figure 1: Site aerial.

Source: Nearmap, edits by Ethos Urban

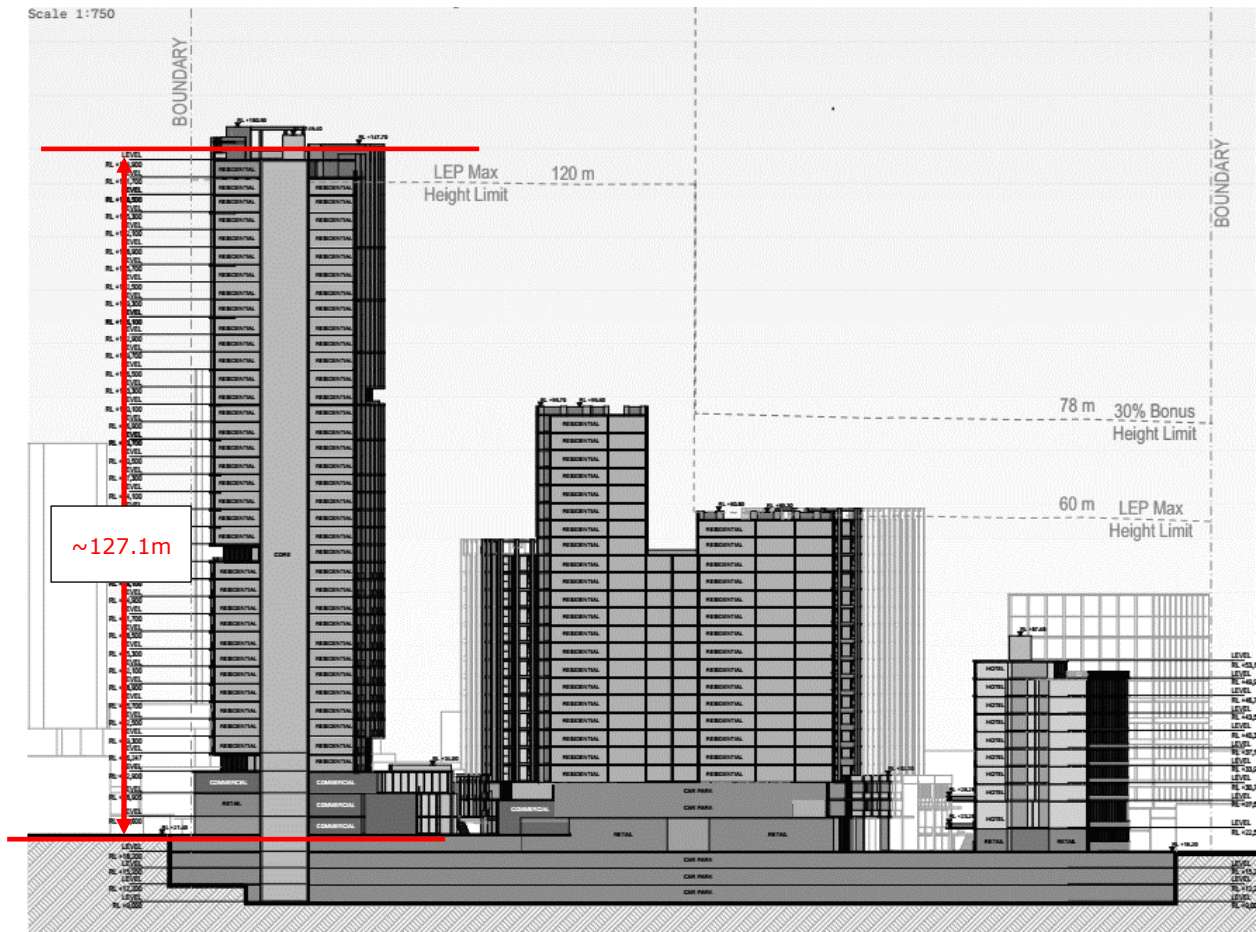


Figure 2: Section view of the proposed development (Feb 2025).

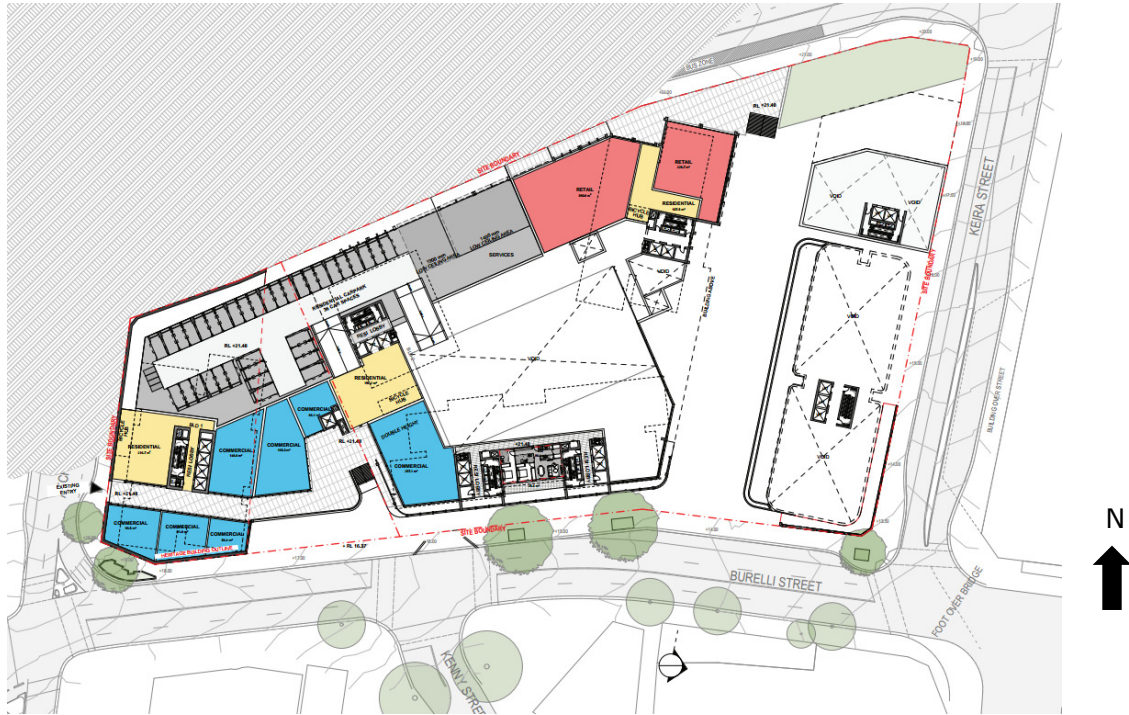


Figure 3: Ground Level Plan of the proposed development (Feb 2025).

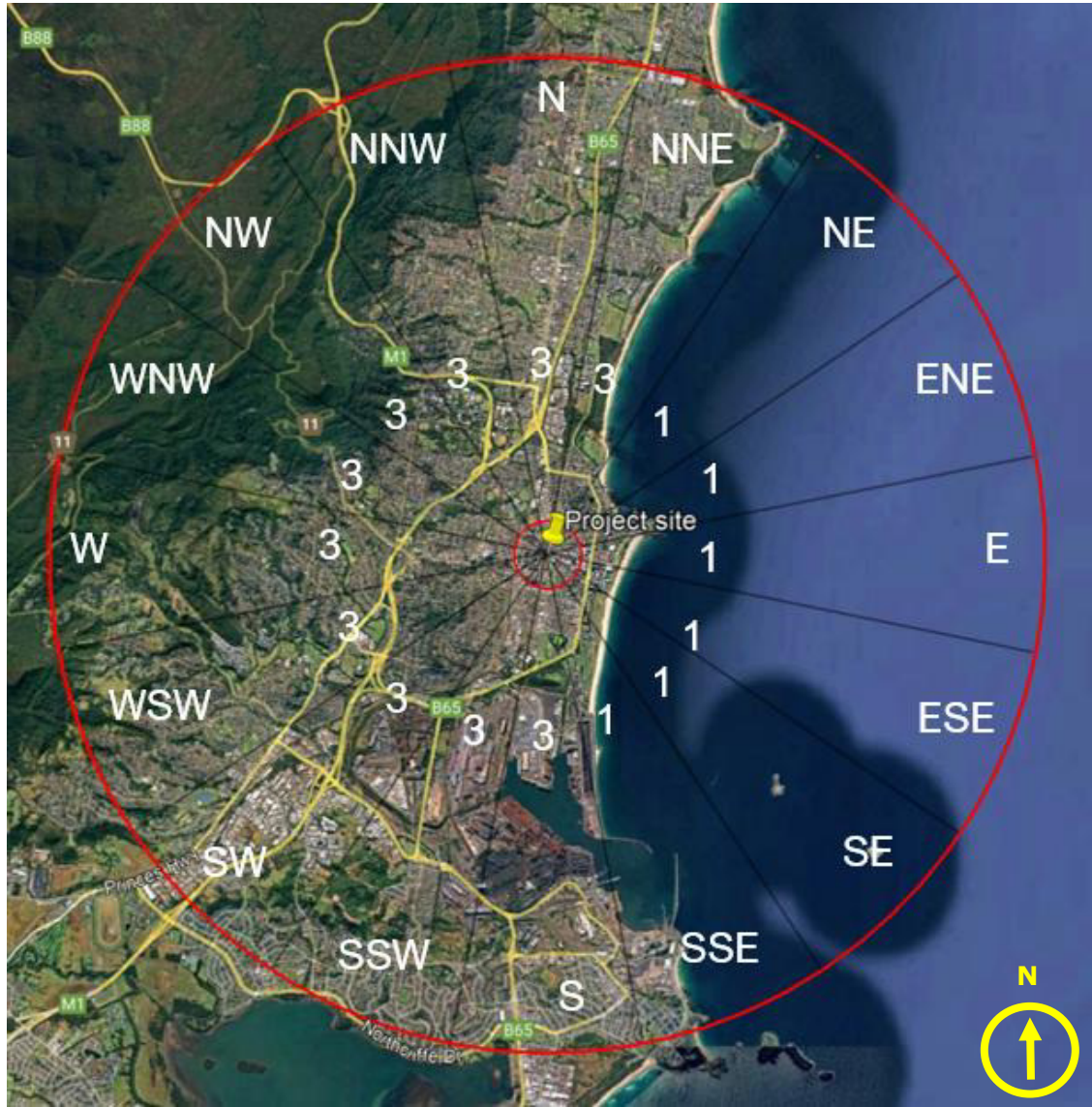


Figure 4: Assumed terrain categories (TC) for wind speed estimation.

## 1.2 Background

An existing consent approved on 12 December 2022 (DA-2021/957) applies to the site. The consent was granted for the demolition of existing structures, retention of heritage facades, tree removal, excavation for basement car parking and construction of a mixed-use development at the street block bound by Crown, Keira, Burelli and Atchison Streets, comprising three (3) residential towers (shop top housing), one (1) commercial building, retail shops, entertainment facilities (cinema, exhibition/performance space) and a wellness centre (pool, gym, and health services).

## 1.3 Secretary’s Environmental Assessment Requirements

This report has been prepared to respond to the Secretary’s Environmental Assessment Requirements (SEARS) dated 8 October 2024 for SSD-76440958. Specifically, this report has been prepared to respond to those SEARS summarised in the table below.

*Table 2: SEARs requirements.*

Environmental Amenity	Response
<p><b>Environmental Amenity</b></p> <ul style="list-style-type: none"> <li>• Address how good internal and external environmental amenity is achieved, including access to natural daylight and ventilation, pedestrian movement throughout the site, access to landscape and outdoor spaces.</li> <li>• 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.</li> <li>• Provide a solar access analysis of the overshadowing impacts of the development within the site, on surrounding properties and public spaces (during summer and winter solstice and spring and autumn equinox) at hourly intervals between 9am and 3pm, comparing the proposed development, existing situation and a development with no bonuses applied.</li> </ul>	<p>Pedestrian Wind Comfort.</p> <p>Refer to Full Report.</p>

## 2 Computational Wind Engineering

The assessment was undertaken through Computational Wind Engineering (CWE) which used Computational Fluid Dynamics (CFD) techniques to model a 'virtual wind tunnel' and simulate wind conditions around the project site.

The main objective of the CWE simulations was to reproduce the macro level wind flow around the proposed development. The wind approaching the modelled area were simulated for 16 wind directions (starting 0°, at 22.5° increments around the compass), accounting for the effects of the Atmospheric Boundary Layer (ABL) and terrain influence. Simulated wind data were obtained in the form of ratios of wind speeds at approximately 1.5m above the concerned levels, to the mean wind speed at the building height (**Zref = 127 m**). The data was then combined with meteorological records obtained from the Wollongong weather station (Annual wind climate) to determine the wind speeds and frequencies in the simulated areas.

### 2.1 Assumptions and Limitations

Gust wind speeds are infrequent but deserve special attention due their potential impact on pedestrian wind safety concerns. The computational modelling method used in the current assessment does not quantify the transient behaviour of the winds, including wind gusts. Instead, to calculate the gust wind speeds from the steady state simulations, we used the following equations to convert the mean wind speeds into gust wind speeds [6,7]:

$$\sigma = \sqrt{\frac{2}{3} \times \text{Turbulent Kinetic Energy}_{CFD}} \quad (\text{eqn. 1})$$

$$U_{Gust} = U_{CFD,mag} + g\sigma \quad [g = \text{Peak factor}] \quad (\text{eqn. 2})$$

$$TI_{\text{Turbulent Intensity}} = \frac{\sigma}{U_{CFD,mag}} \quad (\text{eqn. 3})$$

Trees, natural vegetation, and planter boxes were not included in this analysis as their effectiveness is dependent on wind speeds and may not be accepted as wind control measures by authorities in general. Thus, results presented in this CWE report represent a worst-case scenario. Furthermore, the results presented in this report are valid only under the modelling conditions stated in the document. Any variations to the current design will render the conclusions of the report invalid.

## 3 Computational Fluid Dynamics Methodology

### 3.1 Modelling the geometry

To determine the expected wind conditions around the proposed development, a full-scale 3D model was developed based on the drawings supplied by **DKO Architects** in **February 2025**, as well as the data on the surrounding buildings and variable topography surface.

The wind flow around the proposed development was modelled using commercial CFD software package. Figure 5 to Figure 7 shows the computational fluid enclosure and coordinate system used for this study. The proposed development and surroundings were modelled at a full-scale. The computational enclosure was 2.0km in X direction, 2.0km in Y direction, and 1km in Z direction. The large computational domain ensured that the blockage ratio of the CFD model was less than 5%. It could also ensure that the fluid enclosure boundaries sufficiently far away from the project site and surrounding buildings to have negligible effects on the wind flow in the area of interest.

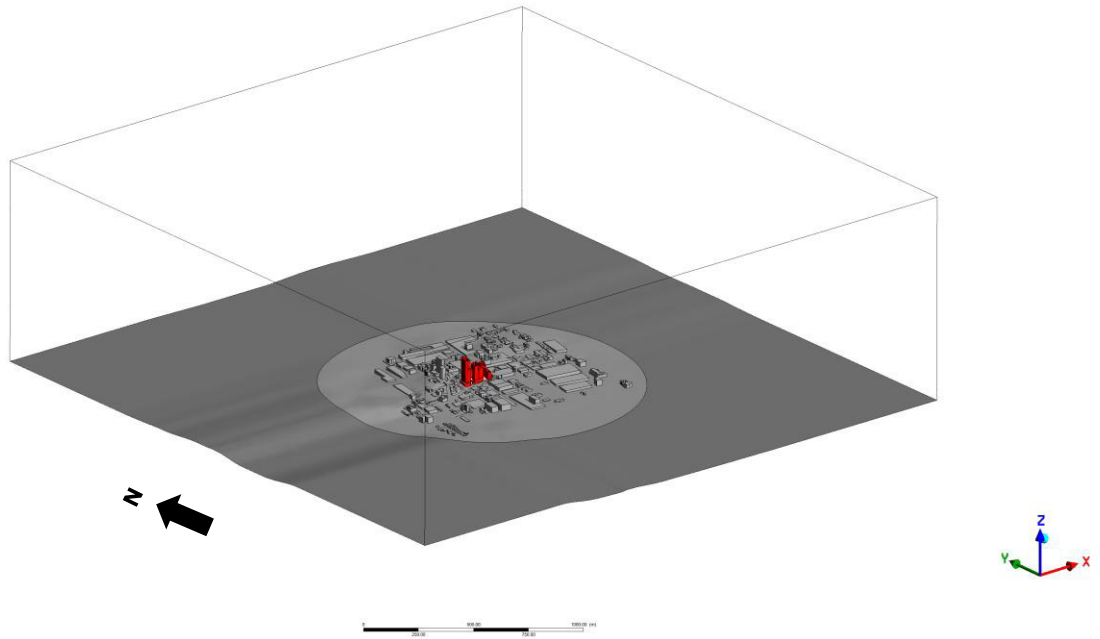


Figure 5: CFD model geometry - full computational enclosure (Feb 2025).

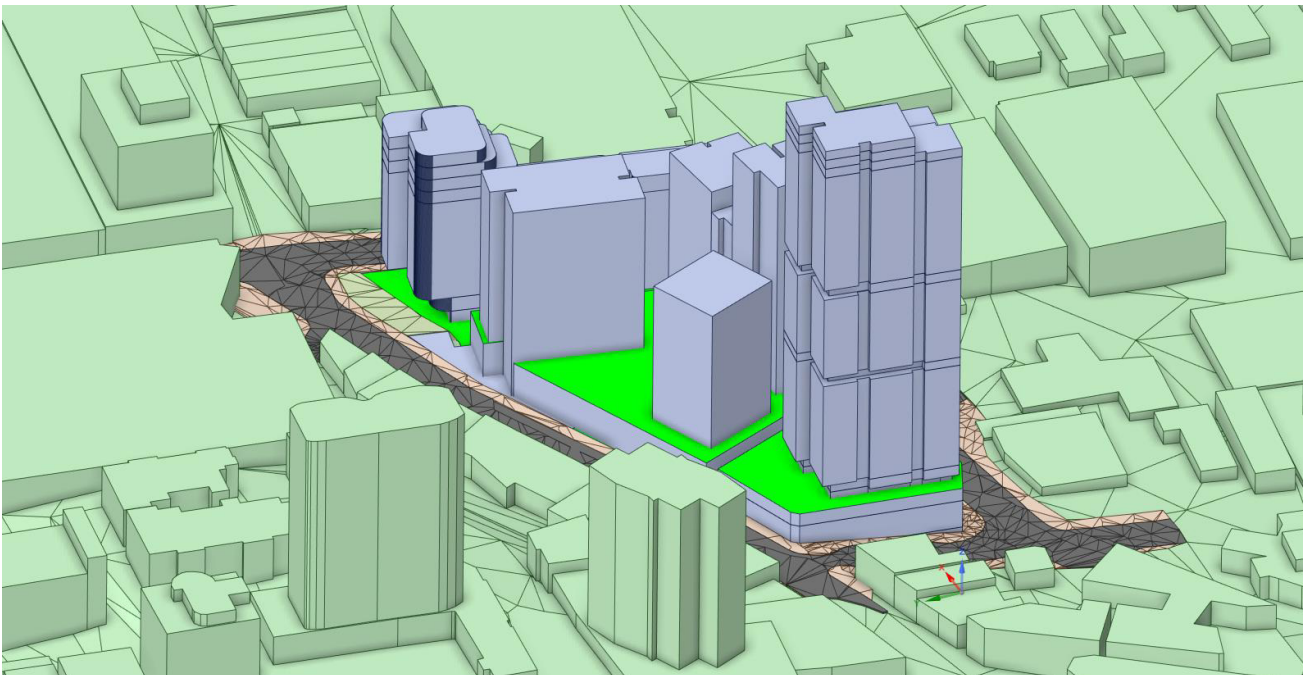
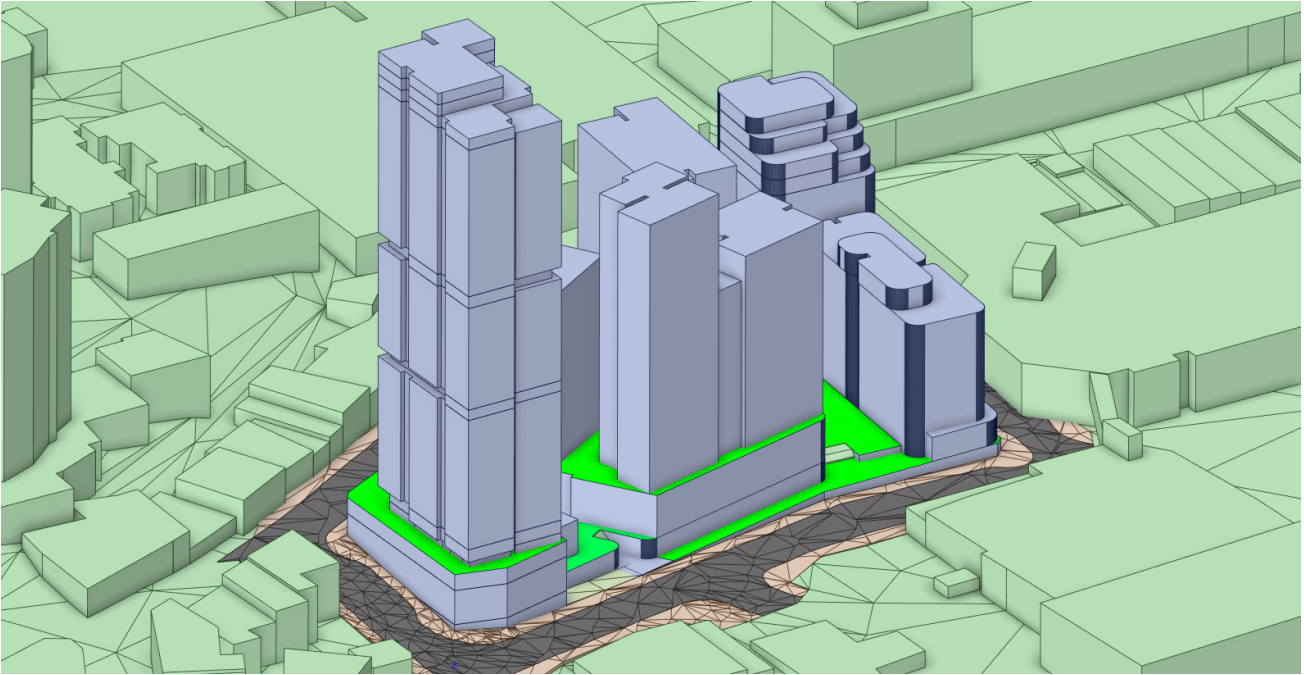


Figure 6: CFD model geometry - northwest close-up view of the proposed development (Feb 2025).



*Figure 7: CFD model geometry - southwest close-up view of the proposed development.*

### **3.2 Computational Grid**

The computational enclosure needs to be discretised into computational control volumes (or mesh) to solve the discretised governing equation of fluid flows. Creating a high-quality mesh allows governing equations to be solved on predictable shaped and mathematically defined volumes with a high-level of accuracy. Meshing the buildings in urban areas balances the accuracy versus computational cost; finer meshes with smaller element size provide accurate results but take longer time to solve.

Computational grid generated is shown in Figure 8. The computational enclosure was discretised into an approximately 12 million cells comprising poly-hexahedral cell types. Furthermore, the mesh was refined around the project site and boundary layer inflation meshed were included on all solid walls. These inflation layers would help to capture the wind flow mechanism in the areas of interest and resolve near wall velocities and pressure gradients (Figure 9).

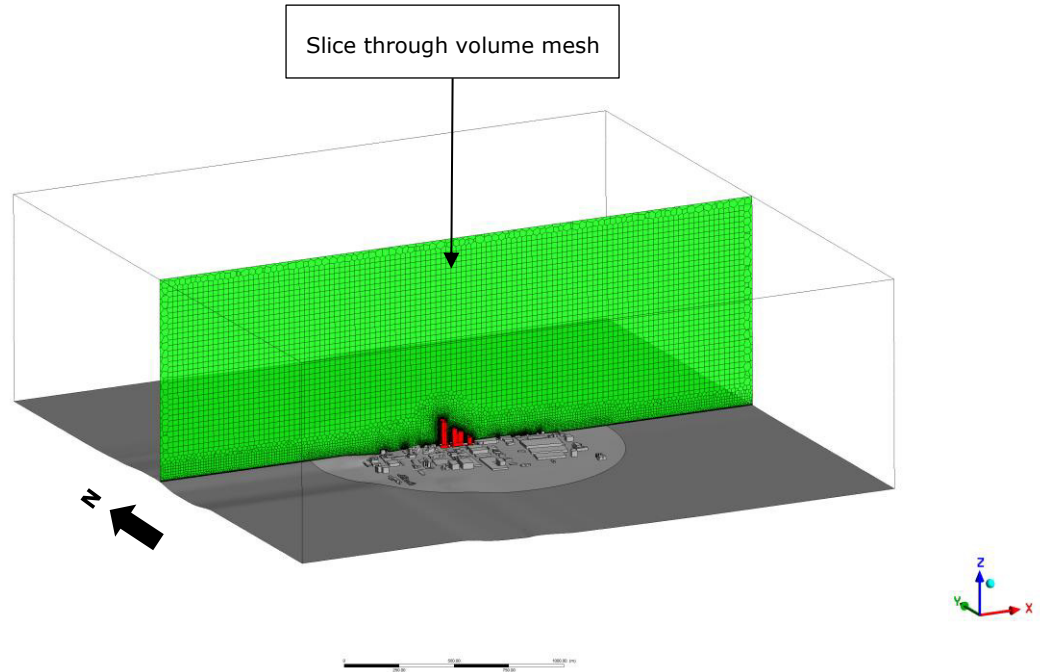


Figure 8: Computational Grid.

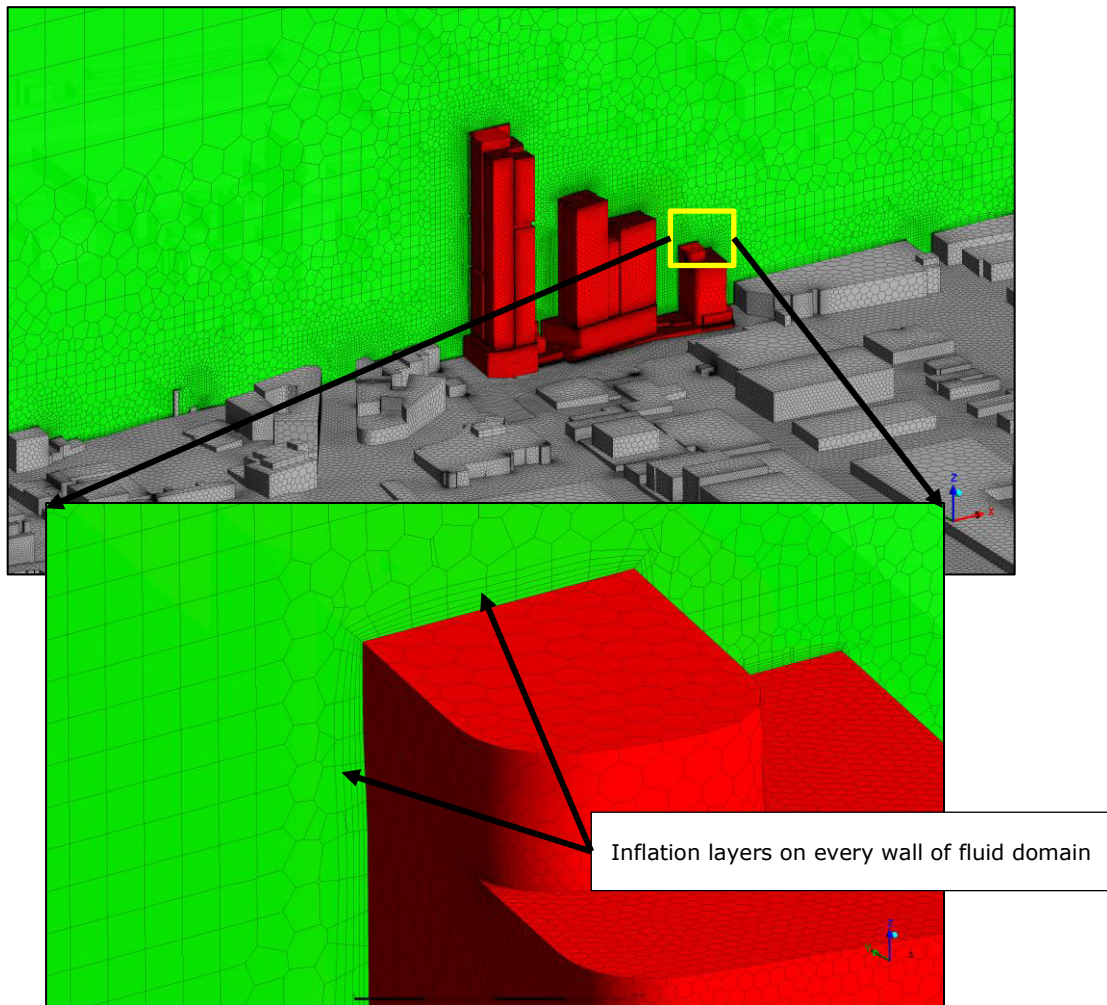


Figure 9: Southwest close-up view of the proposed development.

### 3.3 Turbulence Modelling

The fluid (wind) flow was solved using 3D steady state Reynolds Average Navier Stokes (RANS) k-omega turbulence model. Commercial CFD package used the Finite Volume Method (FVM) to discretise the governing equations, which are then solved using SIMPLE algorithms. Second-order discretization schemes were used for all variables (pressure and momentum equations), except for k and omega terms where a first order discretization was used. The equations for momentum were discretised to second order accuracy to reduce the effect of numerical diffusion.

Many academic publications support that the RANS K-omega Shear Stress Transport (SST) is more robust in solving Computational Wind Engineering simulations [3,4]. Therefore, k-omega SST turbulence model was used in this study. Sixteen wind directions were simulated for this study to assess the wind flow characteristics around the proposed development.

The CFD setup followed the best practices and guidelines for simulating flow in urban environments [12] and consistent with AWES-QAM-3-2024 (Computational Wind Engineering Quality Assurance Manual). Point monitors at different locations around the site were used to monitor the convergence of the results and ensure the CFD solution reached a steady state solution.

### 3.4 Approaching Wind Inlet Profile

An estimate of the upstream terrain category properties for the project site has been made and reproduced in the CFD simulation. The approaching mean and turbulent flows of Terrain Category (TC) 1 and 3 Atmospheric Boundary Layers (ABL) for different exposures were modelled based on AS/NZS 1170.2:2021.

The CFD inlet mean velocity (normalised at the building height) and turbulence intensity profile for TC 1 and 3 are shown in Figure 10 and Figure 11. These ABL profiles represent the mean wind speed and turbulence intensity profiles approaching the model of the development as described in Deaves and Harris (1978) [7]. Ensuring the propagation of the Atmospheric Boundary Layer (ABL) profile into the fluid domain is a key requirement of conducting reliable Computational Wind Engineering (CWE) simulations.

Sand grain roughness techniques were used to ensure that this requirement was achieved for all 16-wind directions. Closer to the ground the wind moves more slowly but with increased turbulence. Some conversion techniques were implanted in the analysis to ensure propagation of the ABL profile to the edge of the CFD modelled turntable geometry.

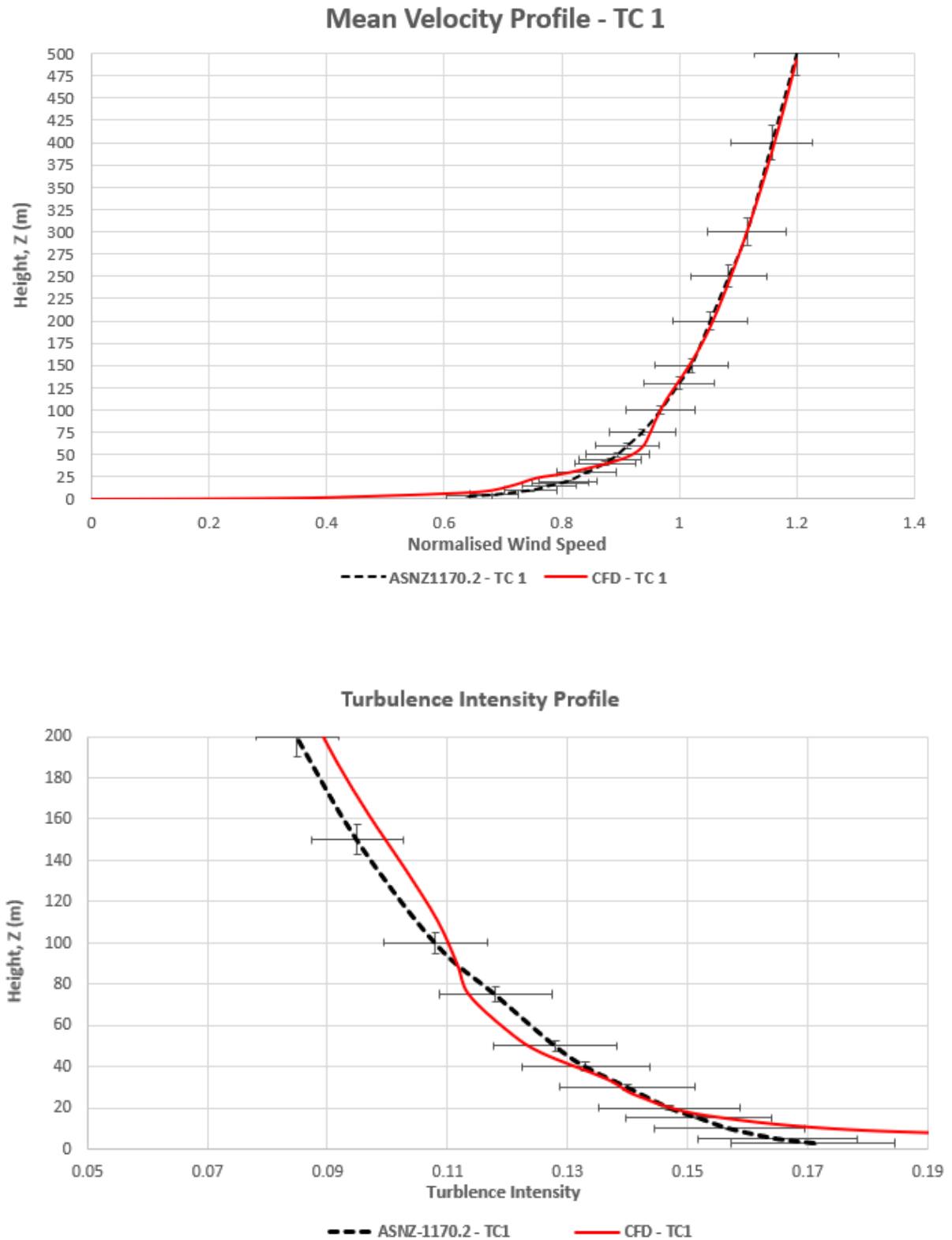
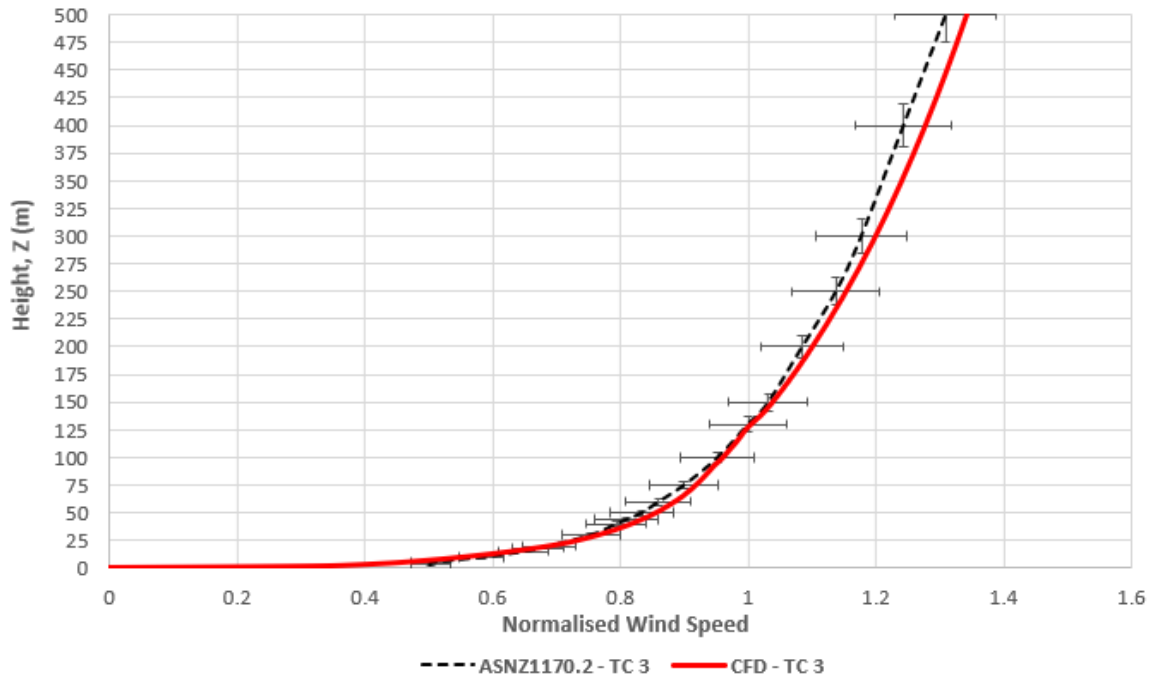


Figure 10: Mean Velocity and Turbulence Intensity Profiles for Terrain Category (TC) 1.

## Mean Velocity Profile - TC 3



## Turbulence Intensity Profile

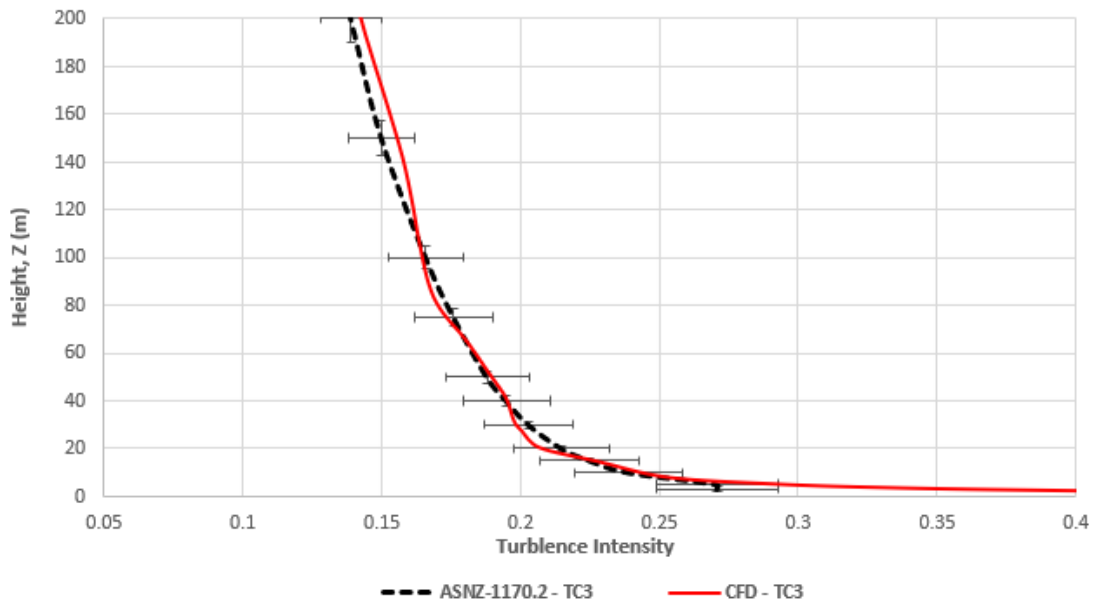


Figure 11: Mean Velocity and Turbulence Intensity Profiles for Terrain Category (TC) 3.

## 4 Regional Wind Climate

The mean and gust wind speeds have been recorded in the Wollongong area for over 30 years. This data has been analysed and directional probability distribution of wind speeds has been determined. The directional distribution of hourly mean wind speed at the gradient height, with a probability of occurring once per year (i.e. 1-year return period) and 5% of time exceeded are shown in Figure 12. The wind data at this free stream height is common to all Wollongong city sites and may be used as reference to assess ground level wind conditions at the project site. Figure 12 indicates that the stronger winds are primarily distributed around the southwest, northwest, and northeast quadrants, and winds from the east are less frequent and generally calmer.

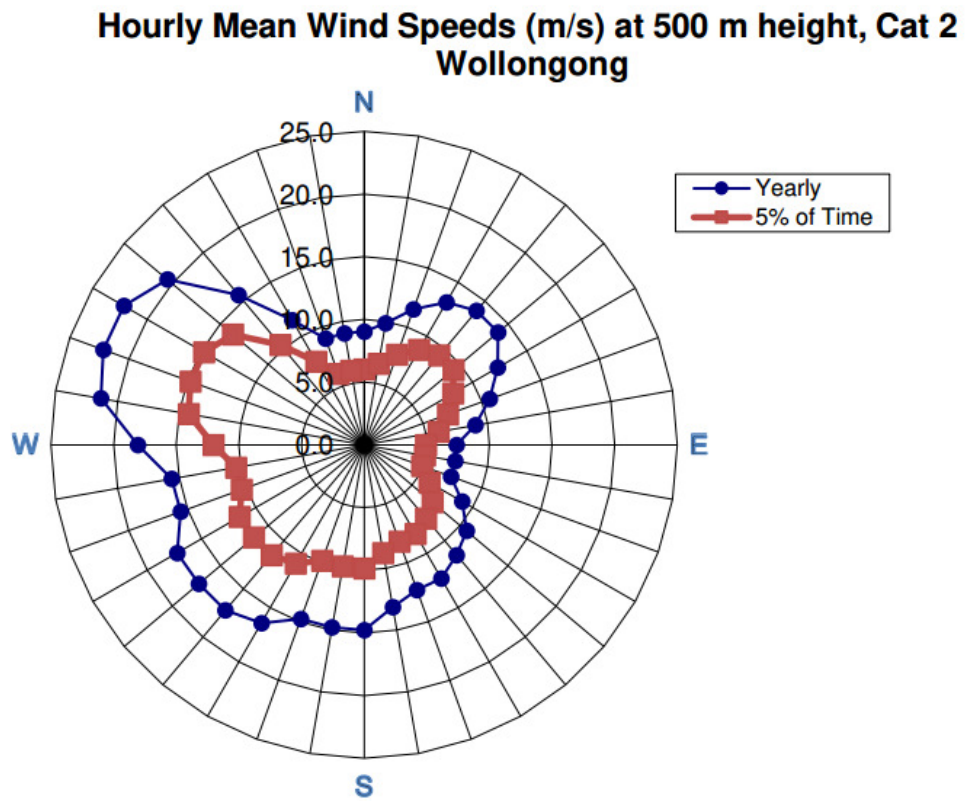


Figure 12: Directional Distribution of Annual Return Period of Mean Hourly Wind Speeds (m/s) and 5% exceeded at Gradient Height for Wollongong.

## 5 Wind Assessment Criteria

It is generally accepted that wind speed and the rate of change of wind velocities are the key parameters that should be used in the wind assessment of how wind affects pedestrians in the area of interests. Local wind effects can be evaluated with respect to a number of environmental wind speed criteria established by various academic researchers. Despite the apparent differences in numerical values and assumptions made in their development, it has been found that when these are compared on a probabilistic basis, there is remarkably good agreement.

Lawson (1990) wind criteria were used to assess the pedestrian level wind speeds in this study. The wind assessment criteria are based upon the research of Lawson (1990), described in Table 3 for both pedestrian comfort and safety. The benefit of these criteria is that they use both a mean and gust equivalent mean (GEM) wind speed to assess the suitability of specific locations. The criteria based on the mean wind speeds define when the steady wind component of the wind causes discomfort, whereas the gust equivalent mean wind speeds define when the wind gusts cause discomfort. The level and severity of these comfort categories can vary based on individual preference, so calibration to the local wind environment for all wind directions is recommended when evaluating with Lawson ratings. **Another benefit of these from a comfort perspective is that the 5% of the time event is appropriate for a precinct to develop a reputation from the general public** – the rating is based on the wind speeds that occur for 95% of the time. Please also refer to the Figure 13 for the comparison between the different wind comfort criteria.

*Table 3: Lawson (1990) wind comfort criteria.*

Measurements	Description
<b>Gust</b> wind speed (max. wind speed exceeded once per year of the time)  $\leq 20\text{m/sec}$ , for combined all directions	Accepted international criterion for human safety to avoid a healthy pedestrian losing balance
Hourly <b>mean/GEM</b> wind speed*, 5% of the time exceedance,  $\geq 10\text{m/sec}$ , for combined all directions.	<b>Uncomfortable</b> (People will purposefully avoid the space for any activities)
Hourly <b>mean/GEM</b> wind speed*, 5% of the time exceedance,  $\leq 10\text{m/sec}$ , for combined all directions.	Acceptable for <b>fast/business walking</b> (Any activities where the person intends to transit through the space where comfort and leisure is not a requirement, such as crossing a road)
Hourly <b>mean/GEM</b> wind speed*, 5% of the time exceedance,  $\leq 8\text{m/sec}$ , for combined all directions.	Acceptable for <b>walking</b> (steady steps for most pedestrians)
Hourly <b>mean/GEM</b> wind speed, 5% of the time exceedance,  $\leq 6\text{m/sec}$ , for combined all directions.	Acceptable for <b>standing</b> (Short-term standing activities: Building entrance, queueing, wind shopping, vehicle drop off or waiting for a bus)
Hourly <b>mean/GEM</b> wind speed, 5% of the time exceedance.  $\leq 4\text{m/sec}$ , for combined all directions.	Acceptable for <b>sitting</b> (gardens, park benches, eating fast food, reading a magazine on a bench, and quick coffee)

*\*Note: Hourly Mean wind speeds is the maximum of mathematical mean or Gust Equivalent Mean (Gust divided by 1.85).*

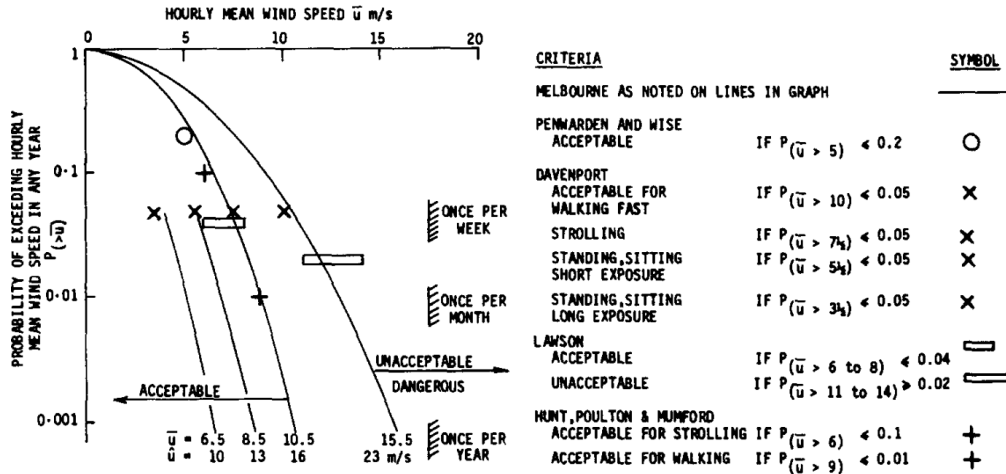


Figure 13: Comparison of various wind criteria for environmental wind conditions for daylight hours.

## 5.1 CWE Assessment – Colour Contours

Table 4: CWE Wind Comfort Colour Contours used in the assessment.

Mean/GEM wind speed that exceeded $\leq 5\%$ of the time	Colour code	Comfort Rating
$\leq 4$ m/s		Sitting
$\geq 4$ m/s – 6 m/s		Standing
$\geq 6$ m/s – 8 m/s		Walking
$\geq 8$ m/s – 10 m/s		Business (or Fast) Walking
$\geq 10$ m/s		Uncomfortable

Table 5: CWE Wind Safety Colour Contours used in the assessment.

Peak wind speed that exceeded once per year of the time	Colour code	Comfort Rating
$< 20$ m/s		Pass
$\geq 20$ m/s		Fail (Unsafe)

## 5.2 Use of Adjacent Pedestrian Occupied Areas & Recommended Wind Comfort Criteria

It is important to consider the intended function of the outdoor amenity area as this heavily influences the assessment of wind comfort for pedestrian and patrons. People frequenting locations such as parks are likely to tolerate a windier environment when compared to patrons at an alfresco dining area. This is due to a personal judgement on clothing, the predetermined expectation of the wind environment and the sensitivity of their activity to wind.

Outdoor activity is highly sensitive to wind due; whereas pedestrians in a park may maintain comfort under otherwise uncomfortable conditions when partaking in more physical activities such as walking, jogging or sports etc.

The following table lists the specific areas adjacent to the proposed development and the corresponding recommended criteria.

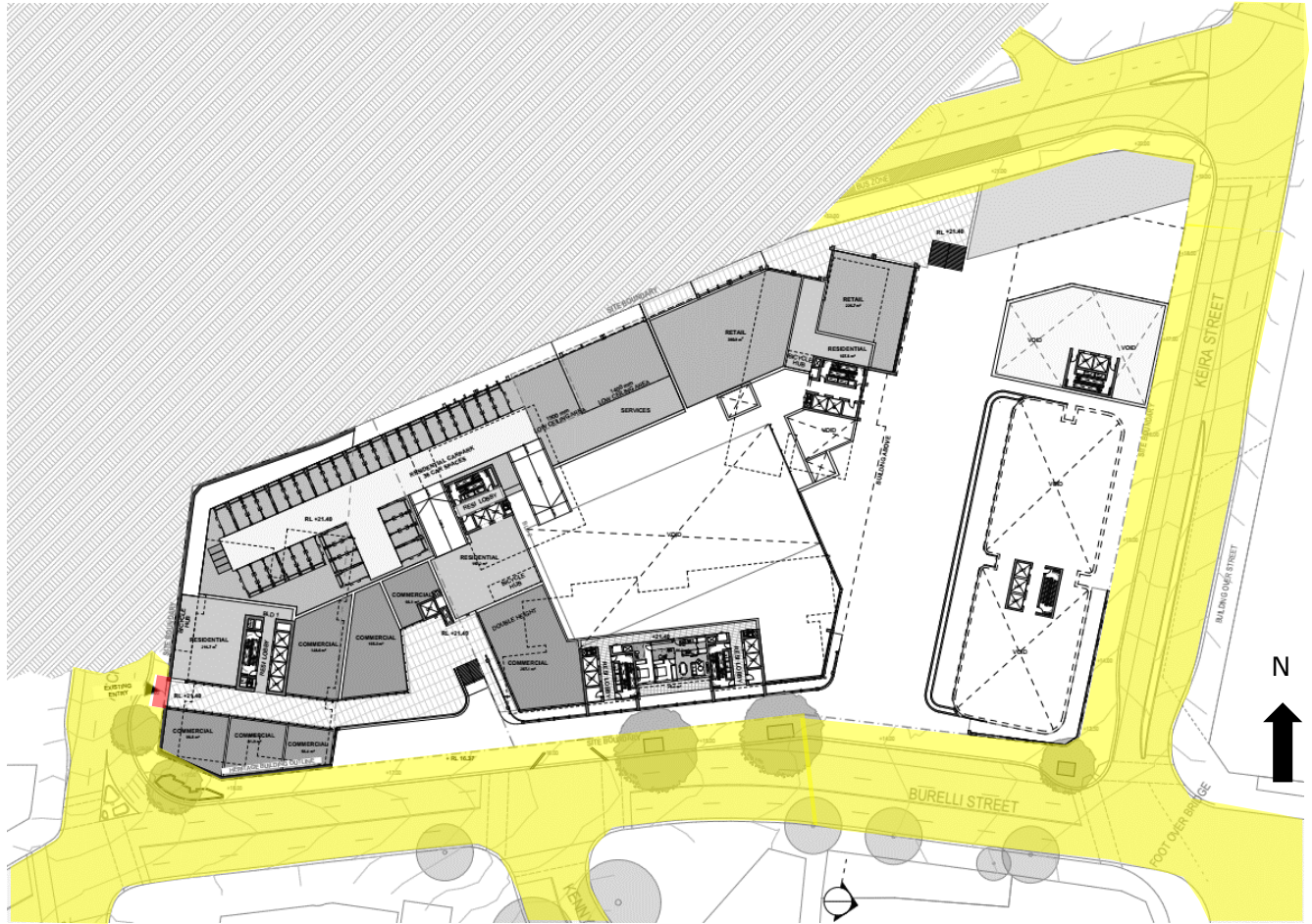
*Table 6: Recommended application of criteria.*

Area	Specific location	Target Criteria
Public footpaths and accessway	Around the project site (Figure 14 and Figure 15)	Walking
Building main entrances	West side of the proposed development (Figure 14)	Standing
Elevated Walkways	Between the development (Figure 15)	Walking
Outdoor Terrace	Level 3 (Figure 16) and Level 4 (Figure 17)	Walking (see discussion below)

## 5.3 Terrace / Balcony Recommended Criterion Discussion

Vipac recommends as a minimum that outdoor terrace areas meet the criterion for **walking** since:

- the use areas is optional, and only intended to be used on fair weather conditions with calm winds;
- a key experience of these terrace areas is to be reasonably open to the environmental conditions;
- these areas are not public spaces;
- residents at private open spaces can choose to retreat indoors during uncomfortable wind conditions, while a pedestrian or person using a public area may not have this option; and
- many similar developments in Wollongong and other Australian capital cities experience wind conditions on balconies and elevated deck areas in the vicinity of the criterion for walking.



Recommended to fulfil Walking  Recommended to fulfil Standing/Sitting

Figure 14: Ground floor plan with the recommended wind criteria overlaid (Feb 2025).




 Recommended to fulfil Walking

Figure 15: Level 1 floor plan with the recommended wind criteria overlaid (Feb 2025).



 Recommended to fulfil Walking

Figure 16: Level 3 floor plan with the recommended wind criteria overlaid (Feb 2025).

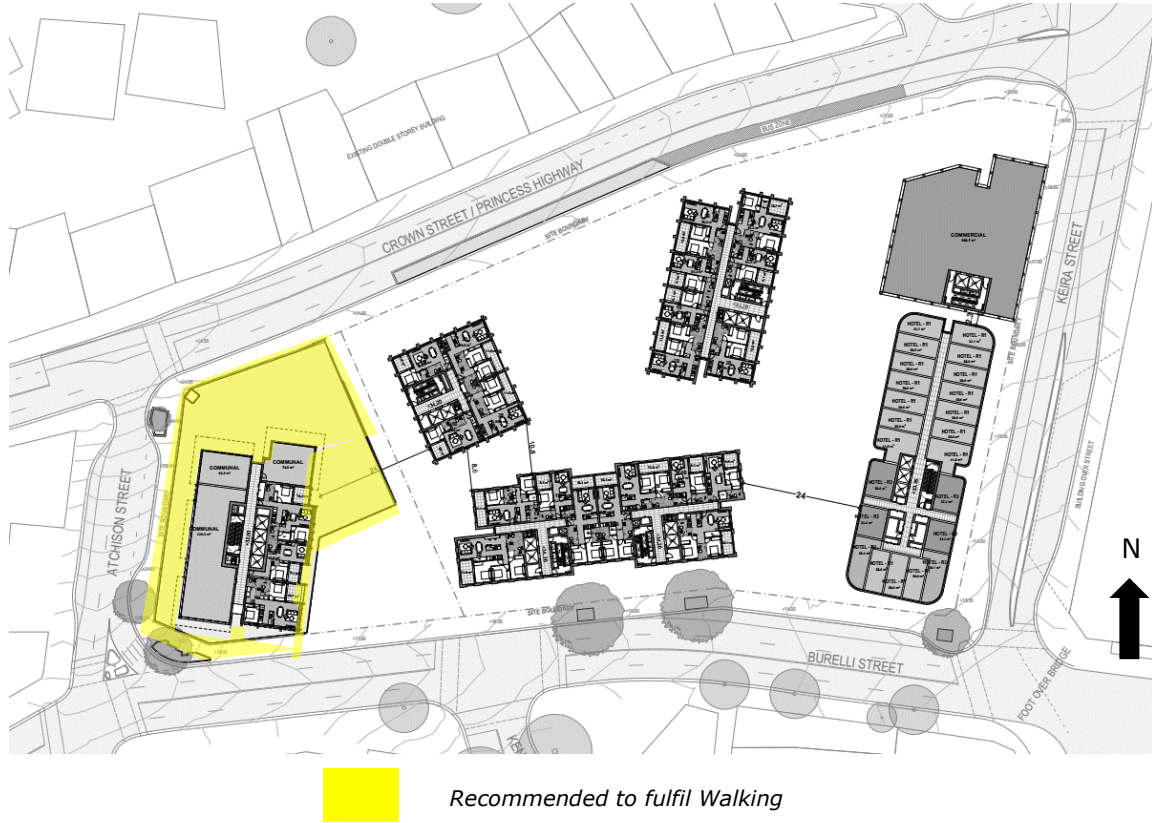


Figure 17: Level 4 floor plan with the recommended wind criteria overlaid (Feb 2025).

## 6 Results and Discussion

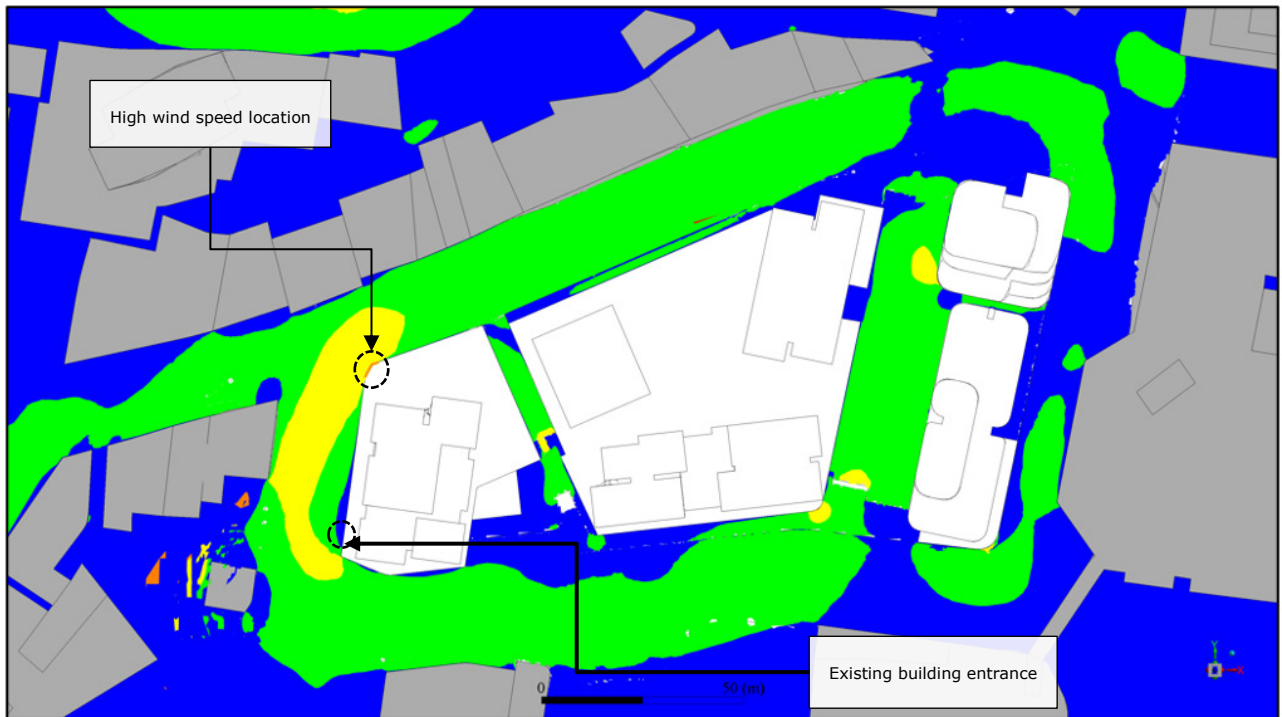
### 6.1 Public Footpaths and Accessway

Wind comfort conditions around the project site is dominated by prevailing north-easterly and north-westerly winds. Locations at the street level around the project site are classified between standing and walking wind comfort ratings (Figure 18). It should be noted that the northwest corner of the tower is slightly windier and exceeded marginally the recommended walking comfort criterion. The velocity ratio contours for all 16 wind directions can be found in Appendix C

Overall, the wind conditions at the street level around the project site are within the recommended waking comfort ratings. As such, no recommendations for wind amelioration were recommended around the project site.

The building entrance is well protected from the prevailing winds and windspeeds are predicted within the recommended standing comfort criterion or better.

The wind safety rating is used to indicate potential areas where wind conditions may pose an occasional risk to the safety of pedestrians. The wind conditions around the proposed development were predicted to be within the recommended wind safety criterion (Figure 19).



■ Sitting   
 ■ Standing   
 ■ Walking   
 ■ Business Walking   
 ■ Uncomfortable

Figure 18: Wind comfort result (combined all wind directions - Annual) - around the project site and walkways between the towers (Feb 2025).

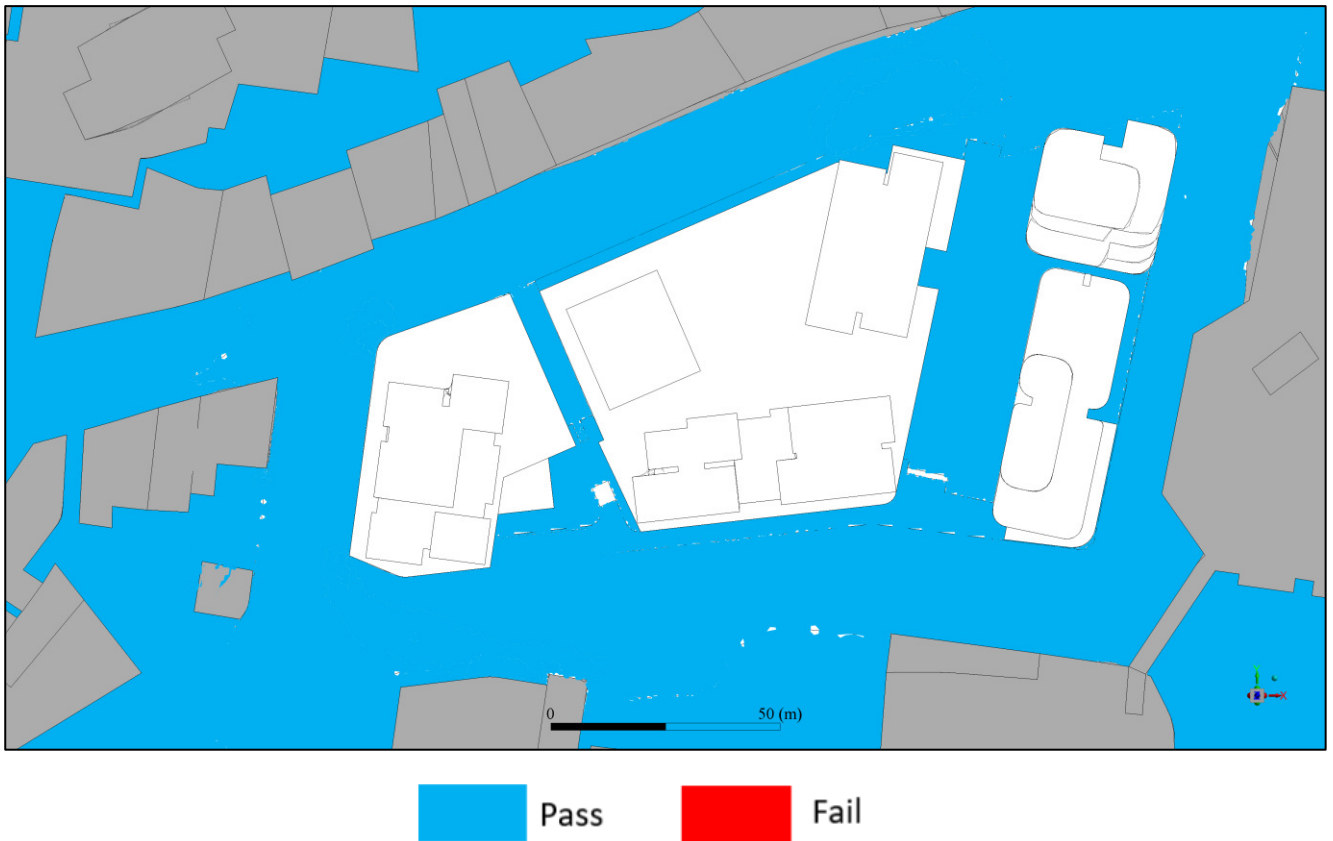


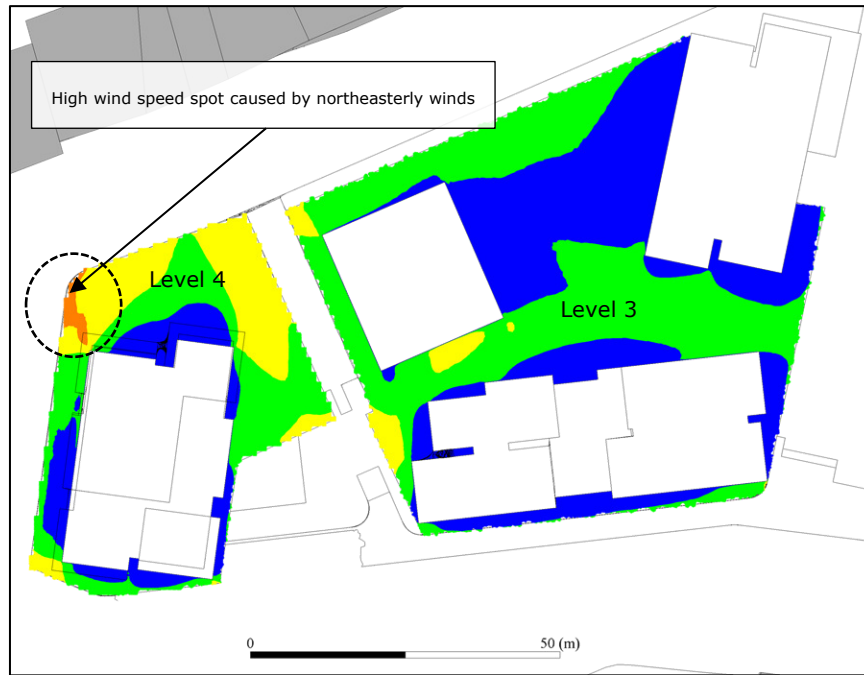
Figure 19: Wind safety result (combined all wind directions - Annual) - around the project site and walkways between the towers (Feb 2025).

## 6.2 Level 3 & 4 Terrace

The simulations were performed without balustrade around the perimeter.

Wind comfort conditions at Level 3 terrace is within the recommended walking comfort criterion (Figure 20)

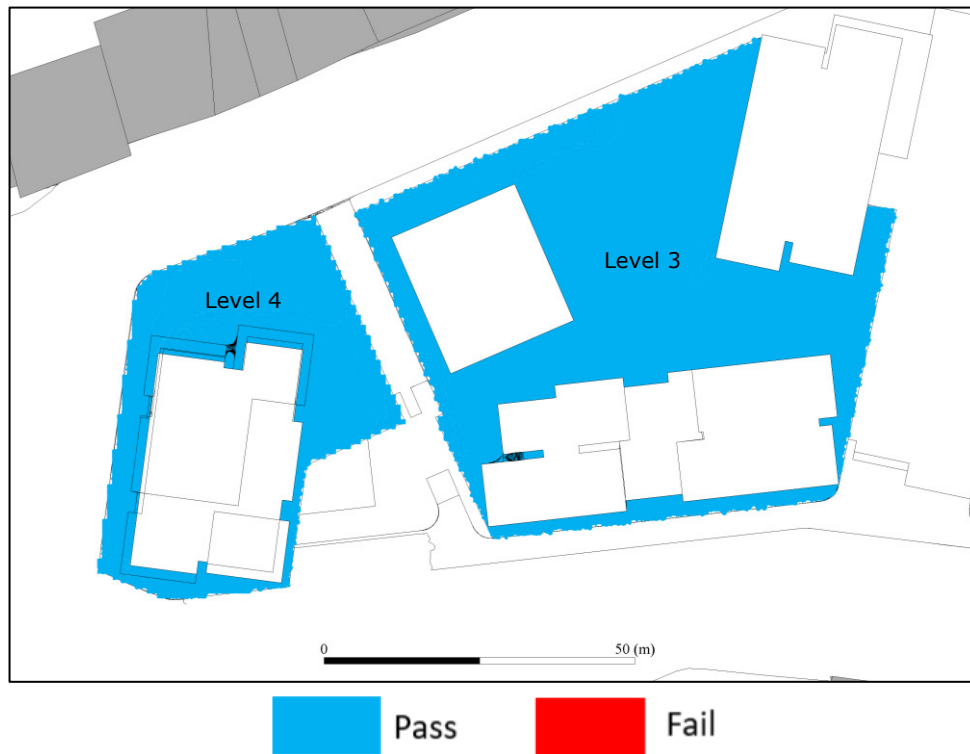
The northwestern side of the Level 4 terrace of the proposed development experiences windier conditions from the northeasterly winds and exceeded the recommended walking comfort criterion (Figure 20). Wind conditions are expected to be improved with the tall dense landscaping around the western to northwestern perimeter as described in the landscaping plan (Refer to section 7 for more detail).



■ Sitting   
 ■ Standing   
 ■ Walking   
 ■ Business Walking   
 ■ Uncomfortable

Figure 20: Wind comfort result (combined all wind directions - Annual) – level 3 and 4 terrace (Feb 2025).

The predicted gust windspeeds were within the recommended wind safety criterion (Figure 21).



■ Pass   
 ■ Fail

Figure 21: Wind safety result (combined all wind directions- Annual) – level 3 and 4 terrace (Feb 2025).

## 7 Updated Drawings

The proposed February 2025 scheme was assessed in a computational wind engineering model to determine a quantitative description of the wind environment within the proposed development site; as well as the wider public and private realms.

By comparing the amended July 2025 and landscaping scheme to the design that underwent computational analysis, we can determine the effect of these changes on the pedestrian wind environment. The key findings from a wind environment perspective are as follows:

- i. Wind conditions around the proposed development are classified between standing and walking ratings (Figure 18). However, the updated landscaping drawings have incorporated tall dense planting around the project site (Figure 23). As such, wind comfort conditions are expected to be slightly better than the current scenario; hence no wind mitigation measures are provided;
- ii. Many of the ground envelopes have largely remained the same and so would not be expected in a significant change that would influence the wind environment over what was predicted in the computational assessment. However, we note that undercroft at the northeastern tower has been filled in with an expanded built form. Given the relatively windspeeds in this area, we do not expect this to have a significant impact on the wind environment. Additionally in consideration of the proposed colonnade along the north (Figure 22);
- iii. Similarly, colonnades and façade features/fins along activated building interface of the eastern and western pedestrian links are expected to introduce shielding effects to the retail entrances. These are generally thought to be beneficial to the local wind environment (Figure 22 & Figure 24);
- iv. The Level 3 & 4 terraces have not changed significantly from the assessed scheme (Figure 25 & Figure 27). Wind comfort conditions around the Level 3 terrace are classified between standing and sitting comfort criteria (Figure 20). Outdoor pool and outdoor BBQ space have now been proposed on this terrace. However, the landscaping plan shows that the Level 3 terrace have incorporated with dense landscaping (Figure 26). This landscaping is expected to have lower and favourable wind conditions for outdoor BBQ space;
- v. Higher wind speeds are predicted around the northwestern corner of the Level 4 terrace (Figure 20). However, the updated landscaping plans have incorporated tall dense landscaping around the western to northwestern perimeter of the Level 4 terrace (Figure 28). These landscaping would be expected to reduce the wind speeds around the northwestern corner and expected to be within the walking comfort criterion or better. Moreover, the pergola structure and dense landscaping has been implemented around the outdoor dining space. These features would be expected to reduce the windspeeds and provide local wind shelter for this area; and
- vi. The proposed height of the development has not changed significantly that would influence the overall results of the wind assessment (Figure 29).

The design has not changed in a way that would significantly or adversely affect the adjacent wind environment. As such the results and recommendations made in the report are still valid for the current design.

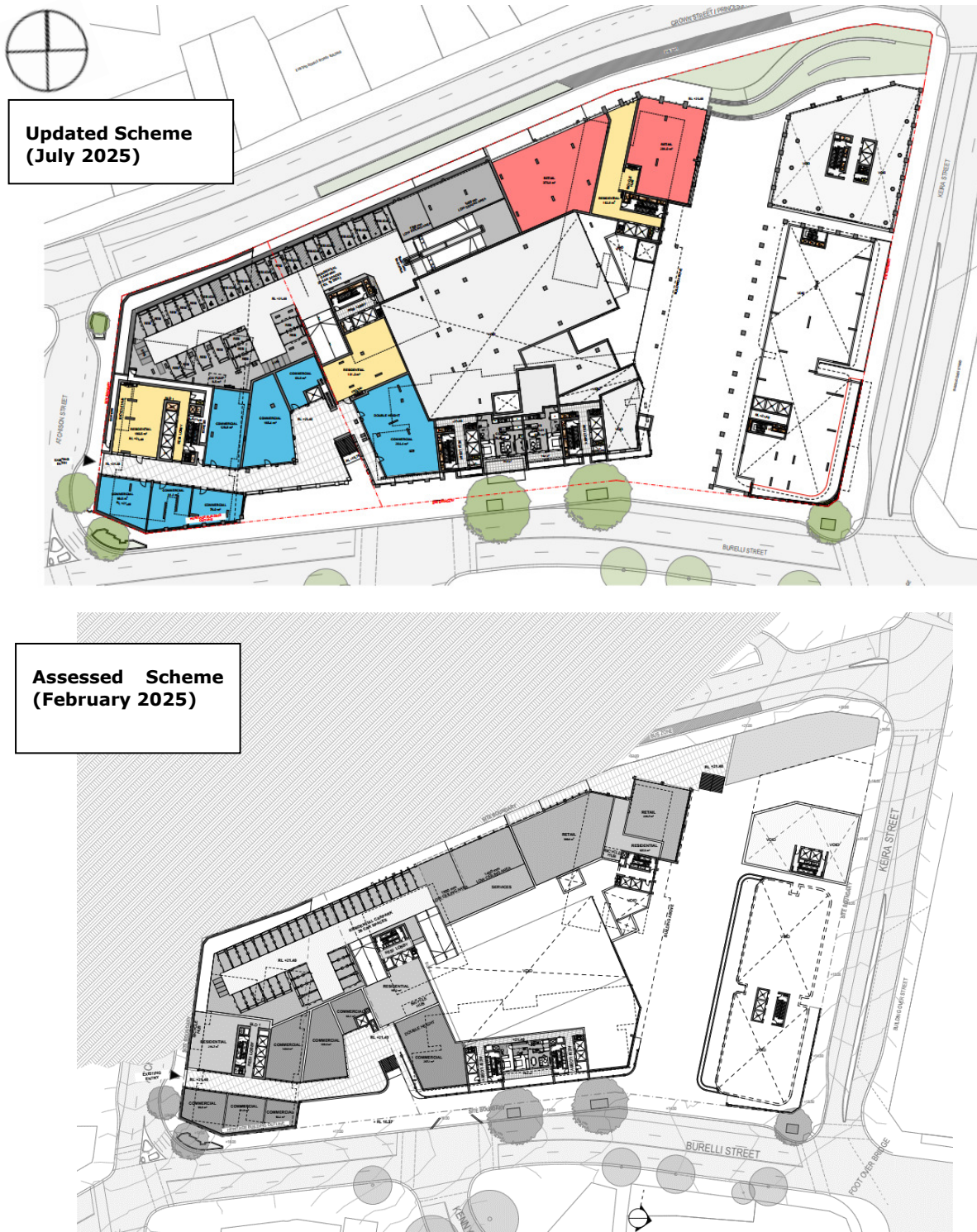


Figure 22: Ground floor plans for the development comparison between updated and assessed schemes.

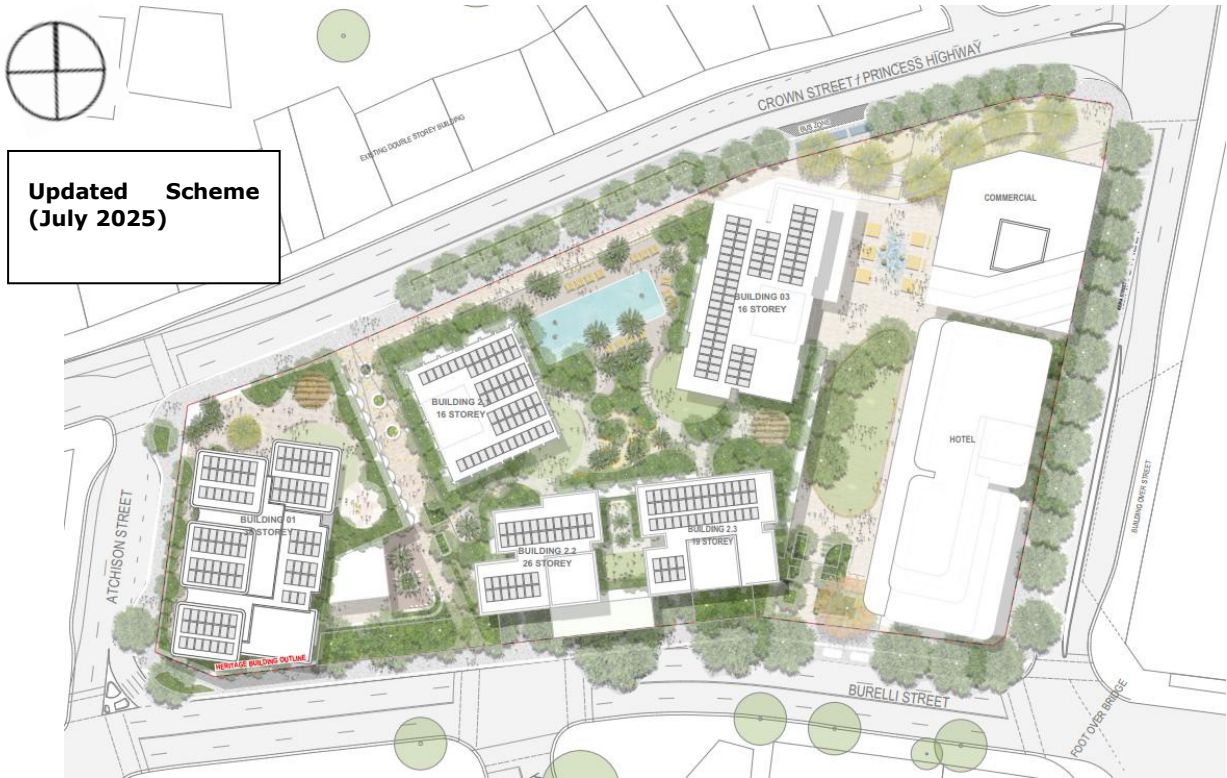


Figure 23: Site plans for the development with the landscaping.

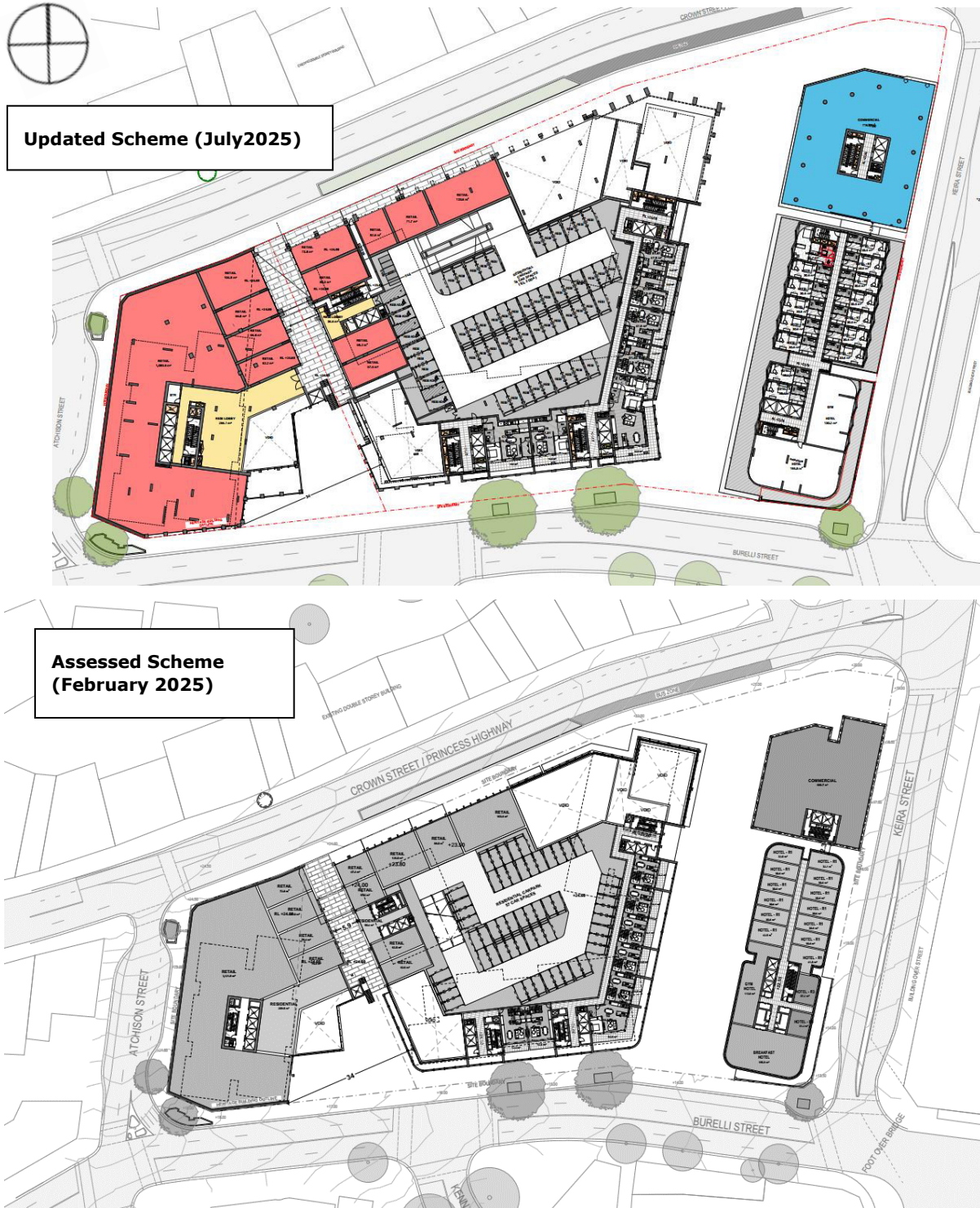


Figure 24: Level 1 floor plans for the development comparison between updated and assessed schemes.

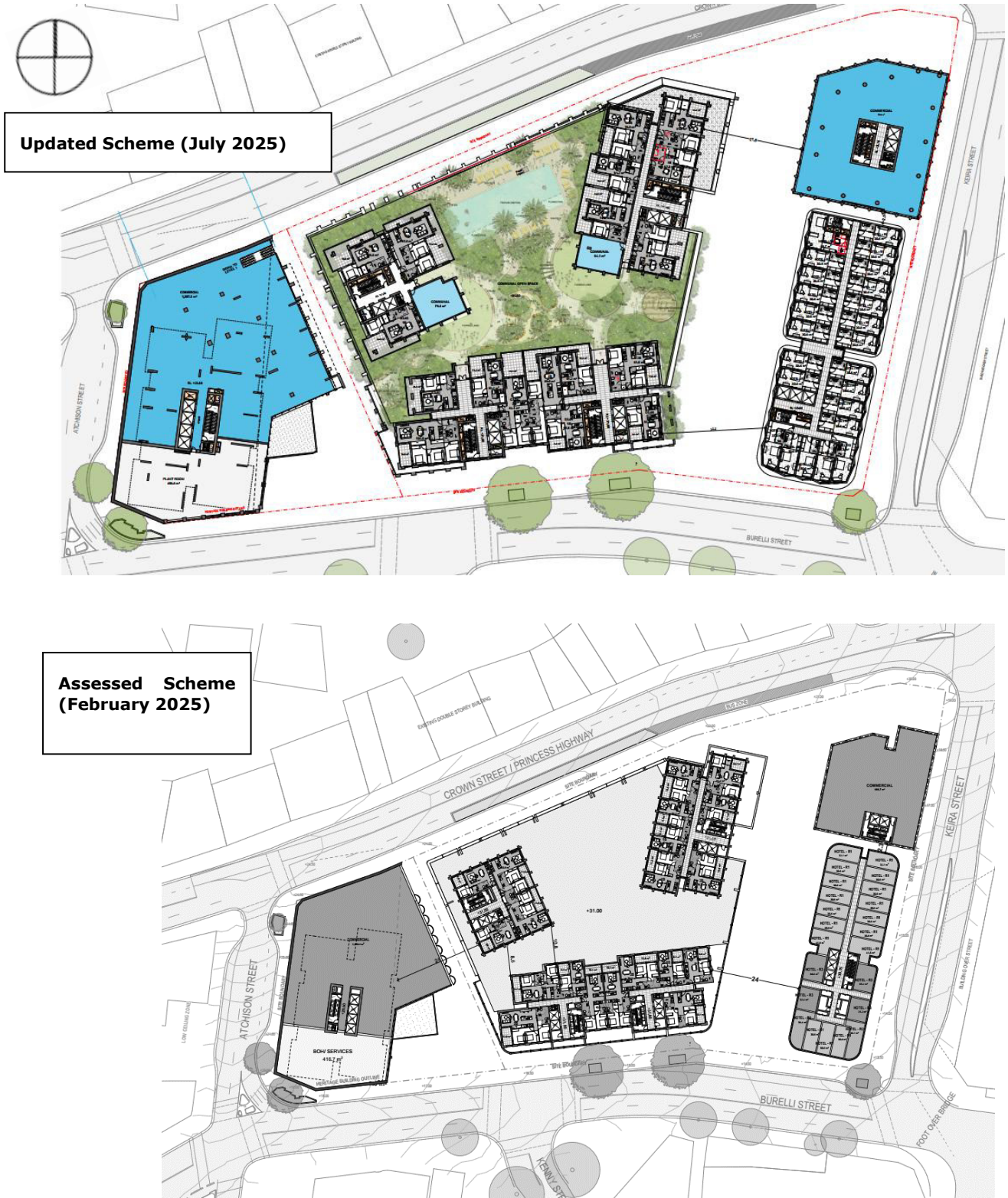


Figure 25: Level 3 floor plans for the development comparison between updated and assessed schemes.



Figure 26: Level 3 floor plans for the development with the landscaping.

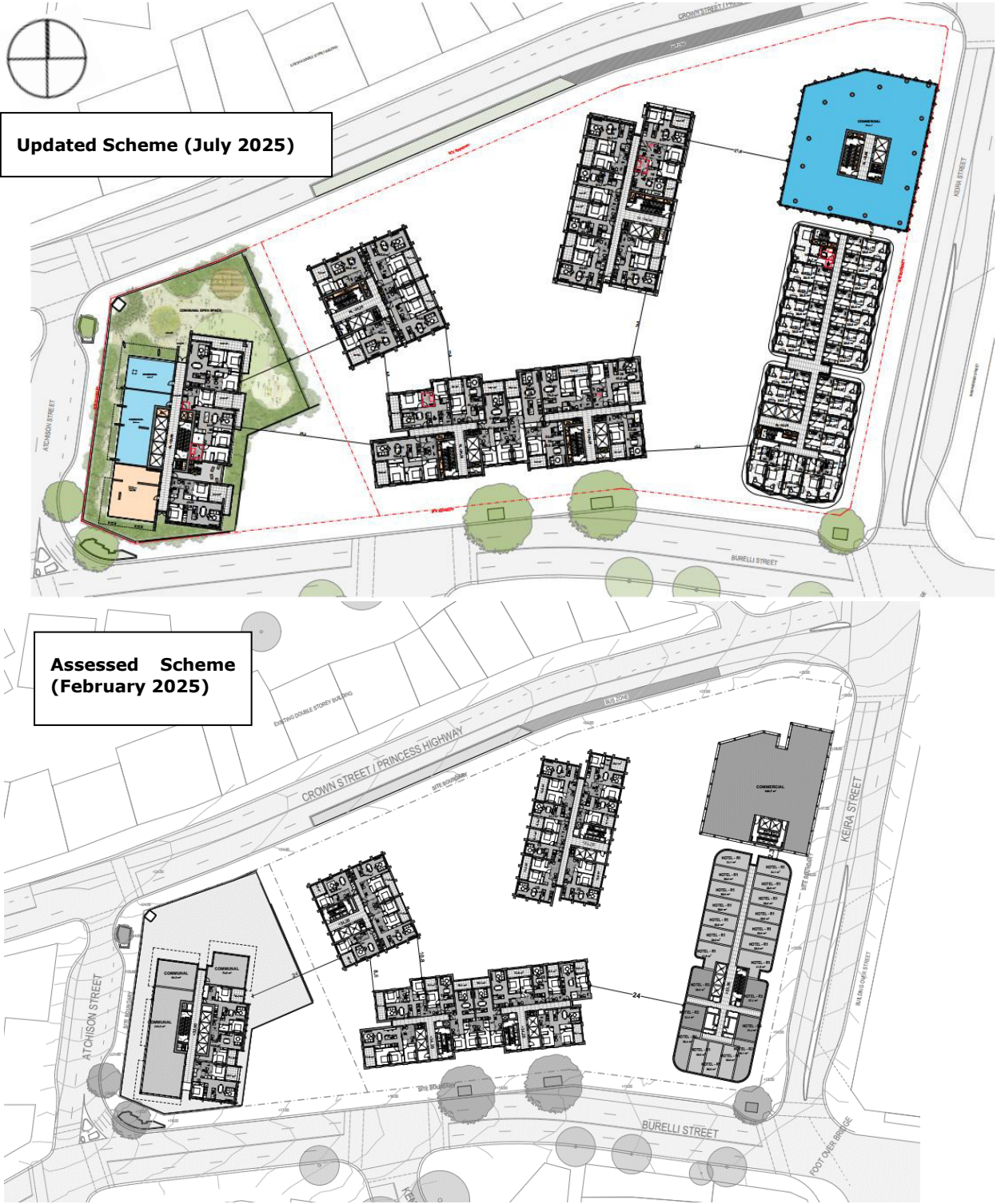


Figure 27: Level 4 floor plans for the development comparison between updated and assessed schemes.

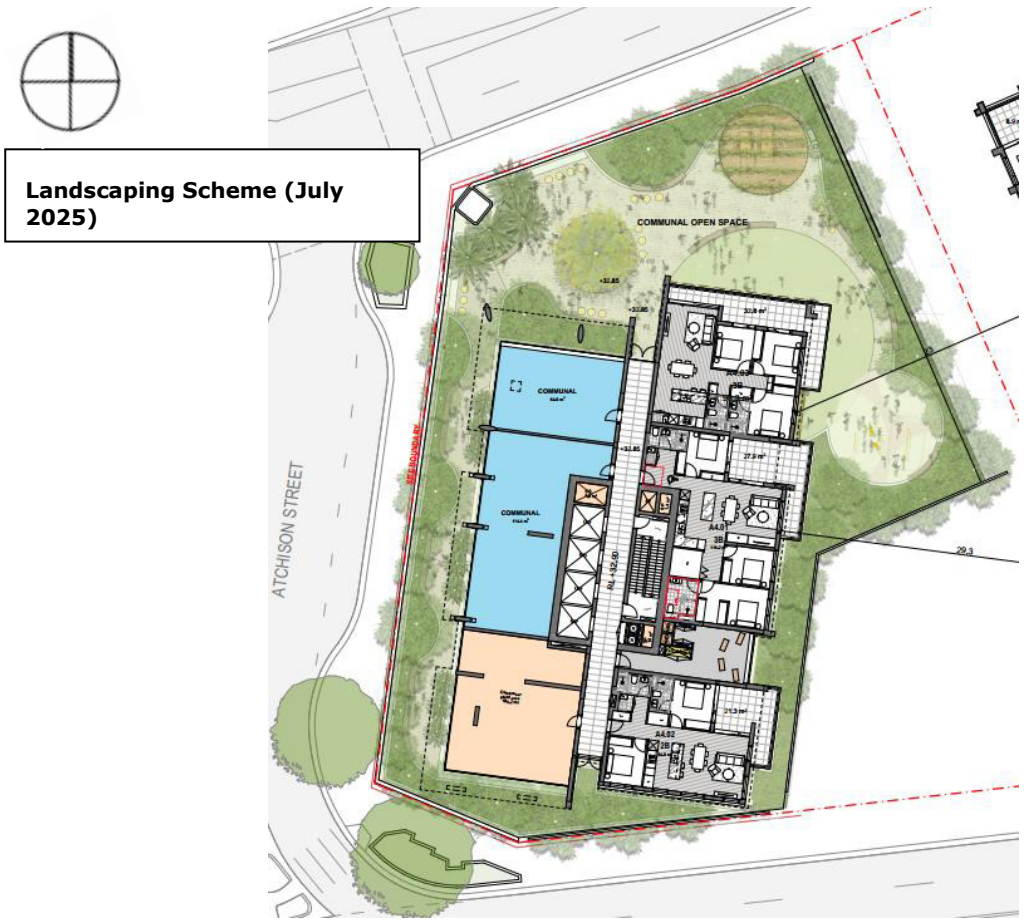


Figure 28: Level 4 floor plans for the development with the landscaping.

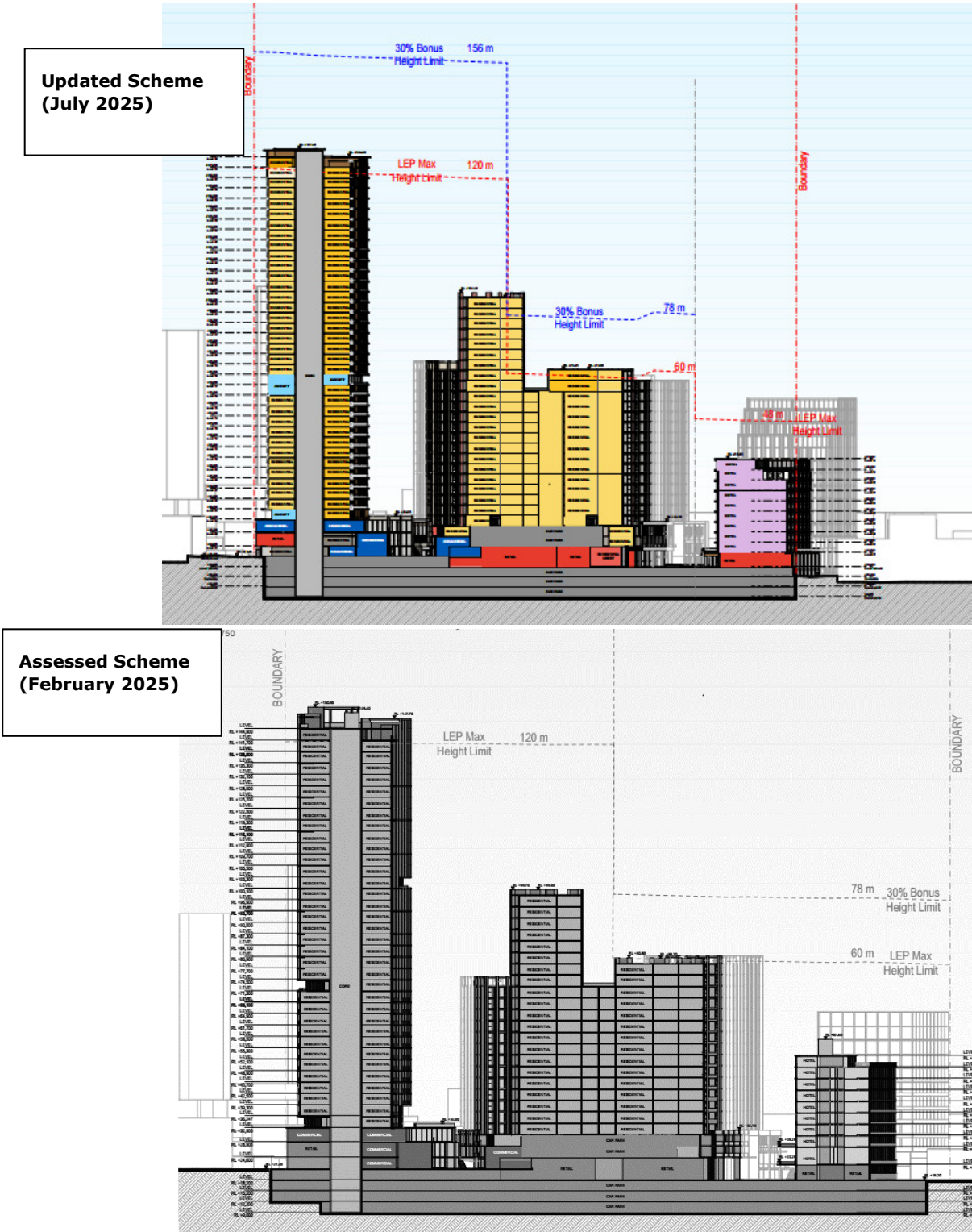


Figure 29: Section view for the development comparison between updated and assessed schemes.

## 8 Conclusion

Vipac Engineers & Scientist Pty Ltd has carried out an assessment of the pedestrian level winds for the proposed development at **221-273 Crown Street, Wollongong** based on Computational Wind Engineering (CWE) simulations.

The 3D model was developed based on drawings supplied by **DKO Architects** in **February 2025**. The proposed development and surrounding buildings covering a circular area of approximately 500m radius were modelled at a full-scale. The approaching mean wind speed and turbulent intensity of Terrain Category (TC) 1 and 3 Atmospheric Boundary Layer (ABL) profiles were modelled based on Australian Standard ASNZ 1170.2:2021.

Wind speeds simulated for 16 wind directions are combined with the local wind climate to determine mean wind speed exceeded **5%** of the time for the wind comfort and gust wind speed at **once per year (0.1%)** for the wind safety.

Updated drawings (Architectural and Landscaping) were provided in **July 2025**. A comparative analysis was conducted with the finding of the Computational Wind Engineering (CWE) study are summarised as follows:

### **The proposed design of the development:**

- fulfils the recommended criterion for **Safety** at all interest areas;
- fulfils the recommended criterion for **Walking** at all footpath and access areas;
- fulfils the recommended criterion for **Standing** at all building entrances;
- fulfils the recommended criterion for **Walking** at the Level 3 terrace; and
- fulfils the recommended criterion for **Walking** at the Level 4 terrace.

The proposed development would not cause a significant adverse impact on the adjacent areas.

As a general statement, common to all new developments, educating occupants about wind conditions at high level terraces/balconies during high-wind events and tying down loose furniture are highly recommended.

## Appendix A Environmental Wind Effects

### Atmospheric Boundary Layer

As wind flows over the earth, it encounters various roughness elements and terrain such as water, forests, houses, and buildings. To varying degrees, these elements reduce the mean wind speed at low elevations and increase air turbulence. The wind above these obstructions travels with unattenuated velocity, driven by atmospheric pressure gradients. The resultant increase in wind speed with height above ground is known as a wind velocity profile. When this wind profile encounters a tall building, some of the fast-moving wind at upper elevations is diverted down to ground level resulting in local adverse wind effects.

The terminology used to describe the wind flow patterns around the proposed development is based on the aerodynamic mechanism, direction, and nature of the wind flow.

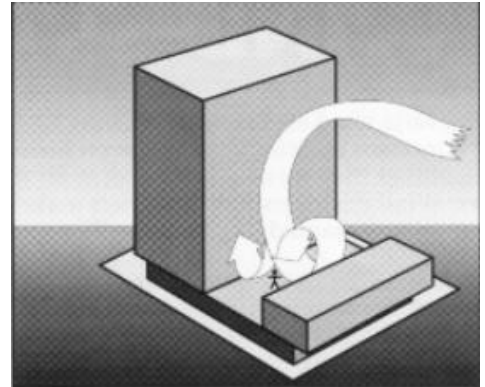
**Downwash** – refers to a flow of air down the exposed face of a tower. A tall tower can deflect a fast-moving wind at higher elevations downwards.

**Corner Accelerations** – when wind flows around the corner of a building it tends to accelerate in a similar manner to airflow over the top of an aeroplane wing.

**Flow separation** – when wind flowing along a surface suddenly detaches from that surface and the resultant energy dissipation produces increased turbulence in the flow. Flow separation at a building corner or at a solid screen can result in gusty conditions.

**Flow channelling** – the well-known “street canyon” effect occurs when a large volume of air is funnelled through a constricted pathway. To maintain flow continuity the wind must speed up as it passes through the constriction. Examples of this might occur between two towers, in a narrowing street or under a bridge.

**Direct Exposure** – a location with little upstream shielding for a wind direction of interest. The location will be exposed to the unabated mean wind and gust velocity. Piers and open water frontage may have such exposure.



## Appendix B Drawing List

3D models Received: **07<sup>th</sup> Feb 2025**

13631\_NSW Wollongong\_Context.3dm  
13631\_NSW Wollongong\_Context.skp  
13631\_NSW Wollongong\_Proposed Massing.3dm  
13631\_NSW Wollongong\_Proposed Massing.skp  
3D Model for IFC context.ifc  
3D Model for IFC Proposed Massing.ifc  
13631\_NSW Wollongong - with context.3ds  
13631\_NSW Wollongong - without context.3ds

Architectural Drawings Received: **07<sup>th</sup> Feb 2025**

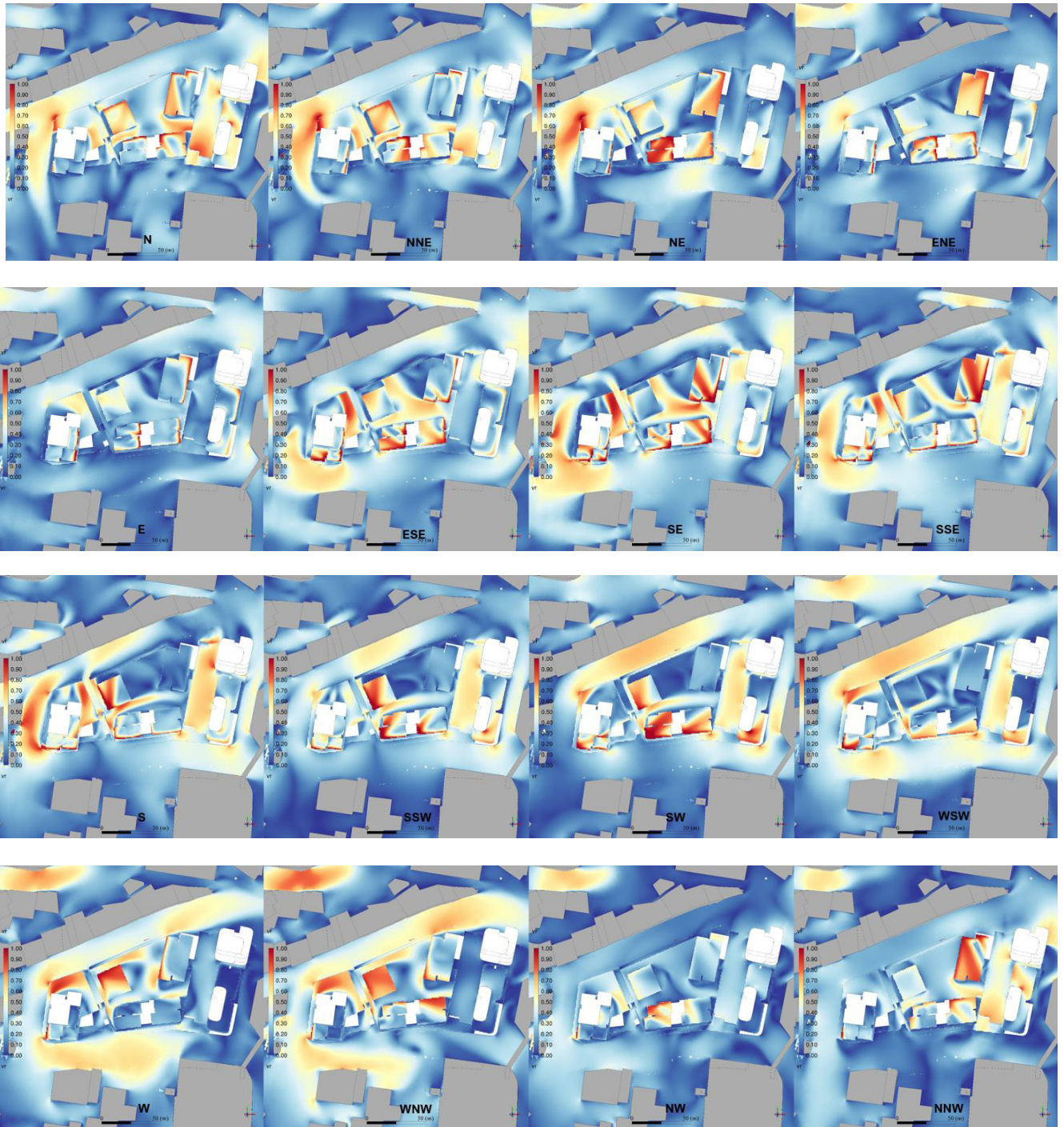
13631 - Crown street, Wollongong - Submission.pdf  
241220\_Crown Street, Wollongong \_Consultant Pack.pdf

### Updated Drawings

Architectural and Landscape Plans Received: **July 2025**

Crown Street, Wollongong \_Architecture Drawings.pdf

## Appendix C Velocity Ratio for all 16 wind directions – 1.5m above the concerned areas



## Appendix D    References

- [1] Structural Design Actions, Part 0: General Principles, Australian/New Zealand Standard 1170.0:2011.
- [2] Structural Design Actions, Part 2: Wind Actions, Australian/New Zealand Standard 1170.2:2021.
- [3] Blocken, B. (2014) '50 years of Computational Wind Engineering: Past, present and future', *Journal of Wind Engineering and Industrial Aerodynamics*, 129, pp. 69–102. doi:10.1016/j.jweia.2014.03.008.
- [4] Blocken a et al. (2011) CFD simulation for pedestrian wind comfort and wind safety in urban areas: General Decision Framework and Case Study for the Eindhoven University Campus, *Environmental Modelling & Software*.
- [5] City of Moonee Valley (2021), *Moonee Ponds Activity Centre – Wind Guidelines for Planning Applicants*.
- [6] Holmes, J.D. and Bekele, S. (2022) *Wind loading of structures*. Boca Raton: CRC Press.
- [7] Selvam, R.P. (2022) *Computational Fluid Dynamics for Wind Engineering*. Hoboken, NJ: Wiley Blackwell.
- [8] Deaves, D.M. and Harris, R.I (1978). A Mathematical model of the structure of strong winds. CIRIA Report 76, England.
- [9] Lawson T. V. (1978). 'The wind content of the built environment' *Journal of Wind Engineering and Industrial Aerodynamics*, 3(2-3), 93-105.
- [10] Minimum design loads on structures (knowns as the SAA Loading Code), Part 2: Wind Loads, AS 1170.2-1989.