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Vipac Engineers & Scientists

DPG Project 23 Pty Ltd

629-639 Pacific Highway, Chatswood

Wind Impact Assessment



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EXECUTIVE SUMMARY

DPG Project 23 Pty Ltd commissioned Vipac Engineers and Scientists Ltd to prepare a statement of wind effects for the ground level areas adjacent to the proposed development at **629-639 Pacific Highway, Chatswood, NSW**. This appraisal is based on Vipac's experience as a wind-engineering consultancy.

Updated drawings of the proposed development were provided by **Dem (Aust) Pty Ltd** in **Aug 2020**. The findings of this study can be summarized as follows:

- With the proposed design, the adjacent footpaths would be expected to have wind levels within the walking comfort criterion.
- The wind conditions near the main entrance areas would be expected to be within the criterion for standing comfort.
- With the proposed design and recommended wind control measures, the wind conditions in the podium roof terrace areas and roof top terraces would be expected to be within the criterion for walking.
- Additional pergola structures are also recommended should the proposed seating areas on the terraces be desired to achieve more stringent comfort criterion.
- In general, on the residential tower portion, the incorporation of winter garden design for the balconies would achieve improved wind environment for these areas.

As a general statement, educating occupants about wind conditions at open terrace/balcony areas during high-wind events and fixing loose, lightweight furniture on the terrace are highly recommended.

The assessments provided in this report have been made based on experience of similar situations in Sydney and around the world. As with any opinion, it is possible that an assessment of wind effects based on experience and without experimental validation may not account for all complex flow scenarios in the vicinity. Vipac recommends a scaled model wind tunnel test to verify the predictions and determine the optimal wind control strategies.



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1 INTRODUCTION

DPG Project 23 Pty Ltd commissioned Vipac Engineers and Scientists Ltd to prepare a statement of wind effects for the ground level areas adjacent to the proposed development at **629-639 Pacific Highway, Chatswood, NSW**. This appraisal is based on Vipac's experience as a wind-engineering consultancy.

The site of proposed development is bounded by Pacific Hwy to the west, Hammond Ln to the east, Gordon Ave to the north and the existing developments to the south (see Figure 1). The proposed development has a rhombus plan with a building height of 27 storeys from the ground level (Figure 2). The surrounding developments within a 3km radius are low density suburban dwellings and forested parklands (Figure 3).

This report details the opinion of Vipac as an experienced wind engineering consultancy regarding the wind effects in ground level public areas and access-ways adjacent to the development as proposed. No wind tunnel testing has been carried out for this development at this stage. Vipac has carried out wind tunnel studies on a large number of developments of similar shape and having similar exposure to that of the proposed development. These serve as a valid reference for the prediction of wind effects for this development. Empirical data for typical buildings in boundary layer flows has also been used to estimate likely ground level wind conditions adjacent to the proposed development [2] & [3].

Updated drawings of the proposed development were provided by **Dem (Aust) Pty Ltd** in **Aug 2020** as listed in Appendix C of this report.



Figure 1: Aerial view of the proposed development site at 629-639 Pacific Highway, Chatswood

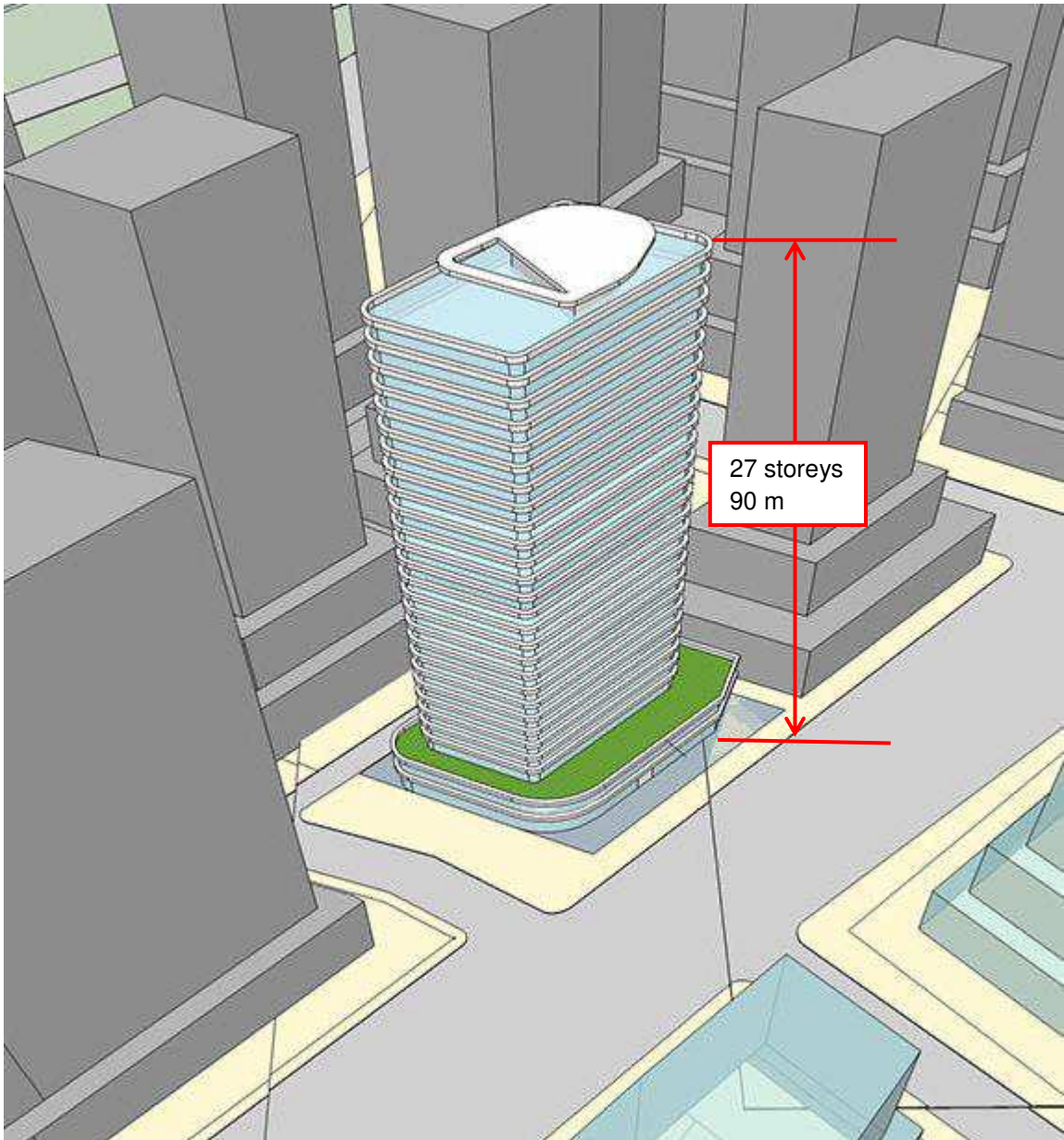


Figure 2: Proposed building envelope with approximate height

2 ANALYSIS APPROACH

When considering whether a proposed development is likely to generate adverse wind conditions in adjacent ground level areas, Vipac considers five main points:

- The exposure of the proposed development to wind;
- The regional wind climate;
- The geometry and orientation of the proposed development;
- The interaction of flows with adjacent developments;
- The assessment criteria, determined by the intended use of the public areas affected by wind flows generated or augmented by the proposed development.

The pedestrian wind comfort at specific locations around a site may be assessed by predicting the worst annual 3-second wind gust expected at that location. The location may be deemed generally acceptable for its intended use if the annual 3-second gust is within the threshold values noted in Section 2.5. For cases where Vipac predicts that a location would not meet its appropriate comfort criterion we may recommend the use of wind control devices and/or local building geometry modifications to achieve the desired comfort rating. For complex flow scenarios or where predicted flow conditions are well in excess of the recommended criteria, Vipac recommends scale model wind tunnel testing to determine the type and scope of the wind control measures required to achieve acceptable wind conditions.

2.1 SITE EXPOSURE

The proposed development spans across a sloping hill (fall from east to west) and is predominantly surrounded within a 3 km radius by suburban housing and low density residential developments and forested parklands. Therefore, for the current study, the site of the proposed development is considered to be Terrain Category 3 for all wind directions [1] (see Figure 3).

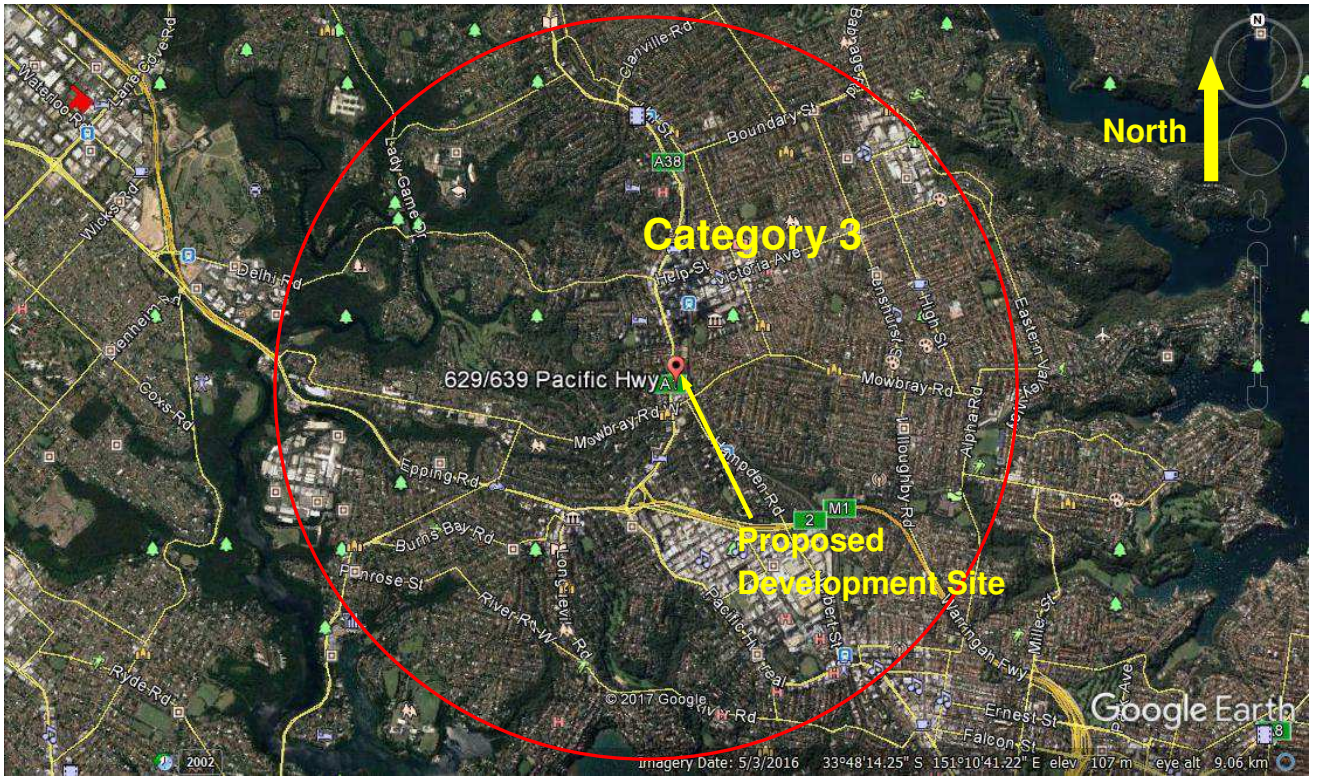


Figure 3: Assumed terrain categories for wind speed estimation.

2.2 REGIONAL WIND CLIMATE

The mean and gust wind speeds have been recorded in the Sydney area for 30 years. These data have been analysed and the directional probability distribution of wind speeds have 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) is shown in Figure 4. The wind data at this free stream height are common to all Sydney city sites and may be used as a reference to assess ground level wind conditions at the site. Figure 4 indicates that the stronger winds can be expected from the south to north-westerly directions, followed by south, then North Easterly directions.

Yearly Mean Wind Speeds (m/s), at 500 m height, Cat 2, Sydney

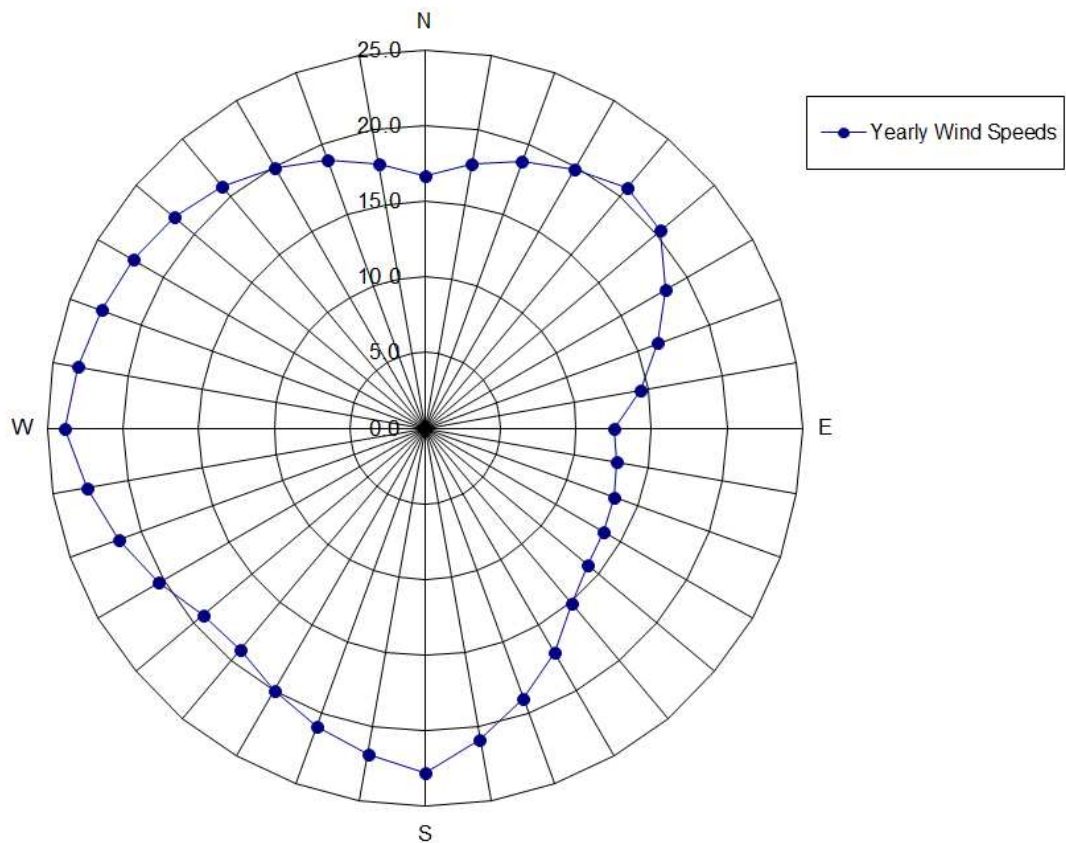


Figure 4: Directional Distribution of Annual Return Period Maximum Mean Hourly Wind Velocities (m/s) at gradient height in Sydney.

2.3 BUILDING GEOMETRY AND ORIENTATION

The ground level plan of the proposed development is shown in Figure 5. The ground floor layout covers a 25 m by 47 m plan with the long side running N - S direction.

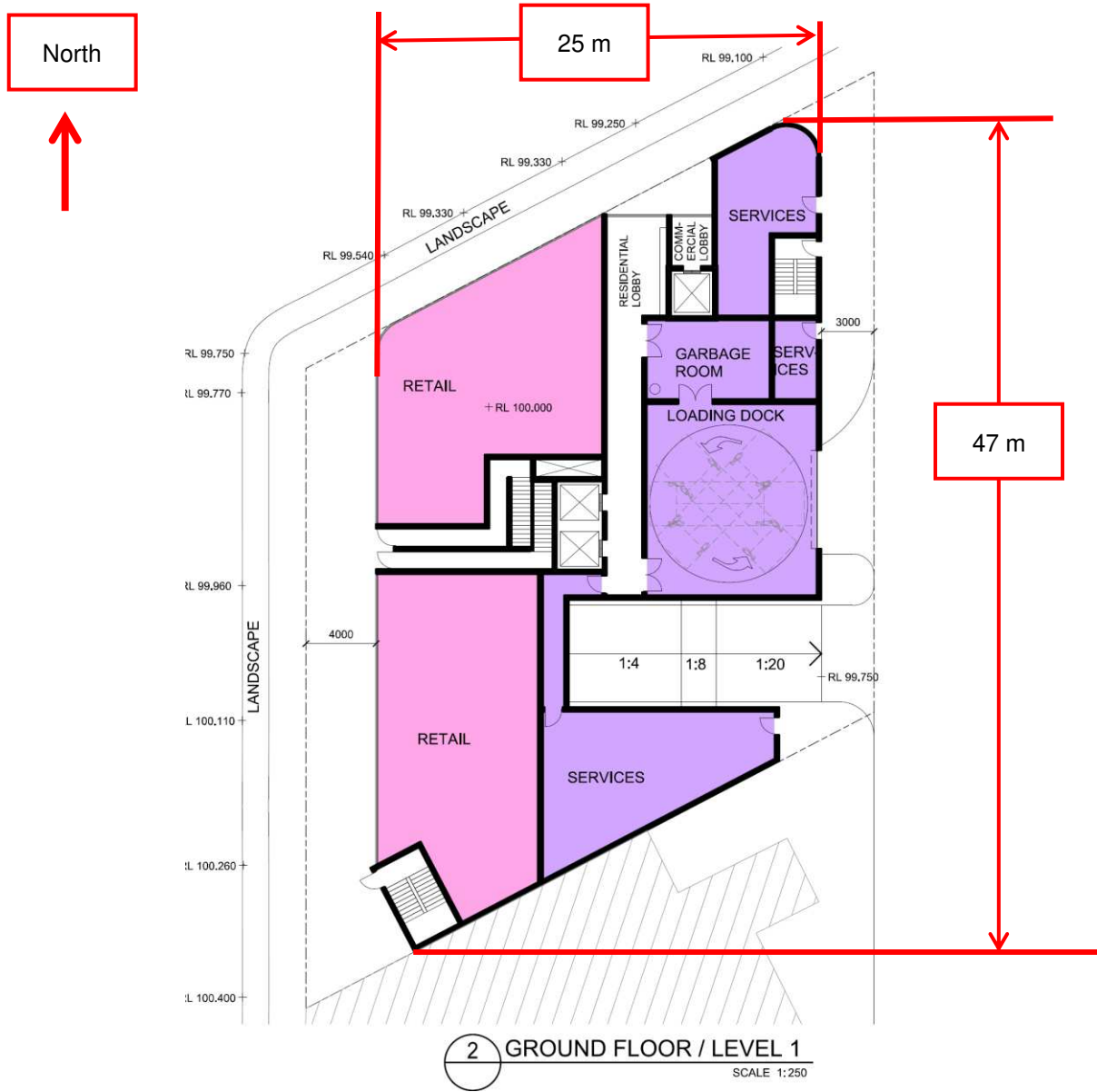


Figure 5: Ground level plan of the proposed development.

2.4 FLOW INTERACTIONS WITH ADJACENT DEVELOPMENTS

The buildings immediately adjacent to the proposed development site, with their approximate number of storeys are shown in Figure 6.

The proposed development is surrounded by low rise buildings (1-5 storeys) in all directions.

The prevailing winds are from the west and the south sectors. The ground level areas are sheltered by neighbouring buildings for southerly, easterly and westerly winds; it is relatively exposed to the prevailing winds for west/northwest sector over the roof of the 1-2 storey buildings across the intersection of Pacific Hwy and Gordon Ave.



Figure 6 : Immediately adjacent buildings and their approximate number of storeys (F)

2.5 ASSESSMENT CRITERIA

With some consensus of international opinion, pedestrian wind comfort is rated according to the suitability of certain activities at a site in relation to the expected annual peak 3-second gust velocity at that location for each wind direction. Each of the major areas around the site are characterized by the annual maximum gust wind speeds. Most patrons would consider a site generally unacceptable for its intended use if it were probable that during one annual wind event, a peak 3-second gust occurs which exceeds the established comfort threshold velocity (shown in Table 1). If that threshold is exceeded once per year then it is also likely that during moderate winds, noticeably unpleasant wind conditions would result, and the windiness of the location would be considered as unacceptable.

Table 1: Recommended Wind Comfort and Safety Gust Criteria

Annual Maximum Gust Speed	Result on Perceived Pedestrian Comfort
>23m/s	Unsafe (frail pedestrians knocked over)
<20m/s	Acceptable for fast walking (waterfront or particular walking areas)
<16m/s	Acceptable for walking (steady steps for most pedestrians)
<13m/s	Acceptable for standing (window shopping, vehicle drop off, queuing)
<11m/s	Acceptable for sitting (outdoor cafés, gardens, park benches)

In a similar manner, a set of hourly mean velocity criteria (see Table 2) with a 0.1% probability of occurrence are also applicable to ground level areas in and adjacent to the proposed development. An area should be within both the relevant mean and gust limits in order to satisfy the particular human comfort and safety criteria in question.

Table 2: Recommended Wind Comfort and Safety Mean Criteria

Mean Speed in 0.1% of Time	Result on Perceived Pedestrian Comfort
>15m/s	Unsafe (frail pedestrians knocked over)
<13m/s	Acceptable for fast walking (waterfront or particular walking areas)
<10m/s	Acceptable for walking (steady steps for most pedestrians)
<7m/s	Acceptable for standing (window shopping, vehicle drop off, queuing)
<5m/s	Acceptable for sitting (outdoor cafés, gardens, park benches)

The Beaufort Scale is an empirical measure that related the wind speed to observed conditions on the land and sea. Table 3 describes the categories of the Beaufort Scale. The comparison between these observed conditions and the comfort criteria described above can be found in Table 4.

Table 3: Beaufort Scale - empirical measure relating wind speed to observed conditions on land

Beaufort Number	Descriptive Term	Wind Speed at 1.75 m height (m/s)	Specification for Estimating Speed
0	Calm	0-0.1	
1	Light Air	0.1-1.0	No noticeable wind
2	Light Breeze	1.1-2.3	Wind felt on face
3	Gentle Breeze	2.4-3.8	Hair disturbed, clothing flaps, newspapers difficult to read
4	Moderate Breeze	3.9-5.5	Raises dust and loose paper; hair disarranged
5	Fresh Breeze	5.6-7.5	Force of wind felt on body, danger of stumbling when entering a windy zone
6	Strong Breeze	7.6-9.7	Umbrellas used with difficulty, hair blown straight, difficult to walk steadily, sideways wind force about equal to forwards wind force, wind noise on ears unpleasant
7	Near Gale	9.8-12.0	Inconvenience felt when walking
8	Gale	12.1-14.5	Generally impedes progress, great difficulty with balance in gusts
9	Strong Gale	14.6-17.1	People blown over

Table 4: Comparison between Mean comfort criteria and the observed conditions

Comfort Criteria	Beaufort Scale Equivalent
Safety	9 – Strong Gale
Walking	5 – Fresh Breeze
Standing	4-5 – Moderate to Fresh Breeze
Sitting	<4 – Moderate Breeze

2.6 USE OF ADJACENT PEDESTRIAN OCCUPIED AREAS & RECOMMENDED COMFORT CRITERIA

The following table lists the specific areas adjacent to the development and the corresponding recommended criteria. These are shown in Figure 7 to Figure 8.

Table 5: Recommended application of criteria

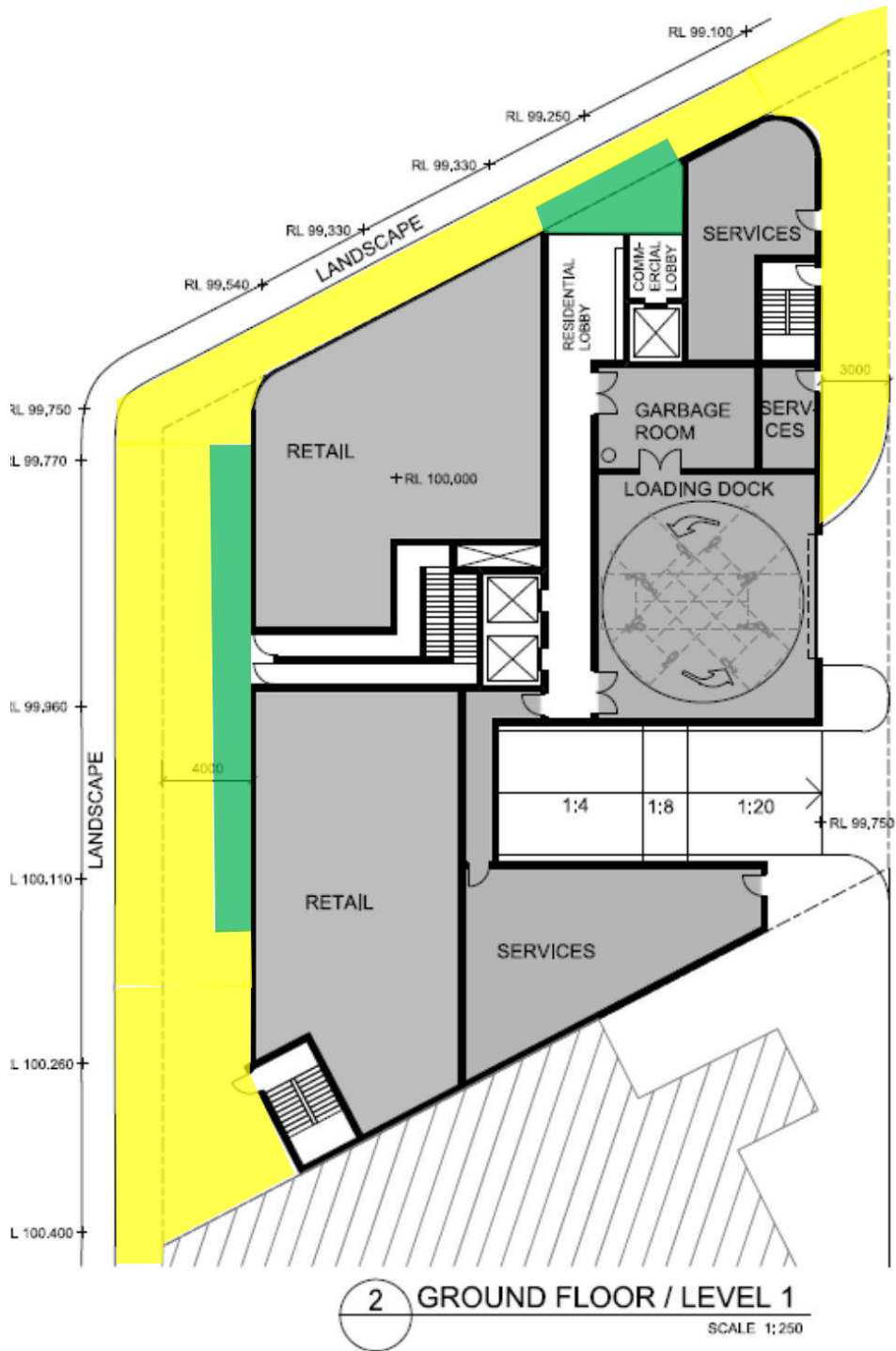
Area	Specific location	Recommended Criteria
Public Footpaths and Access ways	Around the proposed development on Hammond Ln, Pacific Hwy and Gordon Ave (Figure 7)	Walking
Building entrances	Entrances at the street scape on Pacific Hwy and Gordon Ave (Figure 7)	Standing
Podium Roof Terrace/balconies	Communal open space at Level 3 (Figure 8) Balconies on north and east façades of the tower	Walking (refer the discussion below)

2.6.1 APARTMENT BALCONY AND ROOFTOP AREAS RECOMMENDED CRITERION DISCUSSION

Vipac recommends as a minimum that apartment balcony/rooftop terrace areas meet the criterion for walking since:

- these areas are not public spaces;
- the use of these areas is optional;
- many similar developments in Sydney and other Australian capital cities experience wind conditions on balconies and elevated deck areas in the vicinity of the criterion for walking.

However, it should be noted that meeting the walking criterion on elevated recreation areas will be no guarantee that occupants will find wind conditions in these areas acceptable at all times.



Recommended to fulfil Walking Recommended to fulfil Standing

Figure 7: Ground floor plan/L1 of the proposed development with the recommended wind criteria overlaid.

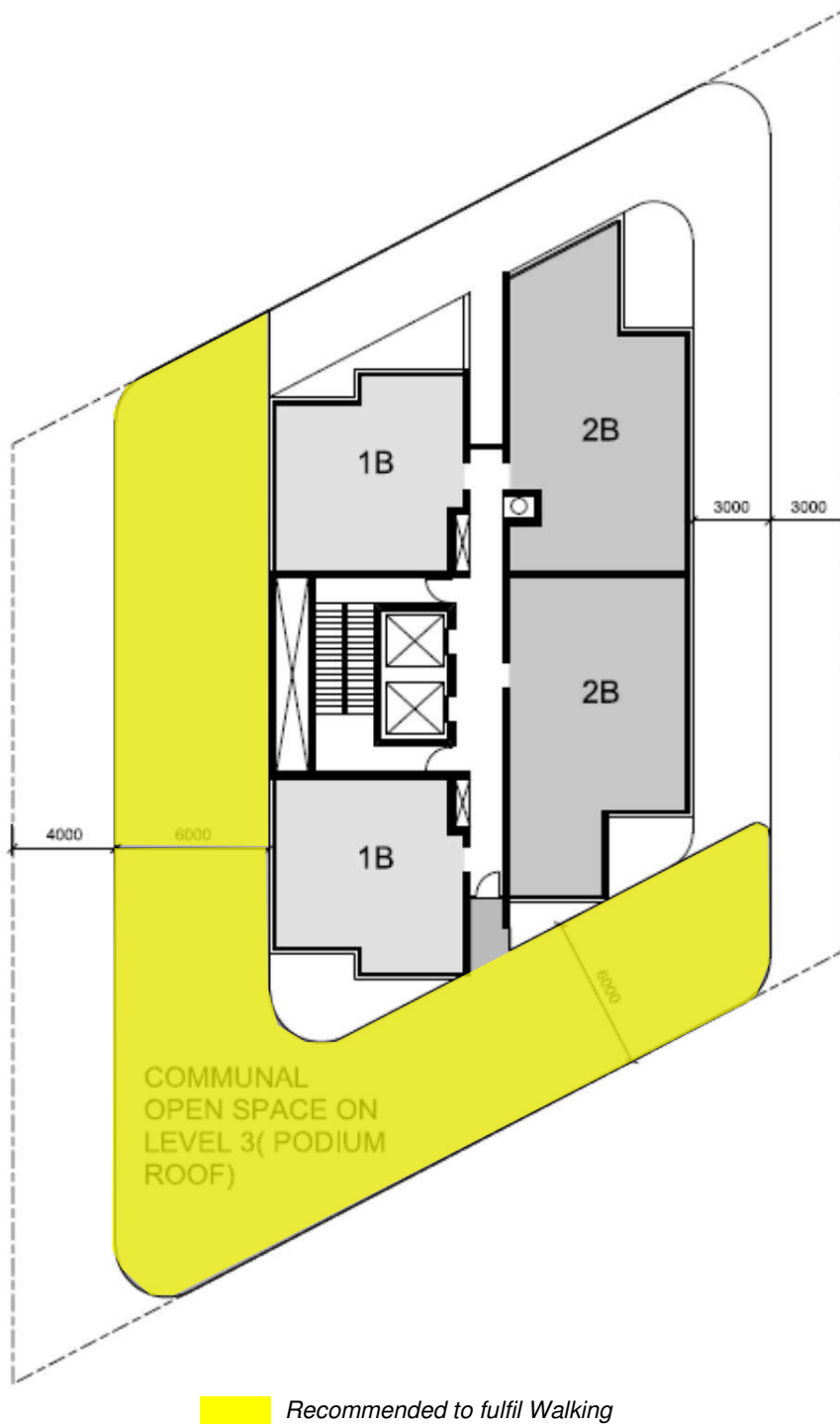


Figure 8: Podium roof plan of the proposed development with the recommended wind criteria overlaid.

3 PEDESTRIAN LEVEL WIND EFFECTS

3.1 DISCUSSION

The proposed design incorporates some wind mitigating features, these include the following:

- 4 m setback from Pacific Highway, and 3 m set back from Hammond Ln;
- Rounded building envelope at the building corners;
- Landscaping at podium roof and tower rooftop;
- Some inset balconies on the tower facades;

Ground Floor

Wind conditions at the footpath areas along Pacific Hwy are relatively exposed to westerly winds; however, due to the setback design, it is not expected that wind levels in this area would exceed the criterion for walking. The footpath at other streetscapes would also be expected to have wind conditions on or within the recommended walking criterion.

The main entry lobby of the building on Gordon Ave has a setback design and would be not expected to experience wind levels in excess of the criterion for standing. The retail entrances would be expected to be within or on the standing criterion, if they are proposed away from building corners.

Podium Roof Terrace

The proposed landscaping at the podium roof can significantly improve the wind conditions at the terrace areas. However, the southwest corner might have wind conditions exceeding the walking criterion due to the westerly winds around the corner. Higher balustrade/windscreen and a pergola could be used to improve the wind environment at these areas (see Section 3.2).

Tower Rooftop Terrace

The proposed landscaping at the rooftop can significantly improve the wind conditions at the terrace areas. However, the roof terrace would be expected to experience high winds exceeding the walking comfort criterion from the west and southwest sectors. Higher balustrade/windcreens at the terrace perimeter could be used to improve the wind environment at these areas (see Section 3.2).

Balconies General

Whilst wind conditions on the balconies of the proposed development will frequently be acceptable for outdoor recreation, during moderate to strong winds, conditions in these areas may exceed human comfort criteria. Balcony areas on similar developments in many major Australian capital cities typically experience similar elevated wind conditions. High exposure, corner acceleration flows and standing vortices would sometimes preclude these areas from use for outdoor recreation. The incorporation of wintergarden designs for the balconies would achieve improved wind environment for these areas.

3.2 RECOMMENDATIONS

After careful consideration of the areas at the base of the proposed development, Vipac predicts that the proposed development will present some changes to existing wind conditions in adjacent ground level areas. However, it would be not expected to have wind levels in exceeding of the recommended comfort criteria in the pedestrian levels.

However, Vipac predicts that the southwest corner of the podium roof terrace would be expected to have some exceedance of the walking criterion. An increasing in balustrade height to ≥ 1.4 m at the west side and a pergola structure at the corner areas are recommended (Figure 9). A pergola structure at the proposed west seating area is also recommended should this area be required to fulfil more stringent criterion for seated comfort.

The tower rooftop terrace would be expected to experience high winds from the west and south west sectors. Incorporating a high balustrade/windscreen of ≥ 1.8 m at the terrace perimeter is recommended to improve these wind conditions (Figure 9). A pergola structure at the proposed seating area is also recommended should this area be required to fulfil more stringent criterion.

Furthermore, as a general statement, common to all developments of this height, educating occupants about wind conditions at high-level terraces/balconies during high-wind events and tying down lightweight furniture are highly recommended.

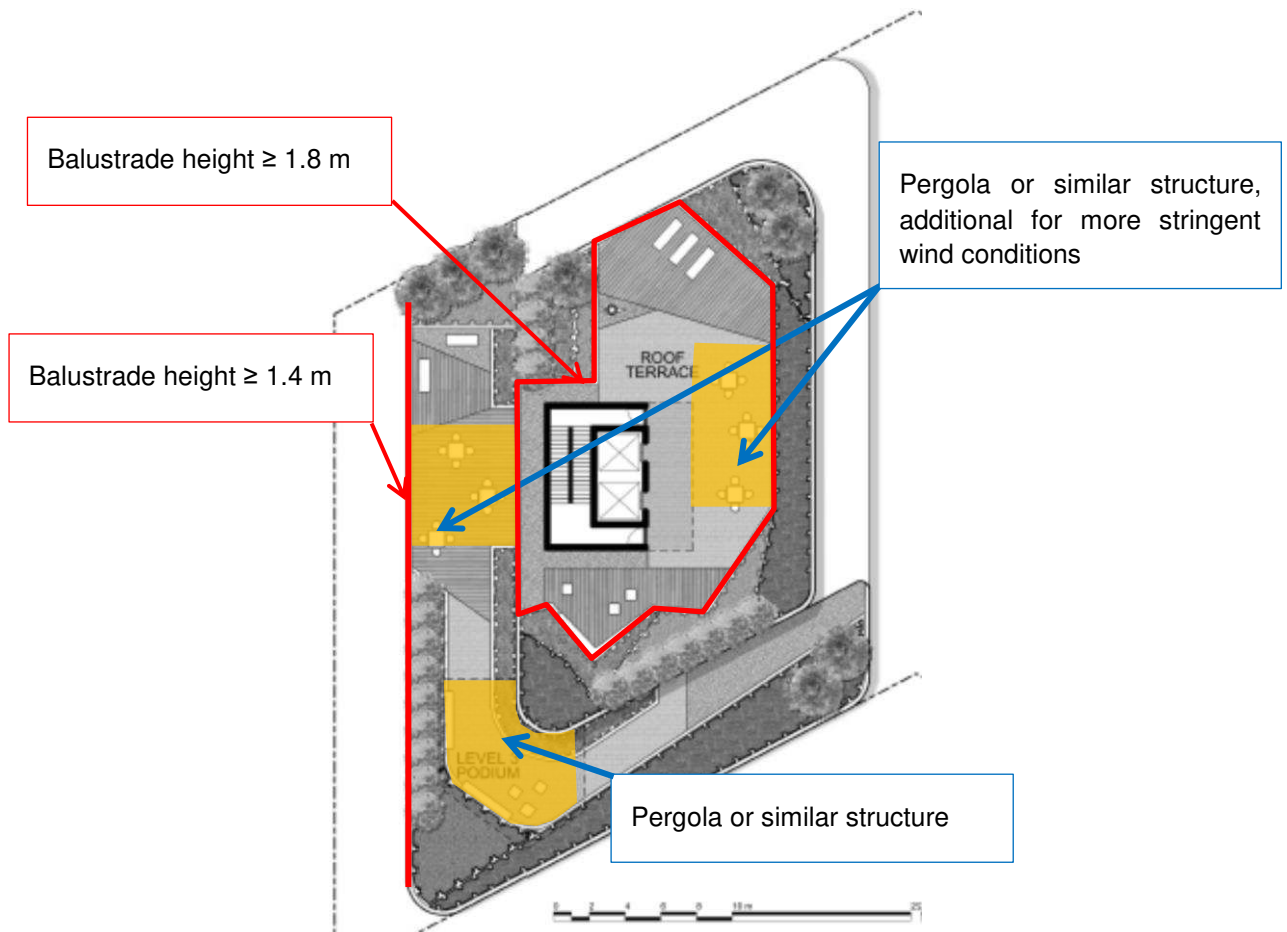


Figure 9: Recommended wind control measures for the open space at the podium roof and tower rooftop terraces

4 CONCLUSIONS

An assessment of the likely wind conditions at pedestrian level of the proposed development at **629-639 Pacific Highway, Chatswood, NSW** has been made.

Vipac has carefully considered the form and exposure of the proposed development, nominated criteria for various public areas according to their function and referred to past experience to produce our opinion of likely wind conditions. Based on this assessment, the following conclusions are drawn:

- With the proposed design, the adjacent footpaths would be expected to have wind levels within the walking comfort criterion.
- The wind conditions near the main entrance areas would be expected to be within the criterion for standing comfort.
- With the proposed design and recommended wind control measures, the wind conditions in the podium roof terrace areas and roof top terraces would be expected to be within the criterion for walking.
- Additional pergola structures are also recommended should the proposed seating areas on terraces be required more stringent sitting comfort criterion.

As a general statement, educating occupants about wind conditions at open terrace/balcony areas during high-wind events and fixing loose, lightweight furniture on the terrace are highly recommended.

The assessments provided in this report have been made based on experience of similar situations in Sydney and around the world. As with any opinion, it is possible that an assessment of wind effects based on experience and without experimental validation may not account for all complex flow scenarios in the vicinity. Vipac recommends a scaled wind tunnel study in the detail design stage to verify the predictions and determine the optimal wind controls, wherever necessary.

This Report Has Been Prepared

For

DPG Project 23 Pty Ltd

By

VIPAC ENGINEERS & SCIENTISTS LTD.

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: REFERENCES

- [1] *Structural Design Actions, Part 2: Wind Actions*, Australian/New Zealand Standard 1170.2:2011
- [2] *Wind Effects on Structures* E. Simiu, R Scanlan, Publisher: Wiley-Interscience
- [3] *Architectural Aerodynamics* R. Aynsley, W. Melbourne, B. Vickery, Publisher: Applied Science Publishers



Appendix C: DRAWING LIST

Name

Date Received

Pages From Appendix B-Urban Design Report

August 2020

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