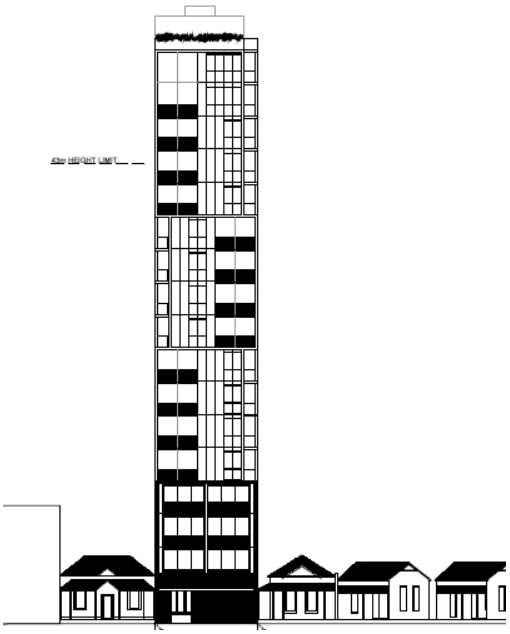
Vipac Engineers and Scientists Limited
279 Normanby Rd, Port Melbourne, VIC 3207, Australia
Private Bag 16, Port Melbourne, VIC 3207, Australia
t. +61 3 9647 9700 | **f.** +61 3 9646 4370 | **e.** melbourne@vipac.com.au
w. www.vipac.com.au | A.B.N. 33 005 453 627 | A.C.N. 005 453 627

Vipac Engineers & Scientists

Lelio Bibbo Consulting Engineers Pty Ltd

126 Wright Street, Adelaide

Wind Impact Statement



30N-17-0061-TNT-616923-0

27 April 2017

Report Title: Wind Impact Statement **Job Title: 126 Wright Street, Adelaide**	
DOCUMENT NO: 30N-17-0061-TNT-616923-0 **PREPARED FOR:** Lelio Bibbo Consulting Engineers Pty Ltd 40 Franklin St Adelaide , South Australia, Australia **CONTACT:** Lelio Bibbo **Tel:** 08 82127966 **Fax:** 08 82124911	**REPORT CODE:** TNT **PREPARED BY:** Vipac Engineers and Scientists Limited 279 Normanby Rd, Port Melbourne, VIC 3207, Australia **Tel:** +61 3 9647 9700 **Fax**: +61 3 9646 4370
PREPARED BY: Author: Eric Yuen Project Engineer	Date: 27 Apr 2017
REVIEWED BY: Reviewer: Dr Zhuyun Xu Senior Wind Consultant	Date: 27 Apr 2017
AUTHORISED BY: Sophie Lamande Wind Group Leader	Date:27 Apr 2017

REVISION HISTORY		
Revision No.	Date Issued	Reason/Comments
0	27/04/2017	Initial Issue
1		
2		

DISTRIBUTION		
Copy No._____	**Location**	
1	Project	
2	Client (PDF Format)	Uncontrolled Copy
3		

KEYWORDS:

EXECUTIVE SUMMARY

Lelio Bibbo Consulting Engineers 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 **126 Wright Street, Adelaide**. . This appraisal is based on Vipac's experience as a wind-engineering consultancy.

The drawings of the proposed development were provisioned by **Enzo Caroscio Architecture & Design** in **April, 2017** as described in Appendix C of this report. The findings of this study can be summarized as follows:

- The proposed development would not generate wind conditions in excess of the criterion for safety.
- The ground level footpath and building entrances would be expected to have wind conditions within the recommended criteria.
- The amenity areas at Level 17 would be expected to have wind conditions over the recommended criterion. A 1.8m high balustrade or porous windscreen has been recommended for this area.
- The high level terrace areas are expected to experience wind conditions close to or above the recommended walking criterion. As a general statement, educating residents about wind conditions at high-level balconies and terrace areas during high-wind events and tying down loose lightweight furniture are highly recommended.

The assessments provided in this report have been made based on experience of similar situations in Adelaide 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 complex flow interactions 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.

TABLE OF CONTENTS

1 INTRODUCTION

Lelio Bibbo Consulting Engineers 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 **126 Wright Street, Adelaide**. This appraisal is based on Vipac's experience as a wind-engineering consultancy.

The proposed development is a residential building with a commercial ground floor. It consists of a single 17 storey tower with a maximum roof height of approximately 57 m. The surrounding developments are medium to high rise towers in the sector from north to northeast and mid to low rise developments plus parklands in all other directions. An aerial view of the proposed development site is shown in Figure 1. Figure 2 presents the north elevation of the proposed development showing the overall heights.

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].

Figure 1: Aerial view of the proposed development site at 126 Wright Street, Adelaide.

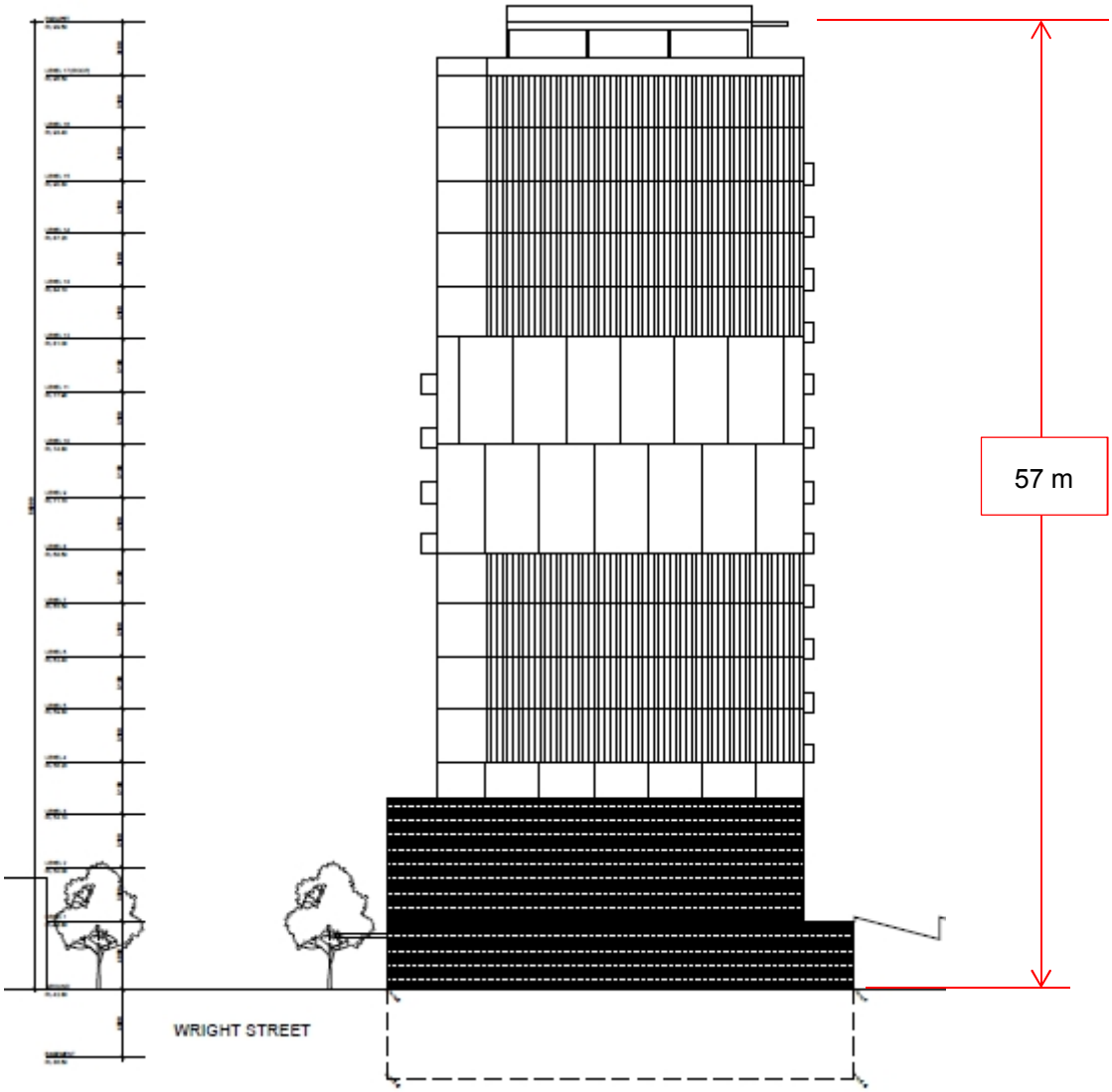


Figure 2: East elevation of the proposed development.

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 is a 17 storey residential building. The surrounding developments (within 2000 m radius) are medium to high rise towers in the sector from north to northeast and mid to low-rise developments plus parklands in all other directions.

Therefore, for the current study, considering the proximity to Adelaide's CBD and the immediate presence of medium to low rise buildings, the site of the proposed development is considered to be Terrain Category 3.5 from NNE to southeast wind directions and Terrain Category 3 for all other wind directions [1] (see Figure 3).

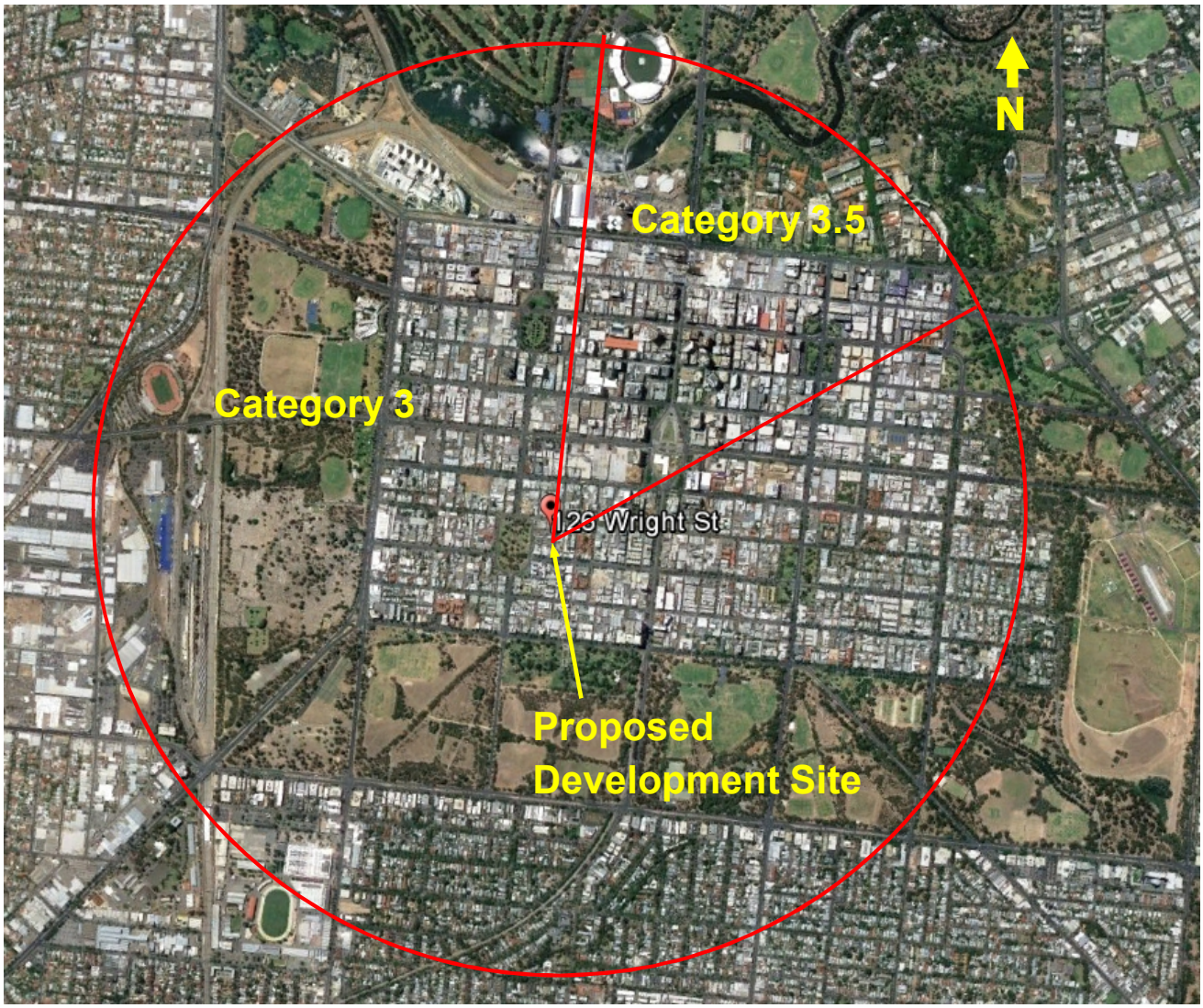


Figure 3: Terrain Categories for the site of the proposed development at 126 Wright Street, Adelaide.

2.2 REGIONAL WIND CLIMATE

The mean and gust wind speeds have been recorded in the Adelaide 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 (≈500m), 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 Adelaide 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-westerly, north-westerly and westerly directions.

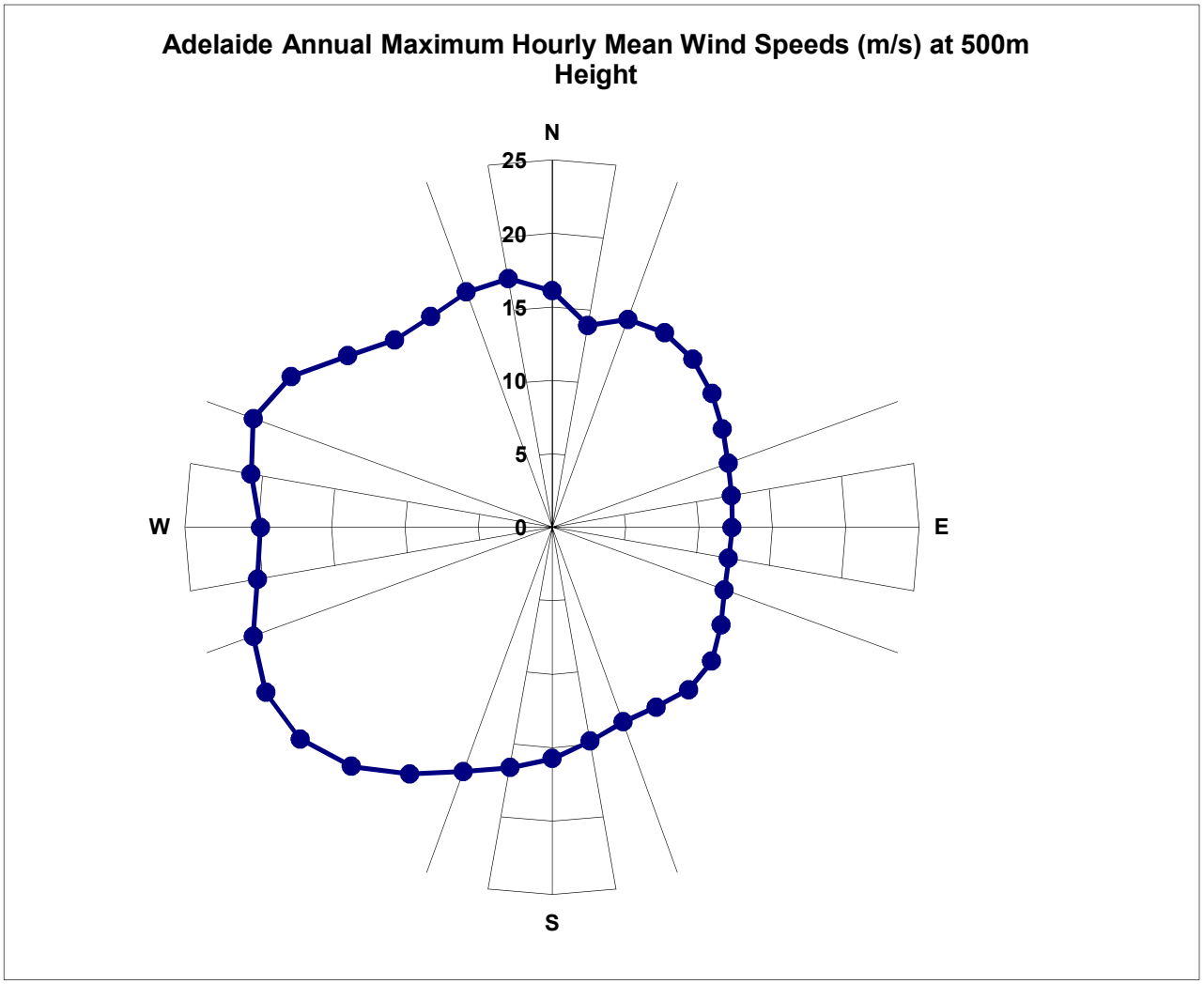


Figure 4: Directional Distribution of Annual Return Period Maximum Mean Hourly Wind Velocities (m/s) at gradient height of 500m in Adelaide.

2.3 BUILDING GEOMETRY AND ORIENTATION

The proposed development is a residential building. It consists of a rectangular building plan and has a maximum roof height of 57 m from the street level. The overall plan-form dimensions are 28 m x 10 m (approximately) with the long axis running north to south. The main building entrances are on the south along Wright Street (See Figure 5). The main footpaths are along Wright Street.

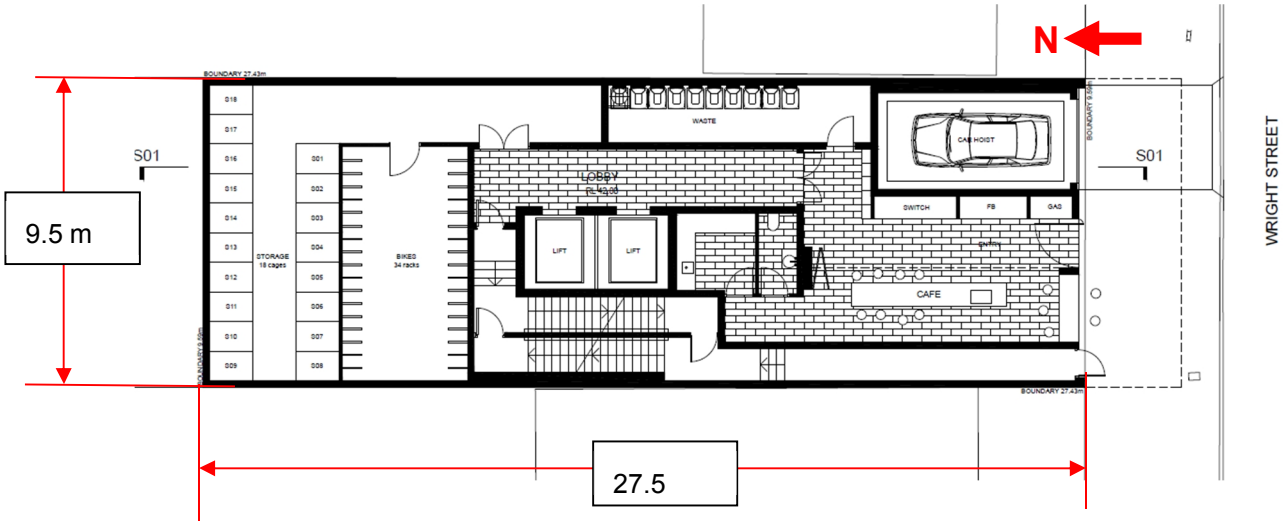


Figure 5: Ground floor plan of the proposed development.

2.4 FLOW INTERACTIONS WITH ADJACENT DEVELOPMENTS

The buildings immediately adjacent to the proposed development, with their number of floors, are shown in Figure 6. The proposed development is surrounded by 1 to 2 storey buildings in all directions. There are developments west of the site that are planned to be 14-22 floors high.

Figure 6: Immediately adjacent buildings and their number of floors.

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)

Intended Use of Adjacent Ground Level and Higher Level Amenity Areas

The ground level areas likely to be affected by wind conditions generated or augmented by the proposed development are the footpaths and entrances on North Terrace and West Terrace (see Figure 7). There is a proposed pool and deck terrace on Level 3 which would be used for communal amenity.

2.6 RECOMMENDED CRITERIA

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

Table 3: Recommended application of criteria

Area	Recommended Criteria
Footpaths and Walkthrough	to comply with the criterion for Walking
Building Entrances	to comply with the criterion for Standing
Terraces, Deck, and Balconies	to comply with the criterion for Walking (see discussion below)

Apartment Balcony and Rooftop areas Recommended Criterion Discussion

Apartment balconies are located on all facades of the proposed Development. Vipac recommends as a minimum the 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 Adelaide and other Australian capital cities experience wind conditions on balconies and elevated deck areas in the vicinity of the criterion for walking.

Figure 7 and Figure 8 highlight the areas on the ground floor and the 17th level of deck where compliance with the above criteria is recommended.

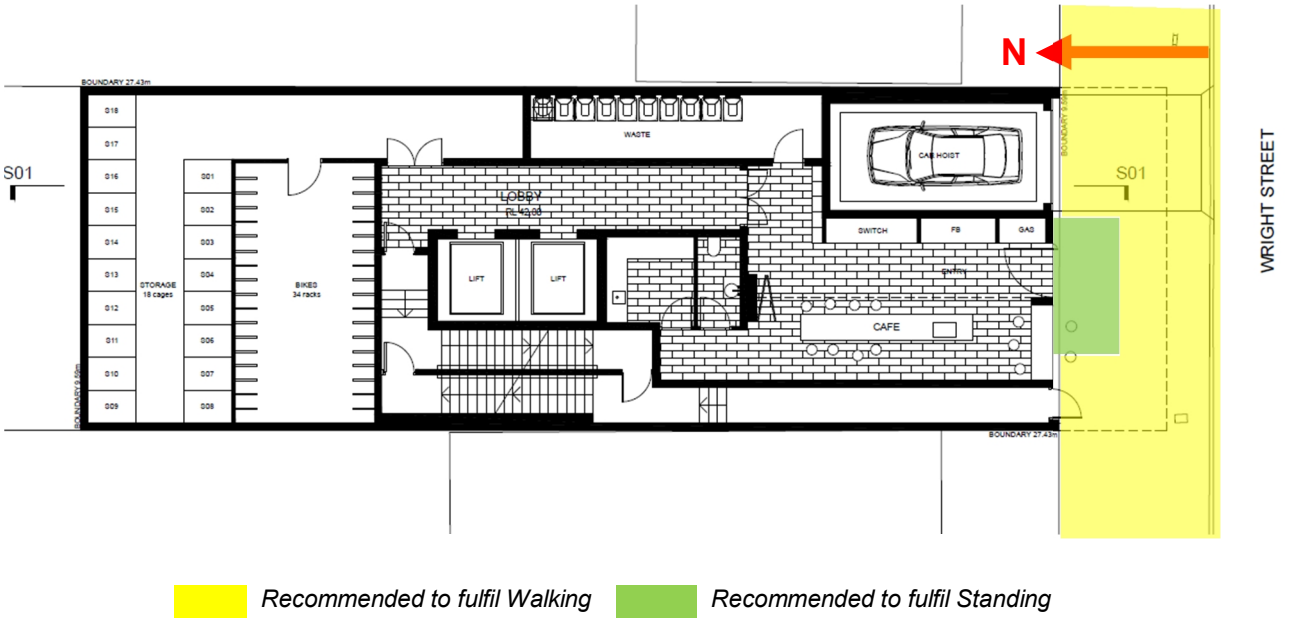


Figure 7: Plan view of the proposed development with the recommended wind criteria overlaid at ground level areas.

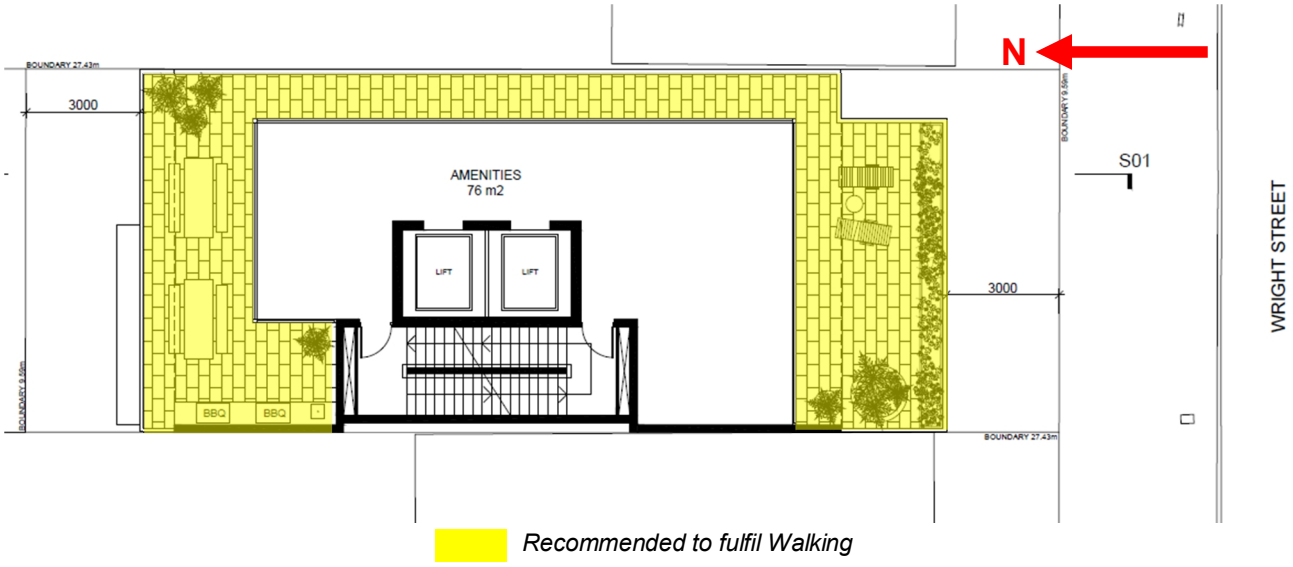


Figure 8: Plan view of the proposed development with the recommended wind criteria overlaid at level 17

3 PEDESTRIAN LEVEL WIND EFFECTS AND RECOMMENDATIONS

Key Points

- The proposed development would not generate wind conditions in excess of the criterion for safety.
- The wind conditions at the ground level footpath areas would be expected to be within the criterion for walking.
- The wind conditions near the entrance areas would be close to/within the criterion for standing.

Ground Level

The proposed development is surrounded by 1 to 2 storey buildings in the north, east and west directions and is significantly higher than the immediate surroundings and will become a wind catcher for most directions. The main entrance into the residential lobby and café area is located on the south side of the proposed development.

The downwash flows from south and west façades are the main concerns for the ground level footpath wind conditions; however, they are not likely to cause an exceedance of the walking or standing criterion due to the inclusion of a canopy at ground level.

Roof terrace at Level 17

Direct winds will be the main impact to the amenity areas at Level 17 as the terrace is exposed to prevailing winds. With the proposed design, this area would be expected to have wind conditions close to or over walking criterion. Recommendations have been made in the following section.

Some areas will need further sheltering should more stationary comfort conditions (standing or sitting) be required.

Balconies

Whilst wind conditions on the proposed apartment balconies 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.

3.1 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, Vipac does not predict any exceedance of the recommended wind comfort criteria at the ground level.

Vipac does predict an exceedance of the recommended walking criteria the Level 17 outdoor amenity area and recommends the following wind control measure:

- >1.8m high balustrade surrounding the outer perimeter of Level 17 (Figure 9).

As a general statement, educating residents about wind conditions at high-level balconies and terraces areas during high-wind events is also recommended. Additionally, tying down loose lightweight furniture is highly recommended.

It should be noted that this study is based on experience only and has not utilised any experimental data for the analysis.

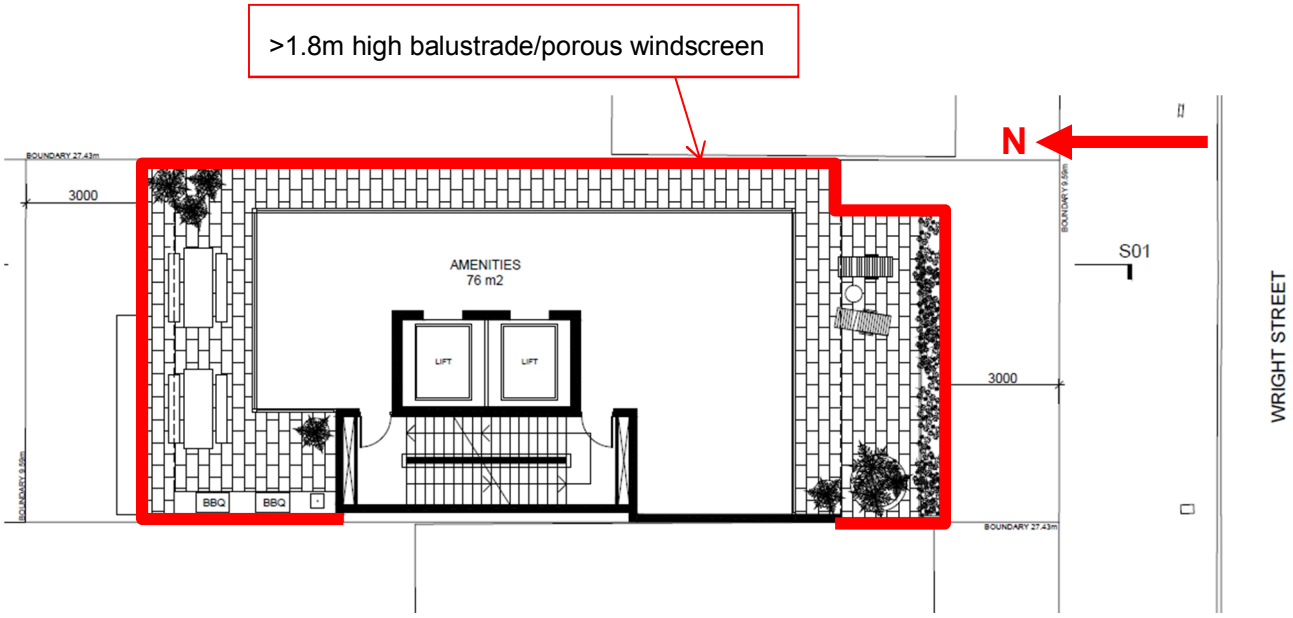


Figure 9: Level 17 of the proposed development with the recommended wind control measures overlaid

4 CONCLUSIONS

An appraisal of the likely wind conditions adjacent to and within the proposed development at **126 Wright Street, Adelaide** has been made

Vipac has carefully considered the flow structures likely to be generated by the proposed development that would affect ground level areas. From this analysis, the following conclusions are drawn:

- The proposed development would not generate wind conditions in excess of the criterion for safety.
- The ground level footpath and building entrances would be expected to have wind conditions within the recommended comfort criteria.
- The amenity areas at Level 17 would be expected to have wind conditions over the recommended criterion. A 1.8m high balustrade or porous windscreen has been recommended for this area.
- The high level terrace areas are expected to experience wind conditions close to or above the recommended walking criterion. As a general statement, educating residents about wind conditions at high-level balconies and terrace areas during high-wind events and tying down loose lightweight furniture are highly recommended.

The assessments provided in this report have been made based on experience of similar situations in Adelaide 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 complex flow interactions 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

Lelio Bibbo Consulting Engineers Pty Ltd

By

VIPAC ENGINEERS & SCIENTISTS PTY LTD

Appendix A: 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

[4] Updated drawings from Ground to Level 23; Elevation 01 to 02; Section 01 to 02; Landscaping plan and Northwest Perspective in pdf format provided by GHD Wood Head in Oct 2015.

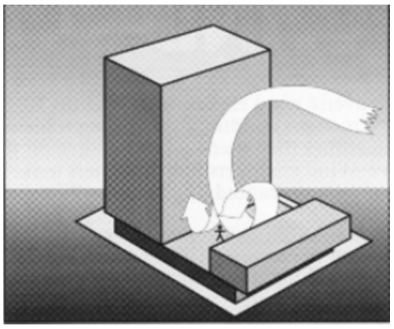
Appendix B: ENVIRONMETAL EFFECTS

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 C: DRAWING LIST

WRIGHT STREET APARTMENTS

Title	Drawing No.	Date
Ground Floor Plan	A2.02	27.02.17
Level 01-03 Plan	A2.03	27.02.17
Level 04-07 Plan	A2.04	27.02.17
Level 08-11 Plan	A2.05	27.02.17
Level 12-24 Plan	A2.06	27.02.17
Level 15 Plan	A2.07	27.02.17
Level 16 Plan	A2.08	27.02.17
Level 17 Plan	A2.09	27.02.17
Elevations	A3.00	27.02.17
Elevations	A3.01	27.02.17
Elevations	A3.02	27.02.17
Elevations	A3.03	27.02.17
Elevations	A3.04	27.02.17