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Bibking Pty Ltd

# 162-168 Gouger Street, Adelaide

# Wind Impact Assessment

30N-24-0295-TNT-86436-0

5 September 2024

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# Executive Summary

**Bibking 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 **162-168 Gouger Street, Adelaide.** This appraisal is based on Vipac's experience as a wind-engineering consultancy.

Drawings of the proposed development were provided by **Bibbo** in **July 2024**.

The findings of this study can be summarized as follows:

**With proposed design <u>and recommendations</u>**:

- Wind conditions in the ground level footpath areas and access ways would be expected to be within the **walking** comfort criterion.
- The building entrances would be expected to be within the **standing** comfort criterion;
- The podium roof terrace is expected to have wind conditions within the recommended **standing** comfort criterion.
- The wind conditions are expected to fulfil **safety** 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 Melbourne 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 wind tunnel test or CFD simulations be conducted to quantity the wind conditions and determine proper wind control measures wherever necessary.

# Table of Contents

# 1 Introduction

Vipac Engineers and Scientists has been commissioned by **Bibking Pty Ltd** to carry out an appraisal of the pedestrian wind effects at the ground level of the proposed development at **162-168 Gouger Street, Adelaide.**

Strong winds in pedestrian areas are frequently encountered in central business districts of cities around the world; including Sydney, Melbourne and Brisbane. Wind characteristics such as the mean speed, turbulence and ambient temperature determine the extent of disturbance to users of pedestrian areas. These disturbances can cause both comfort and safety problems and require careful consideration to mitigate successfully.

The proposed development is a 16-storey mixed use building with a roof height of 53 m from street level. The site is bounded by Gouger Street to the south, Oakley Street to the west, Storr Street to the east and the existing developments to the north. A satellite image of the proposed development site and the west elevation of the building are shown in Figure 1 and Figure 2, respectively.

This report details the opinion of Vipac as an experienced wind engineering consultancy regarding the wind effects in ground level footpath areas 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. Empirical data for typical buildings in boundary layer flows has also been used to estimate the likely wind conditions on the ground level areas of the proposed development [2] & [3].

Drawings of the proposed development were supplied to Vipac by **Bibbo** in **July 2024.** A list of drawings supplied is provided in Appendix C of this report.


*Figure 1: Aerial view of the proposed development site.*

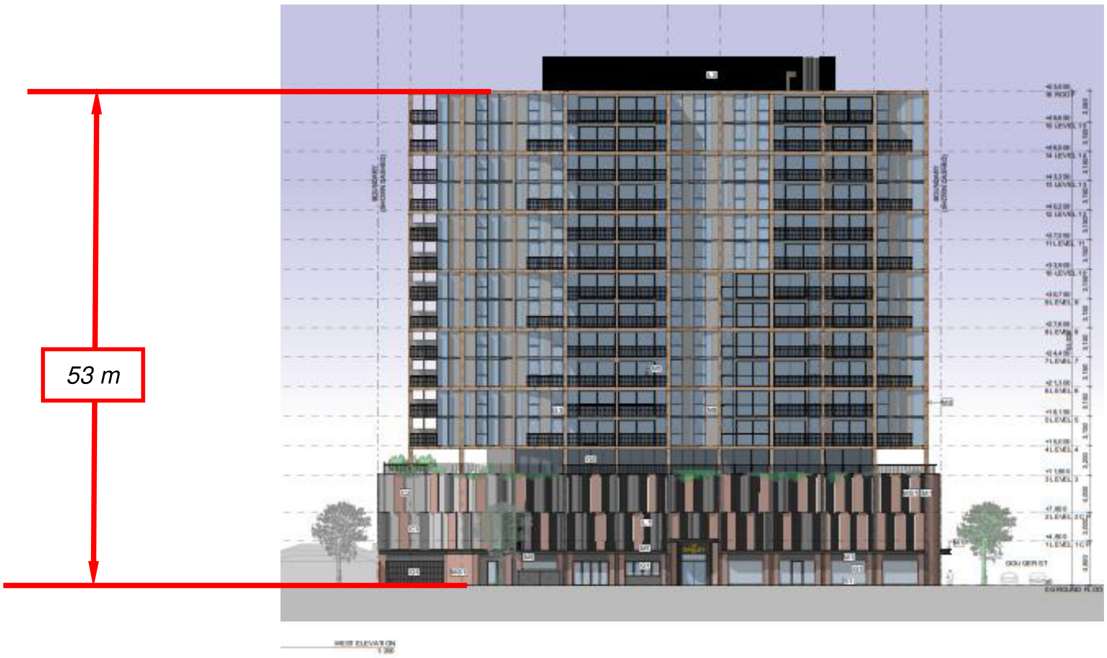



*Figure 2: West elevation of the proposed development.*

# 2 Analysis Approach

In assessing whether a proposed development is likely to generate adverse wind conditions in ground level footpath areas, Vipac has considered the following 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; and
- The assessment criteria determined by the intended use of the areas affected by wind flows generated or augmented by the proposed development.

The pedestrian wind comfort at specific locations of ground level footpath areas may be assessed by predicting the gust and mean wind speeds with a probability of once per year expected at that location. The location may be deemed generally acceptable for its intended use while gust and mean wind speeds are within the threshold values noted in Section 2.5. Where Vipac predicts that a location would not meet its appropriate comfort criterion, the use of wind control devices and/or local building geometry modifications to achieve the desired comfort rating may be recommended. 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 located on a relatively flat terrain. The site is surrounded within an approximately 3.2 km radius predominately by low to mid-rise developments with some high-rise buildings (Adelaide CBD) to the northeast. A satellite image showing these site surroundings is shown in Figure 3.

Considering the immediate surroundings and terrain, for the purposes of this study, the site of the proposed development is assumed to be within Terrain Category 3 for all wind directions (Figure 3).

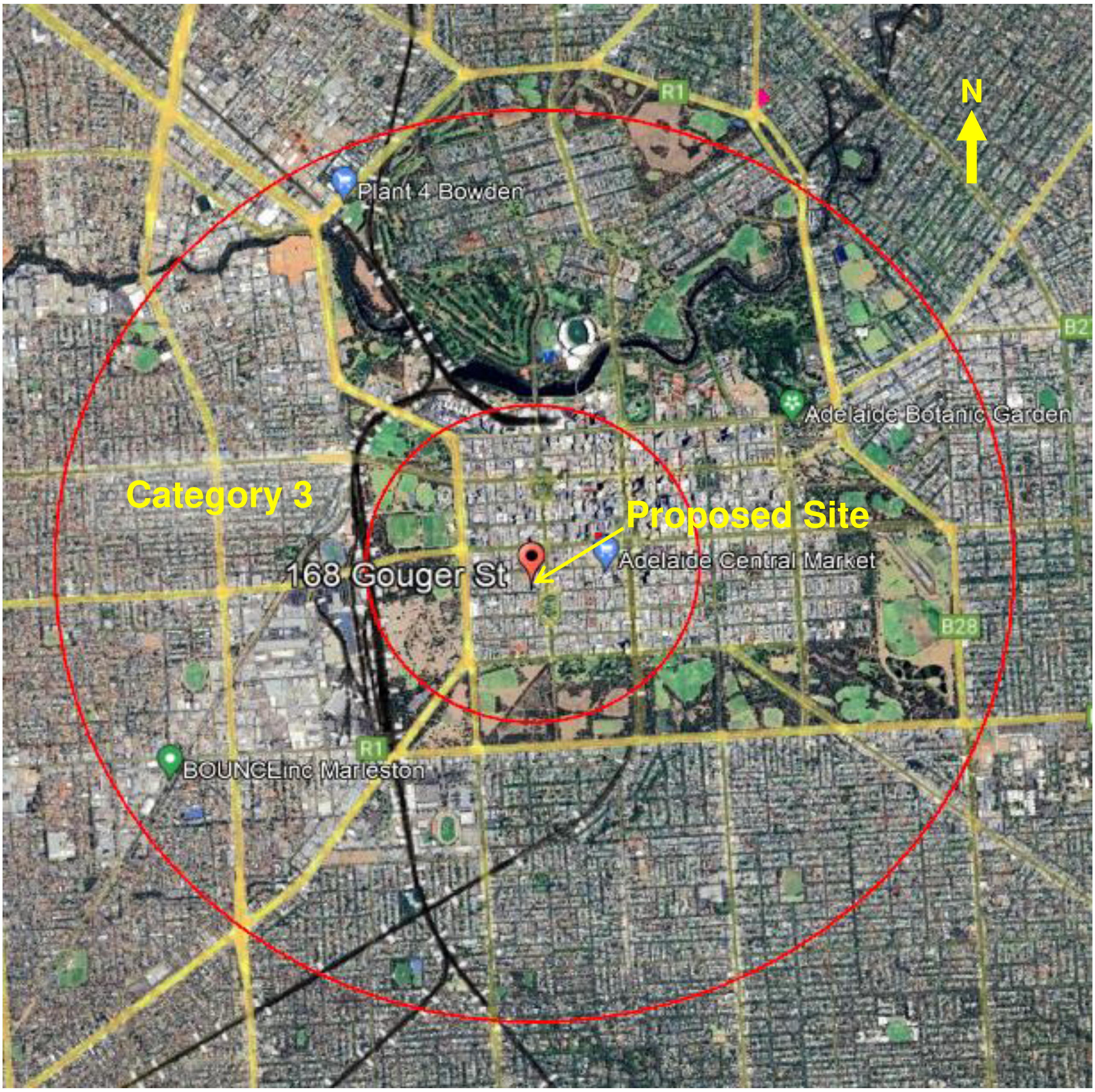



*Figure 3: Assumed terrain categories for wind speed estimation.*

## 2.2 Regional Wind Climate

The mean and gust wind speeds have been recorded in the 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.

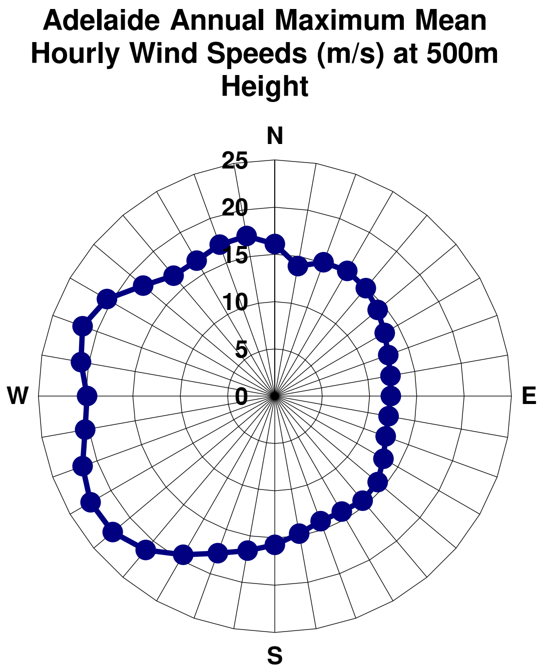



*Figure 4: Directional Distribution of Annual Return Period Maximum Mean Hourly Wind Velocities (m/s) at gradient height of 500m in Adelaide.*

## 2.3 Building Geometry and Orientation

The proposed development is a 16-storey mixed use building. The overall plan-form dimensions are approximately 25.7 m x 54.7 m as shown in Figure 5. The main entrance is located at Oakley Street and retail entrances are located at Oakley and Gouger Streets. The development incorporates some tower setbacks from all surrounding street boundaries.

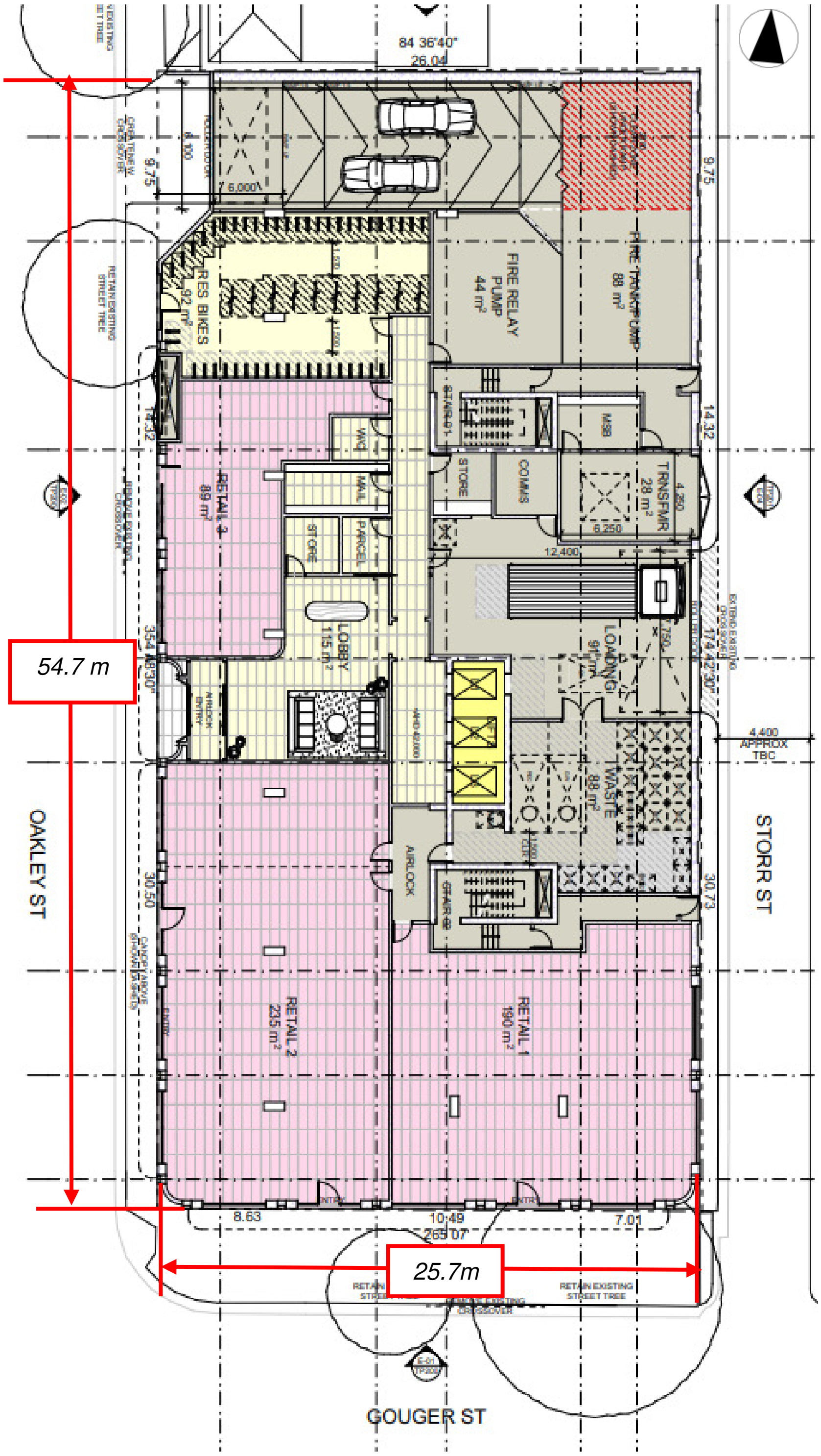



*Figure 5: Ground floor plans with the plan-form dimensions overlaid.*

## 2.4 Flow interactions with Adjacent Developments

The immediately adjacent developments are shown in Figure 6. At ground level, the site is exposed to direct winds from the westerly and southerly directions channelling along the three surrounding streets. The building is oriented such that adverse impacts from corner acceleration of westerly and southerly winds are expected at ground level. The development is taller than the surrounding buildings and so is exposed to winds from all directions at the upper levels.


*Figure 6: Immediately adjacent surroundings and their approximate number of floors (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) |
| <16m/s | Acceptable for Walking (steady steps for most pedestrians) |
| <13m/s | Acceptable for Standing (vehicle drop off, queuing) |
| <10m/s | Acceptable for Sitting (outdoor cafés, pool areas, gardens) |

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) |
| <10m/s | Acceptable for Walking (steady steps for most pedestrians) |
| <7m/s | Acceptable for Standing (vehicle drop off, queuing) |
| <5m/s | Acceptable for Sitting (outdoor cafés, pool areas, gardens) |

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 |

### 2.5.1 Use of Adjacent Pedestrian Occupied Areas & Recommended Comfort Criteria

The consideration of the (intended) function of the environment heavily influences the appropriateness of the recommended wind comfort criteria. For example, people frequenting locations such as parks are will likely tolerate a windier environment when compared to people dining at an outdoor café.

This is partly due to the pedestrian's judgement in clothing and predetermined expectation of the wind environment and partly due to the sensitivity of their activities to wind. For example, patrons at outdoor dining areas are highly sensitivity to wind due to the stationary nature of the activity; whereas pedestrians on the public footpaths may maintain a level of comfort under otherwise uncomfortable conditions by partaking in general activities performed on the footpath such as walking.

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

*Table 5: Recommended application of criteria*

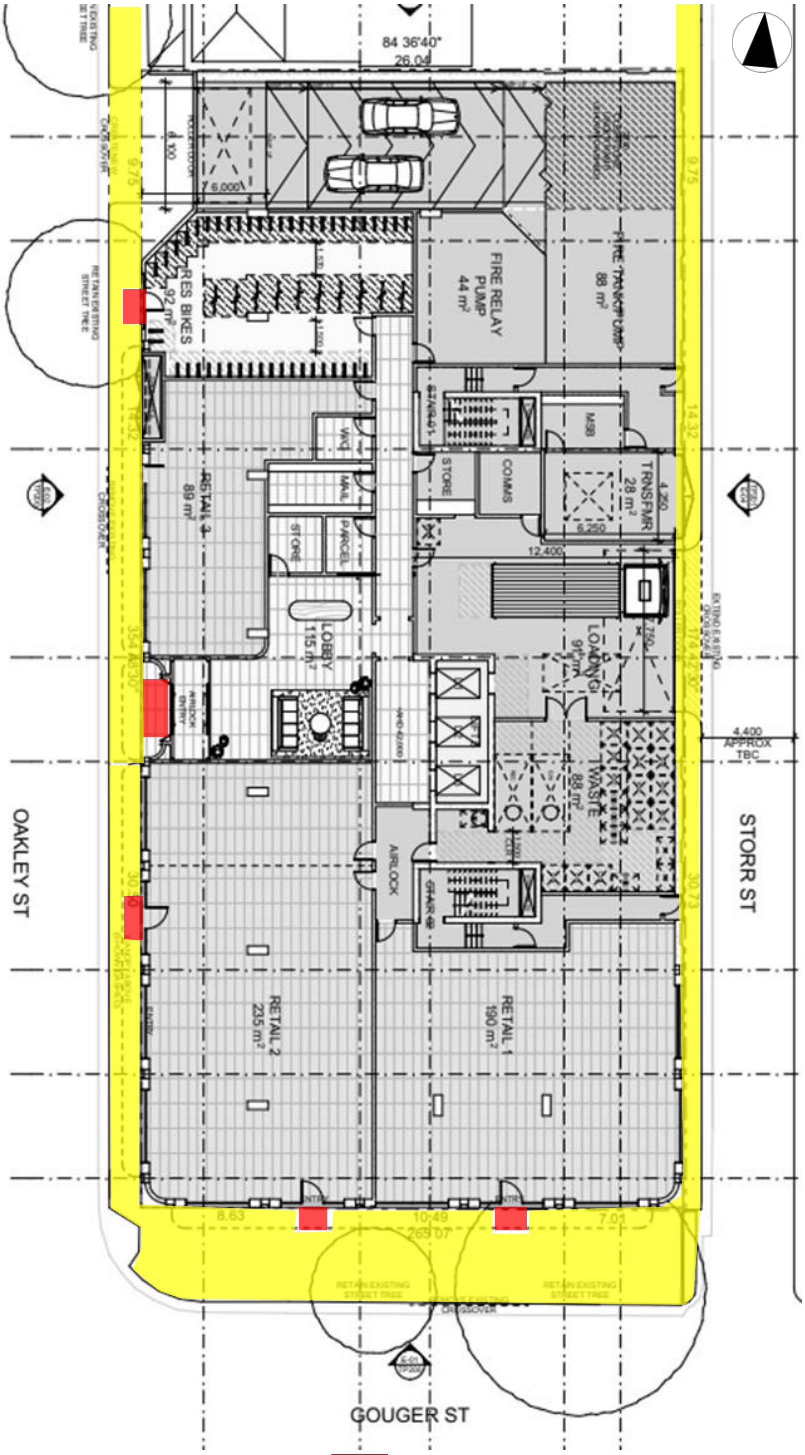
| Area | Specific location | Recommended Criteria |
|---|---|---|
| Public Footpaths, Access ways | Along Oakley Street, Gouger Street, and Storr Street (Figure 7) | Walking |
| Building Entrances | Building Entrances Along Gouger and Oakley Streets (Figure 7) | Standing |
| Outdoor Amenity Terrace | Level 3 (Figure 8) | Walking<br>(See discussion below) |
| Balcony/Terraces | Up the height of the building | Walking<br>(See discussion below) |

### 2.5.2 Terrace / Balcony Recommended Criterion Discussion

There are Private Balconies and Terraces located up the height of the development. Vipac recommends as a minimum that balcony/terrace areas meet the criterion for walking since:

- these areas are not public spaces;
- the use of these areas is optional, and only intended to be used on fair weather days with calm winds;
- residents at private open spaces can chose to retreat indoors during uncomfortable wind conditions, whiel a pedestrian or person using a public area may not have this option.
- 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.

In this study, the amenity terrace at level 3 is assessed against the more stringent standing criterion.




Recommended to fulfil Walking    Recommended to fulfil Standing

*Figure 7: Ground floor with recommended wind criteria overlaid.*


*Recommended to fulfil Standing*

*Figure 8: Level 3 plan with recommended wind criteria overlaid.*

# 3 Pedestrian Level Wind Effects

## 3.1 Discussion & Recommendations

The proposed design has a number of features that are expected to be beneficial to the pedestrian wind environment. This is inclusive but not limited to the following:

- Canopy along Oakley and Gouger Streets;
- Tower set back from level 3 upwards;
- Lobby entrance setback; and
- Landscaping at Level 3 terraces.

Due to the proposed height above the surrounding areas, the proposed development is particularly exposed to adverse winds from all directions. Such that high wind levels are expected along the three streetscapes. However, the proposed development has a setback tower design from level 3 upwards. These tower setbacks in combination with the canopy are expected to be beneficial to the wind environment on the ground floor; such that the most surrounding pedestrian streetscape is expected to be within the recommended walking comfort criterion.

High wind conditions are expected at the southwestern and southeastern corners due to the downwash and corner acceleration effects. It is recommended that some walls of the podium carpark to be made porous to create a bypass for the downwash flows to improve the ground floor wind conditions (Figure 9).

The building entrances are located along Oakley and Gouger Streets and away from building corners. In consideration of the proposed design features and the recommendation provided above, the entrances are expected to be within the recommended standing comfort criterion.

The terrace on level 3 has a number of features that are expected to be beneficial to the pedestrian wind environment. This is inclusive but not limited to the following:

- 1m high porous balustrades;
- Building over majority of the terrace;
- Colonnades; and
- Landscaping

However, as the standing criterion is targeted, it is recommended that the balustrades along the perimeter be made solid and raised to 1.5m. It is also recommended that the landscaping be minimum 1.8m high at strategic locations (Figure 10).

The wind conditions are expected to fulfil safety criterion.

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

Vipac recommends a wind tunnel test or CFD simulations be conducted to quantity the wind conditions and determine proper wind control measures wherever necessary.

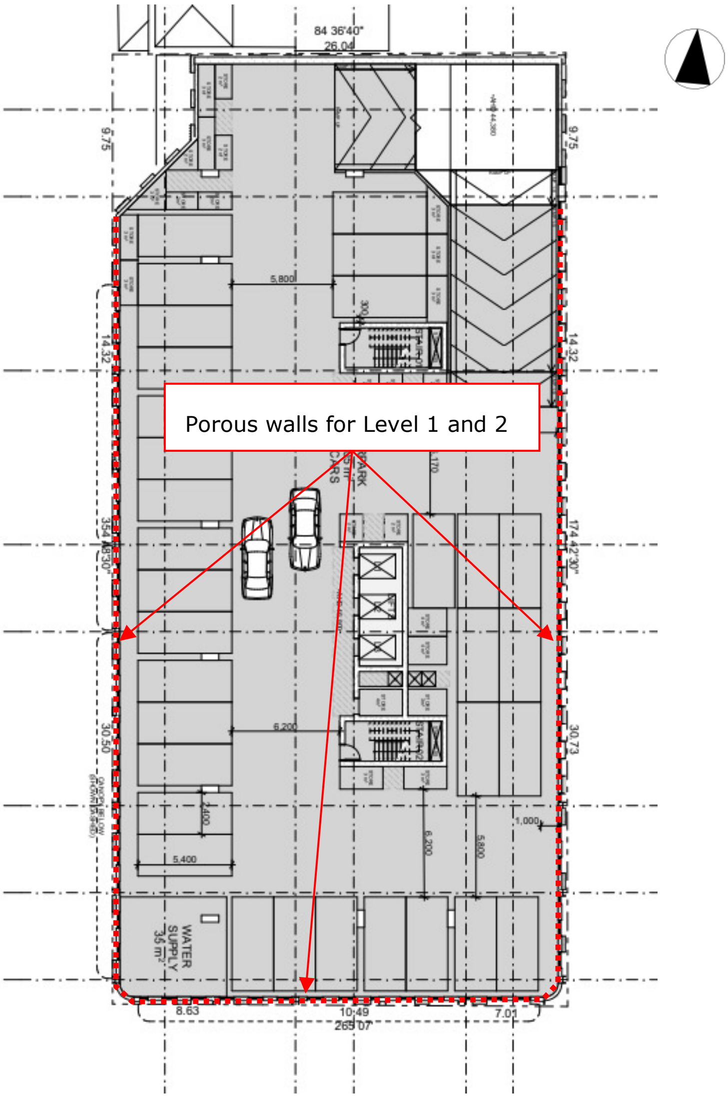



*Figure 9: Wind control measures recommended for Level 1 and Level 2 overlaid on the Level 1 plan.*


*Figure 10: Level 3 plan with the recommended wind control measures overlaid.*

# 4 Conclusions

An appraisal of the likely wind conditions at the pedestrian ground level and level 3 terrace areas of the proposed development at **162-168 Gouger Street, Adelaide** 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.

The findings of this study can be summarised as follows:

**With proposed design and recommendations**:

- Wind conditions in the ground level footpath areas and access ways would be expected to be within the **walking** comfort criterion.
- The building entrances would be expected to be within the **standing** comfort criterion;
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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 Melbourne 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 wind tunnel test or CFD simulations be conducted to quantity the wind conditions and determine proper wind control measures wherever necessary.

*This Report has been Prepared*

*For*

*Bibking Pty Ltd*

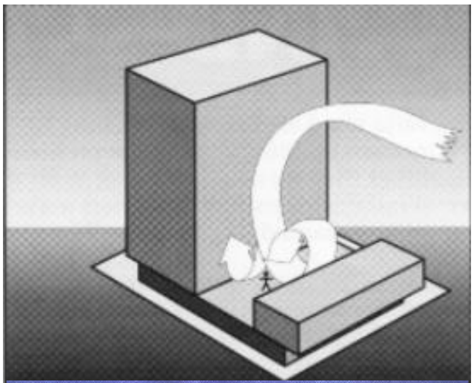
*By*

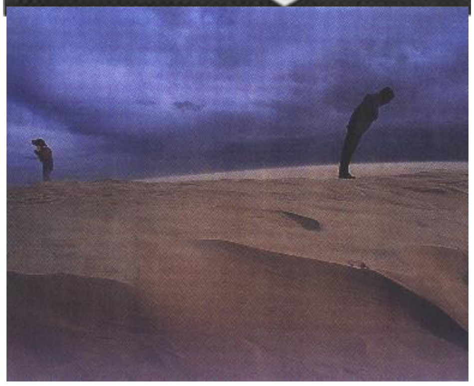
*VIPAC ENGINEERS & SCIENTISTS PTY LTD.*

# 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 1170.2:2021

[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] *The Aerodynamic Characteristics of Windbreaks, Resulting in Empirical Design Rules* J. Gandemer, Publisher: *Journal of Wind Engineering and Industrial Aerodynamics*

[6] *Wind Protection by Model Fences in a simulated Atmospheric Boundary Layer* J.K. Rain, D.C. Stevenson, Publisher: *Journal of Industrial Aerodynamics, 2*

[7] *Criteria for Environmental Wind Conditions* W.H Melbourne, Publisher: *Journal of Wind Engineering and Industrial Aerodynamics*

[8] *Wind Design Guide* J. Bennett Publisher: *BBSC 433 – Architectural Aerodynamics*

[9] *Central City Built Form Review: Wind Assessments*, Global Wind Technology Services

[10] *Wind Guidelines for Planning Applicants* H. Fricke Publisher: *Moonee Valley City Council*

# Appendix C Drawings List

Drawings Received: **July 16th, 2024**

TP100 GROUND FLOOR PLAN
TP101 LEVEL 1 PLAN
TP102 LEVEL 2 PLAN
TP103 LEVEL 3 PLAN
TP104 LEVEL 4, 6 & 8 PLANS
TP105 LEVEL 5, 7 & 9 PLANS
TP110 LEVEL 10 PLAN
TP111 LEVEL 11 PLAN
TP112 LEVEL 12 & 14 PLANS
TP113 LEVEL 13 PLAN
TP115 LEVEL 15 PLAN
TP116 ROOF PLAN

TP200 WEST & SOUTH ELEVATIONS
TP201 EAST & NORTH ELEVATIONS
TP900 3D VIEWS SHEET 1