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Vipac Engineers & Scientists

Pace Development Group Pty Ltd

160 Whitehorse Road, Blackburn

Wind Impact Assessment

30N-18-0243-TRP-6758962-0

21 March 2019

Report Title: Wind Impact Assessment **Job Title: 160 Whitehorse Road, Blackburn**	
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EXECUTIVE SUMMARY

Pace Development Group 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 **160 Whitehorse Road, Blackburn.** This appraisal is based on Vipac's experience as a wind-engineering consultancy.

Updated drawings of the proposed development were provided by **Ascui & Co** in **March 2019.**

The findings of this study can be summarized as follows:

With the proposed design:

- The ground level footpaths and public walkways would be expected to have wind levels within the walking comfort criterion;
- The adjacent pedestrian bridge to the north-east would be expected to have wind levels within the walking comfort criterion;
- The wind conditions near the entrance areas would be expected to be within the criterion for standing;
- The bus shelter on Whitehorse Road would be expected to have wind levels within the standing comfort criterion
- The wind conditions in the outdoor seating areas would be expected to have wind levels within the recommended sitting comfort criterion with the proposed landscaping;
- The communal terrace on Level 1 would be expected to fulfil the sitting criterion with the proposed design.
- The private balconies would be expected to have wind levels within the recommended walking comfort criterion. Most balconies would also meet the more stringent criteria for standing and sitting comfort.

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 scaled wind tunnel study in the detail design stage to verify the predictions and determine the optimal wind controls, wherever necessary.

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1 INTRODUCTION

Pace Development Group 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 **160 Whitehorse Road, Blackburn.** This appraisal is based on Vipac's experience as a wind-engineering consultancy.

Strong winds in pedestrian areas are frequently encountered in central business districts of cities around the world; including Melbourne, Brisbane and Sydney. 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 site is bounded by Whitehorse Rd (Maroondah Hwy) to the north, Railway Rd to the south east, and existing developments plus car park in the west (see Figure 1). The proposed development consists of three multi-storey residential and office towers with a maximum height of approximately 29 m (see Figure 2). The surrounding developments within a 2 km radius are a mixture of suburban residential dwellings.

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].

Drawings of the proposed development were provided by **Ascui & Co.** in **March 2019,** as listed in Appendix C of this report.

Figure 1: Aerial view of the proposed development site at 160 Whitehorse Rd, Blackburn.

Figure 2: North elevation of 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 predominantly surrounded within a 2 km radius by suburban residential dwellings, and low to mid rise residential developments within its immediate vicinity. Therefore, for the current study, the site of the proposed development is considered to be Terrain Category 3 for all directions [1] (see Figure 3)

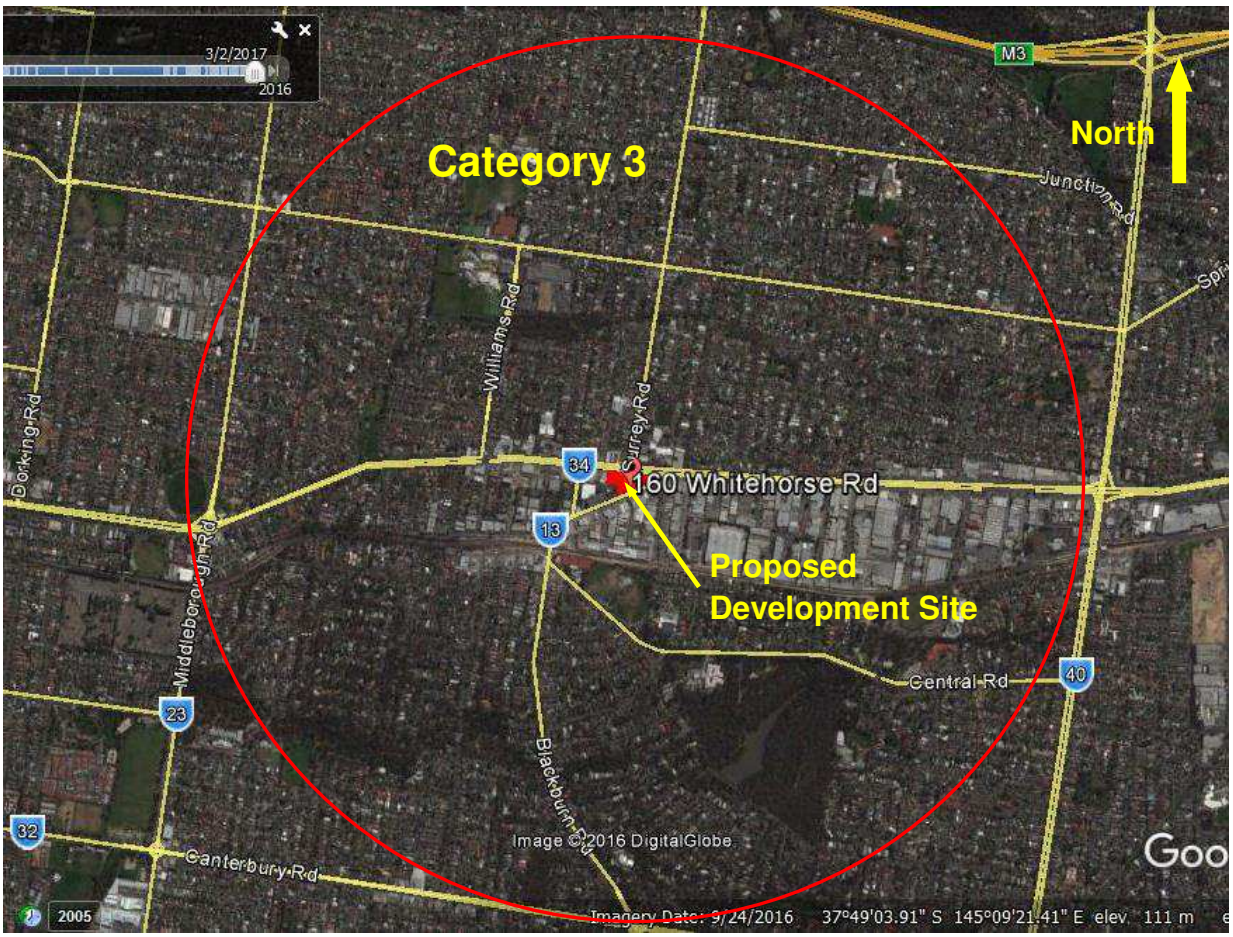

Figure 3: Assumed terrain categories for wind speed estimation.

2.2 REGIONAL WIND CLIMATE

The mean and gust wind speeds have been recorded in the Melbourne 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 Melbourne 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 northerly, southerly, and westerly directions.

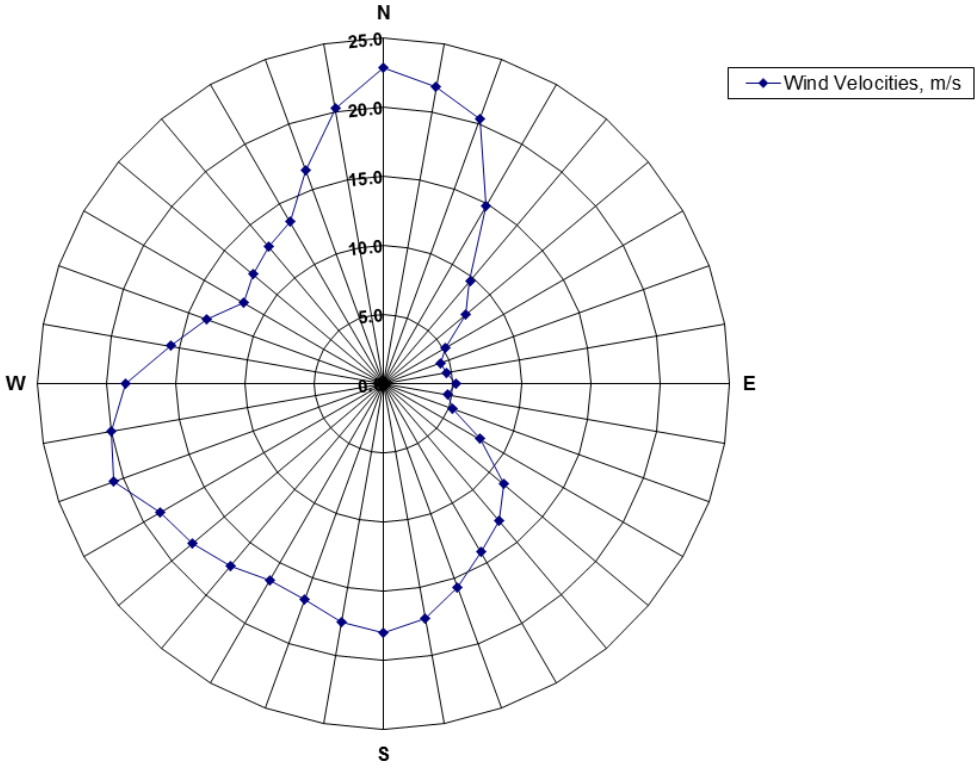

Figure 4: Directional Distribution of Annual Return Period Maximum Mean Hourly Wind Velocities (m/s) at gradient height in Melbourne.

2.3 BUILDING GEOMETRY AND ORIENTATION

The proposed development consists of 3 towers (5-7 storeys) with a common 1 storey podium. The overall plan-form dimensions are approximately 155 m x 74 m (Figure 5) with the long axis running west to east. The main commercial and apartment entries are located on the north side of the development on Whitehorse Rd, with some additional tenancies on Railway Rd to the southeast. The main footpath areas are along Whitehorse Rd and Railway Rd as well as walkthrough connections between the buildings. There is a bus stop on Whitehorse Road and a pedestrian bridge to the north east.

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 height in meters are shown in Figure 6. For the current conditions, there are low buildings surrounded the proposed development. There is an approved future building in the north across Whitehorse Rd. The prevailing winds are from the North and West-south-west. The ground level areas are little sheltered by neighbouring buildings and are exposed from winds for most directions.

Figure 6 : Immediately adjacent buildings and their approximate height in meters (m) overlaid

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.

Table 5: Recommended application of criteria

Area	Specific location	Recommended Criteria
Public Footpaths and Access ways	Around the proposed development on Whitehorse Rd and Railway Rd (Figure 7).	Walking
Building entrances	Entrances to the residential lobby or retail spaces on the ground floor (Figure 7).	Standing
Alfresco dining areas	On ground floor in the arcade between the buildings (Figure 7)	Sitting
Communal Terrace Areas	Terraces on Level 1 (Figure 8).	Sitting
Private Balconies	Balconies from Level 1 up	Walking (Refer to discussion below)

2.6.1 APARTMENT BALCONY AND ROOFTOP AREAS RECOMMENDED CRITERION DISCUSSION

Apartment balconies are located on all facades of the proposed development. 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 Melbourne 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.

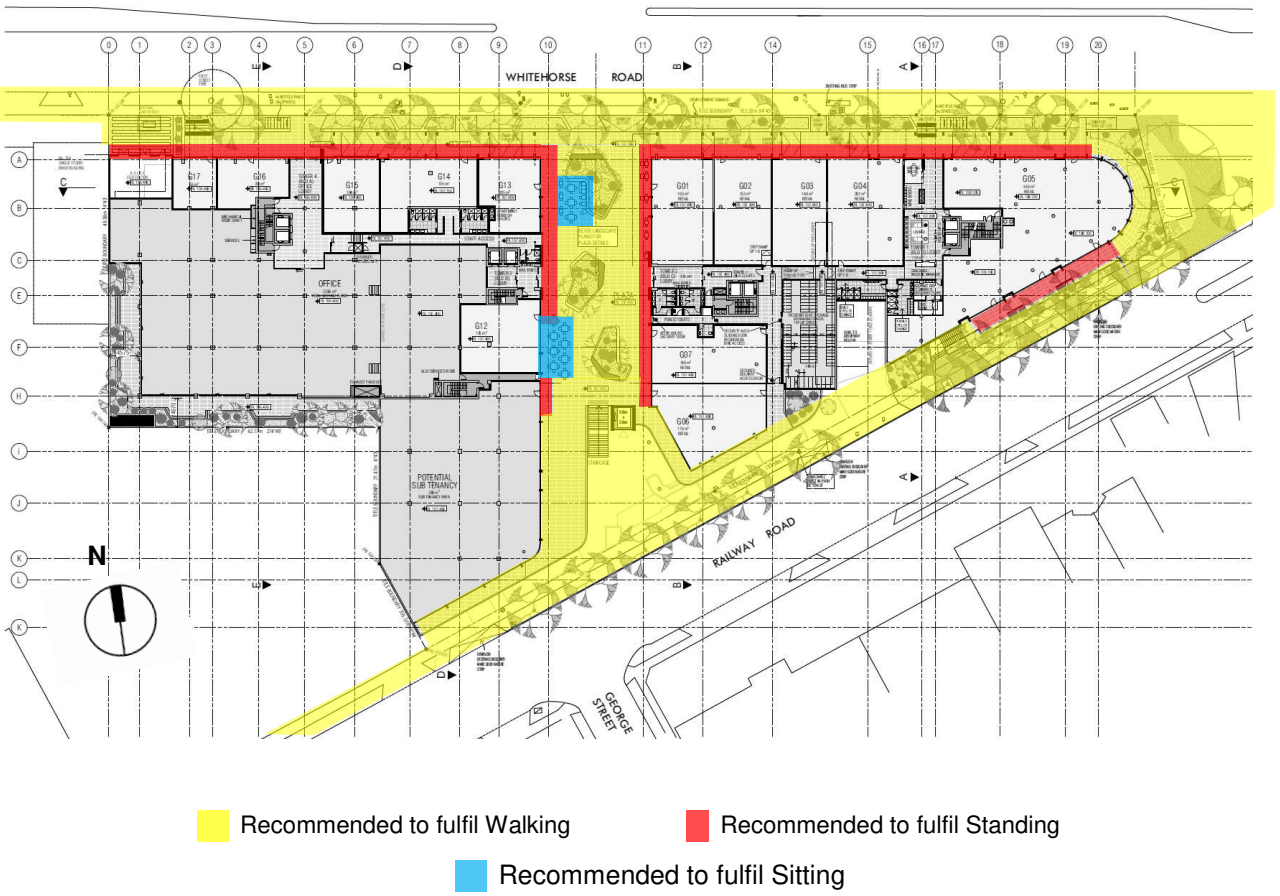

Figure 7: Ground level plan of the proposed development with the recommended comfort criterion overlaid

Figure 8: Level 1 plan of the proposed development with the recommended comfort criterion overlaid

3 PEDESTRIAN LEVEL WIND EFFECTS

3.1 DISCUSSION

Key Points

- With the proposed design, the ground level 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.
- The wind conditions in the outdoor eating areas would be expected to be within the criterion for sitting.

Ground Floor

The set back from the northern boundary, the canopies and awnings and the proposed landscaping would prevent some high winds from downwash and flow accelerations of northerly and westerly winds such that the footpath along Whitehorse Rd and the public walkways would be expected to fulfil the walking comfort criterion.

The footpath on Railway Rd would also be expected to have wind conditions within the walking criterion, as well as the pedestrian bridge to the north-east of the site.

The main apartment entrances are well set back from the access pathway as well as from the building envelope above. The entrances are expected to be within the recommended standing criterion.

The bus stop incorporates a shelter which will shield users from winds. Considering this, we expect that wind levels in the bus stop will be within the standing comfort criterion.

The alfresco dining areas proposed within the arcade have incorporated landscaping that would shield these areas from adverse winds and create spaces comfortable for sitting with the proposed design.

Level 1 Terrace

Level 1 of the proposed development features a Common Terrace area between Tower 1 and Tower 2. The terrace incorporates landscaping and a pergola that will help to reduce channelling effects between the towers. Taking the proposed landscaping into consideration, the communal terrace would be expected to have wind conditions within the sitting comfort criterion.

Balconies General

The proposed balconies are expected to have wind levels within the recommended walking comfort criterion. Many are inset balconies that are sheltered by the surrounding building, and would be expected to meet the more stringent standing or sitting comfort criteria.

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.

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, Vipac does not predict exceedance of the various recommended criteria for the pedestrian level winds at the ground level or in the communal terraces.

As such, Vipac makes no recommendation for the alteration of the design as proposed.

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.

4 CONCLUSIONS

An assessment of the likely wind conditions at pedestrian level of the proposed development of **160 Whitehorse Road, Blackburn** 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 ground level footpaths and public walkways would be expected to have wind levels within the walking comfort criterion;
- The adjacent pedestrian bridge to the north-east would be expected to have wind levels within the walking comfort criterion;
- The wind conditions near the entrance areas would be expected to be within the criterion for standing;
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- The private balconies would be expected to have wind levels within the recommended walking comfort criterion. Most balconies would also meet the more stringent criteria for standing and sitting comfort.

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 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

Pace Development Group Pty Ltd

By

VIPAC ENGINEERS & SCIENTISTS LTD.

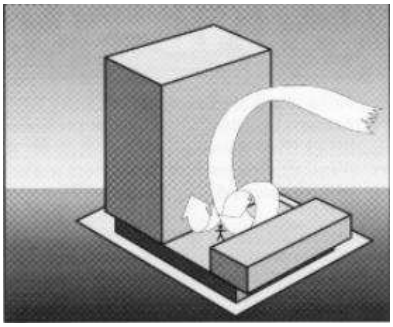
Appendix A: ENVIRONMENTAL WIND EFFECTS

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 un-attenuated 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.

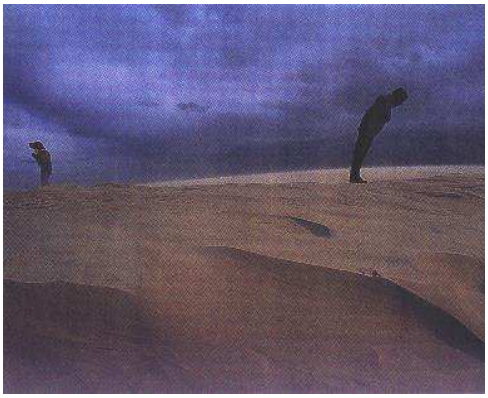


Corner Accelerations – when wind flows around the corner of a building it tends to accelerate in a similar manner to airflow over the top of an aero-plane wing.

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 channeling – 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

DRAWING SCHEDULE

ARCHITECTURAL

CONTENTS

ID	LAYOUT NAME
	COVER
TP-01	SCHEDULES
TP-02	APARTMENT AREAS
TP-03	BASEMENT 5
TP-04	BASEMENT 4
TP-05	BASEMENT 3
TP-06	BASEMENT 2
TP-07	BASEMENT 1
TP-08	GROUND FLOOR
TP-09	LEVEL 1
TP-10	LEVEL 2
TP-11	LEVEL 3
TP-12	LEVEL 4
TP-13	LEVEL 5
TP-14	LEVEL 6
TP-15	LEVEL 7
TP-16	PARAPET
TP-17	NORTH & SOUTH ELEVATIONS
TP-18	T1 T2 EAST & WEST ELEVATIONS
TP-19	T3 & T4 EAST & WEST EVEVATION
TP-20	SECTIONS
TP-21	SECTIONS 2
TP-22	RAMPS SECTIONS
TP-23	APARTMENT TYPES 1
TP-24	APARTMENT TYPES 2
TP-25	APARTMENT TYPES 3
TP-26	MATERIAL SCHEDULE
TP-27	SHADOW DIAGRAMS - SOLAR A...