Webb Property Investments Pty Limited

Proposed 89 George Street Development, Parramatta, NSW

Desktop Wind Assessment Report

Report No. 30B-09-0426-TNT-446486-1

Vipac Engineers & Scientists Ltd

Melbourne VIC

30th November 2009

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Desktop Wind Assessment Report

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EXECUTIVE SUMMARY

Webb Property Investments Pty Limited commissioned Vipac Engineers and Scientists Ltd to prepare a statement of wind effects for the ground level areas adjacent to the proposed **89 George Street Development, Parramatta, NSW**. This appraisal is based on Vipac's experience as a wind-engineering consultancy.

Drawings of the proposed Development were supplied by Woods Bagot dated November 2009, as described in Appendix C

The findings of this study can be summarised as follows:

- Vipac does not expect the proposed Development to generate any wind conditions in excess of the criterion for safety.
- Vipac does not expect the proposed Development to generate any wind conditions in excess of the criterion for walking.
- Vipac does not expect the proposed Development to generate any wind conditions in excess of the criterion for standing.
- Vipac expects the wind conditions would be close to or exceed the acceptability for sitting near the outdoor sitting areas on the western side of the Development.
- Vipac recommends a wait-and-see approach to all the recommended wind control devices (mentioned in this report), which could be included post–construction if required.

The assessments provided in this report have been made based on a desktop assessment and experience of similar situations in Sydney and around the world. No wind tunnel test has been carried out at this stage.

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1. INTRODUCTION

Vipac Engineers and Scientists has been commissioned by Webb Property Investments Pty Limited to carry out an appraisal of the pedestrian level wind effects for the proposed **89 George Street Development in Parramatta**, located approximately 20km to the west of Sydney's CBD area.

The proposed Development is a 55m high (approx.), 13 storey commercial building, surrounded by a number of low to medium rise developments with some scattered high rise developments in all directions (see Figure 1). The site is located on a block bounded by George Street to the north, existing buildings on the east and west directions and open parklands to the south.

A satellite image of the proposed Development site along with the surrounding terrain is shown in Figure 1 below.

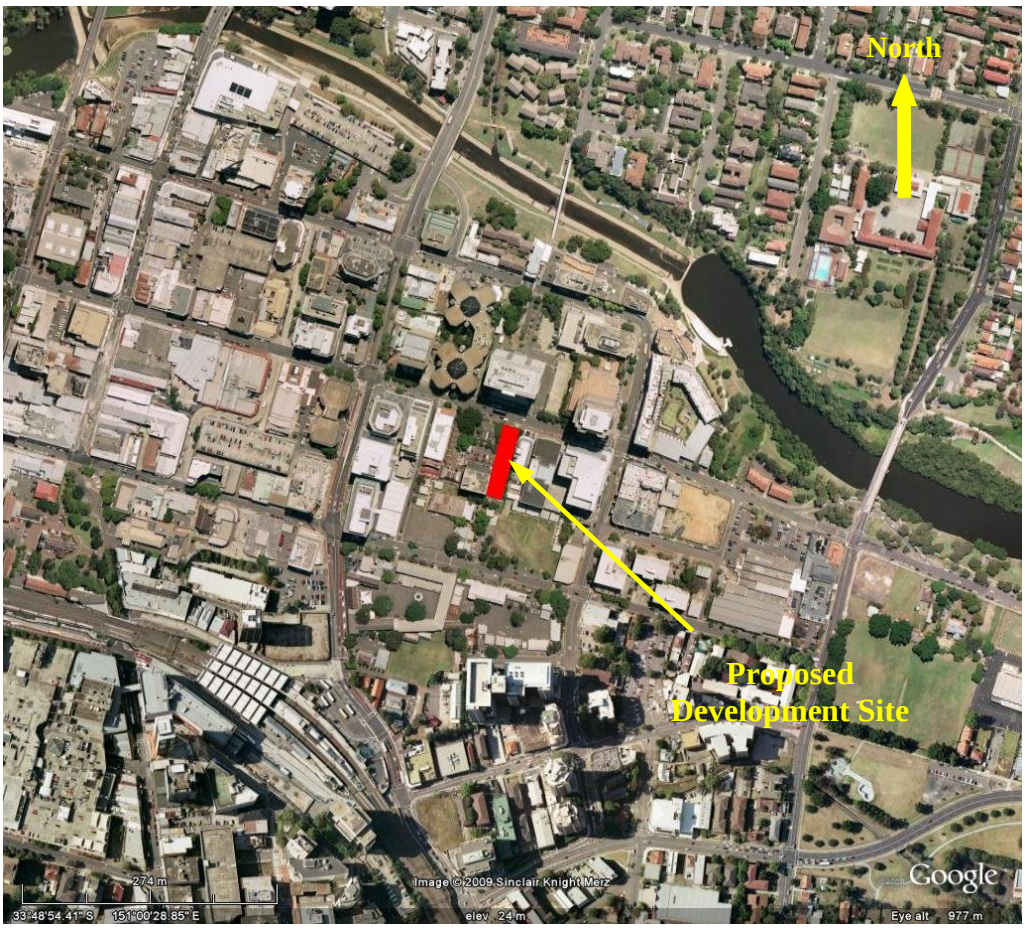


Figure 1- Satellite image of the site of the proposed 89 George Street Development, Parramatta, NSW.

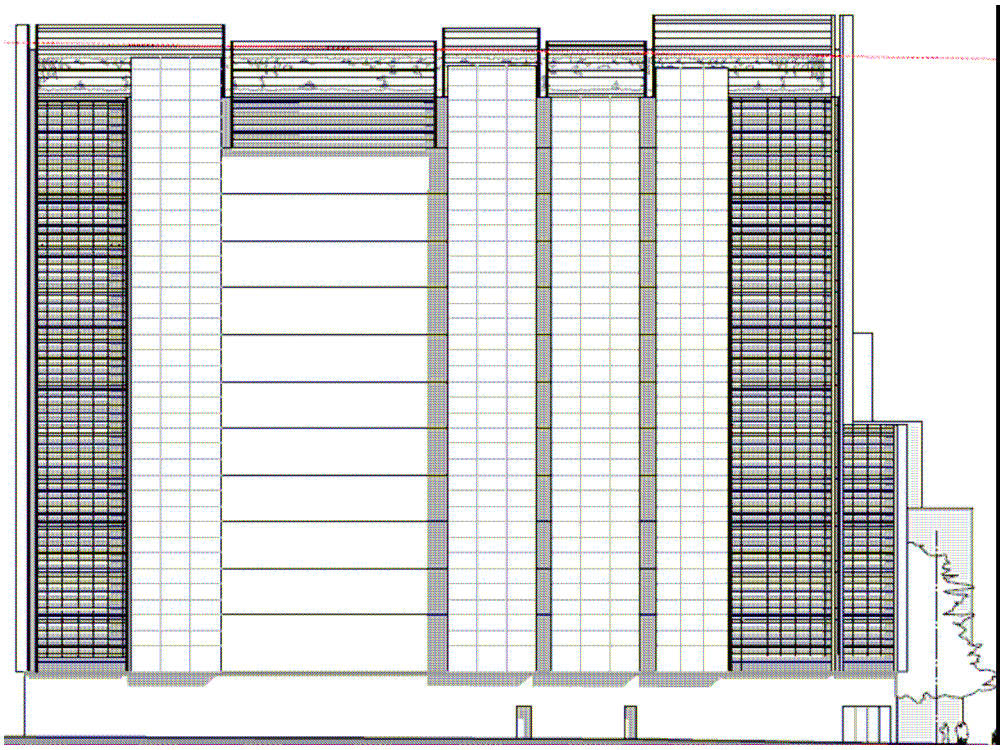


Figure 2 – Schematic east elevation of the proposed Development.

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 in and adjacent to the Development as proposed. No wind tunnel testing has been carried out for this Development. 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 ground level wind conditions adjacent to the proposed Development [2] & [3].

Drawings of the proposed Development were supplied by Woods Bagot dated up to November 2009. A complete list of drawings supplied is provided in Appendix C of this report.

2. ANALYSIS APPROACH

In assessing whether a proposed Development is likely to generate adverse wind conditions in adjacent ground level areas, Vipac has considered 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. 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 recommend 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 terrain that rises towards east at approximately 20km to the west of Sydney's CBD area. Within 1km radius of the site of the proposed Development there is a mixture of low, medium and a few high-rise high-rise developments, expanses of the Parramatta River and parklands.

Considering the immediate surroundings and terrain, the site of the proposed Development is assumed to be within Terrain Category 3 for all approaching wind directions [1].

2.2. REGIONAL WIND CLIMATE

The mean and gust wind speeds have been recorded in the Sydney area for over 30 years. This data has 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 3. The wind data at this free stream height is common to all Sydney city sites and may be used as a reference to assess ground level wind conditions at the Site.

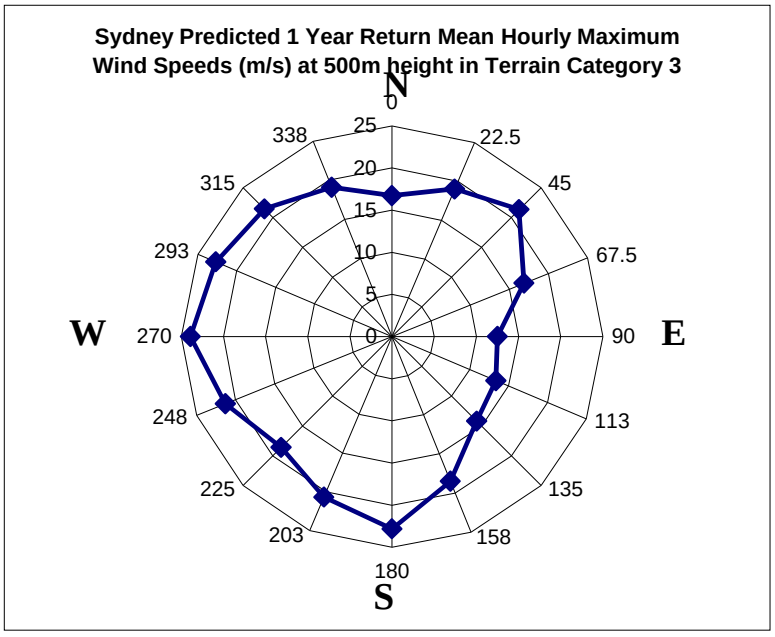


Figure 3 - Directional Distribution of Annual Return Period Mean Hourly Wind Velocities (ms-1) at Gradient Height of 500m for Sydney.

2.3. BUILDING GEOMETRY AND ORIENTATION

The proposed Development is a 13 storey commercial building, possessing a rectangular plan form. The plan form dimensions of the Building are approximately 68 m x 17 m, with the longer axis running along north-south direction. The building orientation of the proposed Development is shown in Figure 4 below.

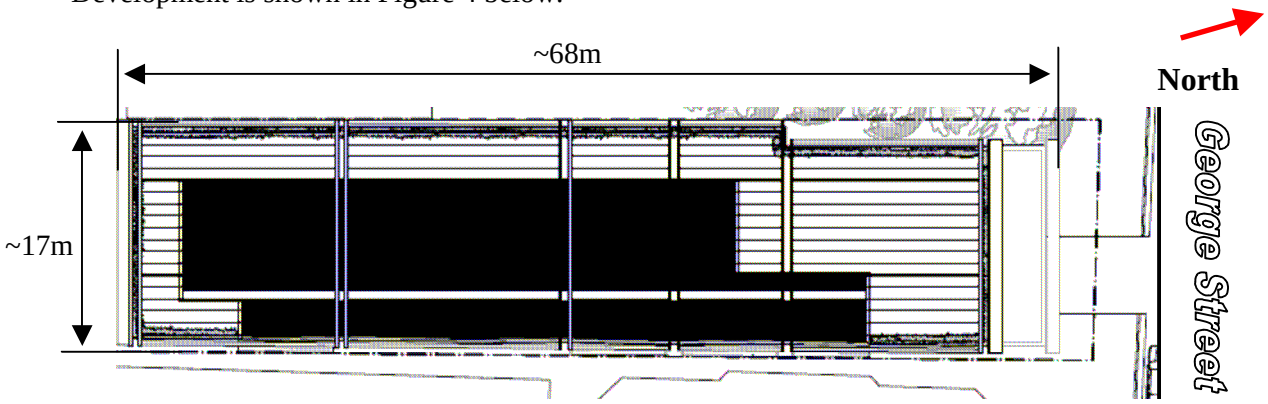


Figure 4 - Plan-form view of the proposed Development

2.4. FLOW INTERACTIONS WITH ADJACENT DEVELOPMENTS

The proposed Development could result in some significant aerodynamic interactions with adjacent developments, especially for the strong wind directions of Sydney's wind climate. The aerodynamic interaction with buildings from the north could result in intermittent wind flows in the adjacent ground level areas with low mean velocities. Furthermore, for the strongest wind direction of Sydney's wind climate, the proposed Development could result in downwash flows over the neighbouring open area and roof top areas (of adjacent developments) located on to the west.

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 characterised 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. 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 voted as unacceptable.

The threshold gust velocity criteria are:

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 (window shopping, vehicle drop off, queuing)
<10m/s	Acceptable for Sitting (outdoor cafés, pool areas, gardens)

Table 1 – Recommended Wind Comfort and Safety Gust Criteria

In a similar manner, a set of hourly mean velocity criteria with a 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.

The threshold mean velocity criteria are:

Annual Maximum Mean Speed	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 (window shopping, vehicle drop off, queuing)
<5m/s	Acceptable for Sitting (outdoor cafés, pool areas, gardens)

Table 2 – Recommended Wind Comfort and Safety Mean Criteria

Intended Use of Adjacent Ground Level Areas

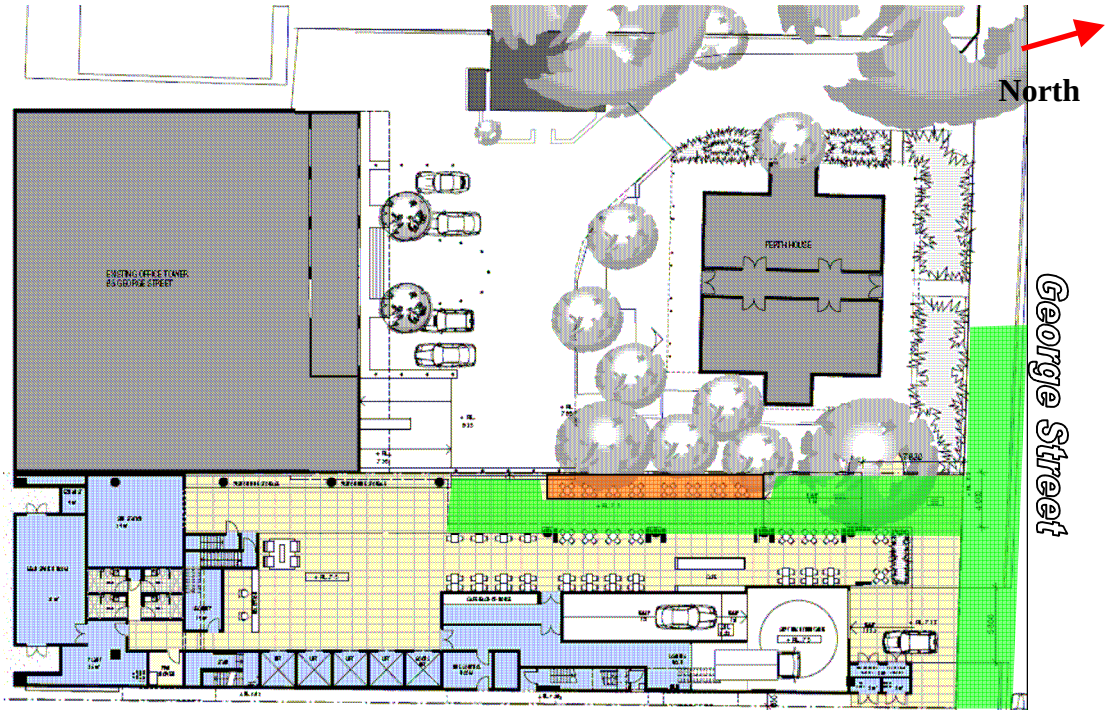
- Main building and car park entrances are located on George Street side of the Development.
- Outdoor dining area is located at ground level on the western side of the proposed Development.
- George Street footpath is a pedestrian walkway.

Recommended Criteria

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

Area	Recommended Criteria
Public Footpaths	Acceptable for Walking
Building Entrances	Acceptable for Standing
Outdoor Dining	Acceptable for Sitting

Table 3 – Recommended application of criteria



Plan – Ground Level

Recommended Acceptable for Walking

Recommended Acceptable for Sitting

Figure 5 - Schematic plan view of the proposed Development with the recommended wind criteria overlaid on adjacent ground level areas.

3. PEDESTRIAN LEVEL WIND EFFECTS AND RECOMMENDATIONS

Discussion

The proposed Development is relatively exposed to the strong north-easterly and north-westerly winds of Sydney's wind climate, which could result in high ground level wind speeds on George Street side of the Development. However, considering the presence of some relatively high upstream buildings and the exposure of slender, discontinuous facades of the proposed Development it is expected that most of the adverse effects (of the approaching wind directions) would be ameliorated. Furthermore, considering the aerodynamic interaction with upstream buildings, ground level wind speeds, on George Street side of the Development would often be intermittent in nature, with low mean velocities.

The westerly winds, considered to be the strongest of all wind directions, could result in downwash flows over the out door sitting area and the adjacent open area (between Perth House and the existing office building) on the western side of the proposed Development. Although the presence of discontinuous façade element, serves to mitigate a part of these downwash flows, a complete amelioration may not be expected due to the relative exposure of the proposed Development (aspect ratio) to this strong wind direction.

The south-westerly and southerly winds, though considered to be relatively strong in magnitude, are not expected to result in adverse conditions in the adjacent ground level areas.

The region of the highest ground level wind speeds adjacent to the proposed Development is likely to be open area to the west (between Perth House and the existing office building). However, calculations from empirical data [2], [3] suggest ground level wind conditions generated by northerly, north easterly, southerly, westerly and north westerly winds would be within the criterion for acceptability for walking adjacent to the proposed Development. For other directions the form of the proposed Development is considered unlikely to produce adverse ground level wind effects or the wind climate for those directions is weak.

Key Points:

- The proposed Development incorporates a number of wind mitigating features, such as discontinuous tower façades and building setbacks.

- Vipac does not expect the proposed Development to generate any wind conditions in excess of the recommended pedestrian comfort criteria for safety, walking and standing as mentioned in Section 2.5.

3.1. RECOMMENDATIONS

After careful consideration of the areas at the base of the proposed Development, Vipac predicts that the proposed Development will not present a significant change in wind conditions in most of the adjacent ground level areas. However, Vipac predicts that wind conditions could be close to or in excess of the recommended criteria for sitting near outdoor sitting areas.

Therefore as a measure for mitigating these adverse wind conditions retractable awnings are recommended over the outdoor sitting area at locations mentioned in Figure 6.

There is a significant uncertainty inherent in the prediction of turbulent flow patterns based on experience alone and there is a limited capacity of the design of the proposed Development to remedy any existing elevated wind conditions for these areas. Therefore, in this case a wait-and-see approach to wind conditions on the outdoor sitting areas would be justified and the recommended wind control device could be added post-construction if required.

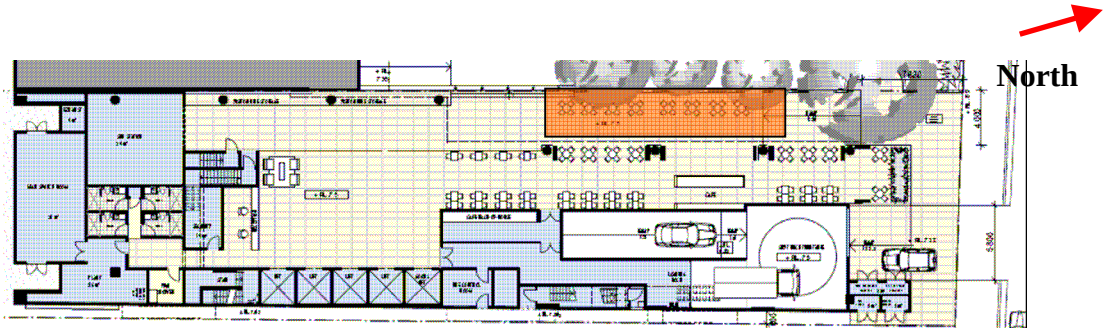


Figure 6 - Schematic plan view of the proposed Development with the recommended wind control devices overlaid on the outdoor sitting area.

4. CONCLUSIONS

An appraisal of the likely wind conditions adjacent to the proposed **89 George Street Development, Parramatta, NSW** has been made.

Vipac have carefully considered the form and exposure of the proposed Development, nominated criteria for various ground level areas according to their function and referred to past experience to produce our opinion of likely ground level wind conditions adjacent to the proposed Development.

From the current analysis it was considered likely that the outdoor sitting areas (in ground level) located on to the western side of the proposed Development could experience wind conditions that are close to or even exceed the criterion for sitting. As a measure to mitigate these adverse effects, retractable awnings were recommended over these locations. However, Vipac recommended a wait-and-see approach to these additions, which could be included post–construction if required.

The recommendations and 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 wind tunnel model testing may be in error.

This Report has been Prepared

For

Webb Property Investments Pty Limited

By

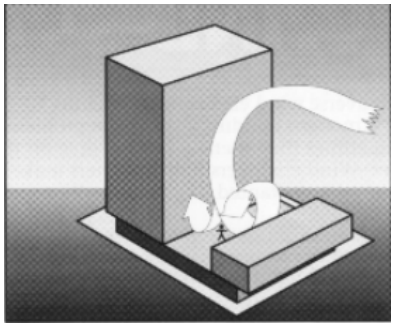
VIPAC ENGINEERS & SCIENTISTS LTD.

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.



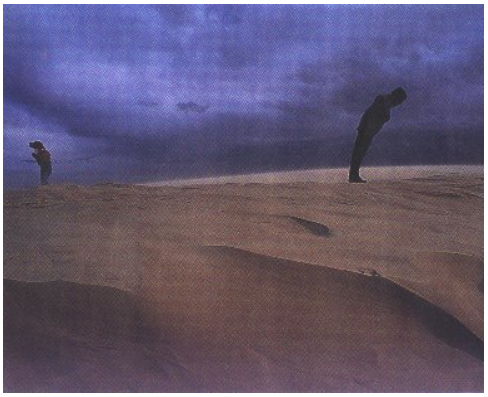
Downwash – refers to a flow of air down the exposed face of a tower. A tall tower can deflect a fast moving wind at higher elevations downwards.

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 1170.2:2002

[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 Number	Title
A1006	Site Plan – Setback Plan
A2200	Floor Plan – Basement 3 & 4
A2201	Floor Plan – Basement 1 & 2
A2202	Floor Plan – Ground Floor
A2203	Floor Plan – Level 1
A2205	Floor Plan – Level 3 – (Levels 1-5 Typical)
A2210	Floor Plan – Level 8 – (Levels 6-13 Typical)
A2216	Floor Plan – Roof
A2230	Floor Plan – Ground – Level 6 GFA
A2231	Floor Plan – Ground – Level 7-12 GFA
A3000	Elevations – North Elevation
A3001	Elevations – West Elevation
A3002	Elevations – South Elevation
A3003	Elevations – East Elevation
A3100	Section AA
A3102	Section CC
A3103	Section DD
A3104	Section EE