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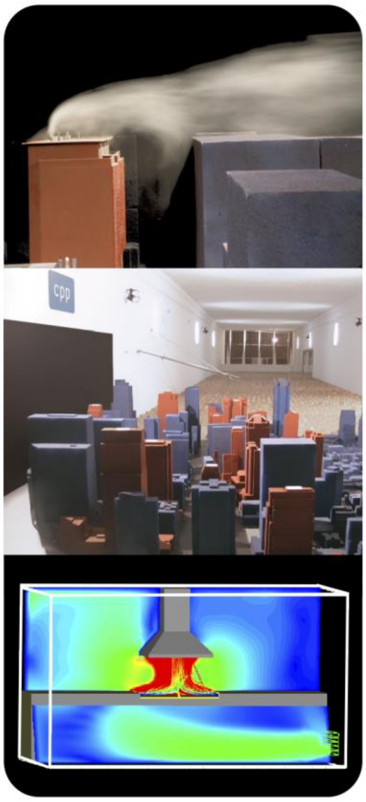
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



Qualitative Wind Assessment for:

Gosford Alive

136 Donnison Street

Gosford, NSW, 2250

Prepared for:

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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Lederer Group to provide a qualitative assessment of the impact of the proposed Gosford Alive development at 136 Donnison Street, Gosford on the pedestrian level local wind environment.

The proposed development is located in the Gosford CBD on the Central Coast of NSW, in a region of low to medium-rise development situated adjacent to Brisbane Water and terrain features, Figure 1. The proposed development will comprise of 5 residential towers and mixed-use podia. The towers vary in height between 17 and 27 storeys, Figure 2. As it is slightly larger than most of the surrounding structures, the addition of the proposed development is expected to have some impact on the local wind conditions, and the extents are broadly discussed in this report.

Figure 1: Site Location (Eagle View, 2019).

Figure 2: Perspective render of proposed development, viewed from the north-west.

2 GOSFORD WIND CLIMATE

To enable a qualitative assessment of the wind environment, the wind frequency and direction information measured by the Bureau of Meteorology at two nearby anemometers has been used in this analysis. The Nora Head weather station is located approximately 27km to the north-west of the subject site, on an exposed headland with open ocean approaches. Wind speeds measured at this location will be determined by coastal weather patterns and resulting strong winds. These strong winds centre about the north-east and south, with frequent winds from the west as well (Figure 3). The Gosford weather station is located approximately 2 km to the east of the site. As this location receives greater shielding due to surrounding terrain, the prevalence of strong winds and their directional bias is less evident, Figure 4. Considering the lower reliability of the Gosford data and the location of the site relative to the coast, for the purposes of this study a combined wind climate has been generated using both stations. The resulting wind rose is shown in Figure 5 and is considered to be representative of prevailing winds at the site. Comparison to long-term data from Sydney Airport (Figure 6) indicates reasonable agreement. Strong prevailing winds are organised into three main groups which centre at about north-east, south, and west. This wind assessment is focused on these prevailing strong wind directions.

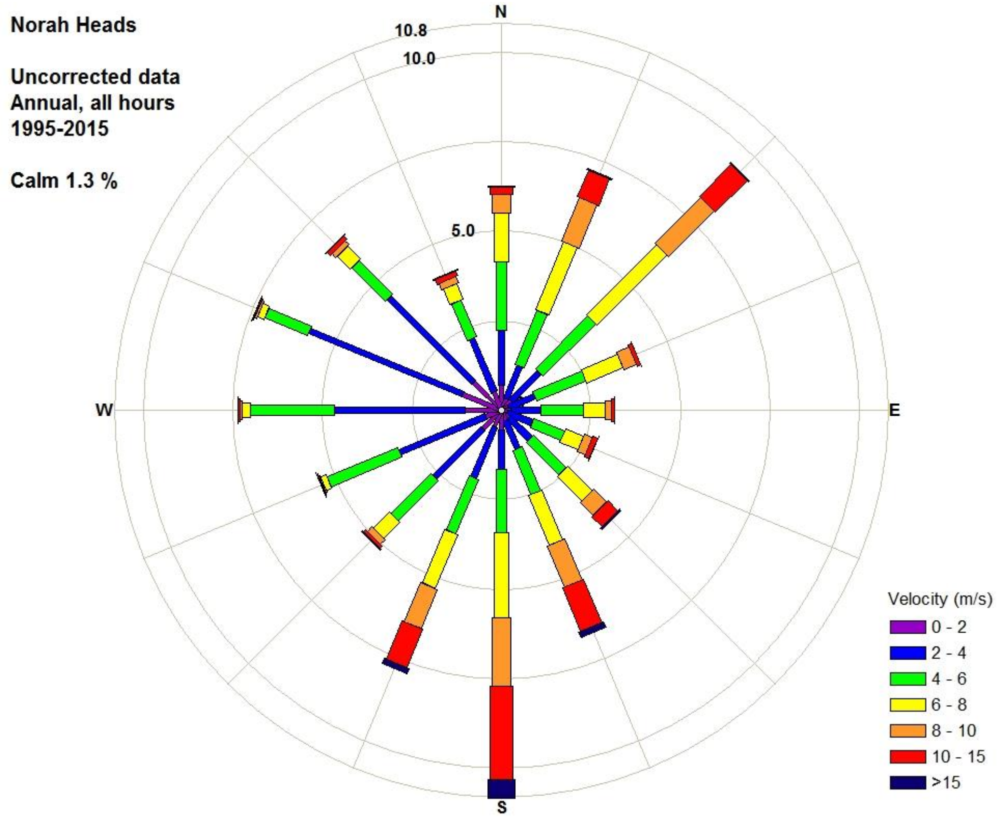

Figure 3 Wind rose showing probability of time of wind direction and speed for Norah Head

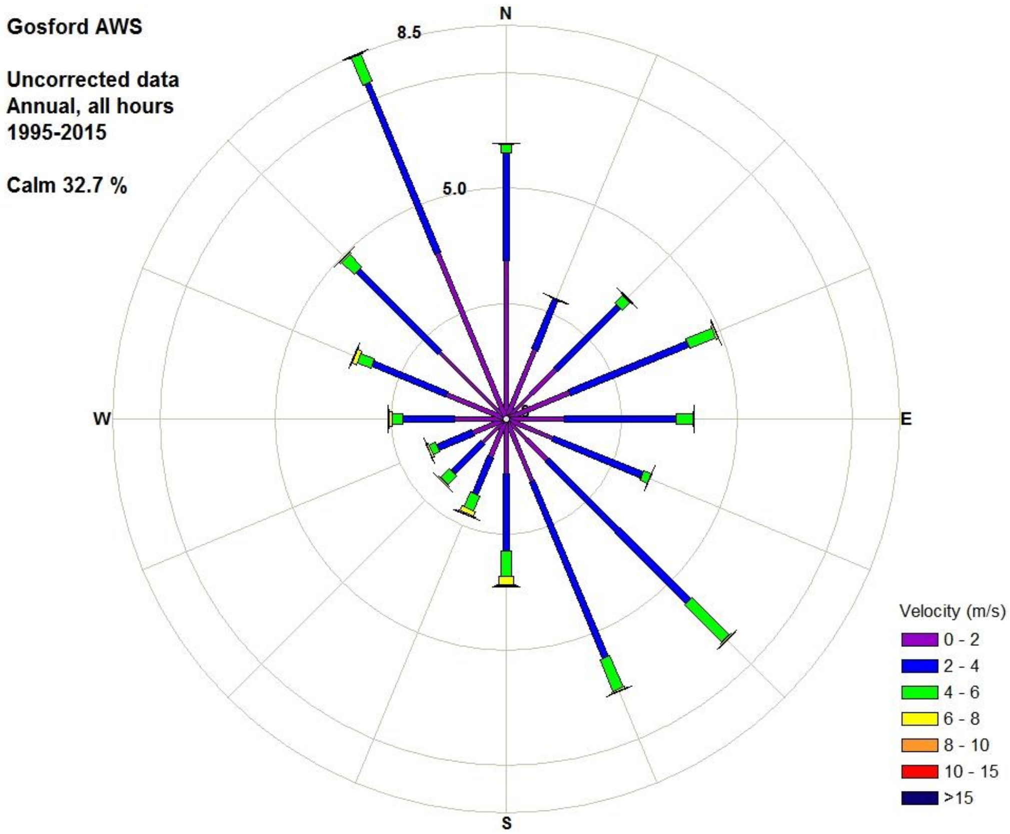

Figure 4 Wind rose showing probability of time of wind direction and speed for Narara Research Station

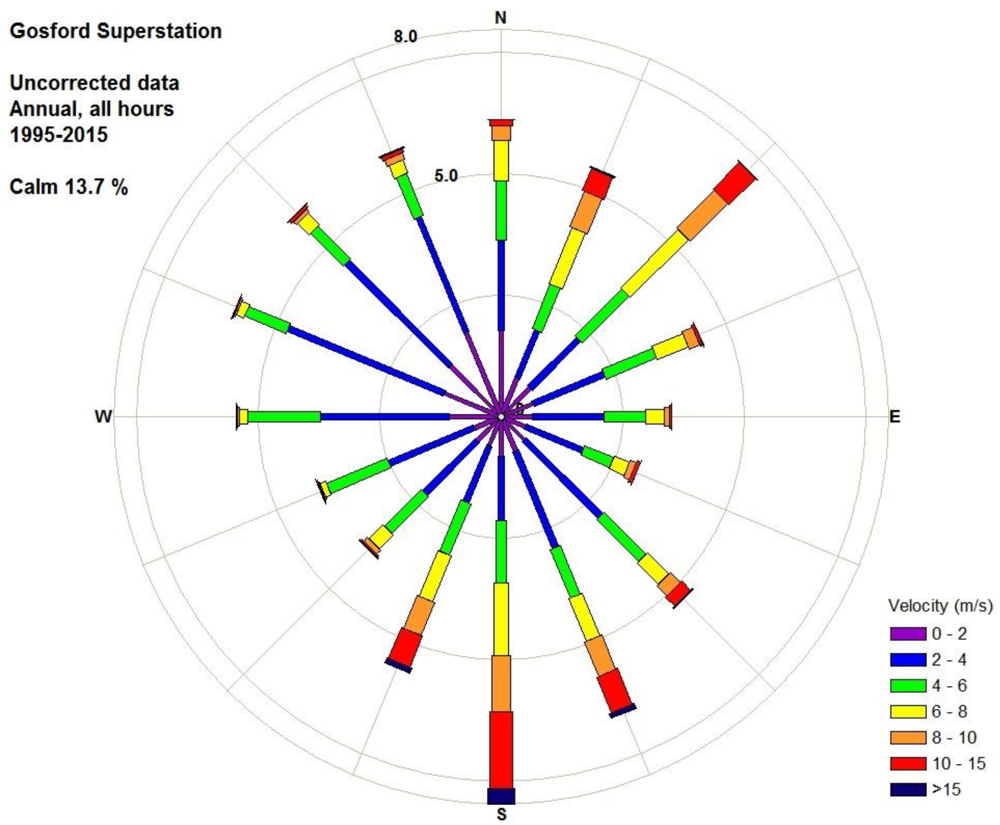

Figure 5 Combination wind rose showing probability of time of wind direction and speed for Gosford Area

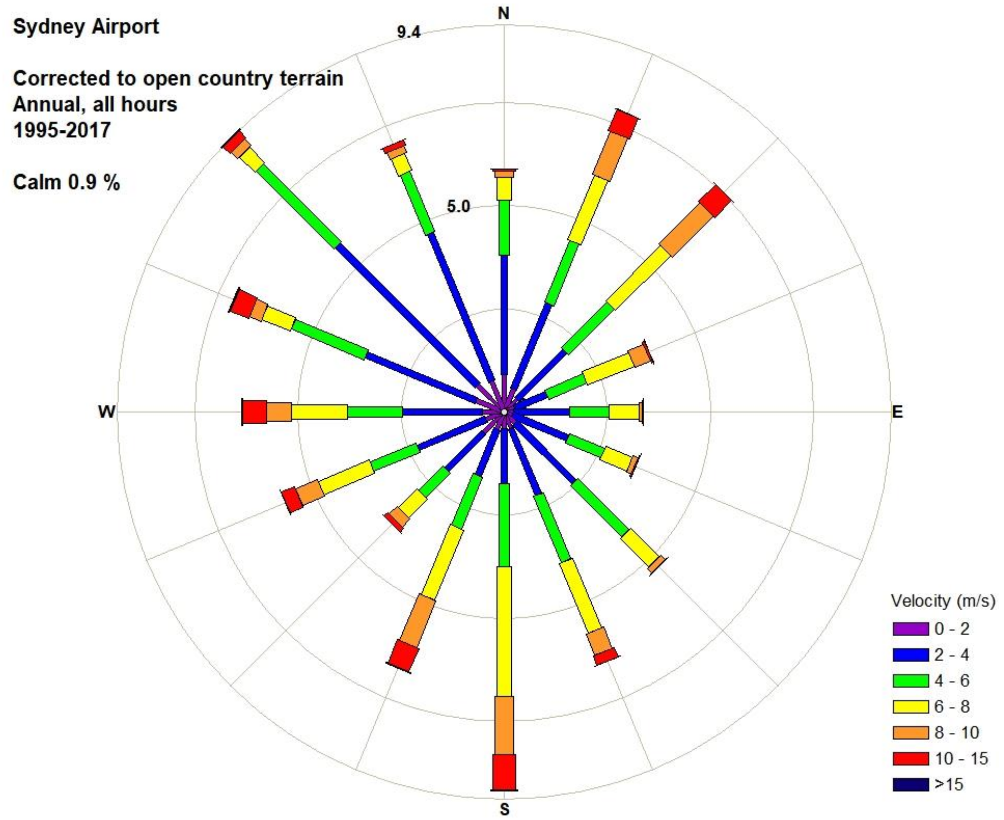

Figure 6: Wind rose showing probability of time of wind direction and speed for Sydney Airport

3 ENVIRONMENTAL WIND CRITERIA

It is generally accepted that wind speed and the rate of change of wind velocity are the primary parameters that should be used in the assessment of how wind affects pedestrians. Local wind effects can be assessed with respect to a number of environmental wind speed criteria established by various researchers. Despite the apparent differences in numerical values and assumptions made in their development, it has been found that when these are compared on a probabilistic basis, there is remarkably good agreement.

The Gosford City Centre DCP (2018) contains the following controls for wind mitigation:

- Towers are to be set back from street frontages
- Towers are to be sufficiently spaced to allow breeze penetration
- Shape, location, and height are to consider wind comfort and safety for public spaces

The DCP does not specify how comfort and safety should be assessed. The wind assessment criteria that will be used in this study will be based upon the criteria of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress/safety. The benefits of these criteria over many in the field are that they use both a mean and gust equivalent mean (GEM) wind speed to assess the suitability of specific locations. The criteria based on the mean wind speeds define when the steady component of the wind causes discomfort, whereas the GEM wind speeds define when the wind gusts cause discomfort. The level and severity of these comfort categories can vary based on individual preference, so calibration to the local wind environment for all wind directions is recommended when evaluating with Lawson ratings. Another benefit of these from a comfort perspective is that the 5% of the time event is appropriate for a precinct to develop a reputation from the general public.

Table 1: Pedestrian comfort criteria for various activities.

Comfort (max. wind speed exceeded 5% of the time)	
<2 m/s	Outdoor dining
2 - 4 m/s	Pedestrian sitting (considered to be of long duration)
4 - 6 m/s	Pedestrian standing (or sitting for a short time or exposure)
6 - 8 m/s	Pedestrian walking
8 - 10 m/s	Business walking (objective walking from A to B or for cycling)
> 10 m/s	Uncomfortable
Distress/Safety (max. wind speed exceeded 0.022% of the time, twice per annum)	
<15 m/s	General access area
15 - 20 m/s	Acceptable only where able-bodied people would be expected; no frail people or cyclists expected
>20 m/s	Unacceptable

The wind speed is either an hourly mean wind speed or a gust equivalent mean (GEM) wind speed. The GEM wind speed is equal to the 3 s gust wind speed divided by 1.85.

4 ENVIRONMENTAL WIND ASSESSMENT

The development site is surrounded in most directions by low-rise buildings, with the open region of Brisbane water to the south and south-west. The site is also adjacent to Rumbalara Reserve to the east and Waterview/ Grahame Park to the west, which have uneven and high topography and are densely vegetated. These topographic features are likely to significantly influence the wind environment at the site. Winds in such surrounds tend to be determined by relative exposure to strong wind directions, as well as local effects being dictated by taller buildings. Several wind flow mechanisms such as downwash and channelling flow are described in Appendix 1, and the effectiveness of some common wind mitigation measures are described in Appendix 2.

The subject site is located on a block bounded by Donnison Street to the south, William Street to the north, Henry Parry Drive to the west and Albany Street to the east. A ground floor plan is shown in Figure 7.

Figure 7: Ground floor of the proposed development.

4.1 Winds from the north-east

Wind from north- east will pass over a region of elevated topography and bushland including the Rumbalara reserve when approaching the site. The proposed development is recessed within this natural feature and is relatively shielded from winds from this quadrant as a result. Slightly stronger breezes may be anticipated at the through-site lane and at the windward corners of the development as a portion of incoming winds will be directed towards ground plane by the presence of the larger towers. In addition, some degree of channelled flow would be expected for the though-site laneway during winds from this direction. The setback of the proposed towers from the podium will limit the impact of downwash flows on pedestrian locations, and the indicated landscape plantings will assist in ameliorating the wind conditions on the footpaths and thoroughfares. Further, large areas of the site will receive shielding from north-easterly winds from adjacent buildings (including adjoining future building) and podia and will experience mostly calm conditions.

4.2 Winds from the south

Winds from the south quadrant will approach the site over a section of Brisbane Water and the low-rise residential buildings of Point Frederick. To the immediate south of the site is small area of medium-rise residential development and a moderate hill feature, which will somewhat mitigate strong winds from this direction. Stronger breezes are likely to occur along Henry Parry Drive and Albany Street, which are aligned with this prevailing wind direction. The inclusion of proposed development is likely to cause a slight increase in wind speeds near to the base to the south of Towers 2, 4 and 5 as approaching flow is pushed toward ground level. The podium setbacks will limit the impact of this mechanism on pedestrian locations, though relatively strong conditions would be expected on podium level, particularly near the windward corners and in between towers 4 and 5, where incoming flow will be channelled and accelerated. Proposed landscaping will assist in mitigating breezes in the spaces between buildings, and calm areas would exist on the leeward sides of the larger buildings, and for most of the northern half of the site during southerly winds.

4.3 Winds from the west

In general, winds from the may west may not be as strong as the coastal winds from the south and north-east, however occur frequently throughout the year. The site is somewhat protected from these winds due to its low elevation relative to nearby topographic features. The combined massing of the buildings that form Gosford’s CBD will also allow some local protection from westerly winds. These winds are expected to channel along William St and Donnison St due to their alignment with this direction. The addition of the proposed towers may create marginally stronger wind conditions along these street frontages by contributing to this mechanism. The podium setback will limit the impact of any downwash from westerly winds on pedestrian locations, which would otherwise affect Henry Parry Drive and the north-east and south-west corners of the site. A degree of channelling flow would also be expected along the east-west laneway during winds from the west, contributing to slightly breezier conditions through this corridor.

4.4 Summary

For most locations, wind conditions within the proposed development site are expected to remain similar to the existing wind conditions. The protection provided by local topography, the massing layout of the development itself, and separation of larger towers from the ground plane through podium setbacks will limit the impact of prevailing strong winds. From a pedestrian comfort perspective, the wind environment around the proposed development site is likely to be classified as acceptable for Pedestrian Standing to Walking under Lawson. These pedestrian comfort levels would be suitable for public accessways, and for stationary short-term exposure activities. Localised amelioration measures would be suggested if calmer areas are desired for particular locations. In particular, measures such as local screening, landscaping, and overhead protection would be suggested for areas intended for long-term seating or outdoor dining. The spacing and layout of the towers is considered sufficient to allow breeze penetration and circulation. All locations would be expected to satisfy the safety/distress criterion.

4.5 Wind conditions within the development

The proposed development includes residential balconies distributed over all 5 towers, as well as communal outdoor space on podium level.

For tall buildings, strong conditions are frequently found on corner balconies as prevailing winds are accelerated along the façade and around the corners. For this reason, it is generally recommended to consider including screens/fins or high (>1.5 m) balustrades near building corners. An example of suggested extent is shown in Figure 8. Over time residents tend to learn to determine the usability of their balconies based on the seasonal weather conditions and will adapt their use of these spaces accordingly. Balconies recessed within the façade are expected to experience conditions suitable for their intended use.

The communal outdoor space on the level 6 podium is expected to experience relatively strong conditions on a reasonably frequent basis, as it is unprotected from flow downwashing from the towers, as well as being exposed to higher velocities due to its elevation. As previously noted, winds may also be accelerated between adjacent towers and affect this area. Depending on the prevailing wind direction, some areas of calm will exist at most times on the podium, and local landscaping will help to improve conditions. For areas intended to be occupied frequently or for long periods, further mitigation in the form of overhead canopies/awnings and local solid or porous vertical screening would be recommended.

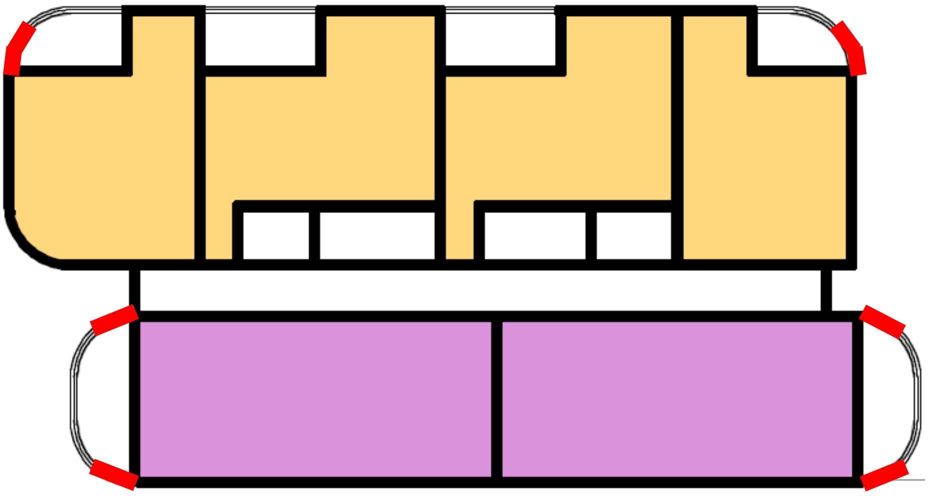

Figure 8: Example layout of screening or extended balustrades for tower balconies

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed Gosford Alive project on the local wind environment in and around the development site. Being slightly taller than most surrounding structures, the proposed development will have some effect on the local wind environment, though any changes are not expected to be significant from the perspective of pedestrian comfort or safety. Wind conditions around the development are expected to be classified as acceptable for Pedestrian Standing or Walking from a Lawson comfort perspective and pass the distress/safety criterion. Local amelioration would likely be necessary for areas intended for long-term stationary or outdoor dining activities.

A wind tunnel test would be required if quantification of the advice provided herein is required.

6 REFERENCES

Gosford City Centre Development Control Plan (2018), NSW Government.

Lawson, T.V. (1990), "The Determination of the Wind Environment of a Building Complex before Construction" Department of Aerospace Engineering, University of Bristol, Report Number TVL 9025.

Appendix 1: Wind flow mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 9; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward corners and sides of the building. In Figure 9, smoke is being released into the wind flow to allow the wind speed, turbulence, and direction to be visualised. The image on the left shows smoke being released across the windward face, and the image on the right shows smoke being released into the flow at about third height in the centre of the face.

Techniques to mitigate the effects of downwash winds on pedestrians include the provision of horizontal elements, the most effective being a podium to divert the flow away from pavements and building entrances. Awnings along street frontages perform a similar function, and the larger the horizontal element, the more effective it will be in diverting the flow.

Channelling occurs when the wind is accelerated between two buildings or along straight streets with buildings on either side.

Figure 10 shows the wind at mid and upper levels on a building being accelerated substantially around the corners of the building. When balconies are located on these corners, they are likely to be breezy, and will be used less by the owner due to the regularity of stronger winds. Owners quickly become familiar with when and how to use their balconies. If the corner balconies are deep enough, articulated, or have regular partition privacy fins, then local calmer conditions can exist.

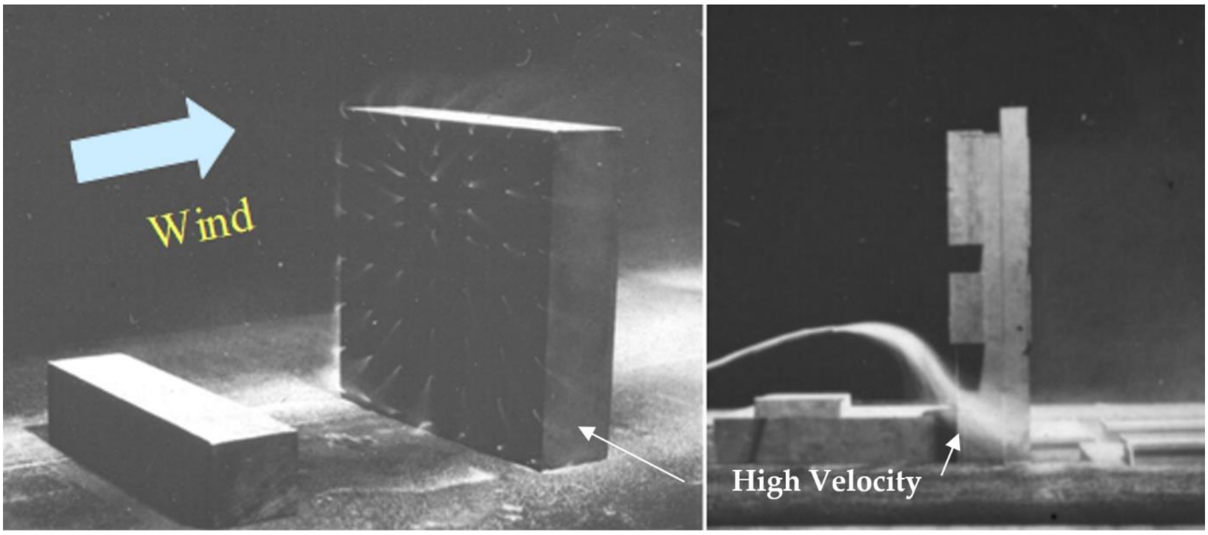

Figure 9: Flow visualisation around a tall building.

Figure 10: Visualisation through corner balconies (L) and channelling between buildings (R).

Appendix 2: Wind Impact Planning Guidelines

It is well known that the design of a building will influence the quality of the ambient wind environment at its base. Below are some suggested wind mitigation strategies that should be adopted into precinct planning guidelines and controls (see also Cochran, 2004).

Building form – Canopies

A large canopy may interrupt the flow as it moves down the windward face of the building. This will protect the entrances and sidewalk area by deflecting the downwash at the second storey level, Figure 11. However, this approach may have the effect of transferring the breezy conditions to the other side of the street. Large canopies are a common feature near the main entrances of large office buildings.

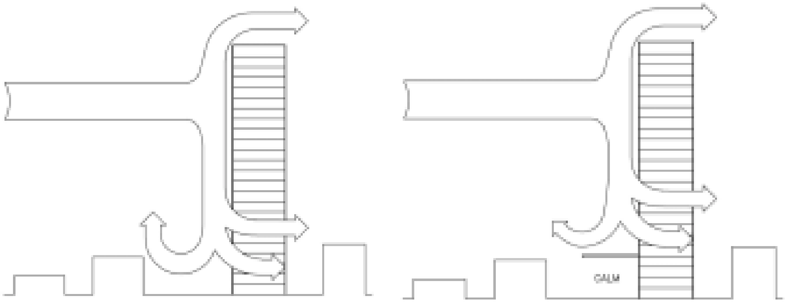

Figure 11: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

Building form – Podiums

The architect may elect to use an extensive podium for the same purpose if there is sufficient land and it complies with the design mandate, Figure 12. This is a common architectural feature for many major projects in recent years, but it may be counterproductive if the architect wishes to use the podium roof for long-term pedestrian activities, such as a pool or tennis court.

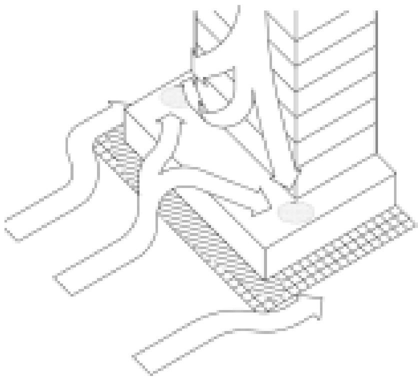

Figure 12: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

Building form – Arcades

Another massing issue, which may be a cause of strong ground-level winds, is an arcade or thoroughfare opening from one side of the building to the other. This effectively connects a positive pressure region on the windward side with a negative pressure region on the lee side; a strong flow through the opening often results, Figure 13. The uninvitingly windy nature of these open areas is a contributing reason behind the use of arcade airlock entrances (revolving or double sliding doors).

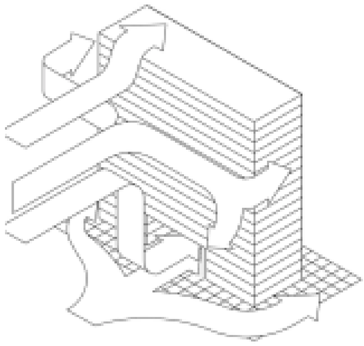

Figure 13: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure 14(L). In some cases, a canopy may not be necessary with this scenario, depending on the local geometry and directional wind characteristics. The same undercut design at a building corner is usually quite unsuccessful, Figure 14(R), due to the accelerated flow mechanism described in Figure 9 and the ambient directional wind statistics. If there is a strong directional wind preference, and the corner door is shielded from those common stronger winds, then the corner entrance may work. However, it is more common for a corner entrance to be adversely impacted by this local building geometry. The result can range from simply unpleasant conditions to a frequent inability to open the doors.

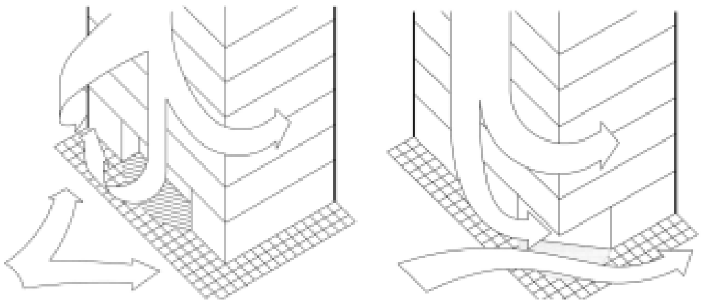

Figure 14: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

Building form – Façade profile and balconies

The way in which a building's vertical line is broken up may also have an impact. For example, if the floor plans have a decreasing area with increased height the flow down the stepped windward face may be greatly diminished. To a lesser extent the presence of many balconies can have a similar impact on ground level winds, although this is far less certain and more geometry dependent. Apartment designs with many elevated balconies and terrace areas near building ends or corners often attract a windy environment to those locations. Mid-building balconies, on the broad face, are usually a lot calmer, especially if they are recessed. Corner balconies are generally a lot windier and so the owner is likely to be selective about when the balcony is used or endeavours to find a protected portion of the balcony that allows more frequent use, even when the wind is blowing.

Use of canopies, trellises, and high canopy foliage

Downwash Mitigation – As noted earlier, downwash off a tower may be deflected away from ground-level pedestrian areas by large canopies or podium blocks. The downwash then effectively impacts the canopy or podium roof rather than the public areas at the base of the tower, Figure 12. Provided that the podium roof area is not intended for long-term recreational use (e.g. swimming pool or tennis court), this massing method is typically quite successful. However, some large recreational areas may need the wind to be deflected away without blocking the sun (e.g. a pool deck), and so a large canopy is not an option. Downwash deflected over expansive decks like these may often be improved by installing elevated trellis structures or a dense network of trees to create a high, bushy canopy over the long-term recreational areas. Various architecturally acceptable ideas may be explored in the wind tunnel prior to any major financial commitment on the project site.

Horizontally accelerated flows between two tall towers, Figure 10(R), may cause an unpleasant, windy, ground-level pedestrian environment, which could also be locally aggravated by ground topography. Horizontally accelerated flows that create a windy environment are best dealt with by using vertical porous screens or substantial landscaping. Large hedges, bushes or other porous media serve to retard the flow and absorb the energy produced by the wind. A solidity ratio (i.e. proportion of solid area to total area) of about 60-70% has been shown to be most effective in reducing the flow's momentum. These physical changes to the pedestrian areas are most easily evaluated by a model study in a boundary-layer wind tunnel.

References

Cochran L., (2004) Design Features to Change and/or Ameliorate Pedestrian Wind Conditions, Proceedings of the ASCE Structures Congress, Nashville, Tennessee, May 2004.