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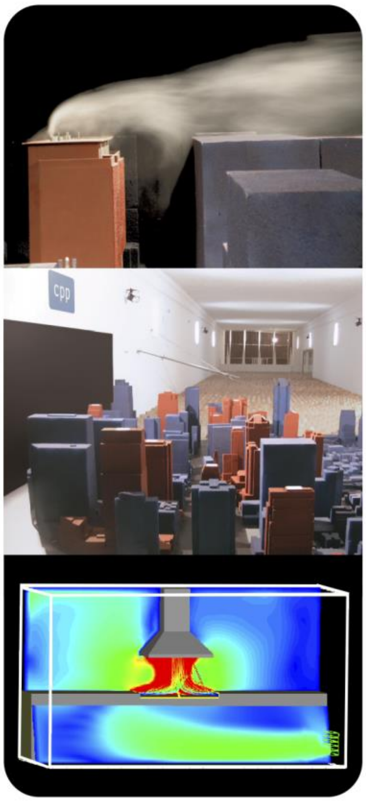
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



Qualitative Wind Assessment for:

9-11 Nelson Street

Chatswood, NSW

Prepared for:

Strata Plan Owners

c/o Urbis

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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Strata Plan Owners to provide a qualitative assessment of the impact of the proposed 9-11 Nelson Street development on the wind conditions in the surrounding areas.

The proposed development is located approximately 300m south of the Chatswood CBD, in a region of low rise suburban development, Figure 1. The proposed development will comprise two medium-rise structures, reaching a maximum height of about 88 m above ground level, Figure 2. As it is slightly larger than most of the existing 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. This assessment is based on a massing model only, and as such is conservative in the sense that it does not consider any potential beneficial features of a future detailed design.

Figure 1: Aerial view of the proposed development site (Google Earth, 2020).

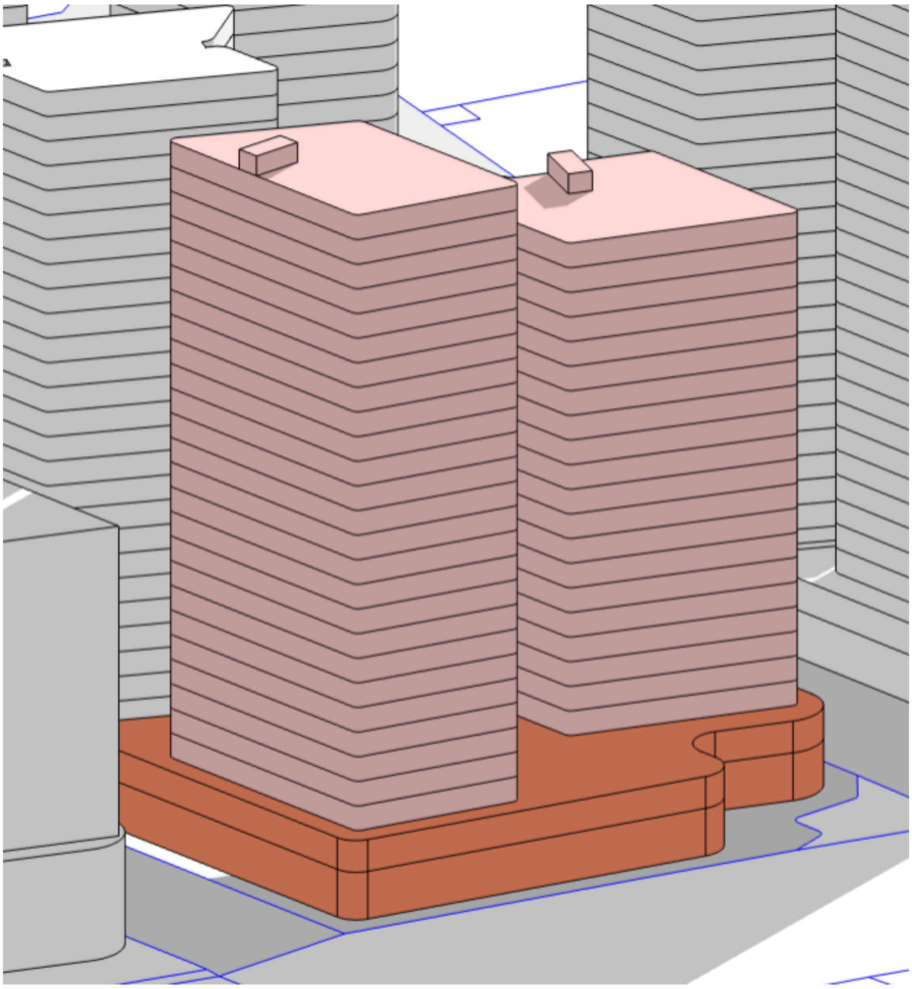

Figure 2: Structures and massing within the proposed development, viewed from the south-east.

2 SYDNEY WIND CLIMATE

The proposed development lies approximately 16 km to the north of the Sydney Airport Bureau of Meteorology anemometer. To enable a qualitative assessment of the wind environment, the wind frequency and direction information measured by the Bureau of Meteorology at a standard height of 10 m at Sydney Airport from 1995 to 2019 have been used in this analysis. The wind rose for Sydney Airport is shown in Figure 3 and is considered to be representative of prevailing winds at the site. 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.

Winds from the north-east tend to be summer sea breezes and bring welcome relief on summer days, typically lasting from noon to dusk. These are small-scale temperature driven effects; the larger the temperature differential between land and sea, the stronger the breeze. Winds from the south are associated with large synoptic frontal systems and generally provide the strongest gusts during summer. Winds from the west are the strongest of the year and are associated with large weather patterns and thunderstorm activity. These winds occur throughout the year and can be cold or warm depending on the inland conditions.

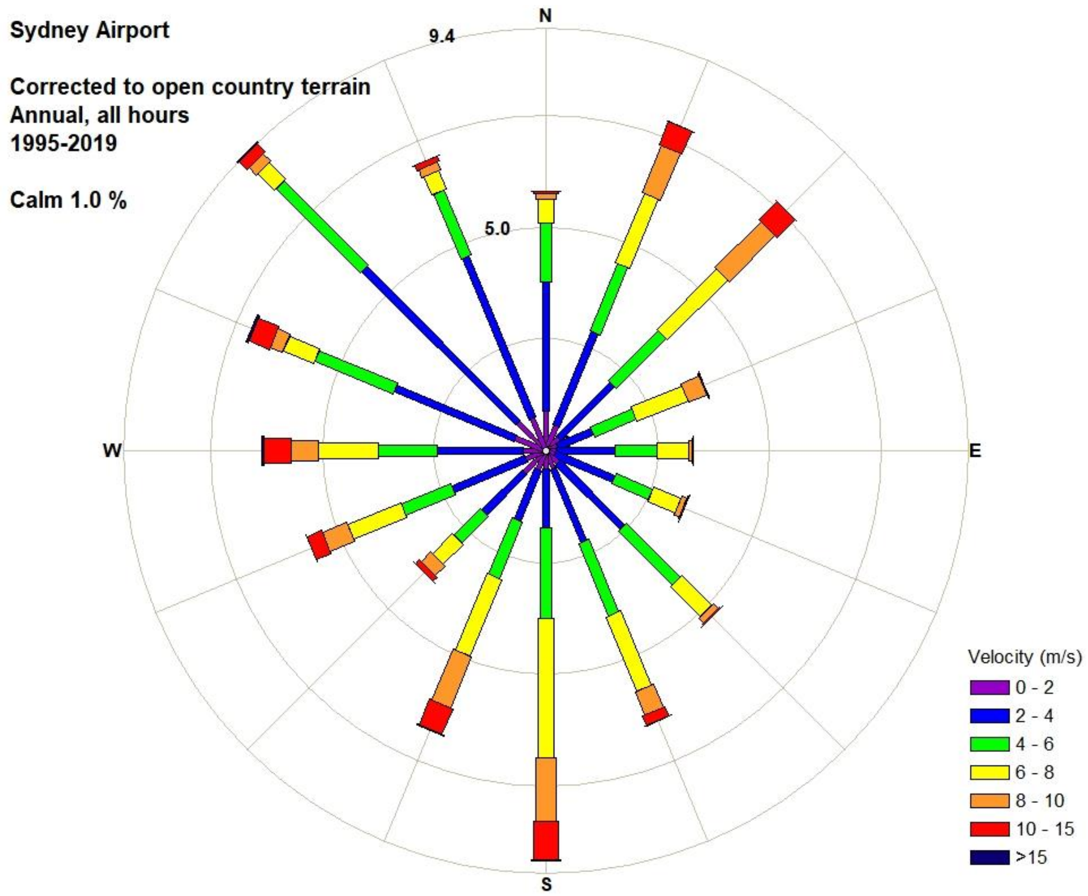

Figure 3: Wind rose for Sydney Airport.

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 Willoughby City Council DCP (2016) has no specific wind assessment criteria. 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 metric is considered an appropriate indicator of the experience of the general public in a precinct.

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 high-rise massing of Chatswood CBD approximately 500m to the north. The proposed development will in future form part of the 'outer centre' of the Chatswood CBD and similarly sized developments are proposed for sites to the immediate west, Figure 4. Railway lines currently border the block to the east, with medium-rise structures proposed in this area once the rail tunnel is completed to the south. Topography surrounding the site is relatively flat from a wind perspective and unlikely to significantly affect the wind climate at the site. Winds in such surrounds tend to experience less channelling than areas with many tall structures, with local effects instead being dictated by exposed buildings and their relation to prevailing strong wind directions. 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.

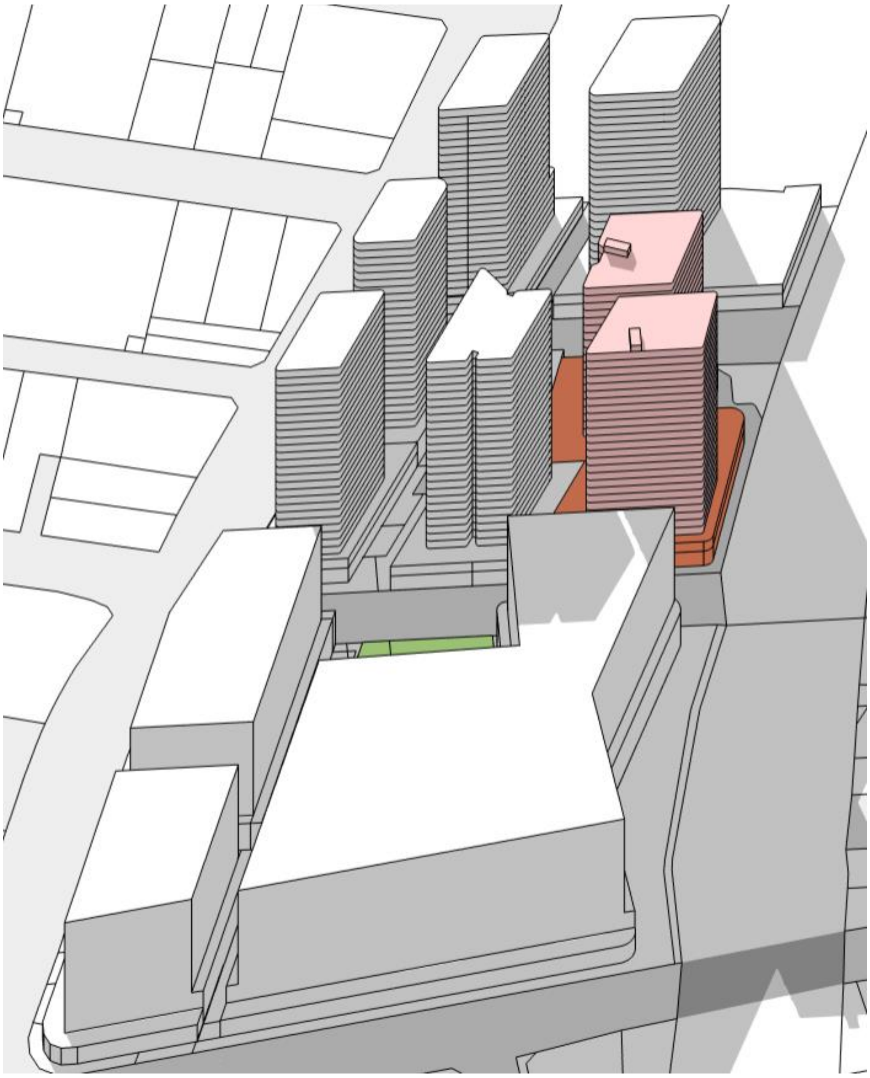

Figure 4: Development site (red) and proposed future surrounds

The subject site is located on a block bounded by Nelson Street to the south and railway lines to the east. The proposed development consists of a two prismatic towers with rectangular planforms, over a shared podium structure with ground-floor retail tenancies. A ground floor plan is shown in Figure 5.

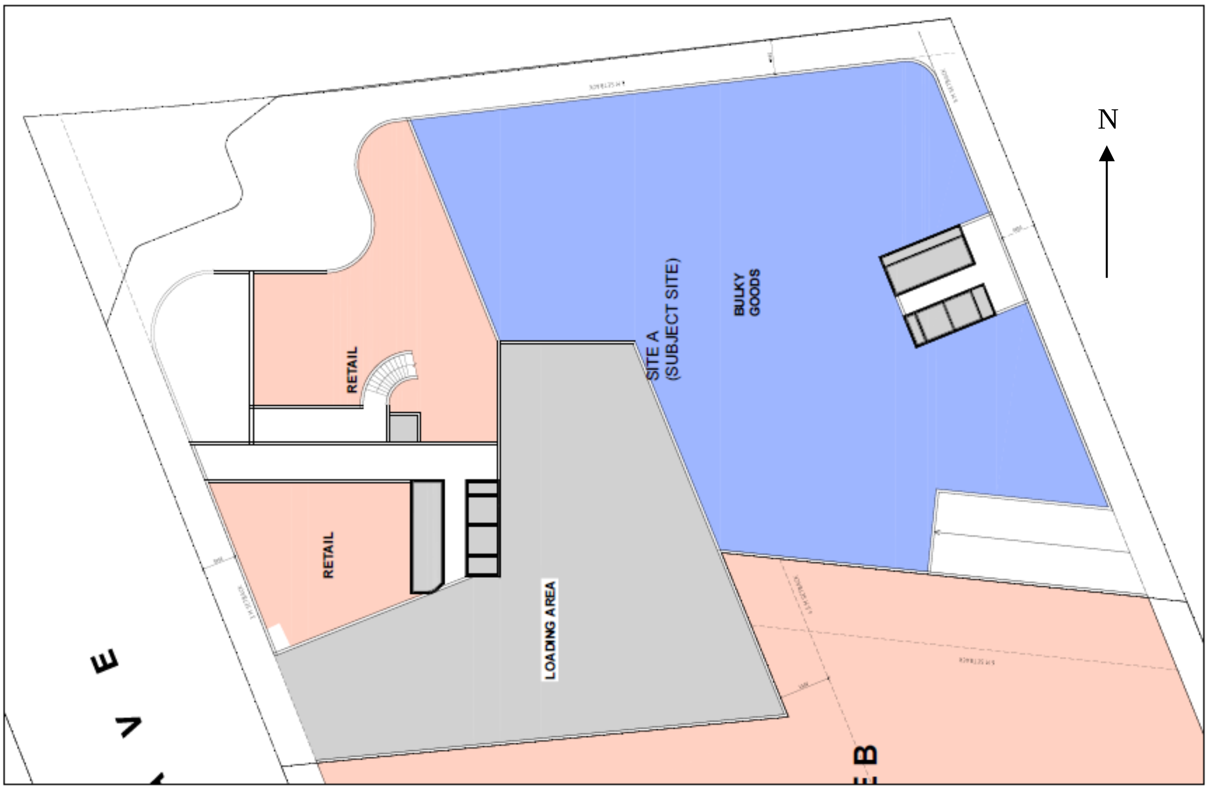

Figure 5: Ground floor of the proposed development.

4.1 Winds from the north-east

Winds from the north-east quadrant will approach over low-rise suburban buildings of Chatswood and the adjacent railway lines. Winds from this quadrant are relatively unimpeded approaching the development. Pedestrian areas along the eastern boundary of the development may be affected by stronger breezes developing along the corridor formed by the existing rail line. As the towers are taller than the upwind surrounds, winds from the north-east are likely to impinge on the tower facades and be directed toward the ground in the form of downwash which may generate accelerated flow at ground level and on the podium rooftop level. The tower levels are set back 3m from the podium edge (Figure 6), which will limit the impact of downwash at street level by redirecting the flow horizontally. Relatively higher wind speeds would be expected on the podium roof near to the windward corners of the towers during winds from the north-east. In addition, flow may be accelerated through the space between the two towers, generating stronger winds here. If the podium roof is to be activated for pedestrian use, amelioration that incorporates vertical and horizontal elements such as awnings are likely to be recommended. During winds from the north-east, conditions at locations on the southern and western sides of the development are expected to remain relatively calm. Overall, for winds from this quadrant, conditions at most public domain locations around the site are expected to remain similar to the existing wind conditions and pass the safety/distress criterion.

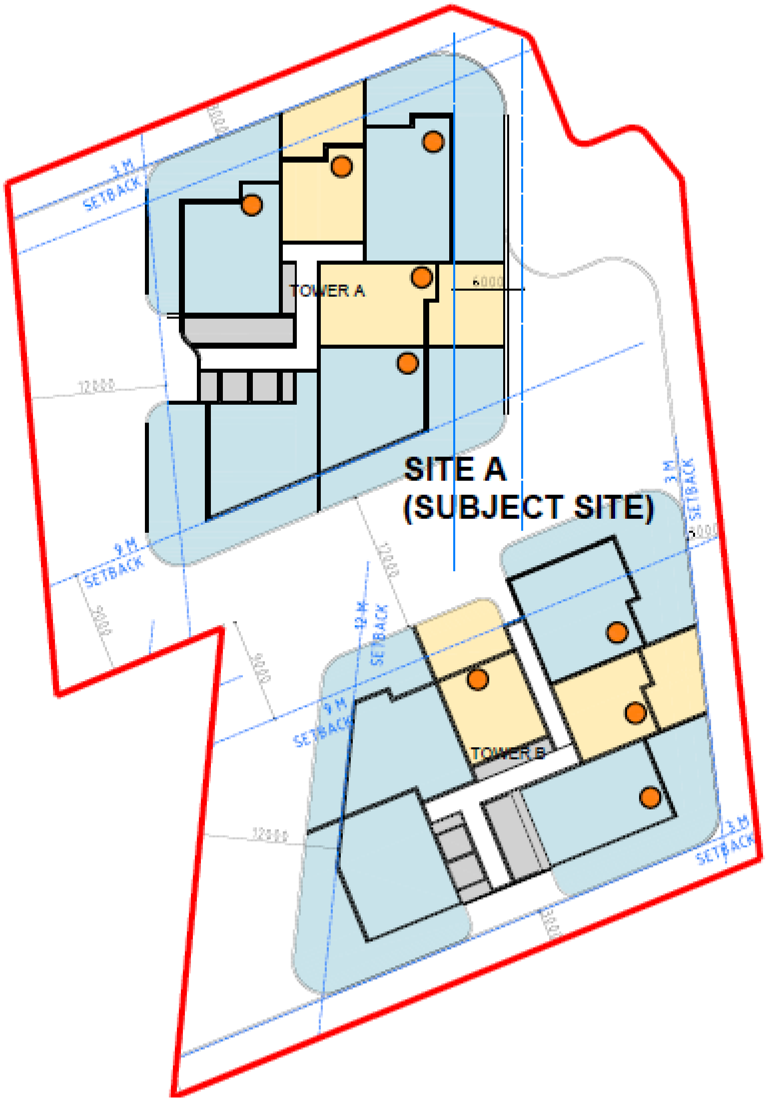

Figure 6: Proposed typical tower plans

4.2 Winds from the south

Winds from the south quadrant will pass over sections of the low-rise and mid-rise industrial buildings of Artarmon. The future development to the south is approximately half the height of the proposed towers and will provide shielding from wind from the south at podium and ground levels. If upper level balconies are planned for the development, they will be relatively exposed to winds from the south and will experience windier conditions expected to be suitable for pedestrian standing or walking under Lawson. The north tower of the development is shielded from winds from the south by the south tower. Most outdoor areas within the site will be relatively shielded from winds from the south, however the south-east corner of the site on Nelson street is somewhat exposed to winds moving along the railway lines from the south-east and will experience slightly stronger conditions. Similarly, the massing of future developments to the west of the site will allow for some channelling of winds from the south-west along the Pacific Highway. These channelling effects will be largely confined to the western side of the black and have minimal noticeable impact on pedestrian wind conditions at the site. For winds from the south quadrant, wind conditions at most locations around the site are expected to remain similar to the existing wind conditions and pass the safety/distress criterion.

4.3 Winds from the west

Winds from the west quadrant will pass over an area of low-rise suburban development of Chatswood and mid-rise buildings in the proposed future configuration directly to the west of the proposed development. The towers are relatively shielded from these winds by the proposed development to the west which consists of three towers of similar height to the south tower. The combined massing of the proposed masterplan will encourage winds from the west to channel along Nelson Street and Gordon Avenue, hence marginally increasing wind speeds on these frontages. The indicated allowance for tower setbacks will limit the potential for localised high wind areas caused by downwashing flow. Retention of street trees where possible will help reduce the impact of strong breezes. On windier days, local amelioration in the form of vertical screening or additional landscape planting may be used to create local areas of calm. This would only be considered necessary if long-term stationary or outdoor dining activity is intended for these street frontages. As the proposed upwind buildings may not exist when the development is built, the site may be less shielded from winds from the west, and the pedestrian wind amenity may be reduced as a consequence.

Due to the orientation and massing of the two towers, winds from the west may be accelerated through the gap on the podium roof creating windy conditions between the two towers. As previously noted, vertical screening element could be used to provide amelioration if this area is to be activated for pedestrian use. Ground level pedestrian spaces within the masterplan block are expected to remain mostly calm during winds from the west due to the protection created by the shared podiums of proposed future developments. Similarly, ground level locations on the eastern side of the site will remain mostly calm during winds from this direction. On average, wind conditions around the proposed development site are expected to remain similar to the existing wind conditions and pass the safety/distress criterion during winds from the western quadrant.

4.4 Summary

The addition of the proposed development may cause wind speeds in some areas to increase, while creating calmer conditions in others. On average and for the majority of locations in the vicinity, the pedestrian level wind environment is expected to remain similar to the existing. From a pedestrian comfort perspective, the wind environment around the proposed development site is likely to be classified as acceptable for pedestrian standing or 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. All locations in the public domain would be expected to satisfy the safety/distress criterion.

4.5 Wind conditions within the development

Some locations within the development may experience higher wind velocities at times, which may necessitate local amelioration depending on how these areas are to be used. As noted, the podium roof may experience relatively high velocities, in particular near to the tower bases and in the space between the two towers. Depending on the intended use of this area, a mitigation strategy incorporating both horizontal and vertical elements is likely to be required. The current plans do not yet detail balconies, however windier conditions are often found on residential balconies for developments of this type, particularly on exposed corner balconies. Winds from the north east and south in particular will drive conditions on balconies. Amenable conditions are achievable though measures such as placement away from building corners, recessing within the façade, and use of partition walls/fins and high balustrades.

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed 9-11 Nelson Street project on the local wind environment in and around the development site. Being slightly larger 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 due to the site surrounds and separation of tower massing from ground level pedestrian locations. 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.

To quantify the wind conditions around the site, a wind-tunnel test would be recommended during detailed design.

6 REFERENCES

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.

Melbourne, W.H., 1978, Criteria for Environmental Wind Conditions, Journal of Wind Engineering and Industrial Aerodynamics, Vol.3, No.2-3, pp.241-249.

Standards Australia (2011), Australian/New Zealand Standard, Structural Design Actions, Part 2: Wind Actions (AS/NZS1170 Pt.2).

Appendix 1: Wind flow mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 7; 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 7, 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 8 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.

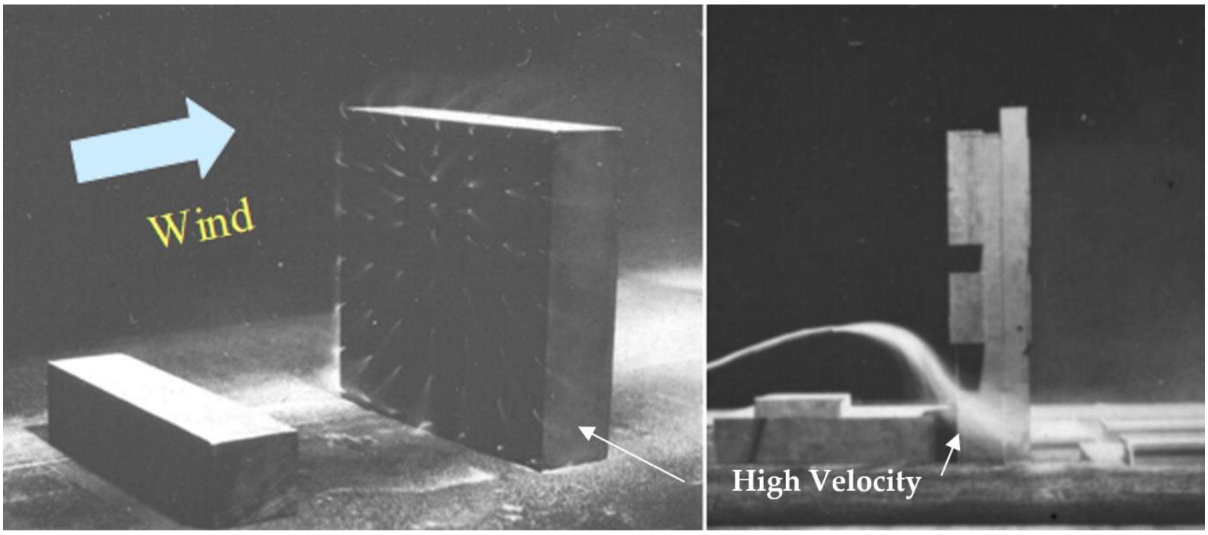

Figure 7: Flow visualisation around a tall building.

Figure 8: 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 9. 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.

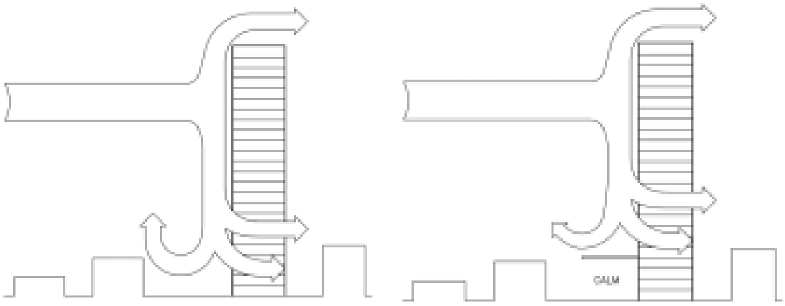

Figure 9: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

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 10. 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.

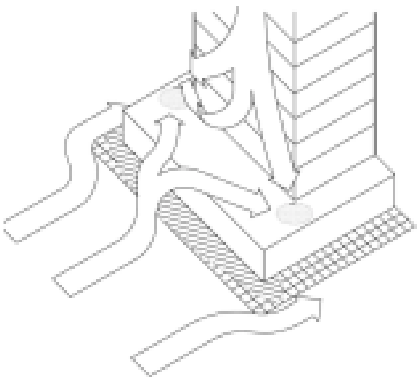

Figure 10: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

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 11. The uninvitingly windy nature of these open areas is a contributing reason behind the use of arcade airlock entrances (revolving or double sliding doors).

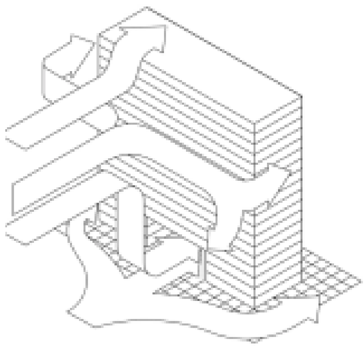

Figure 11: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure 12(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 12(R), due to the accelerated flow mechanism described in Figure 7 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.

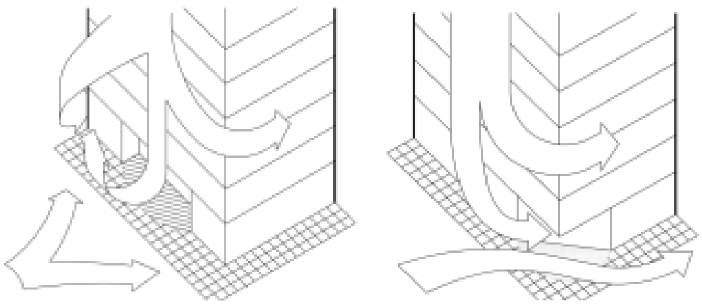

Figure 12: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

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 10. 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 8(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.