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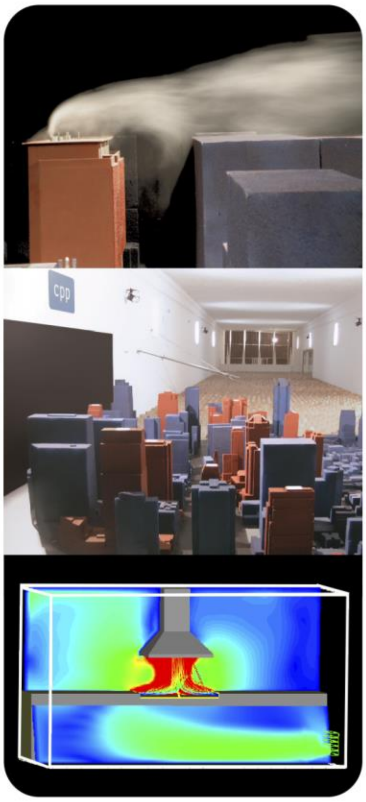
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



UNSW D14

Qualitative Wind Assessment

Kensington, NSW

Prepared for:

UNSW

c/-

Lend Lease Building

L14, Tower 3 ITS

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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Lend Lease Building to provide a qualitative assessment of the impact of the proposed UNSW D14 development on the wind conditions in the surrounding areas.

The proposed development is located on the UNSW Campus in Kensington, approximately 6 km to the south-east of the Sydney CBD, in a region of medium rise structures surrounded by suburban development, Figure 1. The proposed development will comprise a single 7-storey building, reaching a maximum height of approximately 41 m above ground level, Figure 2. Due to its height and massing in the context of the surrounds, the proposed development is not expected to significantly affect local wind conditions. The distribution of wind speeds in and around the development is important to the success of the development, and the impacts are broadly discussed in this report.

Figure 1: Aerial view of the proposed development site (Tzannes).

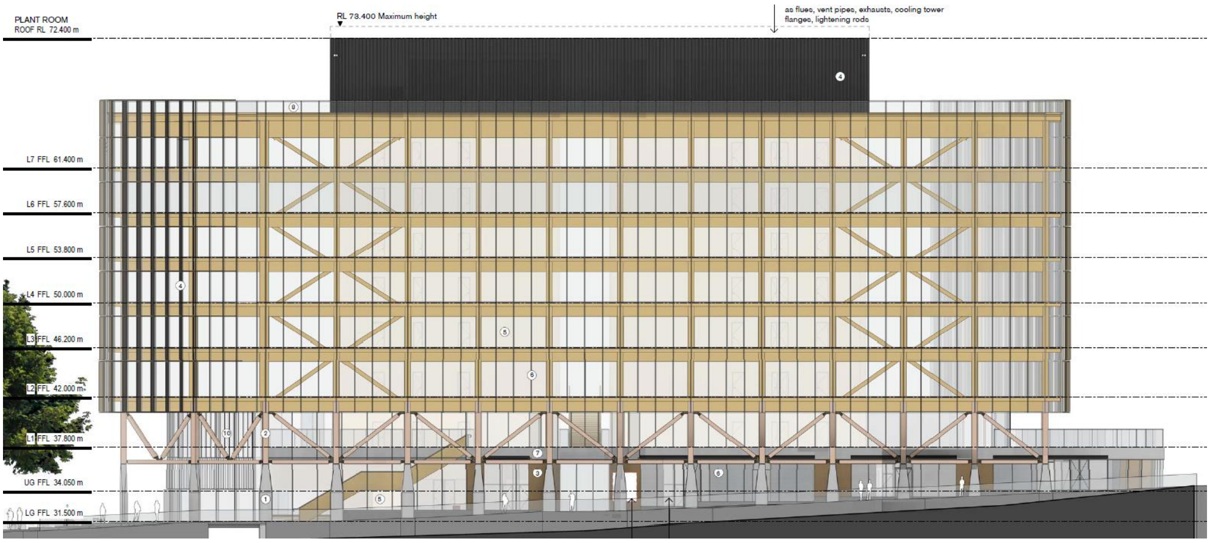

Figure 2: South elevation of the proposed development (Tzannes).

2 SYDNEY WIND CLIMATE

The proposed development lies approximately 5km km to the north-east 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 2017 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.

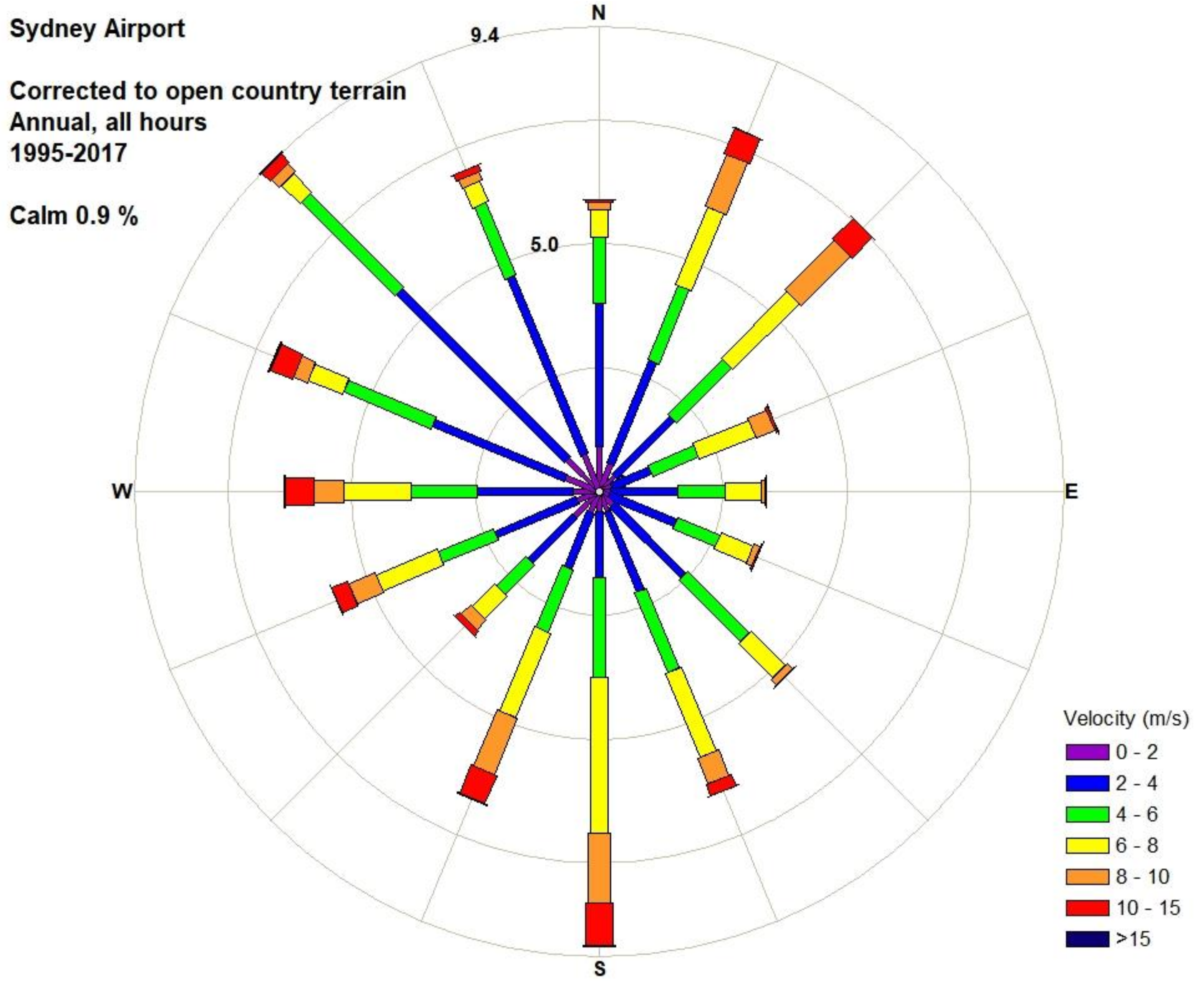

Figure 3: Wind rose for Sydney Airport.

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 Randwick City Council DCP (2013) 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 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 located near the northern boundary of the UNSW campus, in a region of low to medium-rise structures, set out on a grid roughly aligned with the cardinal directions. Further afield to the east, west, and south are areas of low-rise domestic developments. A short distance to the north is the open area of Randwick racecourse, which will allow slightly stronger winds to develop over this approach. Topography at the site is predominantly flat, with a moderate incline toward the east, which may offer a minor shielding effect to the site for wind from this direction. Winds in such surrounds tend to be determined by the interaction of the compound building massing with prevailing winds, with the local conditions being affected by adjacent developments as well as the subject building. 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.

Major pedestrian thoroughfares enclose the site to the north-east, east and south, with a outdoor areas to the west and north-east (Alumni Park and Old Tote Courtyard). Existing residential buildings enclose the site to the east and north. Outdoor seating areas not indicated in the current plans, but are generally intended for the ground level retail spaces. A through-site link runs north to south on the ground floor. A ground floor plan is shown in Figure 4.

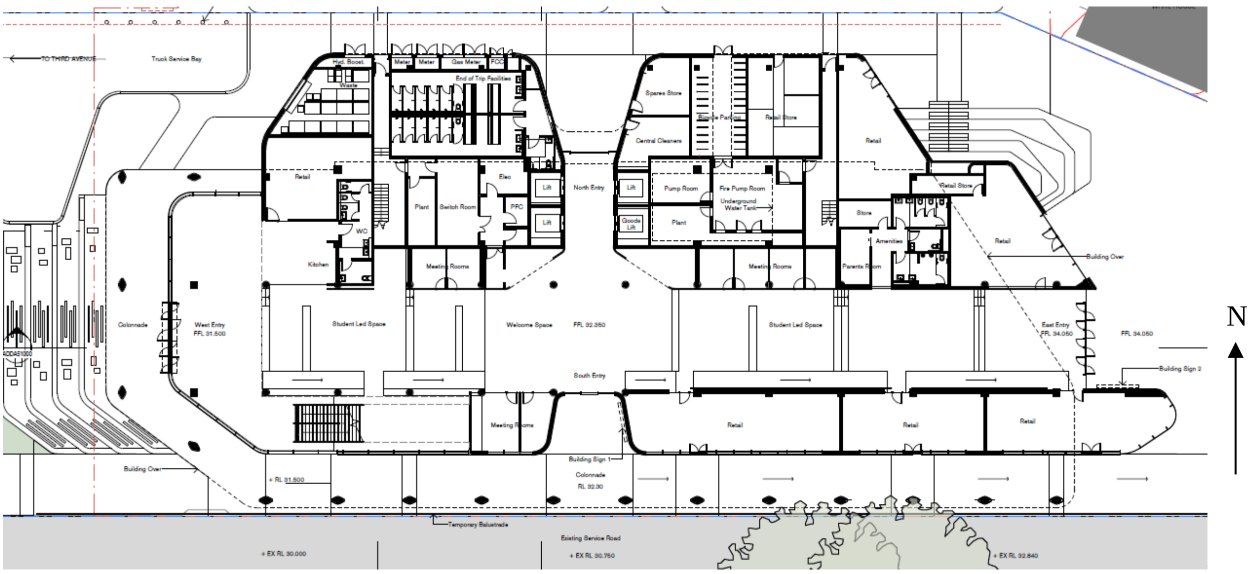

Figure 4: Ground floor of the proposed development (Tzannes)

4.1 Winds from the north-east

Winds from the north-east quadrant approach the site over a region of typical suburban development and part of Randwick racecourse. The lower levels of the proposed development will be shielded to a significant degree by the existing buildings on High Street to the immediate north and north-east of the site. The established large trees on High Street and Fig Tree Lane will also assist in mitigating strong winds from this direction. The oblique orientation of the building relative to flow from this direction will help minimise adverse impacts. Some of the flow impinging on the upper portion of the northern façade will be directed downward and toward the west, however protection is provided to the ground plane in the form of the protruding lower levels, which will redirect the flow horizontally. The open area of Alumni Park and adjacent to the existing residential colleges would not be affected by the inclusion of the proposed development. The areas around the stairs to the east may experience stronger conditions, as they are in a slightly more exposed area. Localised screening to any planned seating areas would be suggested here if very calm conditions are required. The terrace above will limit the impact of the main building to this area. Wind conditions at most locations around the site are expected to remain similar to the existing for prevailing wind from the north-east.

4.2 Winds from the south

The approach from the south of the site is predominated by low-rise suburban development, with larger university buildings to the immediate south offering significant shielding. Reasonably calm conditions would be expected around the site during winds from this direction as a result. As the proposed development is oriented perpendicular to the incoming flow and is slightly taller than the neighbouring structures, a limited amount of downwash would be expected in the low-pressure zone created to the south of the site. The colonnade that extends along the southern perimeter (Figure 4) will offer an area of protection to pedestrians. As with winds from the north-east, the space adjacent to the retail tenancies to the east will experience conditions similar to existing, and will be largely unaffected by the proposed building due to the large overhead canopy. The same is true for Alumni Park to the west, while The Old Tote Courtyard area will likely experience improved conditions during winds from this quadrant. Winds from the south would not be expected to significantly affect conditions at the subject site. It is recommended that seating areas outside the retail spaces on the southern side of the building be located away from the building corners due to accelerated flow in these areas.

4.3 Winds from the west

Winds from the western quadrant will be channelled between the existing university buildings on either side of Alumni Park. The topographic incline to the east may slightly accelerate winds from the west as they approach the site. The chamfered geometry of the western façade will assist in limiting the generation of downwash flows impacting the ground plane, and the colonnade will allow calmer conditions close to the building. Slightly stronger velocities would be expected near the windward corners (north-west and south-west) of the building as flow accelerates around the massing, and it would be suggested to avoid using these areas for outdoor seating. Being located further upwind, conditions on Alumni Park are not likely to be significantly affected by the proposed development. During wind from the west, conditions to the south and west of the new building are likely to be suitable for transient and short-term use.

4.4 Summary

For most locations, wind conditions within the proposed development site are expected to remain similar to the existing wind conditions. 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 in the form of vertical screens or landscaping would be suggested if calmer areas are desired for particular locations such as outdoor seating areas for the retail spaces. All locations would be expected to satisfy the safety/distress criterion.

4.5 Wind conditions within the development

A difference in pressure on the north and south facades of the building may generate pressure-driven flow through the ground floor through-site link if doors are open simultaneously. The strength of the resulting flows is not expected to be particularly severe, and would be expected only during periods of high foot traffic. The potential for this flow to develop could be minimised by incorporating, sealing one end of the link using an airlock or revolver if very calm conditions are required around the entries.

External terraces are located on the northern and eastern aspects of the development at level 1, Figure 5. Elevated outdoor areas often experience windy conditions due to the influence of the adjacent building massing and greater exposure to prevailing winds. The terraces on the proposed development are relatively well shielded from strong winds by neighbouring structures, however the north-facing areas will be affected at times by flow downwashing off the levels above. To increase the proportion of time conditions are suitable for long-term stationary activity, horizontal awnings above the terrace or umbrellas may be effective. Localised elements such as landscaping and temporary screens around seating areas would also be suggested, depending on the intended use of these areas. It is understood that the east facing terrace is primarily intended for transitional activities, and wind conditions are expected to be suitable for this use.

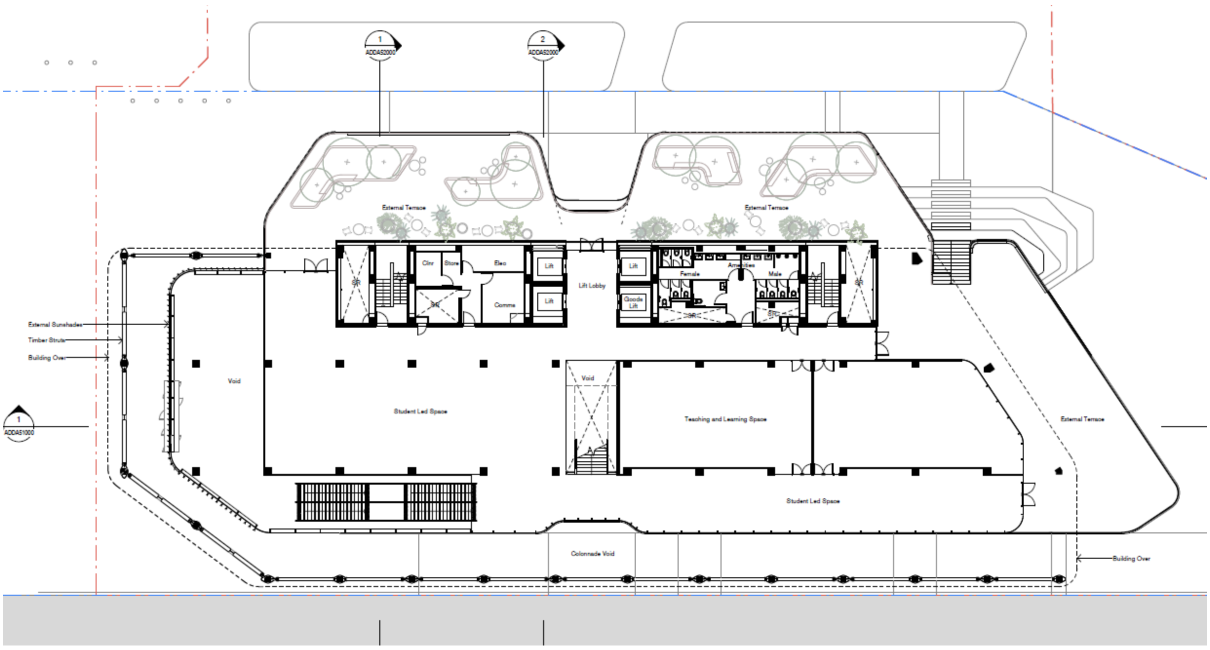

Figure 5: Level 1 plan of the proposed development (Tzannes)

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed UNSW D14 project on the local wind environment in and around the development site. The proposed development is relatively well protected from prevailing strong winds by neighbouring structures of comparable size and massing. Wind conditions around the site are expected to remain largely similar to existing, being classified as suitable for Pedestrian Walking or Pedestrian Standing under Lawson and satisfy the safety/distress criterion. No significant impacts are anticipated for the adjacent passive outdoor spaces or residential buildings. Local amelioration would likely be necessary for areas intended for long-term stationary or outdoor dining activities.

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.

Appendix 1: Wind flow mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 6; 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 6, 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 7 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.

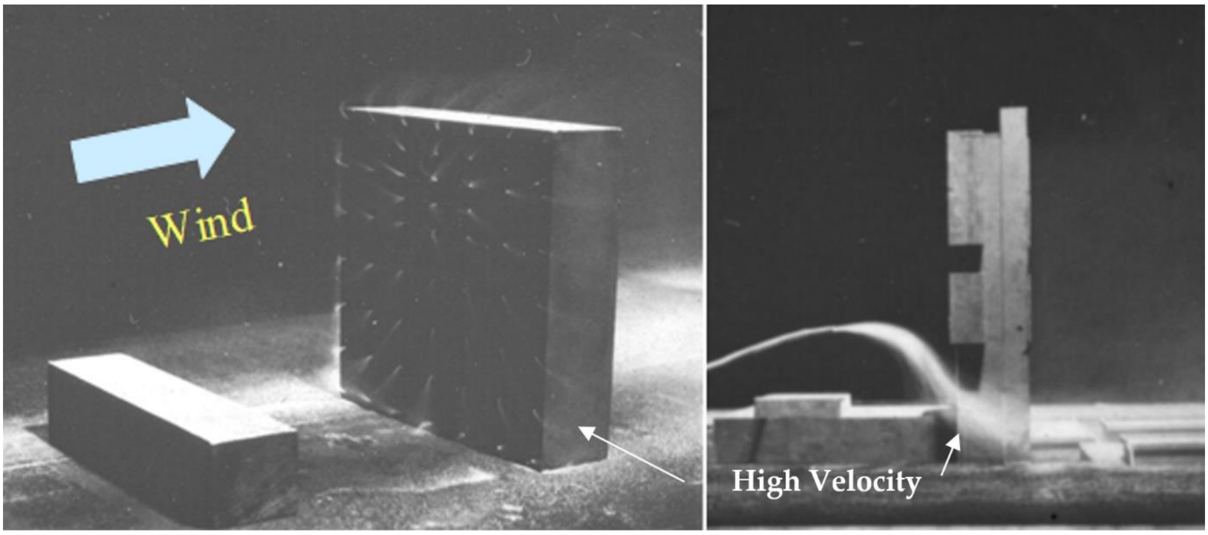

Figure 6: Flow visualisation around a tall building.

Figure 7: 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 8. 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.

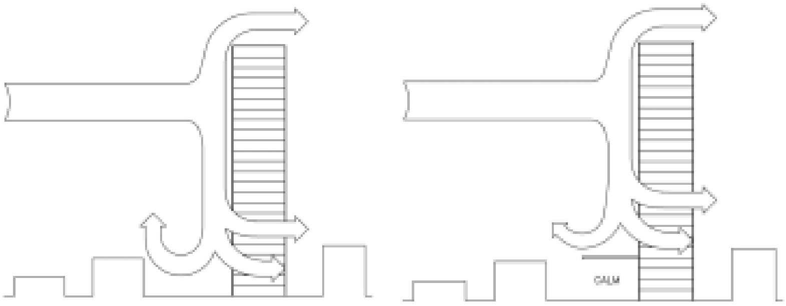

Figure 8: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

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 9. 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.

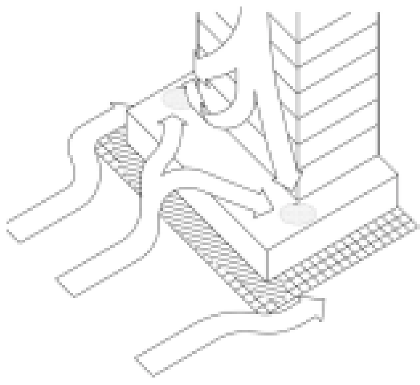

Figure 9: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

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

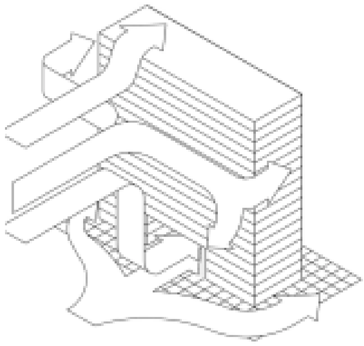

Figure 10: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure 11(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 11(R), due to the accelerated flow mechanism described in Figure 6 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.

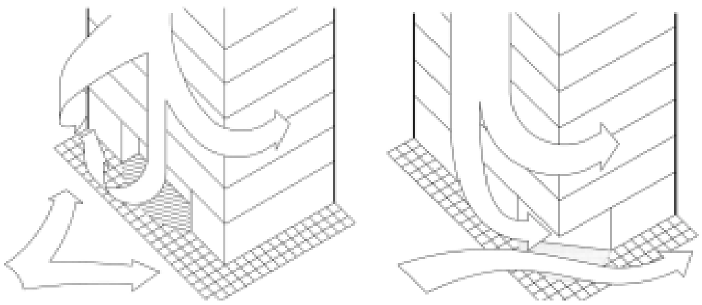

Figure 11: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

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 9. 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 7(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.