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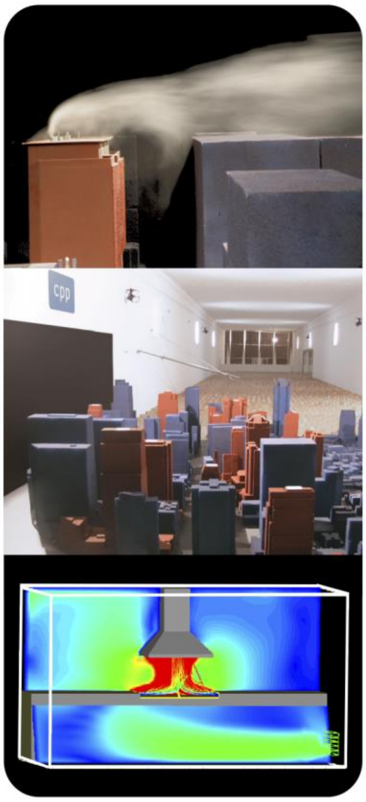
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



Qualitative Wind Assessment for:

Eden Gardens

Macquarie Park, NSW

Prepared for:

Thunderbirds Are Go Pty Ltd aft the Gardeners Trust

307 Lane Cove Road

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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Thunderbirds Are Go Pty Ltd aft the Gardeners Trust to provide a qualitative assessment of the impact of the proposed Eden Gardens development on the wind conditions in the surrounding areas.

The proposed development is bounded by Lane Cove Road to the northwest, M2 Motorway to the southwest, approximately 2 km to the southeast of Macquarie University Campus and surrounded by Lane Cove National Park to most of its north and east quadrant, Figure 1. The proposed development will comprise of an office tower reaching a maximum height of approximately 80 m above ground level as well as several low-rise structures, Figure 2. As the tower is 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.

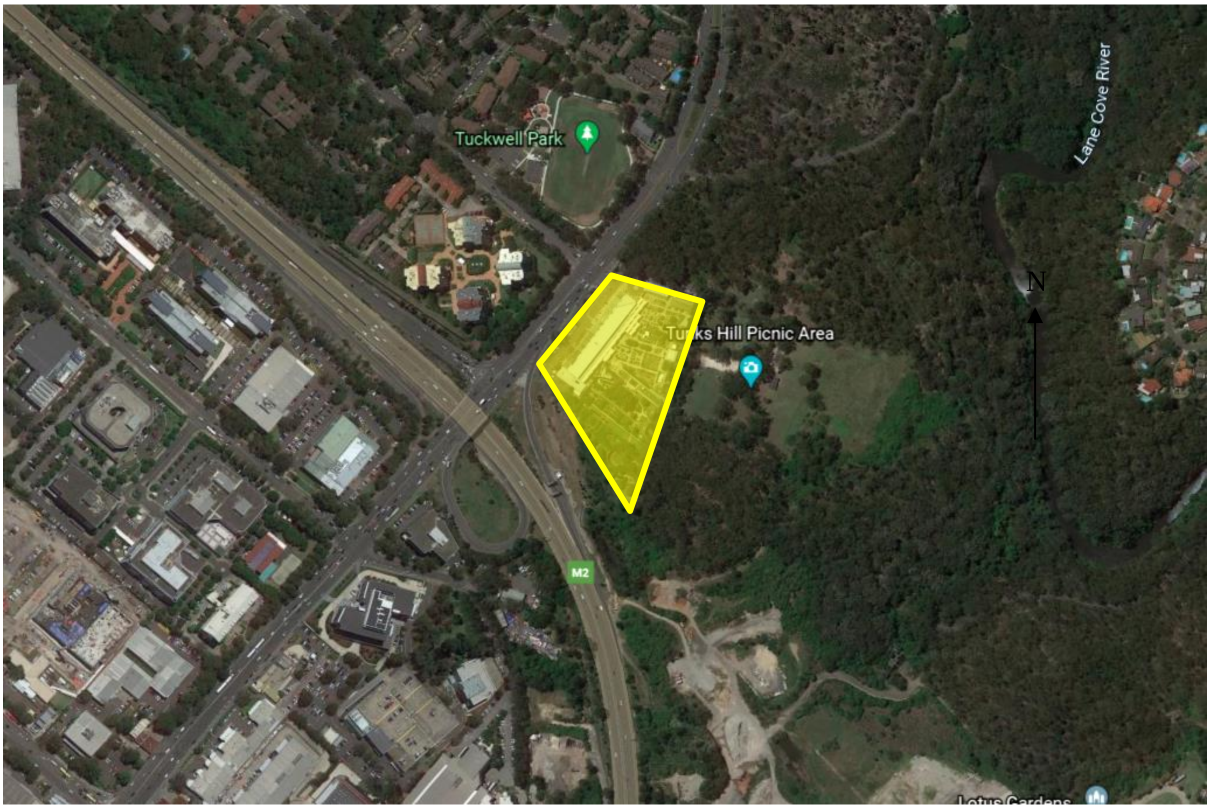

Figure 1: Aerial view of the proposed development site (Google Earth, 2020).

Figure 2: Structures and massing within the proposed development viewed from the north-west.

2 MACQUARIE PARK WIND CLIMATE

The proposed development lies approximately 20 km to the north-east of the Bankstown Airport Bureau of Meteorology anemometer and 19km to the north-west of the Sydney Airport anemometer. The general wind roses for Bankstown and Sydney Airports are presented in Figure 3. In coastal Sydney, winds from the north-east tend to be summer sea breezes and bring welcome relief on summer days but dissipate with distance from the coast and are significantly diminished at Bankstown. In terms of distance from the coast, the site is located approximately halfway between the two airports. For this development, a superstation has been created by analysing data at both stations from 1995 to 2017 and performing statistics on the extended dataset. The result of this analysis is indicated in Figure 3.

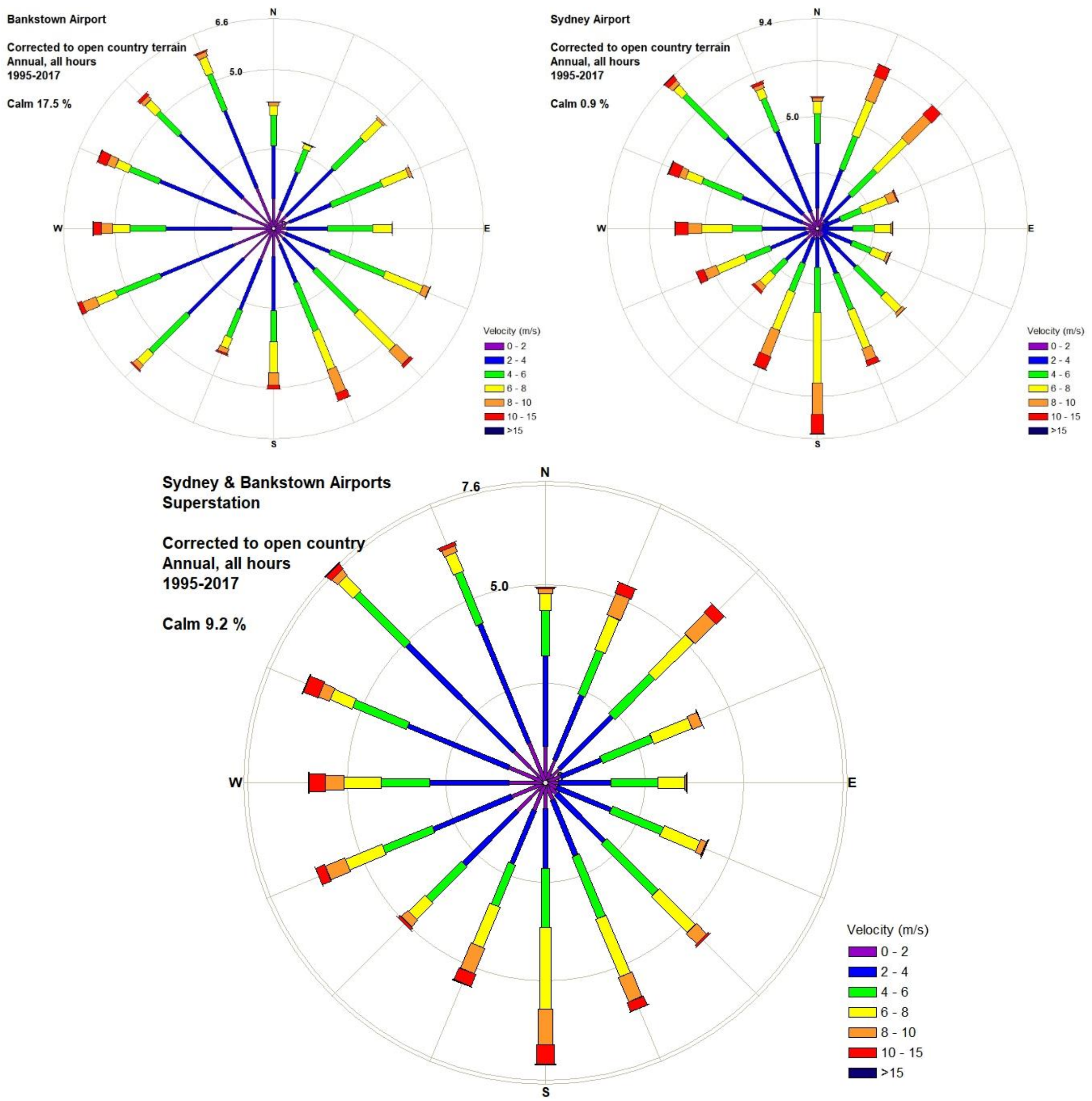

Figure 3: Wind rose for Bankstown and Sydney Airports (top), and superstation (bottom).

Winds from the south-east, which tend to be cold, are often caused by frontal systems that can last several days and occur throughout the year with reduced frequency in winter. Winds from the west tend to be the strongest of the year and are associated with large weather patterns and thunderstorm activity. These winds occur throughout the year, but are reduced in frequency in summer, and can be cold or warm depending on the inland conditions. The prevailing wind directions associated with rain are from the south and west quadrants. This wind assessment is focused on these prevailing wind directions.

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 City of Ryde 2014 Development Control Plan (DCP) has specific wind assessment criteria for the Macquarie Park Corridor based on the maximum allowable wind velocities stating: *Buildings shall not create uncomfortable or unsafe wind conditions in the public domain, which exceeds the Acceptable Criteria for Environmental Wind Conditions.* The specified acceptable criteria are described in Table 1 for both pedestrian comfort and distress, and they appear to be derived from the criteria developed by Davenport (1972) and Melbourne (1978). The DCP criteria require the use of both a mean and gust equivalent mean (GEM) wind speed to assess the suitability of specific locations, as well as an annual maximum gust wind speed. 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. For outdoor dining type activities, a more stringent criterion would be required. The annual maximum gust wind speed of 23 m/s is understood to be a safety criterion as defined by Melbourne (1978), although the necessity for directionality is not included. The gust wind speed may be suitable for safety considerations, but not necessarily for serviceability comfort issues. This is because the instantaneous gust velocity does not always correlate well with mean wind speed, and is not necessarily representative of the parent distribution. Therefore, the weekly criteria defined in the DCP are considered most adequate to assess pedestrian comfort. It is noted that the DCP requires a wind tunnel study to be conducted for buildings over 9 storeys in height.

The superstation wind climate has an average wind speed at 10 m reference height of approximately 4 m/s (8 kt, 14 kph), and five percent of the time the mean wind speed is approximately 10 m/s (19 kt, 36 kph). Converting the five percent of the time mean wind speed to typical pedestrian level at the site using Standards Australia (2011) would result in about 6 m/s (12 kt, 22 kph). Comparing this with the comfort criteria of Table 1 indicates that pre-existing winds at any comparable location with a similar built environment surrounding the proposed development site would be classified as acceptable for footpaths and pedestrian walkways. Specific building massing of the proposed development and their interaction with approaching wind flows will dictate the actual wind environment at the site and the resulting wind acceptability levels; these are explored in detail below.

Table 1: Pedestrian comfort criteria for various activities as defined in the DCP.

Weekly maximum wind speed (understood as the maximum hourly mean wind speed exceeded 5% of the time as defined by Davenport (1972))	
< 3.5 m/s	Outdoor dining, amphitheatres etc. (sitting activities, long exposure)
3.5 – 5.5 m/s	Retail centres and streets, parks and recreational areas (standing activities)
5.5 – 7.5 m/s	Footpaths and pedestrian accessways (walking)
7.5 – 10 m/s	Infrequently used laneways, private balconies
Annual maximum gust wind speed (understood as the maximum gust wind speed exceeded in an hour for 0.1% of the time as defined by Melbourne (1978))	
< 10/13 m/s	Outdoor dining, amphitheatres etc. (sitting activities, long exposure)
10 – 13 m/s	Retail centres and streets, parks and recreational areas (standing activities, short exposure)
13 – 16 m/s	Footpaths and pedestrian accessways (walking)
16 – 23 m/s	Infrequently used laneways, private balconies

The weekly maximum wind speed is either a 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 a gust factor, usually defined as 1.85.

4 ENVIRONMENTAL WIND ASSESSMENT

The proposed developments are mainly surrounded by low- rise residential buildings to the northeast clockwise to south of site and Lane Cove National Park to most of its north and east quadrant. The proposed development site is also surrounded by medium to high density residential and commercial buildings of Macquarie on west quadrant of 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. The immediate topography surrounding the site shows an upward slope along Lane Cove Road from the south-west to the north-east. M2 Hills Motorway runs along a ridge sloping upward from south-east to north-west. To the south of the site, the topography drops by approximately 20m over a distance of 300m. Several wind flow mechanisms such as downwash and channelling flow are described in Appendix 2, and the effectiveness of some common wind mitigation measures are described in Appendix 3.

The subject site is located on a block bounded by Lane Cove Road to the north-west and M2 Hills Motorway to the southwest. The proposed development consists of an 18-storey commercial office building with a lower ground basement, single-storey restaurant to the southeast, two storey function centre to the southwest, 4-storey carpark and single-storey garden centre/ neighbourhood shops to the northeast and northwest respectively. A ground floor plan is shown in Figure 4.

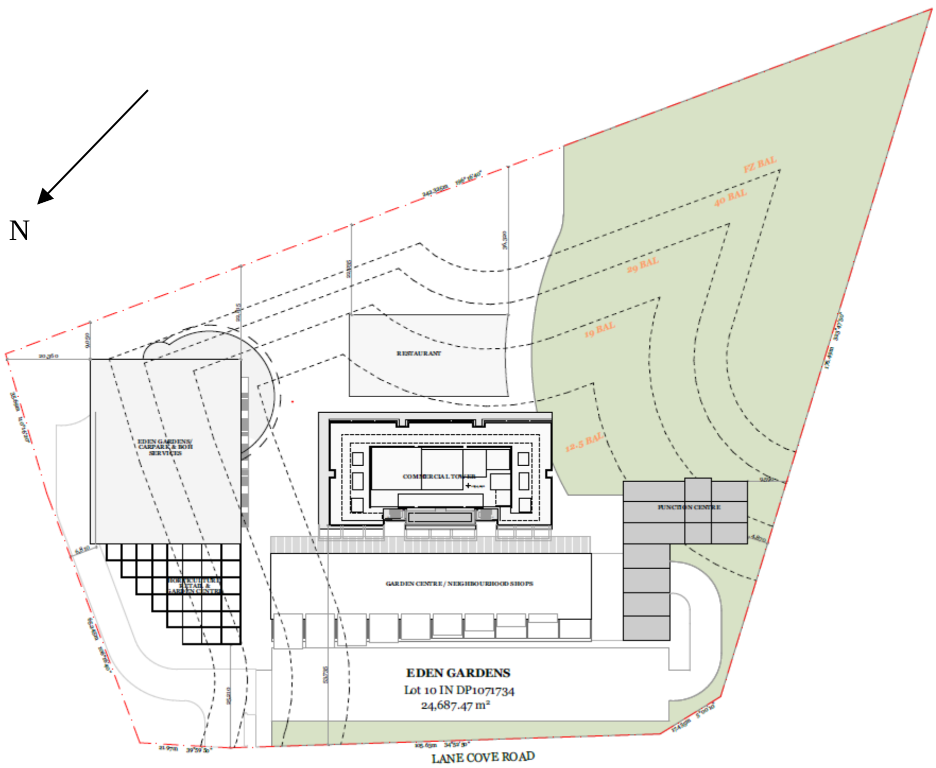

Figure 4: Ground floor of the proposed development.

4.1 Winds from north-east

Winds from north-east are more prevalent during summer period and generally weaker in strength compared to winds from south and west quadrant. Winds from north-east will pass over the low-rise buildings of West Lindfield and Lane Cove National Park, reaching the development site relatively unimpeded. Winds from north-east would strike corner or the narrow façade of the office tower, encouraging flow to pass horizontally around the tower, with only limited amounts of downwash expected. However, somewhat windy conditions might be expected at northeast corner of restaurant and open space to the southeast façade of carpark due to direct wind from north-east and flow around building massing as these two areas will be utilized for outdoor dining and outdoor climbing respectively. Inclusion of planting, and other vertical elements, within this area could be used to ameliorate wind conditions and create local areas of calm.

4.2 Winds from the south quadrant

Winds from south quadrant will reach the site relatively unimpeded by larger structures or obstacles and the slope of the terrain is expected to accelerate winds from south quadrant into the site. As there are no significant upstream obstacles, the development will be relatively exposed to winds from this quadrant which would reach the building corner which encourages horizontal flow around the building. However, winds with a stronger eastern or western component, respectively would impinge on the southeast and southwest façades of office building and some downwash would be generated and directed towards ground plane particularly for winds from the south-east impacting the broad building facade. Due to open nature of the floorplate at ground level, some flow may be directed and channelled into these spaces creating windy conditions there as well as in the corridors between the function centre and garden centre/ neighbourhood shops.

However, the façade cut-out at Level 05 as well as the setback to the southeast of the tower façade from the open floors below would assist in reducing the effect of vertical flow on the ground level wind conditions. The existing garden to the immediate south and indicated landscape plantings will assist in ameliorating the wind conditions at ground level. The area to the north of the multi-storey carpark such as the outdoor nursery would mainly be calm for winds from the south quadrant as they will be receiving shielding from the combined massing of development. Local protection such as overhead awning would be required if any seating or dining type activities are intended at the spaces near south corner of tower on ground level, corridors between function centre and garden centre and also corridors between restaurant and office tower.

4.3 Winds from the west quadrant

For winds from the west, the 1-15 Fontoney Road buildings located on northwest of site will provide some shielding. As the office tower is taller than those buildings, some downwash from the broad northwest façade of the office tower would be expected for winds with a northerly component causing stronger breezes at the open ground level. The northwest awning and Level 5 cutout will slightly reduce the amount of downwash reaching ground level, however due to the size of awning relative to width of façade and lack of any tower setback, the majority of the vertical flow would be expected to reach ground level.

Neighbour buildings such as function centre and single-story garden centre will provide some level of shielding for any low-level winds from west quadrant, but majority of wind conditions would be still dictated by downwash from upper-level winds. The presence of proposed landscape plantings is considered beneficial as they will assist in mitigating breezes at these locations. If calmer conditions are desired for areas such as outdoor seating areas at west corner and outdoor nursery at north corner, local wind protection through solid or porous screening or raised planter boxes with densely foliating plants could be added to improve the wind amenity in the seating areas.

4.4 Summary

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 the DCP comfort criteria. 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 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. The entrances to the buildings are well located from a wind perspective, away from the building corners.

For the carpark rooftop space, the pedestrian comfort category under the DCP criteria is likely to be Pedestrian Walking. At this elevation, parts of the space will be reasonably exposed to strong prevailing winds from west with northerly component and south with easterly component. In general, Pedestrian Walking is suitable for any non-stationary or outdoor type activities. It is noted that space on the rooftop is intended to be utilised for outdoor exercise and yoga type activities, which may require temporary treatment such as installation of vertical screens or high (>1.4m) perimeter balustrades to ameliorate wind conditions and create areas of calm for this type of activity. The outdoor nursery areas under the shade structure are partially enclosed by carpark, office tower and garden centre, and relatively calm conditions would be expected here as a result.

The development features open terraces at Levels 1-4 including around the building corner, Figure 5. As the corner terraces at East façade and West façade are partially enclosed by louvres, relatively calm conditions would be expected here as a result. If calmer conditions are desired for this space, further enclosure of the space through additional screening, solid or porous would be required.

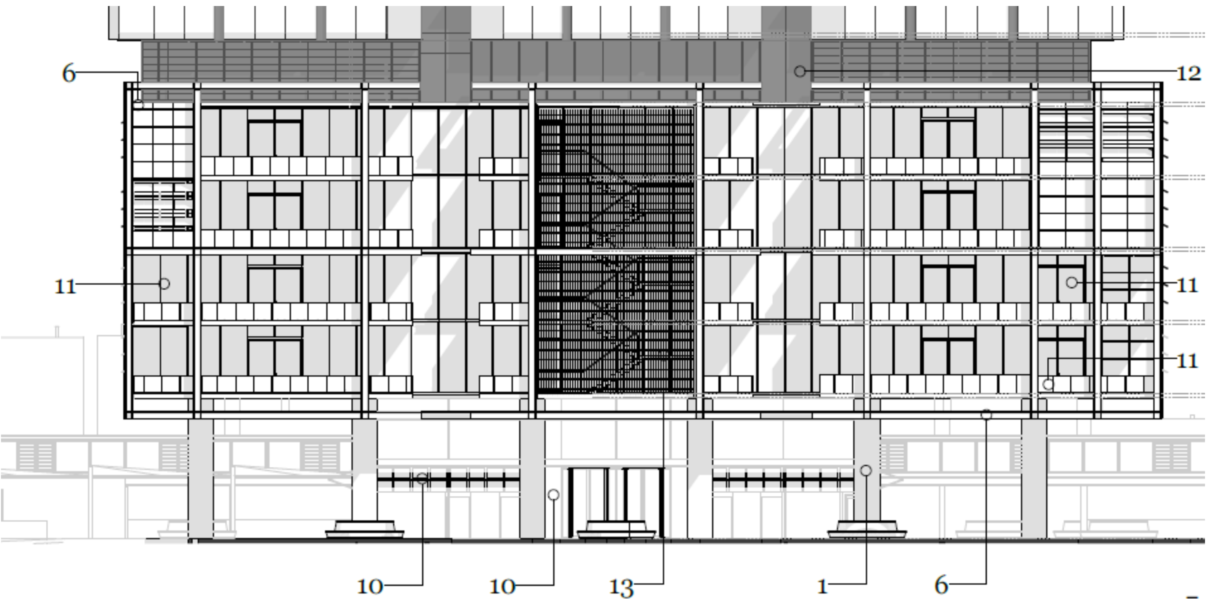

Figure 5: Elevation Plan Level 2 showing open terraces.

The proposed office tower also features open stairs on the northwest façade of the building. Due to recessed nature of the open stairs, the wind environment in these areas is expected to remain suitable for use as a transitory space, and calm areas will even exist on high wind days. The vertical fins on the east and indicated mesh structures will also minimize the impact of strong gust on these floors.

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed Eden Gardens 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. 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

City of Ryde Council (2014) City of Ryde Development Control Plan 2014, Part: 4.5 Macquarie Park Corridor.

Davenport, A.G., (1972), An approach to human comfort criteria for environmental conditions, Colloquium on Building Climatology, Stockholm.

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

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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.

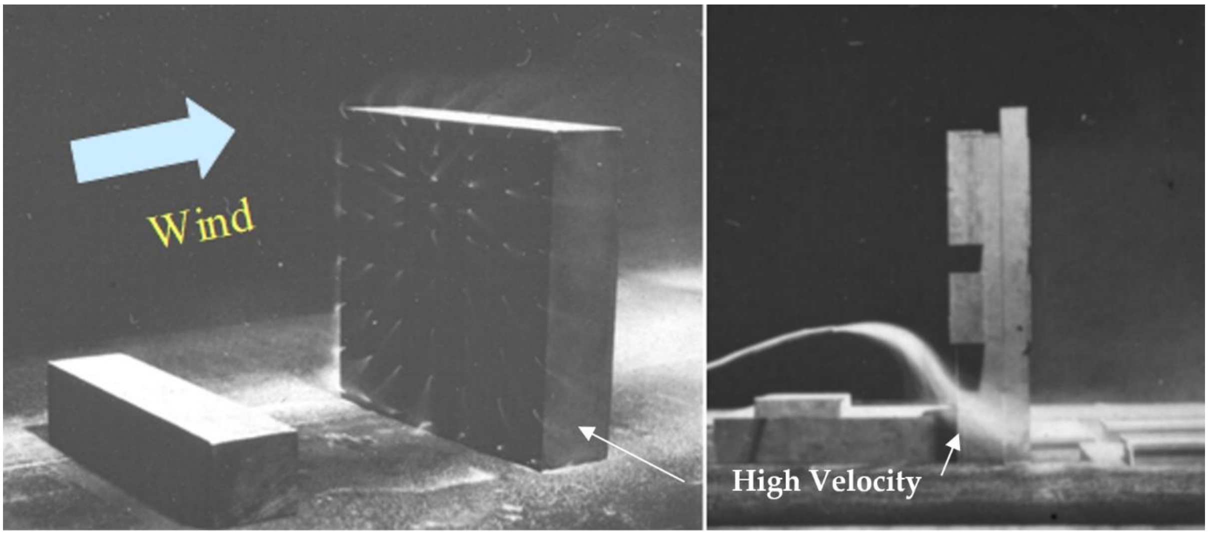

Figure 6: Flow visualisation around a tall building.

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.

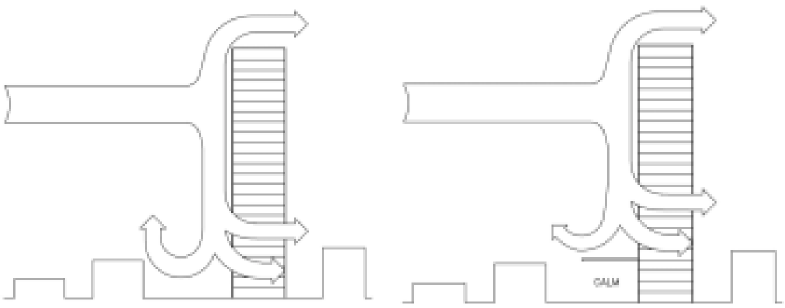

Figure 8: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

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.

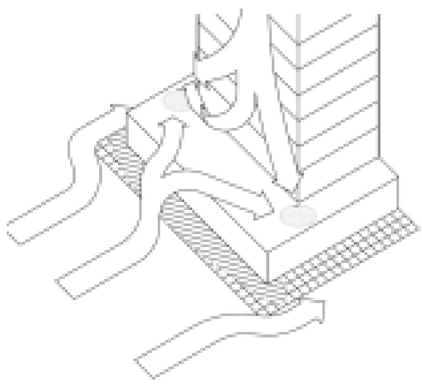

Figure 9: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

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).

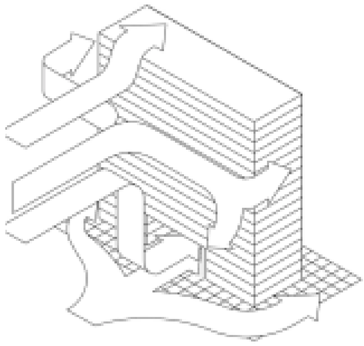

Figure 10: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

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.

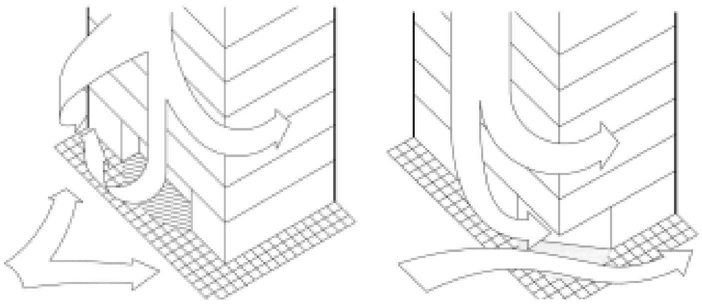

Figure 11: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

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.