CPP WIND ENGINEERING CONSULTANTS

QUALITATIVE WIND ASSESSMENT
CPP PROJECT 19142
30 NOVEMBER 2023

Westmead Hospital Palliative Care Unit

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Executive Summary

A qualitative assessment of the Westmead Hospital Palliative Care Unit development to be built in Westmead, NSW was conducted to provide an initial assessment of the surrounding pedestrian wind environment. The assessment was based on the local wind climate, CPP's experience in the region and on comparable projects, and the characteristics of the proposed development.

The wind environment around the development is likely to be generally suitable for Pedestrian Standing to Walking style activities from a comfort perspective with reference to the Lawson criteria. No major adverse impacts to pedestrian comfort or amenity are foreseen as a result of the proposed development. All areas in the public domain in the vicinity of the subject site are expected to satisfy the relevant wind safety criterion.

Slightly stronger wind conditions may occur on the rooftop terrace during higher wind speeds. The proposed landscaping and screening elements will help to create areas of calm suitable for their intended use. The discretionary use of the terrace space may render the need for further mitigation unnecessary.

No negative effects pertaining to the safe operation of the helipad and its associated flight paths are expected as a result of the proposed development.

The proposed future Childrens Hospital and Integrated Mental Health Complex developments will provide shielding for most wind directions and in general have a beneficial impact on conditions within the proposed development.

This report is a high-level qualitative assessment based on basic features of the local wind climate and proposed built environment.

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1. Introduction

GENERAL INFORMATION

The assessment of the wind environment around developments can ensure adverse impacts are minimized and inform designers about the suitability of outdoor areas for their intended uses. Where necessary, design modifications can be made, or intervention measures added to mitigate areas with the potential for excessive wind speeds.

The proposed development is located in Westmead, approximately 21 kilometres to the west of the Sydney CBD. The surrounding terrain is comprised primarily of low-rise suburban development, with some larger commercial buildings, Figure 1

The proposed development entails adding a new floor atop the current Central Acute Services Building (CASB) level 5, north-west, rooftop. This will increase the height of this section of the building from approximately 18 m to 23 m above ground level, Figure 2. As the main wing of the CASB is slightly larger than most of the surrounding structures, it will have some effect on the local wind conditions of the proposed CASB development. The extents are broadly discussed in this report.

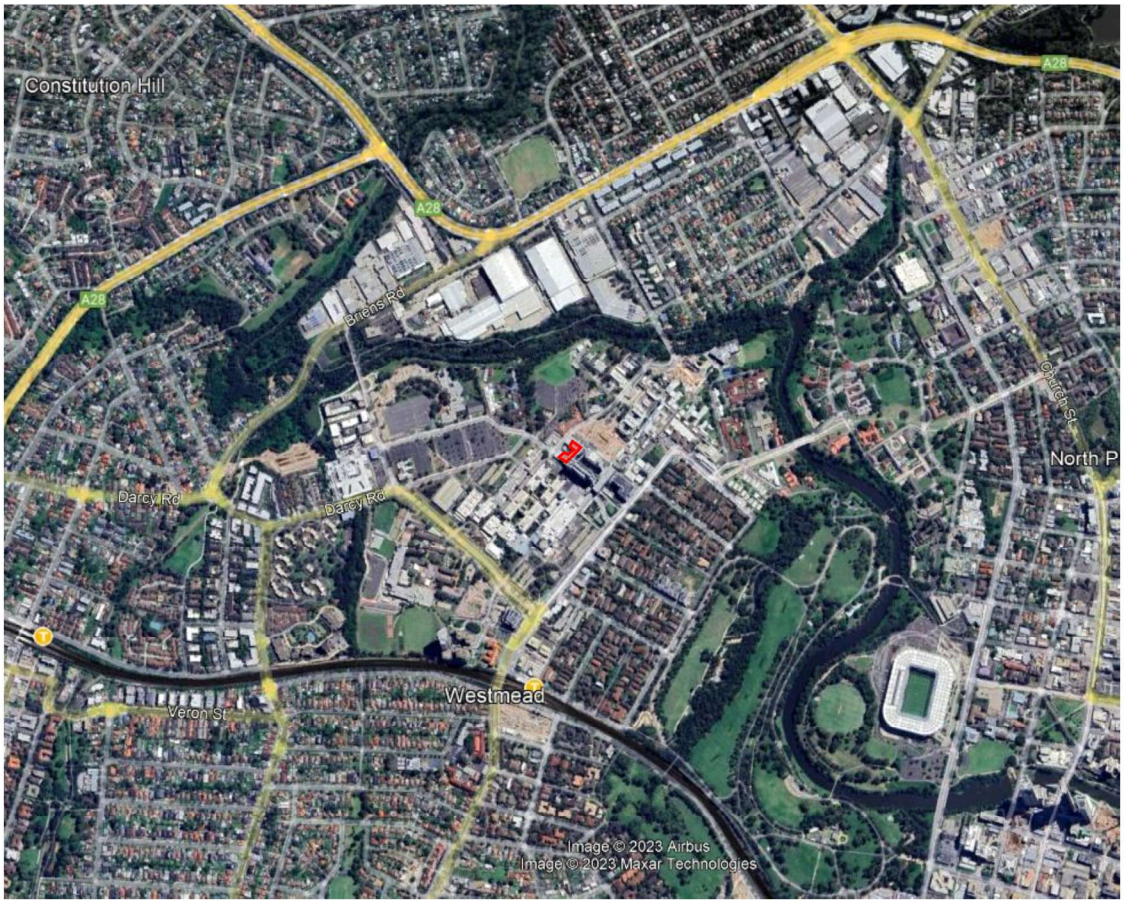

Figure 1: Aerial view of proposed development site (Google Earth, 2023)

Figure 2: Site plan (top) and south-west Section (bottom) of proposed development

2. Wind Climate

The proposed development lies approximately 12 km to the north of the Bankstown Airport Bureau of Meteorology anemometer, which provides the best source of historical wind data for the project. 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 from 1995 – 2022 have been used in this analysis.

The wind rose for Bankstown Airport is shown in Figure 3. The arms of the wind roses point in the direction from where the wind is blowing, the width and color of the arm represent the wind speed, and the length of the arm indicates the percent of the time that the wind blows for that combination of speed and direction.

The distribution and frequency of winds on an annual basis were analyzed to assess the project with regards to wind comfort and safety. As can be seen from the wind rose in Figure 3, winds from the west and south-east directions are predominant. This wind assessment is structured around these prevailing wind directions.

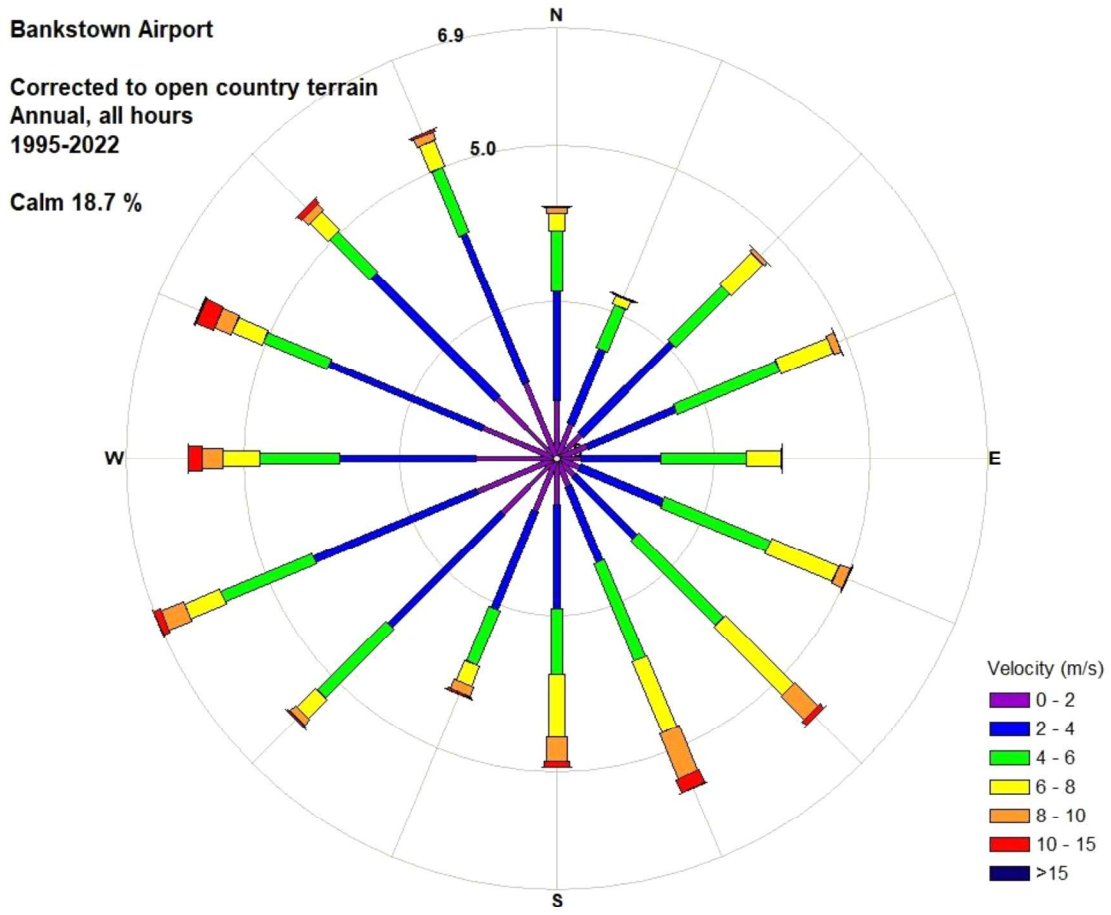

Figure 3: Probability of Wind Speeds by Direction Bankstown Airport –(1995 – 2022, All Hours)

3. Wind Assessment Criteria

A number of researchers have suggested quantitative methods for assessing wind comfort and safety based on estimated wind speeds and local climate statistics. These criteria provide a means of evaluating the wind amenity of location based on the frequency of threshold wind speeds, noting that pedestrians will tolerate higher wind speeds for a shorter time period than lower speeds. The comfort criteria also allow planners to assess the usability, with respect to the wind environment, of different locations for various purposes.

The City of Parramatta specifies the use of the criteria developed by Lawson (1990) for assessing wind comfort and safety (Parramatta DCP 2023). Lawson's criteria are divided into separate categories of comfort and distress (safety).

Lawson's criteria are based on wind speeds exceeded 5% of the time, and are described as categories for comfort ranging from 'Pedestrian Sitting' to 'Business Walking', allowing planners to judge the usability of locations for various intended purposes. The criteria also include a distress rating, for safety assessment, which is based on occasional (once or twice per year) wind speeds, to identify locations where wind speeds may be hazardous to pedestrians.

The categories and criteria are specified in Table 1. In general, wind conditions comfortable for Sitting and Standing are considered appropriate for areas such as entrances where pedestrians are likely to gather for longer durations, while wind conditions comfortable for Casual Walking and Business Walking are more appropriate for sidewalks where pedestrians are actively in transit. Locations rated as Uncomfortable are generally less suitable for most pedestrian activities and wind control solutions are often sought. Whether mitigation is needed at a location depends upon the intended pedestrian use of the location.

Satisfaction of the safety rating is generally required for areas accessible to the general public. A rating of 'Able-Bodied' may be acceptable for areas with managed access or where pedestrians are unlikely to be present under adverse conditions.

Assessment using the Lawson criteria is preferred to methods based on once per annum gust speeds such as Melbourne (1978) as it is based on more regularly occurring wind speeds relevant to perception by pedestrians and uses a combined probability integrated over all directions. In addition, it is less susceptible to variations in turbulence levels in urban environments while still considering the impact of short-duration gusts.

Pedestrians' perception of wind can often be subjective and vary depending on regional difference in wind climate and thermal conditions, as well as by individual. Calibration to the local wind environment should be taken into account when evaluating predicted wind comfort conditions. Note that the ratings of 'Uncomfortable' and 'Safety' are the words of the published wind criteria and applicability may vary by project and location.

Table 1: Wind Comfort and Safety criteria (after Lawson, 1990)

COMFORT RATING	U_{EQUIV}*	DESCRIPTION
Dining**	< 2 m/s	Calm / light breezes suitable for outdoor restaurant uses, seating areas, and other amenities based on CPP experience.
Sitting	2-4 m/s	Calm or light breezes suitable for long duration seating areas, and other amenities.
Standing	4-6 m/s	Gentle breezes suitable for sitting for shorter periods, main entrances and bus stops where pedestrians may linger.
Pedestrian Walking	6-8 m/s	Moderate winds appropriate for window shopping and strolling along a downtown street, or park.
Business Walking	8-10 m/s	Relatively high speeds that can be tolerated if one's objective is to walk, run, or cycle.
Uncomfortable	> 10 m/s	Strong winds unacceptable for all pedestrian activities; wind mitigation is typically required.

*U_{Equiv} = Max (U_{Mean}, U_{Gust} / 1.85).
*U_{Equiv} speeds are based on an annual exceedance of 5% (~8 hours / week) assessed over all hours.
** For regular outdoor dining, and in semi-enclosed spaces, it has been the experience of CPP that the comfort rating of Sitting may be windier than desired and a comfort criterion of 4 m/s or less may be more applicable.

SAFETY RATING	U_{EQUIV}*	DESCRIPTION
Pass	< 15 m/s	Meets wind safety criterion.
Able-Bodied	15-20 m/s	Acceptable where only able-bodied people would be expected; not acceptable for frail persons or cyclists
Fail	>20 m/s	Excessive wind speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is often required.

* U_{Equiv} = Max (U_{Mean}, U_{Gust} / 1.85).
*U_{Equiv} speeds are based on an annual exceedance of 0.022% (~2 / year or 1 / season) assessed over all hours.

4. Assessment

SITE DESCRIPTION

The development site is surrounded in most directions by low-rise buildings, with a region of parkland to the south-east and a small area of medium rise buildings immediately to the south-west of the development. 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 A and the effectiveness of some common wind mitigation measures are described in Appendix B

The subject site is located on a block bounded by Redbank Road to the north-west and Hospital Road to the south-west. The proposed development involves adding an additional floor atop the fifth level of the existing CASB level 5, north-west, rooftop. A site plan, featuring landscaping detail is shown in Figure 4.

Figure 4: Site plan of proposed development

WINDS FROM THE WEST

Winds from the north-west to south-west will approach the site over a region of suburban development. Winds from this region are relatively unimpeded approaching the development for most westerly directions due to the absence of tall buildings or obstacles. Close to the site, winds from a more south-westerly direction will encounter the medium-rise buildings of the Westmead heath precinct. Pedestrian regions in open areas at the north-western boundary of the development may be affected by stronger breezes as the CASB massing directs wind flow to the north of the hospital building.

As the main wing of the CASB is taller than the upwind surrounds, some incoming winds from the west are likely to be directed toward the proposed development in the form of downwash. For most westerly directions, the building orientation is such that the incident flow would impinge on the corner of the CASB, encouraging the flow to pass around the building horizontally, minimising the effect of downwash on the proposed development.

Relatively high wind speeds would be expected on the CASB, level 5, roof near to the windward corners of the development during winds from the west. The proposed landscaping and screening features in The Pocket, Water Garden and The Verandahs areas will help to create areas of calm and increase wind amenity in these regions and will be necessary for the success of this area.

During winds from the west, conditions in the Staff Retreat area and Gardens of Reflection are expected to remain reasonably calm and satisfy the Lawson Safety criterion.

Overall, for winds from this quadrant, conditions within the public domain surrounding the proposed development are expected to remain similar to the existing wind conditions and satisfy the Lawson safety/distress criterion.

The proposed future developments of the Children's Hospital and Integrated mental Health Complex will have little impact for most westerly directions. However, the Integrated Mental Health Complex will provide some shielding for winds from a more north-westerly direction.

WINDS FROM THE SOUTH-EAST

Winds from the south-east quadrant will approach over a large region of low-rise suburban development. Winds from this region are relatively unimpeded approaching the development. Pedestrian areas along Hospital Road and the private road to the north-east of the development may be affected by stronger breezes as the CASB massing directs wind flow through these areas.

During winds from the south-east, the main wing of the CASB will provide significant shielding to the proposed Palliative Care development on the level 5, north-west, rooftop. Conditions within the proposed development and in public areas on the north-west of the CASB are expected to remain reasonably calm for south-easterly winds.

The proposed future developments of the Childrens Hospital and Integrated Mental Health Complex will have little effect on wind conditions within the proposed development for winds from the south-east.

SUMMARY

The proposed Palliative Care Unit constitutes a minor change to the overall massing of the existing CASB building. Therefore, the proposed addition will have minimal effect on public domain locations surrounding the site. 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.

In general, conditions on the rooftop terrace of the proposed development are likely to be rated Pedestrian Sitting to Walking from a wind comfort perspective, with milder wind conditions in the Staff Retreat and Garden of Reflection and windier conditions on the north-western part of the terrace. These conditions would be suitable for short to medium stationary occupation. The proposed landscaping and vertical screen elements will help to create areas of calm and are recommended to be retained. The discretionary use of the terrace space may render the need for further mitigation unnecessary.

All locations in the public domain and on the rooftop terrace would be expected to satisfy the safety/distress criterion.

IMPACT ON HELIPAD

For helicopter operations there is only one known criterion for the approach wind conditions, Rowe et al. (2006). This criterion limits the standard deviation of air flow in the vertical turbulence to 2.4 m/s (4.7 kt). This criterion was developed for offshore structures where typically a large dominant object is located close to the helicopter landing site. The criterion was developed through wind tunnel testing, and testing of helicopter pilots in known operating wind conditions.

The proposed Palliative care development on the CASB level 5 rooftop is relatively small compared to the CASB massing and will therefore not have a significant effect on the overall massing of the CASB. The vertical component of turbulence is expected to be unchanged from existing conditions. As such, no adverse impact on the helipad and its approach flight paths are expected.

IMPACT OF FUTURE DEVELOPMENTS

The proposed future developments of the Childrens Hospital and Integrated Mental Health Complex (Figure 5) will aid in shielding the proposed development from most wind directions and in general, create more beneficial wind conditions on the roof terrace. However, increased wind speeds for some directions may occur due to wind channelling between buildings. The proposed landscaping and screening on the rooftop terrace of the Palliative Care Unit will aid in reducing the impact of such conditions.

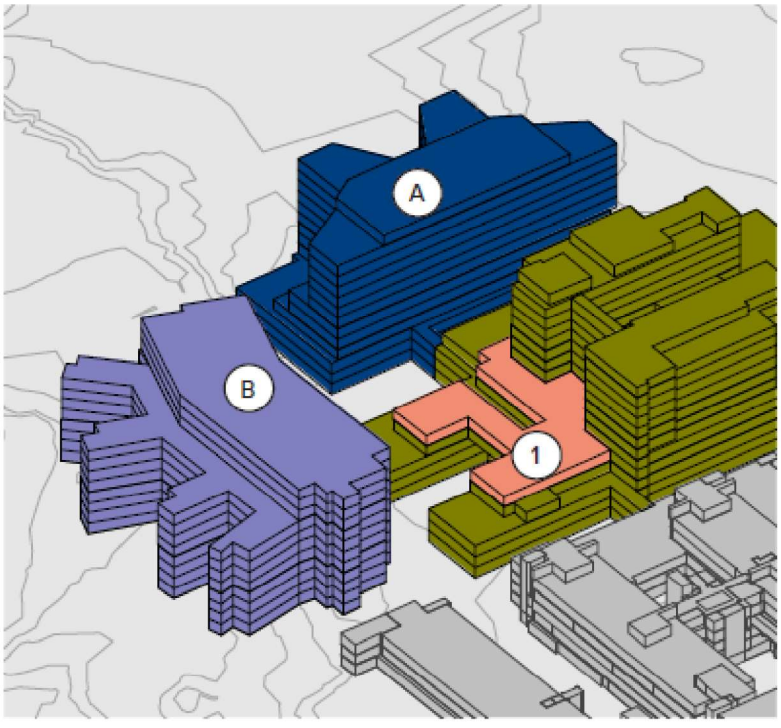

Figure 5: Future Developments

5. Conclusion

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed Westmead Hospital Palliative Care Unit project on the local wind environment in and around the development site. The proposed Palliative Care Unit constitutes a minor change to the overall massing of the existing CASB building. Therefore, the proposed addition is not expected to cause any significant changes to the existing wind environment surrounding the site 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.

The rooftop terrace is relatively exposed for some wind directions and may experience higher winds in some areas. Wind conditions on the terrace are expected to be classified as Pedestrian Standing to Walking and pass the distress/safety criterion. The proposed landscaping features and vertical screening elements will aid in creating beneficial wind conditions and are recommended to be retained. No adverse conditions requiring specific mitigation are foreseen.

No negative effects pertaining to the safe operation of the helipad and its associated flight paths are expected as a result of the proposed development.

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Appendix A – Wind Flow Mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure A1 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 A1smoke 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 A2 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.

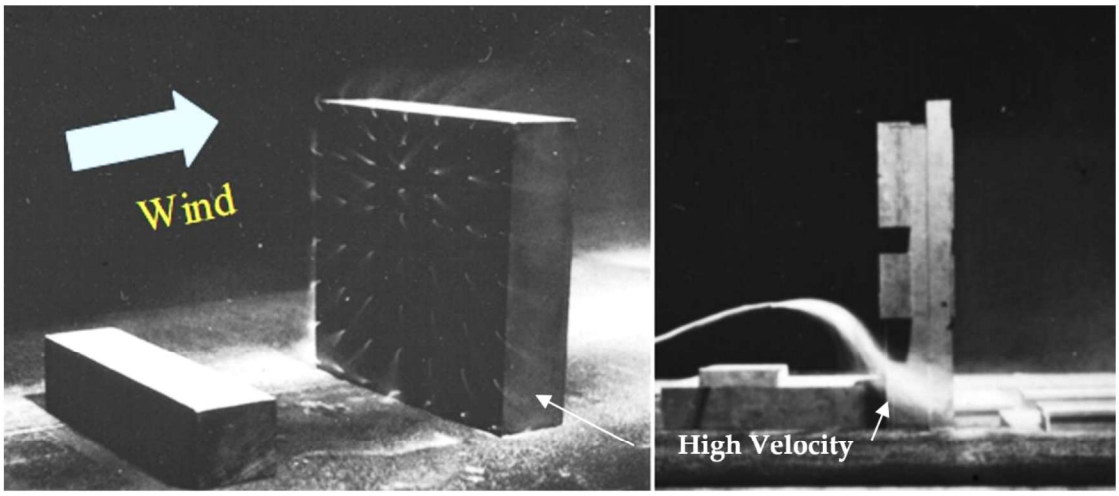

Figure A1: Flow visualisation around a tall building.

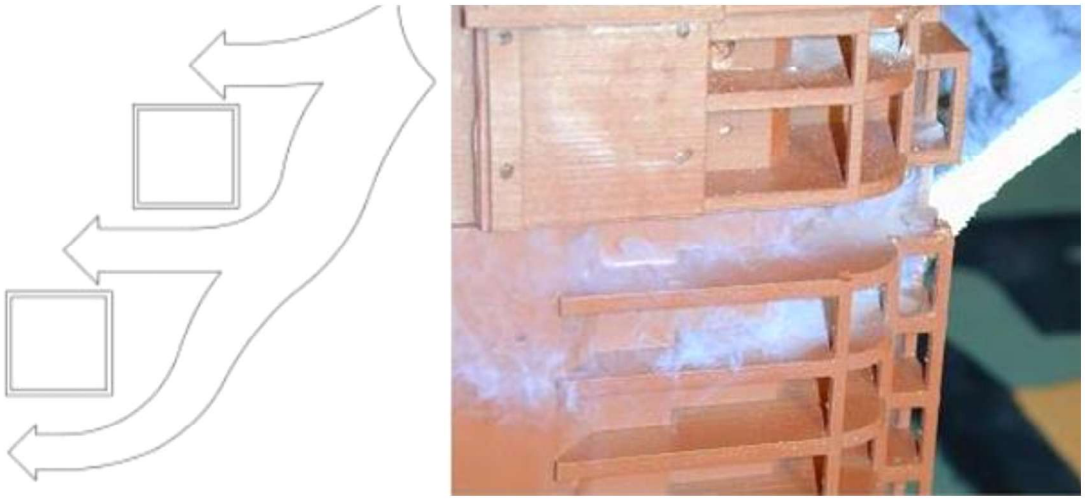

Figure A2: Channelling between buildings (L) and visualisation through corner balconies (R).

Appendix B - 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 B1. 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.

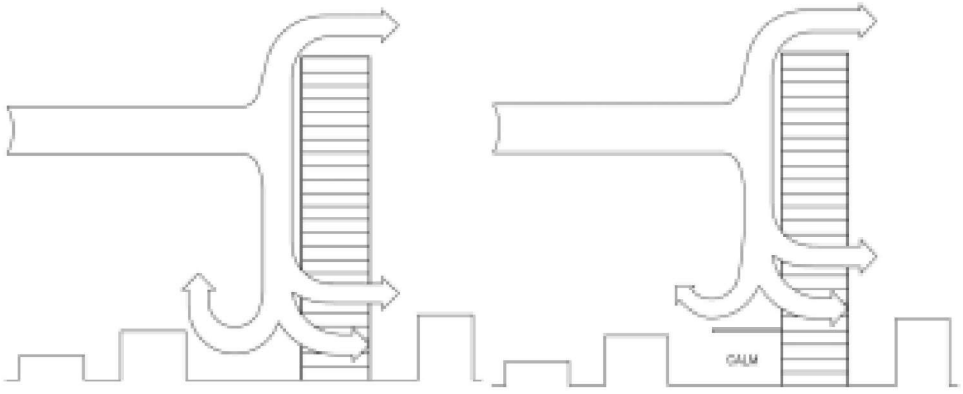

Figure B1: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

Building form – Podiums

The architect may elect to use an extensive podium for the same purpose, Figure B2, if it complies with the design mandate. This is a common architectural feature for many major projects, 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.

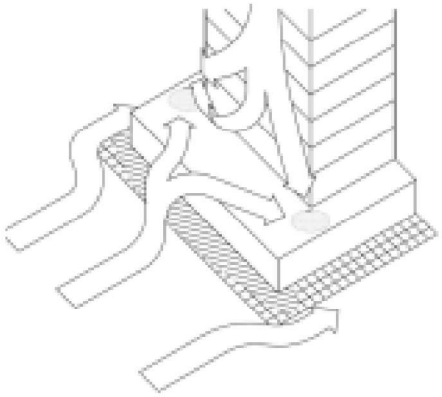

Figure B2:The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

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 B3. The uninvitingly windy nature of these open areas is a contributing reason behind the use of arcade airlock entrances (revolving or double sliding doors).

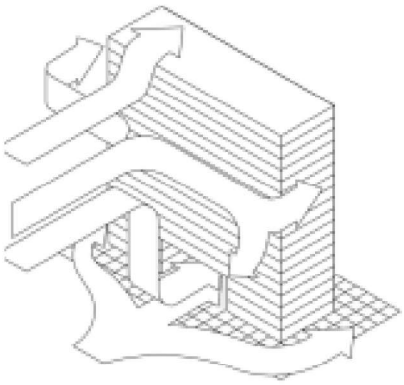

Figure B3: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure B4(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 B4 (R), due to the accelerated flow mechanism described in Figure B1 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.

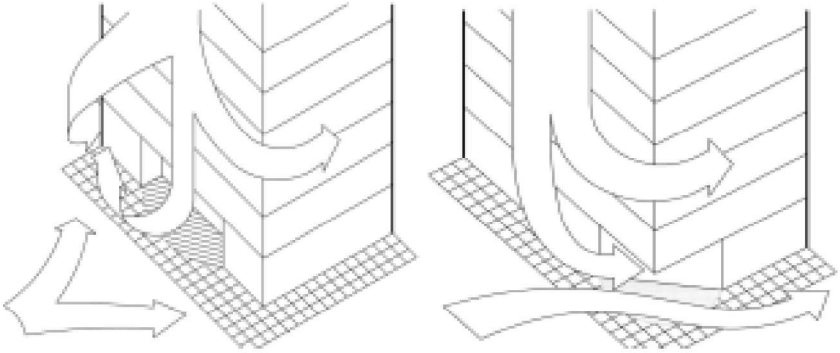

Figure B4: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

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 B2. 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 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.

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