FINAL REPORT

Qualitative Wind Assessment for:

10 GORDON AVE AND 15-19 NELSON ST

Chatswood, NSW

CPP PROJECT: 16644

March 2022

PREPARED FOR:

DPG105 Partnership

C/- Develotek

Level 10, 97-99 Bathurst Street

Sydney NSW 2000

PREPARED BY:

Joe Paetzold, Engineering Manager

Thomas Evans, Senior Engineer

CPP Pty Ltd
Unit 2, 500 Princes Highway
St Peters, NSW 2044
info-syd@cppwind.com
www.cppwind.com

WIND ENGINEERING CONSULTANTS

DOCUMENT VERIFICATION

Date	Revision	Prepared by	Checked by	Approved by
22/03/22	Initial release	JP	TXE	TXE

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by DPG105 Partnership to provide a qualitative assessment of the impact of the proposed 10 Gordon Ave and 15-19 Nelson St development on the wind conditions in the surrounding areas.

The proposed development is located approximately 400 m to the south of the Chatswood CBD, in a region of low-rise suburban development, Figure 1. The proposed development will comprise of a single high-rise residential tower of 26 storeys over a mixed-use 2 storey podium, reaching a maximum height of about 90 m above ground level, Figure 2. As it is taller 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. It is noted that the design assessed for this report is preliminary only at this stage.

Figure 1: Aerial view of the proposed development site (Google Earth, 2018).

Figure 2: Structures and massing of the proposed development (preliminary design) viewed from the south.

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.

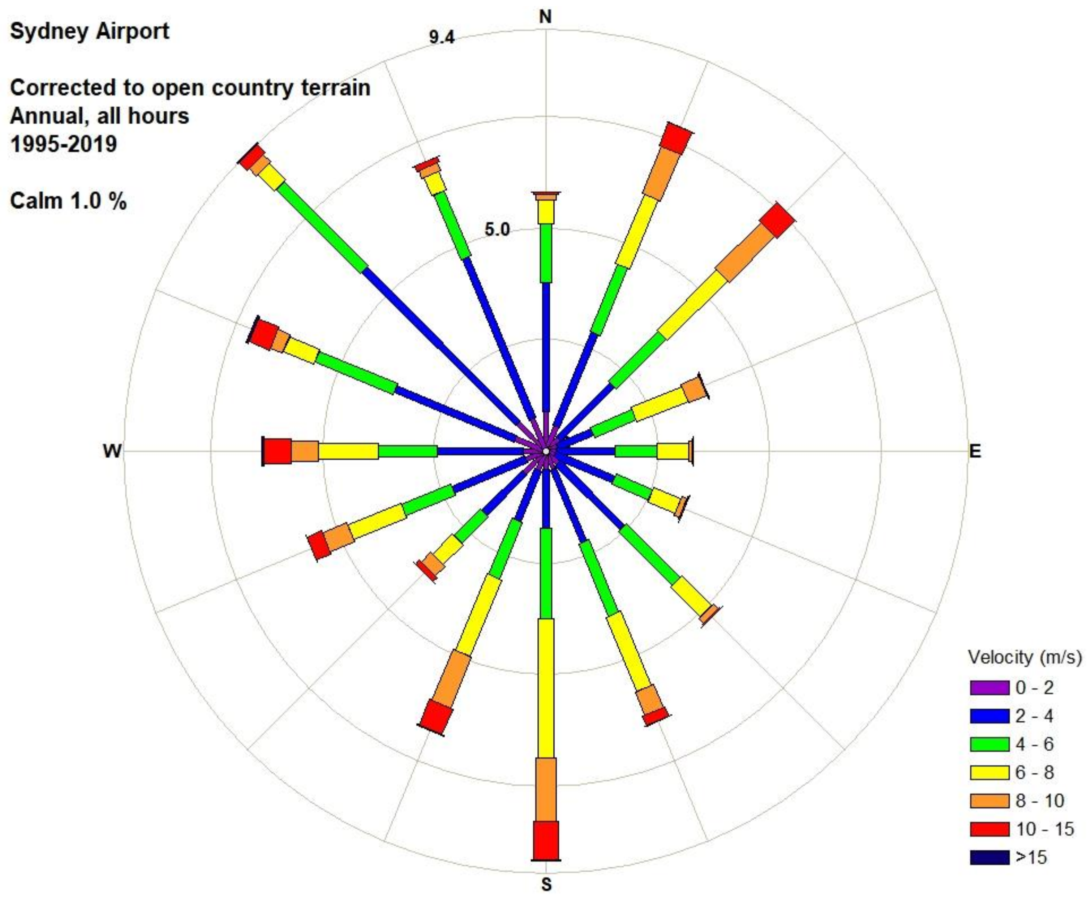

Figure 3: Wind rose for Sydney Airport.

3 ENVIRONMENTAL WIND CRITERIA

A number of researchers have suggested quantitative methods for assessing wind comfort and safety based on wind tunnel data 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. In addition, the acceptability of the location may be linked to its intended use, such as for a café seating area or pedestrian footpath.

The Willoughby City Council DCP (2016) does not specify a wind comfort criterion for this site. One of the most widely accepted sets of criteria was developed by Lawson (1990), which are described in Table 1.

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 level and severity of these comfort categories can vary based on individual preference, so calibration to the local wind environment is recommended when evaluating the Lawson ratings. The criteria also include a distress rating, for safety assessment, which is based on occasional (once or twice per year) wind speeds[1]. In both cases, the wind speed used is the larger of a mean or gust equivalent-mean (GEM) wind speed. The GEM is defined as the peak gust wind speed divided by 1.85; this is intended to account for locations where the gustiness is the dominant characteristic of the wind.

[1] The rating of "uncomfortable" in Table 1 is the word of the acceptance criteria author and may not apply directly to any particular project. High wind areas are certainly not uncomfortable all the time, just on windier days. The word uncomfortable, in our understanding, refers to acceptability of the site by pedestrians for typical pedestrian use; i.e., on the windiest days, pedestrians will not find the areas "acceptable" for walking and will tend to avoid such areas if possible. The distress rating fail indicates some unspecified potential for causing injury to a less stable individual who might be blown over. The likelihood of such events is not well described in the literature and is likely to be strongly affected by individual differences, presence of water, blowing dust or particulates, and other variables in addition to the wind speed.

Table 1: Summary of Lawson criteria.

Comfort (maximum of mean or gust equivalent mean (GEM[†.]) wind speed exceeded 5% of the time)	
< 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[1]
Distress (maximum of mean or GEM wind speed exceeded 0.022% of the time)	
<15 m/s	not to be exceeded more than two times per year (or one time per season) for general access area
<20 m/s	not to be exceeded more than two times per year (or one time per season) where only able-bodied people would be expected; frail or cyclists would not be expected

Note: [†.] The gust equivalent mean (GEM) is the peak 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 400 m 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 surrounding sites to the immediate east and west as well as some areas to the north and south of the site. 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.

The subject site is located on a block bounded by Nelson Street to the south, Gordon Avenue to the north, Pacific Highway to the west, and railway lines to the east. The proposed development consists of a single prismatic tower with a rectangular planform. A preliminary ground floor plan is shown in Figure 4.

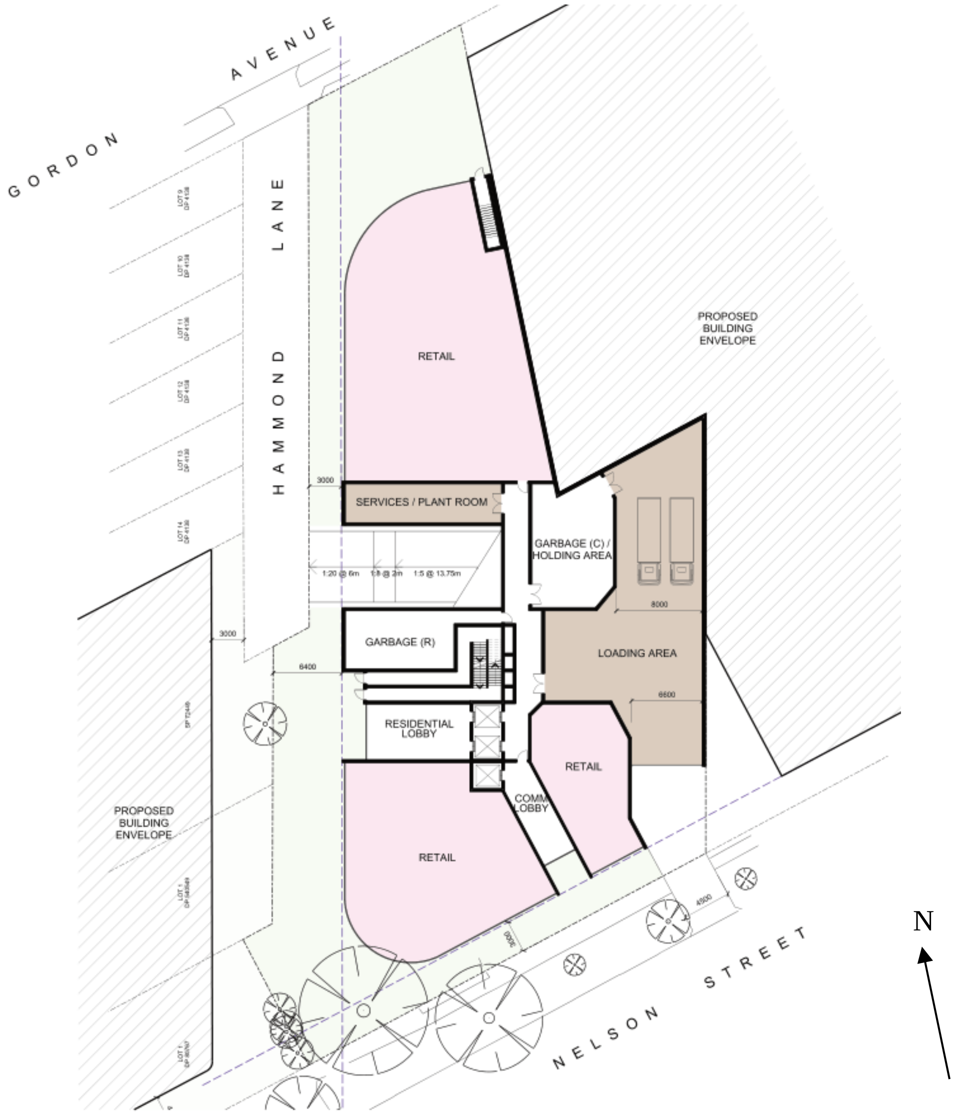

Figure 4: Ground floor of the proposed development.

4.1 Winds from the north-east

Winds from the north quadrant will approach over the low-rise suburban buildings of Chatswood. Winds from this quadrant are relatively unimpeded upon approaching the development site. As the proposed tower is taller than the upwind surrounds, winds from the north-east are likely to impinge on the tower façade and be directed downwards due to the concave shape on the north-eastern side of the floorplate. A more convex profile on this part of the tower would be beneficial from a wind perspective in reducing downwash flow and encouraging wind to flow horizontally around the tower as marked up in Figure 5. The minimum 4.5 m tower setback from the podium on the north-eastern perimeter of the development would minimise the impact of downwash by redirecting the flow horizontally over the podium roof, however would generate accelerated flow on the podium rooftop level, particularly near the windward corners of the tower. Options for mitigating stronger winds in this area are discussed in the next section. Upon completion of the similarly sized development to the immediate east of the site, the tower is likely to receive some shielding from winds from the north-east by the upwind towers, though this will depend on the shape and positioning of the towers on the adjacent site. . The currently proposed envelope of that site has the potential to increase the amount of flow impinging on the north-east corner of the tower due to the gap between the two proposed towers, through which incoming flow may be accelerated and directed toward the subject site Figure 5.

Wind conditions on Hammond Lane as well as in the proposed pocket park on the northern side of the site are expected to be mild for approaching wind from the north-east quadrant. The alignment of both Gordon Avenue and Nelson Street with the north-east direction may allow stronger breezes to develop along these road corridor, though this is considered to be largely an existing condition.. For winds from the north-east quadrant, conditions around the proposed development site are expected to remain similar to the existing wind conditions.

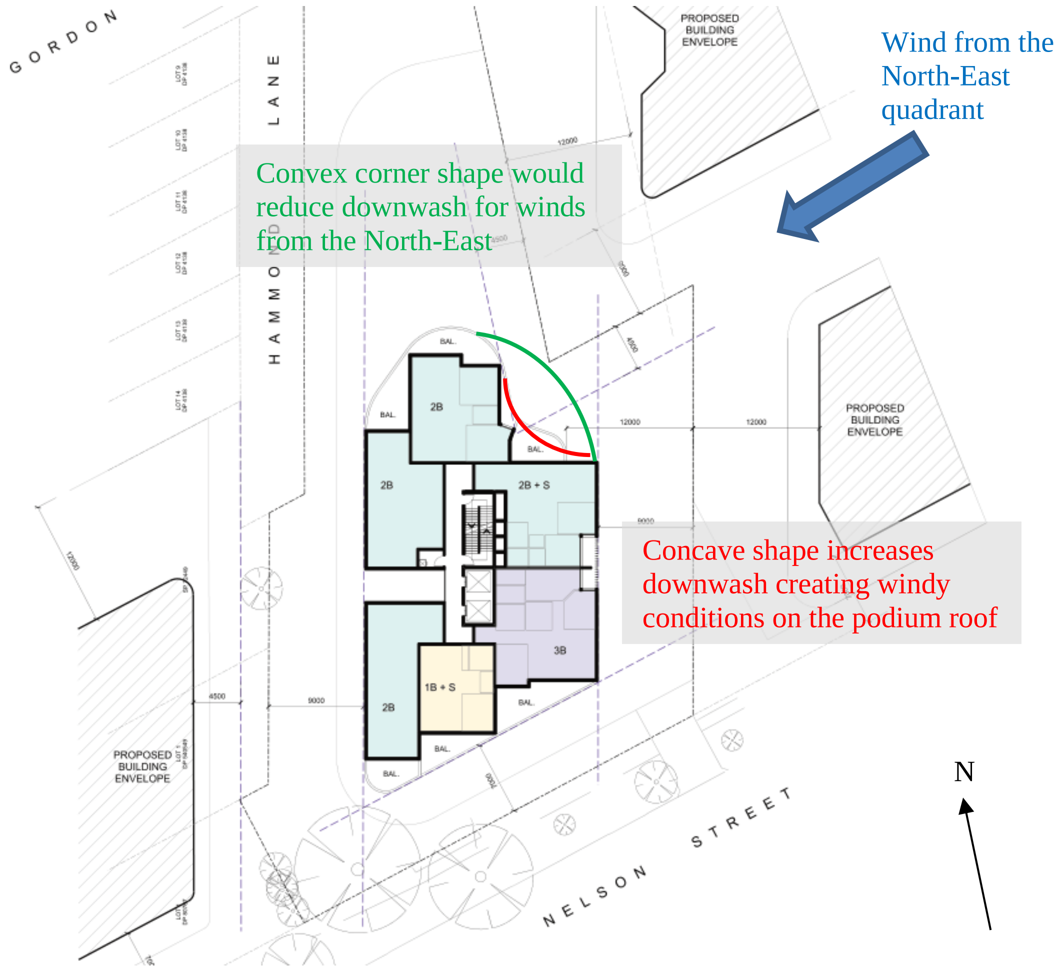

Figure 5: Typical tower floor plan (Level 8-19) marked up for wind from the North-East.

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. With the proposed development being significantly taller than upwind buildings to the south, the development will be exposed to winds from the south quadrant. The orientation and shape of the tower would facilitate flow horizontally around the tower, reducing the amount of downwash generated on the south façade. The 4 m tower setback from the southern podium façade would deflect the majority of the remaining vertical flow at podium level and minimise any impact on ground level wind conditions.

Particularly upon completion of the adjacent proposed development to the west, some channelling flow would be expected in Hammond Lane, though the existing mature trees and proposed landscaping on the southern end of Hammond Lane would assist in minimising these effects. Additional street trees along Nelson Street and local landscaping in this area can be utilised to create calmer areas in this space particularly for any intended seating areas. The Sydney Metro buildings on the southern side of Nelson Street shield pedestrian locations along Nelson Street from the direct impact of winds from the south quadrant.

For winds from the south quadrant, wind conditions at most locations around the site are expected to remain similar to the existing wind conditions.

4.3 Winds from the west

Winds from the west quadrant will pass over an area of low-rise suburban development of Chatswood leaving the proposed development somewhat exposed to winds from the west quadrant prior to completion of the proposed adjacent development to the west. The broad west façade of the tower would be expected to lead to downwash flow which would be partially deflected at podium level due to the 2.6 m tower setback at this level in the preliminary design. However, some of the downwash would still be expected to reach ground level and disperse primarily around the south-west corner into Nelson Street with potential to cause windy conditions near this corner. The proposed landscaping and existing mature trees in this area would assist in reducing the effect on the pedestrian areas in this space. An increase in the setback to the west would further reduce the potential for stronger winds reaching ground level. Alternatively, an awning above ground level along the western side of the podium and around the south-western corner could be used to achieve a similar effect and could be beneficial especially if retail seating is intended for this area.

Upon completion of the towers on the site to the immediate west, these would provide significant shielding to the proposed development hence minimise impacts on ground level wind conditions. The extent of the shielding effect depends on the relative location of the towers towards each other and the alignment of the gap between the adjacent towers.

The main building entrance and residential lobby is located on the western side in Hammond Lane. An inset location in the centre of the broad face of the site is a beneficial location for the entrance from a wind perspective, as it provides for some wind protection near the entrance area.

For winds from the west quadrant, wind conditions around the proposed development site are expected to remain similar to the existing wind conditions with the potential for slightly windier conditions near the south-west corner of the site before the adjacent tower to the west is completed.

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 would be suggested if calmer areas are desired for particular locations. The proposed pocket park on the northern portion of the site would be expected to experience milder wind conditions with a significant portion falling in the pedestrian sitting comfort category, particularly upon completion of the adjacent towers to the east and west. 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. As noted, the podium roof is expected to experience relatively high velocities, in particular near to the tower base, which may be intensified or reduced for specific wind directions upon completion of the adjacent building to the east due to the alignment of the gap between the two proposed towers on that site. An adjustment of the tower shape as outlined in Figure 4 would reduce the wind speeds on the podium level. The lower the overlap between the tower massing and the direct flow through the gaps between the adjacent towers to the east and west, the more shielding the tower would receive for winds from the west and north-east quadrant. The higher the level of shielding, the more amenable the podium wind conditions would be. For winds from the west the completion of the adjacent tower to the west would result in significant shielding of the proposed development and allow calmer conditions on the podium by reducing downwash flow. Depending on the intended use of the podium roof area, a mitigation strategy incorporating both horizontal and vertical elements is likely to be required. Awnings or pergolas in the areas close to the tower base can assist in deflecting downwash flow above podium level, and local screens or booths can be utilised to shelter specific areas of the podium rooftop where calmer conditions are desired. For any open areas underneath the tower overhang, it would be recommended to keep two sides closed off or include the possibility to partially enclose these areas to increase the time of usage in adverse wind conditions. For the outer portions of the podium rooftop, high balustrades can be used to provide some protection from direct winds.

Private balconies are located throughout the development. Wind conditions within the balconies are expected to be mostly calm provided they are recessed within the façade. From a wind perspective most balconies in the current floor plate would act as recessed balconies with only limited possibilities for cross flow. Balconies located on building corners or protruding from the façade are typically more exposed and can experience strong cross flows. This would apply for the balconies on the northern and the south-western corner of the tower. For these exposed balconies it would be recommended to include vertical fins and/or screens, or extend the façade line out to allow calm areas to exist for a larger portion of time. Over time residents tend to learn to determine the usability of their balconies based on the seasonal weather conditions.

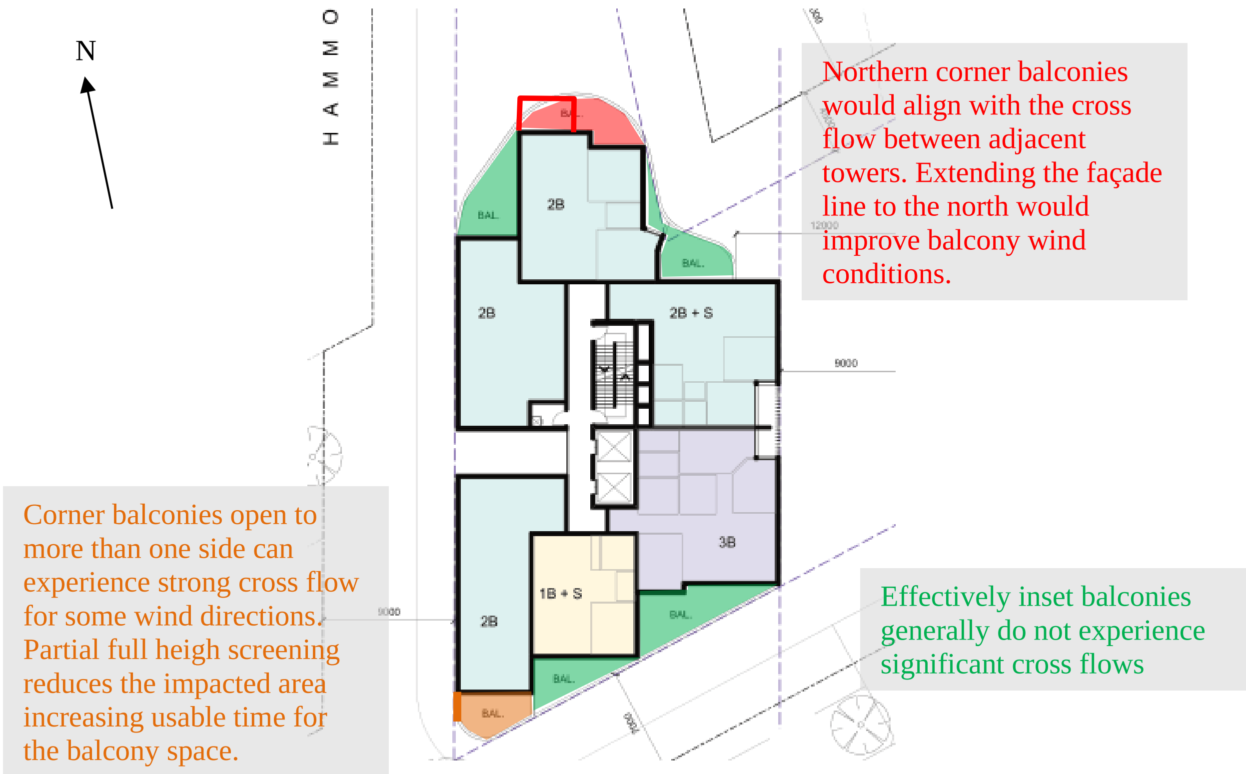

Figure 6: Typical tower floor plan (Level 8-19) marked up for wind from the North-East.

It is understood that the top floor is intended as a penthouse apartment with a large outdoor recreational space on the rooftop. Given its exposed location and no direct shielding from current or future buildings at that height, wind mitigation measures would be required for the rooftop terrace to fulfil expectations for an outdoor space on a premium apartment. Tall perimeter balustrades of minimum 1.8 m would be recommended to mitigate direct wind impact and to direct the upwash flow over the terrace. Partitioning the large terrace into smaller section by use of landscaping, screening, booth style seating areas, and pergolas would be beneficial in preventing flow over the balustrades from impacting the terrace further downwind as indicated in Figure 7. The lift core and any other internal building space on the roof level (in combination with horizontal features such as awnings/pergolas) can assist in ensuring the majority of the oncoming flow stays above terrace level and does not impact wind amenity of the terrace.

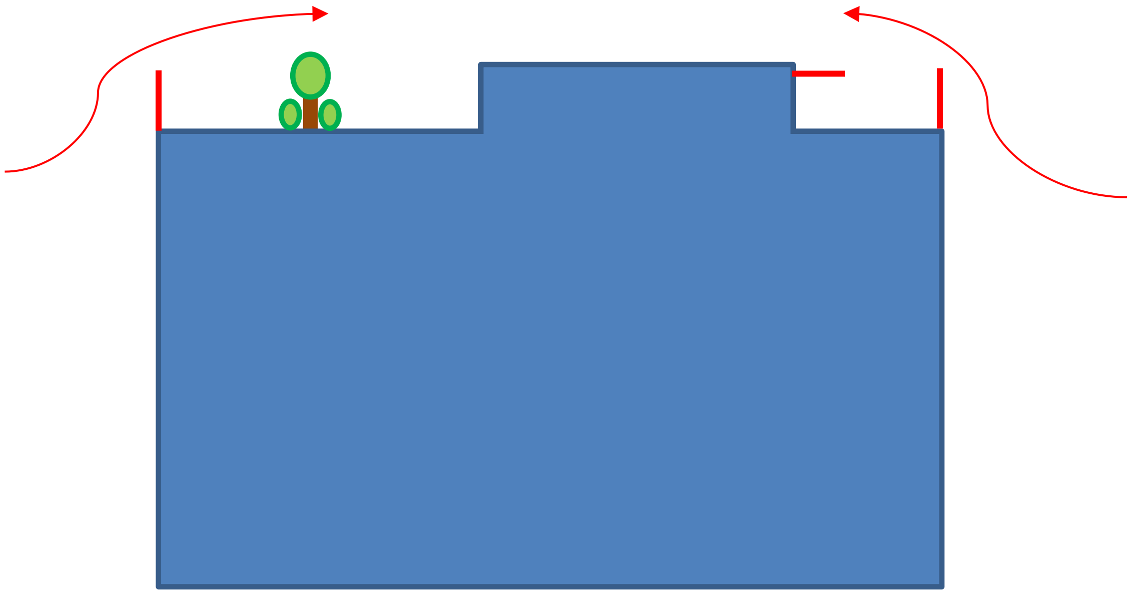

Figure 7: Schematic sketch of wind mitigation measures for the rooftop terrace.

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed 10 Gordon Ave and 15-19 Nelson St project on the local wind environment in and around the development site. Being taller than most surrounding structures, the proposed development will have some effect on the local wind environment, though any changes are not expected to be significant from the perspective of pedestrian comfort or safety. The tower setbacks from the podium massing in the preliminary design prevent significant impact on 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. Wind mitigation measures are also likely to be required for podium and rooftop terraces.

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

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.

Willoughby City Council (2016), "Willoughby Development Control Plan 2016".

Appendix 1: Wind flow mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 8; 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 8, 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 9 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.

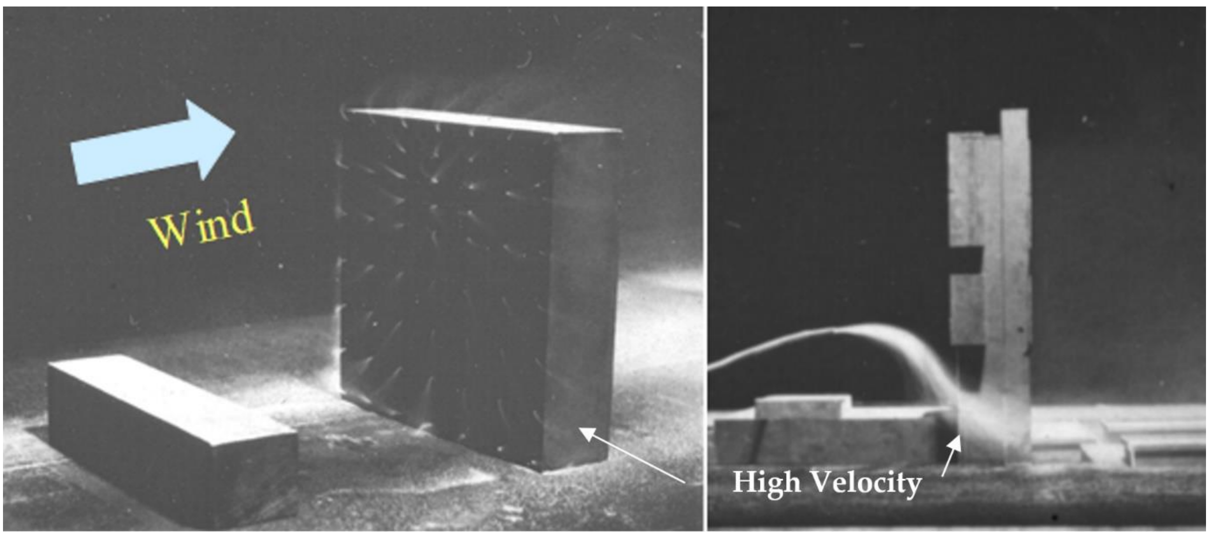

Figure 8: Flow visualisation around a tall building.

Figure 9: 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 10. 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.

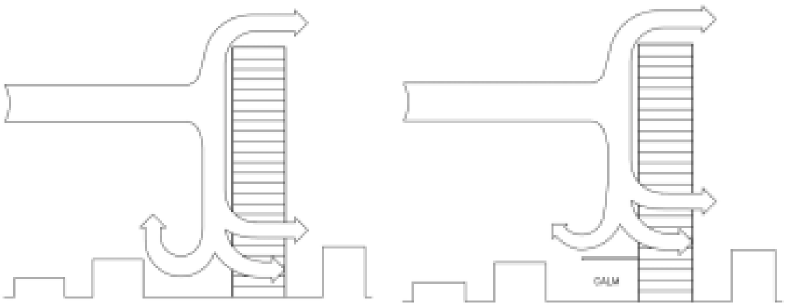

Figure 10: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

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 11. 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.

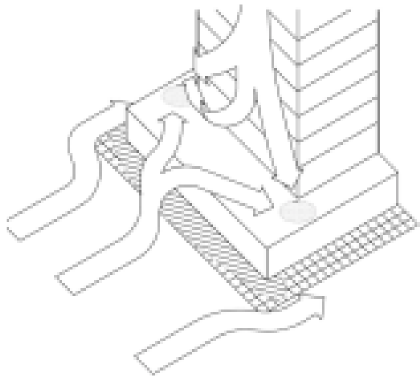

Figure 11: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

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

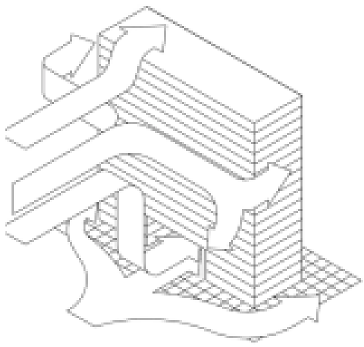

Figure 12: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure 13(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 13(R), due to the accelerated flow mechanism described in Figure 8 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.

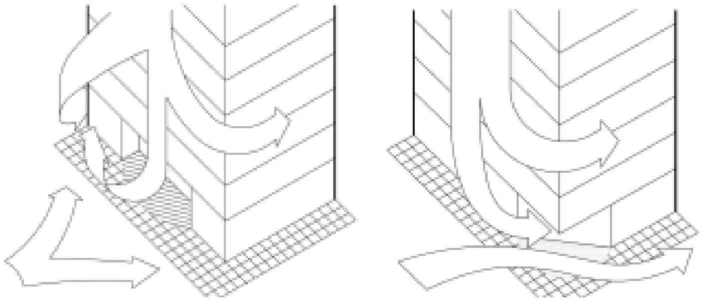

Figure 13: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

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 11. 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 9(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.