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WIND ENGINEERING AND AIR QUALITY CONSULTANTS

DEPARTMENT OF PLANNING, LANDS AND HERITAGE

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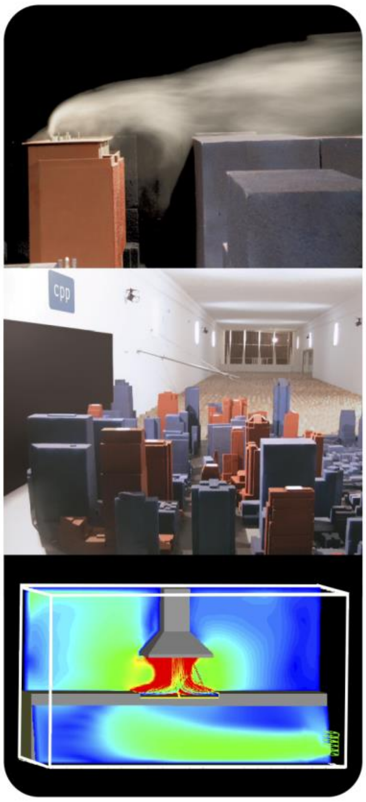

Qualitative Wind Assessment for:

88 Mill Point Road

Perth, WA

Prepared for:

Southlink Investment Properties Pty Ltd

Trading as Peakstone

c/- NS Group

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TABLE OF CONTENTS

TABLE OF CONTENTS i
LIST OF FIGURES i
LIST OF TABLES ii
1 INTRODUCTION 3
2 PERTH WIND CLIMATE 5
3 ENVIRONMENTAL WIND CRITERIA 6
4 ENVIRONMENTAL WIND ASSESSMENT 8
4.1 Winds from the east 11
4.2 Winds from the south-west 11
4.3 Summary – Public Domain 12
4.4 L02 Podium Roof 12
4.5 Private Balconies 13
5 CONCLUSION 14
6 REFERENCES 15
Appendix 1: Wind flow mechanisms 16
Appendix 2: Wind Impact Planning Guidelines 18

LIST OF FIGURES

Figure 1: Aerial view of the proposed development site (Google Earth). 3
Figure 2: Context massing view facing west (Hassel) 4
Figure 3: Wind rose for Perth Airport. 5
Figure 4: Ground floor (L00) plan of proposed development 9
Figure 5: Ferry Street elevation of proposed development 10
Figure 6: L02 Plan 13
Figure 7: Typical tower plan – balcony layout 14
Figure 8: Flow visualisation around a tall building. 16
Figure 9: Visualisation through corner balconies (L) and channelling between buildings (R). 17
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. 18
Figure 11: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable. 18
Figure 12: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition. 19
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. 19

LIST OF TABLES

Table 1:Pedestrian Comfort Criteria (after Melbourne, 1978)..7
Table 2: Pedestrian comfort criteria (Lawson, 1990)..7

1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Southlink Investment Properties Pty Ltd to provide a qualitative assessment of the impact of the proposed 88 Mill Point Road on the wind conditions in the surrounding areas.

The proposed development is located on Mill Point in South Perth, a small peninsula on the Swan River. This region of the city is made up of primarily low rise structures, with several high rise towers proposed to the south of the site, Figure 1. Sections of the Swan River form open approaches to the site from the north-east and south-west quadrants. To the south-east is an area of suburban development, while the massing of the CBD lies approximately 2 km to the north. The proposed development is a mixed-use tower of 34 levels, reaching a maximum height of approximately 123 m above ground, Figure 2. As the proposed development is generally larger than other structures in the immediate vicinity and located in a relatively exposed location, it is expected to have some influence on the pedestrian-level wind environment in the vicinity, and the extents are broadly discussed in this report.

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

Figure 2: Context massing view facing west (Hassel)

2 PERTH WIND CLIMATE

The proposed development lies approximately 10 km to the south-west of the Perth 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 Perth Airport from 1995 to 2017 have been used in this analysis. The wind rose for Perth Airport is shown in Figure 3 and is considered to be representative of prevailing winds at the site. Strong prevailing winds are organised into two main groups which centre at about the east and south-west. Winds from the east occur most frequently in the morning, while winds from the south-west quadrant are predominant in the afternoon. This wind assessment is focused on these prevailing strong wind directions.

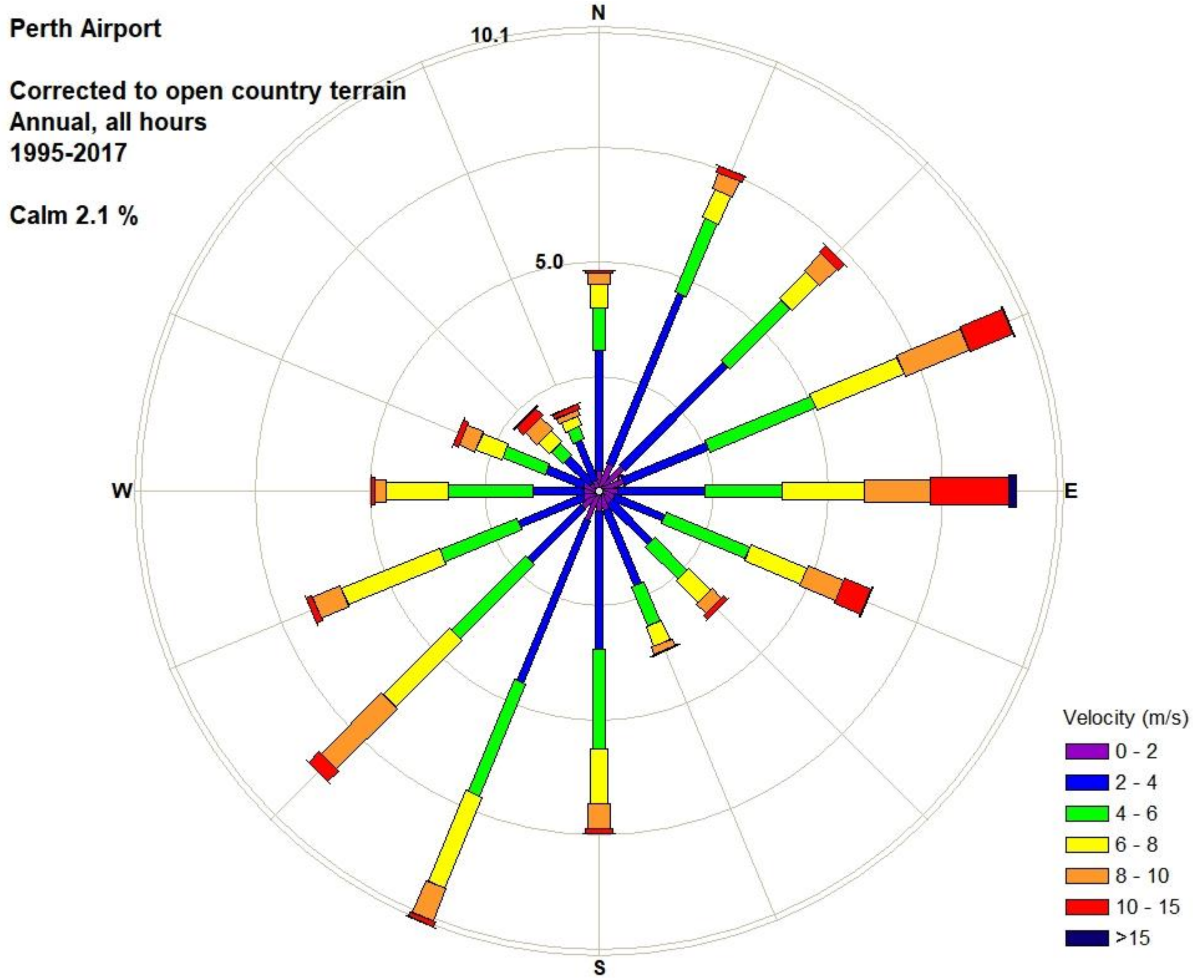

Figure 3: Wind rose for Perth Airport.

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 City of South Perth Town Planning Scheme (2017) makes reference to minimising wind impacts from new developments, however does not specify any wind assessment criteria for this area of the city. Guidelines for the nearby development areas of Perth City Link and Elizabeth Quay contain reference to the criteria of Melbourne (1978), which are summarised in Table 1. These categorise a location based on an infrequent gust event, occurring from a single direction approximately once per year. The use of an infrequent gust speed to assess may over-predict the windiness of a location, and for this reason assessment criteria based on more frequently occurring wind speeds and integrated over all directions are considered preferable.

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 2 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 – the rating is based on the wind speeds that occur for 95% of the time.

Table 1:Pedestrian Comfort Criteria (after Melbourne, 1978)

Comfort (based on the peak 3 second gust wind speed exceeded 0.1% of the time **from any 22.5° wind direction sector**)	
< 10 m/s	Long-term stationary activities (outdoor sitting, theatres)
10 - 13 m/s	Short-term stationary activities (window shopping, standing, or sitting in plazas)
13 - 16 m/s	Walking in urban and suburban areas (main public accessways)
16 - 23 m/s	Uncomfortable for walking
Distress (based on the peak 3 second gust)	
23 m/s	Unacceptable, not to be exceeded with a probability greater than 0.1% of the time from any 22.5° wind direction sector

Table 2: Pedestrian comfort criteria (Lawson, 1990)

Comfort (max. wind speed exceeded 5% of the time from **all wind directions combined**)	
<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 on a narrow peninsula on the Swan River. Topography surrounding the site is relatively flat from a wind perspective and unlikely to significantly affect the wind climate at the site. The surrounding street grid is approximately aligned along the northwest-southeast and northeast-southwest axes, which will promote channelling of wind from these quadrants.

As the proposed development is somewhat taller than its immediate surrounds, local effects caused by the relative exposure of the tower to prevailing winds are likely to affect the pedestrian wind environment. 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 development site is situated at the corner of Labouchere Road and Mill Point Road, and bounded by Ferry Street to the north. A residential tower of approximately 20 storeys occupies the neighbouring block to the immediate south of the subject site, with a number of similarly-sized structures proposed further to the south-east as part of a future masterplan (Figure 2).

The proposed rectangular tower sits over a two-storey podium, which forms a setback to the south-west and north-east site boundaries. The main residential entries are located at the corner of Mill Point Road and Ferry Street. Ground floor retail tenancies are proposed for the Mill Point Road frontage, which may involve alfresco-type areas. The site interfaces with the public domain along Mill Point Road and Ferry Street. Other areas of interest for this assessment include the landscaped podium roof (Level 02) and private terraces and balconies. A ground floor plan and section are shown in Figure 4 and Figure 5

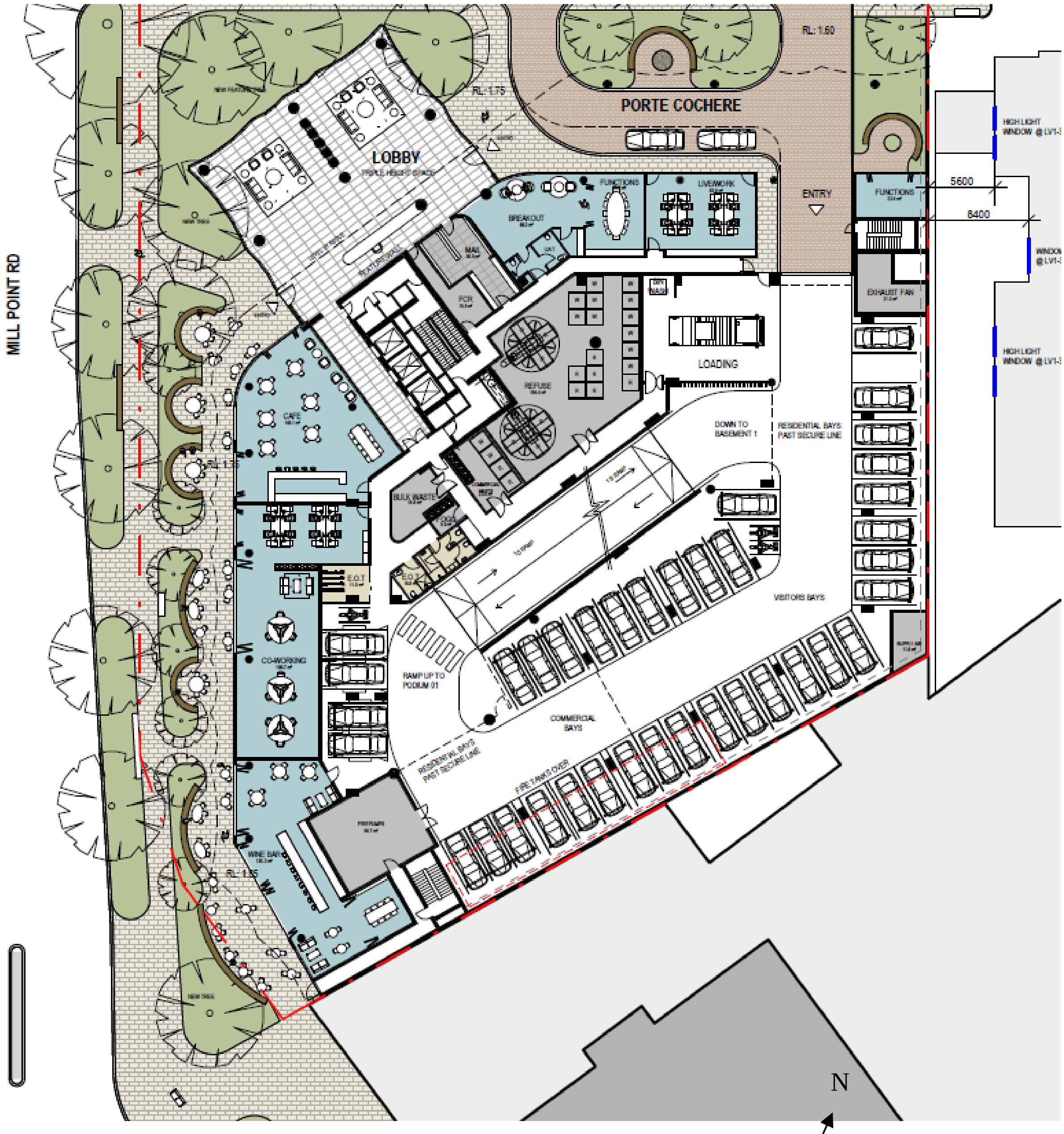

Figure 4: Ground floor (L00) plan of proposed development

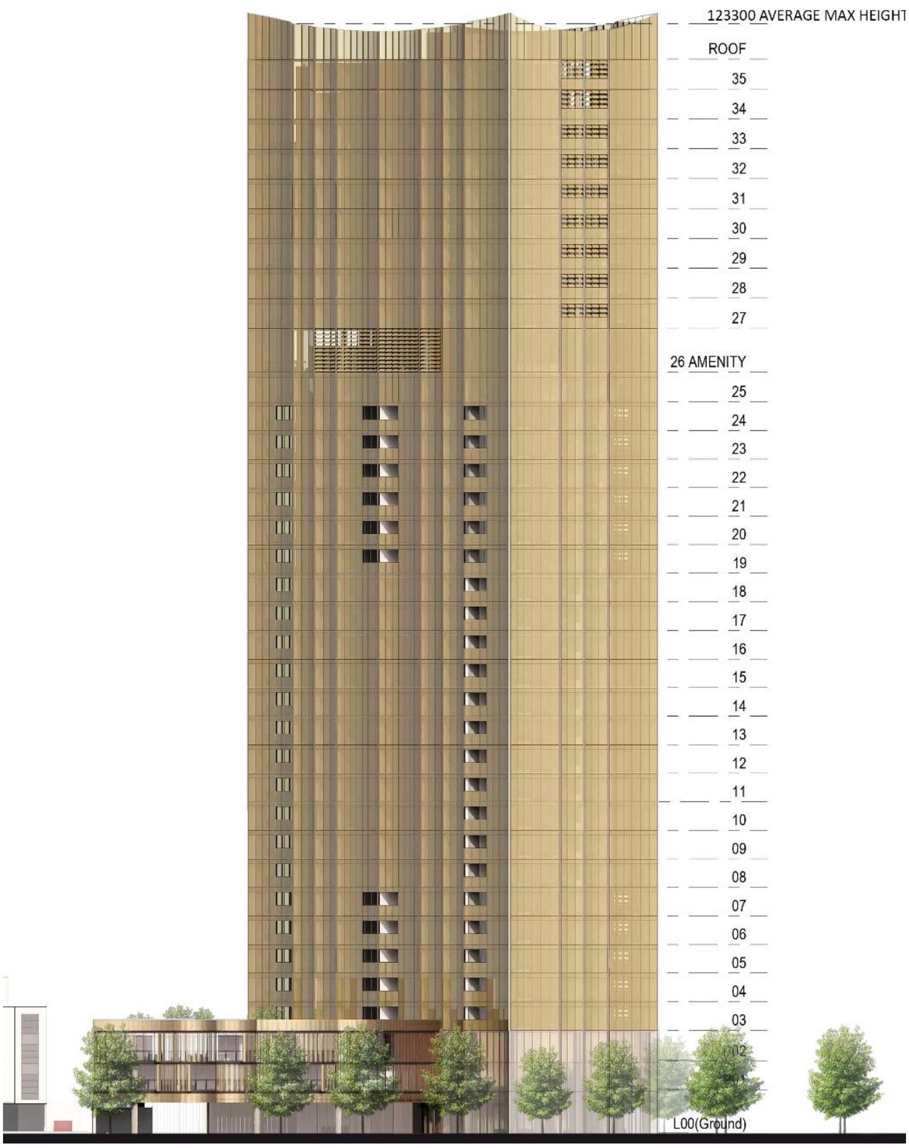

Figure 5: Ferry Street elevation of proposed development

4.1 Winds from the east

Winds from the east approach the site over an open region formed by the Swan River and adjacent parkland. Neighbouring low-rise structures to the east of the site will provide shielding to ground level locations near the site, however the tower massing remains relatively exposed to wind from this direction.

Easterly winds will impinge on the tower levels and downwash toward the ground. The most impacted areas would be on the podium rooftop, where strong winds would be anticipated near the tower base. The inclusion of a covered pergola/pavilion structure on the eastern side of the tower will provide a sheltered area for pedestrians and allow reasonable conditions within. Near to the corner of Ferry Street and Mill Point Road, some downwashing flow will combine with channelled winds moving east to west along Ferry Street.. Though the overhead protection formed by the porte cochere will limit wind impacts at the lobby entry, relatively strong winds would be anticipated near the tower base on Ferry Street Along the Mill Point Road frontage on the western side of the site, conditions are expected to be relatively calm during winds from the east due to the shielding provided by the massing of the subject and neighbouring developments.

4.2 Winds from the south-west

Winds from the south-west have a similarly unobstructed approach to the site. The wide façade of the tower is oriented perpendicular to incoming wind from this direction, which will encourage downwash and produce relatively high velocities at the tower base and particularly at the windward tower corners. The podium roof is likely to experience strong conditions near to where it interfaces with the tower, as incoming wind accelerates down and around the tower massing. As noted above, the inclusion of a covered area as indicated on L02 will create an area of calm conditions here.

Downwashing flow is also likely to impact ground level locations near the corner of Ferry Street and Mill Point Road, where there is no tower setback. The strongest winds would be anticipated near the westernmost corner of the building, and it would be suggested to provide some form of separation between the tower and ground plane at this location, such as an awning or canopy if this area is to be activated for pedestrian use. The landscaping concept proposed for this area will not significantly mitigate strong downwashing winds, though may form a buffer area to discourage pedestrian access to areas most impacted by accelerated flow.

The western lobby entry is expected to experience reasonably comfortable conditions, being effectively recessed under an external canopy.

The large street trees existing and proposed along Mill Point Road will offer some level of benefit in terms of mitigating direct winds, and locations close the façade are further protected from downwashing flows by the perimeter canopy. Though planter beds as proposed will also mitigate direct winds from the west somewhat, street level locations remain reasonably exposed and may experience relatively strong wind velocities at times, as flow . is directed along the street corridor by the combined massing of the existing neighbouring development and proposed development. Where the outdoor space is intended to be used as a commercial seating or alfresco dining space, it would be suggested to incorporate measures such as booth-style seating, balustrades, or other screening elements to encourage a comfortable environment even during breezy conditions. On the northern and north-eastern sides of the site, conditions would be expected to be mostly calm during winds from the south-west.

4.3 Summary – Public Domain

Previous wind tunnel studies conducted by CPP for this region of Perth have indicated that typical pedestrian locations are rated as suitable for Pedestrian Standing to Pedestrian Walking under the Lawson criteria, though less favourable ratings at more exposed locations are not uncommon. The wind environment at locations in the public domain around the proposed development site is likely to be classified as acceptable for Pedestrian Walking under Lawson in most areas, with some areas exceeding this level to meet a Business Walking classification, particularly near the corner of Ferry Street and Mill Point Road. Some areas with greater protection from prevailing winds are likely to meet the Pedestrian Standing level. A small number of areas may exceed the Lawson safety/distress criterion for non Able-Bodied persons.

This environment is typical for an outdoor environment in Perth, though it would be suggested to incorporate the suggested amelioration measures to address windier areas. Localised mitigation measures would also be recommended if calmer areas are desired for particular locations, for example, for outdoor seating or commercial dining.

4.4 L02 Podium Roof

As noted above, the accessible podium rooftop is likely to be impacted by down drafts from the tower above. Further, stronger winds are generally expected at higher elevations, meaning this space will experience breezier conditions than at ground level. The surrounding townhouse levels will assist in protecting against prevailing strong winds by forming a barrier to the perimeter. The inclusion of an enclosed pergola/pavilion on the eastern side of the tower (Figure 6) will provide a location where calm conditions are available to pedestrians even on windier days. The addition of seating nodes and significant planting as indicated on landscape concept plans will assist in mitigating the effects of strong breezes.

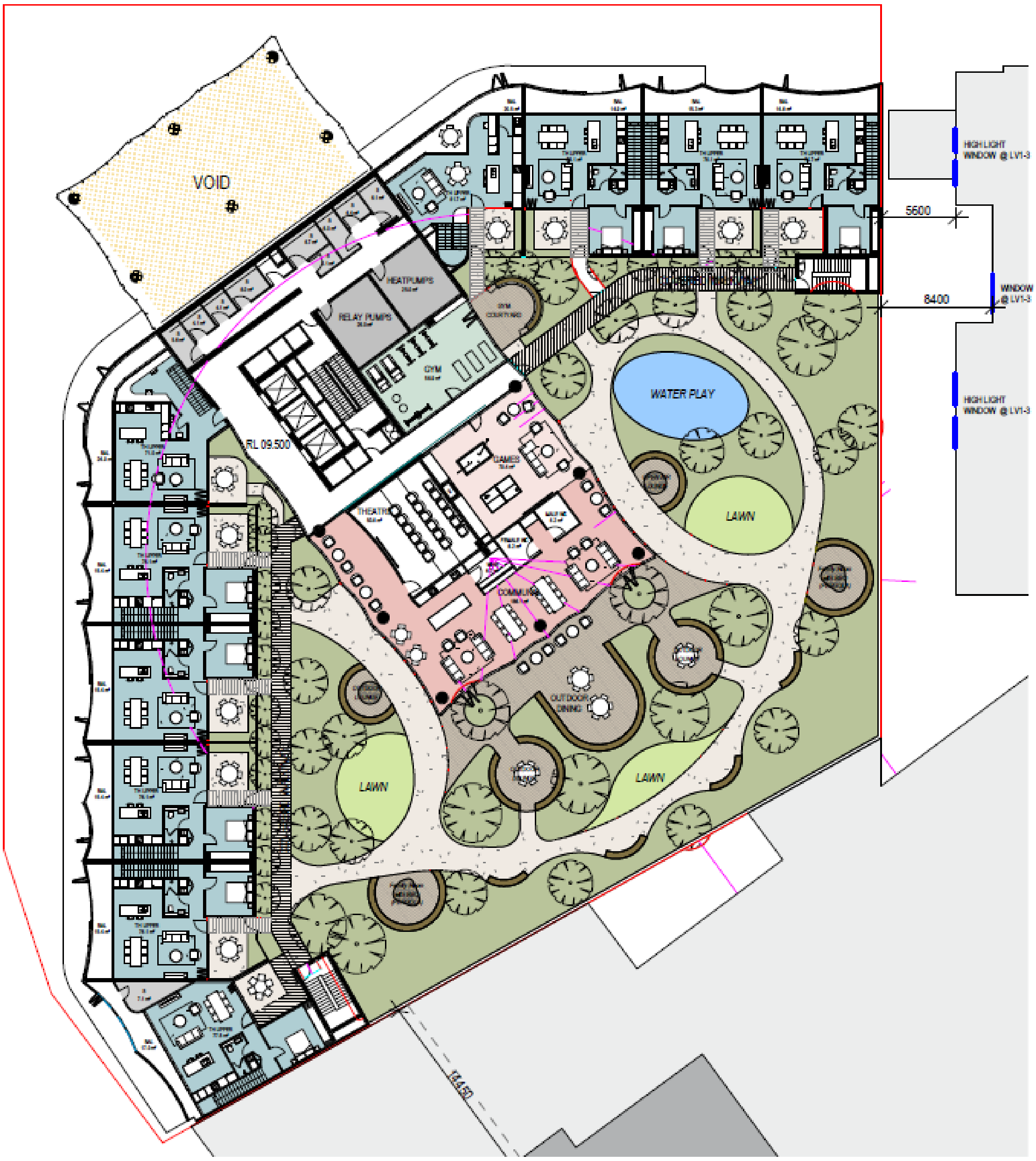

Figure 6: L02 Plan

4.5 Private Balconies

Residential balconies are proposed for Levels 3-33. Such spaces may often be the windiest areas on high-rise developments due to their exposure to strong winds at elevation and flows accelerating around the building massing. For this development, however, the situating of balconies at the centre of the façade (Figure 7) instead of corners, and the relatively small balcony volume will limit adverse wind impacts. Where louvred wintergardens are proposed, largely calm conditions will be available for residents regardless of ambient conditions. Residents will adjust their use of these spaces based on seasonal and temporal variations of wind conditions, so that specific mitigation is not considered necessary.

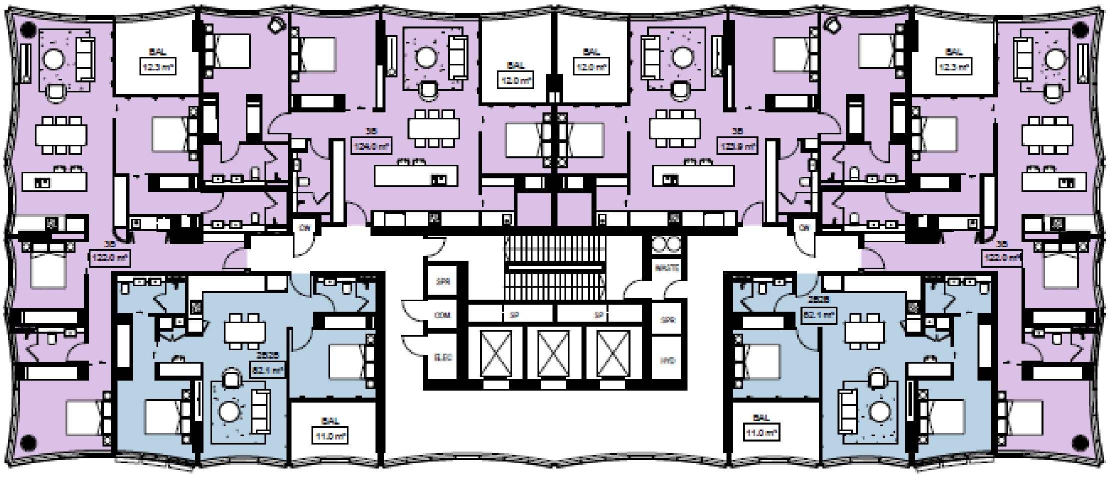

Figure 7: Typical tower plan – balcony layout

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed 88 Mill Point Road project on the local wind environment in and around the development site.

Being a relatively tall structure in an exposed location, the proposed development is expected to have some impact on local wind conditions. Conditions at most locations in the vicinity of the site are expected to meet the Pedestrian Walking classification under Lawson, however there is potential for windier areas to arise and some locations may not satisfy the Lawson safety/distress criterion for non Able-Bodied persons. Other areas are expected to experience relatively calm wind conditions. General guidance on mitigation measures has been provided.

Wind tunnel testing would be recommended to quantify the conclusions of this report and for the development of appropriate mitigation measures.

6 REFERENCES

Lawson, T.V. (1990), "The Determination of the Wind Environment of a Building Complex before Construction" Department of Aerospace Engineering, University of Bristol, Report Number TVL 9025.

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

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.

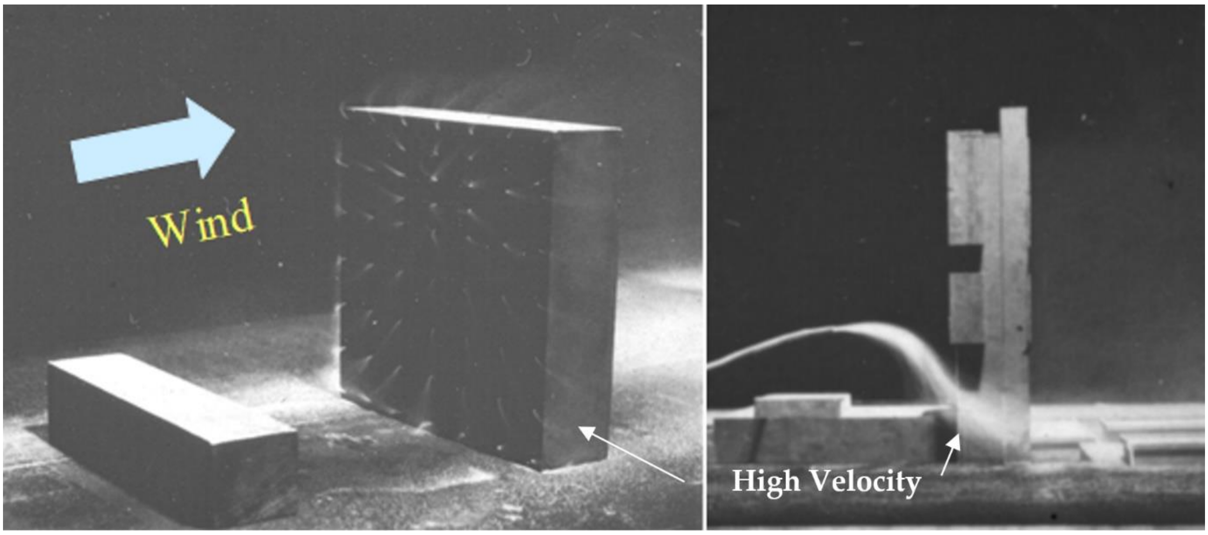

Figure 8: Flow visualisation around a tall building.

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.

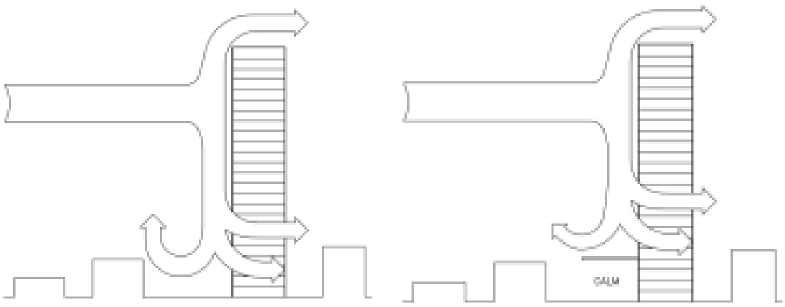

Figure 10: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

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.

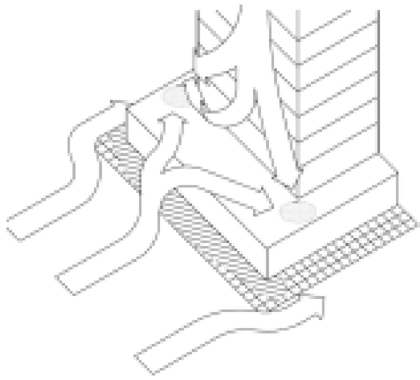

Figure 11: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

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).

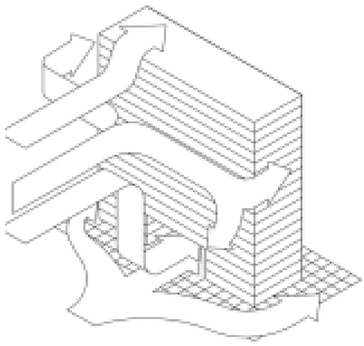

Figure 12: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

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.

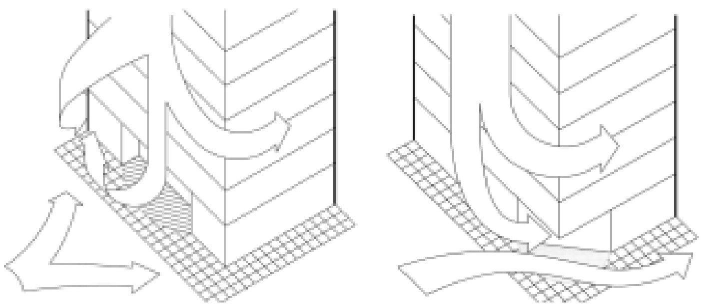

Figure 13: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

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.