CERMAK
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WIND ENGINEERING AND AIR QUALITY CONSULTANTS

FINAL REPORT

Wind Assessment for:

41 MCLAREN STREET

North Sydney, Australia

Prepared for:

RGB Services Group

Level 2, 41 McLaren St
North Sydney
NSW 2060

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Introduction

Cermak Peterka Petersen Pty. Ltd. has been engaged by RGB Services Group to provide an opinion based assessment of the impact of the proposed development at 41 McLaren Street, Sydney, on the pedestrian level local wind environment in and around the site.

The proposed development is located toward the northern edge of the North Sydney CBD, Figure 1. The site is bounded by McLaren Street to the north, Harnett Street to the east, and a private laneway to the west. Approximately 900 m to the south and south east are Lavender and Neutral Bays, Sydney Harbour. The proposed development is surrounded by high and medium-rise buildings, with a relatively unimpeded approach from the east due to the open area of the Bradfield Highway. The topographic decline towards the south and south east will slightly accelerate winds from these directions.

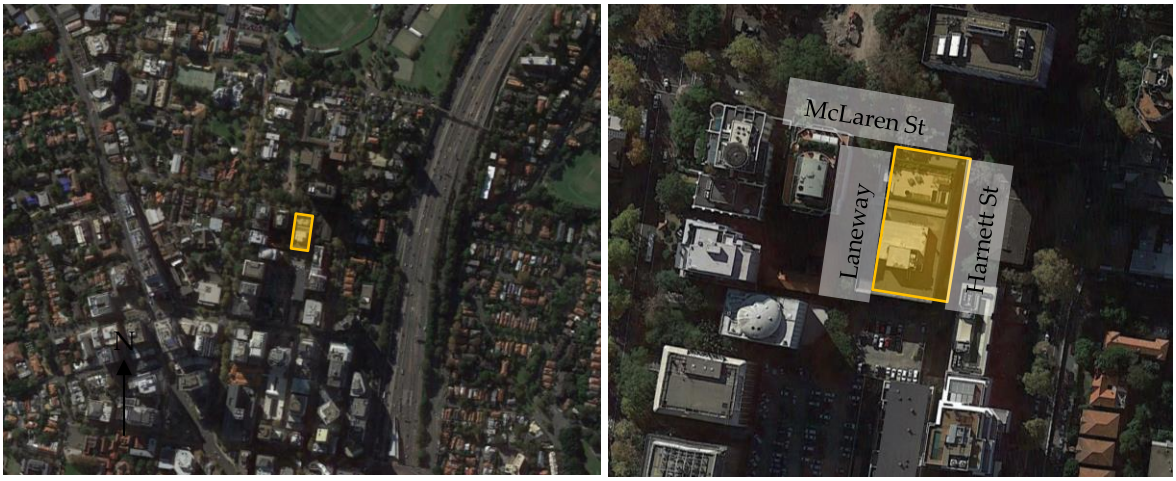

Figure 1: Remote (L) and close-up (R) aerial images of site (Google Earth, 2017)

Sydney Wind Climate

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 2016 have been used in this analysis, Figure 2. The anemometer is located about 11 km to the south of the site and is considered representative of the wind conditions at the site. It is noted from Figure 2 that 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.

Strong summer winds occur mainly from the south quadrant and the north-east. Winds from the south are associated with large synoptic frontal systems and generally provide the strongest gusts during summer. Moderate intensity winds from the north-east tend to bring cooling relief on hot

summer afternoons 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.

Winter and early spring winds typically occur from the south and west quadrants. West quadrant winds provide the strongest winds affecting the area throughout the year and are large scale synoptic events that can be hot or cold depending on inland conditions.

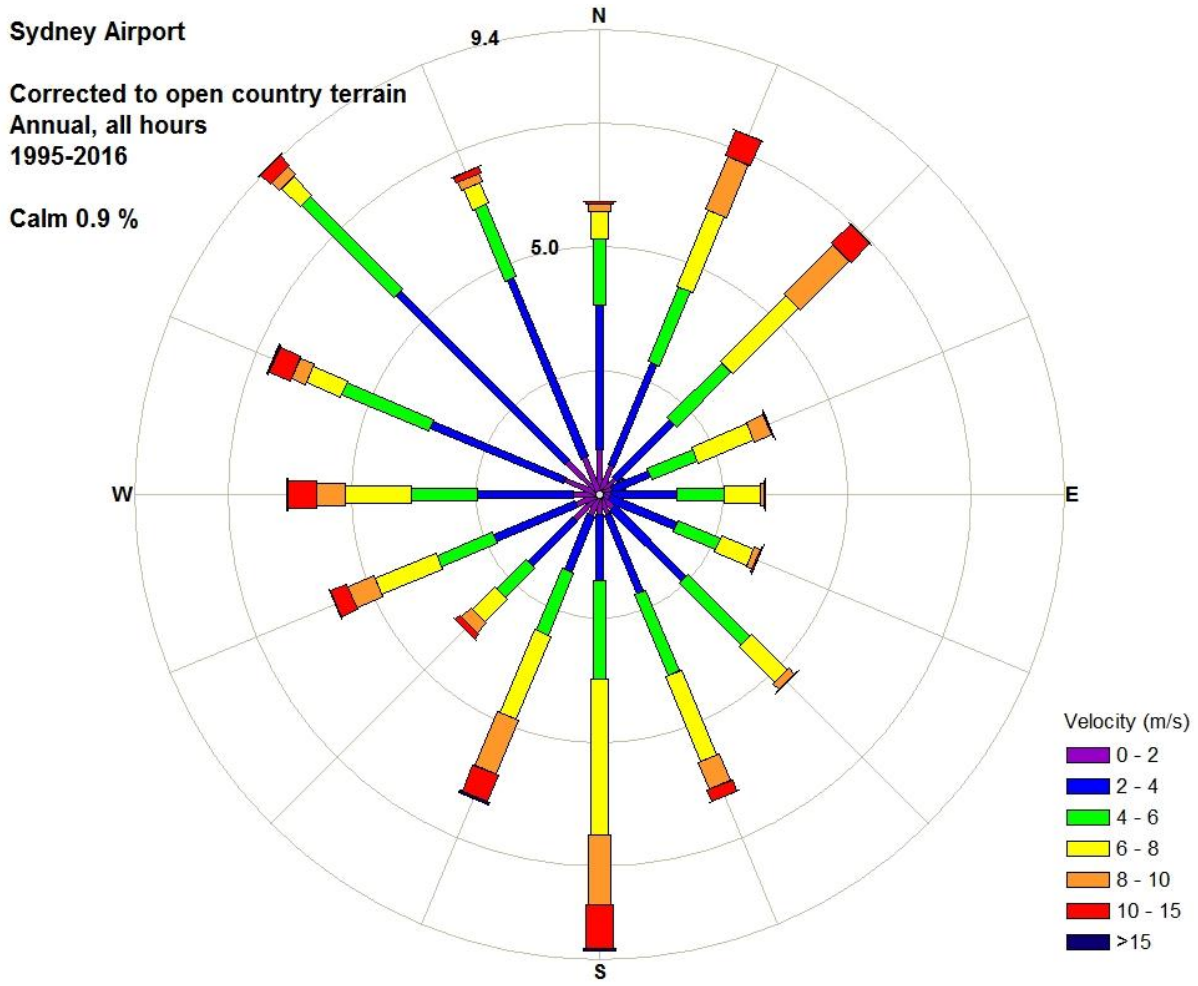

Figure 2: Wind rose showing probability of time of wind direction and speed for Sydney Airport

Wind Flow Mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 3; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward and sides of the building. Downwash will occur on buildings of all heights, but the vertical component is dictated by the height to width ratio of the building. In Figure 3 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.

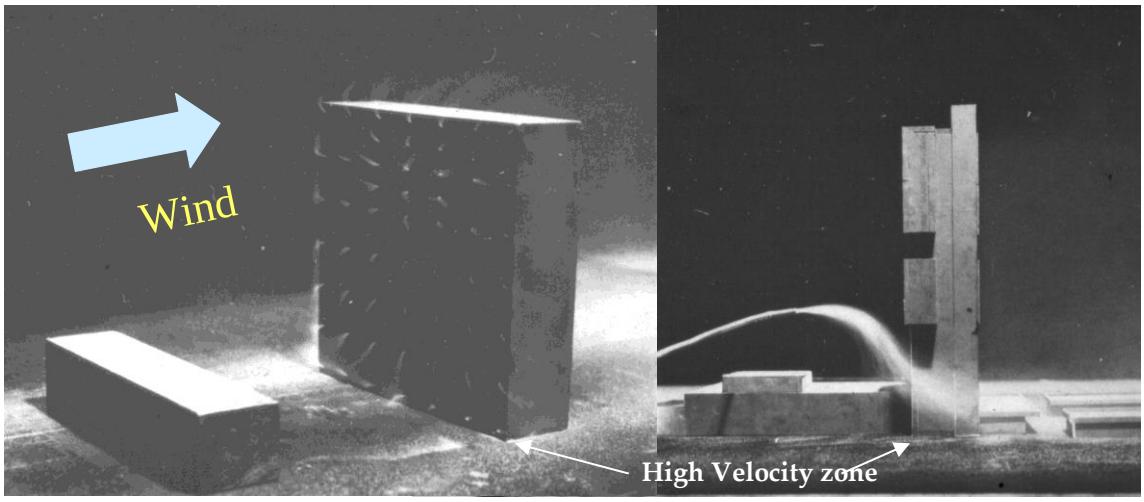

Figure 3: Flow visualisation around a tall building

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. The deeper the horizontal element generally 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. For long buildings relative to their height the flow around the corners will generally be horizontal.

Environmental Wind Speed 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. Over the years, a number of researchers have added to the knowledge of wind effects on pedestrians by suggesting criteria for comfort and safety. Because pedestrians will tolerate higher wind speeds for a smaller period of time than for lower wind speeds, these criteria provide a means of evaluating the overall acceptability of a pedestrian location. A location can further be evaluated for its intended use, such as for an outdoor café or footpath.

The current North Sydney (2013) DCP stipulates a minimisation of wind impact for new developments, and specifies wind speed should not exceed 13 m/s for footpaths and outdoor spaces. It is not clear whether this is a mean or gust wind speed nor the required frequency of occurrence throughout the year. It is expected that this metric is derived from the work of Melbourne (1978), which specifies that this is a maximum 3 s gust wind speed in an hour, occurring for 0.1% of the year

from each direction. A location meeting this requirement would be suitable for pedestrian standing activities such as window shopping. The DCP wind speed is interpreted as a comfort rather than a safety criterion.

From Figure 2, the 0.1% mean wind speed measured at 10 m above ground for all directions is about 16.5 m/s. Converting this to a mean and gust wind event at pedestrian level in a built-up environment in accordance with Standards Australia (2011) would result in mean and gust wind speeds of 10.5 and 20.5 m/s respectively, which is evidently greater than the 13 m/s in the DCP. There are few locations in Sydney that would meet this criterion without some shielding to improve the wind conditions

The work of Melbourne (1978), uses the infrequent (0.1%) gust wind event as basis of classification, which may not adequately characterise the general wind conditions at the site. To address this limitation, the current study is based upon the criteria of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress. The limiting criteria are defined for both a mean and gust equivalent mean (GEM) 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.

Assessment using the Lawson criteria generally provides a classification of pedestrian walking at a similar wind speed to the North Sydney DCP, however also provides information regarding the serviceability of the wind climate.

Table 1: Pedestrian comfort criteria for various activities

Comfort (maximum of mean or gust equivalent mean ($GEM^{+\cdot}$) 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
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
<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

The 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 1.85.

Environmental Wind Assessment

The site is surrounded on three sides by primarily medium- to high-rise buildings, with lower structures and the Bradfield Highway to the east. The surrounding street grid pattern is roughly oriented along north-south and east-west directions, which generates channelled flow for incident

winds along these axes. There is a moderate topographic gradient rising from Sydney Harbour to the south-east of the site to the north.

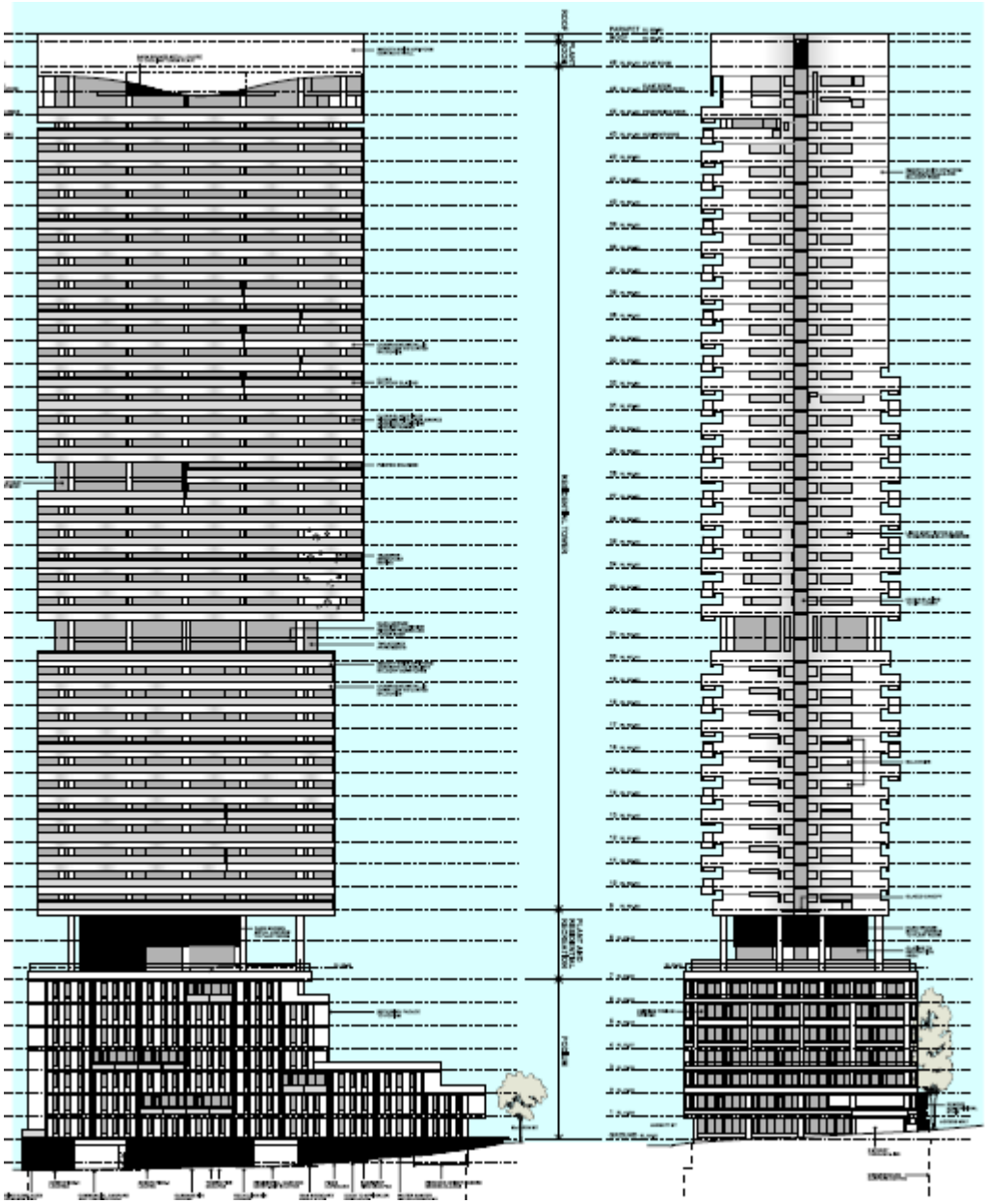

Figure 4: East (L) and North (R) elevations of proposed development

Previous wind tunnel testing conducted by CPP in the vicinity of the site has indicated that most areas in the existing configuration are classified as suitable for pedestrian standing or walking under Lawson, and would not pass the North Sydney DCP requirement.

The proposed development comprises a slender tower above an existing 7-storey podium structure, rising to approximately 160 m in height above ground level. The building has an irregular

planform, consisting of two joined curved components, as well as an alternating curved façade. The broad sides of the building face east and west. The ground floor and typical tower plans are shown in Figure 5 . The main pedestrian entries are located on the western and northern boundaries. A pedestrian through-link runs north-south along the western edge of the site, and an outdoor seating area is planned on ground level to the north, Figure 5. Open terraces are located on three podium levels, as well as the podium roof and on three tower levels, Figure 4.

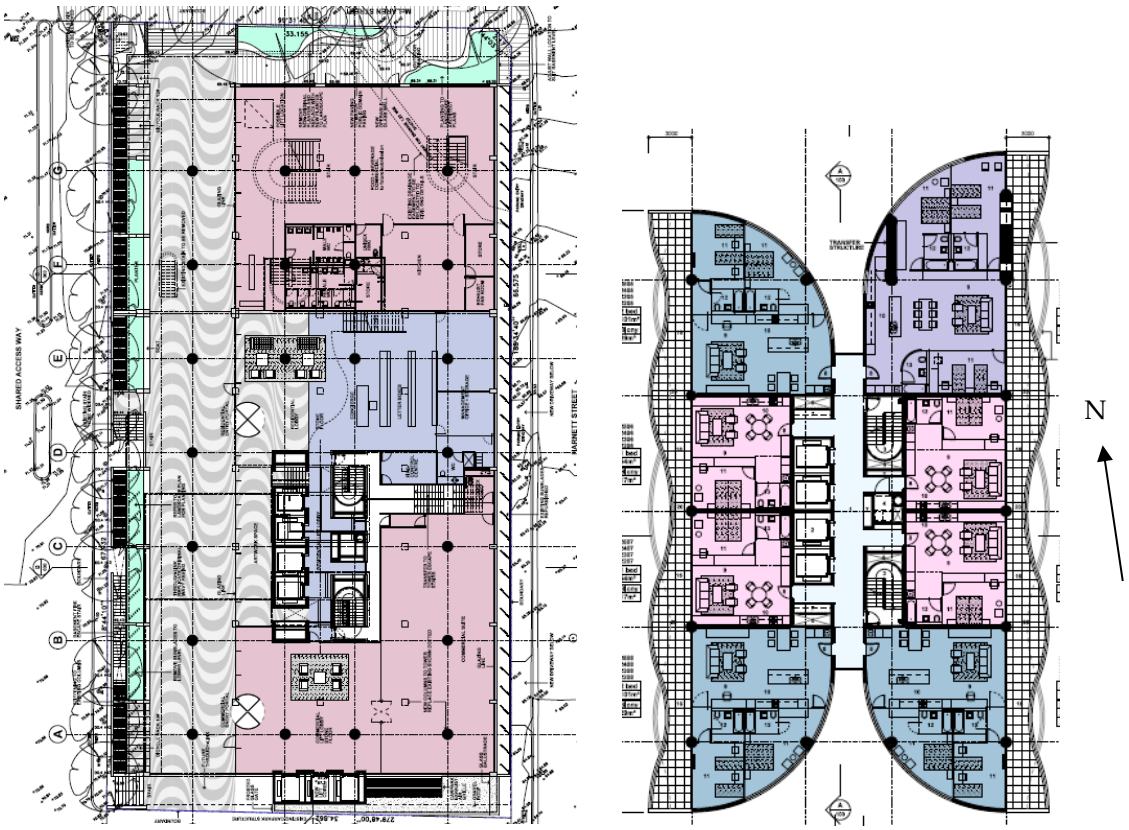

Figure 5: Ground floor plan (L) and typical tower level (R) of the proposed development

Winds from the north-east

Winds from the north-east approach along the open channel of the Bradfield Highway. Lower levels of the subject site would be somewhat shielded from direct winds by the steep embankment to the immediate west of the freeway, as well as the neighbouring buildings in this direction. The upper portion of the proposed tower is exposed to winds from the north-east, although the orientation of the building relative to the incoming flow will reduce the amount of downwash generated. The setback of the tower from the podium levels will promote calm conditions at street level by redirecting flow horizontally. Windy conditions would be expected on the podium roof and open terrace on level 3,

particularly at locations close to the building corners. The wind conditions in these areas could be improved through local amelioration measures such as horizontal awnings..

Winds from the south

Winds from the south approach the subject site over the massing of the North Sydney CBD, and will be channelled along the streets between the taller buildings. The area to the immediate south of the proposed development is occupied by low-rise developments, meaning that the upper portion of the tower will receive little direct shielding from southerly winds. The narrow south façade of the proposed development will generate relatively little downwash, and the existing three-storey building to the south will provide protection to Harnett Street and the laneway by redirecting flow horizontally. Conditions on the ground plane around the development would be expected to remain similar to existing during winds from this direction due to the orientation of the tower and the protection provided by the podium.

Winds from the west

Lower levels of the proposed development are relatively shielded from prevailing winds from the west due to the massing of several medium rise towers currently under construction in this direction. As the subject development is taller than these structures, the tower façade will generate some downwash during winds from the west. The tower setback from the podium will allow some protection for the ground plane, particularly for locations along McLaren Street and around the north-west corner of the site. Marginally stronger conditions would be anticipated along the laneway area. The addition of the proposed development is likely to slightly exaggerate the channelling of winds from the west along McLaren Street. Established tall trees along the northern site boundary will contribute to the wind amenity of the McLaren Street frontage. The proposed outdoor seating area near the northern entrance will likely require additional amelioration if it is to be used for dining activity. The use of temporary or permanent vertical screening elements around proposed outdoor dining locations would be suggested. Portable canopies, planters, and landscaping as planned would also be of benefit in encouraging wind conditions commensurate with the intended use of this space.

Private Spaces

The outdoor recreational terraces located on levels 3 and 6 would be expected to be relatively windy due to their exposure to effects of downwash. Locations close to the tower corners will be most strongly affected. Horizontal awnings would offer some protection by redirecting the flow, and would be recommended for these areas. Vertical screening elements distributed over the space could be used in conjunction with planned landscaping to provide local calm areas for sitting and dining. Similar

measures would be suggested for the level 2 terrace if long-term stationary or outdoor dining activities are intended.

The recreational terrace on level 7 is also expected to experience relatively strong conditions for a significant proportion of the time. Flow impinging on the tower facades above will be directed down onto the terrace and accelerated across the corners of the colonnade. Particularly high velocities would be expected at locations near the tower corners during winds from the south and west. A horizontal awning over areas intended for long-term stationary activity would be recommended to redirect flow away from pedestrians. Alternatively, solid or porous vertical screens or blade walls around the terrace could be included to disrupt the flow.

The larger elevated terraces on the southern side of the tower (Levels 29, 31, 33) would be expected to be uncomfortably windy for a significant proportion of the time to their exposure to prevailing strong winds and downwash flows. Including overhead awnings where there is no overhang from the level above, and vertical screening to partially enclose the space would assist in ameliorating conditions. An example layout is shown in Figure 6. Similarly, smaller balconies located close to the tower edges will experience strong cross-flows and relatively high velocities. Suggested mitigation measures for these areas are indicated in Figure 7, using Levels 20 and 27 as examples. The majority of balcony spaces on the development would be expected to be classified as suitable for pedestrian standing from a comfort perspective and pass the distress criterion. It would be expected that these areas would meet the wind speed associated with the upper level of pedestrian sitting for about 50-60% of the time, which is typical for elevated terraces. Most balconies on the development are large enough to have an area of calmer conditions for most wind directions, however storage of furniture and items may be problematic for corner balconies.

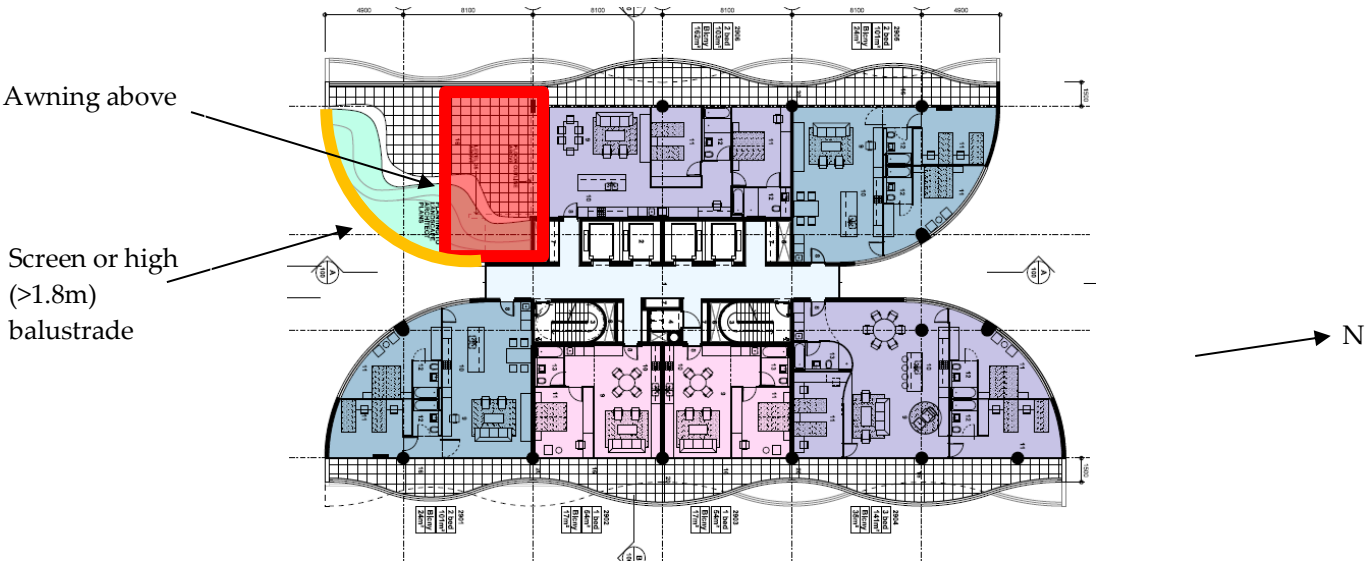

Figure 6: Level 29 plan indicating suggested amelioration measures

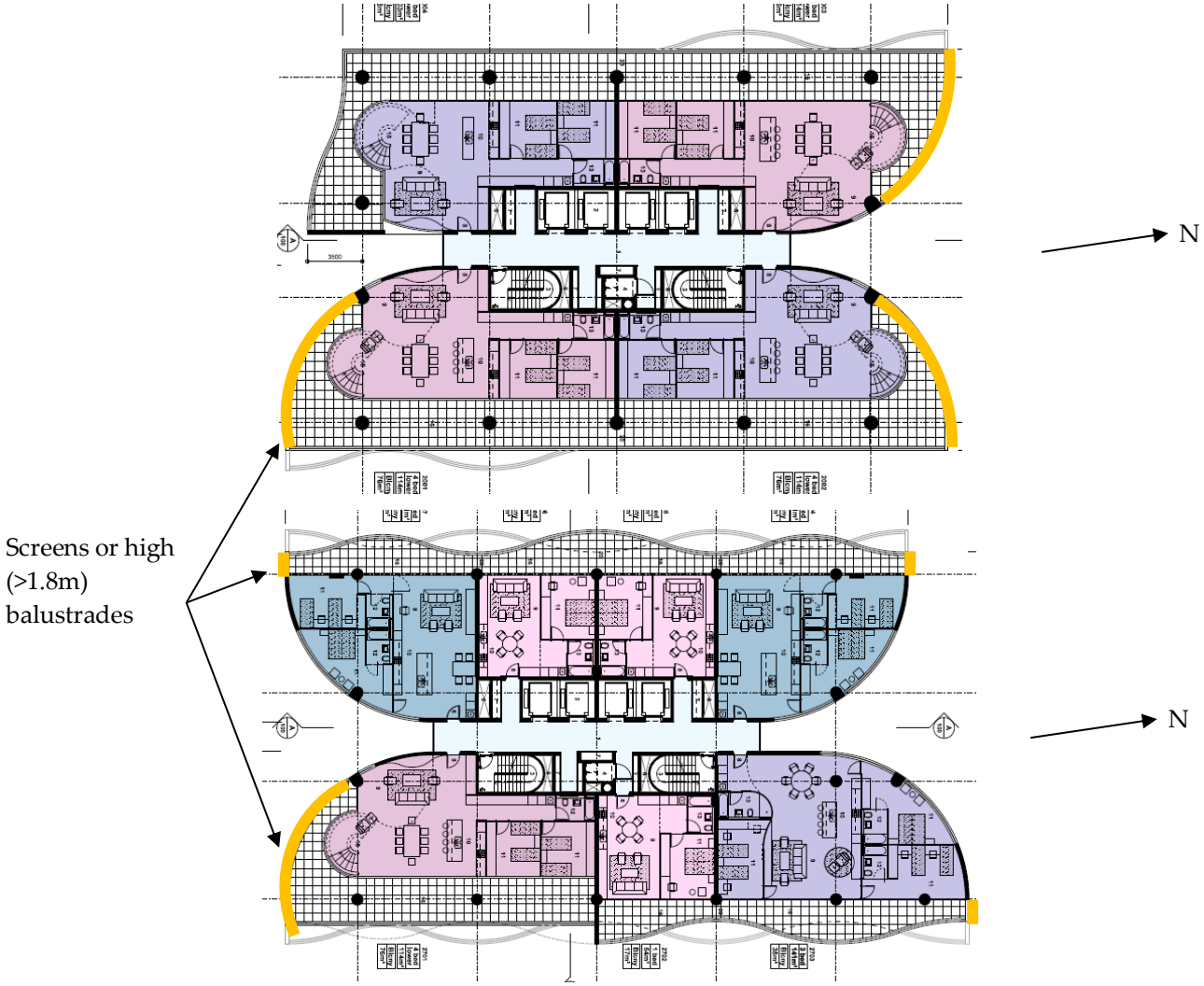

Figure 7: Level 20 (T) and 27 (B) plans indicating location of suggested screening

Summary

The results of wind tunnel testing conducted by CPP at nearby sites have indicated that most locations are classified as suitable for pedestrian standing or walking from a comfort perspective, and pass the distress criterion under Lawson. Qualitatively, integrating the expected directional wind conditions around the proposed development with the wind climate, it is considered likely that wind conditions at the majority of locations around the site would remain in these categories.

It is considered unlikely that the existing wind conditions around the site would meet the 13 m/s criterion contained in the North Sydney DCP, and this would be unlikely to change with the inclusion of the proposed development. Additional protection to pedestrians from the effects of downwash may be required, particularly on podium levels and areas intended for outdoor dining. The necessity for such amelioration would be determined through wind-tunnel testing during detailed design.

Conclusions

Cermak Peterka Petersen Pty. Ltd. has provided an opinion based assessment of the impact of the proposed development at 41 McLaren Street, North Sydney on the local wind environment.

Wind conditions around the site are expected to be somewhat affected by the addition of the proposed tall tower. The narrow planform of the proposed tower, its orientation relative to prevailing strong winds, and setback from the podium edges will each assist in minimising wind impact at pedestrian level. On average the wind conditions around the site would be expected to be similar to existing conditions, with most locations being classified as suitable for pedestrian standing or walking under the Lawson criterion. All locations would pass the distress criterion. Wind tunnel testing for this development has been commissioned, and will quantify the wind advice provided herein.

References

North Sydney Council (2013) “North Sydney Development Control Plan 2013”.

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, *J. Industrial Aerodynamics*, **3**, 241-249.