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WIND ENGINEERING AND AIR QUALITY CONSULTANTS

FINAL REPORT

Wind Assessment for:

BARANGAROO SOUTH BUILDING C1

Sydney, Australia

Prepared for:

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Introduction

Cermak Peterka Petersen Pty. Ltd. has been engaged by Lend Lease to provide an expert opinion qualitative assessment of the impact of the proposed Barangaroo South Building C1 development on the pedestrian level local wind environment in and around the proposed development. This qualitative report has been based on previous wind-tunnel testing around the Barangaroo South development.

This report is intended for inclusion in the development application and assesses the impact of the revised geometry based on drawings provided on 11th October 2017 on the pedestrian level wind environment. This report is informed by the results from previous wind tunnel testing reported in Cermak Peterka Petersen (2014) using the massing model for the building.

The site is located to the north-east of Barangaroo South, Stage 1a to the north-west of the Sydney CBD, Figure 1. The site is surrounded by existing and approved high-rise buildings and consequently receives shielding from all wind directions. The development consists of a medium-rise building of prismatic form. Comparative images of the tested and current designs are presented in Figure 2 and Figure 3. The current building design is of the same height and planform shape as that tested previously. The wind conditions around the development will be governed by the larger surrounding buildings and the minor changes to the current massing from that measured will have minimal impact on the previously measured wind conditions.

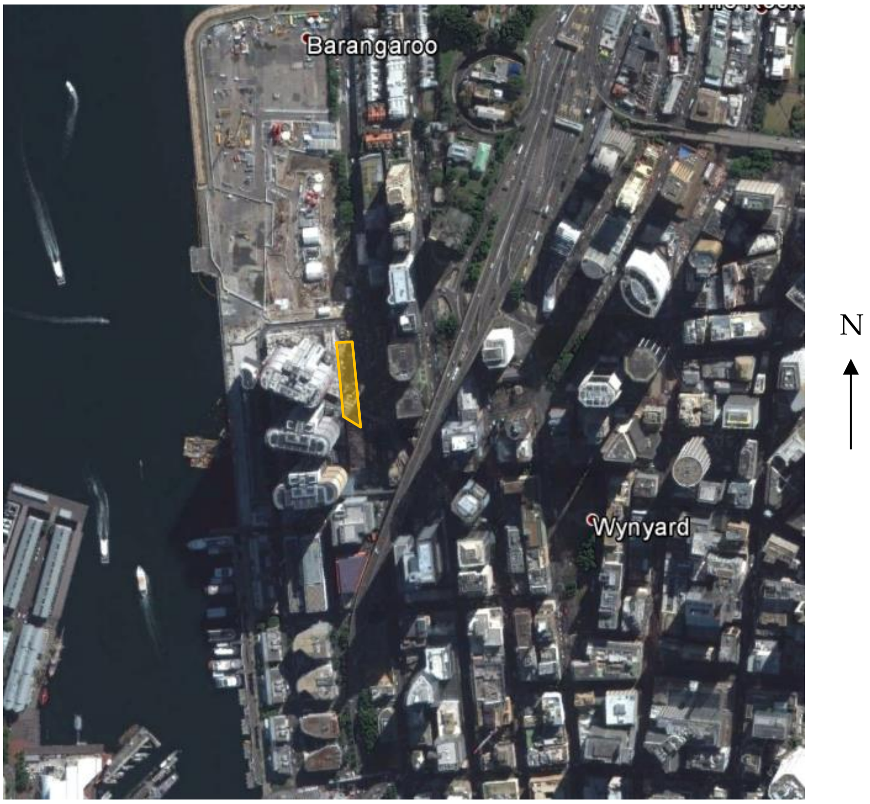

Figure 1: Location of the proposed development (Google Earth 2016)

Figure 2: Turntable layout for Barangaroo South (CPP 2014)

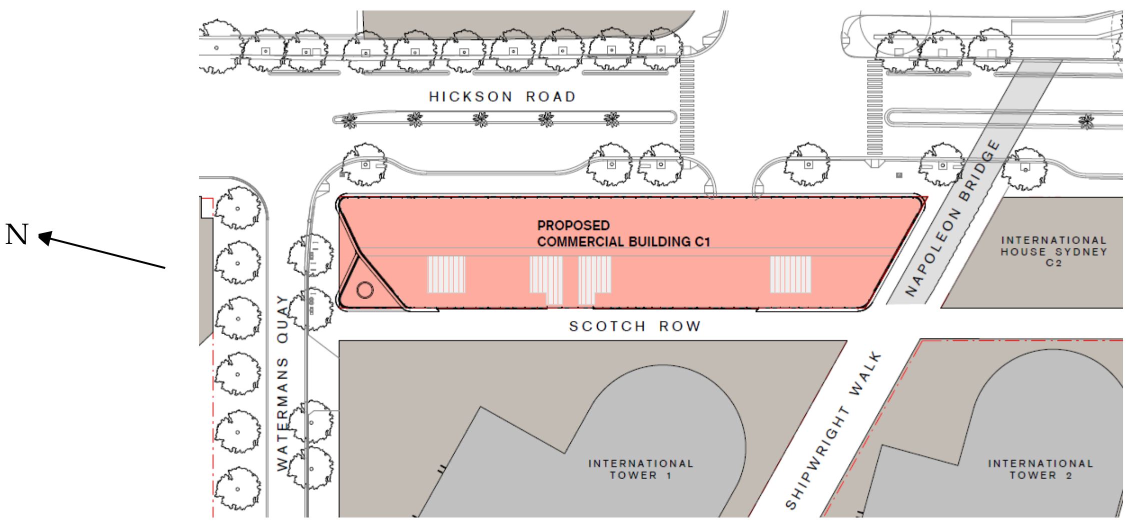

Figure 3: Site plan

Sydney Wind Climate

The proposed development lies approximately 10 km to the north of Sydney Airport Bureau of Meteorology anemometer. The wind rose for the airport is shown in Figure 4 and is considered to be representative of prevailing winds at the site. It is evident that the prevailing winds for coastal Sydney come from the north-east, south, and west. Winds from the north-east tend to be summer sea breezes and bring welcome relief on summer days. Winds from the south occur throughout the year and tend to be cold, generally associated with frontal systems that can last several days. 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.

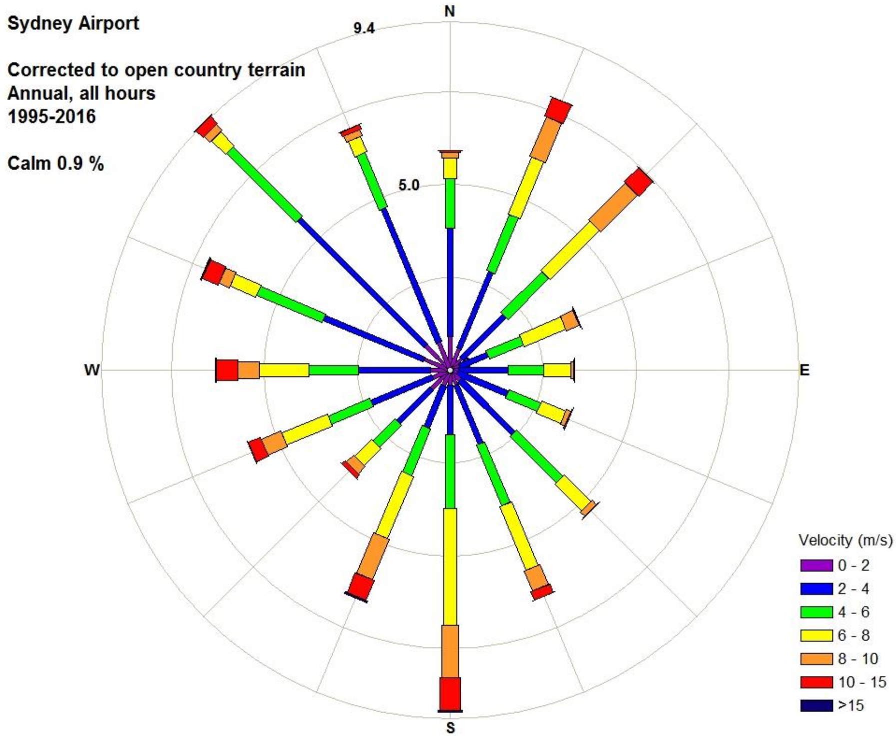

Figure 4: Wind rose for Sydney Airport

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. 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 current City of Sydney (2012) DCP does not cover the Barangaroo precinct, and there are no known wind criteria for the area. From previous projects, the wind criteria used were those of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress. 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.

Table 1: Pedestrian comfort criteria for various activities

Comfort (maximum wind speed exceeded 5% of the time)	
<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 (maximum 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 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.

Wind Flow Mechanisms

When the wind hits an isolated building, the wind is accelerated down and around the windward corners, Figure 5; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward and sides of the building. In Figure 5 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.

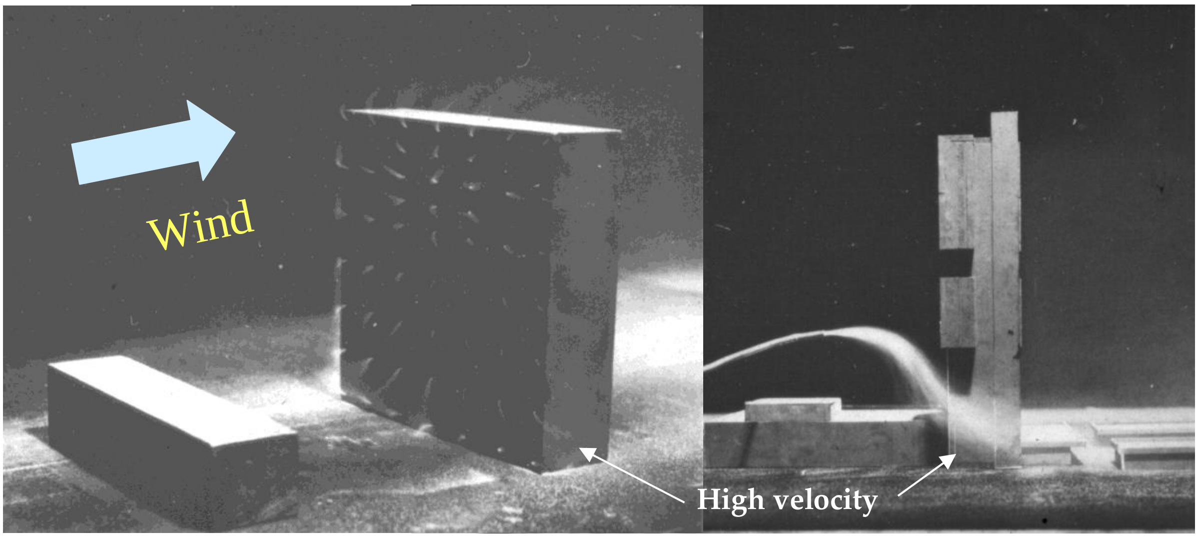

Figure 5: Flow visualisation around a tall building

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 and generally, 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 5 shows wind is 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 than intended 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.

Environmental Wind Assessment

From a wind perspective, there are no significant differences in massing between the proposed and previously tested building designs. The relevant wind tunnel test results are presented in Figure 6.

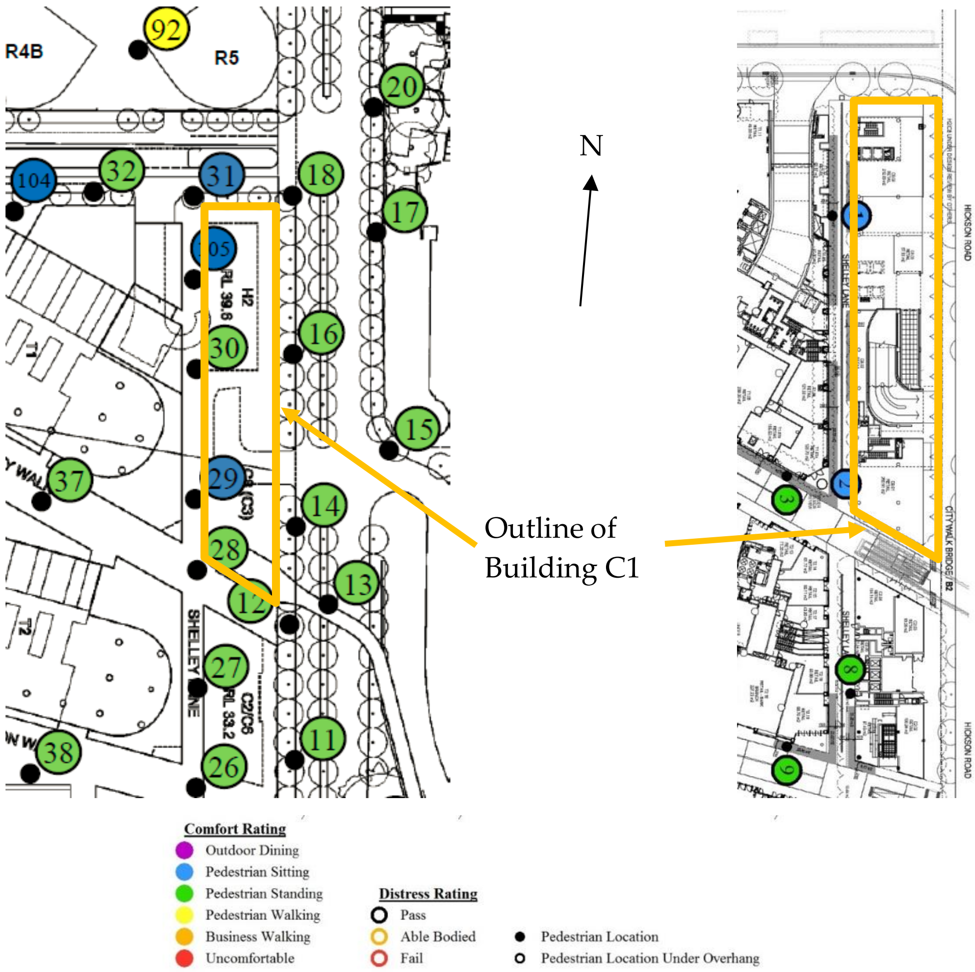

Figure 6: Pedestrian wind speed measurement locations at ground plane CPP 2013 (L), CPP 2014 (R)

It is evident from the wind tunnel test results that the wind conditions around the site are typically classified as suitable for pedestrian sitting or standing, and all locations pass the safety criterion. These measured wind conditions are considered appropriate for the general intended use of the space around the development. If the areas are to be used for outdoor dining, they would require some local amelioration during windy conditions. These would likely be vertical screens to offer protection to patrons. Due to the nested nature of the building in the surrounds, the colonnade to the east, and undercroft to the south of the building, Figure 7, are expected to be beneficial from a pedestrian wind comfort perspective.

Wind conditions on the Level 6 terrace to the north of the building, Figure 7,are expected to be stronger than at ground level, due to the observed flow pattern through the site. The height of the balustrade around the terrace is understood to be 1.6 m, which is expected to provide conditions on the terrace suitable for pedestrian standing, which is considered appropriate for the intended use of the space.

Figure 7: 3d render of the proposed development

Conclusions

Cermak Peterka Petersen Pty. Ltd. has provided an expert opinion qualitative assessment of the impact on the surrounding local wind environment of the proposed Barangaroo South Building C1 development, Sydney. The building features of the current design (drawings provided 11th October) that were not present in the previous wind tunnel test of the maximum building envelope, are expected to improve the wind conditions at pedestrian level at some locations compared with the test results. It is expected that the areas immediately to the north of the proposed development will pass the pedestrian standing comfort criterion under Lawson in this current design and be similar to the existing wind conditions. Overall, the pedestrian level wind environment is considered to be satisfactory for the intended use of the areas around the proposed development, based on previous testing and experience-based analysis.

Additional wind tunnel testing of the pedestrian level wind with the current building design has been commissioned and is underway.

References

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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.