CERMAK
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WIND ENGINEERING AND AIR QUALITY CONSULTANTS

FINAL REPORT

Qualitative Wind Assessment for:

UNIVERSITY OF SYDNEY ETP

Sydney, Australia

Prepared for:

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INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Laing O'Rourke Australia Pty. Ltd. to provide an opinion based assessment of the impact of the proposed University of Sydney ETP redevelopment on the pedestrian level local wind environment in and around the site.

The development site is located toward the east of the Camperdown Campus adjacent to the Seymour Centre to the north, Figure 1, with terrain gently rising to the north. The proposed building is an addition to the existing Electrical Engineering Building, and to be connected by a vertical enclosed atrium and circulation corridors, Figure 2. The site is surrounded by low- to medium-rise buildings in all directions with some open areas bordered by mature trees to the west.

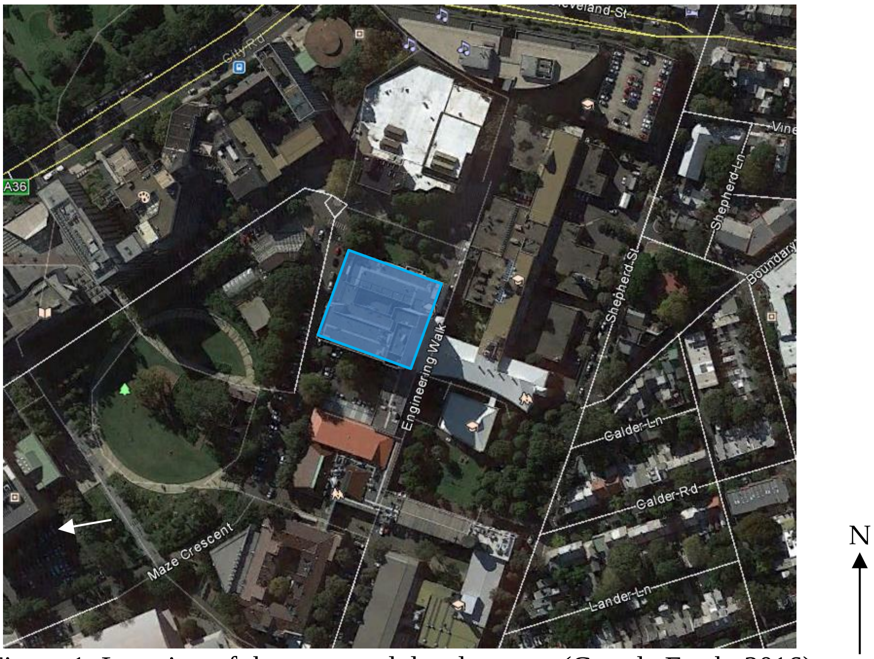

Figure 1: Location of the proposed development (Google Earth, 2016)

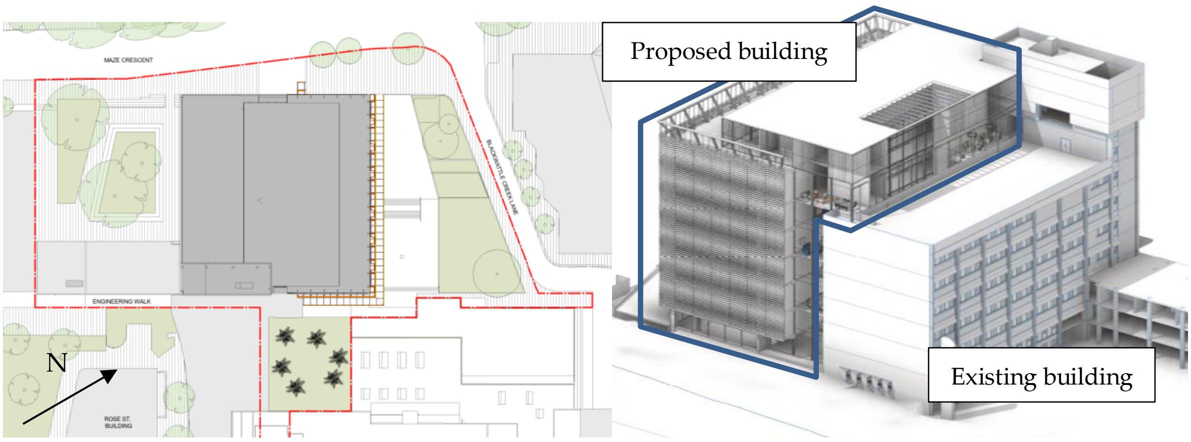

Figure 2: Level 1 floor plan (left) and 3D render (right) (Cox Architect, 2017)

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 3. The anemometer is located about 8 km to the south of the site and is considered representative of the wind conditions at the site. It is noted from Figure 3 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.

Seasonal wind roses are presented in Figure 4, with the arms pointing in the direction from where the wind is coming. It is evident that 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 strong winds typically occur from the south-west, 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.

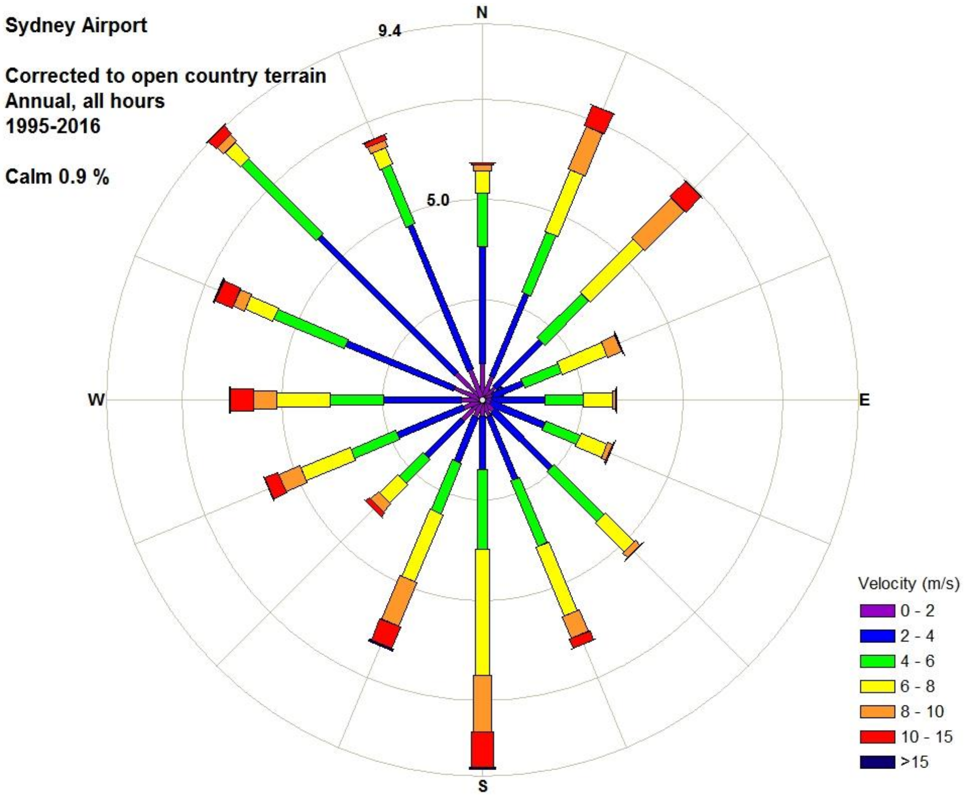

Figure 3: Wind rose showing probability of wind direction and speed for Sydney Airport

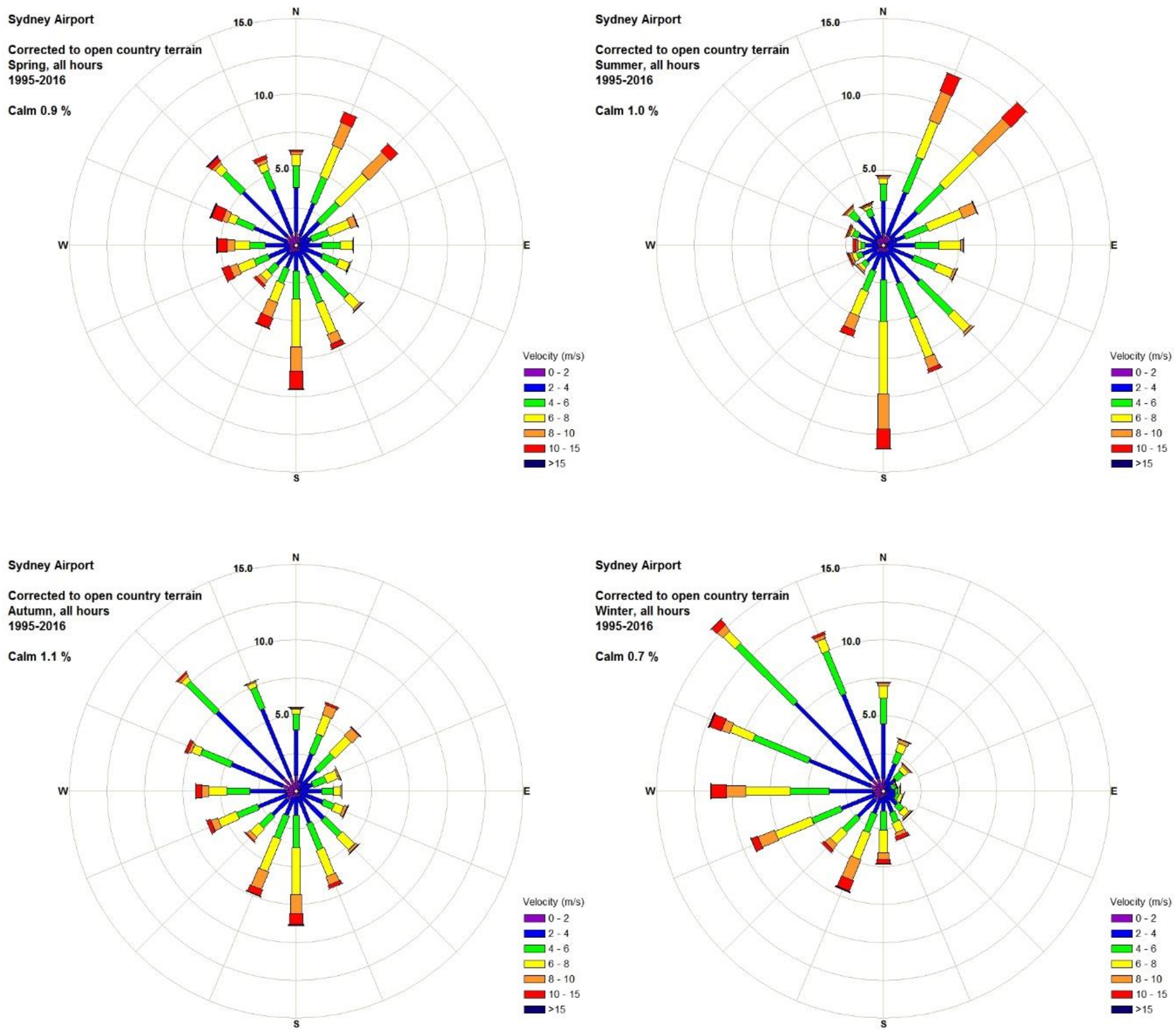

Figure 4: Seasonal wind roses for Sydney Airport

WIND FLOW MECHANISMS

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 5; 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 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.

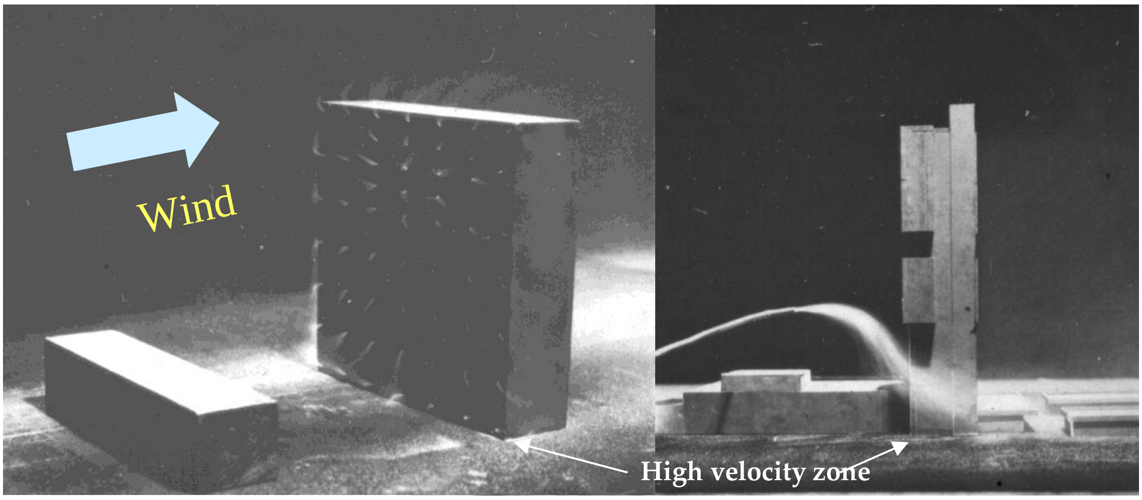

Figure 5: Flow visualisation around a tall building

Techniques to mitigate the effects of downwash winds on pedestrians include façade articulation, provision of horizontal elements, and 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 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 City of Sydney (2012) DCP specifies wind effects not to exceed 16 m/s in the area. There are few locations in Sydney that would meet this criterion without some shielding to improve the wind conditions. From discussions with Council this is a once per annum gust wind speed similar to the wind criteria in City of Sydney 2004 DCP, but is meant to be interpreted as a comfort level criterion and is not intended to be used as a distress requirement. The once per annum gust wind speed criterion used in the City of Sydney (2012) DCP is based on the work of Melbourne (1978), and the 16 m/s level is classified as generally acceptable for use as a main public accessway. This criterion gives the once per annum wind speed, and uses this as an estimator of the general conditions at a site, which may be more relevant to the success of the development. To combat this limitation, this 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.

From ongoing findings using the criteria, and clients who have issues with strong wind, a more stringent criterion is required for outdoor dining style activities and a value of 2 m/s for 5% of the time is recommended for such intended use. As the 5% of the time wind speed recorded at the airport is about 9 m/s, and even with the benefits of shielding from suburban buildings compared with the airport, most locations in the Sydney region require some level of shielding to meet the criterion.

Assessment using the Lawson criteria provides a similar classification as using the once per annum gust, which is the basis of the City of Sydney (2011) DCP, however also provides information regarding the serviceability wind climate.

Table 1: Pedestrian comfort criteria for various activities

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
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 proposed redevelopment involves an addition to the existing building with a 13 storey massing on the north side, Figure 6; the final building shape being generally prismatic with a stepped rooftop to the south.

Winds amongst such complex surrounds tend to flow over the medium-rise structures with only local downwash and channelling effects dictated by surrounding university buildings and street grid pattern beyond, which is random thereby disrupting the channelling effect. At the development site, the ground-level winds are governed by the topography and landscaping, and the building massing of the medium-rise surrounding university buildings, which provide partial shielding to the site, Figure 1.

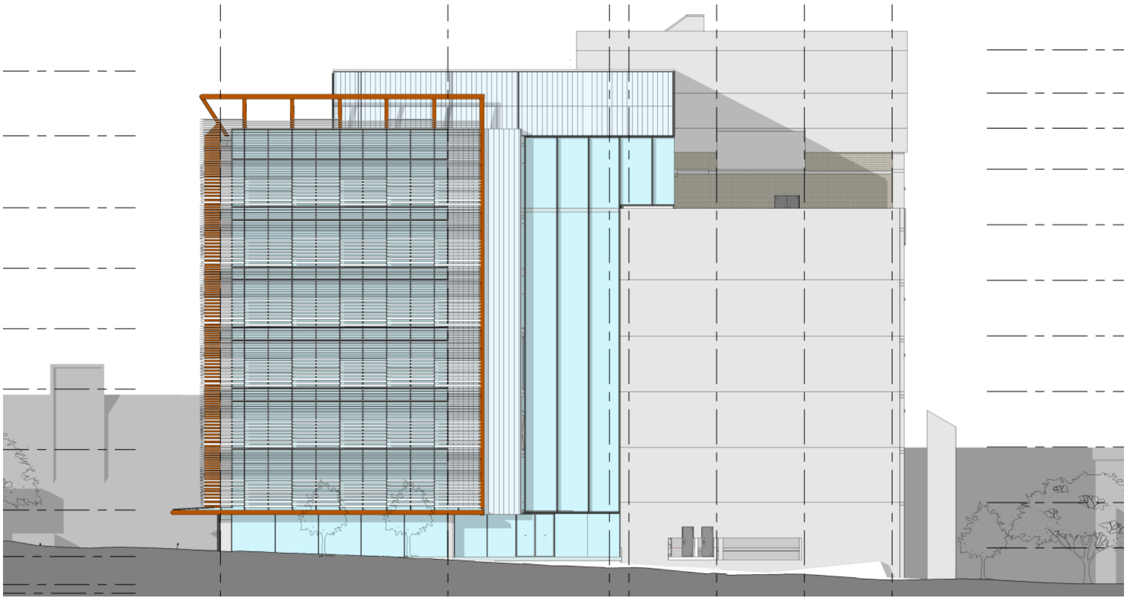

Figure 6: West elevation of proposed development (Cox Architect, 2017)

Ground Plane

Winds from the North-east

Winds from the north-east pass over the densely developed, low-rise suburbia of Chippendale terrace houses before reaching the site. The proposed building is slightly taller than the surrounding buildings catching high-level wind flow some of which will be directed toward ground level. North-east winds are often associated with sea breezes in coastal Sydney and any downwash flows reaching ground level from this direction are likely to bring a beneficial cooling effect to the site.

Wind from the South

The proposed addition will be mostly shielded by the existing Electrical Engineering building during wind events from the south. The top two storeys will be exposed, however winds will tend to flow over, Figure 6. It is expected that during wind events from the south, the ground plane wind conditions will not be significantly impacted by the proposed building.

Winds from the West

Increasing the height of the building will marginally increase downwash into the west side of the development site. Although, the taller buildings a short distance to the west would significantly shield the proposed building during winds from the west, and it is considered the downwash from the western façade of the proposed building will not significantly impact the existing wind conditions at ground level.

Summary

For all wind directions, it is expected the proposed addition to the existing Electrical Engineering building will not significantly impact the wind conditions on the ground plane surrounding the development site. Wind conditions from a comfort perspective would be expected to be classified under Lawson as pedestrian standing, and pass the distress criterion, suitable for public accessways.

CONCLUSIONS

Cermak Peterka Petersen Pty. Ltd. has provided an opinion based assessment of the impact of the proposed University of Sydney ETP redevelopment on the local wind environment in and around the development site.

In general, the proposed University of Sydney ETP building is not expected to have a significant impact on the local wind climate, due to its nested location being shielded by local topography, and existing surrounding buildings. For all wind directions, the wind conditions around the site would be expected to be similar to existing conditions with the pedestrian level wind environment for most locations being classified as suitable for pedestrian standing under the Lawson comfort criterion, and all locations would pass the distress criterion. It is considered that the design would have limited environmental impact on the surrounding space from a wind perspective.

Wind-tunnel testing would be recommended to quantify the wind conditions through the precinct, and for the development of any specific amelioration measures to help achieve suitable conditions for long term stationary activities such as outdoor dining.

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