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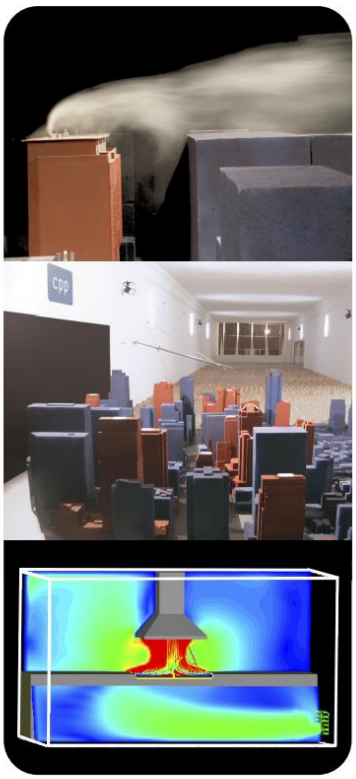
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

FINAL REPORT



Wind Assessment for:

ART GALLERY OF NSW EXPANSION

SYDNEY MODERN BUILDING

Art Gallery Road, Sydney, NSW 2000, Australia

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October 2017

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EXECUTIVE SUMMARY

This report provides an opinion based qualitative assessment of the impact of the proposed Sydney Modern Building at the Art Gallery of NSW on the local pedestrian-level wind environment in and around the development. This assessment is based on knowledge of the local Sydney wind climate and previous wind-tunnel tests on similar sized developments.

The proposed development is relatively exposed to the prevailing wind conditions. Wind conditions at ground level in and around the proposed development are expected to be similar to the existing conditions and be classified as suitable for pedestrian standing or walking from a comfort perspective and pass the Lawson distress criterion. These wind conditions are considered to be suitable for the intended use of the space around the development.

The open nature of the entrance plaza presents a serviceability issue given the intended use of the space. Operable walls or landscaping around the perimeter is recommended to mitigate wind conditions blowing through the space on windy days. Without any amelioration, wind conditions are expected to be suitable for pedestrian standing from a comfort perspective.

It is expected that the proposed development, along with the proposed amelioration measures, will have negligible impact on the wind amenity of The Royal Botanic Garden and Domain.

DOCUMENT VERIFICATION

Date	Revision	Prepared by	Checked by	Approved by
28/04/16	Initial release	KF	GSW	GSW
30/06/16	Updated drawings	GSW	GSW	GSW
06/09/17	Updated drawings	KF	JP	JP
03/10/17	Updated drawings	KF	JP	JP
01/11/17	Minor revision	KF	PB	PB

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1. INTRODUCTION

Client Provided Information

The Art Gallery of NSW proposes to undertake a major expansion of the existing art gallery adjacent to the Phillip Precinct in the Domain. The expansion, proposed as a separate, stand-alone building, is located north of the existing gallery, partly extending over the Eastern Distributor land bridge and includes a disused Navy fuel bunker located to the north east of this land bridge.

The new expansion comprises a new entry plaza, new exhibition spaces, shop, food and beverage facilities, visitor amenities, art research and education spaces, new roof terraces and landscaping and associated site works and infrastructure, including loading and service areas, services infrastructure and an ancillary seawater heat exchange system.

Introduction

Cermak Peterka Petersen Pty. Ltd. has been engaged by Architectus to provide an opinion based assessment of the impact of the proposed Sydney Modern Building, at the Art Gallery of NSW, on the wind conditions in the surrounding areas, as illustrated in Figure 1. The proposed development consists of a series of low-rise structures, with the main entrance situated on Art Gallery Road, as illustrated in Figure 2. The proposed development is a stand-alone structure, and will not be physically connected to the existing Art Gallery of NSW building.

Topography surrounding the site slopes steeply downward toward to the east quadrant, gently downwards to the north, and remains essentially flat toward the south and west. Wind conditions in this relatively exposed area are known to be windy, and the architectural design of this proposed development will have an impact on the local wind climate.

Figure 1: Aerial view of the proposed development site (Google Earth, 2015)

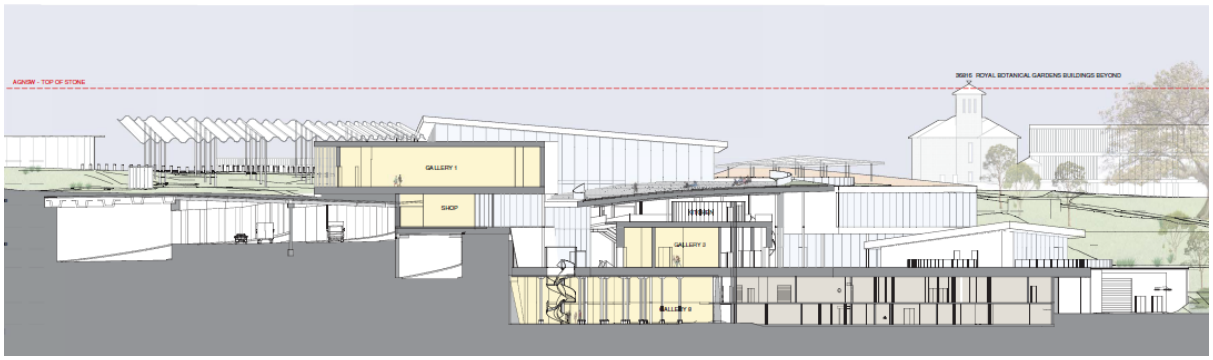

Figure 2: Section through the proposed development viewed from the south-west

2. SYDNEY WIND CLIMATE

The proposed development lies approximately 10 km north-north-east of the Sydney Airport Bureau of Meteorology anemometer. 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 around noon to dusk. These are small-scale temperature driven effects; generally, 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.

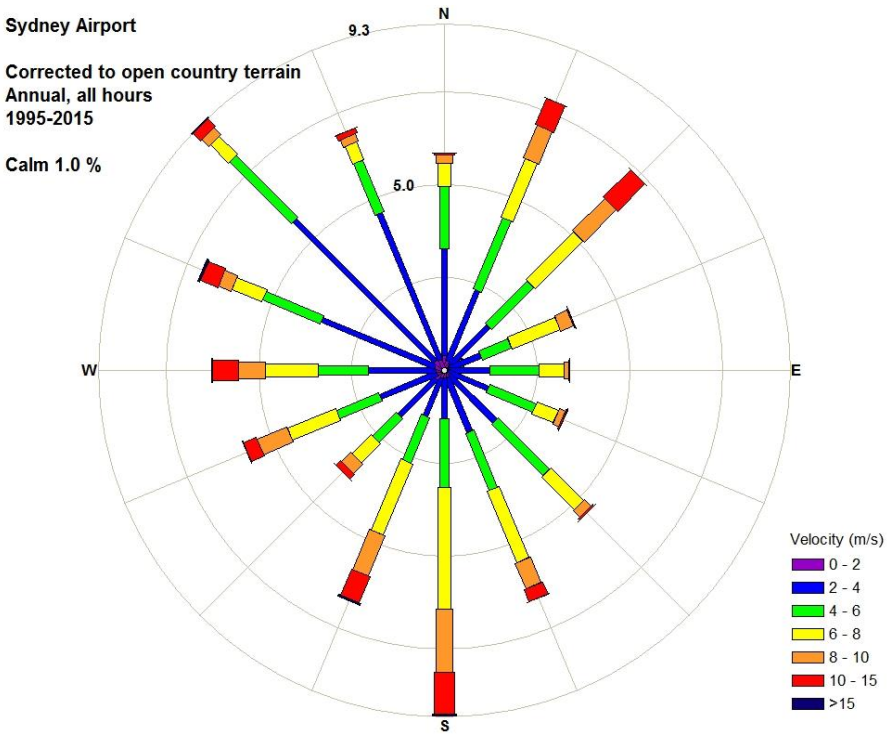

Figure 3: Wind rose for Sydney Airport corrected to open country terrain

3. 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 specifies wind effects not to exceed 16 m/s, as the area around the site is not classified as an 'active frontage'. There are few exposed locations in Sydney that meet this criterion without shielding to improve the wind conditions. From previous discussions with Council, this is a once per annum gust wind speed similar to the wind criteria in City of Sydney (2011) 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 10 m/s level is classified as generally acceptable for use as generally acceptable for pedestrian sitting. This criterion gives the once per annum wind speed, and uses this as an estimator of the general wind conditions at a site, which may be more relevant. To combat this limitation, as well as the once per annum maximum gust wind speed, this study is based upon the criteria of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress. The benefits 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 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.

Table 1: Pedestrian comfort criteria for various activities

Comfort (max. 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 (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. WIND FLOW MECHANISMS

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 4; 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 4, 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 5.

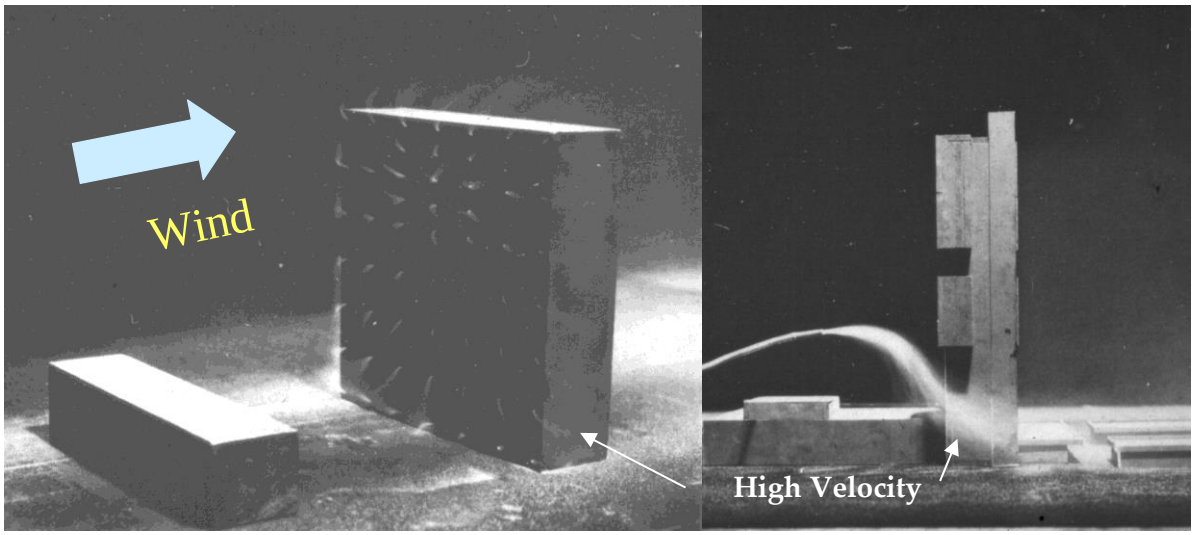

Figure 4: Flow visualisation around a tall building

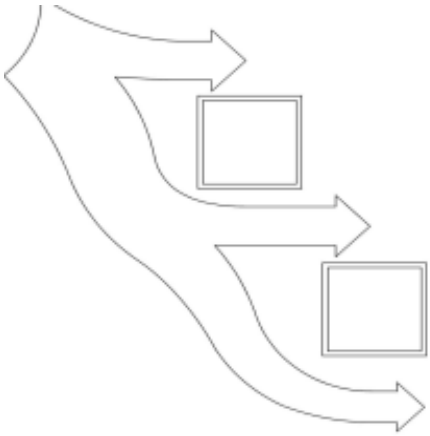

Figure 5: Channelling between buildings

5. ENVIRONMENTAL WIND ASSESSMENT

The proposed development is relatively exposed to prevailing winds from the north-east, south-east, and north-west quadrants. The ground floor of the proposed development is shown in Figure 6. The inclusion of the low-rise development is expected to have minimal impact on the existing local wind conditions.

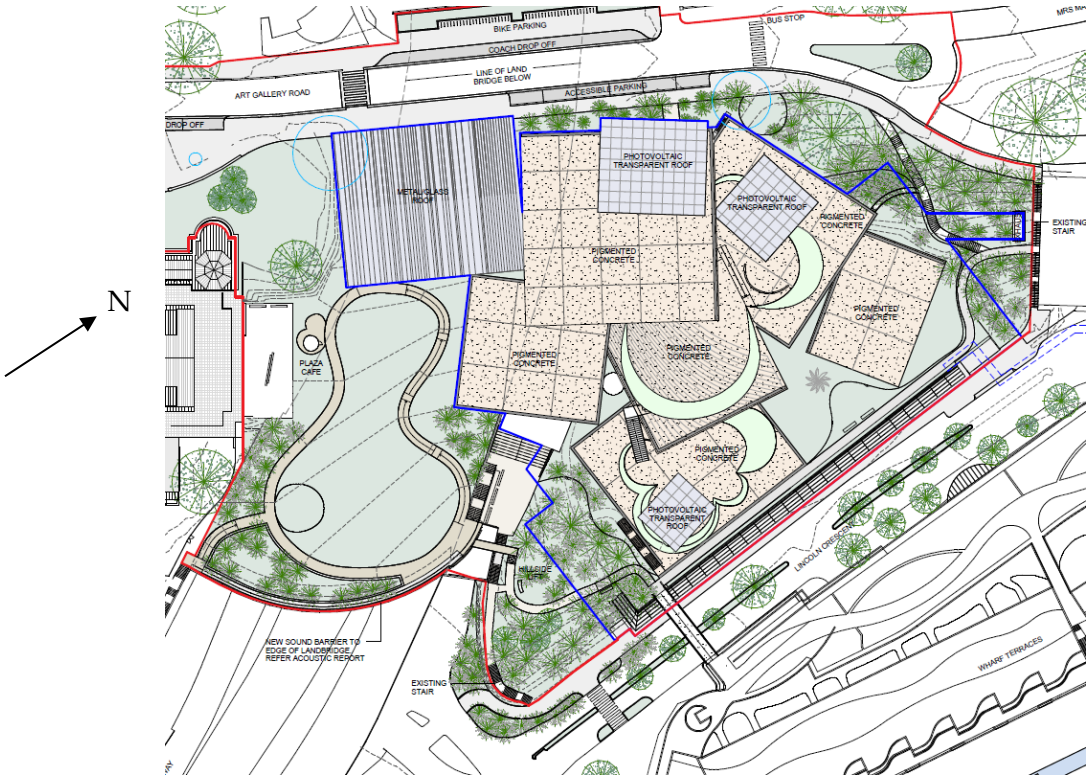

Figure 6: Ground floor of proposed development

Winds from the north-east

Winds from the north-east quadrant coming across Sydney harbour and Wolloomooloo Bay are relatively unimpeded on reaching the site. These summer afternoon prevailing winds will accelerate up the topography towards the development. The low-rise massing of the structure sunken into the topography is expected to have minimal impact on the flow with minor acceleration around the windward corners. Given the size and massing of the proposed development, the expected wind conditions are expected to be similar to the existing wind conditions.

Winds from the south

Winds from the southeast quadrant will pass over the low- and medium-rise buildings of Woolloomooloo before accelerating up the topography to the site. The pedestrian footpath leading up to entrance foyer, Figure 6, is expected to experience accelerated flow from the topography and between the proposed buildings. The proposed landscaping will ameliorate the wind conditions for pedestrians

on the footpath. The wind conditions on the footpath are expected to be similar to the existing conditions and no amelioration measures are considered necessary.

Winds from the south-west quadrant are expected to be ameliorated by the existing massing of the Art Gallery of NSW, encouraging the wind to flow around the proposed development. The local wind conditions are expected to be similar to those currently experienced around the existing Art Gallery of NSW. No amelioration measures are necessary.

Winds from west

Winds from the west will pass over Sydney CBD and the Domain before reaching the site. The medium- and high-rise buildings as well as the dense planting across the Domain will ameliorate the incident wind at ground level. The proposed development is expected to channel the flow over the buildings, which is beneficial to pedestrians within the development. To the east of the site, the steeply sloping topography and building massing will offer significant protection to pedestrians.

The wind conditions around the site are expected to be similar to existing conditions. Qualitatively, integrating the expected directional wind conditions around the site with the wind climate, it is considered that wind conditions around the site would be classified as acceptable for pedestrian standing or walking from a comfort perspective and pass the distress criterion under Lawson. It would be expected that the majority of the site would meet the once per annum gust wind speed of 16 m/s, thereby meeting the Sydney DCP requirements.

It is considered that the main serviceability wind issue within the development is the open nature of the entrance plaza. This area is intended to be used for scheduled events for a large number of people. However, the close proximity of the structures within the development mitigates any channelling flows, producing a calmer wind environment for pedestrians. In the event of windy days, the most effective solution to ameliorate the serviceability conditions would be to install operable walls or landscaping around the perimeter of the plaza within the roofline of the structure. Without amelioration, this area would be expected to be classified as suitable for pedestrian sitting/standing.

It is expected that the proposed development, along with the proposed amelioration measures, will have negligible impact on the wind amenity of The Royal Botanic Garden and Domain.

6. CONCLUSIONS

Cermak Peterka Petersen Pty. Ltd. has provided an opinion based assessment of the impact on the local wind environment of the proposed Sydney Modern Building at the Art Gallery of NSW. The environmental wind conditions at ground level around the proposed development are expected to be suitable for pedestrian standing from a comfort perspective and pass the distress criterion.

It is expected that the proposed development, along with the proposed amelioration measures, will have negligible impact on the wind amenity of The Royal Botanic Garden and Domain.

For such a prestigious development in a unique environment, it would be recommended to quantify the serviceability wind conditions and confirm the qualitative findings using wind-tunnel testing.

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