Hassell

60 Martin Place

Environmental Wind

JM

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Contents

1 Introduction

Arup have been engaged by Investa to assess the likely wind conditions around the proposed redevelopment at 60 Martin Place within Sydney CBD. The redevelopment is located at the corner of Martin Place and Macquarie Street and surrounded by high rise buildings as indicated below. The proposed redevelopment of the site in the future would involve the demolition of the existing building and replacement with a new podium and tower at the same location.

The objectives of this environmental wind assessment is to provide a high-level comparison of the wind conditions for the current building and the proposed maximum envelope for the Sydney LEP 2012 Amendment.

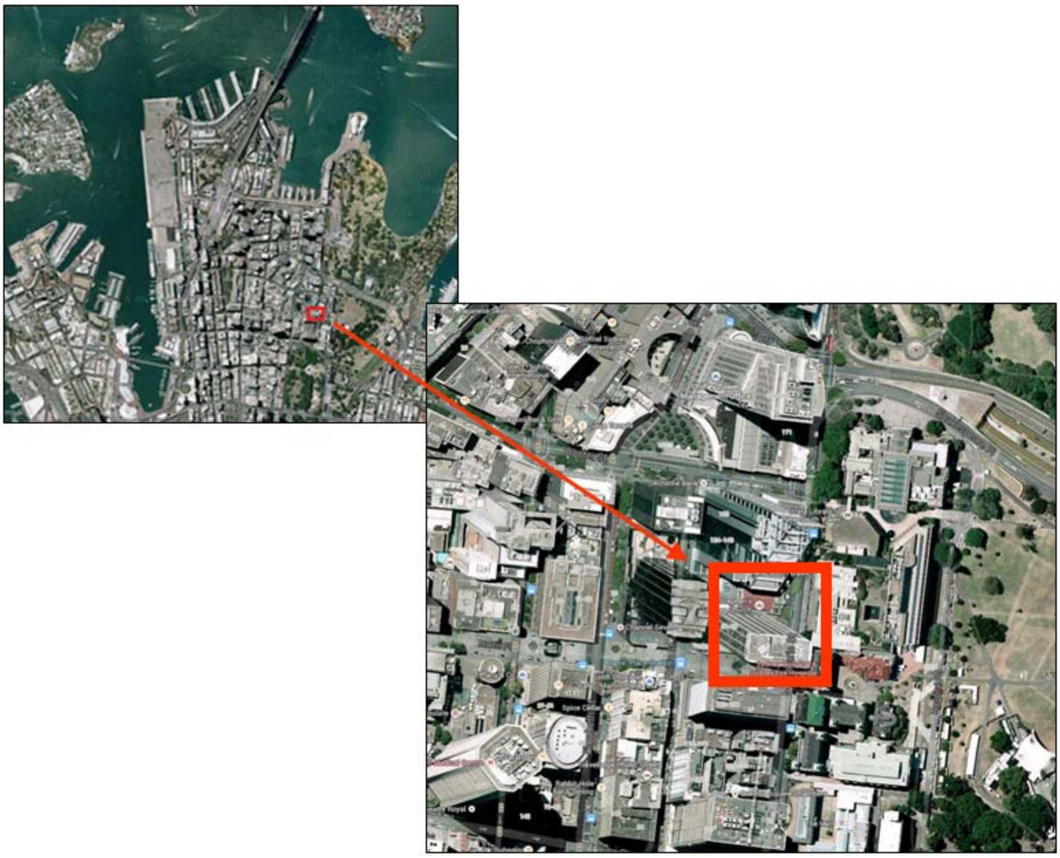

Figure 1 Location plan

2 Massing Options

The purpose of this assessment is to test the impact of different massing options on the environmental wind conditions in and around the site. The following two massing options have been assessed based on 3D architectural models provided by Hassell on 1st July 2014 that include the surrounding buildings from the council context model.

- The current building that stands on the corner of Martin Place and Macquarie Street. This scheme is characterised by an 8.5 metre tower setback on the south side and a 11.8 metre setback to the west. There is a 7 metre setback between the podium and the low-rise building to the north, and there are pedestrian-level voids in the podium. The building height is approximately 115 metres.
- The proposed maximum envelope as documented for the LEP amendment. Major differences between the proposed maximum envelope and the current building (Figure 3 and Figure 4) include a reduced tower setback to 4.7m on the south side, removal of setback and increased wall height to 45m on Macquarie Street, 5.5m cantilever on the north towards the church and an increased building height to approximately 145m. The massing model differs from the sketch for the top 6m of the tower where a non-solid architectural element will be explored as part of the future competitive design process. This architectural element is not expected to have a significant impact on pedestrian level wind flows.

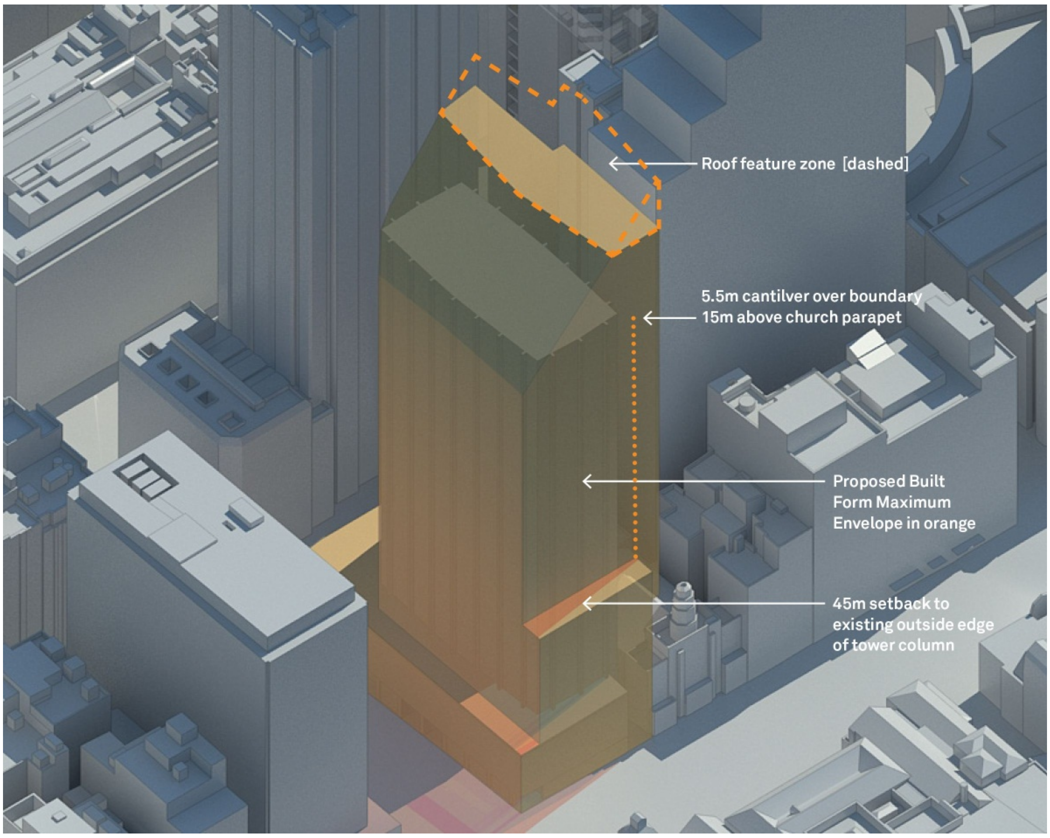

Figure 2 Sketch of current building and proposed maximum envelope

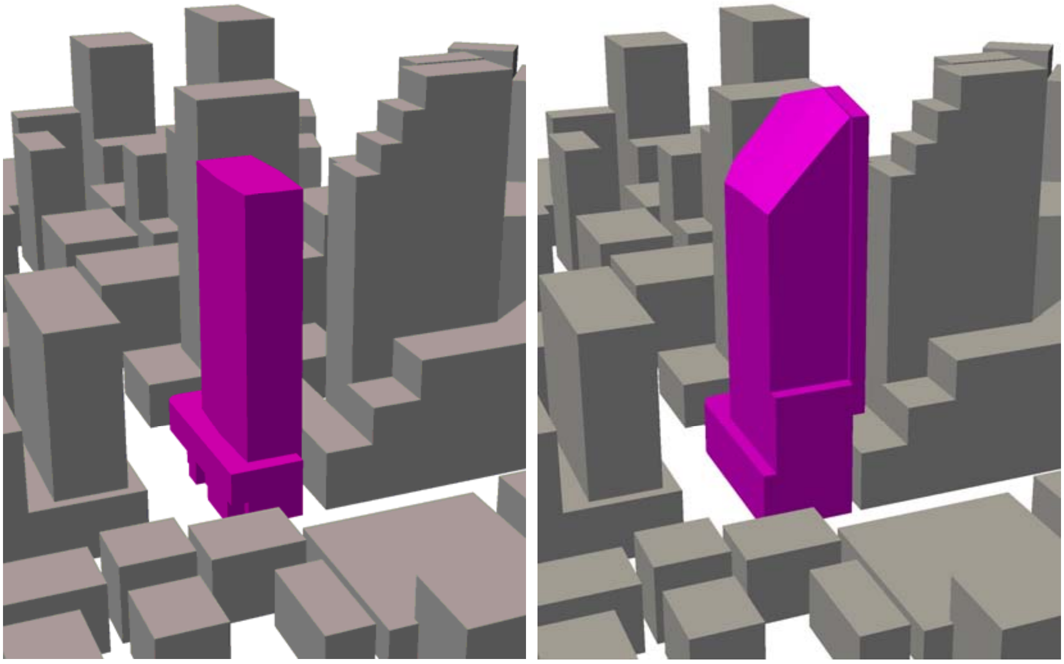

Figure 3 Simulation models for current building and proposed maximum envelope

3 Measured Wind Data

The statistical wind assessment is based on long-term weather data recorded at Sydney Kingsford Smith for the period 1995 through to 2013. The diagram below provides a summary of all measured data for this period in the form of a wind-rose, which clearly indicates that the strongest and most frequent winds are from the south with secondary winds from the north-east and north-west.

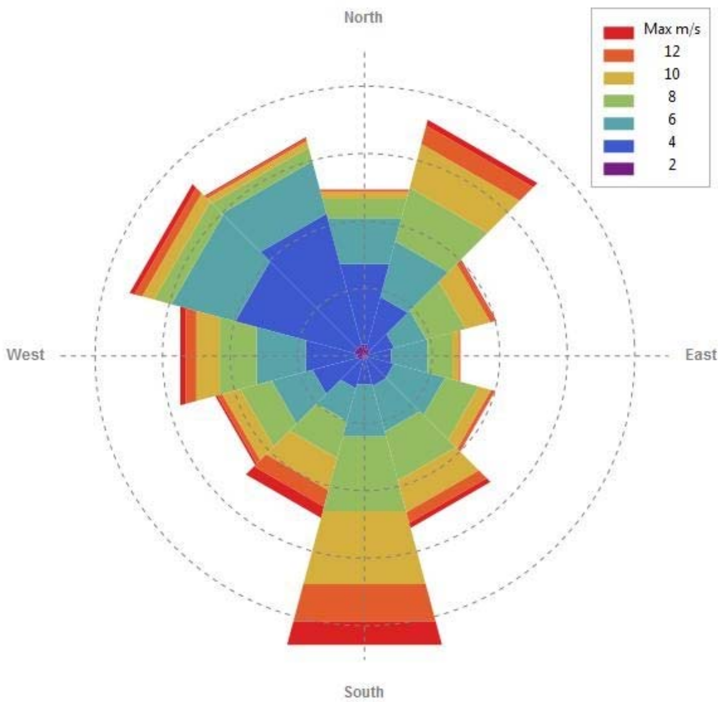

Figure 4 Annual wind rose for data sourced from Sydney Kingsford Smith (1995 through to 2013)

The measured wind data has been processed using an industry-standard approach assuming a Weibull approximation to the statistical wind distribution for each wind direction. The subsequent analysis of wind speed probability is based on this statistical analysis.

The Weibull wind distributions have been transformed from the airport to the site to account for the effects of terrain roughness. The wind transformation has been done in accordance with a well-established approach developed by the UK-based engineering advisory organisation, ESDU.

The methodology for generating wind statistics based on long-term measured data and then transforming this information from the meteorological site to the reference location near the building is identical to the approach used when undertaking a wind-tunnel assessment.

4 Numerical Wind

The assessment provided in this report is based on computer simulation of wind flow through the city of Sydney and around the proposed development. The type of software used for this purpose, generally called computational fluid dynamics (CFD), has a long history of application in the aerospace and automotive industries. The accuracy and functionality of CFD software is continually improving and it now finds useful application in a diverse range of industrial applications.

CFD is finding useful application in some specific areas of architectural aerodynamics including the assessment of environmental wind conditions. A number of recent academic studies have looked closely at the strengths and weaknesses of CFD for this purpose and concluded that it provides a valid assessment approach so long as it is used in accordance with best-practice methodologies. CFD can be used to predict the key characteristics of wind flows in urban environments that cause wind nuisance including downdrafts, corner flows, passage flows etc. and is generally most accurate in predicting areas of relatively high-wind speed, thus making it well-suited to evaluating environmental wind conditions that have the strongest effect on wind discomfort (Blocken, et al., 2012) (Blocken, et al., 2011).

Arup have used the recommended best practice approach to wind modelling described in *Best Practice Guideline for the CFD simulation of flows in the urban environment* produced as part of European intergovernmental research organisation COST action 732 (Franke, et al., 2007). A steady state, RANS approach is used for the assessment, which is compatible with the best practice guidelines and in accordance with the methods used by Blocken et al for environmental wind assessment.

The steady-state approach is compatible with the wind speed criterion based on mean hourly wind speeds as used in this assessment when the prediction of wind gustiness is not required. Further this environmental wind assessment is a comparative analysis, comparing the existing building with the proposed maximum envelope LEP amendment condition. The nature of this comparative analysis ensures that a consistent level of accuracy is achieved across all of the different massing options.

A key advantage offered to designers using CFD is the ability to visualise wind speeds in three-dimensional space and also being able to undertake rapid design iterations. Compared to wind tunnel testing, CFD provides the ability to map the whole flow field rather than discrete measuring locations. This provides the designer with the ability to generate cross-sectional data and wind streamlines, both of which are useful in aiding the understanding of wind effects and being able to identify design solutions and appropriate wind mitigation strategies.

Vegetation in the streetscape and surrounding parks has been excluded from the analysis due to limitations with CFD being able to accurately model their effect. In general, vegetation has a beneficial effect by reducing wind speeds and consequently some conservatism is built into the CFD assessment.

Overall it is expected that this comparative analysis will be more conservative than wind tunnel testing and appropriate for this stage in the development process. In following development applications wind tunnel testing will be used to confirm environmental wind patterns and the specific environmental conditions as well as specific wind mitigation measures.

5 Environmental Wind Speed Criteria

The wind environment becomes less comfortable as wind speeds increase; particular wind speed ranges are considered appropriate for different uses. Above a certain threshold, higher wind speeds start to cause distress and can potentially create unacceptable wind conditions. The choice of wind speed criteria tends to vary from one region to the next; however, the generally accepted approach for Sydney is outlined in Table 1 and Table 2 below. This approach has formed the basis of our assessment.

Table 1: Criteria for wind comfort

Mean hourly wind speed exceeded 5% of the time [m/s]	
<2	Outdoor fine dining
2-4	Long periods of standing of sitting
4-6	Short periods of sitting or standing
6-8	Leisurely walking or window shopping
8-10	Fast or business walking
> 10	Uncomfortable for all uses

Table 2: Criteria for wind distress

Mean hourly wind speed exceeded 0.022% of the time (twice per year) [m/s]	
<15	General access
15-20	Acceptable for able-bodied persons (not frail or cyclists)
>20	Unacceptable

A review of the wind statistics indicates that mean wind speed at 10m at the airport is around 6m/s. Transformed to the site at a typical pedestrian height, the mean wind speed is expected to be in the order 3.5m/s with a 5% exceedance speed around 6m/s in a location away from local building effects. This generally indicates suitability for outdoor activities involving short periods of sitting and standing as per the criteria outlined above and in general agreement with direct experience of the Sydney wind climate.

6 Assessment Results

The following graphics provide contour plots of relative wind speed from *low* to *high* on a section plane at pedestrian height through the area of interest around the site. The *low* end of the relative wind speed range covers areas that are acceptable for sitting and standing activities, the *high* end of the range covers areas that are more suited as a general thoroughfare where pedestrians have a clear objective in walking from one place to another such as business walking.

Results are presented for the current building and the proposed maximum envelope.

Phillip Street

- For the proposed maximum envelope, wind conditions on Phillip Street to the north of 60 Martin Place are not expected to change significantly from the existing situation. Areas that are currently identified as having higher wind speeds will remain so and the pedestrian experience is not expected to change.

Martin Place

- Increased wind speeds are expected close to the base of the podium at the corner of Phillip Street and Martin Place. Wind conditions in this location are influenced by the reduced tower setback, increased façade area facing west and absence of corner cut-outs. This area would be appropriate as a general thoroughfare - activities or uses that include extended periods of sitting and standing may be made possible through the inclusion of mitigation measures in any future design (as discussed in Section 7 below).

- For the proposed maximum envelope, no significant changes are expected along Martin Place between Philip Street and Macquarie Street away from the podium corners; this area is expected to remain suitable for its current use. There should not be a noticeable change in wind environment in front of the Reserve Bank which is expected to remain suitable for its current purpose as a general thoroughfare.

Macquarie Street

- For the proposed maximum envelope, conditions are expected to be windier in the area approaching the intersection with Martin Place. Wind conditions in this location are influenced by the reduced tower setback, increased street wall height and increased façade area facing east, which generates stronger downdrafts and corner wind flows. This area would be appropriate as a general thoroughfare which is consistent with how the area is currently used. Activities or uses that include extended periods of sitting and standing may be may be made possible through the inclusion of mitigation measures in any future design (as discussed in Section 7 below).
- The area immediately adjacent to Sydney Hospital is unlikely to change significantly although there may be some impact further north along Macquarie Street.

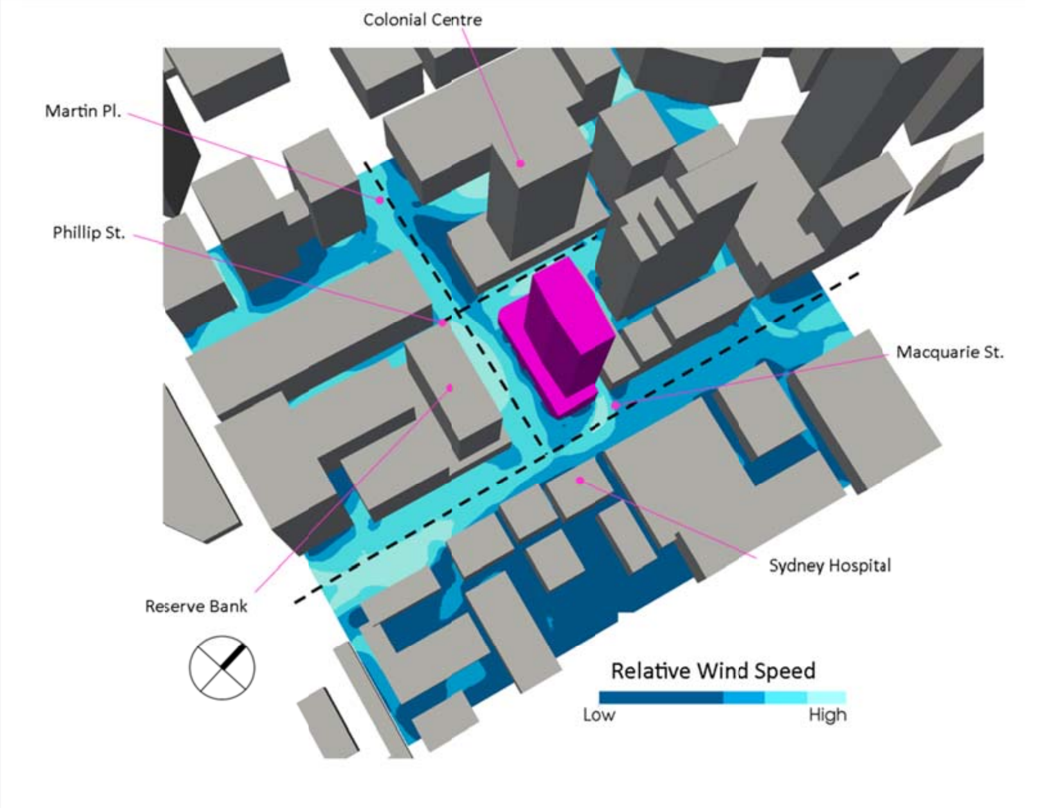

Figure 5 Relative wind speed – existing building

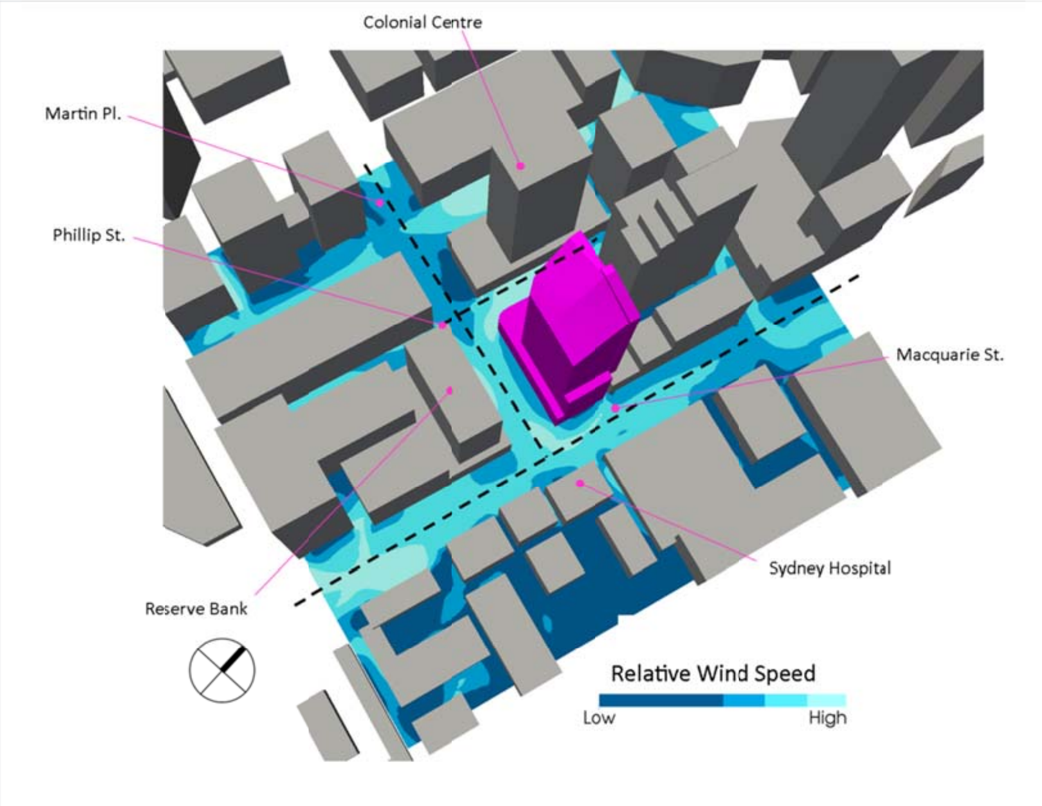

Figure 5 Relative wind speed – maximum envelope

7 Design Opportunities

For the proposed maximum envelope there is likely to be a general increase in wind speed as a result of the reduced podium setback, increased street wall height and increased façade areas facing east and west.

Wind conditions expected to change significantly at the podium corners close to the intersections of Martin Place with Philip Street and Macquarie Street; this change is caused by stronger downdrafts and corner wind flows that are associated with the increased massing, reduced podium and absence of corner cut-outs. The area further north along Macquarie Street is also expected to see some increase in wind speeds. All other locations are expected to experience less significant changes,

The proposed maximum envelope is appropriate so long as wind mitigation strategies are considered as part of any future design development. It is reasonable to expect that the incorporation of sensible and practical wind mitigation strategies will be able to reduce environmental wind speeds such that they are comparable with the current condition and thus remain acceptable for use as a general thoroughfare and suitable for fast and/or business walking.

Some of the following mitigation measures may be further considered during the development of design options for Stage 2 DA.

- Introducing articulation and corner cut-outs for the tower and podium massing in strategic locations, such as the south-east and south-west corners.

- Recessing the building at the base of the tower where it intersects with the podium, particularly on the east elevation where the higher street wall is currently proposed.
- Introducing canopies at street level and substantial parapet screens around the podium to prevent wind downdrafts from reaching ground level.
- Introducing planting and/or screens at pedestrian level to reduce local wind speeds.

CFD assessment provides sufficient confidence in the expected change in wind conditions and impact on the pedestrian level wind environment. CFD will be used to further refine the design as part of the Stage 2 DA process to assess future design schemes. This will be confirmed with physical testing to provide an accurate quantitative assessment and confirm the environmental wind performance against the defined acceptance thresholds.

8 Bibliography

Blocken, B., Janssen, W. D. & van Hooff, T., 2012. CFD simulation for pedestrian wind comfort and wind safety in urban areas: General decision framework and case study for the Eindhoven University Campus. *Environmental Modelling & Software,* Volume 30, pp. 15-34.

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