PEDESTRIAN WIND ENVIRONMENT STATEMENT

173-179 WALKER STREET AND 11-17 HAMPDEN STREET, NORTH SYDNEY (PLANNING PROPOSAL SUBMISSION)

WD816-04F02(REV2)- WS REPORT

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Prepared for:

Avenor

Level 17, 9 Castlereagh Street

Sydney NSW, 2000

WINDTECH Consultants Pty Ltd
Head Office: 607 Forest Road, Bexley, NSW 2207, Australia
P +61 2 9503 0300 **E** reception@windtechglobal.com **W** www.windtechconsult.com

Sydney | Abu Dhabi | London | Melbourne | Mumbai | New York | Hong Kong | Singapore

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EXECUTIVE SUMMARY

This report is in relation to the proposed development located at 173-179 Walker Street & 11-17 Hampden Street, North Sydney and presents an opinion on the likely impact of the proposed design on the local wind environment on the critical outdoor areas within and around the subject development. The effect of wind activity is examined for the three predominant wind directions for the Sydney region; namely the north-easterly, southerly and westerly winds. The analysis of the wind effects relating to the proposed development was carried out in the context of the local wind climate, building morphology and land topography.

The conclusions of this report are drawn from our extensive experience in this field and are based on an examination of the latest architectural drawings. No wind tunnel testing has been undertaken for the subject development, and hence this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection. Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects.

The results of this assessment indicate that the subject development benefits from shielding provided by the subject and neighbouring buildings. There are however several outdoor trafficable areas within and around the subject development precinct that are potentially exposed to a variety of adverse wind effects due to the interaction of the prevailing winds with the built form and detailed further within the report. It is expected that the wind effects identified in the report can be ameliorated with the consideration of the following treatment strategies into the design of the development:

Ground Level Outdoor Trafficable Areas:

- Densely foliating street trees along the Walker Street and Hampden Street frontages of the precinct; in particular around the corners of the building.
- Impermeable awnings along the Walker Street and Hampden Street frontages of the precinct.
- Retention of the existing street trees along the Hampden Street frontage of the precinct.
- Densely foliating vegetation such as trees or shrubs/hedge planting within and around the Hampden Street Pocket Park; in particular along the northern and eastern boundary.
- Localised densely foliating vegetation such as trees or shrubs/hedge planting around the proposed outdoor seating areas along Walker Street and the Hampden Street Pocket Park.

- Densely foliating vegetation such as trees or shrubs/hedge planting along the eastern boundary of the communal open space fronting the M1 Motorway; in particular around the corners of the building.
- Densely foliating vegetation such as trees or shrubs/hedge planting along the western and southern boundary of the communal open space fronting Walker Street.
- Localised screening, pergolas or densely foliating vegetation such as trees or shrubs/hedge planting within and around the remaining areas of the communal open space; in particular areas intended for short duration stationary activities such as outdoor seating etc.
- Restrict areas intended for short duration stationary activities such as outdoor seating, away from the corner areas of the building.

Private Balconies:

- Protruding single aspect balconies – Blade walls or operable louver screens along one or both of the exposed short perimeter edges of the balconies.
- Corner private balconies – Blade walls or operable louver screens along one or both of the exposed perimeter edges of the balconies.

Trafficable Rooftop Areas:

- The various rooftop areas of the subject building are assumed to be communal areas trafficable by the occupants of the development.
- Impermeable screens along the exposed perimeter edges of the various rooftops.
- Impermeable awnings along the building façade facing onto the various rooftops.
- Localised screening, pergolas or densely foliating vegetation such as trees or shrubs/hedge planting within and around various rooftops; in particular areas intended for short duration stationary activities such as outdoor seating etc.
- Restrict areas intended for short duration stationary activities such as outdoor seating, away from the corner areas of the building.

The suggested treatment strategies detailed above are also applicable for the Special Provisions Reference Design and Separate Landholdings Reference Design of the subject development. Furthermore, as a general note, the use of loose glass-tops and light-weight sheets or covers (including loose BBQ lids) is not appropriate on high-rise outdoor balconies or terraces. Lightweight furniture is not recommended unless it is securely attached to the balcony or terrace floor slab.

Due to the overall massing of the subject development and the complexity of the building form, wind tunnel testing is recommended to be undertaken as part of the detailed design phase. This

will provide a quantitative analysis of the wind conditions and determine the size and extent of the treatments required to ensure suitable wind conditions are achieved at all outdoor pedestrian accessible locations within and around the development.

CONTENTS

1 INTRODUCTION

An opinion on the likely impact of the proposed design on the local wind environment affecting pedestrians within the critical outdoor areas within and around the subject development is presented in this report. The analysis of wind effects relating to the proposed development has been carried out in the context of the predominant wind directions for the region, building morphology of the development and nearby buildings, and local land topography. The conclusions of this report are drawn from our extensive experience in the field of wind engineering and studies of wind environment effects.

No wind tunnel testing has been undertaken for this assessment. Hence this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection, and any recommendations in this report are made only in-principle.

2 DESCRIPTION OF THE DEVELOPMENT AND SURROUNDINGS

The proposed development precinct is located in North Sydney, bounded by Walker Street to the west, Hampden Street to the north, M1 Motorway to the east, and medium to high rise buildings varying up to 21 storeys to the south. Across Walker Street to the west of the subject development is an 18 storey apartment building (Belvedere, 138 Walker Street). Further away from the precinct to the north and east are predominantly low to mid-rise residential buildings and single to double storey housing units. St Leonards Park is situated to the north of the subject development beyond the block. Further away from the precinct to the west through to south are predominantly medium to high-rise buildings. A survey of the land topography indicates a general rise in elevation towards the southern and western directions. An aerial image of the subject precinct and the local surroundings is shown in Figure 1.

The Reference Design of the proposed development is a 24 storey high "L" shaped building comprised of 24 storeys in a staggered design with the peak located at the centre of the Walker Street frontage, with an additional 18 storey high tower at the north-eastern corner of the precinct. Vehicular access is provided off Walker Street and Hampden Street. Two alternative reference designs are also proposed for the proposed development that are detailed as follows:

- Special Provisions Reference Design: A 29 storey high "L" shaped building in a staggered design with the peak towards the north of the precinct.
- Separate Landholdings Reference Design: A 24 storey high "L" shaped building comprised of 24 storeys in a staggered design with the peak located at the centre of the precinct, with a similar configuration to the Reference Design, without the 18 storey tower at the north-eastern corner of the precinct.

The design of the proposed development is still in its concept design phase, hence the assessment has assumed the following outdoor areas to be trafficable within and around the development precinct for all three Reference Designs:

- Ground floor pedestrian footpaths and seating areas along the Walker Street and Hampden Street frontages of the precinct.
- The Hampden Street Pocket Park.
- The ground level communal open space along the eastern and southern boundaries of the precinct.
- Private balconies located on the corners and along the main building façade.
- The various rooftop areas are assumed to be trafficable by the occupants of the development.

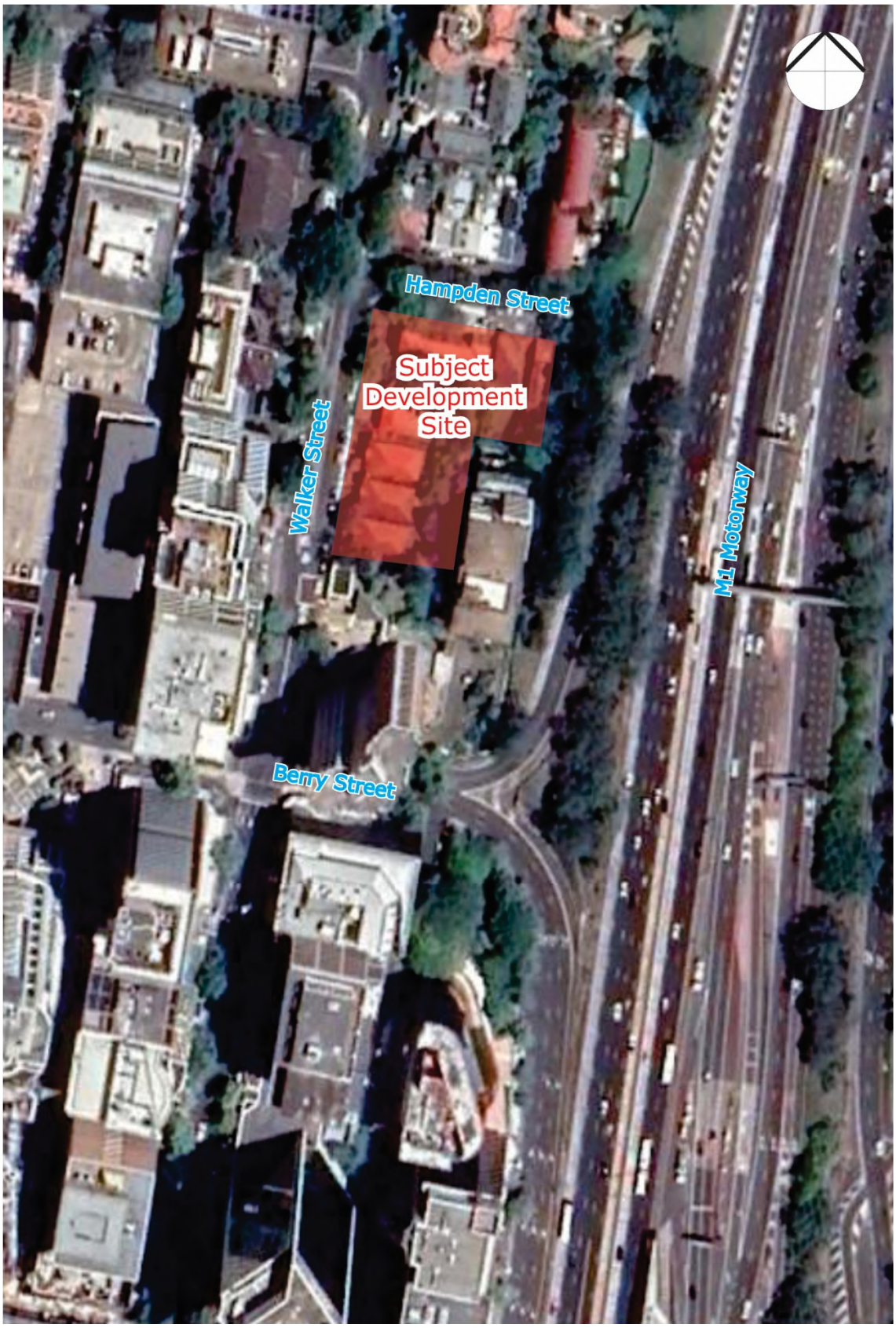

Figure 1: Aerial Image of the Precinct Location

3 REGIONAL WIND

The Sydney region is governed by three principal wind directions, and these can potentially affect the subject development. These winds prevail from the north-east, south and west. A summary of the principal time of occurrence of these winds throughout the year is presented in Table 1 below. This summary is based on a detailed analysis undertaken by Windtech Consultants of recorded directional wind speeds obtained at the meteorological station located at Kingsford Smith Airport by the Bureau of Meteorology (recorded from 1995 to 2016). From this analysis, directional probabilities of exceedance and directional wind speeds for the region are determined. The directional wind speeds and corresponding directional frequencies of occurrence are presented in Figure 2.

As shown in Figure 2, the southerly winds are by far the most frequent wind for the Sydney region, and are also the strongest. The westerly winds occur most frequently during the winter season for the Sydney region, and although they are typically not as strong as the southerly winds, they are usually a cold wind since they occur during the winter and hence can be a cause for discomfort for outdoor areas. North-easterly winds occur most frequently during the warmer months of the year for the Sydney region, and hence are usually welcomed within outdoor areas since they are typically not as strong as the southerly or westerly winds.

Table 1: Principal Time of Occurrence of Winds for the Sydney Region

Month	North-Easterly Winds	Southerly Winds	Westerly Winds
January	X	X	
February	X	X	
March	X	X	
April		X	X
May			X
June			X
July			X
August			X
September		X	X
October	X	X	
November	X	X	
December	X	X	

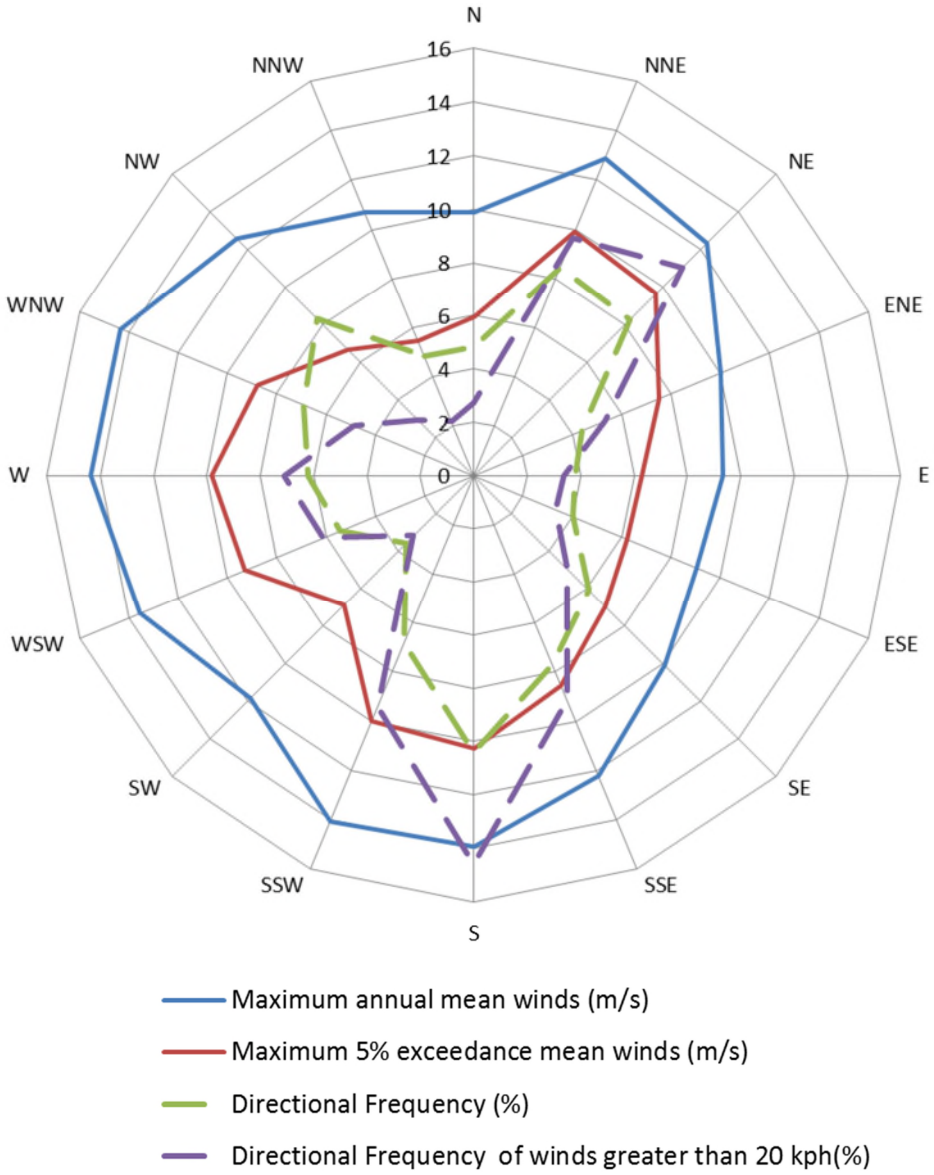

Figure 2: Annual and 5% Exceedance Hourly Mean Wind Speeds, and Frequencies of Occurrence, for the Sydney Region (referenced to 10m above ground in standard open terrain)

4 WIND EFFECTS ON PEOPLE

The acceptability of wind in any area is dependent upon its use. For example, people walking or window-shopping will tolerate higher wind speeds than those seated at an outdoor restaurant. Various other researchers, such as A.G. Davenport, T.V. Lawson, W.H. Melbourne, and A.D. Penwarden, have published criteria for pedestrian comfort for pedestrians in outdoor spaces for various types of activities. Some Councils and Local Government Authorities have adopted elements of some of these into their planning control requirements.

For example, A.D. Penwarden (1973) developed a modified version of the Beaufort scale which describes the effects of various wind intensities on people. Table 2 presents the modified Beaufort scale. Note that the effects listed in this table refers to wind conditions occurring frequently over the averaging time (a probability of occurrence exceeding 5%). Higher ranges of wind speeds can be tolerated for rarer events.

Table 2: Summary of Wind Effects on People (A.D. Penwarden, 1973)

Type of Winds	Beaufort Number	Mean Wind Speed (m/s)	Effects
Calm	0	Less than 0.3	Negligible.
Calm, light air	1	0.3 – 1.6	No noticeable wind.
Light breeze	2	1.6 – 3.4	Wind felt on face.
Gentle breeze	3	3.4 – 5.5	Hair is disturbed, clothing flaps, newspapers difficult to read.
Moderate breeze	4	5.5 – 8.0	Raises dust, dry soil and loose paper, hair disarranged.
Fresh breeze	5	8.0 – 10.8	Force of wind felt on body, danger of stumbling
Strong breeze	6	10.8 – 13.9	Umbrellas used with difficulty, hair blown straight, difficult to walk steadily, wind noise on ears unpleasant.
Near gale	7	13.9 – 17.2	Inconvenience felt when walking.
Gale	8	17.2 – 20.8	Generally impedes progress, difficulty balancing in gusts.
Strong gale	9	Greater than 20.8	People blown over.

It should be noted that wind speeds can only be accurately quantified with a wind tunnel study. This assessment addresses only the general wind effects and any localised effects that are identifiable by visual inspection and the acceptability of the conditions for outdoor areas are determined based on their intended use (rather than referencing specific wind speeds). Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects.

5 RESULTS AND DISCUSSION

The expected wind conditions are discussed in the following sub-sections of this report for the various outdoor areas within and around the subject development. The interaction between the wind and the building morphology in the area is considered and important features taken into account including the distances between the surrounding buildings and the proposed building form, as well as the surrounding landform. Note that only the potentially critical wind effects are discussed in this report. The following commentary relates to the Reference Design.

5.1 Ground Floor Outdoor Trafficable Areas

The various outdoor trafficable areas within and around the subject development precinct benefits from the shielding provided by the subject and surrounding buildings from direct wind effects when these buildings are located upstream of the prevailing wind directions. However, the outdoor trafficable areas are also potentially exposed to a variety of adverse wind effects due to the interaction of the prevailing winds with the built form detailed as follows:

- The pedestrian footpath and seating areas along the Walker Street frontage is potentially exposed to the prevailing southerly winds due to the north-south alignment of Walker Street. It should be noted that this is an existing wind condition for the precinct, however the inclusion of the subject building may induce side-stream wind effects along the building facade. The outdoor seating and entrance areas along the Walker Street frontage may be susceptible to down-wash wind effects captured off the western building façade of the development. The pedestrian footpath areas around the corner intersection of Walker Street and Hampden Street is exposed to accelerating flows around the corner of the building from the north-easterly and southerly directions.

- The pedestrian footpath and Pocket Park along the Hampden Street frontage are potentially exposed to the prevailing north-easterly winds as it travels over the M1 Motorway and around the low-rise buildings to the north of the precinct. Similarly, these areas are somewhat exposed to reattachment flows from the westerly direction as the prevailing wind travels over neighbouring buildings along Walker Street. It should be noted that these are existing wind conditions for the precinct, however the inclusion of the subject building may induce side-stream wind effects along the building facade. The pedestrian footpath and Pocket Park may be susceptible to down-wash wind effects captured off the northern building façade of the development.

- The communal open space along the southern boundary of the precinct is potentially exposed to the prevailing westerly winds as it is funnelled between the neighbouring buildings along Walker Street and reattaching onto communal open space. Similarly, the communal open space along the eastern boundary of the precinct is potentially

exposed to prevailing north-easterly winds travelling over the M1 Motorway and funnelling wind effects between the subject and neighbouring buildings.

It is expected that the potential adverse wind effects identified above can be mitigated with the consideration of the following treatment strategies into the design of the development:

- Densely foliating street trees along the Walker Street and Hampden Street frontages of the precinct; in particular around the corners of the building.
- Impermeable awnings along the Walker Street and Hampden Street frontages of the precinct.
- Retention of the existing street trees along the Hampden Street frontage of the precinct.
- Densely foliating vegetation such as trees or shrubs/hedge planting within and around the Hampden Street Pocket Park; in particular along the northern and eastern boundary.
- Localised densely foliating vegetation such as trees or shrubs/hedge planting around the proposed outdoor seating areas along Walker Street and the Hampden Street Pocket Park.
- Densely foliating vegetation such as trees or shrubs/hedge planting along the eastern boundary of the communal open space fronting the M1 Motorway; in particular around the corners of the building.
- Densely foliating vegetation such as trees or shrubs/hedge planting along the western and southern boundary of the communal open space fronting Walker Street.
- Localised screening, pergolas or densely foliating vegetation such as trees or shrubs/hedge planting within and around the remaining areas of the communal open space; in particular areas intended for short duration stationary activities such as outdoor seating etc.
- Restrict areas intended for short duration stationary activities such as outdoor seating, away from the corner areas of the building.

Due to the overall massing of the subject development and the complexity of the building form, wind tunnel testing is recommended to be undertaken as part of the detailed design phase. This will provide a quantitative analysis of the wind conditions and determine the size and extent of the treatments required to ensure suitable wind conditions are achieved at all outdoor pedestrian accessible locations within and around the development.

5.2 Private Balconies

Wind conditions for single aspect private balconies along the main building facades that are recessed into the build form are expected to be suitable for their intended uses as it limits the ability for the prevailing winds to side-stream across them.

Conversely for single aspect private balconies that are protruding on the main building facades are susceptible to side-stream wind effects. The protruding balconies are also potentially exposed to direct wind effects on the upper floor levels where the surrounding buildings offer little to no shielding to the prevailing winds.

Corner private balconies are exposed to the prevailing winds accelerating flows around the corners of the building as well as potentially direct wind effects on the upper floor levels where the surrounding buildings offer little to no shielding to the prevailing winds. Larger corner private balconies that wrap around and extend further along the building façade are also potentially exposed to side-stream winds travelling along the building façade and reattaching onto the balconies.

To ensure suitable wind conditions is achieved within the various private balconies, the following treatment strategies are recommended to be considered in the design of the development:

- Protruding single aspect balconies – Blade walls or operable louver screens along one or both of the exposed short perimeter edges of the balconies.
- Corner private balconies – Blade walls or operable louver screens along one or both of the exposed perimeter edges of the balconies.

Furthermore, as a general note, the use of loose glass-tops and light-weight sheets or covers (including loose BBQ lids) is not appropriate on high-rise outdoor balconies or terraces. Lightweight furniture is not recommended unless it is securely attached to the balcony or terrace floor slab.

Nonetheless, due to the overall height of the subject development relative to the surrounding buildings, and the exposure of the development to the prevailing winds, it is recommended to verify the effectiveness of these suggested treatment strategies by wind tunnel testing at a more detailed design stage.

5.3 Trafficable Rooftop Areas

The various rooftop areas of the subject building are assumed to be communal areas trafficable by the occupants of the development. The various rooftop areas are potentially exposed to a variety of adverse wind effects due to the interaction of the prevailing winds with the built form detailed as follows:

- Direct wind effects from the prevailing wind directions due to the lack of shielding provided by surroundings buildings at the various rooftop areas elevated position.
- The prevailing north-easterly and southerly winds down-washing off the northern and building facades respectively onto the various rooftop areas.
- The prevailing winds accelerating flows around the corners of the building onto the various rooftop areas.
- Funnelling wind effects between the two towers of the subject development precinct onto the Level 8 rooftop area at the north-eastern corner of the precinct.
- Down-wash wind effects captured the western building façade of the north-eastern corner tower onto the Level 8 rooftop area below.

It is expected that the potential adverse wind effects identified above can be mitigated with the consideration of the following treatment strategies into the design of the development:

- Impermeable screens along the exposed perimeter edges of the various rooftops.
- Impermeable awnings along the building façade facing onto the various rooftops.
- Localised screening, pergolas or densely foliating vegetation such as trees or shrubs/hedge planting within and around various rooftops; in particular areas intended for short duration stationary activities such as outdoor seating etc.
- Restrict areas intended for short duration stationary activities such as outdoor seating, away from the corner areas of the building.

Due to the overall massing of the subject development and the complexity of the building form, wind tunnel testing is recommended to be undertaken as part of the detailed design phase. This will provide a quantitative analysis of the wind conditions and determine the size and extent of the treatments required to ensure suitable wind conditions are achieved at all outdoor pedestrian accessible locations within and around the development.

5.4 Commentary on the Special Provisions Reference Design

The down-wash wind effects off the western building facade onto the ground level trafficable areas along Walker Street are expected to be further concentrated closer to the northern areas along Walker Street due to the relocated position of the tower in the Special Provisions Reference Design. The down-wash wind effects off the northern building facade onto the ground level trafficable areas along Hampden Street are expected to be less for the Special Provisions Reference Design due to the reduced surface area that was contributed by the tower at the north-eastern corner of the precinct in the reference design. The Level 9 rooftop area along the Hampden Street frontage will benefit from the additional shielding provided by relocated tower component of the development, however the rooftop area is now susceptible to the accelerating flows around the north-eastern corner of the tower. Furthermore, the Special Provisions Reference Design introduces an additional rooftop area along the southern boundary of the tower on Level 9 that is susceptible to direct wind effects from the prevailing wind directions and accelerating flows around the southern corners of the tower.

The wind conditions within the remaining outdoor trafficable areas within and around the precinct are expected to be similar to those identified for the primary concept design. The treatment strategies suggested for the primary concept design are expected to be effective in wind mitigation for the Special Provisions Reference Design. Hence, they are recommended to be considered for the Special Provisions Reference Design.

5.5 Commentary on the Separate Landholdings Reference Design

The down-wash wind effects off the northern building facade onto the ground level trafficable areas along Hampden Street are expected to be less for the Separate Landholdings Reference Design due to the reduced surface area that was contributed by the tower at the north-eastern corner of the precinct in the Reference Design. The funnelling wind effect on the Level 8 rooftop area is reduced without the 18 storey high tower at the north-eastern corner of the precinct. The Level 8 rooftop area however is still susceptible to accelerating flows around the corner of the tower.

The wind conditions within the remaining outdoor trafficable areas within and around the precinct are expected to be similar to those identified for the primary concept design. The treatment strategies suggested for the primary concept design are expected to be effective in wind mitigation for the Separate Landholdings Reference Design. Hence, they are recommended to be considered for the Separate Landholdings Reference Design.

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