PEDESTRIAN WIND ENVIRONMENT STATEMENT

CHERRYBROOK STATION GOVERNMENT LAND STATE SIGNIFICANT PRECINCT

WF580-02F01(REV2)- WS REPORT

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Prepared for:

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EXECUTIVE SUMMARY

This report presents an opinion on the likely impact of the proposed Cherrybrook Station reference scheme, located within the Cherrybrook Station State Significant Precinct, on the local wind environment at 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 region: namely the north-easterly, south-easterly sector 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 illustrative reference scheme drawings. No wind tunnel testing was 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 is relatively exposed to the three prevailing wind directions. As a result, there is a potential for wind impacts on the wind comfort for pedestrian trafficable areas within and around the site. Future developments around this precinct could reduce prevailing wind exposure.

The general design of the reference scheme incorporates several beneficial features to reduce the effect of the prevailing wind impacts. These include the following:

- The provision for landscaping in the form of trees and shrubs throughout the Village square, Community gathering space, communal open spaces and ground level areas within and around the site.
- Existing Blue Gum High Forest to the north-east of the Environmental open space.
- Awnings over the ground level around the base of the tower forms.
- Chamfered or rounded building corners.
- Varied orientations of the building forms to avoid alignment with prevailing winds.

Further specific treatment strategies can be developed at a later more detailed design stage to further improve wind conditions where required for longer duration stationary activities. Examples of these are summarised as follows:

- Additional densely foliating evergreen landscaping for areas where winds are expected to funnel or side stream, such as communal open spaces or through site links that are situated between two buildings. Where planting cannot be utilised, the inclusion of localised screening, placing awnings to deflect downwashing winds away from pedestrian trafficable areas to lessen this wind effect is recommended.

- The inclusion of densely foliating evergreen landscaping, permanent screening or operable screening where the prevailing winds are expected to interact with building corners.
- The inclusion of awnings, canopies or densely foliating evergreen trees where winds are expected to downwash from facades onto footpaths or communal open spaces.
- The inclusion of high impermeable balustrades or densely foliating evergreen landscaping for areas that are exposed to directly impacting winds.

With the inclusion of these considerations in the detailed design of the development, wind conditions within outdoor trafficable areas of the development are expected to be suitable for their intended uses.

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1 INTRODUCTION

1.1 Overview

This study relates to a proposal to develop land called the 'Cherrybrook Station Government Land State Significant Precinct' (the State Significant Precinct) by Landcom on behalf of the landowner, Sydney Metro. The State Significant Precinct is centred around Cherrybrook Station on the Metro North West Line. The Metro North West Line delivers a direct connection with the strategic centres of Castle Hill, Norwest, Macquarie Park and Chatswood. It covers 7.7 hectares of government-owned land that comprises the Cherrybrook Station, commuter carpark and station access road (Bradfield Parade) and vacant land to the east of the station (referred to as the Developable Government Land) (DGL). It is bound by Castle Hill Road (south), Franklin Road (south east) and Robert Road (north west).

As a State Significant Precinct, the Minister for Planning and Public Spaces (the Minister) has determined that it is of State planning significance and should be investigated for rezoning. This investigation will be carried out in accordance with study requirements issued by the NSW Department of Planning, Industry and Environment (now Department of Planning and Environment (DPE)) in May 2020. These study requirements were prepared in collaboration with Hornsby Shire Council and The Hills Shire Council.

The outcome of the State Significant Precinct process will be new planning controls. This will enable the making of development applications to create a new mixed-use local centre to support Cherrybrook Station and the needs of the local community.

At the same time, DPE is also working with Hornsby Shire and The Hills Shire Councils, as well as other agencies such as Transport for NSW, to undertake a separate planning process for a broader area called the Cherrybrook Precinct. Unlike the State Significant Precinct, the outcome of this process will not be a rezoning. Instead, it will create a Place Strategy that will help set the longer term future for this broader area. Landcom will be consulted as part of this process.

Figure A illustrates the site boundaries of the State Significant Precinct and the Cherrybrook Precinct.

Figure A: Cherrybrook Precinct and Cherrybrook Station State Significant Precinct (subject of this proposal) (Source: NSW Department of Planning & Environment)

1.2 Purpose

The purpose of this study is to address the relevant study requirements for the State Significant Precinct, as issued by DPE. It is part of a larger, overall State Significant Precinct Study. This State Significant Precinct Study undertakes planning investigations for the precinct in order to achieve a number of objectives that are summarised as follows (refer to the State Significant Precinct Study Planning Report for a full list of the study requirements):

- facilitate a mixed-use local centre at Cherrybrook Station that supports the function of the station and the needs of the local community
- deliver public benefit through a mixed use local centre
- deliver transport and movement initiatives and benefits
- demonstrate the suitability of the site for the proposed land uses
- prepare a new planning framework for the site to achieve the above objectives.

This report serves to address Section 19 of the Study Requirements, which is the following: *Section 19.1: Consider and address potential wind impacts and amelioration approaches through the layout and arrangement of the public domain/open space and the proposed built form envelopes.*

1.3 Proposal

The proposed new planning controls for the State Significant Precinct are based on the investigations undertaken as part of the State Significant Precinct Study process. A Reference Scheme has also been prepared to illustrate one way in which the State Significant Precinct may be developed in the future under the proposed new planning controls.

The proposed planning controls comprise amendments to the Hornsby LEP 2013 to accommodate:

- Rezoning of the site for a combination of R4 High Density Residential, B4 Mixed Use and RE1 Public Recreation zoned land;
- Heights of between 18.5m – 22m;
- FSR controls of 1:1 – 1.25:1;
- Inclusion of residential flat buildings as an additional permitted use on the site in the B4 Mixed Use zone;
- Site specific LEP provisions requiring the delivery of a minimum quantity of public open space and a maximum amount of commercial floor space; and
- New site-specific Design Guide addressing matters such as open space, landscaping, land use, built form, sustainability and heritage.

The Reference Scheme (refer to Figure B) seeks to create a vibrant, transit-oriented local centre, which will improve housing choice and affordability and seeks to integrate with Hornsby's bushland character. The Reference Scheme includes the following key components:

- Approximately 33,350m^2 of residential GFA, with a yield of approximately 390 dwellings across 12 buildings ranging in height from 2 to 5 storeys (when viewed from Bradfield Parade).
- A multi-purpose community hub with a GFA of approximately 1,300m².
- Approximately 3,200m² of retail GFA.
- Over 1 hectare of public open space, comprising:
    - A village square with an area of approximately 1,250m², flanked by active retail and community uses.
    - A community gathering space with an area of approximately 3,250m².
    - An environmental space around the pond and Blue Gum High Forest with an area of approximately 8,450m^2.
- Green corridors and pedestrian through site links, providing opportunities for potential future precinct-wide integration and linkages to the north.

Parcel	*Area	Res GFA	Units	Non-Res GFA	Community	Portion FSR*
A	8,597	12,031	141	749		1.49
B	9,610	11,924	140	2,452	1,300	1.68
C	2,574	2,736	32			1.06
D	6,715	6,621	78			0.98
	27,272	33,312	391	3,201	1,300	

Notes:
Residential GBA > GFA : 75%
Non-residential GBA > GFA : 85%
Average unit size : 85m

Figure B: Reference Scheme (Source: SJB)

1.4 Wind Environment

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 was 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 was 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. At this early design stage, the advice given is general in nature and is intended to guide the ongoing development of the design. Wind tunnel testing can be undertaken at a later, more detailed design stage to provide a quantitative assessment of the wind conditions to align with the intended uses of the spaces.

2 DESCRIPTION OF THE DEVELOPMENT AND SURROUNDINGS

In the context of the wind environment, the Cherrybrook Station State Significant Precinct is bounded by a park area to the north-east and Cherrybrook Station and Commuter Car Park to the south-west. Castle Hill Road and Bradfield Parade run along the southern aspect of the site, while Franklin Road and Robert Road run along the east and west of the site, respectively. Further from the site are low-rise suburban buildings in all directions. Future developments around this precinct could reduce prevailing wind exposure.

The proposed reference scheme comprises of four 'development portions' (A, B C and D), with buildings ranging up to five storeys. The Village Square is located between portions A and B. Portion B incorporates a Library/Community Centre, Outdoor communal open spaces are located between and around the various buildings, and a natural water feature is located to the north of the site.

A survey of the local land topography around the site indicates that the terrain has a significant gradient, in the context of wind effects. The terrain rises up in all directions from the natural water feature to the north of the site. Castle Hill Road runs along the top of a ridge, sloping upwards gradually from west to east to the peak of the hill at the south-east of the site. An aerial image of the site and the local surroundings is shown in Figure 1a. The critical trafficable outdoor areas associated with the proposed development, which are the focus for pedestrian wind effects in this assessment, are detailed as follows:

- The various pedestrian footpaths and thoroughfares within and around the site
- The Village Square
- The library/community centre
- The community gathering space
- The communal open spaces between buildings
- The natural water feature and environmental open space
- The Cherrybrook Station and Commuter car park

For the purposes of this assessment, the main building forms discussed are referred to as per Figure 1b.

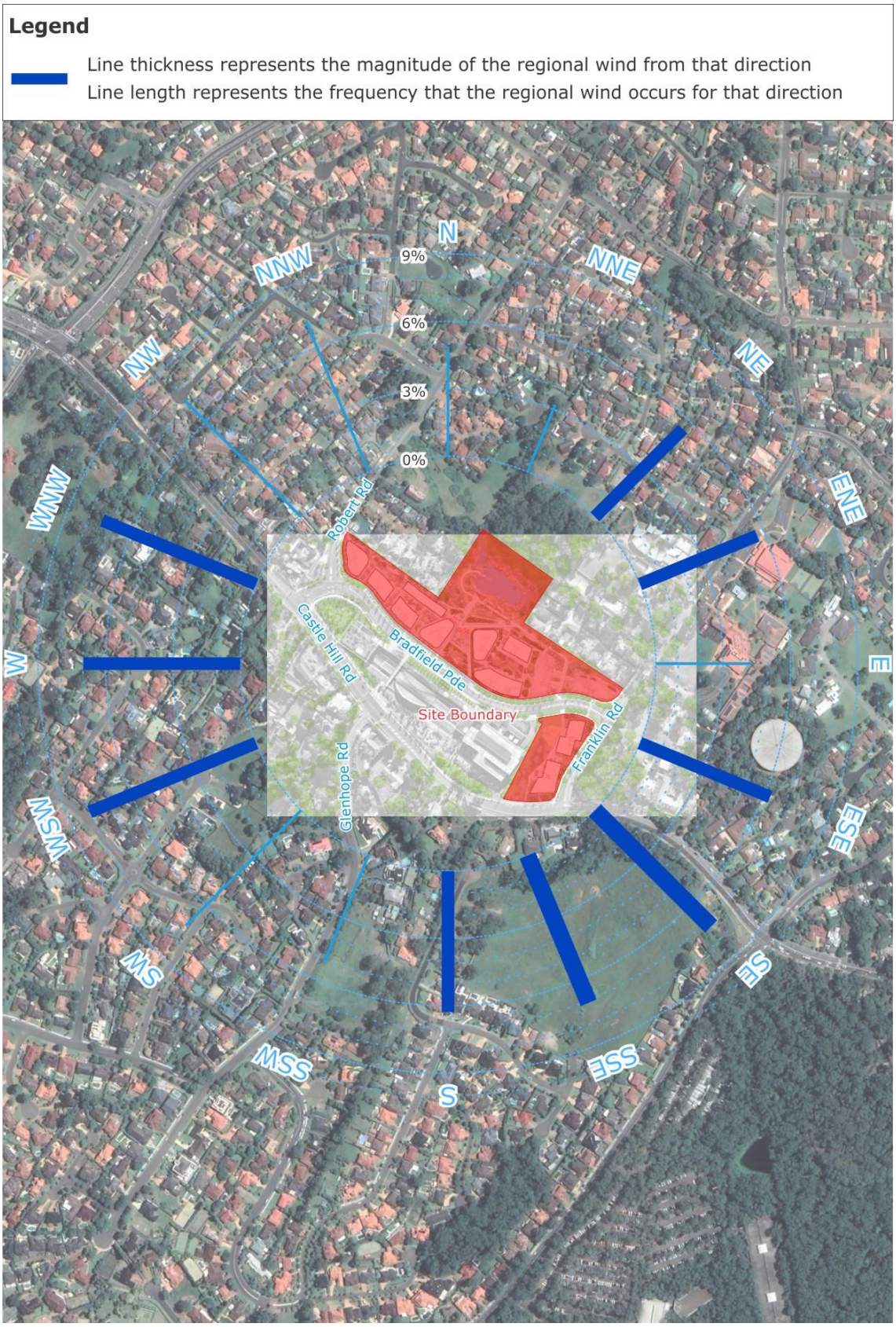

Figure 1a: Aerial Image of the Site Location

Figure 1b: Building Form Labels and number of stories

3 REGIONAL WIND

The regional wind is governed by three principal wind directions that can potentially affect the subject development. These winds prevail from the north-east, south to south-east and west. These wind directions were determined from an analysis undertaken by Windtech Consultants of recorded directional wind speeds obtained at the meteorological station located at Bankstown Airport by the Bureau of Meteorology (recorded from 1993 to 2016). The data has been corrected to represent the winds over a standard open terrain at a height of 10m above ground level. Figure 2 shows a summary of this analysis in the form of a directional plot of the annual and 5% exceedance mean winds for the Bankstown region. The frequency of occurrence of these winds is also shown in Figure 2.

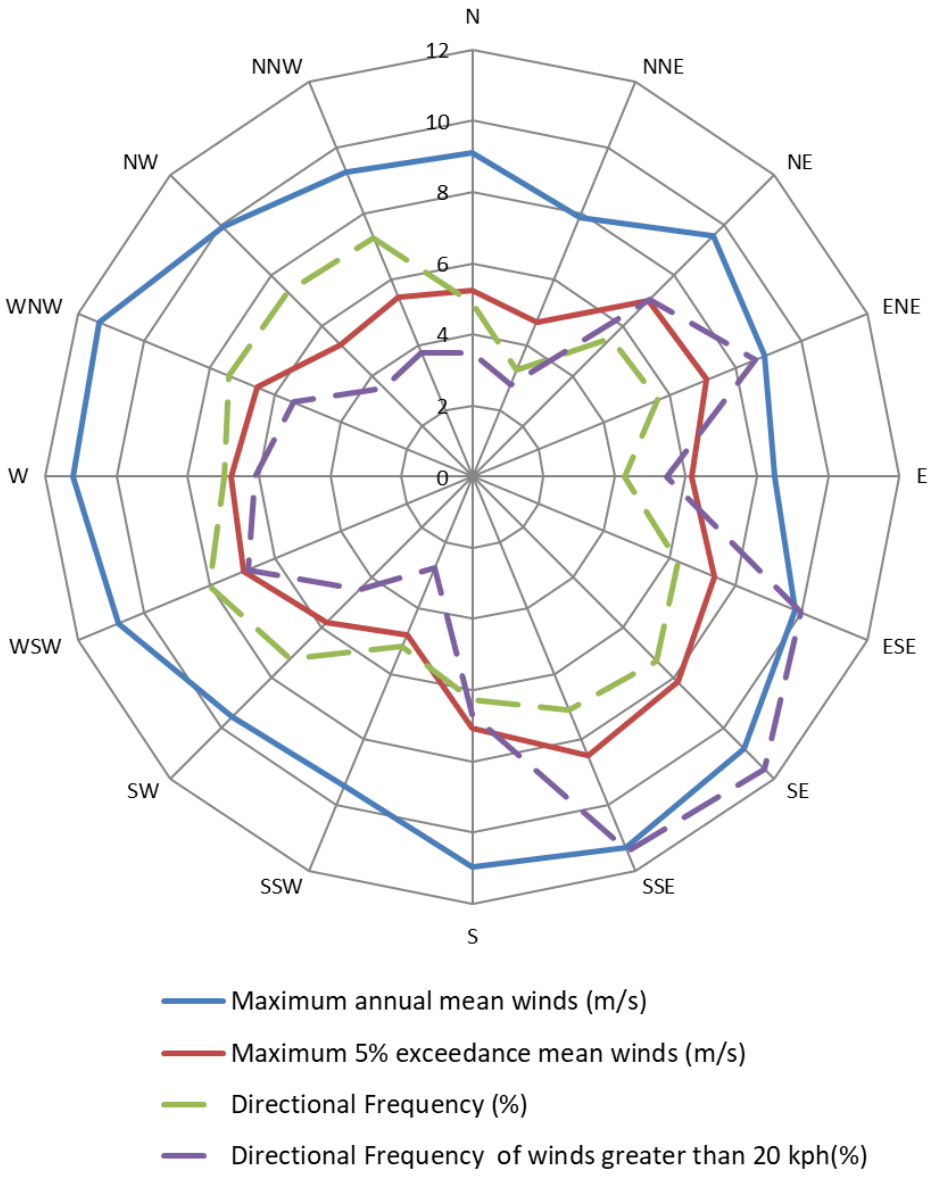

Figure 2: Annual and 5% Exceedance Hourly Mean Wind Speeds, and Frequencies of Occurrence, for the Bankstown Region

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 1 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 1: 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. 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. A glossary of the different wind effects described in this report is included in the Appendix section.

For this assessment, the wind comfort criterion that were considered as part of this assessment were the following:

- Comfortable Walking Criterion (7.5m/s with a 5% probability of exceedance) for general circulation and pedestrian thoroughfares, e.g. footpaths, private balconies/terraces, through-site links etc.
- Short Exposure Criterion (5.5m/s with a 5% probability of exceedance) for stationary activities generally less than an hour, e.g. waiting areas, communal terraces, main entries, café seating etc.
- Long Exposure Criterion (3.5m/s with a 5% probability of exceedance) for stationary activities longer than an hour, e.g. outdoor cinemas, outdoor fine dining etc.

Although this assessment is of a qualitative nature, the abovementioned comfort criteria are considered when assessing the wind environment impacts. All areas are also assessed with consideration of the 23m/s annual gust criterion for safety.

5.1 North-Easterly Winds

The north-easterly prevailing winds is expected to impact the site directly, due to the lack of significant upstream shielding. Furthermore, the rise in topography is expected to speed up the wind as it flows up the hill.

The Cherrybrook Station and the southern pedestrian trafficable footpaths along Bradfield Parade of each portion is significantly shielded by the proposed reference scheme's massing, primarily by portions A and B. The C1 building form also provides some shielding for D1 and D2.

There are, however, some hot spots that have been identified in Figure 3 which are expected to be impacted by the prevailing winds. These effects include corner acceleration around the indicated areas, as well as funnelling between each of the built forms. Some upwash is also

expected on the portion B retail podium. Some sidestreaming north-easterly winds are also expected along Franklin Road for D1 and D2.

In order to further improve conditions at the corner hot spots, treatments such as screens or landscaping to trip the wind as it accelerates around the corners of the built form are recommended to be considered. Wind sensitive uses can also be relocated away from the corners of building forms. Furthermore, to reduce the effect of funnelling, staggered vegetation can be implemented to break up the flow within the through-site links between the various buildings. Similarly, street trees and other similar forms of landscaping along the footpath is beneficial in mitigating adverse sidestreaming winds.

Short duration stationary activities are anticipated along the building façades of the central Village Square 'spine' of the site, between A5 and B1, with uses such as café seating, window shopping, retail entries etc. Additional localised screening, planting or operator-controlled screens are recommended to be implemented for any area that is expected to be used for these purposes. Landscaping on top of the retail podium is expected to improve wind conditions for the expected communal use. The other pedestrian trafficable areas such as the environmental open space and water feature areas are expected to be similar to or better than the existing site conditions.

Figure 3: North-Easterly Wind Flow and Hotspots

5.2 South-Easterly Sector Winds

The south-easterly sector winds are the most frequent for the region, and impacts the site from a range of directions, mainly from the east-south-east to south-south-east.

Some low-level direct shielding is provided by the large trees on the opposite side of Franklin Road to the east of the site as the wind crests the hill. Furthermore, the development itself provides some shielding to the downstream buildings, as well as the pedestrian trafficable areas to the north of the site, such as the community gathering space and natural water feature.

The wind hot spots have been identified in Figure 4 which are expected to be affected by south-easterly sector prevailing winds (south-easterly winds shown in the figure). These effects include corner acceleration around the indicated areas, as well as funnelling between each of the built forms. This effect is expected to be less pronounced due to the orientation of the building forms, particularly near portion A. Some downwash is also expected on the windward faces of B1, B4 and B5 however, this effect is likely to be less pronounced due to the oblique orientation of the façade aspects. Some sidestreaming south-easterly winds are also expected along Bradfield Parade.

Landscaping is recommended to ameliorate the effects of funnelling and side streaming winds, such as within the Village Square and Community gathering space. Landscaping is also recommended along the windward aspect of C1, D1, D2 and D3. Incorporating an awning can help with keeping the sidestreaming winds above the pedestrian level and will also assist in deflecting downwashing winds away from pedestrian trafficable areas, such as for B4. For areas that will be used for short or long duration stationary activities such as cafes or seating areas, localised screening planting or operable screening can be utilised. Further away from the building forms such as the community gathering space where picnic areas or other public use areas may be situated, staggered densely foliating trees and/or vegetation is expected to aid in reducing the impact of funnelling in this area.

Other areas are expected to be largely unaffected by the south-easterly winds or are expected to be better than the existing site conditions.

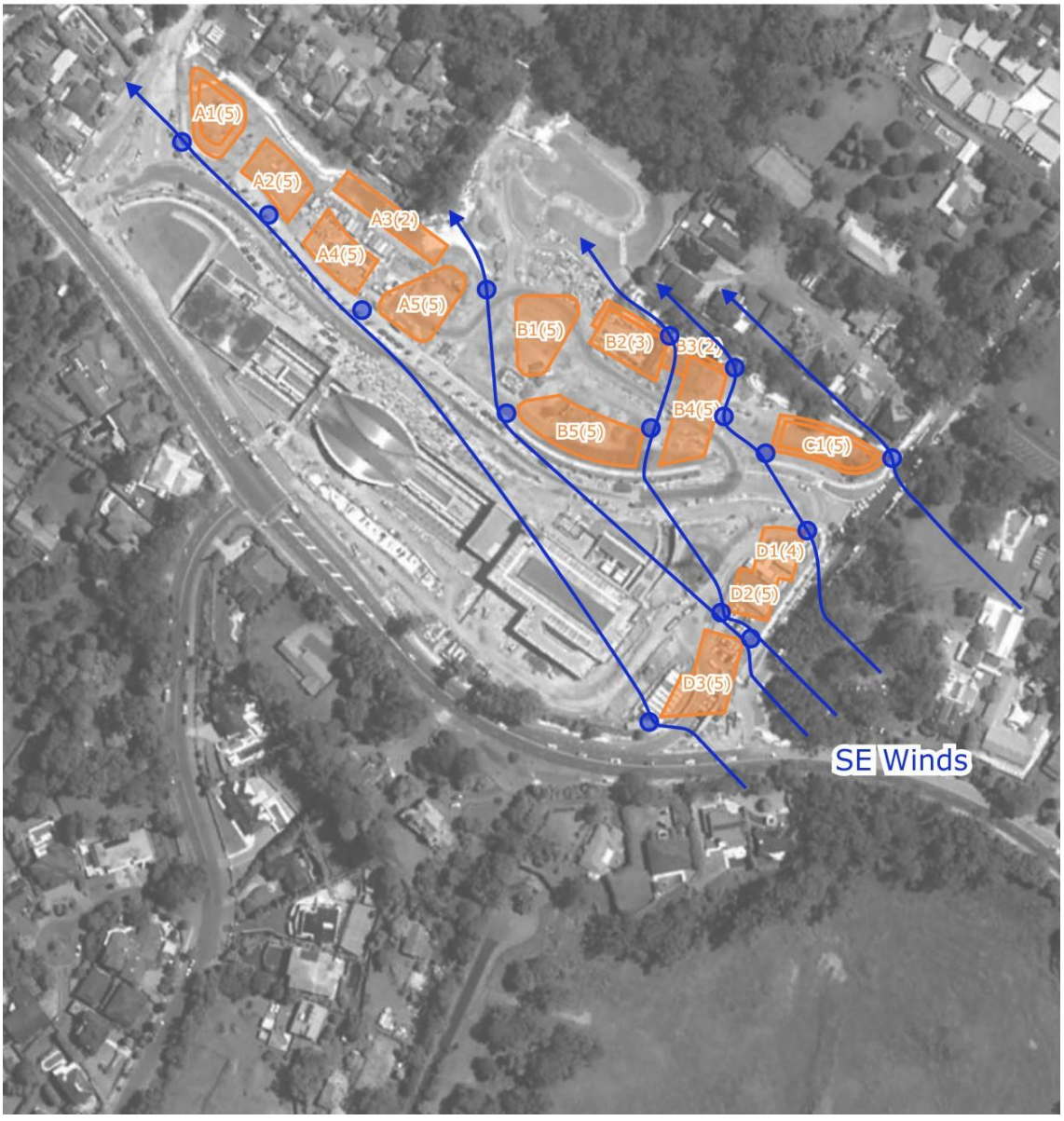

Figure 4: South-Easterly Wind Flow and Hotspots

5.3 Westerly Winds

The westerly winds, while still strong, are less frequent for the stronger winds than the south-easterly sector winds. However, they can still affect the site and cause undesirable wind conditions.

Due to the topography of the site, the Cherrybrook Station area is not expected to provide much shielding for D1, D2 and D3 as the winds accelerate up the hill.

The wind hot spots in Figure 5 are expected to be affected by westerly prevailing winds. These effects include corner acceleration around the indicated areas, as well as funnelling between each of the built forms. The downwash is minimised on the windward faces of A4, B1, B4 and B5 due to the relatively low height of the buildings. This effect combined with the corner acceleration at the south-eastern corner of A5 is expected to result in funnelling through the Village Square. Some sidestreaming south-easterly winds are also expected along Bradfield Parade.

The aforementioned adverse wind effects can be mitigated through the use of awnings that wrap around corners of the building form, extending from the façade over the ground floor (at least 2-3m to be effective). This is expected to protect areas below from any downwash effects and reduce the effect of the ensuing sidestreaming winds.

In the event that the aspects flanking the Village Square are activated, with café seating or other short duration stationary activities, it is recommended that additional localised screening, planting or operator-controlled screens along the façade be provided to further reduce the wind effect. The landscaping within and around the site is also expected to provide some further shielding throughout these areas.

The other pedestrian trafficable areas on the leeward side of the building forms are expected to be similar to or better than the existing conditions.

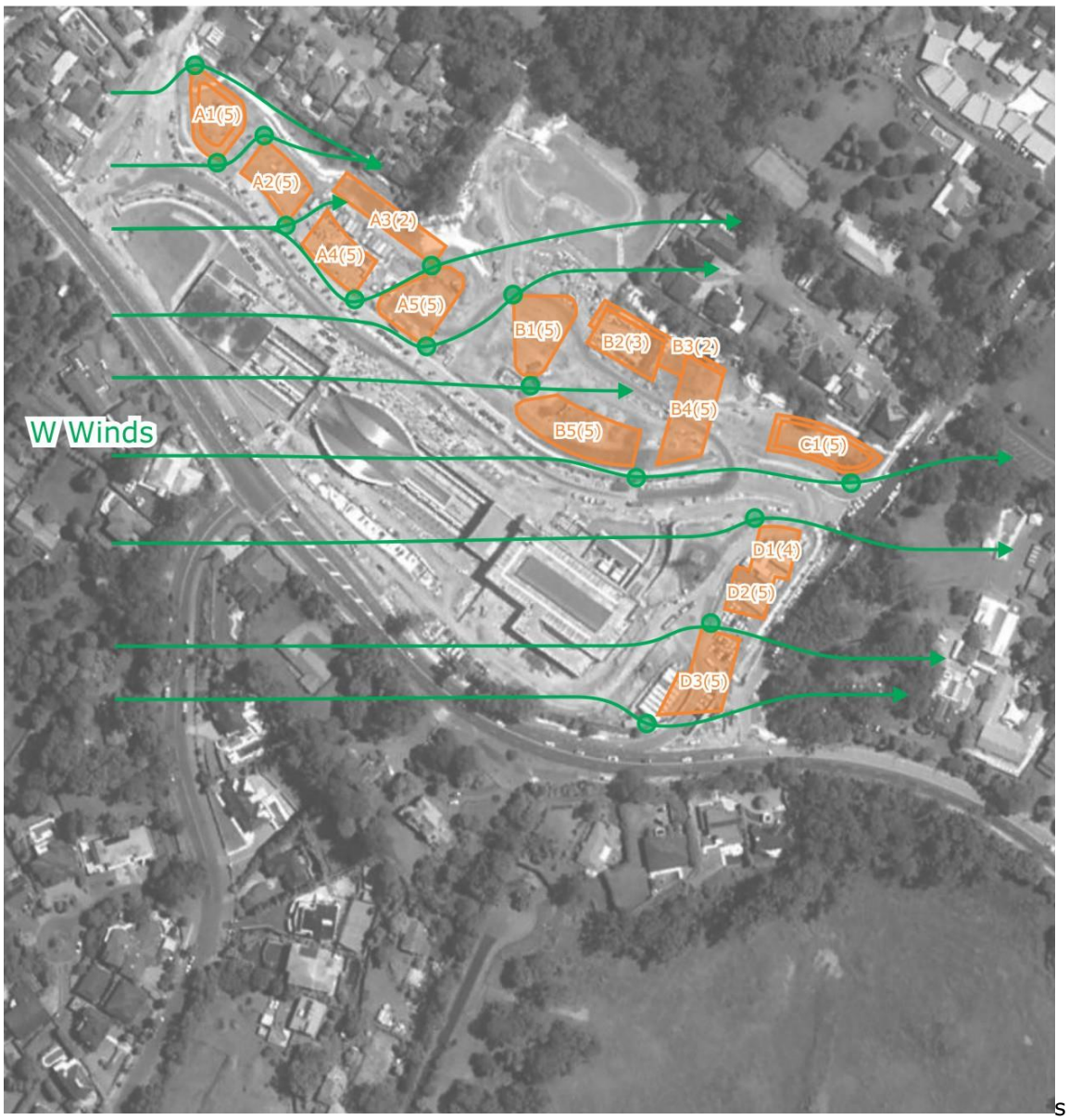

Figure 5: Westerly Wind Flow and Hotspots

5.4 Other General Design Considerations

For tree planting/landscaping to be effective as a wind mitigation device, the species should be of a densely foliating variety. If the area is affected by a winter wind (primarily the westerly winds for this region), it is recommended that an evergreen species be selected to ensure year-round effectiveness. Trees should also be planted in clusters with interlocking canopies to effectively absorb incident winds. In sensitive areas or hotspots where strong winds are expected, mature trees should be used as immature trees have difficulty establishing themselves in strong wind conditions. If immature trees are initially planted, the inclusion of porous screens around these tree plantings, or temporary wind screens is recommended to provide some wind mitigation while the trees develop and also provide some protection as the trees establish. Conditions can be further improved through the use of low-level vegetation such as shrubs/hedges or planter boxes. When utilised below a tree canopy, they provide protection from low level winds, especially for more sensitive areas where longer duration activities are expected. In general, landscaping can help mitigate adverse wind effects caused by winds directly impacting an area, or side streaming winds by slowing the winds upstream.

In areas where stronger winds are expected, wind screens may be required as trees are generally not effective in particularly strong gusts. These can be in the form of impermeable screens, porous screens, signage, artwork etc. which are strategically located to mitigate winds at a particular location. In areas where longer duration stay is expected, such as café or restaurant seating areas, or communal recreation areas, additional localised screening, tenancy-operated screening deployable during windy conditions, or planting may be required. The location of these areas at the corners of buildings places them in an area where there is a high potential for adverse winds.

Downwash is most likely to occur at the base of tall buildings that present a flat façade to the prevailing winds. The proposed setback in the various towers of the development is expected to assist in breaking up the downwash flows, however, to be effective in downwash mitigation it is suggested the setback be at least 3m in length. In downwash affected areas, especially at the ground level, awnings and canopies can be used to deflect the winds away from pedestrian accessible areas. Generally, for these to be effective in achieving this, an awning of at least 3m would be required. This combined with tree planting alongside for the winds to be absorbed into would be particularly effective in mitigating this wind effect. Wrap-around awnings at the corners of buildings can also prevent the down washed winds from combining with winds side streaming around the corners of the development. To reduce the ability of winds to downwash along the tower facades, horizontal and vertical feature elements can also be included.

Through-site links and tower aspects should be oriented to avoid direct alignment with the prevailing winds, incorporate bends, planting or screens in order to mitigate funnelling effects between building and tower massings. The funnelling between buildings may be severe enough for further mitigation measures such as a baffle screen arrangement. This tends to reduce the severity of winds affecting a particular area by redirecting it around obstacles, and thus reducing the wind speed.

6 CONCLUSION

The results of this assessment indicate that the subject development is relatively exposed to the three prevailing wind directions. As a result, there is a potential for wind impacts on the wind comfort for pedestrian trafficable areas within and around the site. Future developments around this precinct could reduce prevailing wind exposure.

The general design of the reference scheme incorporates several beneficial features to reduce the effect of the prevailing wind impacts. These include the following:

- The provision for landscaping in the form of trees and shrubs throughout the Village Square, Community gathering space, communal open spaces and ground level areas within and around the site.
- Existing Blue Gum High Forest to the north-east of the Environmental open space.
- Awnings over the ground level around the base of the tower forms.
- Chamfered or rounded building corners.
- Varied orientations of the building forms to avoid alignment with prevailing winds.

Further specific treatment strategies can be developed at a later more detailed design stage to further improve wind conditions where required for longer duration stationary activities. Examples of these are summarised as follows:

- Additional densely foliating evergreen landscaping for areas where winds are expected to funnel or side stream, such as communal open spaces or through site links that are situated between two buildings. Where planting cannot be utilised, the inclusion of localised screening, placing awnings to deflect downwashing winds away from pedestrian trafficable areas to lessen this wind effect is recommended.
- The inclusion of densely foliating evergreen landscaping, permanent screening or operable screening where the prevailing winds are expected to interact with building corners.
- The inclusion of awnings, canopies or densely foliating evergreen trees where winds are expected to downwash from facades onto footpaths or communal open spaces.
- The inclusion of high impermeable balustrades or densely foliating evergreen landscaping for areas that are exposed to directly impacting winds.

With the inclusion of these considerations in the detailed design of the development, wind conditions within outdoor trafficable areas of the development are expected to be suitable for their intended uses.

7 REFERENCES

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8 APPENDIX – WIND EFFECTS GLOSSARY

8.1 Downwash and Upwash Effects

The downwash wind effect occurs when wind is deflected down the building's windward facade causing accelerated wind speeds at pedestrian level. This can lead to other adverse effects as corner acceleration as the wind attempts to flow around the building, as seen in Figure A1. This can also lead to recirculating flow in the presence of a shorter upstream building, causing the local ground level wind flow to move towards the prevailing wind.

The upwash effect occurs near upper level edge of a building form as the wind flows over the top of the building. This has the potential to cause acceleration of winds near the leading edge, as well as potentially reattaching onto the roof area. This effect causes wind issues particularly near the leading edges of tall building and on the rooftop areas if there is sufficient depth along the wind direction. Upwash is more apparent in taller towers and podia.

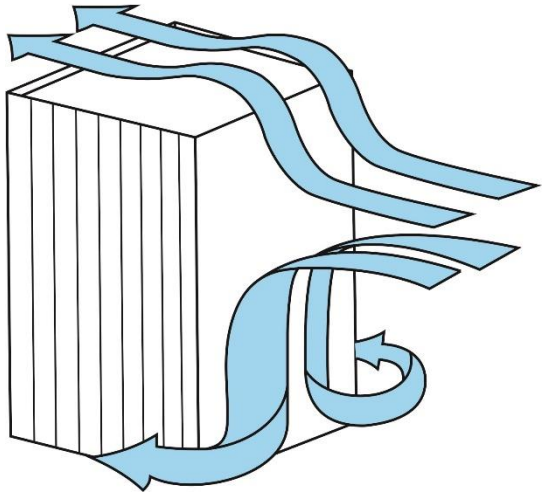

Figure A1: Downwash Leading to Corner Wind Effect, and Upwash Effects

8.2 Funnelling/Venturi Effect

Funnelling effects occur when the wind interacts with two or more buildings which are located adjacent to each other and the building form design results in a bottleneck, as shown in Figure A2. This can cause the wind to be forced through the gap between the buildings resulting in adverse wind conditions and pedestrian discomfort within the constricted space. Funnelling effects are common along pedestrian links and thoroughfares generally located between neighbouring buildings that have moderate gaps between them.

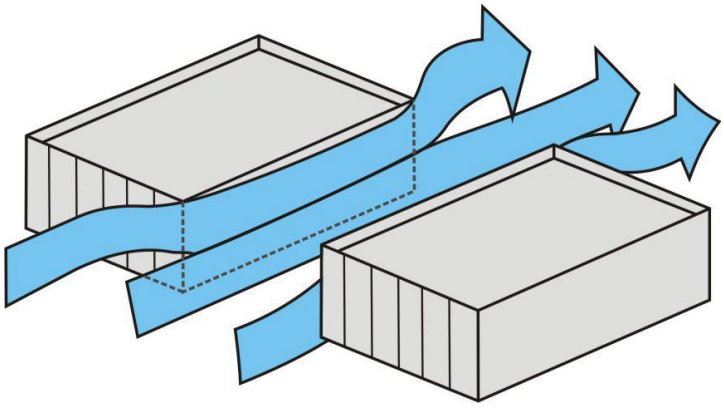

Figure A2: Funnelling/Venturi Wind Effect

8.3 Gap Effect

The gap effect occurs in small openings in the façade that are open to wind on opposite faces, as seen in Figure A3. This can involve a combination of funnelling and downwash effects. Presenting a small gap in the façade on the windward aspect as the easiest means through which the wind can flow through can result in wind acceleration through this gap. The pressure difference between the windward façade and the leeward façade also tends to exacerbate the wind flow through this gap.

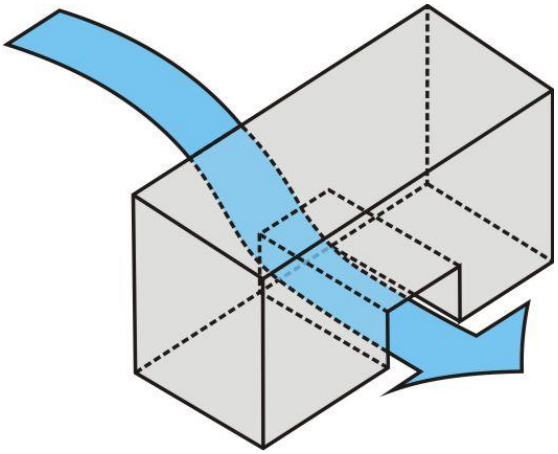

Figure A3: Gap Wind Effect

8.4 Sidestream and Corner Effects

The sidestream effect is due to a gradual accumulation of winds shearing along the building façade that eventuates in an acceleration corner effect. The flow is parallel to the façade and can be exacerbated by downwash effects as well, or due to corner effect winds reattaching on the façade. This is shown in Figure A4

The corner refers to the acceleration of wind at the exterior vertical edge of a building, caused by the interaction of a large building massing with the incident wind, with the flow at the corner being accelerated due to high pressure differentials sets up between the windward façade and the orthogonal aspects. It can be further exacerbated by downwash effects that build up as the flow shears down the façade.

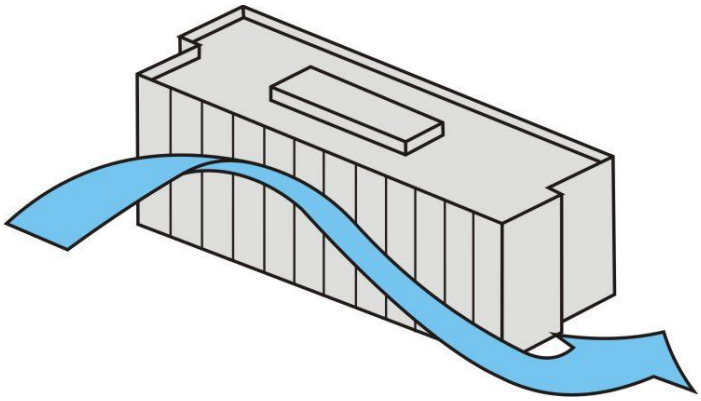

Figure A4: Sidestream and Corner Wind Effect

8.5 Stagnation

Stagnation in a region refers to an area where the wind velocity is significantly reduced due to the effect of the flow being impeded by the bluff body. For a particular prevailing wind direction, this is typically located near the middle of the windward face of the building form or over a short distance in front of the windward face of a screen or fence. Concave building shapes tend to create an area of stagnation within the cavity, and wind speeds are generally low in these areas.