



# PEDESTRIAN WIND ENVIRONMENT STATEMENT

## BUILDING R4B, BARANGAROO SOUTH

WA567-38F01(REV6)- WS REPORT

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Prepared for:

Lendlease (Millers Point) Pty Ltd

Level 14, Tower Three,  
International Towers Sydney, Exchange Place,  
300 Barangaroo Avenue, Barangaroo, NSW 2000

**WINDTECH Consultants Pty Ltd**

Head Office: 607 Forest Road, Bexley, NSW 2207, Australia

**P** +61 2 9503 0300 **E** [reception@windtechglobal.com](mailto:reception@windtechglobal.com) **W** [www.windtechconsult.com](http://www.windtechconsult.com)

Sydney | Dubai | London | Melbourne | Mumbai | New York | Hong Kong | Singapore

## DOCUMENT CONTROL

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## EXECUTIVE SUMMARY

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This report is in relation to Building R4B located at Barangaroo South 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, received 13 May 2020, and the results of wind tunnel testing previously undertaken for the development as part of earlier planning applications.

Since the site is located within a major redevelopment precinct, the two scenarios that were wind tunnel tested for the wind tunnel assessment were the following:

- Scenario 1: Building R4A, Building R5, Crown Hotel Resort and Barangaroo Central are not included in this scenario. Additionally, the bridge and canopy between Building R4A and Building R4B are not included in this scenario.
- Scenario 2: Building R4A, Building R5, Crown Hotel Resort and Barangaroo Central are included in this scenario. Additionally, the bridge and canopy between Building R4A and Building R4B are included in this scenario.

The results of the wind tunnel assessment for the original SSD 6965 submission indicated that the subject development has significant exposure to the three prevailing wind directions. Therefore, the previously recommended treatment strategies to ameliorate the adverse wind conditions are as follows, and based on the additional height proposed by the Amending SSD, these strategies remain:

### Ground Level Scenario 1:

- The inclusion of the planting of evergreen trees such as *Harpullia Pendula*, which typically have a height of 7-10 metres with a 3-6 metre wide canopy, along the north eastern, south-eastern and southern edges of the R4B site, and to the west of the site.
- The inclusion of portable screening to the north-east of the development, which is to be controlled by the operator and is expected to provide suitable wind conditions for short-exposure activities during times of high wind.

### Ground Level Scenario 2:

- The inclusion of the planting of evergreen trees such as *Harpullia Pendula*, which typically have a height of 7-10 metres with a 3-6 metre wide canopy, along the north

eastern, south-eastern and southern edges of the R4B site, and to the west of the site, within the public domain (SSD 7944).

- The inclusion of portable screening to the north-east of the development, which is to be controlled by the operator and is expected to provide suitable wind conditions for short-exposure activities during times of high wind.
- The inclusion of operable doors recessed into the Strada
- The extension of the Strada roof towards the south-west, wrapping around the southern corner of R4A.
- The inclusion windbreak screens along the western aspect of R4B.
- The retention of the proposed awnings.

Level 02 Outdoor Terrace:

- The inclusion of evergreen landscaping, to be distributed generously throughout the terrace, particularly at the western corner of the R4B podium.
- With the inclusion of these treatments to the final design, the results of this study indicate that wind conditions for all outdoor trafficable areas within and around the proposed development are expected to be suitable for their intended uses. It is noted that the addition of eight floors to the tower form does not significantly alter the previously assessed wind conditions, and therefore, no further wind tunnel testing is required for this.

## CONTENTS

1	Introduction	1
2	Site Description	2
3	Background	4
4	Overview of Proposed Development	6
5	Regional Wind	7
6	Wind Effects on People	9
7	Results and Discussion	10
	7.1 Ground Level – Scenario 1	10
	7.2 Ground Level – Scenario 2	12
	7.3 Level 02 Outdoor Terrace	14
	7.4 Tower Private Wintergardens	14
	7.5 Skyhomes Level Terraces	14
8	Conclusion	15
9	References	16

# 1 INTRODUCTION

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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.

This report supports a State Significant Development (SSD) Development Application (DA) submitted to the Department of Planning, Infrastructure and Environment (DPIE) pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The 'amending' SSD DA seeks approval for eight additional storeys and 5,650sqm of gross floor area (GFA), amongst other items, to Residential Building R4B approved under SSD 6965. This SSD DA proposes to amend the 60-storey Residential Building R4B development approved under SSD 6965, which in turn necessitates the inclusion of condition(s) of consent to this SSD DA that require the modification of SSD 6965.

## 2 SITE DESCRIPTION

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Barangaroo is located on the north western edge of the Sydney Central Business District (CBD), bounded by Sydney Harbour to the west and north, the historic precinct of Millers Point (for the northern half), The Rocks and the Sydney Harbour Bridge approach to the east; and bounded to the south by a range of new development containing large CBD commercial tenants.

The Barangaroo site has been divided into three distinct redevelopment areas (from north to south) – the Headland Park, Barangaroo Central and Barangaroo South. The Residential Building R4B site is located within Barangaroo South. The site of this proposed DA is located on land generally known and identified in the approved Concept Plan (as modified) as Block 4A, as shown in **Figure 1** below.

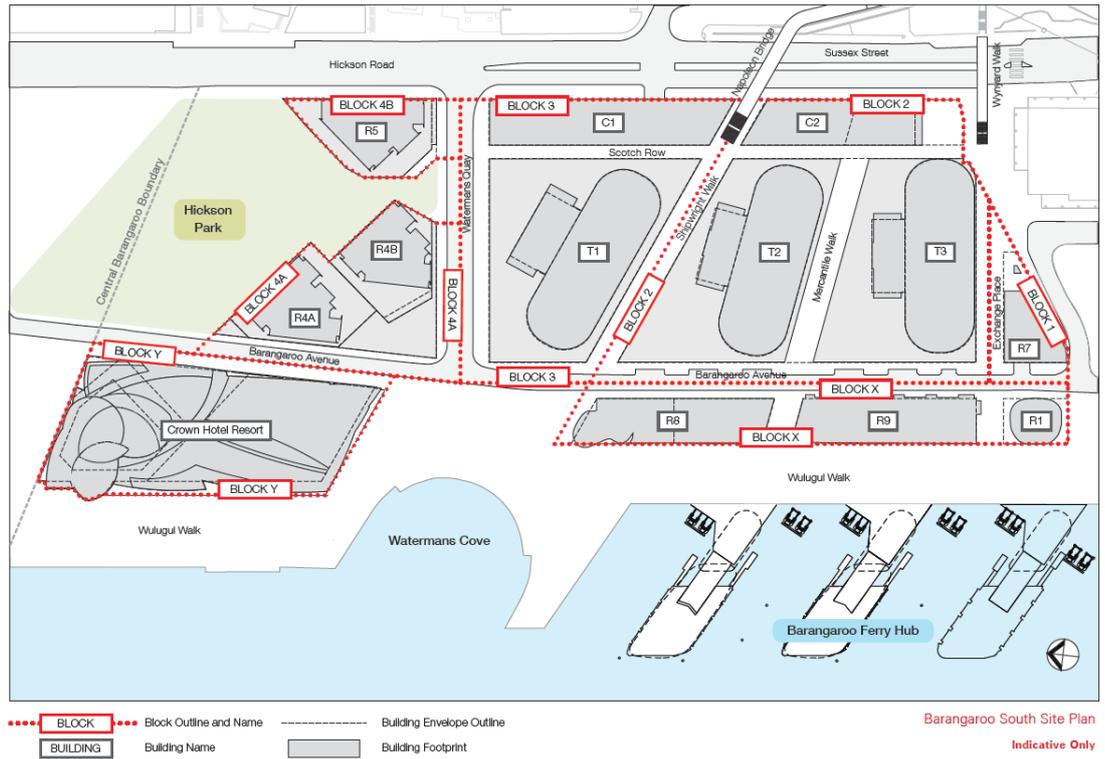
Since the site is located within a major redevelopment precinct, with other proposed nearby buildings which are yet to commence construction, two scenarios will be considered for this assessment.

- Scenario 1: Buildings R4A, R5, Crown Hotel Resort and Barangaroo Central are not included in this scenario. Additionally, the bridge and canopy between Buildings R4A and R4B are not included in this scenario.
- Scenario 2: Buildings R4A, R5, Crown Hotel Resort and Barangaroo Central are included in this scenario. Additionally, the bridge and canopy between Buildings R4A and R4B are included in this scenario.

A study of the local land topography has revealed that the terrain height increases gradually when moving towards the north-east from Darling Harbour. An aerial photograph of the proposed site is given in Figure 1, below.

The following outdoor trafficable areas within and around the site have been considered in this report:

- The surrounds trafficable areas on Ground Level.
- The Level 02 outdoor terrace.
- The various tower private wintergardens (no open balconies).
- The Skyhomes level terraces.



**Figure 1: Block 4A in Relation to Barangaroo South (Source: Lendlease)**

### 3 BACKGROUND

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Barangaroo South Concept Plan (as modified)

The approved Barangaroo South Concept Plan (MP06\_0162) (as modified), includes approval for the following:

- A mixed use development involving a maximum of 602,354 sqm gross floor area (GFA), comprised of:
  - a maximum of 191,031 sqm of residential GFA of which a maximum of 162,031 sqm will be in Barangaroo South;
  - a maximum of 76,000 sqm of GFA for tourist uses of which a maximum of 59,000 sqm will be in Barangaroo South;
  - a maximum of 34,000sqm of GFA for retail uses of which a maximum of 30,000 sqm will be in Barangaroo South;
  - a maximum of 5,000 sqm of GFA for active uses in the Public Recreation zone of which 3,500 will be in Barangaroo South; and
  - a minimum of 12,000sqm GFA for community uses.
- Approximately 11 hectares of new public open space/public domain, with a range of formal and informal open spaces serving separate recreational functions and including an approximate 2.2km public foreshore promenade.
- Built form design principles, maximum building heights and GFA for each development block within the mixed use zone.
- Public domain landscape concept, including parks, streets and pedestrian connections.
- Alteration of the existing seawalls and creation of a partial new shoreline to the harbour.
- Construction, operation and maintenance of a concrete batching plant to supply concrete for construction of future development under this Concept Plan at Barangaroo South.
- No approval is granted or implied for the future use of a heliport and/or a helipad.

This 'amending' SSD DA seeks to achieve the maximum permissible GFA and height for Residential Building R4B that was approved as part of the latest modification to the Concept Plan (modification 10). Any consent that is granted to this SSD DA will be generally consistent with the terms of approval of the Concept Plan (as modified).

#### Residential Building R4B - Development Consent SSD 6965

Development consent SSD 6965 was granted by the NSW Minister for Planning on 7 September 2017 for Residential Building R4B, comprising of a 60-storey mixed use building, with 297 residential units and retail floor space at ground level. This included a total gross floor area (GFA) of 38,896sqm, 38,602sqm of which was approved for residential floor space, and the remaining 294sqm was approved for retail floorspace.

Consent was also provided for associated building public domain works, fit-out and use of the basement, a link bridge connecting to Building R4A and associated building identification signage.

On 7 February, 2020, development consent SSD 6965 was amended to account for a range of design changes, including an increase in total GFA from 38,896sqm to 38,911sqm, comprised of an increase in retail GFA from 294sqm to 309sqm, and a reduction in the number of apartments to 283.

A second application to modify development consent SSD 6965 has been submitted to the DPIE. The amendments contained within the modification application broadly relate to the following changes:

- increase the number of apartments from 283 to 290;
- revised dwelling mix and internal layout changes;
- changes to the landscaped podium layout; and
- changes to the number of car spaces from 320 to 324.

It is anticipated that this modification application to development consent SSD 6965 will be determined prior to the determination of this SSD DA. As such, this SSD DA is made with the above changes in mind.

## 4 OVERVIEW OF PROPOSED DEVELOPMENT

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This 'amending' SSD DA seeks consent for eight additional storeys with 5,650sqm of GFA and containing 32 additional apartments, and an allocation of 7 additional car parking spaces to Residential Building R4B. More specifically, this SSD DA proposes to amend Residential Building R4B, through:

- an increase to the overall building height from RL208.23 up to RL235 (an additional 8 levels)
- increase the overall number of apartments from 290 to 322
- revise the dwelling mix and apartment relocations within the building envelope; and
- change to the number of car spaces from 324 to 331.

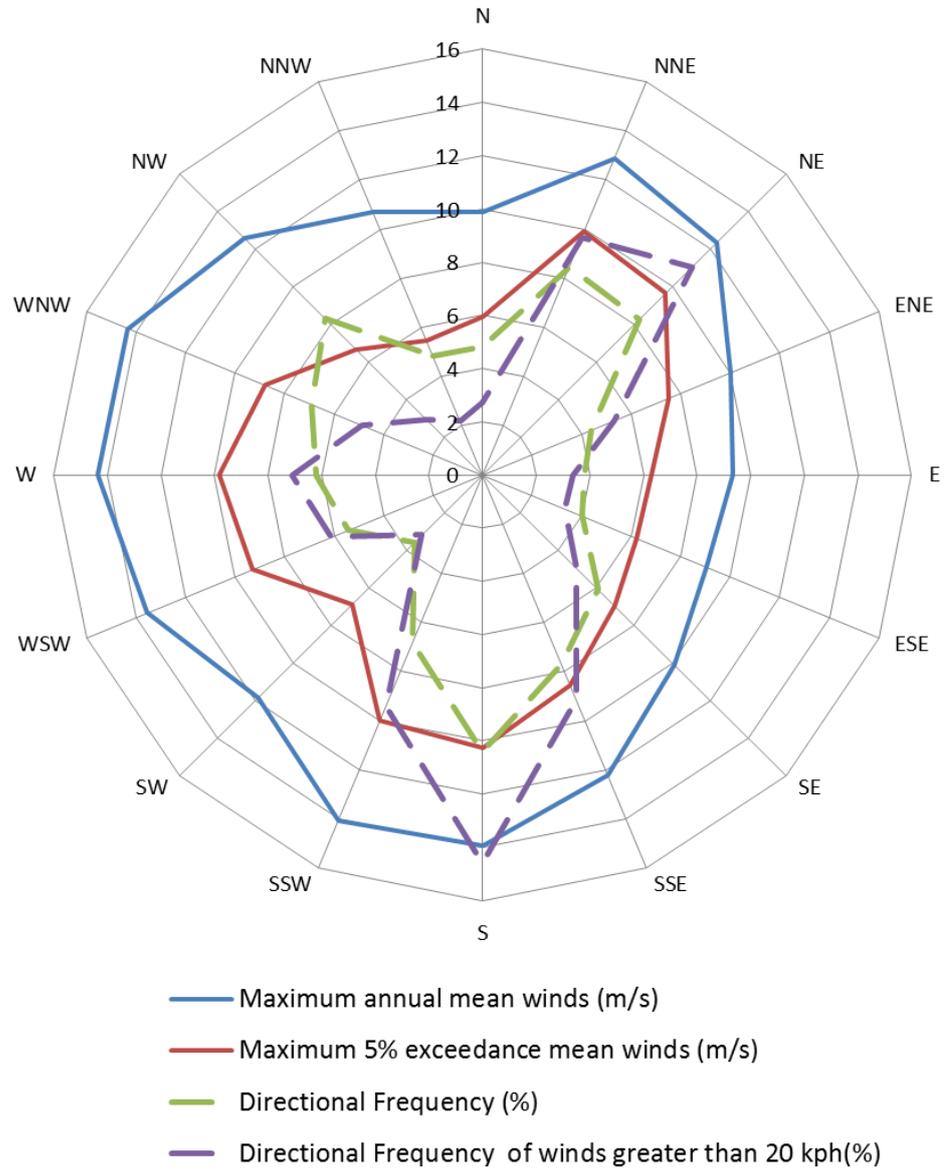
## 5 REGIONAL WIND

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)**

## 6 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. The recommendations in this report are made based on wind tunnel testing previously undertaken for this development, and the latest architectural drawings.

## 7 RESULTS AND DISCUSSION

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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 ground plane will be used primarily for circulation. However, there are potential seating areas in various locations. The recommended criterion for wind conditions for the circulation area is 7.5m/s with a 5% probability of exceedance, whereas the proposed seating areas will need to satisfy a more stringent comfort criterion of 5.5m/s with a 5% probability of exceedance. Although this assessment is of a qualitative nature, the abovementioned criteria are considered when assessing the wind environment impacts.

### 7.1 Ground Level – Scenario 1

This scenario and associated mitigation measures were for the original application approval for SSD 6965. Based on the additional increase in height to RL233.485, the following wind effects and mitigation measures remain in place.

The south-eastern corner of the development experiences west to south-westerly winds accelerating around the corner. The northern corner of the development is exposed to strong corner accelerations from westerly and north-easterly winds.

The inclusion of strategic planting in the form of densely foliating trees at ground level around the site. A tree species such as the *Harpullia Pendula* or similar will be effective in providing the suitable level of wind mitigation for these areas. This tree species is capable of growing to a height of approximately 7m to 10m, with a canopy diameter of approximately 3m to 6m. The suggested layout of the trees is presented in Figure 3, based on the provided landscape drawing. Further refinements to the landscaping strategy to what has been suggested can also be acceptable.

The inclusion of portable screening on the north-eastern aspect of Building R4B is to be controlled by the operator to provide suitable conditions for patrons during adverse wind conditions. Conditions will be suitable as a pedestrian thoroughfare without screening. This is shown in Figure 3.



## 7.2 Ground Level – Scenario 2

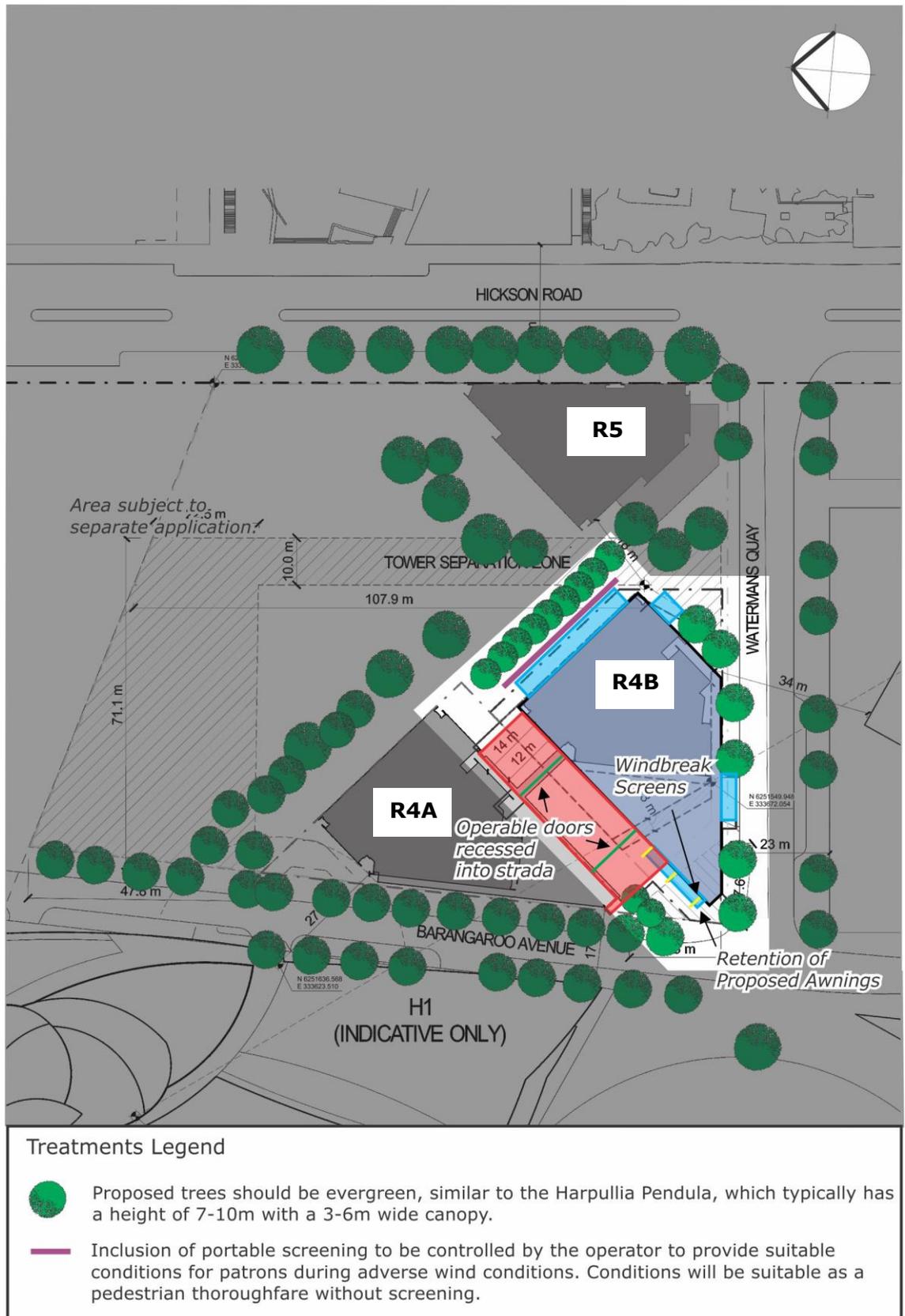
This scenario and associated mitigation measures were for the original application approval for SSD 6965. Based on the additional increase in height to RL233.485, the following wind effects and mitigation measures remain in place.

The development experiences strong western and north-easterly winds accelerating around the south-eastern corner. Strong westerly and north-easterly winds will funnel between buildings R4A and R4B, beneath the Strada Roof, resulting in adverse wind conditions. The north-eastern corner of the development will be exposed to corner accelerating north-easterly and westerly winds.

The inclusion of strategic planting in the form of densely foliating trees at ground level around the site. A tree species such as the *Harpullia Pendula* or similar will be effective in providing the suitable level of wind mitigation for these areas. This tree species is capable of growing to a height of approximately 7m to 10m, with a canopy diameter of approximately 3m to 6m. The suggested layout of the trees is presented in Figure 4, based on the provided landscape drawing.

The inclusion of portable screening on the north-eastern aspect of Building R4B is to be controlled by the operator to provide suitable conditions for patrons during adverse wind conditions. Conditions will be suitable as a pedestrian thoroughfare without screening. This is shown in Figure 4.

Desirable wind conditions within the Strada precinct have been a notable area of concern to ensure a suitable and effective outcome for the project. Amelioration measures outside of the precinct to mitigate the potential for funnelling through this area have been suggested in Figure 4 with the optimisation of the canopy design, additional screening and landscaping arrangement. Allowance has also been made in the current design to allow for an airlock/baffle arrangement within the Strada space to mitigate any adverse winds during strong westerly and north-easterly wind events. It is recommended to retain the various proposed awnings in the final design.



**Figure 4 – Suggested Treatments for the Ground Level – Scenario 2**

### **7.3 Level 02 Outdoor Terrace**

The majority of the terrace is expected to experience wind conditions that are suitable for its intended use. However, there is potential for westerly winds to accelerate around the protruding corners of the tower form. It is recommended to include densely foliating evergreen landscaping in the final design, to be distributed generously throughout the terrace, particularly at the western corner of the podium. With the additional height, same recommendation remains applicable.

### **7.4 Tower Private Wintergardens**

The enclosed design of the various tower private wintergardens, including the additional height, is expected provide adequate shielding for safe and comfortable conditions for residents. The proposed design is recommended to be retained for all private areas (and not open private balconies).

### **7.5 Skyhomes Level Terraces**

The Skyhomes level terraces (as shown in drawing BR2 AD B1L8501 [B], received 13 May 2020) will benefit from the glazing design, which is expected to provide sufficient shielding for safe and comfortable contentions for residents. The glazing design is recommended to be retained in the final design.

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 spaces. Furthermore, lightweight furniture is not recommended unless it is securely attached to the balcony floor slab.

With the inclusion of the abovementioned treatments, it is expected that adequate wind conditions will be achieved for all outdoor trafficable areas within and around the site. Furthermore, the development is not expected to have any adverse impact onto the wind conditions for the local surrounding area.

## 8 CONCLUSION

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The results and recommendations of this report are drawn from our extensive experience in this field and are based on an examination of the latest architectural drawings, received 13 May 2020, and the results of wind tunnel testing previously undertaken for the development as part of earlier planning applications.

With the inclusion of the aforementioned treatments to the final design (that were previously recommended, and should remain), the results of this study indicate that wind conditions for all outdoor trafficable areas within and around the proposed development are expected to be suitable for their intended uses. It is noted that the addition of eight floors to the tower form does not significantly alter the previously assessed wind conditions, and therefore, no further wind tunnel testing is required for this.

## 9 REFERENCES

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