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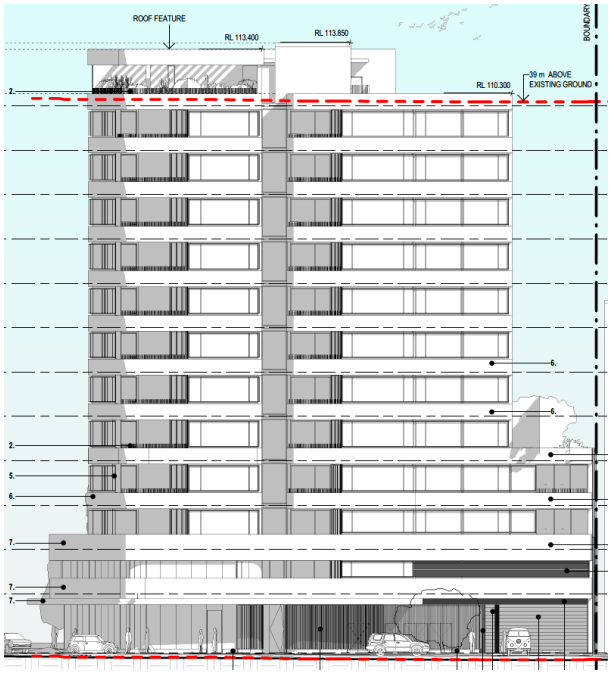

PEDESTRIAN WIND ENVIRONMENT STATEMENT

1 BUTLER ROAD, HURSTVILLE

WH327-01F02(REV1)- WS REPORT.DOCX

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EXECUTIVE SUMMARY

This report presents an opinion on the likely impact of the development located at 1 Butler Road, located in Hurstville, on the local wind environment at the critical outdoor areas within and around the subject site. The effect of wind activity has been examined for the three predominant wind directions for the region, namely the north-easterly, southerly, and westerly winds. The analysis of the wind effects relating to the proposed development have been carried out in the context of the local wind climate, building morphology and land topography. This assessment entails reviews of a 'DA Approved Scheme' and a proposed 'S4.55 Scheme' for the subject site.

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 of the architectural drawings provided (received 29 September 2022). 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 S4.55 scheme is similar to the DA approved scheme to a large extent from the perspective of wind comfort. The major revision to the external façade is the change to the layout of the southern fire staircase area, where two staircases are combined to one and placed directly in front of the breezeway at each level. As a result of this change, the level of exposure of the open breezeway is reduced in the S4.55 scheme due to the presence of the fire stairs and built up areas located directly to the south of the breezeway. In our opinion, this change is expected to improve the wind conditions within the open breezeway at all the levels in general (compared to the DA approved scheme).

Considering both the schemes, the development has incorporated several design features and wind mitigating strategies and is expected to be suitable for the intended use for the majority of the outdoor trafficable areas. However, there are some areas that are likely to be exposed to stronger winds. 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:

DA Approved Scheme:

- Ground Level:
    - Inclusion of the proposed awning structure along the northern and eastern facades at level 1.
    - Extension of the awning structure to cover the entire northern façade (Ormonde Parade).
- Open Breezeway at Levels 2 to 11 and the Roof Level
    - Conversion of the porous balustrade at the western end of the breezeway to a full-height porous (35-45% porosity) screen. This can be achieved by simply extending the individual balusters/blades to full-height, although more blades may have to be provided to maintain 35-45% porosity.

- Extending the porous balustrade at the eastern end of the breezeway to at least 1.5m in height, ensuring a maximum porosity of 35-45%.

- Extending the balustrade/parapet along the southern façade between the two staircases to at least 1.5m in height.

- Private Balconies
    - Inclusion of the proposed full-height blade wall (Level 2) and the full height frameless glass screen (Levels 3-11) along the eastern aspect of the north-east corner balconies.

    - Inclusion of the proposed 1.2m high balustrade along the northern boundary of the north-east corner balconies (Levels 2 -11).

- Roof Level Common Outdoor Space/Terrace
    - Inclusion of a 1.8m high impermeable screen along the northern and eastern perimeters of the terrace. Note that this screen can be of a transparent nature if desired.

    - Inclusion of 1.8m high densely foliating evergreen hedges/shrubs within the proposed landscaped areas to break up the winds that flow past the perimeter screens and re-attach within the terrace.

    - Inclusion of the proposed pergola structure above the BBQ area (maximum porosity = 35%).

S4.55 Scheme:

- Ground Level:
    - Inclusion of the proposed awning structure along the northern and eastern facades at level 1.

    - Extension of the awning structure to cover the entire northern façade (Ormonde Parade).

- Open Breezeway at Levels 2 to 11 and the Roof Level
    - Conversion of the porous balustrade at the western end of the breezeway to a full-height porous (35-45% porosity) screen. This can be achieved by simply extending the individual balusters/blades to full-height, although more blades may have to be provided to maintain 35-45% porosity.

    - Extending the porous balustrade at the eastern end of the breezeway to at least 1.5m in height, ensuring a maximum porosity of 35-45%.

- Private Balconies
    - Inclusion of the proposed full-height blade wall (Level 2) and the full height frameless glass screen (Levels 3-11) along the eastern aspect of the north-east corner balconies.

    - Inclusion of the proposed 1.2m high balustrade along the northern boundary of the north-east corner balconies (Levels 2 -11).

- Roof Level Common Outdoor Space/Terrace
    - Inclusion of a 1.8m high impermeable screen along the northern and eastern perimeters of the terrace. Note that this screen can be of a transparent nature if desired.
    - Inclusion of 1.8m high densely foliating evergreen hedges/shrubs within the proposed landscaped areas to break up the winds that flow past the perimeter screens and re-attach within the terrace.
    - Inclusion of the proposed pergola structure above the BBQ area (maximum porosity = 35%).

With the inclusion of the abovementioned recommendations in the final design, it is expected that wind conditions for the various trafficable outdoor areas within and around the ground plane and the elevated outdoor trafficable communal areas will be suitable for their intended uses, and that the wind speeds will satisfy the applicable criteria for pedestrian comfort and safety.

Wind tunnel testing using a scaled physical model of the development can be undertaken to quantitatively assess the wind conditions and to optimise the size and extent of the treatments required.

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Appendix A Wind Effects Glossary

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 DEVELOPMENT AND SURROUNDINGS

The site is located at 1 Butler Road, Hurstville, and is bounded by Ormonde Parade to the north-east, Butler Road to the south-east, Hurstville Fire Station to the south-west (3 storeys) and Hurstville Police Station to the north-west (7 storeys). Further to the north-west of the Police Station (across Greenbank Street) is an 11 storey residential building. Directly to the south of the subject site (across Butler Road), there is a 5 storey commercial building, followed by a 7 storey residential building, which can help reduce the impact of the winds approaching the site from the south. Other than these developments, majority of the buildings surrounding the subject development are predominately low-rise residential and commercial buildings, with Hurstville Central/Train station and tracks located to the north-east (across Ormonde Parade).

A survey of the land topography indicates that there are no major elevation changes in the area immediately surrounding the site. An aerial image of the subject site and the local surroundings is shown in Figure 1, with the frequency and magnitude of the prevailing winds is superimposed for each wind direction.

The existing site at 1 Butler Road consists of a 2 storey commercial building. The proposed development is a 13 storeys high (including the Ground and the Roof Levels) residential building, with service areas and a retail space at the Ground Level.

The critical outdoor trafficable areas associated with the proposed development, which are the focus of this assessment with regards to wind effects, are listed as follows:

- Pedestrian Footpaths surrounding the subject site.
- Ground Level pedestrian trafficable areas within and around the subject site (including the retail and residential entries facing the north-east).
- The open breezeways located to the south-west at Level 2 to the Roof Level.
- Private Balconies.
- Roof Level Common Outdoor Space/Terrace.

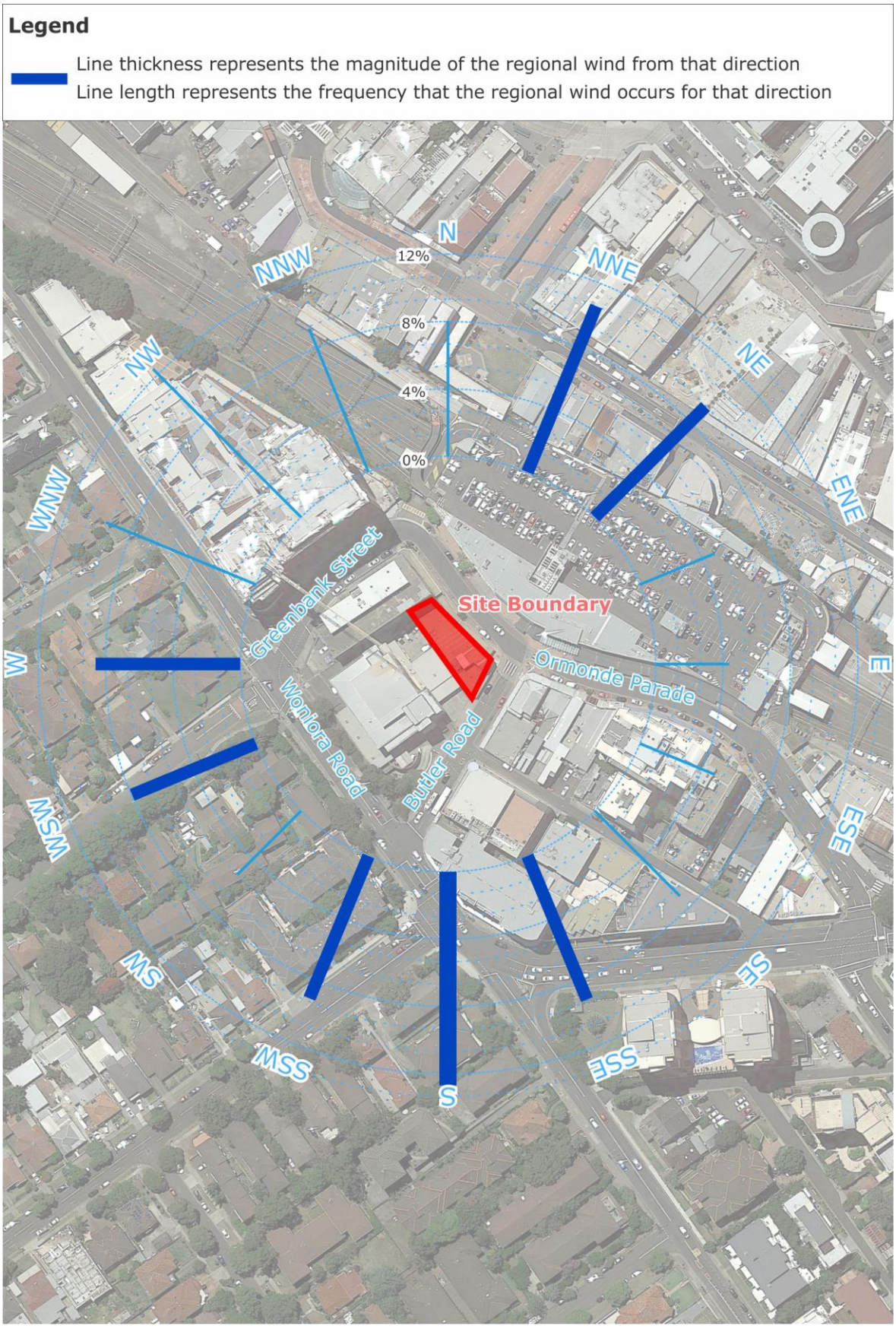


Figure 1: Aerial Image of the Site Location and Prevailing Wind Directions

3 REGIONAL WIND

The Sydney region is governed by three principal wind directions that can potentially affect the subject development. These winds prevail from the north-east, south, and west. These wind directions were determined from an analysis undertaken by Windtech Consultants of recorded directional wind speeds obtained from the meteorological station located at Kingsford Smith Airport by the Bureau of Meteorology (recorded from 1995 to 2016). The data has been corrected to represent winds over standard open terrain at a height of 10m above ground level. The results of this analysis are presented in Figure 2 in the form of a directional plot of the annual and 5% exceedance mean winds for the region. The frequency of occurrence of these winds is also shown in Figure 2.

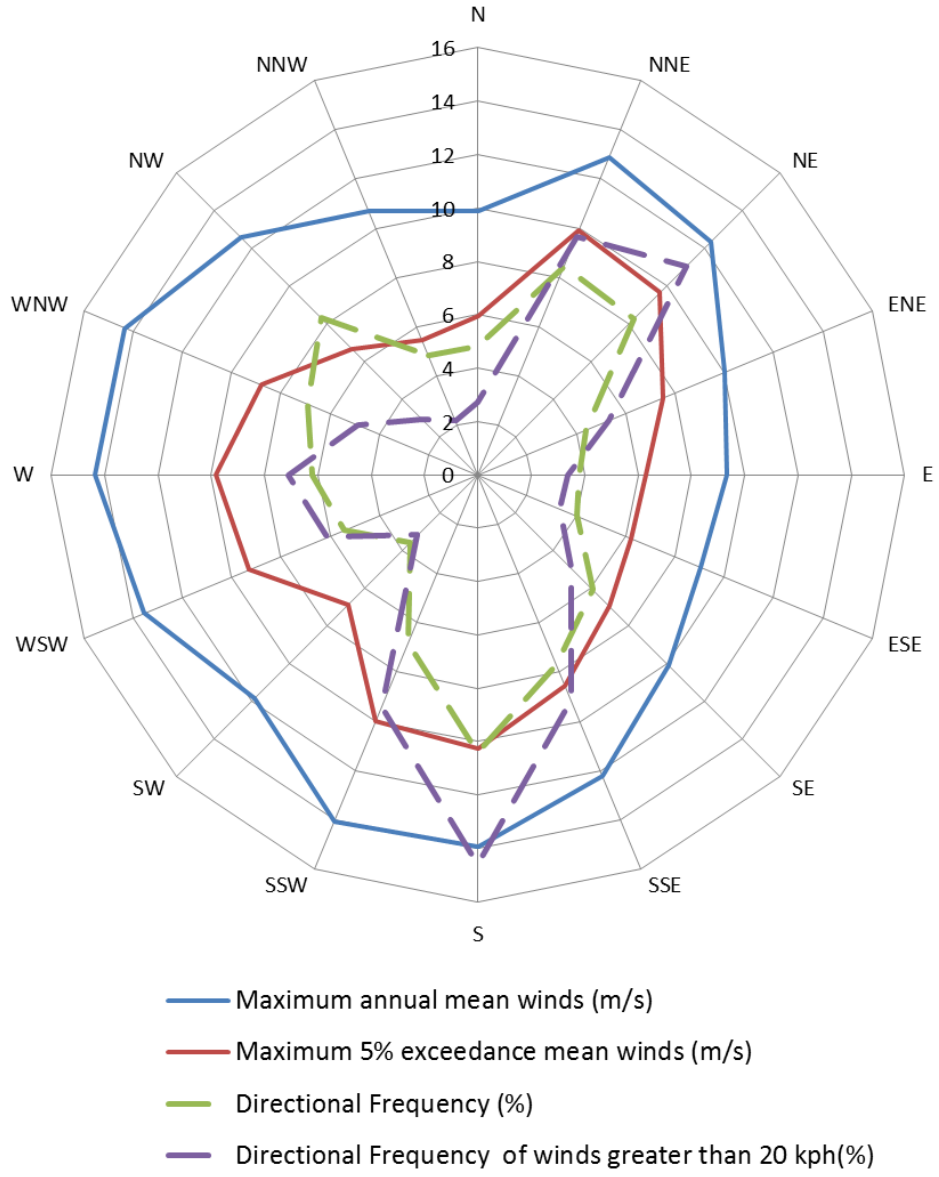


Figure 2: Directional Annual and 5% Exceedance Hourly Mean Wind Speeds (referenced to 10m height in standard open terrain), and Frequencies of Occurrence, for the Sydney Region

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 affecting this particular development 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 affecting the development 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 included in Appendix A.

For this assessment, the wind speed criteria for pedestrian comfort that are considered are listed as follows:

- Comfortable Walking Criterion (8m/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 (6m/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.

Although this assessment is qualitative in nature, the abovementioned criteria for pedestrian comfort are considered when assessing the wind environment impacts. However, all areas are also assessed with consideration to a pedestrian safety criterion of 24m/s for the annual maximum gust.

5.1 DA Approved Scheme

5.1.1 Ground Level

The site is bounded by Ormonde Parade to the north-east, Butler Road to the south-east, Hurstville Fire Station to the south-west (3 storeys) and Hurstville Police Station to the north-west (7 storeys). Further to the north-west of the Police Station (across Greenbank Street) is an 11 storey residential building. Directly to the south of the subject site (across Butler Road), there is a 5 storey commercial building, followed by a 7 storey residential building, which can help reduce the impact of the winds approaching the site from the south. Given the presence of these multi-storey developments to the south, west and north of the site, there is considerable shielding of direct westerly and southerly prevailing winds from the subject development at the Ground Level. However, the north-easterly prevailing winds approaching the site above the Hurstville Central can impact the northern and eastern aspects of the development. These prevailing north-easterly winds can also be caught by the northern façade (which is facing the north-east) and be down-washed towards the Ground Level. These wind effects can be ameliorated with the inclusion of the proposed awning structure along the northern and eastern aspects of the building at Level 1. It is also recommended that the awning is extended to cover the entire northern façade (Ormonde Parade).

Given the orientation of the building in relation to the cardinal wind directions, prevailing southerly and westerly winds are unlikely to be down-washed off the building façade. In the event that these winds do down-wash off the southern façade, the setback of the building envelope above Leve 2 on the southern aspect allows the winds to be contained to the non-pedestrian gravel roof areas at Level 2.

In summary, the following wind mitigation measures are recommended to be included in the final design to ameliorate the undesirable effects of the direct and down-washing prevailing winds on the Ground Level footpath areas and the building entrances (refer to Figure 3):

- Inclusion of the proposed awning structure along the northern and eastern facades at level 1.
- Extension of the awning structure to cover the entire northern façade (Ormonde Parade).

5.1.2 Open Breezeway at Levels 2 to 11 and the Roof Level

The design of the development proposes to include open breezeways along the southern aspect at each level from Level 2 to the Roof Level. It is our opinion that the pedestrian wind comfort and safely levels within these breezeways can satisfy the relevant criteria with the incorporation of some mitigation measures, i.e. without closing off the openings completely.

The shielding provided by the taller buildings to the south as well as the fire station to the west can help reduce the impact of direct prevailing southerly and westerly winds at the Level 2 and 3 breezeways where the open areas are larger (compared to those at Level 4 and above). For the Level 2 and 3 breezeways, the porous balustrade at the western end is recommended to be converted to a full-height porous (35-45% porosity) screen. This can be achieved by simply extending the individual balusters/blades to full-height, although more blades may have to be provided to maintain 35-45% porosity. The porous balustrade at the eastern end of the breezeway is recommended to be at least 1.5m in height. The impermeable balustrade/parapet along the southern façade between the two staircases is also recommended to be at least 1.5m in height.

The breezeway at Levels 4 and above is of a much smaller size, with smaller opening areas as well. However given the absence of shielding from neighbouring buildings at this height, the above discussed mitigation measures for Levels 2 and 3 are recommended to be adopted for Levels 4 and above as well. These are summarised as follows (refer to Figures 3 and 4).

- Conversion of the porous balustrade at the western end of the breezeway to a full-height porous (35-45% porosity) screen. This can be achieved by simply extending the individual balusters/blades to full-height, although more blades may have to be provided to maintain 35-45% porosity.
- Extending the porous balustrade at the eastern end of the breezeway to at least 1.5m in height, ensuring a maximum porosity of 35-45%.
- Extending the balustrade/parapet along the southern façade between the two staircases to at least 1.5m in height.

5.1.3 Private Balconies

The majority of the balconies of the development are expected to be suitable for their intended use due to the inclusion of various wind mitigation features such as their overall recessed design, impermeable balustrades, impermeable intertenancy screens, and full-height impermeable end screens. These features should be retained in the final design. The most critical balcony location within the proposed development is the north-east corner balcony, which in addition to direct north-easterly winds, can experience corner acceleration of southerly winds as these winds side stream off the eastern façade in to the balcony. Hence it is crucial that the proposed full-height blade wall (Level 2) and the full height frameless glass screen (Levels 3-11) along the eastern aspect of these corner balconies are retained in the final design – Refer to Figures 3 and 4.

5.1.4 Roof Level Common Outdoor Space/Terrace

The common outdoor terrace located within the eastern half of the roof level is exposed to all the prevailing winds for the Sydney region, and hence if left untreated, the wind comfort and safety levels within the various terrace areas are likely to be deteriorated. It is worth noting that the proposed design already incorporates a number of wind mitigation features that can help reduce the effects of the prevailing winds within the terrace space. In summary, the following treatment measures are recommended to be included in the final design to ensure that the roof level common outdoor terrace is suitable for the intended uses (Figure 4):

- Inclusion of a 1.8m high impermeable screen along the northern and eastern perimeters of the terrace. Note that this screen can be of a transparent nature if desired.
- Inclusion of 1.8m high densely foliating evergreen hedges/shrubs within the proposed landscaped areas to break up the winds that flow past the perimeter screens and re-attach within the terrace.
- Inclusion of the proposed pergola structure above the BBQ area (maximum porosity = 35%).

With the inclusion of the abovementioned recommendations in the final design, it is expected that wind conditions for the various trafficable outdoor areas within and around the ground plane and the elevated outdoor trafficable communal areas will be suitable for their intended uses, and that the wind speeds will satisfy the applicable criteria for pedestrian comfort and safety. Wind tunnel testing using a scaled physical model of the development can be undertaken to quantitatively assess the wind conditions and to optimise the size and extent of the treatments required.

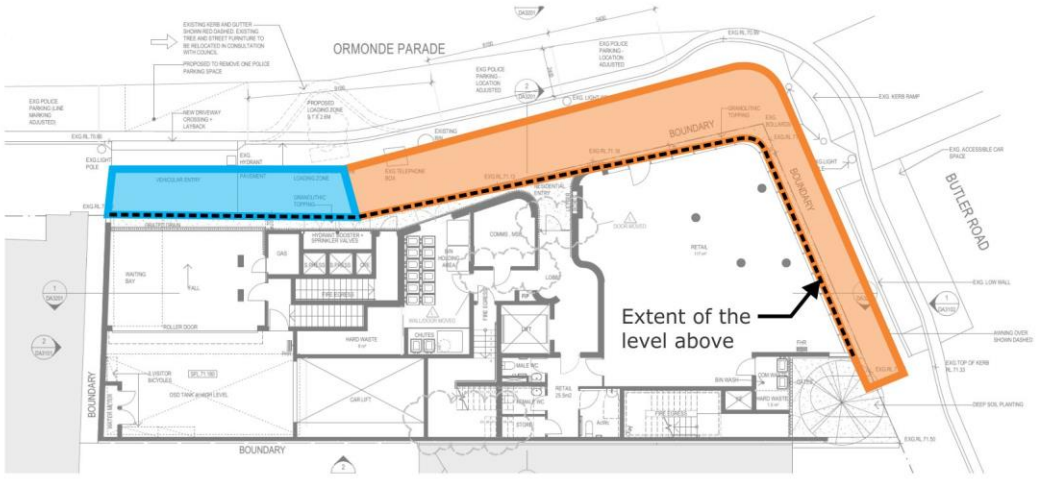
5.2 S4.55 Scheme

The S4.55 scheme is similar to the DA approved scheme to a large extent from the perspective of wind comfort. The major revision to the external façade is the change to the layout of the southern fire staircase area, where two staircases are combined to one and placed directly in front of the breezeway at each level. As a result of this change, the level of exposure of the open breezeway is reduced in the S4.55 scheme due to the presence of the fire stairs and services built up areas directly to the south of the breezeway. In our opinion, this change is expected to further improve the wind conditions within the open breezeway at all the levels in general (compared to the DA approved scheme). The treatment measures considering the S4.55 scheme are presented in Figures 5 and 6 for ease of reference.

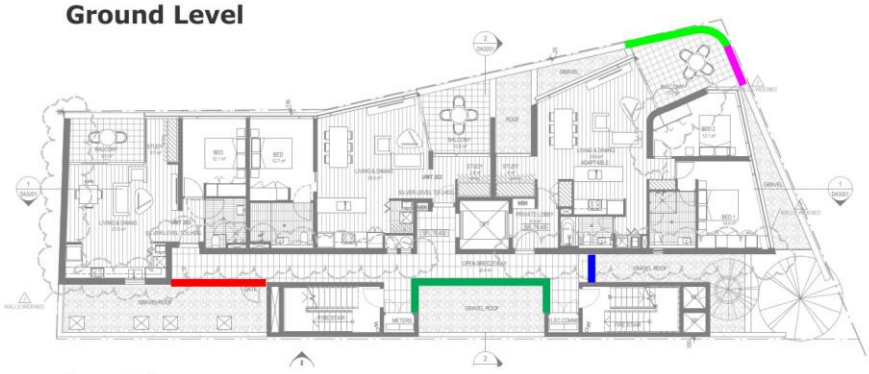
With the inclusion of the recommendations illustrated in Figure 5 and 6 in the final design, it is expected that wind conditions for the various trafficable outdoor areas within and around the ground plane and the elevated outdoor trafficable communal areas will be suitable for their intended uses, and that the wind speeds will satisfy the applicable criteria for pedestrian comfort and safety. Wind tunnel testing using a scaled physical model of the development can be undertaken to quantitatively assess the wind conditions and to optimise the size and extent of the treatments required.

Treatments Legend

- Inclusion of the proposed impermeable awning.
- Extension of the proposed impermeable awning.
- Inclusion of a full height porous screen (maximum porosity = 35-45%).
- Inclusion of the proposed impermeable balustrade, ensuring at least 1.5m height.
- Inclusion of the proposed porous balustrade, ensuring at least 1.5m height.
- Inclusion of the proposed full height impermeable screen
- Inclusion of the proposed 1.2m high balustrade (impermeable or porous).



Ground Level



Level 2

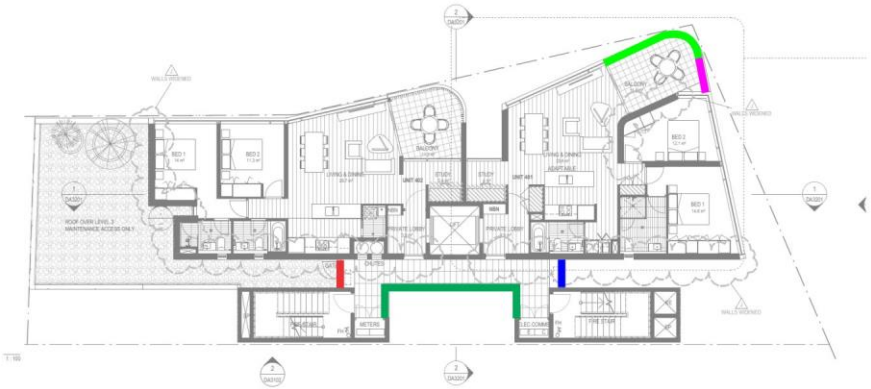
Level 3

Figure 3: Treatment Recommendations (Ground Level, Level 2, Level 3)

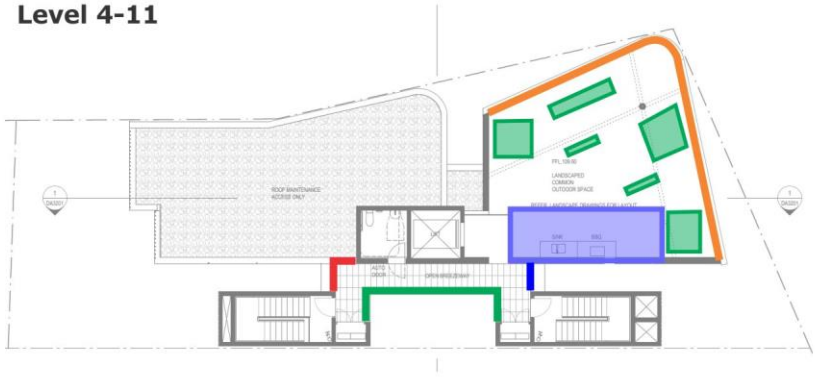
DA Approved Scheme

Treatments Legend

- Inclusion densely foliating evergreen shrubs/hedges (1.8m height).
- Inclusion of the proposed pergola structure (maximum porosity = 35%).
- Inclusion of a full height porous screen (maximum porosity = 35-45%).
- Inclusion of the proposed impermeable balustrade, ensuring at least 1.5m height.
- Inclusion of the proposed porous balustrade, ensuring at least 1.5m height.
- Inclusion of the proposed full height impermeable screen
- Inclusion of the proposed 1.2m high balustrade (impermeable or porous).
- Inclusion of a 1.8m high impermeable screen.



Level 4-11



Roof Level

Figure 4: Treatment Recommendations (Levels 4-11, Roof Level)

DA Approved Scheme

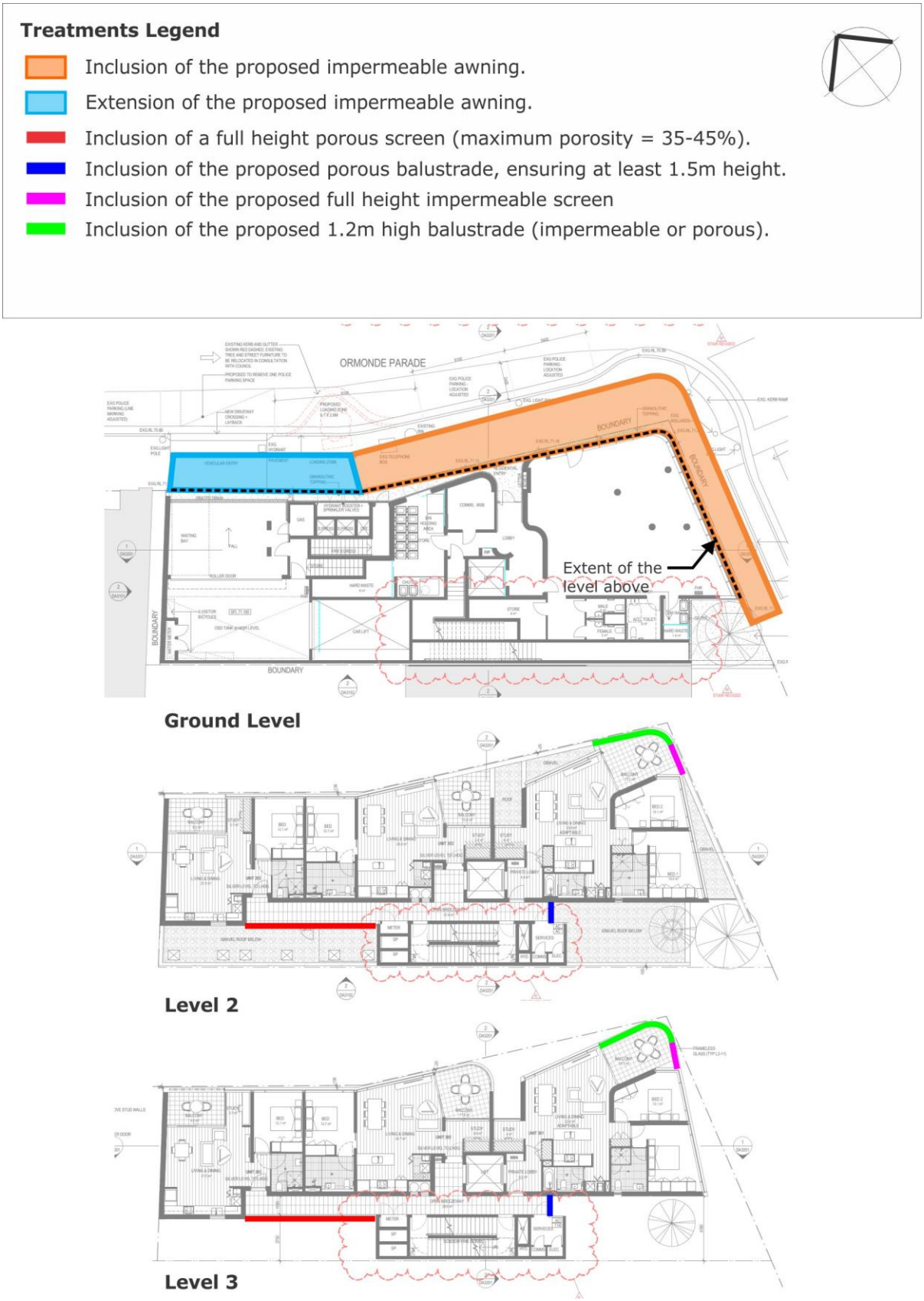


Figure 5: Treatment Recommendations (Ground Level, Level 2, Level 3)

S4.55 Scheme

Treatments Legend

- Inclusion densely foliating evergreen shrubs/hedges (1.8m height).
- Inclusion of the proposed pergola structure (maximum porosity = 35%).
- Inclusion of a full height porous screen (maximum porosity = 35-45%).
- Inclusion of the proposed porous balustrade, ensuring at least 1.5m height.
- Inclusion of the proposed full height impermeable screen
- Inclusion of the proposed 1.2m high balustrade (impermeable or porous).
- Inclusion of a 1.8m high impermeable screen.

Figure 6: Treatment Recommendations (Levels 4-11, Roof Level)

S4.55 Scheme

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APPENDIX A WIND EFFECTS GLOSSARY

A.1 Downwash and Upwash Effects

The downwash wind effect occurs when wind is deflected down the windward face of a building, causing accelerated winds 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 A.1.

This can also lead to recirculating flow in the presence of a shorter upstream building, causing local ground level winds to move back into 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.

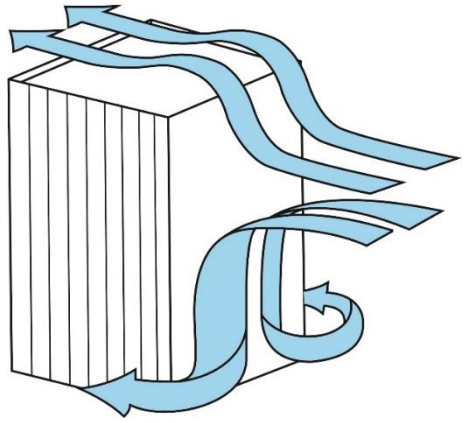

Figure A.1: Downwash Leading to Corner Wind Effect, and Upwash Effects

A.2 Funnelling/Venturi Effect

Funnelling occurs when the wind interacts with two or more buildings which are located adjacent to each other, which results in a bottleneck, as shown in Figure A.2. This causes the wind to be accelerated 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.

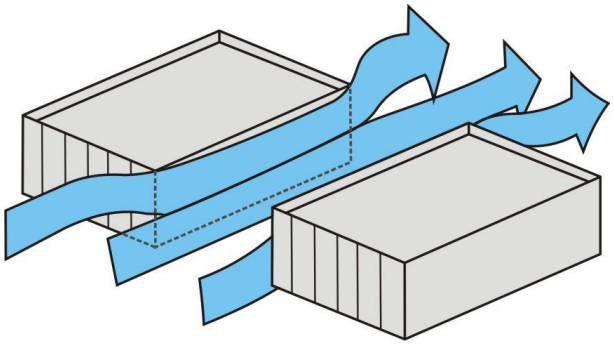

Figure A.2: Funnelling/Venturi Wind Effect

A.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 A.3. 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.

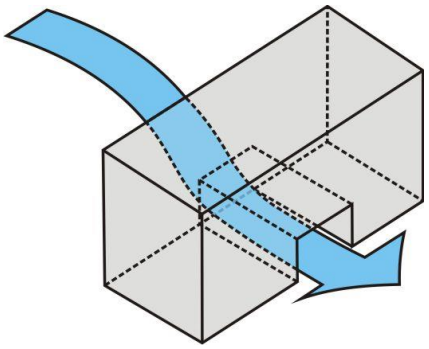

Figure A.3: Gap Wind Effect

A.4 Sidestream and Corner Effects

The sidestream effect is due to a gradual accumulation of wind 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 A.4. 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.

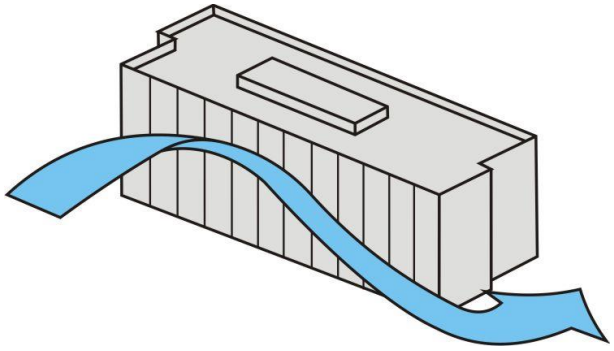

Figure A.4: Sidestream and Corner Wind Effect

A.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.