WINDTECH

PEDESTRIAN WIND ENVIRONMENT STATEMENT

31 O'CONNELL & 9 ALBERT STREET, NORTH PARRAMATTA

WI373-01F02(REV1)- WS REPORT
FEBRUARY 16, 2024

Prepared for:
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DOCUMENT CONTROL

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EXECUTIVE SUMMARY

This report presents an opinion on the likely impact of the proposed development located at 31 O'Connell & 9 Albert Street, North Parramatta, 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, south to south-easterly, 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.

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 January 25, 2024). 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 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:

Ground Level:

- Inclusion of 1.2m high impermeable or porous screens on the staircase leading to the through-site link between Buildings B and C.
- Inclusion of 1.2-1.5m high evergreen and densely foliating vegetation (e.g. hedges, shrubs) within the planter areas proposed to the west of Building C.
- Retention of the proposed impermeable canopy structures along the eastern and northern aspects.
- Inclusion of additional impermeable canopy structures to the west of Building C, as well as around south-eastern corner of Building B.
- Retention of the proposed trees within the site generally (ensuring that the trees are of a densely foliating and evergreen species capable of growing to a height of 3-5m, with 3-5m wide canopies).
- Inclusion of additional trees throughout the site, particular within the main through-site link and along the eastern aspect (ensuring that the trees are of a densely foliating and evergreen species capable of growing to a height of 3-5m, with 3-5m wide canopies).

<u>Important Notes:</u>

(1) The Ground Level of the proposed development also benefits from the existing line of dense and evergreen trees located to the west of the entire site. This assessment assumes that these trees will be retained. In their absence additional mitigation measure may be required to satisfy comfortable wind conditions along the western boundary of the site, including the proposed PCOS area situated to the west of Building C.

(2) The main through-site link (between Buildings B and D) is currently designated only for pedestrian circulation (i.e. walking) and not for activities that require short/long exposure criteria. If standing/sitting comfort is sought within this through-site link, then additional mitigation measures are recommended to be included within this space (e.g. strategic distribution of baffle screens and/or canopy structures).

Roof-Top Garden (Building C):

- Inclusion of a 1.5m high impermeable screen/balustrade along the exposed perimeter of the garden terrace.
- Inclusion of patches of 1.5m high evergreen and densely foliating vegetation (e.g. hedges, shrubs) along the central third of the garden to break-up the winds that re-attach past the perimeter screening.

Podium-Top Areas (Buildings A, B and D) – If accessible to building patrons:

- Inclusion of 1.5m high impermeable screening/balustrades along the exposed perimeters of the terraces.
- Inclusion of 1.5m high evergreen and densely foliating vegetation (e.g. hedges, shrubs) along the perimeters of the terraces (i.e. inside of the above perimeter screening).

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. However, the various corner balconies throughout the development are exposed to strong wind effects (typically corner acceleration), and are recommended to be treated as follows:

- Corner balconies at the various podium levels are recommended to be treated with the inclusion of a 1.2m high impermeable balustrades along the exposed perimeters.
- The corner balconies of the various tower levels are recommended to be treated with the inclusion of 1.5m high impermeable screening along the shorter aspect of each balcony (1.2m high standard balustrades are recommended to be included along the adjoining aspect(s)).

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 development will be suitable for their intended uses, and that the wind speeds will satisfy the applicable criteria for pedestrian comfort and safety. The wind conditions within and around the development are expected to satisfy the wind safety criterion generally and meet the walking comfort criterion within the pedestrian thoroughfares, as well as standing/sitting comfort criteria around the building entrances/communal spaces.

Wind tunnel testing is recommended to be undertaken at a more detailed design stage to quantitatively assess the wind conditions and to optimise the size and extent of the treatments required.

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 of the architectural drawings provided (Table 1), and any recommendations in this report are made only in-principle.

Table 1: List of Architectural Drawings Referenced

Drawing Title	Date
Lower Ground Floor	24/01/2024
Upper Ground Floor	24/01/2024
Lower Podium / Upper Podium	24/01/2024
Mid-Tower / Upper-Tower	24/01/2024
Section A-A with Key Plan	24/01/2024

2 DESCRIPTION OF DEVELOPMENT AND SURROUNDINGS

The site is located at 31 O'Connell & 9 Albert Street, North Parramatta, and is bounded by Albert Street to the north, O'Connell Street to the east and low rise residential and commercial buildings to the south and west. Parramatta river and some sporting complexes with a tall stadium can be found further towards south to south-west. The building morphology around the subject site as well as further away is general low, comprising of houses, low rise residential buildings and commercial tenancies.

A survey of the land topography indicates a gradual downward slope towards the south from the north and gradual slope towards the west from the east. However, 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 is predominantly an empty lot. The proposed development consists of four buildings. Tower A is 22 storeys high, tower B is 13 stories high, tower C is 6 stories high and tower D is 8 stories high.

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:

- Ground Level areas and pedestrian footpath, including the various through-site links.
- Roof-top Gargen (Building C).
- Private balconies and terraces.

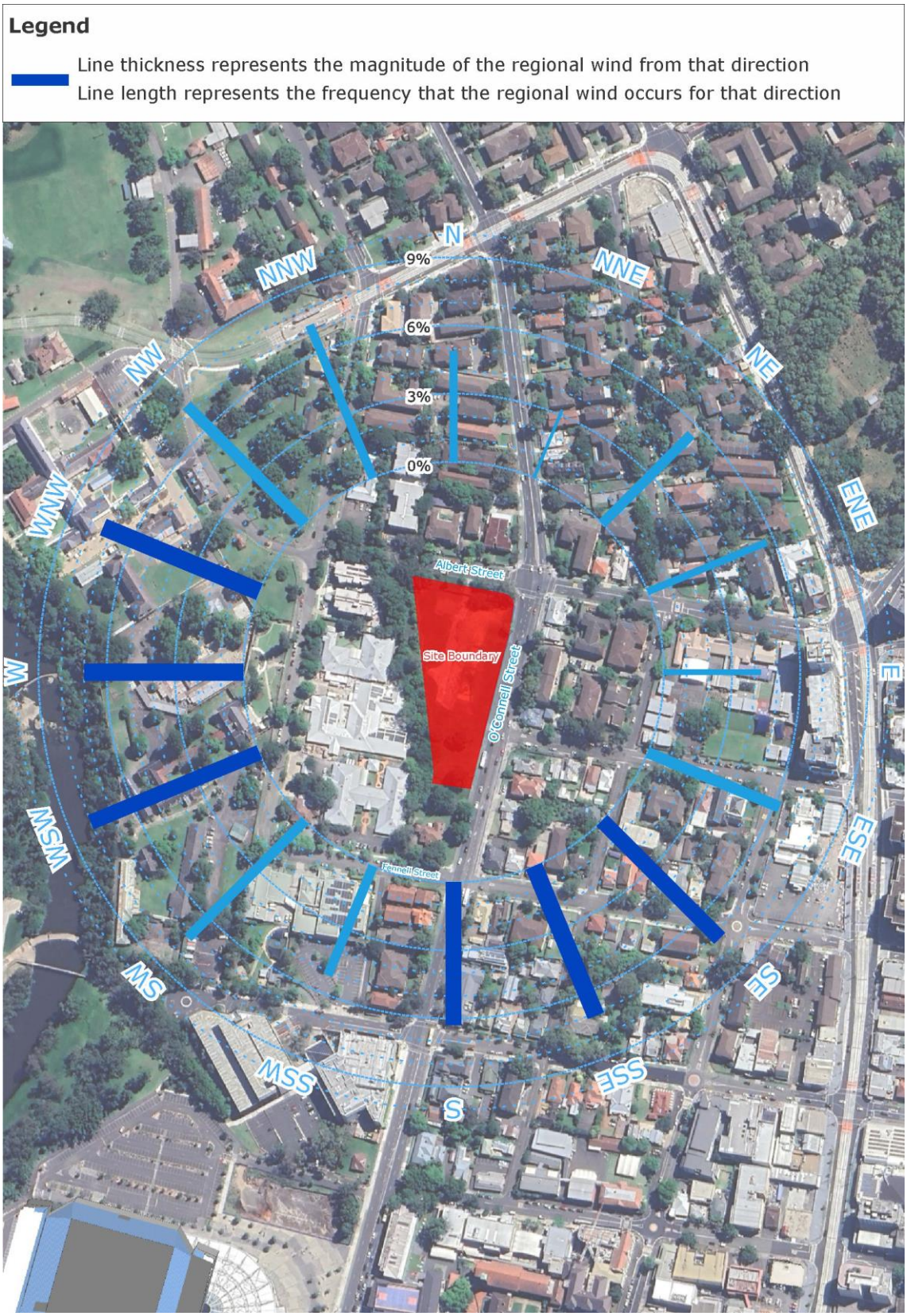

Figure 1: Aerial Image of the Site Location and Prevailing Wind Directions

3 REGIONAL WIND

The Bankstown region 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 from the meteorological station located at Bankstown Airport (recorded from 1993 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.

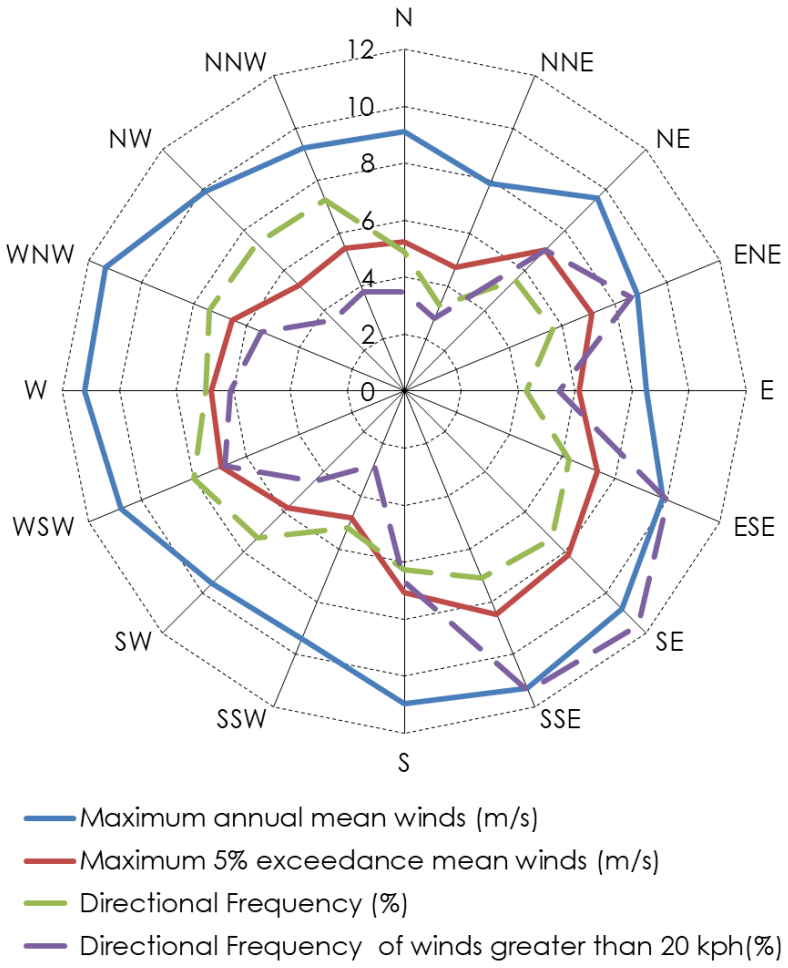

Figure 2: Directional Annual and 5% Exceedance Hourly Mean Wind Speeds (referenced to 10m height in standard open terrain), and Frequencies of Occurrence, for the Bankstown Region

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 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 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:

- 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.

- Standing (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.

- Sitting (Long Exposure) (4m/s with a 5% probability of exceedance)
  for stationary activities longer than an hour, e.g. outdoor cinemas, outdoor fine dining etc.

Note that the above wind comfort levels are derived from the Lawson (1975) criteria. 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 23m/s for the annual maximum gust.

5.1 Public Footpath Areas

The pedestrian footpath along O'Connel St is exposed to direct prevailing winds from the north-east and south, although the setback of the proposed massing along this aspect (6m) from the site boundary will avoid resulting adverse wind effects from impacting the footpath areas. The pedestrian footpath along Albert St is exposed to direct prevailing winds from the north-east and west, although the setback of the proposed massing along this aspect (6m) from the site boundary as well as the high density of existing vegetation situated to the west, are expected to shield Albert St from these prevailing winds generally. The alignment of the prevailing westerly winds with the northern aspect of the building may results in side-streaming effects along this aspect, however the 6m set-back of the building façade from the site boundary avoids these wind effects from impacting the footpath. Similar side-streaming wind effects (off the eastern façade) apply for the southerly winds travelling along O'Connel St, and the same set-back (6m) of the building façade from the site boundary avoids the prevailing southerly wind from impacting the O'Connel St footpath.

Given the above, the impact of the proposed building is expected to be minimal on the surrounding public footpath areas, where walking comfort conditions are expected to be met.

5.2 Ground Level

As discussed in Section 5.1, the ground plane around the subject site benefits from shielding of direct prevailing westerly winds by the existing dense line of mature trees located to the west of the entire site. It is assumed that these trees will be retained. Further to this, the main entrances to the proposed buildings are set-back/recessed into the building envelope, which shields these areas from direct prevailing winds.

The north-easterly winds that approach the site can have direct wind impacts as well as side streaming off the eastern and northern façades, which can also funnel through the through-site links between the various buildings. These wind effects can be ameliorated with the inclusion of strategic landscaping and with the retention of the awning structures proposed around the northern and eastern aspects of the development.

The alignment of the southerly winds with the eastern façade can cause side-streaming effects off the same façade, which can also generate some corner acceleration effects off the north-eastern corner of Building B and D and into the respective through-site links. These wind effects can be ameliorated with the inclusion of screening and tree planting along the eastern aspect of the development site. The relatively small width of the southern aspect of Building D will avoid down-washing effects of the southern façade, however the southerly winds that travel past Building D may be caught by the upper levels of Building B, which may down-wash towards the through-site link. The southerly winds that travel past Building B may caught by the upper levels of Building A, however any down-wash effects off this upper portion are expected to be relatively weak to cause any safety concerns within the communal space located to the south of Building A. The existing dense line of mature trees located to the west of the site are expected to ameliorate any direct effects of the southerly winds as well as westerly winds that impact the western aspect the development.

The westerly winds may down-wash off the western façade of Building C, which may also funnel through the narrower through-site links located to the north and south of Building C.

The following in-principle wind mitigation measures are recommended to be included/retained in the design to ameliorate the effects of prevailing winds on the Ground Level pedestrian trafficable areas (Refer to Figure 3):

- Inclusion of 1.2m high impermeable or porous screens on the staircase leading to the through-site link between Buildings B and C.
- Inclusion of 1.2-1.5m high evergreen and densely foliating vegetation (e.g. hedges, shrubs) within the planter areas proposed to the west of Building C.
- Retention of the proposed impermeable canopy structures along the eastern and northern aspects.
- Inclusion of additional impermeable canopy structures to the west of Building C, as well as around south-eastern corner of Building B.
- Retention of the proposed trees within the site generally (ensuring that the trees are of a densely foliating and evergreen species capable of growing to a height of 3-5m, with 3-5m wide canopies).
- Inclusion of additional trees throughout the site, particular within the main through-site link and along the eastern aspect (ensuring that the trees are of a densely foliating and evergreen species capable of growing to a height of 3-5m, with 3-5m wide canopies).

Important Notes:

(1) The Ground Level of the proposed development also benefits from the existing line of dense and evergreen trees located to the west of the entire site. This assessment assumes that these trees will be retained. In their absence additional mitigation measure may be required to satisfy comfortable wind conditions along the western boundary of the site, including the proposed PCOS area situated to the west of Building C.

(2) The main through-site link (between Buildings B and D) is currently designated only for pedestrian circulation (i.e. walking) and not for activities that require short/long exposure criteria. If standing/sitting comfort is sought within this through-site link, then additional mitigation measures are recommended to be included within this space (e.g. strategic distribution of baffle screens and/or canopy structures).

5.3 Roof-Top Garden (Building C)

The Roof-Top Garden located on Building C is exposed to all the prevailing winds for the region. Given the lack of shielding available from the surround building morphology, the prevailing winds can cause direct effects as well as corner acceleration effects as they side-stream along the south-eastern corner of Building A.

The following in-principle wind mitigation measures are recommended to be included in the design to ameliorate the effects of prevailing winds on Roof-Top Garden on Building C (Refer to Figure 4):

- Inclusion of a 1.5m high impermeable screen/balustrade along the exposed perimeter of the garden terrace.
- Inclusion of patches of 1.5m high evergreen and densely foliating vegetation (e.g. hedges, shrubs) along the central third of the garden to break-up the winds that re-attach past the perimeter screening.

5.4 Podium-Top Areas of Buildings A, B and D

The pre-liminary architectural plan provided shown no indication that the podium-top areas of Buildings A, B and D are accessible to building patrons. If these areas are accessible (e.g. if communal), the following treatment measures are recommended to be included in the design to ameliorate the effects of prevailing winds:

- Inclusion of 1.5m high impermeable screening/balustrades along the exposed perimeters of the terraces.
- Inclusion of 1.5m high evergreen and densely foliating vegetation (e.g. hedges, shrubs) along the perimeters of the terraces (i.e. inside of the above perimeter screening).

5.5 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. However, the various corner balconies throughout the development are exposed to strong wind effects (typically corner acceleration), and are recommended to be treated as follows:

- Corner balconies at the various podium levels are recommended to be treated with the inclusion of a 1.2m high impermeable balustrades along the exposed perimeters.
- The corner balconies of the various tower levels are recommended to be treated with the inclusion of 1.5m high impermeable screening along the shorter aspect of each balcony (1.2m high standard balustrades are recommended to be included along the adjoining aspect(s)).

5.6 Concluding Remarks

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 development will be suitable for their intended uses, and that the wind speeds will satisfy the applicable criteria for pedestrian comfort and safety. The wind conditions within and around the development are expected to satisfy the wind safety criterion generally and meet the walking comfort criterion within the pedestrian thoroughfares, as well as standing/sitting comfort criteria around the building entrances/communal spaces.

Wind tunnel testing is recommended to be undertaken at a more detailed design stage to quantitatively assess the wind conditions and to optimise the size and extent of the treatments required.

Figure 3: Recommended Treatments (Ground Level)

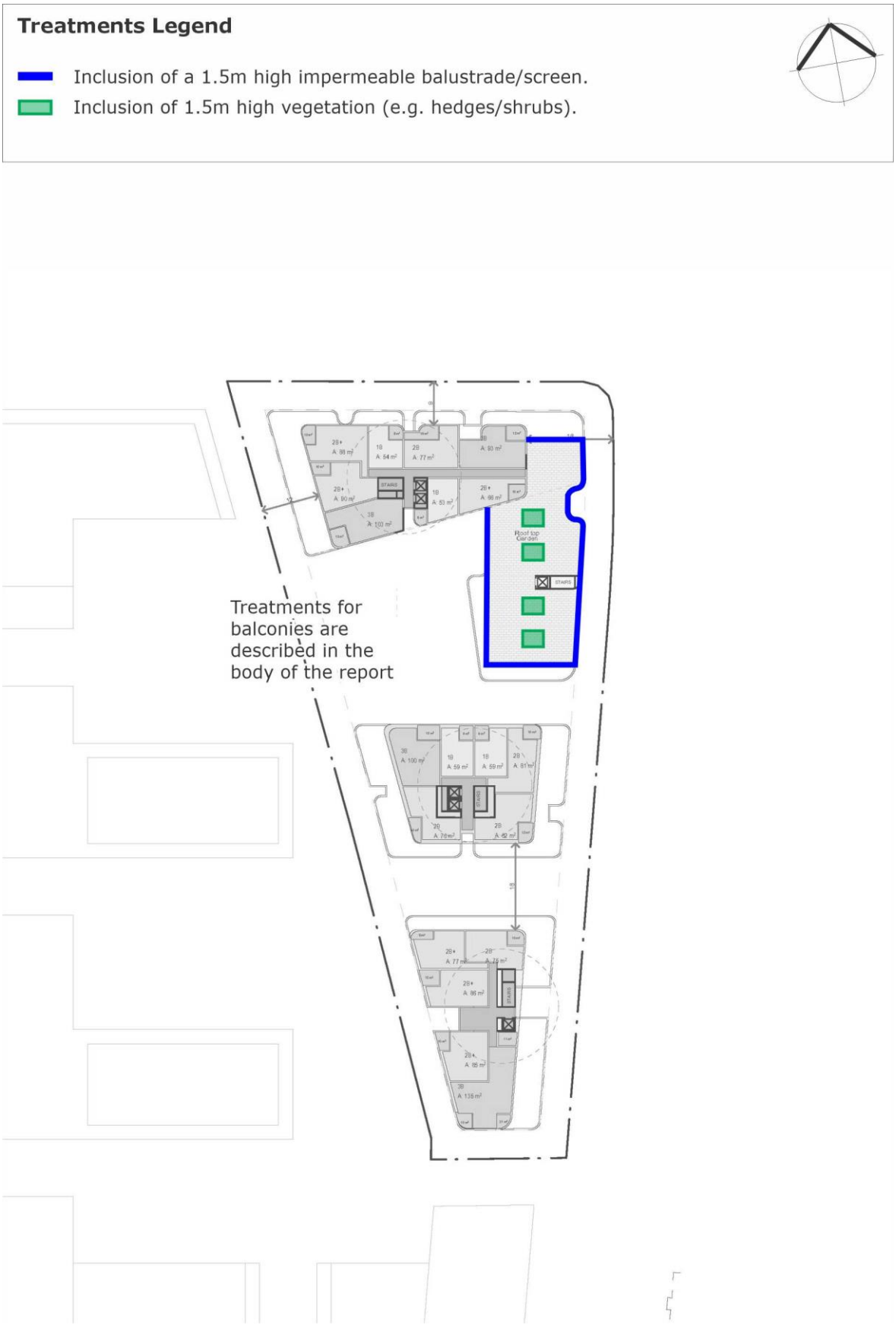

Figure 4: Roof-top Garden (Building C)

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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.

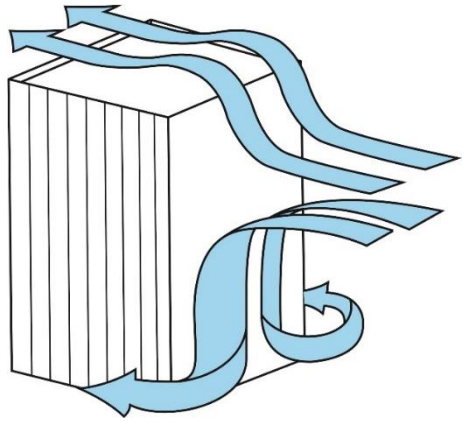

Figure A.1: Downwash Leading to Corner Wind Effect, and Upwash Effects

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.

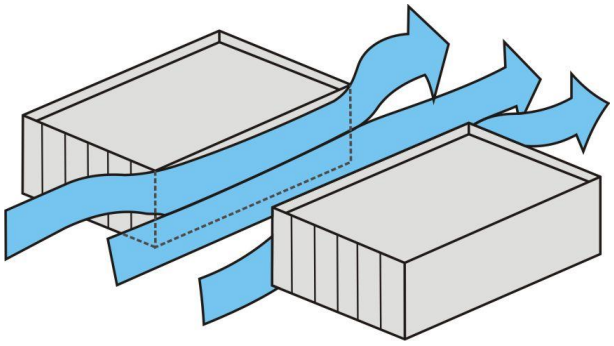

Figure A.2: Funnelling/Venturi Wind Effect

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.

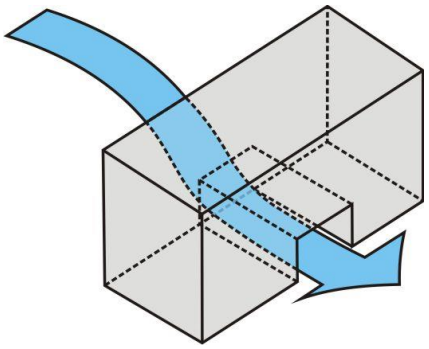

Figure A.3: Gap Wind Effect

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.

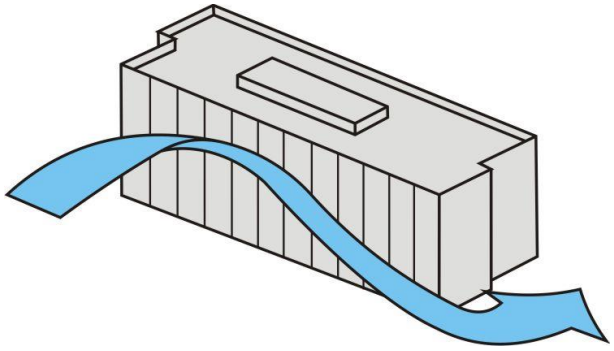

Figure A.4: Sidestream and Corner Wind Effect

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.