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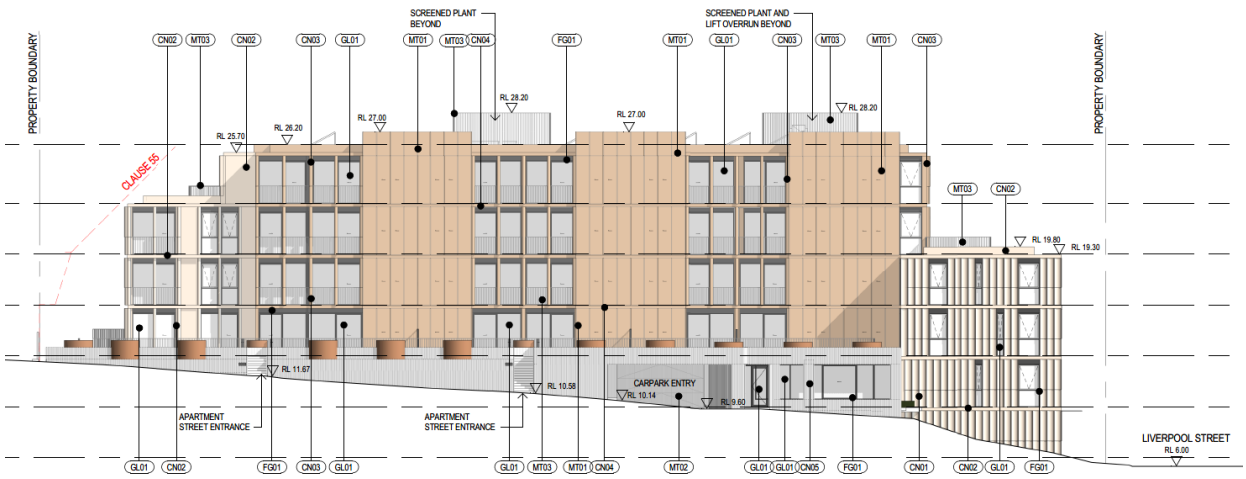

PEDESTRIAN WIND ENVIRONMENT STATEMENT

STAGE 5, BALMORAL QUAY, RIPPLESIDE, GEELONG

WG689-02F01(REV0)- WS REPORT

JULY 7, 2022

Prepared for:

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DOCUMENT CONTROL

Date	Revision History	Issued Revision	Prepared By (initials)	Instructed By (initials)	Reviewed & Authorised by (initials)
July 7, 2022	Update of WG689-01F02(rev0)- WS Report for updated drawings	0	DN	TR	RL

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EXECUTIVE SUMMARY

This report presents an opinion on the likely impact of the Stage 5 Balmoral Quay development, located in Rippleside, Geelong, 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 southerly, westerly, and north-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 1 July 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 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 trafficable areas:
    - Retention of the proposed awning over the main entryway.
    - Retention of the proposed dense landscaping along Liverpool Street and Harbourside Drive frontage.
    - Retention of densely foliating evergreen trees, capable of growing to a height of 3-4m, with a canopy diameter of 3-4m.
    - Recommended densely foliating evergreen trees along Liverpool Street and Harbourside Drive, capable of growing to a height of 3-4m, with a canopy diameter of 3-4m.
- Level 02 Private Balconies/Terraces:
    - Retention of the proposed landscaping planter zones along the private balcony perimeters. Vegetation should be of a densely foliating evergreen species, capable of growing to a height of 0.5m above a 1.0m planter box.
    - Retention of densely foliating evergreen trees, capable of growing to a height of 3-4m, with a canopy diameter of 3-4m.
    - Recommended 2.0m to full height impermeable privacy screens between private balconies.

- Level 03 Communal area:
    - Recommended 1.8m high impermeable privacy screen between Private Balcony and Communal Area.
    - Recommended 1.5-1.8m high impermeable perimeter screen
    - Strategic landscaping zone within central area of communal area. Vegetation should be of a densely foliating evergreen species, capable of growing to a height of 0.5m above a 1.0m planter box.
- Level 04 Private Balconies/Terraces:
    - Recommended 1.8m high impermeable privacy screen along the northern perimeter of the northern balconies, on the eastern perimeter of the south-eastern corner balcony, and on the western perimeter of the south-western corner balcony.
    - Retention of densely foliating evergreen shrubs capable of growing to a height of 0.5m above a 1.0m planter box between and along the southern aspect of the southern balconies.
- Level 05 Private Balconies/Terraces:
    - Recommended 1.8m high impermeable privacy screen along the western perimeter of the northern most balcony.
    - Retention of densely foliating evergreen shrubs capable of growing to a height of 0.5m above a 1.0m planter box along the northern and eastern aspects of the northern most balcony.
- Private Balconies
    - Recommended impermeable balustrades on all balconies.
    - Retention of full height impermeable intertenancy walls between private balconies.
    - Recommended full height impermeable end screens on balconies exposed to more than one aspect. It is also suitable to implement full height vertical louvres (porosity 20-30%) in-lieu of the impermeable screens. The orientation of the louvres is specific dependent on the balcony location and is detailed in Section 5.

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. Nonetheless, wind tunnel testing is recommended to be undertaken at a more detailed design 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, and any recommendations in this report are made only in-principle.

2 DESCRIPTION OF DEVELOPMENT AND SURROUNDINGS

The site is located at 1 Balmoral Crescent, Rippleside, Geelong, and is bounded by Balmoral Crescent to the west, Harbourside Drive to the east, Liverpool Street to the south.

The site is surrounded by low rise residential buildings to the immediate north and west with Port Phillip Bay extending outwards to the east and Rippleside Park to the south. The buildings surrounding the subject development further to the north, south and west are predominately low-rise residential and commercial buildings.

A survey of the land topography indicates a gradual slope down towards the east due to the shoreline of Port Phillip Bay and towards Rippleside Park, with the steepest elevation changes immediately surrounding the site along Balmoral Crescent forming the north and west perimeter.

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 consists of undeveloped land.

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 footpaths.
- Communal Open Spaces in the centre of the site at ground level and at the north-eastern aspect on Level 03.
- Private balconies and terraces.

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

3 REGIONAL WIND

The Geelong region is governed by three principal wind directions that can potentially affect the subject development. These winds prevail from the west, south, and north-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 Avalon Airport from 1997 to 2015. 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.

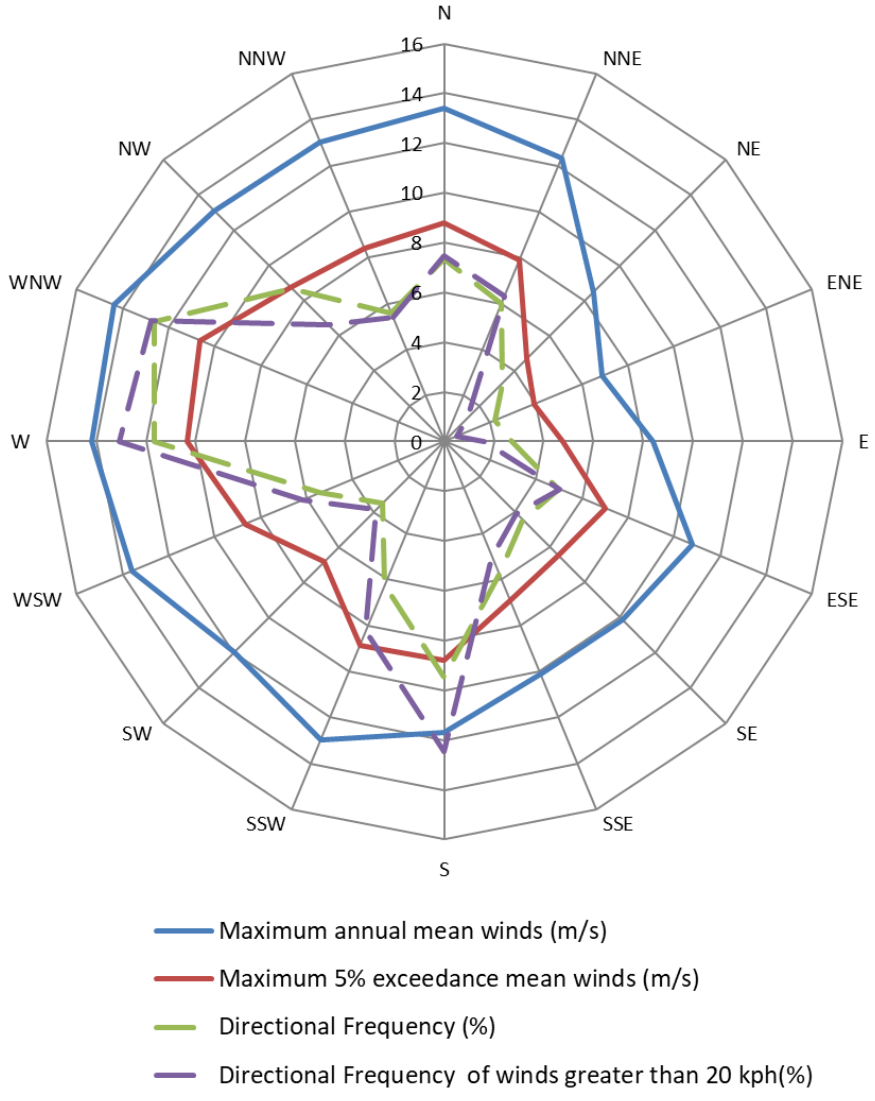

Figure 2: Directional Annual and 5% Exceedance Hourly Mean Wind Speeds (referenced to 10m height in standard open terrain), and Frequencies of Occurrence, for the Geelong Region

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 (7.5m/s to 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 (5.5m/s to 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.

Note that the lower end of the above ranges reflect the Davenport (1972) criteria and the upper end of these ranges reflect a modified 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 Ground Level Areas

The pedestrian footpath area along Liverpool Street is primarily exposed to the prevailing westerly and southerly winds due to the east-west alignment and exposure from Rippleside Park. The southern façade consists of a building setback on Level 4 as well as an awning above the main entry, which are expected to assist with any downwash effects from the prevailing southerly winds. The southern frontage consists of landscaping, which is recommended to consist of densely foliating evergreen hedges capable of growing to a minimum height of 0.5m above 1.0m planter boxes. The vegetation is expected to filter the prevailing westerly winds. It is recommended to implement densely foliating evergreen trees along Liverpool frontage to assist with the side streaming westerly winds.

The footpath along Harbourside Drive is expected to be exposed to the prevailing southerly winds, with the potential for the prevailing north-westerly winds to wrap around the north-eastern building corner. Due to the north-south alignment of Harbourside Drive the prevailing southerly winds have the potential to sidestream along the pedestrian footpath area. The proposed vegetation and tree planting along Harbourside Drive is recommended to be retained. It is recommended to add an additional tree at the south-eastern corner of the development, so that the trees are planted in a cluster, therefore increasing the density of the canopies. The eastern façade consists of a stepped design, with recessed balconies, which has the potential to disrupt the strength of the sidestreaming wind effects.

The northern area of the Ground Level consists of a grassed area with proposed tree planting. The trees are recommended to be retained so to filter the prevailing westerly winds which may wrap around the north-eastern corner of the site. It is recommended that the trees are planted in clusters, such that the canopies are capable of interlocking. The trees should be of a dense evergreen species so to provide year-round protection. The above-mentioned treatments are shown in Figure 3 below.

5.2 Communal Open Spaces

The Communal Garden Courtyard on Level 01 is positioned in a well enclosed central location, is exposed to a single aspect and incorporates significant landscaping centrally and along the perimeters. The building form protects the courtyard from the prevailing winds and remains exposed only to the winds from the northern sector. Direct winds are expected to be mitigated due to the sufficient height of the development as well as the surrounding terrain and trees to the north-east.

The Communal Roof Terrace on Level 03 is exposed to the prevailing winds and is expected to be impacted by the southerly winds wrapping around the south-east aspect as well as direct winds from the north and east, which do not receive any shielding from the neighbouring development. Due to the exposure of this communal space the following recommendations should be implemented to assist with the expected adverse wind conditions:

- Recommended 1.8m high impermeable privacy screen between the private balcony areas and communal area.
- Recommended 1.5-1.8m high impermeable perimeter screening along the perimeter of the courtyard and private balcony.
- Centrally located landscape zones with densely foliating evergreen vegetation/hedges capable of growing to a minimum height of 0.5m above a 1.0m planter box.

The abovementioned treatments are shown in Figure 4 below. It is also recommended to retain the perimeter landscape zones, to consist of densely foliating evergreen vegetation/hedges. Tree planting within this zone is recommended in clusters so that the canopies are capable of interlocking.

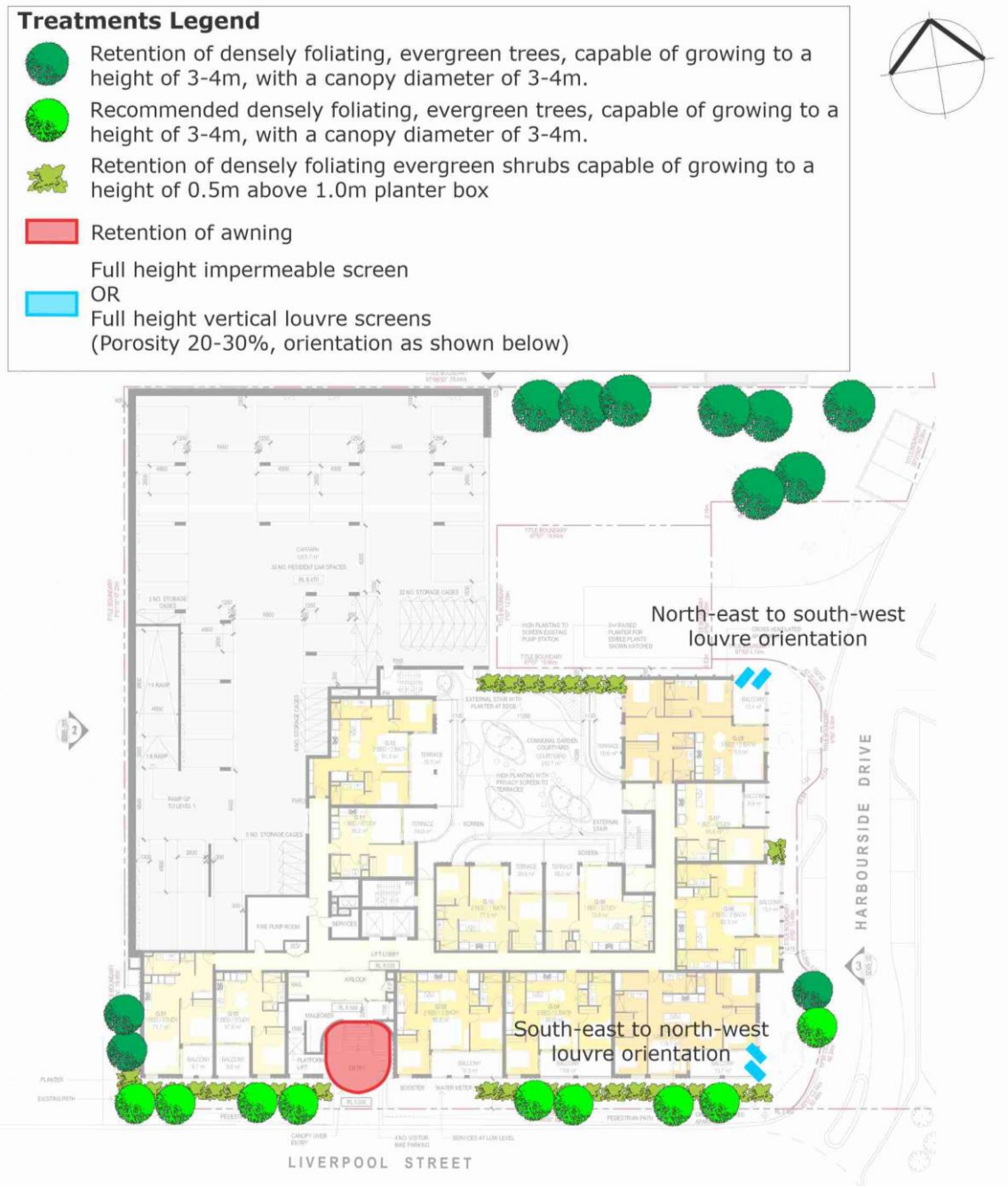

Figure 3: Recommended Treatment for the Ground Level and Level 01 Communal Open Space

Figure 4: Recommended Treatment for Level 03 Open Space

5.3 Private Balconies

The site is generally exposed to the south and the north-east wind directions, which receive minimal shielding and has the potential to impact the balcony areas due to direct winds, especially at the higher floor levels. The majority of the balconies are generally well recessed within the floor plan, therefore limiting exposure to a single aspect, which is a feature that should be retained. The balconies located at the corners of the floor plans are expected to experience adverse wind conditions due to wrap around wind conditions from the prevailing westerly and southerly winds.

It is recommended that impermeable balustrades be incorporated on all balconies, with full height intertenancy impermeable screens between balconies and full height impermeable end screens on balconies which are exposed to more than one aspect. There is the option to incorporate full height vertical louvre screens on the end screens (porosity 20-30%), however the orientation of the louvres would need to be as shown in the figures below.

The Level 2 balconies consist of a larger floor area than the remainder of the development. These balconies consist of planters along the external perimeter, which should be retained. The planting is recommended to be of a dense evergreen species, capable of growing to a minimum height of 0.5m above a 1.0m planter.

It is recommended to implement a full height impermeable screen along the eastern perimeter of the south-east balconies located on Ground to Level 3 as well as the northern perimeter of the northern corner balconies. The screening can be full height vertical louvres (porosity 20-30%) which are orientated south-east to north-west.

The Level 4 corner balconies corner are susceptible to adverse corner acceleration winds due to the prevailing southerly and westerly winds. It is recommended to incorporate a full height impermeable screen along one of the exposed aspects to assist with these wind conditions. The screening can be full height vertical louvres (porosity 20-30%) which are orientated as shown in Figure 6. It is also recommended to retain the densely foliating evergreen shrub plantings between and along the southern balconies on Level 4. These plantings should be capable of growing to a minimum height of 0.5m above a 1.0m planter.

It is recommended to implement a full height impermeable screen along the eastern perimeter of the eastern corner balconies located on Level 5. The balcony located at the northern end of Level 5 is exposed to the prevailing westerly and north-easterly winds. It is recommended to implement a 1.8m high impermeable perimeter screen along the western perimeter, combined with densely foliating evergreen vegetation/shrubs within the surrounding landscape zone, so to deflect and filter the direct wind impact. The abovementioned treatments are shown in Figure 7 below.

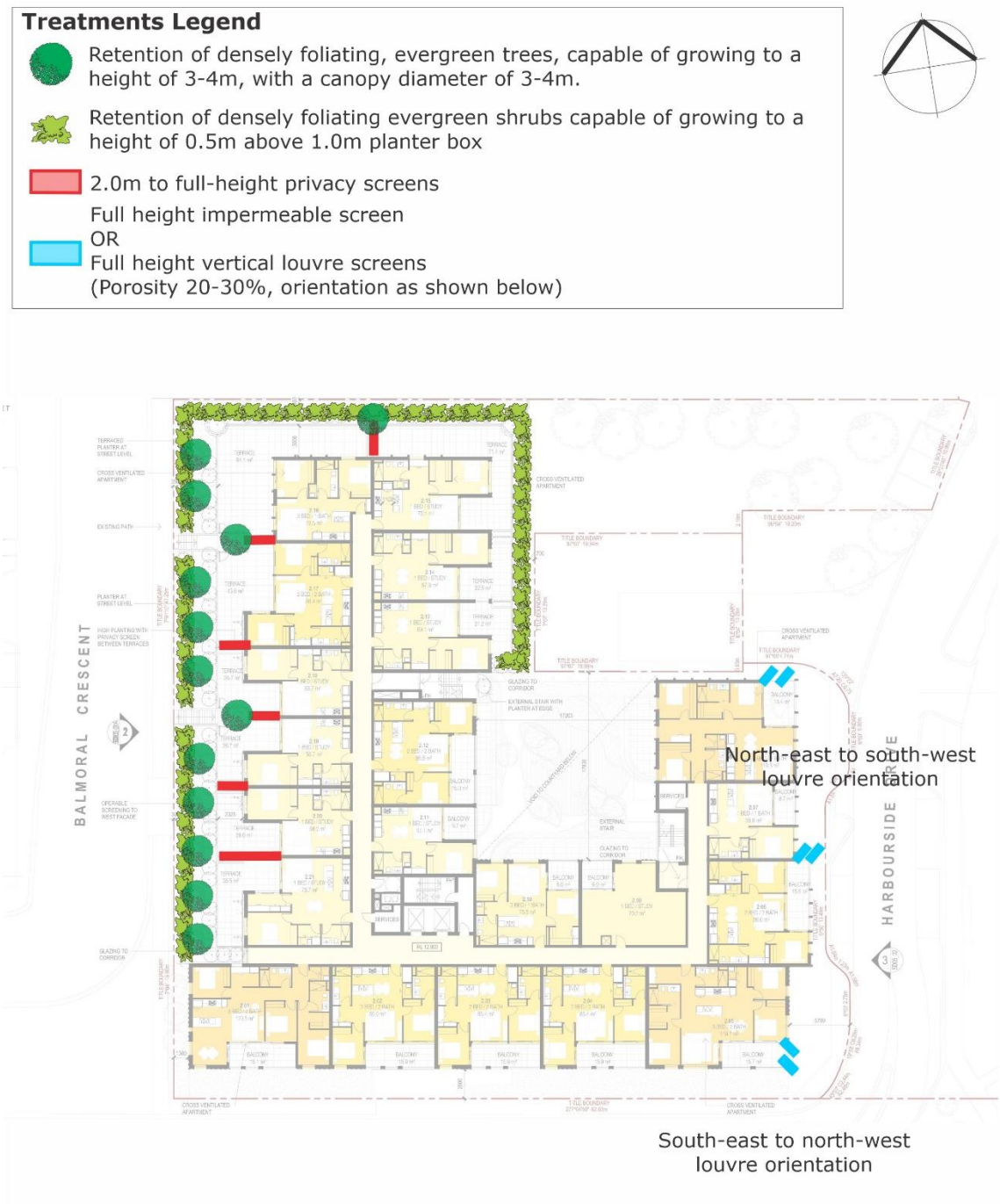

Figure 5: Recommended Treatment for Level 02

Figure 6: Recommended Treatment for Level 04

Figure 7: Recommended Treatment for Level 05

6 REFERENCES

Davenport, A.G., 1972, "An approach to human comfort criteria for environmental conditions". Colloquium on Building Climatology, Stockholm.

Lawson, T.V., 1973, "The wind environment of buildings: a logical approach to the establishment of criteria". Bristol University, Department of Aeronautical Engineering.

Lawson, T.V., 1975, "The determination of the wind environment of a building complex before construction". Bristol University, Department of Aeronautical Engineering.

Lawson, T.V., 1980, "Wind Effects on Buildings - Volume 1, Design Applications". Applied Science Publishers Ltd, Ripple Road, Barking, Essex, England.

Melbourne, W.H., 1978, "Criteria for Environmental Wind Conditions". *Journal of Wind Engineering and Industrial Aerodynamics*, vol. 3, pp241-249.

Penwarden, A.D. (1973). "Acceptable Wind Speeds in Towns", Building Science, vol. 8: pp259–267.

Penwarden, A.D., Wise A.F.E., 1975, "Wind Environment Around Buildings". Building Research Establishment Report, London.

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.

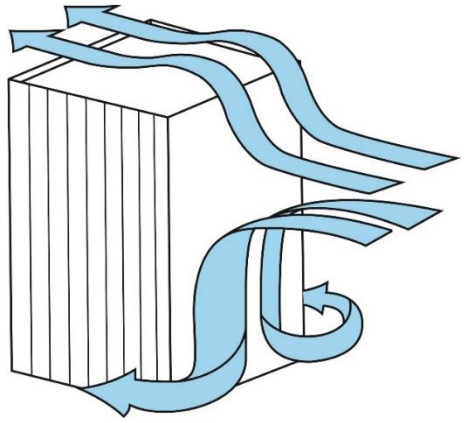

Figure A.1: Downwash Leading to Corner Wind Effect, and Upwash Effects

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.

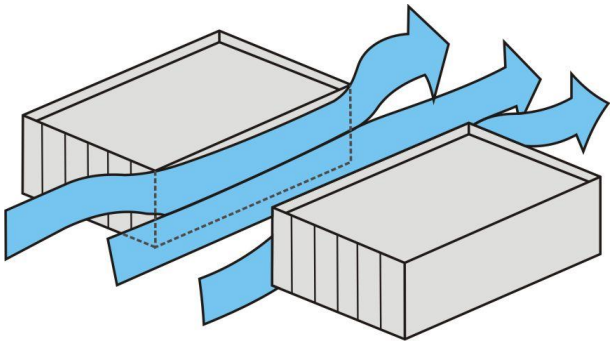

Figure A.2: Funnelling/Venturi Wind Effect

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.

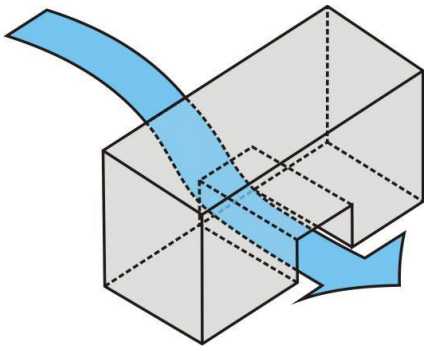

Figure A.3: Gap Wind Effect

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.

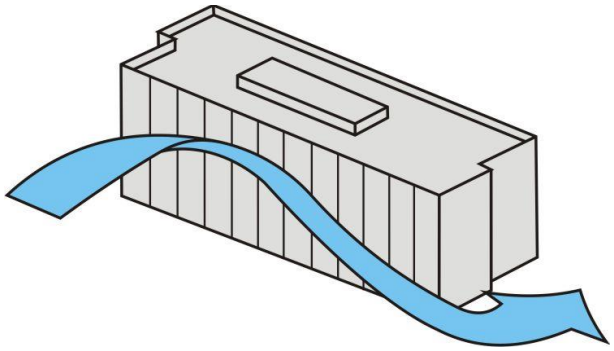

Figure A.4: Sidestream and Corner Wind Effect

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.