IVANHOE STAGE 2

Qualitative Environmental Wind Assessment

Prepared for:

Frasers Property Australia
Level 2, 1C Homebush Bay Drive, RHODES, 2138 NSW

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PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Tenancy 202 Submarine School, Sub Base Platypus, 120 High Street
North Sydney NSW 2060 Australia

T: +61 2 9427 8100
E: sydney@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Frasers Property Australia (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.30337-R01-v1.0	7 July 2021	James Cleary	Neihad Al-Khalidy	Neihad Al-Khalidy

EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Frasers Property Australia to undertake a qualitative wind assessment of the proposed Ivanhoe Stage 2 development, located off Epping Road, Macquarie Park. This assessment forms part of the development application to the Department of Planning NSW.

The Ivanhoe Estate is situated to the northeast of Epping Road, with surrounds consisting of dense urban development of varying heights to surrounding aspects.

Within the context of the Ivanhoe Site, Site 2 will comprise development across Subject Sites C2, C3 and C4. The Stage 2 development will be bound by Main Street to the north, The eastern Ivanhoe Site boundary to the east, Neighbourhood Street 2 to the south and Site C1 to the west.

Prevailing wind directions of interest in Sydney are from northeast, south, southeast and west quadrants. Their seasonal variation is described in **Section 2** of this report.

Existing Winds

Existing street level wind conditions in the vicinity of the site could be close to the 16 m/s *"walking comfort"* criterion for some prevailing wind directions given the orientation of the site and the spacing of upstream shielding afforded to the site, by surrounding buildings and vegetation. In particular adverse winds of more than 16 m/s may occur from the southeast and southwest due to reduced wind shielding.

Future Wind Environment

In terms of the future wind environment for the proposed development, SLR has found the design to satisfy windspeed design safety criteria. When considering comfort criteria, SLR has determined that ground level wind speeds should remain within acceptable levels, with there being some upper level spaces where comfort conditions may be exceeded. SLR has provided recommendations within this report to mitigate the impact of adverse wind conditions throughout the development.

The following features of the development are noted as being of most significance:

- The winds along the surrounding footpaths should remain at similar levels with consideration of the approved public domain plans.
- There may be some potential for wind channelling between buildings, landscaping should mitigate the associated risks.
- Upper level balconies may require additional shielding, to be determined during detailed design via quantitative wind assessment.
- Vertical windbreaks are recommended to upper level open areas, the full extent of required shielding will be determined through quantitative assessment.

The above analysis has been made on the basis of our best engineering judgment and on the experience gained from scale model wind tunnel testing and CFD analysis of a range of developments.

Wind Tunnel Testing will be conducted to quantify wind speeds and specify the exact mitigation treatments at the areas of interest.

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1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Frasers Property Australia to undertake a qualitative wind assessment of the proposed Ivanhoe Stage 2 development, located off Epping Road, Macquarie Park. This assessment forms part of the development application to the Department of Planning NSW.

1.1 Site and Surrounds

1.1.1 Ivanhoe Site

The Ivanhoe Estate is situated to the northeast of Epping Road, with surrounds consisting of:

- Low to medium-rise development to the north.
- Highrise commercial buildings to the east.
- Low-level development on the southern side of Epping Road.
- Highrise development to the west.

1.1.2 Stage 2 Development

Within the context of the Ivanhoe Site, Site 2 will comprise development across Subject Sites C2, C3 and C4. The Stage 2 development will be bound by Main Street to the north, The eastern Ivanhoe Site boundary to the east, Neighbourhood Street 2 to the south and Site C1 to the west.

Figure 1 Aerial View of Proposed Development Site

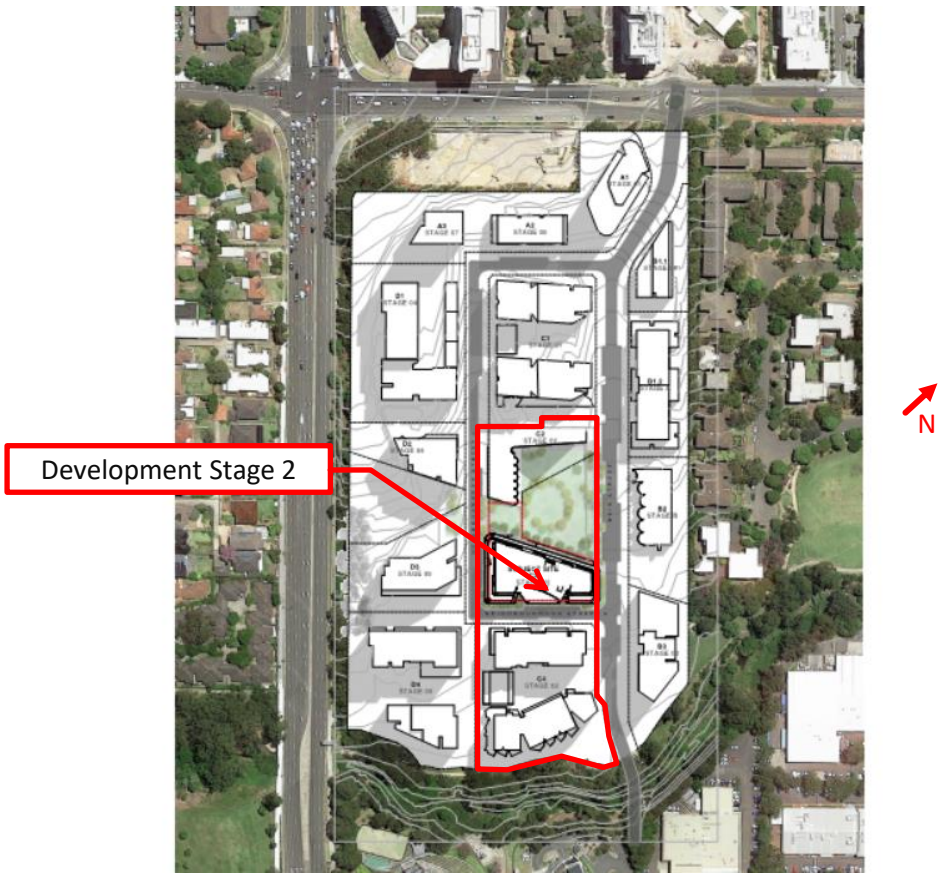
Image: Nearmap (December 2020)

1.2 Proposed Development Description

The proposed report will focus on sites C2, C3 and C4 of the planned development. From the plans provided, the proposed development contains the following:

- Site C2 with:
  - Three (3) storey community building with pool, gym and café adjacent to the Village Green, a new public park.
- Site C3 with:
  - Basement car parking
  - Ground level with building lobbies, supermarket, retail tenancies and loading dock;
  - Level 1 podium with residential apartments and rooftop garden;
  - Level 2-4 podium with residential apartments;
  - Level 5-14 with residential apartments;
  - Forest rooms on levels 5-7 and 10-12;
  - Level 15 with residential apartments, communal conference room, communal outdoor area and garden; and
  - Level 16 residential apartments.
- Site C4 with:
  - Basement car parking;
  - Ground level with building lobbies, residential apartments, communal outdoor area and central courtyard;
  - Level 1-17 with residential apartments;
  - Level 18 with residential apartments and sky garden;
  - Level 19-23 with residential apartments; and
  - Level 22 private terrace.

Figure 2 Context Plan



2 Sydney's Wind Climate

The data of interest in this study are the mean hourly wind speeds and largest gusts experienced throughout the year (especially higher, less frequent winds), how these winds vary with azimuth, and the seasonal break-up of winds into the primary Sydney Region wind seasons.

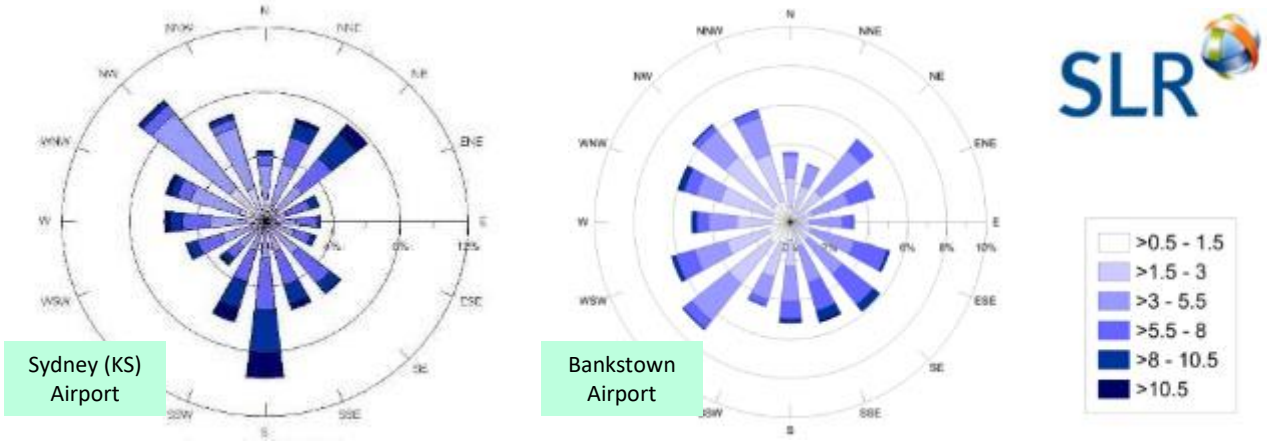
2.1 Annual and Seasonal Variations

Key characteristics of Sydney's Regional Wind Climate are illustrated in two representative wind roses shown in **Figure 3**, taken from Bureau of Meteorology (BoM) data recorded during the period 1999-2017 at Sydney (Kingsford Smith) Airport and Bankstown Airport. A review of the associated seasonal wind roses (refer **Appendix A**) shows that Sydney is affected by two primary wind seasons with relatively short (1-2 month) transition periods in between:

- Summer winds occur mainly from the northeast, southeast and south. While northeast winds are the more common prevailing wind direction (occurring typically as offshore land-sea breezes), southeast and southerly winds generally provide the strongest gusts during summer. Both northeast winds (as sea breezes) and stronger southerly winds associated with "Southerly Busters" and "East Coast Lows" typically have a significantly greater impact along the coastline. Inland, these systems lose strength and have altered wind direction characteristics.

- Winter/Early Spring winds occur mainly from west quadrants and to a lesser extent from the south. West quadrant winds provide the strongest winds during winter and in fact for the whole year, particularly at locations away from the coast.

Figure 3 Annual Wind Roses for Sydney (KS) Airport and Bankstown Airport (BoM Data)



2.2 Wind Exposure at the Site – the "Local"' Wind Environment

Close to the ground, the "regional" wind patterns described above are affected by the local terrain, topography and built environment, all of which influence the "local" wind environment.

- As noted in **Section 1**, the site is currently surrounded by low to mid rise development to the north, northeast and east, low rise development to the south and some higher level construction to the west and northwest.
- The site will therefore receive moderate wind shielding to some of the prevailing wind directions with some greater wind shielding provided to the west.

2.3 Design Wind Speeds

SLR has carried out a detailed study of Sydney Basin wind speeds using continuous records of wind speed and direction measured at the Bureau of Meteorology's (BoM) Sydney weather stations. The above analysis is described in detail in …

- SLR Technical Note: *"9300-TN-CW&E-v2.0 Sydney Region Design Winds"*, March 2018.

In particular, SLR has determined statistical wind information for locations not situated in close proximity (ie within say approximately a kilometre) of BoM weather stations. Particular emphasis was given to weather stations with a "clean" surrounding exposure, ie stations such as Sydney (Kingsford Smith) Airport and Bankstown Airport, which are relatively free of immediately surrounding obstacles such as buildings, vegetation, trees, etc, which would otherwise distort the winds seen by the weather station anemometer.

For Macquarie Park, SLR has determined that local upper level winds reflective of the weather systems experienced at the site have characteristics in between Bankstown Airport than Sydney (KS) Airport, given the site's distance (15 km) inland from the coast compared to Bankstown Airport (25 km) and Sydney (KS) Airport (5 km).

Accordingly, the adopted Macquarie Park wind model has slightly lower strength characteristics from the northeast and south compared to Sydney (Kingsford Smith) Airport and correspondingly higher strengths from the southeast and southwest/northwest relative to Sydney (KS) Airport.

3 Wind Acceptability Criteria

3.1 Standard Local Government Criteria

The choice of suitable criteria for evaluating the acceptability of particular ground level conditions has been the subject of relatively recent research. The acceptability criteria that have been developed from this research and currently referenced by most Australian Local Government Development Control Plans have been summarised below in **Table 1**.

Table 1 Standard Local Government Wind Acceptability Criteria

Type of Criteria	Limiting Gust Wind Speed Occurring Once Per Year	Activity Concerned
Safety	**24 m/s**	**Knockdown in Isolated Areas**
	23 m/s	**Knockdown in Public Access Areas**
Comfort	**16 m/s**	**Comfortable Walking**
	13 m/s	**Standing, Waiting, Window Shopping**
	10 m/s	**Dining in Outdoor Restaurant**

The primary objectives relating to the above wind impact criteria are as follows:

- The general objective is for annual 3-second gust wind speeds to remain at or below the so-called 16 m/sec "Walking Comfort" criterion. Whilst this magnitude may appear somewhat arbitrary, its value represents a level of wind intensity which the majority of the population would find unacceptable for comfortable walking on a regular basis at any particular location.
- In many urban locations, either because of exposure to open water conditions or because of street "canyon" effects, etc., the 16 m/s "Walking Comfort" level may already be currently exceeded. In such instances a new development should ideally not exacerbate existing adverse wind conditions and, wherever feasible and reasonable, ameliorate such conditions.

It can be seen in **Table 1** that the recommended limiting wind speeds for spaces designed for activities such as seating, outdoor dining, etc., are lower than for "walking comfort".

3.2 Application of Standard Council Wind Criteria

The criteria provided in **Table 1** should not be viewed as *"hard"* numbers as the limiting values were generally derived from subjective assessments of wind acceptability. Such assessments have been found to vary with the height, strength, age, etc., of the pedestrian concerned.

A further factor for consideration is the extent of windy conditions, and some relaxation of the above criteria may be acceptable for small areas under investigation provided the general site conditions satisfy the relevant criteria.

Finally, it is noted that the limiting wind speed criteria in **Table 1** are based on the maximum wind gust occurring (on average) once per year. Winds at all other times, i.e. monthly winds, weekly winds, etc., would be of lesser magnitude. So for example, a location with a maximum annual gust of 10 m/sec would experience winds throughout the year of a generally very mild nature, conducive to stationary activities (seating, dining, etc).

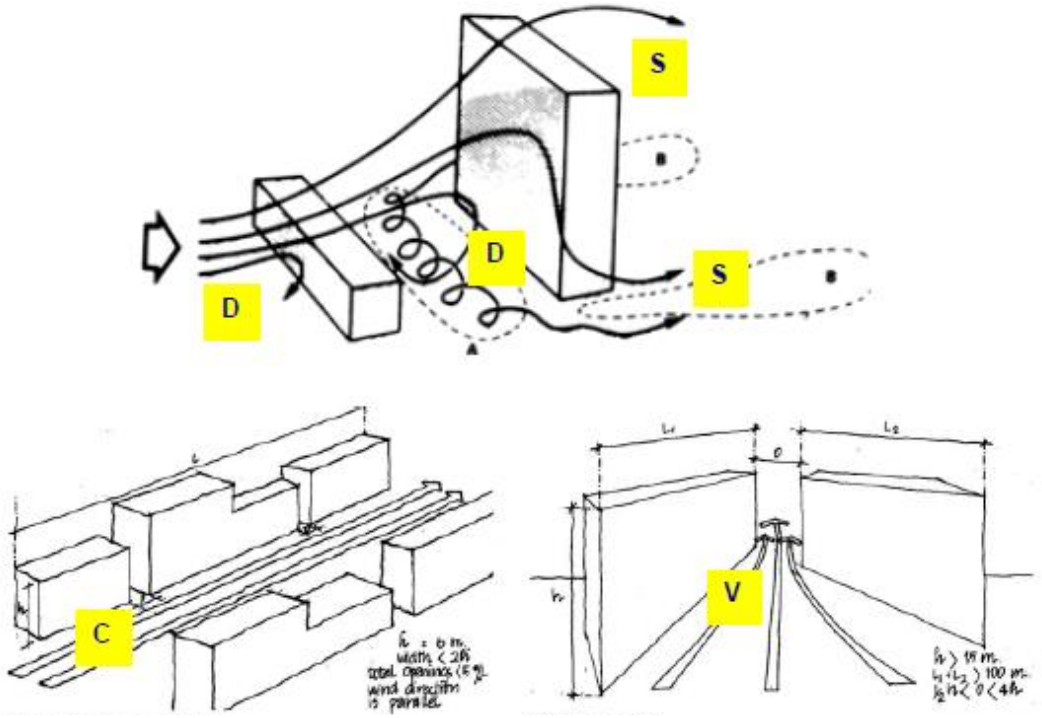
4 Building-Wind Interaction – Some General Observations

The impact of wind flowing past buildings has well known general impacts at ground level – refer **Figure 4**:

- **Downwash winds "D"** are the winds which impact on the windward face of a building and are then deflected downwards to ground level in a vertical direction
- Accelerating **Shearflow winds "S"** are the winds which experience an acceleration as they pass by the building edges and roof, as the wind flow moves around and past the building

In general, the taller the building, the more pronounced the impact on ground level winds. Local building details can also influence winds in the immediate vicinity; eg building undercrofts are often associated with local acceleration of winds.

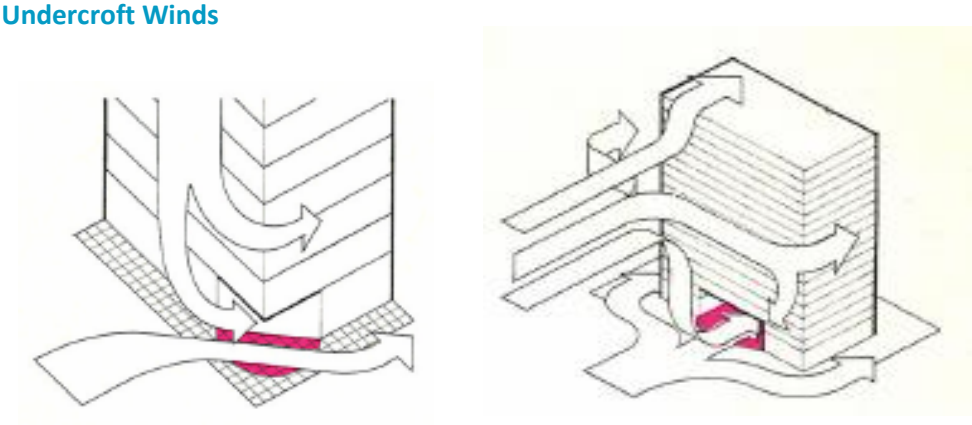
Figure 4 Wind flow Patterns Past Regular Shaped Buildings



The grouping of buildings can also have an impact on resulting pedestrian winds – refer **Figure 4**:

- **Canyon Effect winds "C"** result when there are rows of parallel buildings (especially taller ones) where the gaps in between line up with prevailing wind directions.
- **Venturi Effect winds "V"** result when wind flow is forced to pass between two converging buildings or groups of buildings with a resulting increase in flow.
- **"Undercroft"** effect is a well-known adverse building-wind characteristic as depicted in the generic building wind effect diagrams shown in **Figure 5**. The winds are induced towards the negative pressure area within the undercroft, creating concentrated adverse wind flow through undercrofts.

Figure 5 Undercroft Winds



Building Undercrofts (left) and Building Cross-Façade Openings (right) can induce concentrated adverse wind flow past and through a building.

5 Wind Impact of the Proposed Development

5.1 Existing Winds – Wind Impacts and Effects

Existing street level wind conditions in the vicinity of the site could be close to the 16 m/s *"walking comfort"* criterion for some prevailing wind directions given the orientation of the site and the spacing of upstream shielding afforded to the site, by surrounding buildings and vegetation. In particular adverse winds of more than 16 m/s may occur from the southeast and southwest due to reduced wind shielding.

Northeast Winds

There is generally low to medium level developments to the northeast of the development. Northeast winds are generally mild and the potential therefore for exceedance of the 16 m/s criterion along the pedestrian pathways at the site is small, i.e. occurrences, if any, are likely to be very infrequent. Existing vegetation should provide further shielding to the current environment.

South and South Easterly Winds

The site has reasonable shielding to the southeast with most of that available being low level. Some reduced shielding is present to the south and southeast. There may be some expectation for exceeding of the 16m/s walking criterion for adjoining pedestrian pathways, with potential for channelling of winds along the Epping road.

Westerly Winds

There is predominantly high-level residential development to the west of the proposed site, with mid-level shielding also present to the northwest. Existing development and vegetation should provide good shielding to winds approaching the site from the west.

Upper Level Winds

Existing upper level wind conditions at the site are likely to exceed the 10 m/sec comfort criterion for some of the stronger prevailing wind directions (eg south, southeast and southwest).

5.2 Future Winds – Predicted Wind Flow Patterns

The following sections analyse the expected impacts of the proposed development on the pedestrian wind environment in the adjacent streetscape.

The wind impact of the proposed development is described by examining the impact of prevailing wind conditions on all public access areas of interest within and external to the development.
Areas of interest (i.e. surrounding footpaths, primary entry points, internal public access areas, seating and dining areas, etc) are identified in **Figure 6** and **Figure 11**.

Figure 6 Areas of Interest C2

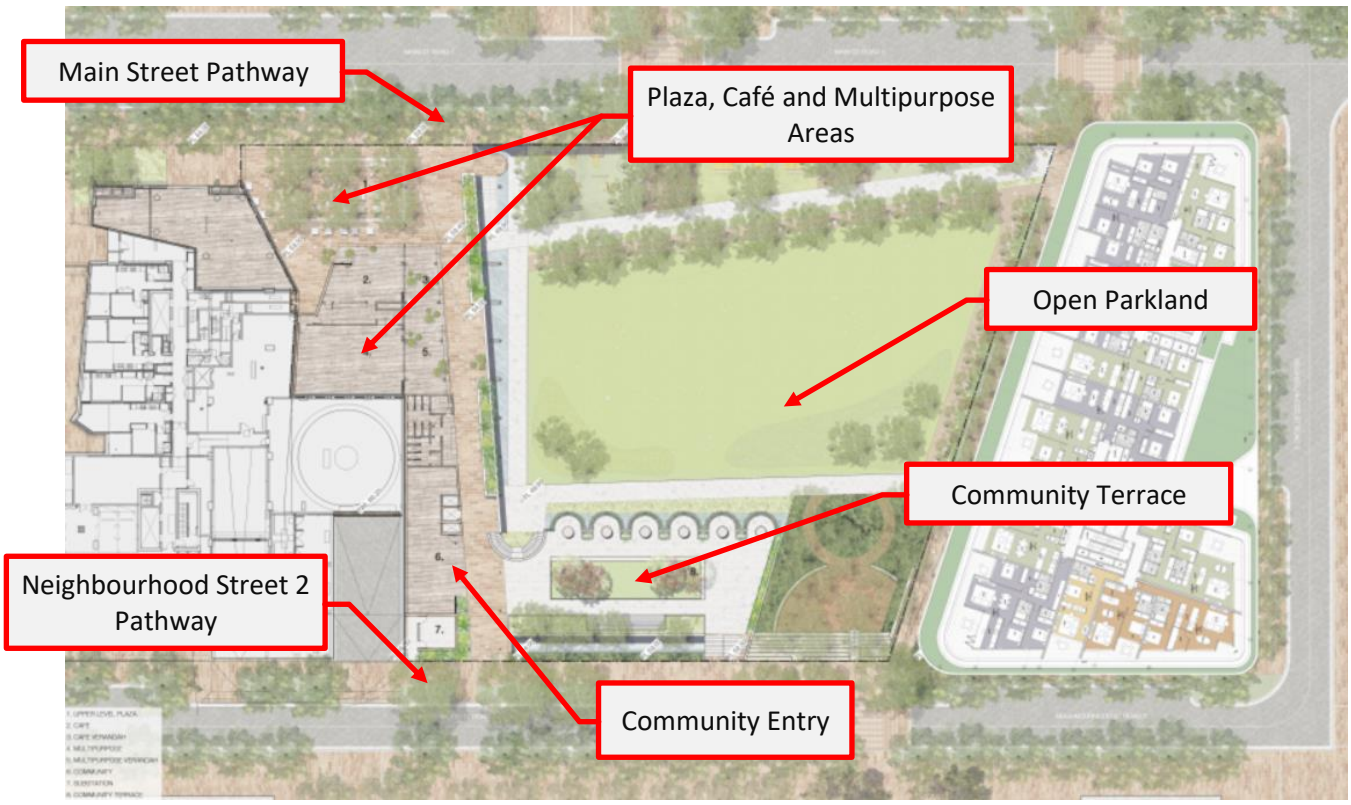


Figure 7 Areas of Interest C3 Ground Level

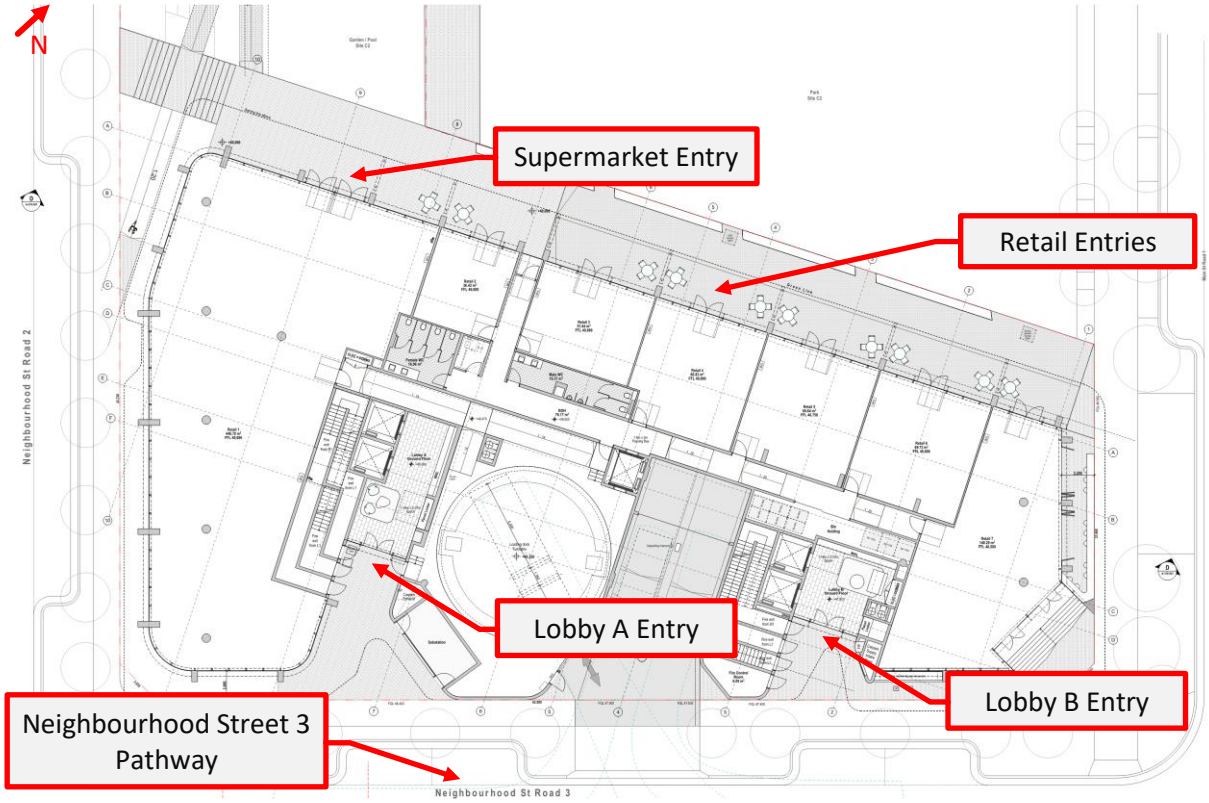


Figure 8 Areas of Interest C3 Level 5 and 10

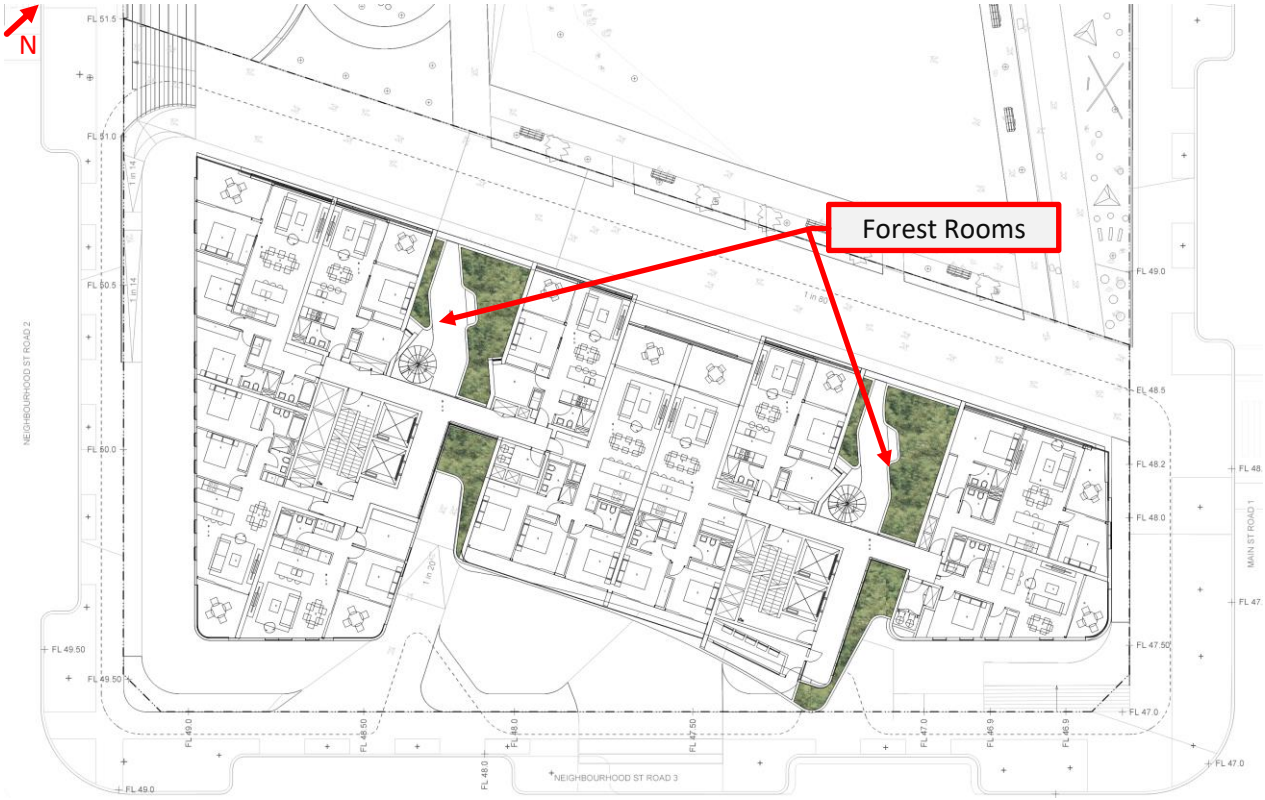


Figure 9 Areas of Interest C3 Level 15

Figure 10 Areas of Interest C4 Ground Level

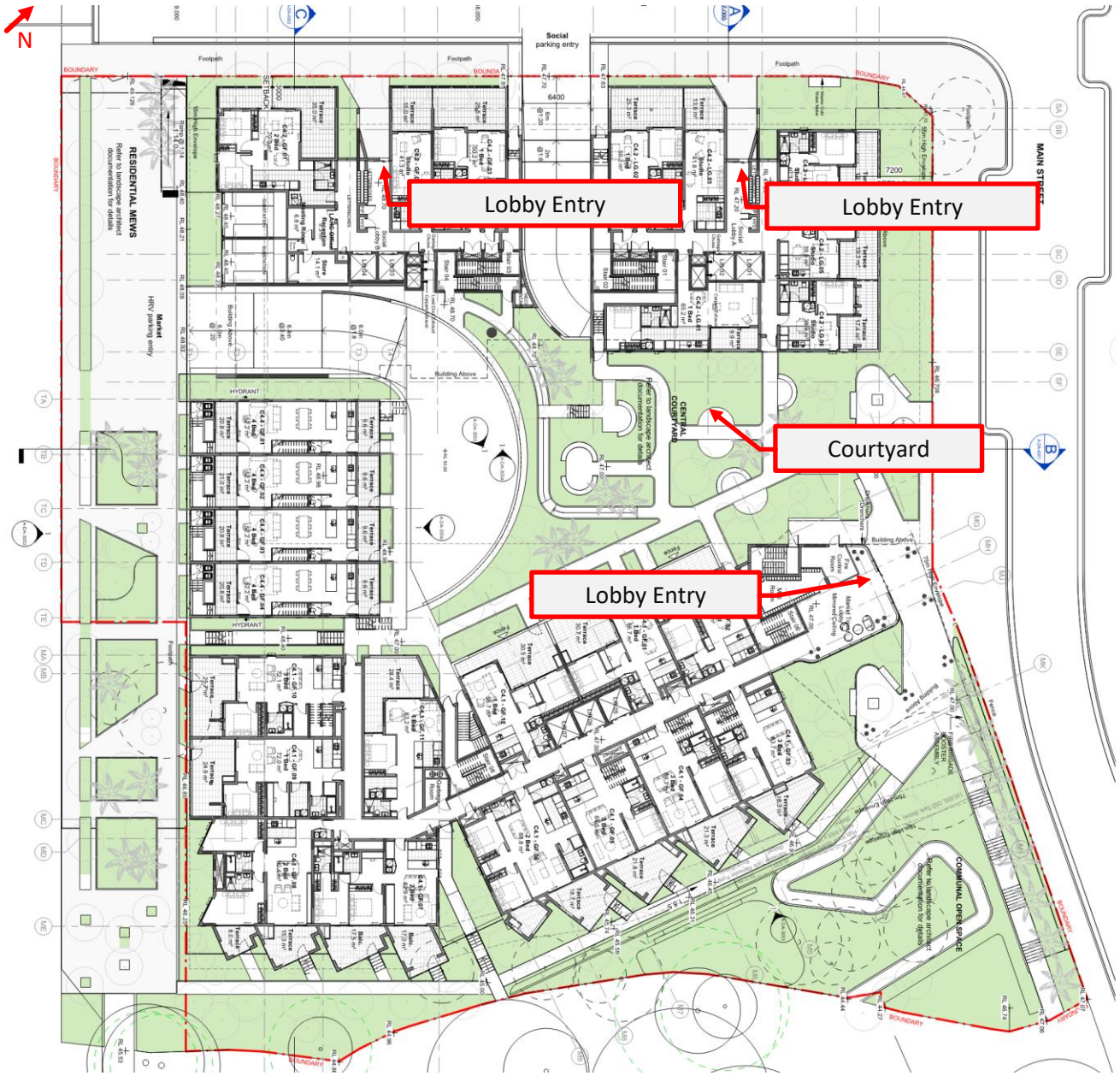


Figure 11 Areas of Interest C4 Level 18

Figure 12 Areas of Interest C4 Level 22

5.2.1 Northeast Winds

Location	Wind Impact
Site C2	
Main Street Pathway	Potential impact here should be **less than 16m/s**, affected by: • Shielding from upstream buildings. • Shielding from existing landscaping. • Shielding from proposed landscaping.
Neighbourhood Street 2 Pathway	Potential impact here should be **less than 16m/s**, affected by: • Shielding from upstream buildings. • Shielding from existing landscaping. • Shielding from proposed landscaping. • Shielding from the development itself.
Plaza, Café and Multipurpose Area	Potential impact here should be **less than 10m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Potential downwash from building facades. • Shielding from proposed pergolas.
Community Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Potential downwash from building facades. • Shielding from proposed pergolas.
Community Terrace	Potential impact here should be **less than 10m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Shielding from the development itself.
Open Parkland	Potential impact here should be **less than 10m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Shielding from the development itself.
Site C3	
Neighbourhood Street 3 Pathway	Potential impact here should be **less than 16m/s**, affected by: • Shielding from upstream buildings. • Shielding from existing landscaping. • Shielding from proposed landscaping. • Shielding from the development itself.
Lobby A Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Shielding from the development itself.
Lobby B Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Shielding from the development itself.

Location	Wind Impact
Supermarket Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Potential for downwash winds from building facades. • Shielding via setback from podium above.
Retail Entries	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Potential for downwash winds from building facades. • Shielding via setback from podium above.
Forest Rooms	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Some shielding from the development itself. • Stronger upper level winds. • Potential downwash from development facades.
Upper Level Balconies	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.
Level 15 Communal Outdoor Area	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds. • Potential for channelling between buildings.
Site C4	
Lobby Entries	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Potential downwash from development facades. • Shielding via setback from levels above.
Courtyard	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Shielding from upstream buildings. • Some shielding from the development itself. • Potential wind channelling between buildings.
Upper Level Balconies	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.
Sky Garden	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.
Level 22 Private Terrace	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Some shielding from the development itself. • Stronger upper level winds.

5.2.2 South and Southeast Winds

Location	Wind Impact
Site C2	
Main Street Pathway	Potential impact here should be **less than 16m/s**, affected by: • Shielding from upstream buildings. • Shielding from existing landscaping. • Shielding from proposed landscaping. • Shielding from the development itself.
Neighbourhood Street 2 Pathway	Potential impact here should be **less than 16m/s**, affected by: • Shielding from upstream buildings. • Shielding from existing landscaping. • Shielding from proposed landscaping.
Plaza, Café and Multipurpose Area	Potential impact here should be **less than 10m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Shielding from the development itself.
Community Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Potential downwash from building facades. • Shielding from proposed pergolas.
Community Terrace	Potential impact here should be **less than 10m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping.
Open Parkland	Potential impact here should be **less than 10m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping.
Site C3	
Neighbourhood Street 3 Pathway	Potential impact here should be **less than 16m/s**, affected by: • Shielding from upstream buildings. • Potential for downwash winds from development façade. • Shielding from existing landscaping. • Shielding from proposed landscaping.
Lobby A Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Potential for downwash winds from building facades. • Shielding via setback from podium above.
Lobby B Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Potential for downwash winds from building facades. • Shielding via setback from podium above.

Location	Wind Impact
Supermarket Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Potential for downwash winds from building facades. • Shielding via setback from podium above.
Retail Entries	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Shielding from the development itself.
Forest Rooms	Potential impact here should be **less than 10m/s**, affected by: • Shielding from the development itself.
Upper Level Balconies	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.
Level 15 Communal Outdoor Area	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds. • Potential for channelling between buildings.
Site C4	
Lobby Entries	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Shielding from the development itself.
Courtyard	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Shielding from upstream buildings. • Some shielding from the development itself. • Potential wind channelling between buildings.
Upper Level Balconies	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.
Sky Garden	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds. • Some shielding via the development itself.
Level 22 Private Terrace	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.

5.2.3 Westerly Winds

Location	Wind Impact
Site C2	
Main Street Pathway	Potential impact here should be **less than 16m/s**, affected by: • Potential for wind channelling along street. • Shielding from existing landscaping. • Shielding from the development itself.

Location	Wind Impact
Neighbourhood Street 2 Pathway	Potential impact here should be **less than 16m/s**, affected by: • Potential for wind channelling along street. • Shielding from existing landscaping. • Shielding from the development itself.
Plaza, Café and Multipurpose Area	Potential impact here should be **less than 10m/s**, affected by: • Shielding from proposed landscaping. • Shielding from the development itself.
Community Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from the development itself.
Community Terrace	Potential impact here should be **less than 10m/s**, affected by: • Shielding from proposed landscaping. • Shielding from the development itself.
Open Parkland	Potential impact here should be **less than 10m/s**, affected by: • Shielding from proposed landscaping. • Shielding from the development itself.
Site C3	
Neighbourhood Street 3 Pathway	Potential impact here should be **less than 16m/s**, affected by: • Shielding from upstream buildings. • Shielding from existing landscaping. • Shielding from proposed landscaping.
Lobby A Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Shielding from the development itself.
Lobby B Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Shielding from the development itself.
Supermarket Entry	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Shielding from the development itself.
Retail Entries	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping.
Forest Rooms	Potential impact here should be **less than 10m/s**, affected by: • Shielding from the development itself.
Upper Level Balconies	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.
Level 15 Communal Outdoor Area	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.
Site C4	

Location	Wind Impact
Lobby Entries	Potential impact here should be **less than 13m/s**, affected by: • Shielding from upstream buildings. • Shielding from proposed landscaping. • Potential downwash from development facades. • Shielding via setback from levels above.
Courtyard	Potential impact here should be **less than 10m/s**, affected by: • Shielding from upstream buildings. • Shielding from the development itself.
Upper Level Balconies	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.
Sky Garden	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.
Level 22 Private Terrace	Potential impact here could be **close to or exceeding 10 m/s**, affected by: • Reduced upstream shielding. • Stronger upper level winds.

6 Wind Amelioration Recommendations

On the basis of the expected wind impacts outlined in previous four sections, recommendations for wind break features are made in areas where winds are expected to

- Approach or exceed 10 m/s, 13 m/s or 16m/s depending on the designed use for hat area.

These wind mitigation recommendations are summarised in **Table 2**.

Table 2 Recommended Wind Mitigation

Location of Interest	Wind Impact Potential	Windbreak Treatment/Recommendation
Site C2		
Main Street Pathway	**Low** Winds should be below 16 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed landscaping is required to be retained. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds.
Neighbourhood Street 2 Pathway	**Low** Winds should be below 16 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed landscaping is required to be retained. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds.
Plaza, Café and Multipurpose Area	**Low** Winds should be below 10 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed pergolas are to be retained above seating and entry areas. Proposed landscaping is to be retained throughout the space. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds.
Community Entry	**Low** Winds should be below 13 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed pergolas are to be retained above entry areas.

Location of Interest	Wind Impact Potential	Windbreak Treatment/Recommendation
Community Terrace	**Low** Winds should be below 10 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed landscaping is required to be retained. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds.
Open Parkland	**Low** Winds should be below 10 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed landscaping is required to be retained. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds.
Site C3		
Neighbourhood Street 3 Pathway	**Low** Winds should be below 16 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed landscaping is required to be retained. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds.
Lobby A Entry	**Low** Winds should be below 13 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed landscaping is required to be retained. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds. Retain setback of lobby entry from podium and levels above.
Lobby B Entry	**Low** Winds should be below 13 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed landscaping is required to be retained. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds. Retain setback of lobby entry from podium and levels above.

Location of Interest	Wind Impact Potential	Windbreak Treatment/Recommendation
Supermarket Entry	**Low** Winds should be below 13 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed landscaping is required to be retained. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds. Retain setback of supermarket entry from podium and levels above.
Retail Entries	**Low** Winds should be below 13 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed landscaping is required to be retained. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds. Retain setback of retail entries from podium and levels above.
Forest Rooms	**Moderate** Winds could be above 10 m/s for north-easterly winds.	**Mitigation Required** SLR recommends a 2.1m vertical windbreak be retained to the lower level boundary of the space. Additionally, vertical windbreaks (eg operable louvres should be installed to be closed during wind conditions). Wind Tunnel Testing will be conducted to specify the required wind mitigation.
Upper Level Balconies	**High** Winds could be above 10 m/s for all prevailing wind directions.	**Mitigation Required** Corner or dual aspect balconies may require additional shielding, such as, full height balustrades, wind screens, fins or other practical vertical wind shielding. SLR recommends that further quantitative assessment be carried out during the detailed design stage to better determine wind shielding to balconies.

Location of Interest	Wind Impact Potential	Windbreak Treatment/Recommendation
Level 15 Communal Outdoor Area	**High** Winds could be above 10 m/s for all prevailing wind directions.	**Mitigation Required** SLR recommends a 1.8m balustrade, windscreen, planter or other practical wind shielding be installed to the boundary of the space. Additionally, landscaping should be provided throughout the space to decrease higher upper level wind speeds.
Site C4		
Lobby Entries	**Low** Winds should be below 13 m/s for all prevailing wind directions.	**No Mitigation Required** Proposed landscaping is required to be retained. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m. Additional landscaping could be added to further reduce wind speeds. Retain setback of entries from levels above.
Courtyard	**Moderate - High** Winds could be above 16 m/s for north-easterly and southerly winds.	**Mitigation Required** Additional landscaping is recommended to the north and south of the courtyard. Landscaping should be densely foliated evergreen species, with a minimum canopy height of 3.0m.
Upper Level Balconies	**High** Winds could be above 10 m/s for all prevailing wind directions.	**Mitigation Required** Corner or dual aspect balconies may require additional shielding, such as, full height balustrades, wind screens, fins or other practical vertical wind shielding. SLR recommends that further quantitative assessment be carried out during the detailed design stage to better determine wind shielding to balconies.

Location of Interest	Wind Impact Potential	Windbreak Treatment/Recommendation
Sky Garden	**High** Winds could be above 10 m/s for all prevailing wind directions.	**Mitigation Required** SLR recommends a 1.8m balustrade, windscreen, planter or other practical wind shielding be installed to the boundary of the space. Additionally, landscaping should be provided throughout the space to decrease higher upper level wind speeds.
Level 22 Private Terrace	**High** Winds could be above 10 m/s for all prevailing wind directions.	**Mitigation Required** SLR recommends that additional shielding elements be incorporated into the design of the space. As the terrace is connected to a private terrace, SLR recommends the space be subjected to further analysis during the detailed design phase, to better gauge the extent of required mitigations.

Figure 13 Mitigation Recommendations C2

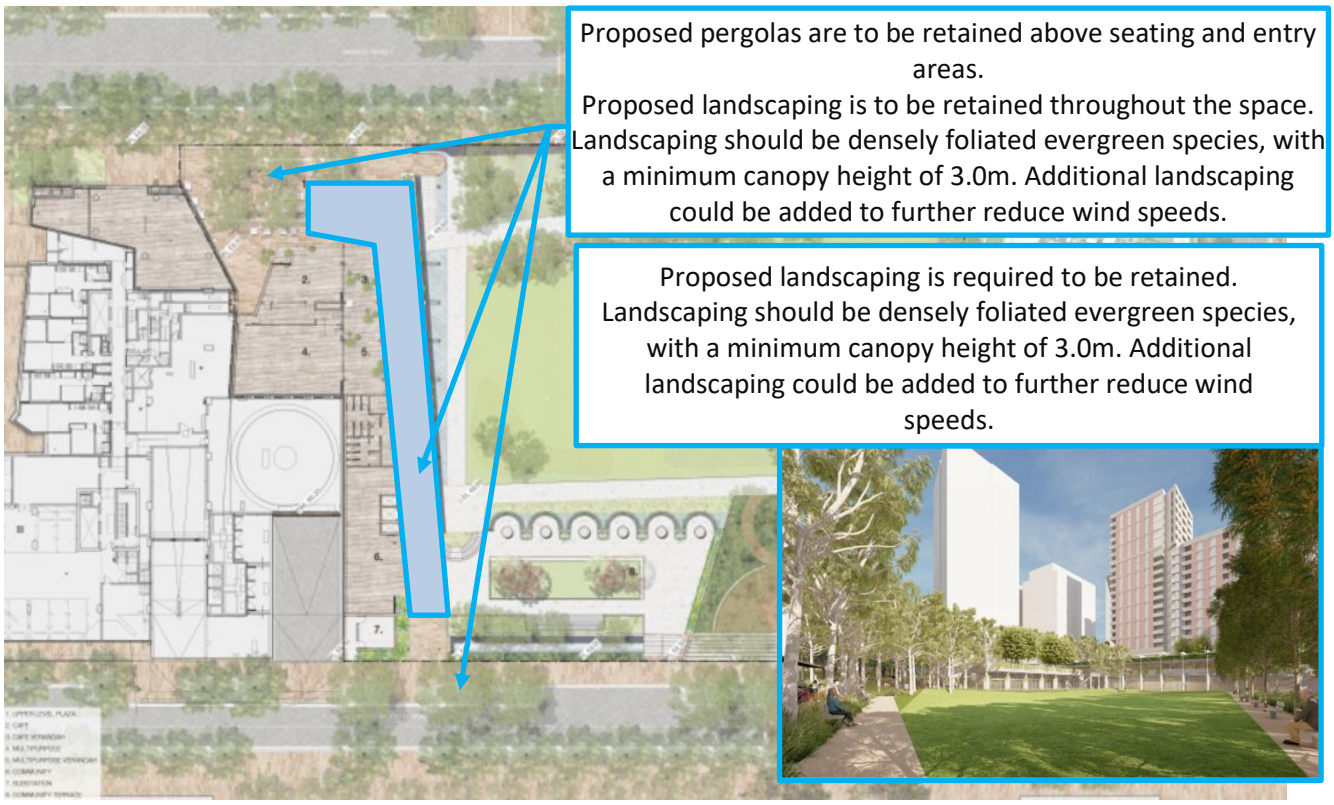


Figure 14 Mitigation Recommendations C3 Ground Level

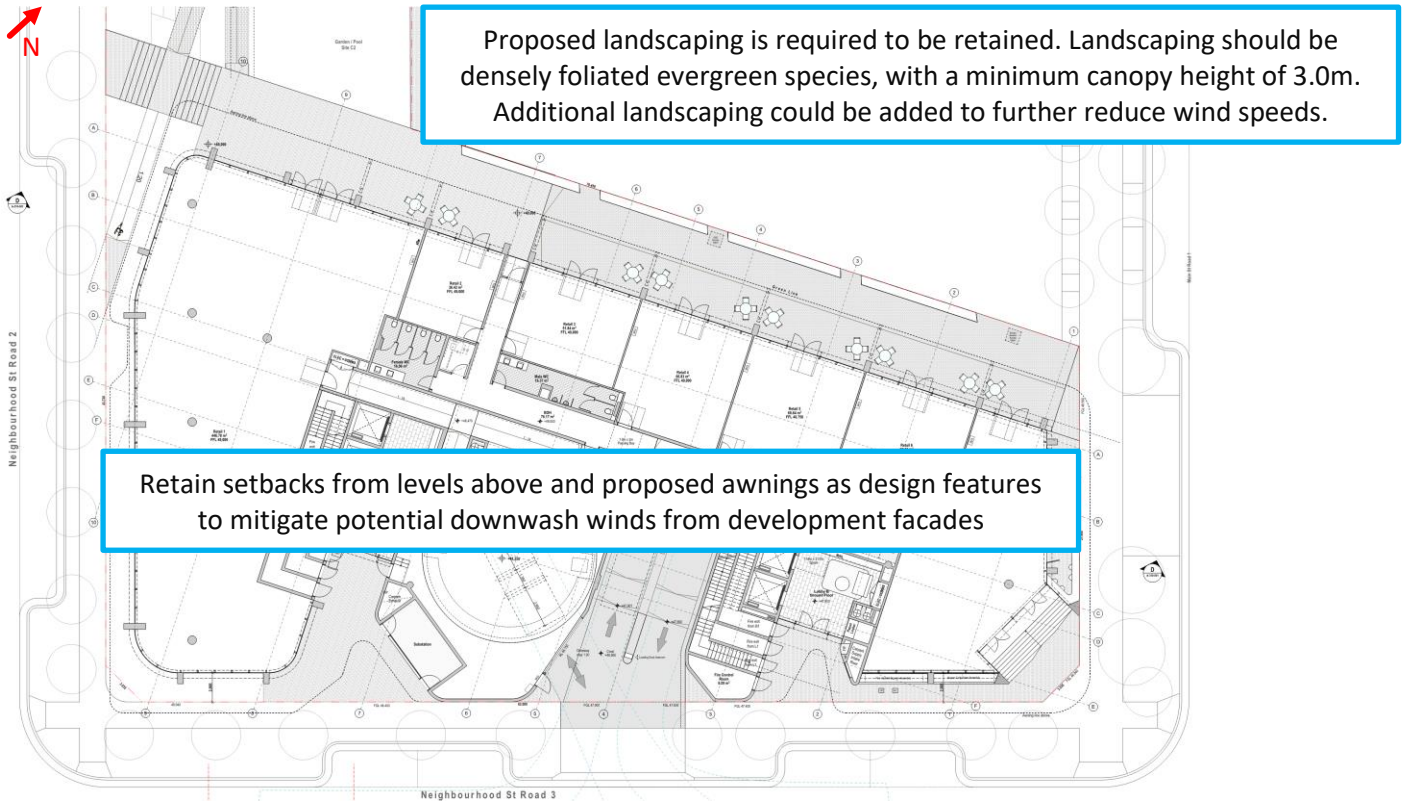


Figure 15 Mitigation Recommendations C3 Level 6 and 11

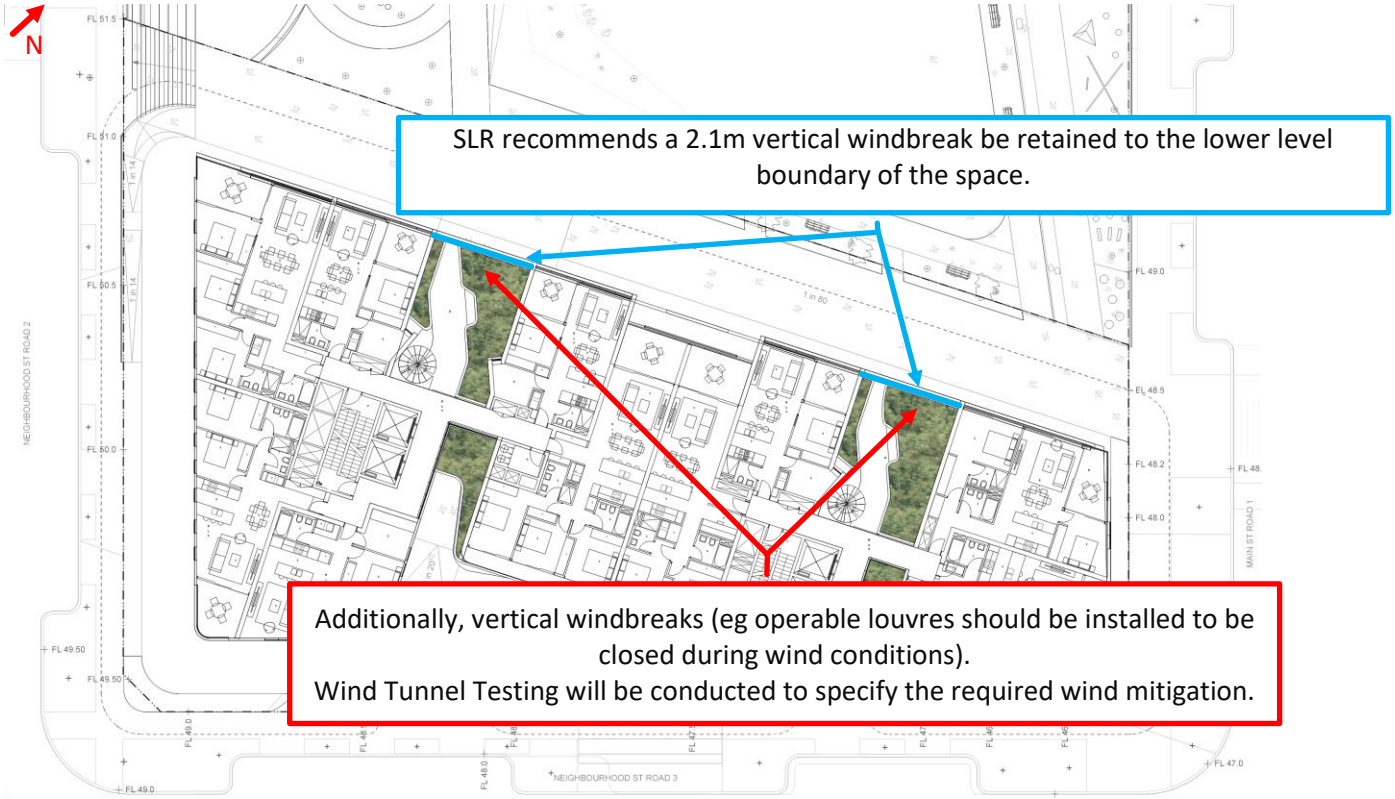


Figure 16 Mitigation Recommendations C3 Level 15

Figure 17 Mitigation Recommendations C4 Ground Level

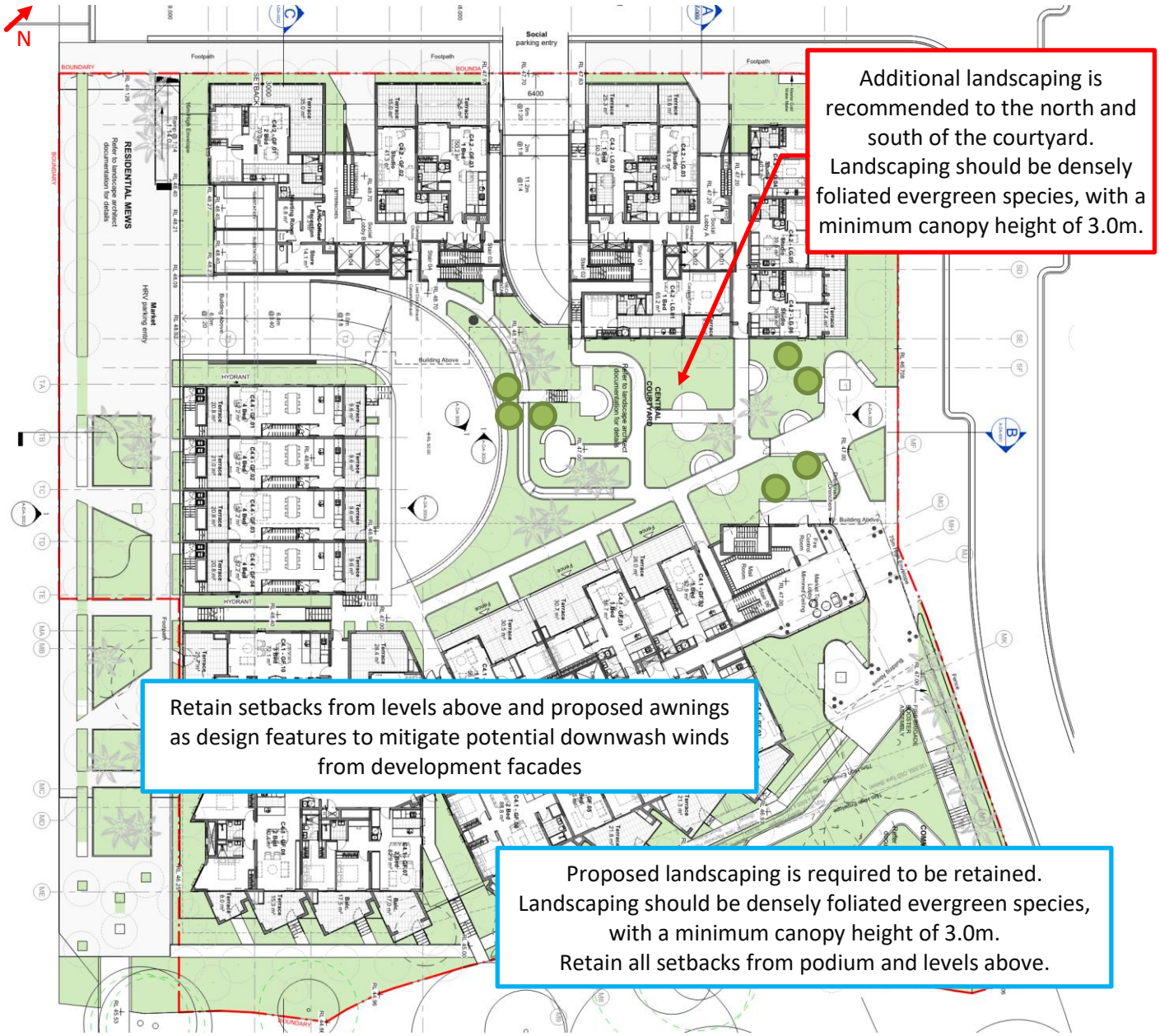


Figure 18 Mitigation Recommendations C4 Level 18

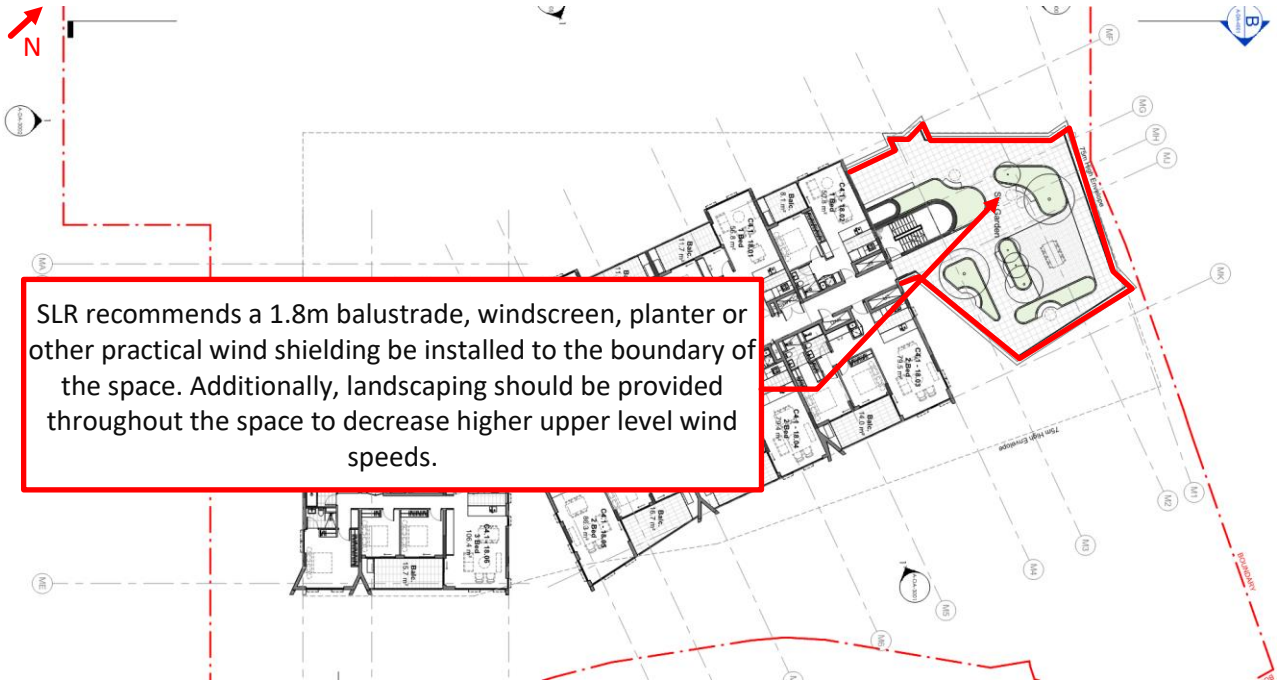
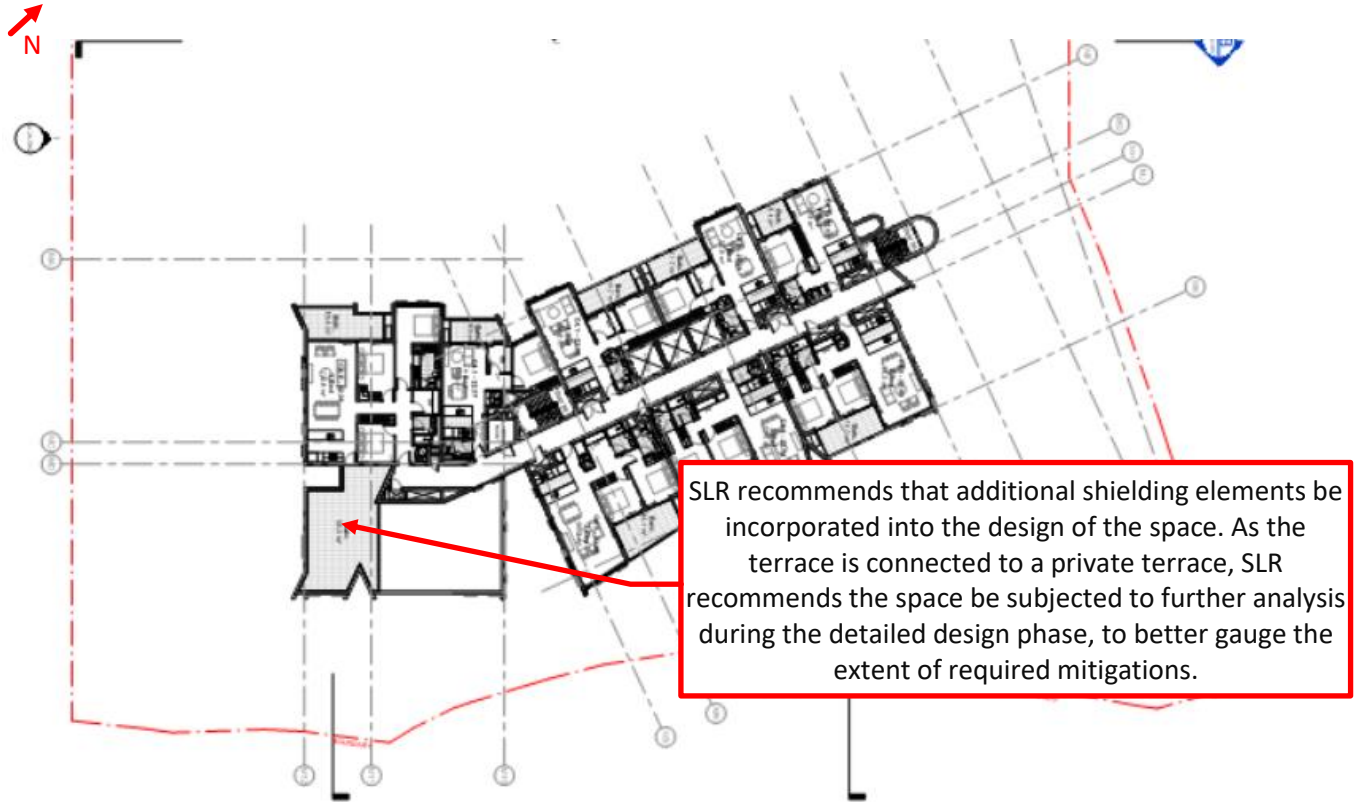


Figure 19 Areas of Interest C4 Level 22



7 Conclusion

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Frasers Property Australia to undertake a qualitative wind assessment of the proposed Ivanhoe Stage 2 development, located off Epping Road, Macquarie Park. This assessment forms part of the development application to the Department of Planning NSW.

The Ivanhoe Estate is situated to the northeast of Epping Road, with surrounds consisting of dense urban development of varying heights to surrounding aspects.

Within the context of the Ivanhoe Site, Site 2 will comprise development across Subject Sites C2, C3 and C4. The Stage 2 development will be bound by Main Street to the north, The eastern Ivanhoe Site boundary to the east, Neighbourhood Street 2 to the south and Site C1 to the west.

Prevailing wind directions of interest in Sydney are from northeast, south, southeast and west quadrants. Their seasonal variation is described in **Section 2** of this report.

Existing Winds

Existing street level wind conditions in the vicinity of the site could be close to the 16 m/s *"walking comfort"* criterion for some prevailing wind directions given the orientation of the site and the spacing of upstream shielding afforded to the site, by surrounding buildings and vegetation. In particular adverse winds of more than 16 m/s may occur from the southeast and southwest due to reduced wind shielding.

Future Wind Environment

In terms of the future wind environment for the proposed development, SLR has found the design to satisfy windspeed design safety criteria. When considering comfort criteria, SLR has determined that ground level wind speeds should remain within acceptable levels, with there being some upper level spaces where comfort conditions may be exceeded. SLR has provided recommendations within this report to mitigate the impact of adverse wind conditions throughout the development.

The following features of the development are noted as being of most significance:

- The winds along the surrounding footpaths should remain at similar levels with consideration of the approved public domain plans.
- There may be some potential for wind channelling between buildings, landscaping should mitigate the associated risks.
- Upper level balconies may require additional shielding, to be determined during detailed design via quantitative wind assessment.
- Vertical windbreaks are recommended to upper level open areas, the full extent of required shielding will be determined through quantitative assessment.

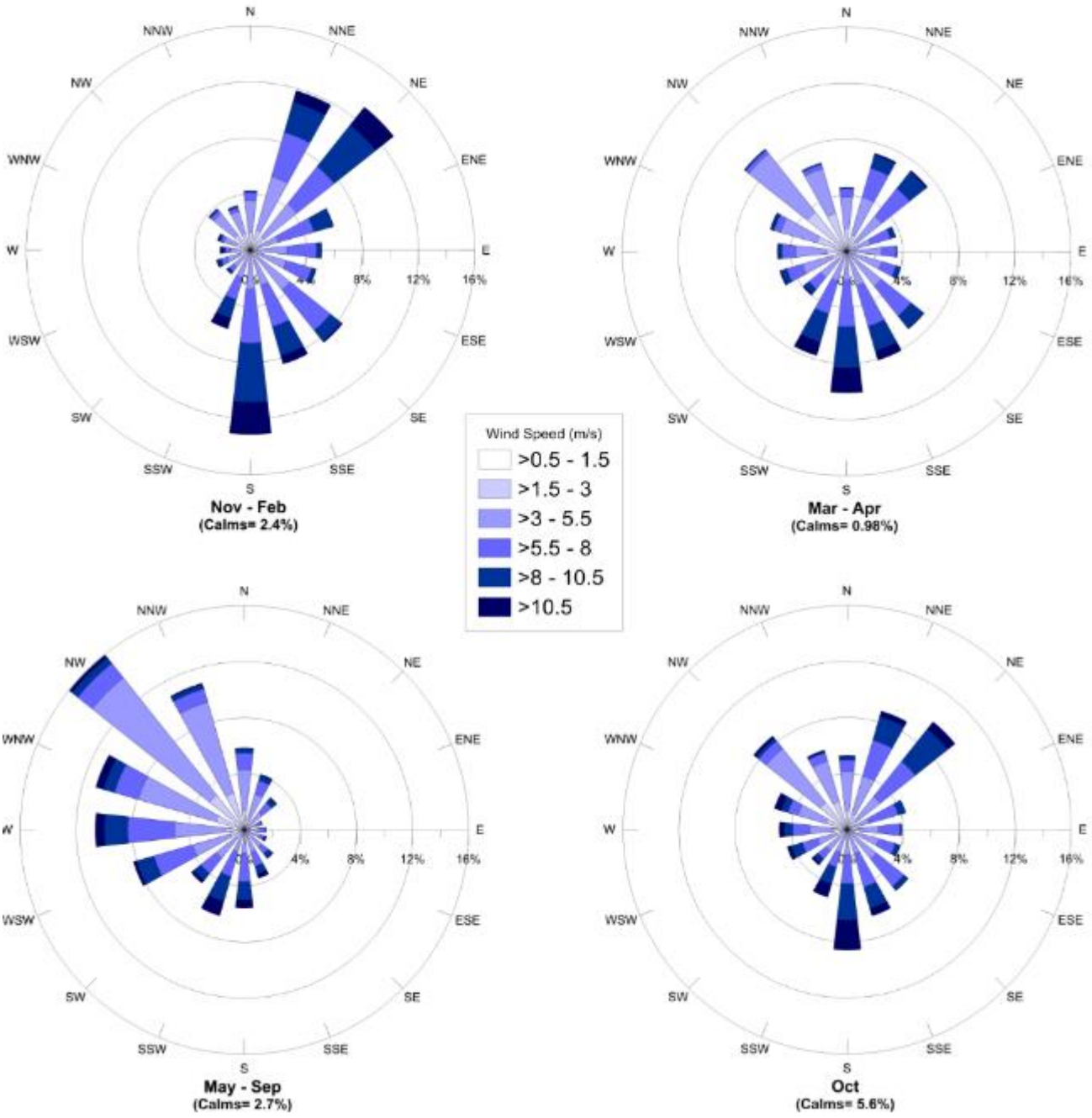
The above analysis has been made on the basis of our best engineering judgment and on the experience gained from scale model wind tunnel testing and CFD analysis of a range of developments.

Wind Tunnel Testing will be conducted to quantify wind speeds and specify the exact mitigation treatments at the areas of interest.

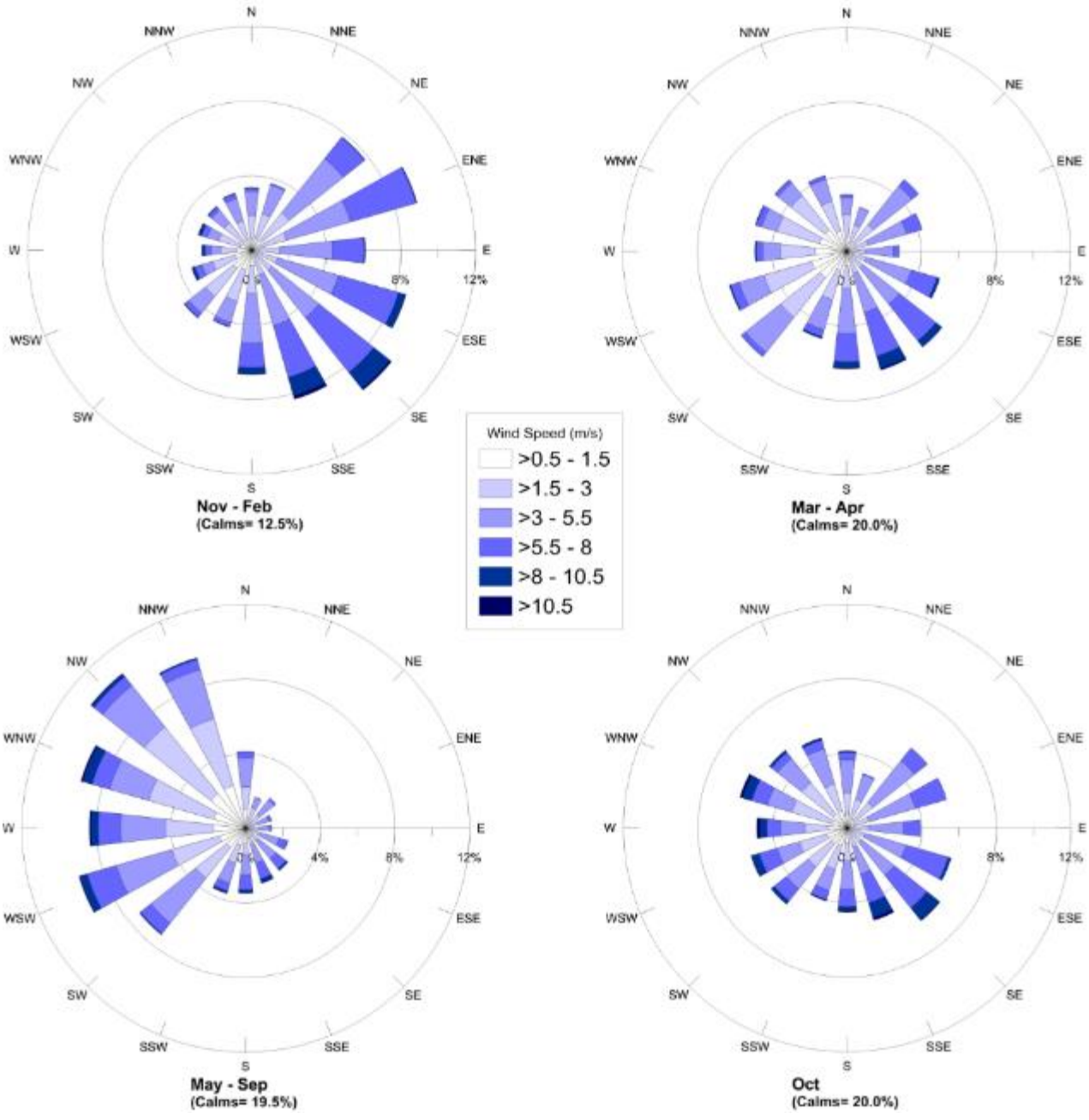
APPENDIX A

Seasonal Wind Roses for Bureau of Meteorology Met Stations at Sydney (Kingsford Smith) Airport and Bankstown Airport

Sydney Airport AWS
(Observations)
1999-2017
600.09300



Bankstown Airport AWS
(Observations)
1999-2017
600.09300



ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

NEWCASTLE CBD
Suite 2B, 125 Bull Street
Newcastle West NSW 2302
Australia
T: +61 2 4940 0442

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
Level 4, 12 O'Connell Street
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628