PROPOSED MIXED-USE DEVELOPMENT - SSDA 11429726

Eden Street & Princes Highway, Arncliffe
Desktop Environmental Wind Study

Prepared for:

Arncliffe Eden Property Pty Ltd
c/o Billbergia
Suite 101, 25 Angas Street
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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 Arncliffe Eden Property Pty Ltd (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
610.30190-R01-v1.3	28 June 2021	Dr Peter Georgiou	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy
610.30190-R01-v1.2	21 June 2021	Dr Peter Georgiou	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy
610.30190-R01-v1.1	1 June 2021	Dr Peter Georgiou	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy
610.30190-R01-v1.0	24 May 2021	Dr Peter Georgiou	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy

EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Arncliffe Eden Property Pty Ltd to assess the wind impact on the immediate surrounds of a proposed Mixed-Use Development (herein the Project) located at Eden Street and Princes Highway, Arncliffe – refer Figure 1.

The present study is a qualitative (expert opinion) study of potential wind impacts.

This initial assessment has been made on the basis of our best engineering judgment and on the experience gained from (decades of) scale-model Wind Tunnel Testing and CFD Simulation Modelling of a range of similar scale developments.

This assessment is submitted to the Department of Planning, Industry and Environment (DPIE) in support of a State Significant Development Application (SSDA-11429726) for the development of the Project for the purposes of a mixed-use precinct with open space, retail, and residential uses, comprising social and market housing as part of the NSW Land and Housing Corporation (LAHC)'s 'Communities Plus' program.

Local Wind Climate

On the basis of long-term wind records obtained from the Bureau of Meteorology stations weather at Sydney Kingsford Smith Airport, SLR has determined that key prevailing wind directions of interest are the northeast and south/southeast for summer/early autumn and west quadrant winds for winter/early spring.

Future Wind Environment

In terms of the future wind environment with the proposed Development, the following features are noted as being of most significance:

- The proposed Development's main residential blocks are set back from its two perimeter street frontages with extensive landscaping (large trees) planned along both Eden Street and Princes Highway.
- Areas potentially requiring wind mitigation are largely within the site, especially the elevated Communal Spaces and Roof Gardens.
- Windbreak recommendations, all of which will be implemented in the design of the development, have been made to assist in ameliorating potentially adverse winds identified in this study. Accordingly, all affected areas should be able to comply with the recommended wind acceptability criteria – refer Section 7 and Figures 8 and 9 for details.

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TABLES

FIGURES

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Billbergia to assess the wind impact on the immediate surrounds of a proposed Mixed-Use Precinct (herein the Project) located at 26-42 Eden Street and 171-179 Princes Highway, Arncliffe.

The present study is a qualitative (expert opinion) study of potential wind impacts. It is intended to follow this up with a model-scale Wind Tunnel Environmental Test to reliably quantify these impacts and confirm the efficacy of recommended wind mitigation treatments.

This initial assessment has been made on the basis of our best engineering judgment and on the experience gained from (decades of) scale-model Wind Tunnel Testing and CFD Simulation Modelling of a range of similar scale developments.

Objective of the Study

This assessment is submitted to the Department of Planning, Industry and Environment (DPIE) in support of a State Significant Development Application (SSDA-11429726) for the development of the Project for the purposes of a mixed-use precinct with open space, retail, and residential uses, comprising social and market housing as part of the NSW Land and Housing Corporation (LAHC)'s 'Communities Plus' program.

In accordance with section 4.39 of the Environmental Planning & Assessment Act 1979 (EP&A Act), the Secretary's Environmental Assessment Requirements (SEARs) for SSDA-11429726 were issued on 18 December 2020.

This report has been prepared in response to the following SEARs elements:

5. Public domain

The EIS must demonstrate how the development:

- maximises the amount, access to and quality of public spaces (including open space, public facilities and streets/plazas within and surrounding the site)
- reflects relevant design guidelines and advice from Council and the Department
- ensures the public space is welcoming, attractive and accessible for all
- maximise permeability and connectivity
- ensures public spaces have excellent amenity, suitable for their intended use, such as through adequate facilities, solar access, shade and wind protection
- maximises street activation
- minimises potential vehicle, bicycle and pedestrian conflicts

7. Environmental amenity

The EIS must:

- demonstrate how the proposal achieves a high level of environmental amenity within the proposal and on surrounding buildings, assessing impacts associated with view loss, ventilation, pedestrian movement, access to landscape and outdoor spaces, visual privacy, lighting and wind
- provide a solar access analysis of the overshadowing impacts of the development within the site, on surrounding buildings and public spaces (during summer and winter solstice and spring and autumn equinox) at hourly intervals between 9am and 3pm, when compared to the existing situation and a compliant development
- provide an assessment of the development against State Environmental Planning Policy No 65 - Design Quality of Residential Apartment Development and the associated guidelines.

2 PROPOSED DEVELOPMENT OVERVIEW

2.1 Development Site Location

The proposed Development is bounded by Eden Street to the northwest and Princes Highway to the Southeast. The intersection of Princes Highway, Forest Road and Wickham Street lies just to the south - refer Figure 1.

Figure 1 Proposed Development Site Location

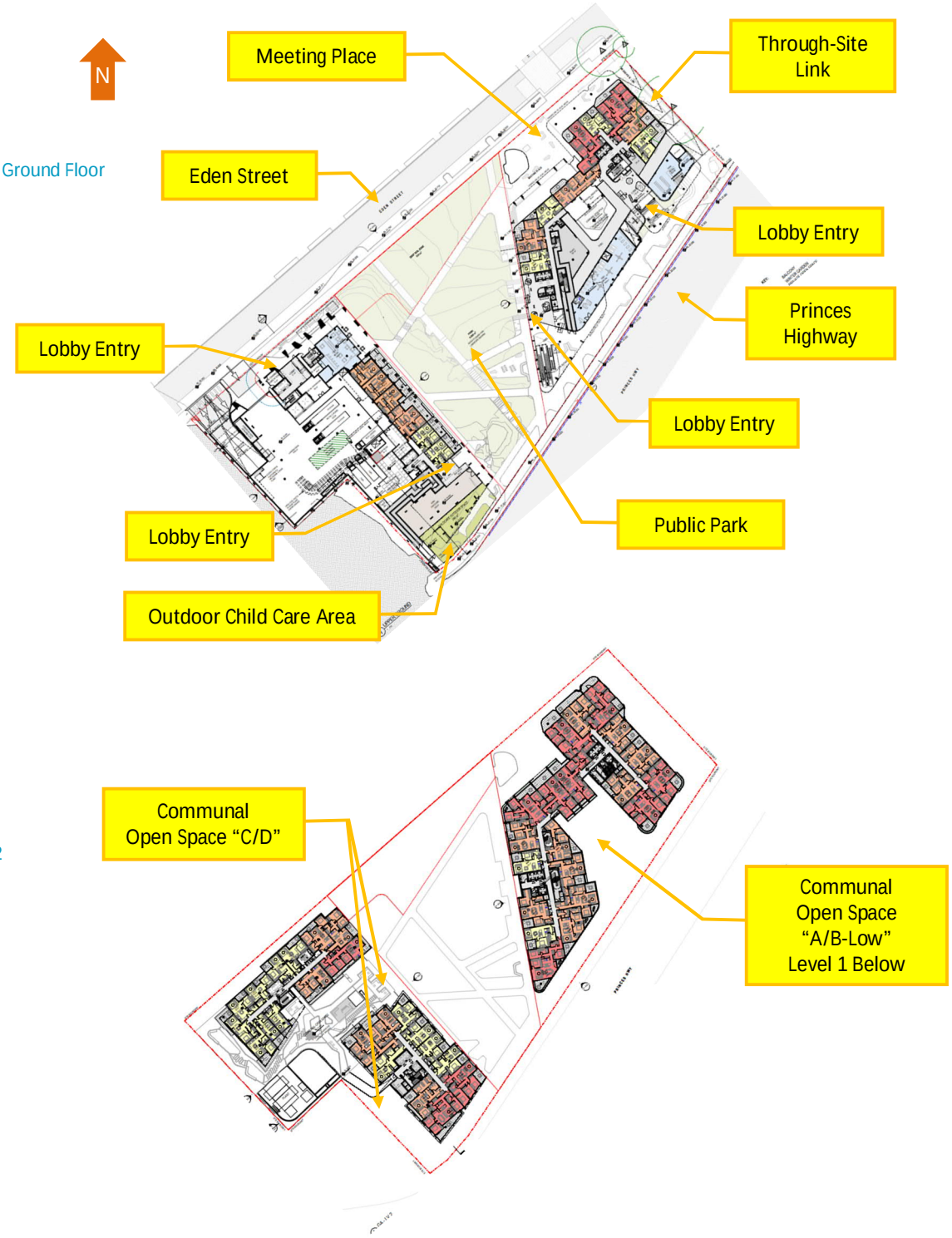
2.2 Proposed Development Description

SSDA-11429726 seeks approval for the following mixed-use development:

- Demolition of all existing buildings and structures on the site, site preparation works, excavation and tree removal;
- The construction of a mixed-use development comprising:
  - 744 apartments across (4) buildings “A”, “B”, “C”, “D”, between 19-23 storeys in height;
  - 3,113 m^2 retail gross floor area; 240 m^2 for a future childcare centre; 3,706 m^2 of communal open space; and
  - 4,870 m^2 of publicly accessible open space including a 4,000 m^2 park, an 870 m^2 public plaza (meeting space), and through site link connecting Eden Street and the Princes Highway.

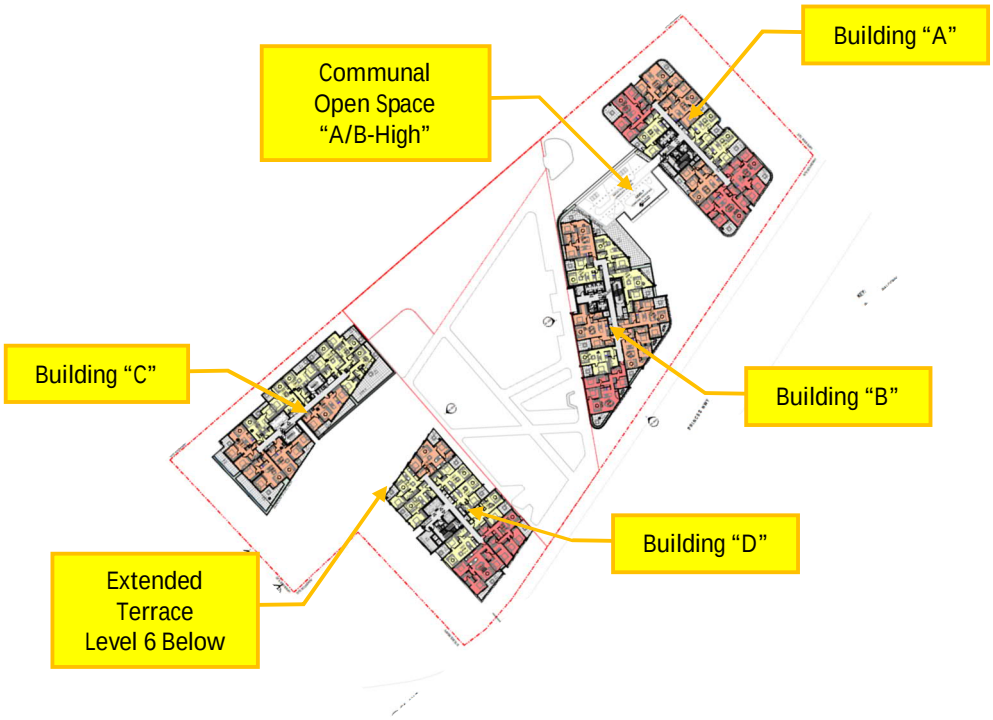
Representative Floor Plans and Development Images are shown in Figure 2.

Figure 2 Representative Plans of the Proposed Development

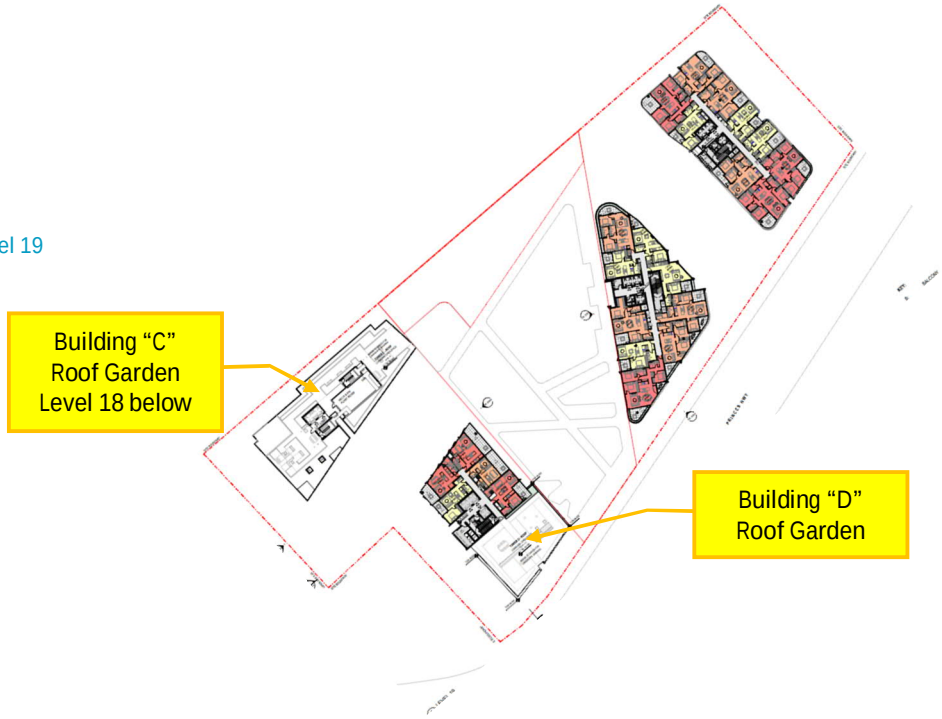


(Fig.2 cont'd)

C. Level 7

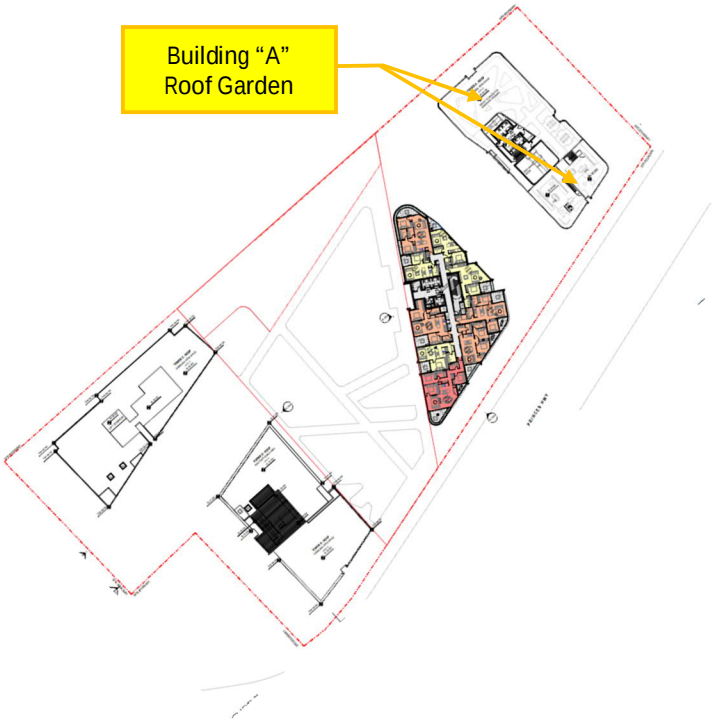


D. Level 19

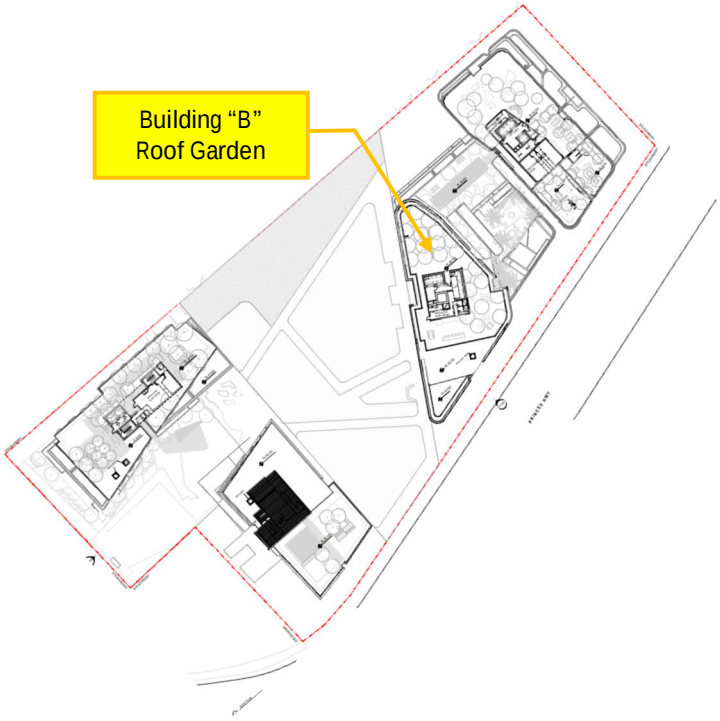


(Fig.2 cont'd)

E. Level 21



F. Level 22



2.3 Surrounding Built Environment

"Near Field"

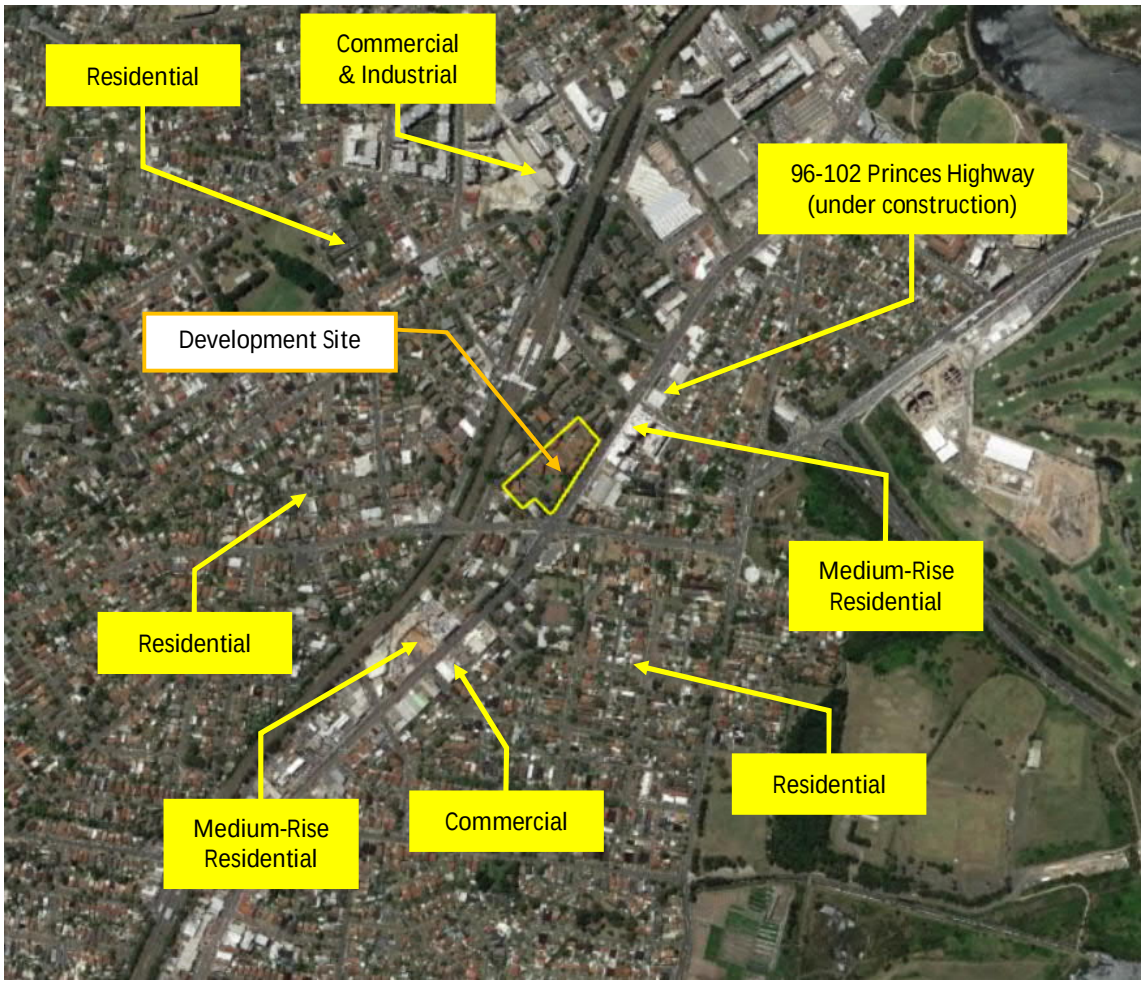
The "near-field" built environment comprises mainly low-rise residential, commercial and industrial in all directions, with the exception of several medium rise residential developments located along the Princes Highway to the east and northeast and the southwest – refer Figure 3. These buildings will exert a significant influence on winds arriving at the site, especially from the northeast.

"Far Field"

The "far-field" built environment comprises the same mix of typically low-rise residential areas and commercial/industrial buildings, with scattered similar height residential buildings. To the east lies Kogarah Golf Club and the Sydney Kingsford Smith Airport Precinct.

The surrounding topography is generally flat with no significant features (hills, ridges, escarpments, etc) influencing local wind speeds.

Figure 3 Nearby Similar Height Residential Buildings



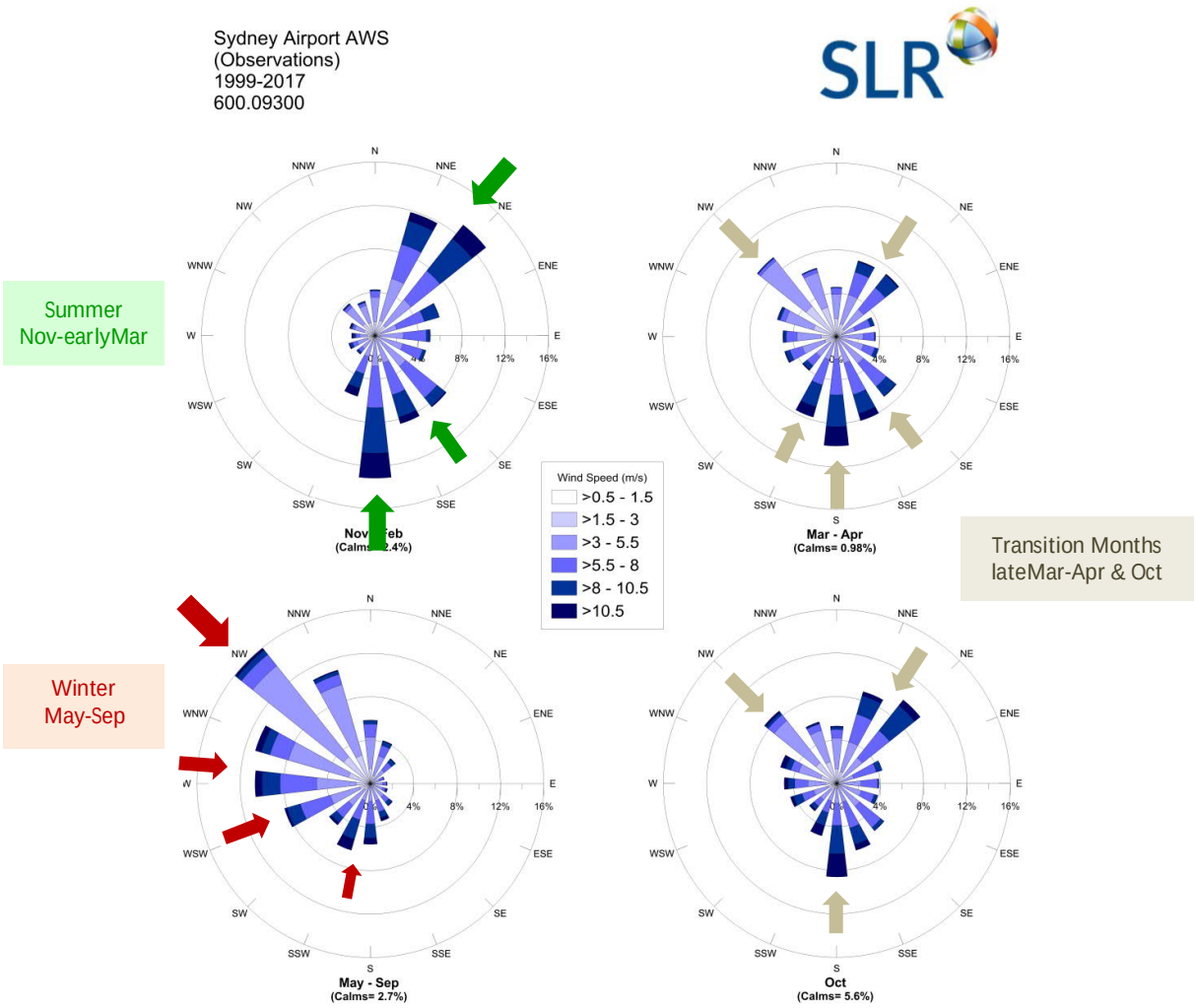
3 SYDNEY'S WIND CLIMATE

3.1 Seasonal Variations of Sydney's Regional Wind Climate

Key characteristics of Sydney's "regional" wind climate relevant to the development site are shown in the Figure 4 seasonal wind roses, recorded at the nearby Bureau of Meteorology weather station at Sydney Kingsford Smith Airport. These indicate that Sydney is affected by two primary wind seasons, with brief transition periods in between:

- Summer/Early Autumn 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.
- Winter/Early Spring winds occur mainly from the west-northwest: these provide the strongest winds during winter and in fact for the whole year. There is a smaller contribution from southerly winds.

Figure 4 Sydney Airport (Bureau of Meteorology Station) Seasonal Wind Roses (1999-2017)

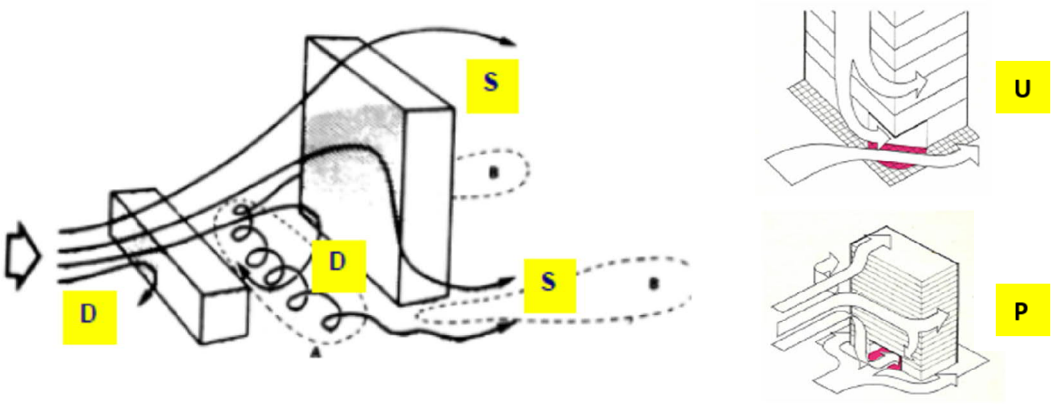


4 BUILDING-WIND INTERACTION – GENERAL OBSERVATIONS

The impact of wind flowing past buildings has well understood general impacts at ground level - refer Figure 5. In general, the taller the building, the more pronounced the impact on ground level winds.

- 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
- Concentrated adverse windflow can also be created when winds are accelerated by the negative pressure area at an undercroft ("U") or through passages ("P") at the base of buildings.

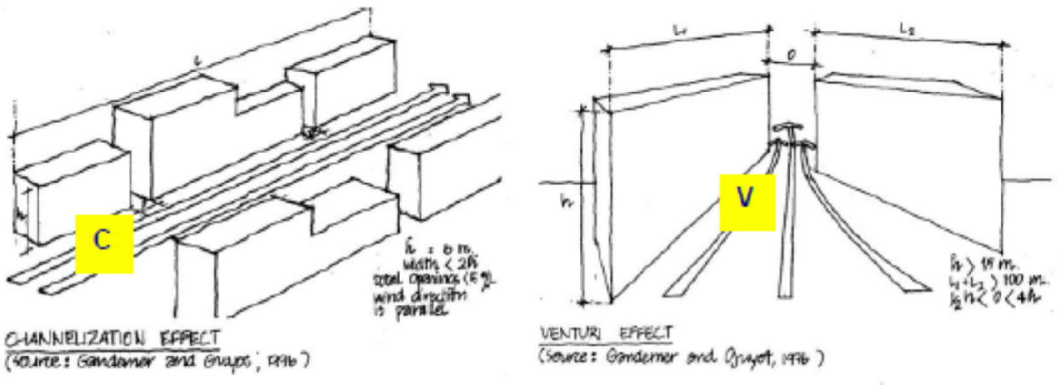
Figure 5 Wind Flow Patterns Past Regular Shaped Buildings



The grouping of buildings can also have an impact on surrounding pedestrian winds – refer Figure 6.

- Channelling Effect winds "C" result when there are rows of parallel buildings (especially taller ones) where the gaps in between the buildings 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.

Figure 6 Wind Flow Patterns Past Groups of Buildings



5 WIND ACCEPTABILITY CRITERIA

5.1 Standard Local Government Criteria

The choice of suitable criteria for evaluating the acceptability of particular ground level conditions has been the subject of international research over the past few decades. One of the commonly accepted set of acceptability criteria developed from this research, currently referenced by many Australian Local Government Development Control Plans, is summarised in Table 1. The limiting wind speed criteria in Table 1 are based on the maximum wind gust occurring (on average) once per year.

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/s "Walking Comfort" criterion. Whilst this magnitude may appear somewhat arbitrary, its value represents a level of wind intensity above 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 (ie more stringent) than for "walking comfort".

5.2 Application of Wind Criteria

The criteria provided in Table 1 (especially in relation to Comfort) 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 considerably 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 satisfies the relevant criteria.

6 WIND IMPACTS OF THE PROPOSED REDEVELOPMENT

6.1 Areas of Interest in Relation to Wind Impact

Areas of interest in relation to the expected wind impact of the proposed Development on surrounding footpaths, primary building entry points, communal open spaces, balconies, etc, are identified in Figure 2.

- The Eden Street and Princes Highway footpaths — refer Figure 2-A
- The Public Park spanning between Eden Street and Princes Highway — refer Figure 2-A
- The "Meeting Place", at the northeast end of the Public Park — refer Figure 2-A
- The "Through-Site Link", at the northeast end of the site — refer Figure 2-A
- The various Building Lobby Entries — refer Figure 2-A
- The Outdoor Child Care Play Area — refer Figure 2-A
- The "A/B-Low" Communal Open Space on Level 1 — refer Figure 2-B
- The "C/D" Communal Open Space on Level 2 — refer Figure 2-B
- The Level 6 Building "D" Extended Terrace — refer Figure 2-C
- The "A/B-High" Communal Open Space on Level 7 — refer Figure 2-C
- The Level 18 Building "C" Roof Garden — refer Figure 2-D
- The Level 19 Building "D" Roof Garden — refer Figure 2-D
- The Level 21 Building "A" Roof Garden — refer Figure 2-E
- The Level 22 Building "B" Roof Garden — refer Figure 2-D

6.2 Future Wind Impact at All Areas of Interest

The wind impact of the proposed Development is described by examining the impact of key prevailing wind conditions on areas of interest within and external to the development. The key directions analysed are:

- NE and S/SE winds for spring-summer-autumn months and
- W winds (ranging from SW to NW) for winter months.

The predicted wind environment at the site is examined in terms of both:

- Existing Winds, and
- Future Winds with the addition of the proposed development.

The above predictions are made on the basis of our best engineering judgement and (decades of) experience in carrying out Environmental Wind Tunnel Testing and CFD Simulation Studies.

The above predictions are made without necessarily assuming any benefit from the already planned landscaping for the proposed development.

Prevailing Wind Direction:
NORTHEAST Winds

Period of Annual Cycle:
Summer (October to March)

Location	Existing Compliance	Future Compliance	Key Factors
Eden Street Footpath	Likely comply	Moderate Increase Likely comply	NE winds are generally mild. The proposed development's Eden Street façades are set back from the footpath and existing trees will either be retained or replaced.
Princes Highway Footpath	Likely comply	Likely comply	NE winds are generally mild, although the wider expanse of the Princes Highway allows for more wind channelling of NE winds. The proposed development's Princes Highway façades are set back from the footpath and existing trees will either be retained or replaced.
Public Park	Locations not relevant to "existing" built environment	Likely comply	Sheltering from the proposed development's Buildings "A" and "B" will limit northeast winds throughout the Public Park area.
Meeting Place		Likely comply	Sheltering from the proposed development's Building "A" and upstream trees along Eden Street will limit northeast winds within the Meeting Place area.
Through-Site Link		Likely comply	Sheltering from the adjoining residential properties to the northeast as well as the existing trees along the northeast boundary line will limit northeast winds along the Through-Site Link.
Outdoor Child Care Area		May just comply	Although NE winds are generally mild, there will be infrequent occasions where higher NE winds are directed downwards off Building "D"'s southeast facing corner and through the undercroft Outdoor Child Care area.
Building "A" Lobby Entry		May just comply	Although NE winds are generally mild, there will be infrequent occasions where infrequent higher NE winds are directed downwards off Building "A"'s Princes Highway façade onto the undercroft area in front of the Building "A" Lobby
Building "B" Lobby Entry		Likely comply	Sheltering from the proposed development's Building "B" will limit northeast winds at this Lobby entry.
Building "C" Lobby Entry		Likely comply	Sheltering from the proposed development's Building "C" will limit northeast winds at this Lobby entry.
Building "D" Lobby Entry		May just comply	Although NE winds are generally mild, there will be infrequent occasions where higher NE winds are directed downwards off Building "D"'s Public Park facing façade onto the undercroft area in front of the Building "D" Lobby
Communal Open Space "A/B-Low"		Likely comply	Sheltering from the proposed development's Building "A" will limit winds throughout this public access area.
Communal Open Space "C/D"		Likely comply	Sheltering from the proposed development's Buildings "A" and "B" will limit winds throughout this public access area.
Communal Open Space "A/B-High"		Likely comply	Sheltering from the proposed development's Building "A" will limit winds throughout this public access area.
Level 18 Building "C" Roof Garden		May not comply without appropriate mitigation	Although NE winds are generally mild, there will be infrequent occasions where higher NE winds accelerate over the top of Building "C" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc)

Location	Existing Compliance	Future Compliance	Key Factors
Level 19 Building "D" Roof Garden		May not comply without appropriate mitigation	Although NE winds are generally mild, there will be infrequent occasions where higher NE winds accelerate over the top of Building "D" (also after accelerating around the southern façade of Building "B") creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc)
Level 21 Building "A" Roof Garden		May not comply without appropriate mitigation	Although NE winds are generally mild, there will be infrequent occasions where higher NE winds accelerate over the top of Building "A" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc)
Level 22 Building "B" Roof Garden		May not comply without appropriate mitigation	Although NE winds are generally mild, there will be infrequent occasions where higher NE winds accelerate over the top of Building "A" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc)

Prevailing Wind Direction:
SOUTH & SOUTHEAST Winds

Period of Annual Cycle:
All-Year-Round (South) Summer (Southeast)

Location	Existing Compliance	Future Compliance	Key Factors
Eden Street Footpath	Likely comply	Moderate Increase Likely comply	Eden Street footpath areas shielded by the proposed development will be mild. Areas adjacent to the proposed Public Park may increase but still able to comply if existing trees are either retained or replaced.
Princes Highway Footpath	May not comply	Moderate Increase Same level of compliance	The wider expanse of the Princes Highway allows for more wind channelling of S and SE winds in the existing built environment. The proposed development's Princes Highway façades are set back from the footpath, thereby limiting downwash effects along the footpath; also the existing trees will either be retained or replaced.
Public Park	Locations not relevant to "existing" built environment	May not comply without appropriate mitigation	This area will have a direct exposure to S/SE winds with sheltering only from Princes Highway footpath trees. Areas within the Public Park closer to Eden Street will also experience the downwash effect of windflow accelerating around the western façade of Building "B" and eastern façade of Building "D".
Meeting Place		Likely comply	Sheltering from the proposed development's Building "B" and any landscaping within the Public Park will limit S/SE winds within the Meeting Place area.
Through-Site Link		May not comply without appropriate mitigation	This area will have a direct exposure to S/SE winds with sheltering only from any Princes Highway landscaping immediately adjacent to the Link. Areas along the Link will also experience the downwash effect of windflow accelerating around the eastern façade of Building "B".
Outdoor Child Care Area		May not comply without appropriate mitigation	This area will have a direct exposure to S/SE winds with sheltering only from any Princes Highway landscaping immediately adjacent. The area will also experience downwash winds off Building "D"'s Princes Highway façade.
Building "A" Lobby Entry		May not comply without appropriate mitigation	S/SE winds will be directed downwards off Building "A"'s Princes Highway façade onto the undercroft area in front of the Building "A" Lobby

Location	Existing Compliance	Future Compliance	Key Factors
Building "B" Lobby Entry		May not comply without appropriate mitigation	S winds will be accelerated along Building "B"'s western façade impacting the area in front of this Lobby entry.
Building "C" Lobby Entry		May not comply without appropriate mitigation	SE winds will be accelerated along Building "D"'s eastern façade impacting the area in front of this Lobby entry.
Building "D" Lobby Entry		Likely comply	Sheltering from the proposed development's Building "C" will limit winds in this area.
Communal Open Space "A/B-Low"		May not comply without appropriate mitigation	S/SE winds will be directed downwards as downwash off the proposed development's Building "A" and Building "B" internal south facing facades.
Communal Open Space "C/D"		Some areas comply Others are may not comply without appropriate mitigation	Areas in between Buildings "C" and "D" will be shielded from S/SE winds. Areas along the western side of Building "D" will experience accelerated flow around this building's western façade.
Communal Open Space "A/B-High"		May not comply without appropriate mitigation	S/SE winds will channel in between Buildings "A" and "B" creating accelerated flow over this area.
Level 18 Building "C" Roof Garden		May not comply without appropriate mitigation	S/SE winds will accelerate over the top of Building "C" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc) especially in areas close to the southern perimeter of the roof garden.
Level 19 Building "D" Roof Garden		May not comply without appropriate mitigation	S/SE winds will accelerate over the top of Building "D" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc) especially in areas close to the southern perimeter of the roof garden.
Level 21 Building "A" Roof Garden		May not comply without appropriate mitigation	S/SE winds will accelerate over the top of Building "A" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc) especially in areas close to the southern perimeter of the roof garden.
Level 22 Building "B" Roof Garden		May not comply without appropriate mitigation	S/SE winds will accelerate over the top of Building "B" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc) especially in areas close to the southern perimeter of the roof garden.

Prevailing Wind Direction:
WESTERLY Winds (SW-NW)

Period of Annual Cycle:
Winter (May to October)

Location	Existing Compliance	Future Compliance	Key Factors
Eden Street Footpath	May not comply	Moderate Increase Same level of compliance	Higher westerly winds, especially from the southwest, can channel along Eden Street and may not comply in the existing built environment. The proposed development's Eden Street façades are set back from the footpath, thereby limiting downwash effects along the footpath; also the existing trees will either be retained or replaced.

Location	Existing Compliance	Future Compliance	Key Factors
Princes Highway Footpath	May not comply	Moderate Increase Same level of compliance	Higher westerly winds, especially from the south-southwest, can channel along Princes Highway and may not comply in the existing built environment. The proposed development's Princes Highway façades are set back from the footpath, thereby limiting downwash effects along the footpath; also the existing trees will either be retained or replaced.
Public Park	Locations not relevant to "existing" built environment	May not comply without appropriate mitigation	Areas in the north half of the Park will have a direct exposure to winds from the northwest with sheltering only from Eden Street footpath trees. Areas in the eastern half of the Park will also experience the downwash effect of windflow accelerating around the northern façade of Building "C".
Meeting Place		May not comply without appropriate mitigation	This area will have a direct exposure to winds from the northwest with sheltering only from Eden Street footpath trees. This area will also experience the downwash effect of windflow accelerating around the northern façade of Building "C".
Through-Site Link		Likely comply	Sheltering from the proposed development's Building "A" will limit winds in this area.
Outdoor Child Care Area		May not comply without appropriate mitigation	The western part of this area will have a direct exposure to winds from the southwest as winds accelerate around the southwest corner of Building "D".
Building "A" Lobby Entry		Likely comply	Sheltering from the proposed development's Buildings "A" and "B" will limit winds in this area.
Building "B" Lobby Entry		May not comply without appropriate mitigation	The area in front of the Lobby entry will have a direct exposure to winds from the northwest and will also experience the downwash effect of windflow accelerating around the northern façade of Building "C".
Building "C" Lobby Entry		May not comply without appropriate mitigation	The area in front of the Lobby entry will have a direct exposure to winds from the northwest and will also experience the downwash effect of windflow accelerating around the northern façade of Building "C".
Building "D" Lobby Entry		Likely comply	Sheltering from the proposed development's Building "D" will limit winds in this area.
Communal Open Space "A/B-Low"		Likely comply	Sheltering from the proposed development's Building "B" will limit winds in this area.
Communal Open Space "C/D"		May not comply without appropriate mitigation	Areas in between Buildings "C" and "D" will experience channelling flow between the two buildings. Areas on the western side of Building "D" will experience downwash off this building.
Communal Open Space "A/B-High"		May not comply without appropriate mitigation	Northwest winds will channel in between Buildings "A" and "B" creating accelerated flow over this area close to its northern perimeter.
Level 18 Building "C" Roof Garden		May not comply without appropriate mitigation	Westerly winds will accelerate over the top of Building "C" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc) especially in areas close to the western perimeter of the roof garden.
Level 19 Building "D" Roof Garden		May not comply without appropriate mitigation	Westerly winds will accelerate over the top of Building "D" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc) especially in areas close to the western perimeter of the roof garden.

Location	Existing Compliance	Future Compliance	Key Factors
Level 21 Building "A" Roof Garden		May not comply without appropriate mitigation	Westerly winds will accelerate over the top of Building "A" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc) especially in areas close to the western perimeter of the roof garden.
Level 22 Building "B" Roof Garden		May not comply without appropriate mitigation	Westerly winds will accelerate over the top of Building "B" creating adverse winds for stationary type activities (eg long-exposure sitting, dining, etc) especially in areas close to the western perimeter of the roof garden.

7 WIND MITIGATION RECOMMENDATIONS

Section 6 provided guidance as to the areas where the adopted wind acceptability criteria had the potential to be exceeded and an indication as to the likely local optimum wind treatment strategy, eg whether the wind condition of interest is likely to arise from accelerating winds which require vertical windbreaks (such as landscaping) or downwash winds which require horizontal windbreaks (such as awnings, canopies).

The wind conditions of potential concern in relation to the proposed development include:

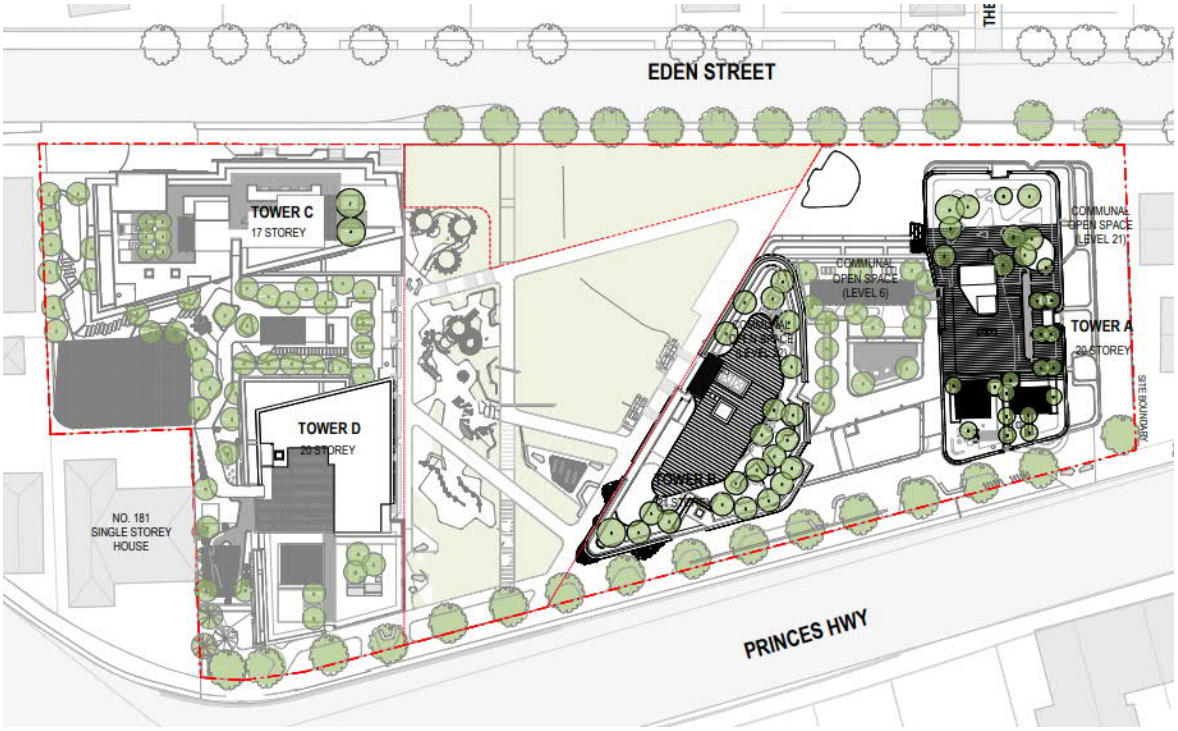
- Public Park and Meeting Place;
- Main Lobby Entries;
- The Outdoor Child Care Play Area;
- All elevated Communal Spaces
- All Roof Gardens

7.1 Already Planned Wind Mitigation

The following features, already planned for the development, will have an ameliorating impact on local wind conditions:

- Extensive landscaping along Eden Street, Princes Highway, the Public Park and Through-Site Link - refer Figure 7, as well as throughout the four high-rise building Roof Gardens.
- Note that some of the footpath landscaping involves retention of existing trees, etc.

Figure 7 Planned Landscaping at Lower and Upper Ground Levels and Roof Gardens



7.2 Additional Wind Mitigation Recommendations

On the basis of the expected wind impacts outlined in Section 6, the following recommendations for wind amelioration features are made in areas where winds have the potential, without suitable wind mitigation, to approach or exceed the relevant 10 m/s, 13 m/s or 16 m/s criterion depending on the designated use for that area.

The recommendations shown in Figure 8 are designed to mitigate adverse wind conditions.

Eden Street and Princes Highway Footpaths

- Retain or replace the existing trees along both footpaths, especially adjacent to the Public Park areas.

Public Park

- Retain or replace the existing trees along the Duncan Street footpath close to the intersection with Kyle Street and add additional landscaping and/or pergolas, shade cloths, etc, at any seated/dining areas.

Outdoor Child Care Play Area

- Retain or replace all existing trees along Princes Highway immediately adjacent to the Outdoor Child Care Play Area;
- Add horizontal wind mitigation (awnings, pergolas, shade cloths, etc) above exposed areas relative to the Building “D” outline above; and
- Add full height, vertical wind mitigation (wall, louvres of maximum porosity 25%, etc) along the western perimeter to shelter against westerly winds.

Main Building Entries

- Provide a solid horizontal windbreak (canopy, awning, etc) protecting the main entry areas into Buildings “A”, “B” and “C”, protecting these areas from the downwash created by south, southeast and westerly winds.

Elevated Communal Spaces

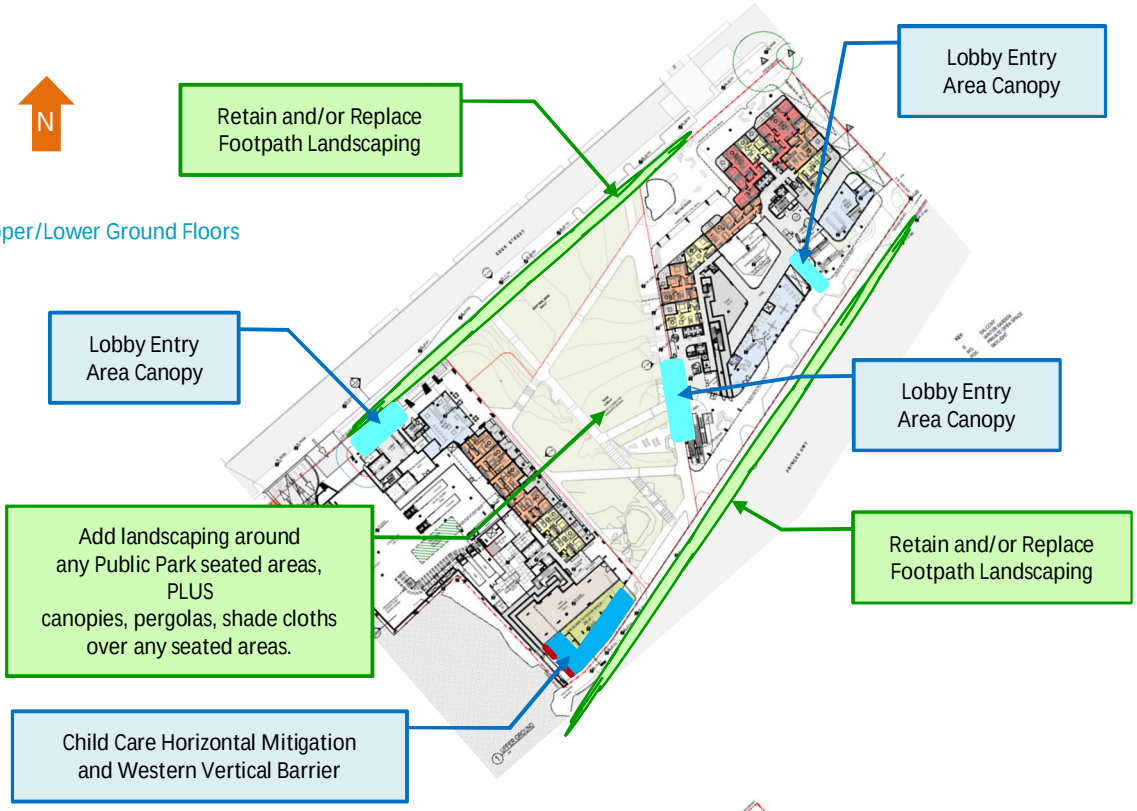
- Provide minimum 1.8 m height balustrade along the communal space perimeters indicated in Figure 8 along with horizontal shading near building facades and landscaping close to any planned seating areas.

Roof Gardens

- Provide minimum 1.8 m height balustrade or equivalent (eg wall plus planter of same height) along the roof garden perimeters facing south, southeast and west along with landscaping close to any planned seating areas.

Figure 8 Wind Mitigation Recommendations

A. Upper/Lower Ground Floors



B. Level 2

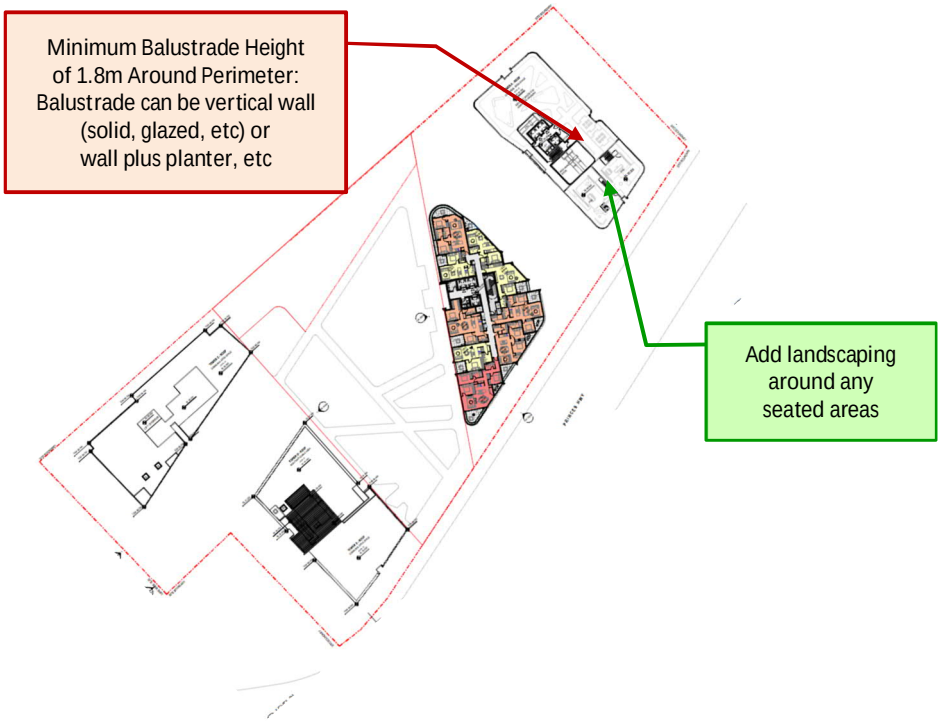
(Fig.8 cont'd)

C. Level 7

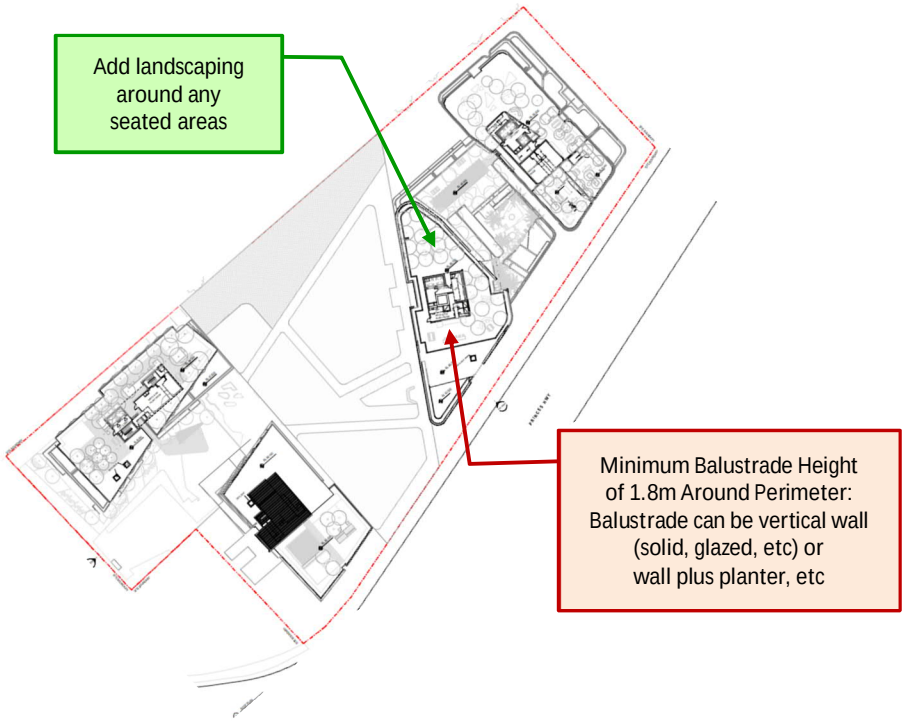
D. Level 19

(Fig.8 cont'd)

E. Level 21



F. Level 22



7.3 Upper Level Balconies

The proposed development's main residential blocks have balconies around all facades. It is almost certain that some of these balconies, especially those at upper levels and near building corners, will experience adverse wind conditions requiring wind treatment beyond standard height (ie code-compliant) balustrades. There may also be interaction between the development's buildings which results in increased balcony winds, eg westerly winds accelerating around the northern edge of Building "B" onto Building "A".

Balconies where such treaments may be considered are shown in Figure 9.

Treatments might include increased balustrade height or partial screening via moveable louvres, to take advantage of the beneficial impact of cooler, milder winds during summer, while providing the capacity to limit the impact of colder and potentially much stronger winds during winter. Where balconies have exposure to more than one aspect, partial balcony treatment on the most exposed façade would be a practical means of wind shielding, eg full height balustrade, louvres, pull-down screens, etc, on the most exposed aspect of the balcony. Balconies with predominantly west exposure could also consider winter gardens.

The following is therefore recommended:

- During the Detailed Design phase of the project, once the design of the various building facades is finalised, further modelling could be carried out to confirm zones of the building, by height and by plan view location (eg which building corners), where wind mitigation (ie beyond the standard balustrade height) may be beneficial IF it is intended for balconies and terraces to be used all-year-round, also noting that the strongest westerly winds occur during winter.
- The preference here would be for detailed 3D CFD Simulation Modelling rather than Wind Tunnel Testing, given the issue of balcony scaling at typical 1:400 wind tunnel test scales.

Figure 9 Upper Level Balconies Potentially Exposed to Adverse Wind Conditions

8 CONCLUSIONS

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Arncliffe Eden Property Pty Ltd to assess the wind impact on the immediate surrounds of a proposed Mixed-Use Development (herein the Project) located at Eden Street and Princes Highway, Arncliffe – refer Figure 1.

The present study is a qualitative (expert opinion) study of potential wind impacts.

This initial assessment has been made on the basis of our best engineering judgment and on the experience gained from (decades of) scale-model Wind Tunnel Testing and CFD Simulation Modelling of a range of similar scale developments.

Local Wind Climate

On the basis of long-term wind records obtained from the Bureau of Meteorology stations weather at Sydney Kingsford Smith Airport, SLR has determined that key prevailing wind directions of interest are the northeast and south/southeast for summer/early autumn and west quadrant winds for winter/early spring.

Future Wind Environment

In terms of the future wind environment with the proposed Development, the following features are noted as being of most significance:

- The proposed Development's main residential blocks are set back from its two perimeter street frontages with extensive landscaping (large trees) planned along both Eden Street and Princes Highway.
- Areas potentially requiring wind mitigation are largely within the site, especially the elevated Communal Spaces and Roof Gardens.
- Windbreak recommendations, all of which will be implemented in the design of the development, have been made to assist in ameliorating potentially adverse winds identified in this study. Accordingly, all affected areas should be able to comply with the recommended wind acceptability criteria – refer Section 7 and Figures 8 and 9 for details.

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