



HILLS SHOWGROUND STATION PRECINCT, CASTLE HILL PEDESTRIAN WIND ENVIRONMENT STATEMENT

WF043-01F02(REV3)- WS REPORT

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Prepared for:

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DOCUMENT CONTROL

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EXECUTIVE SUMMARY

This report is in relation to the Hills Showground Station Precinct Concept Proposal located in Castle Hill, and presents an opinion on the likely wind conditions affecting the various trafficable outdoor areas within and around the subject development. The effect of wind activity is examined for the predominant wind directions for the Sydney region. The analysis of the wind effects relating to the subject site has 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 final 3D massing model and conceptual masterplan drawings set prepared by Cox Architecture, received April 22, 2020. No wind tunnel tests have 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. 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 subject development will be exposed to the prevailing winds from all directions due to the low-rise surrounding structures. However, the prevailing winds are expected to be shielded by the development itself once built. Similarly, further shielding from the prevailing winds is expected once the future development of the surrounding area is complete. Certain regions of the development may be prone to adverse wind effects due to the interaction of the prevailing winds with the built form, specifically:

- The proposed north-west plaza within Doran Drive Precinct.
- The eastern and western station plazas adjacent the showground metro station.
- The existing plaza east of the Hills Showground Car Park.
- The east-west pedestrian link through Precinct East.
- The communal spaces between the towers and podia of Precinct East.
- The proposed Precinct East Park adjacent to the pedestrian.

The potentially adverse wind effects include:

- Direct impact of the prevailing winds.
- Funnelling winds between the various podia and towers due to the alignment of the buildings to the prevailing winds directions.
- Side-streaming and acceleration of winds around the various corners of the development.
- Downwash caused by the prevailing winds impacting the building and redirecting winds downwards.

To address the potential for adverse wind effects impacting the comfort of pedestrians within and around the development, generalised wind mitigation treatments that should be considered are discussed within this report, and are summarised as follows:

Landscaping

- Planting and vegetation as densely foliating and evergreen species throughout the site. Undergrowth such as shrubs or hedges are expected to further improve wind conditions.
- Impermeable/porous screens signage, artwork, sculptures around areas subjected to stronger winds
- Localised screening around areas where longer duration activities are expected
- Operable screening to be utilised by the various retail tenancy owners for patron flexibility.
- Wind screens or planting within through site links, and at corners of buildings.

Building location and orientation

- Orient through-site links and tower aspects to avoid direct alignment with the prevailing winds and/or incorporate bends.
- Locate areas intended for long duration exposure away from building corners, walkways that are aligned to prevailing winds and large open areas.

Building Articulation and design

- Tower setbacks from podium aspects should be at least 3m in depth or incorporate ground level down-wash mitigation through an impermeable awning or tree/vegetation planting.
- Inclusion of impermeable continuous awnings over trafficable areas below towers or podia of a significant height which are exposed to the prevailing winds and wrap around the corners of the development where side-streaming winds are expected.
- Horizontal feature elements and other façade elements that create a discontinuous façade surface along tower aspects

The outdoor trafficable areas within the site are expected to be suited for their intended uses such as sitting for plaza areas through the consideration of the above generalised wind mitigation treatment recommendations. We have reviewed the Concept Proposal and consider the design to be capable of conforming to the recommendations within this report. Appropriate treatments of specific areas within the site will be confirmed through quantitative wind tunnel testing during the detailed design at the Development Application stage.

1 INTRODUCTION

This report has been prepared for Landcom on behalf of Sydney Metro to support a Concept development application (DA) under Section 4.22 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This report also addresses the Planning Secretary's environmental assessment requirements (SEARs) regarding the wind conditions at the development site and provides an analysis of the expected wind impacts to existing and proposed public domain areas and open spaces. The report will also determine the existing wind characteristics of the site and its locality, significant locations for wind sensitivity and mitigating measures through wind tunnel testing at a later detailed design stage.

Buildings 8 or more storeys in height or over 25 metres in height require wind tunnel testing to demonstrate satisfaction of the wind criteria stipulated in Part D Section 19 of the Hills Development Control Plan for the Showground Station Precinct. Hence it is recommended that wind tunnel testing is conducted during the detailed design stage to verify the wind conditions and enable more detailed feedback and design of the potential wind mitigation measures.

The concept for which approval is sought (the 'Concept Proposal') is for a high-density mixed-use precinct with a new public park and plaza, and associated facilities on land located within the Hills Showground Station Precinct (the 'Site') on development lots (Lot 53, Lot 55 and 56 in DP 1253217) (the 'DA Area') as shown in Figure 1a.

This report considers 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. The analysis of wind effects relating to the proposed development was 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 was 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 THE DEVELOPMENT AND SURROUNDINGS

The Concept Proposal comprises residential, retail and commercial uses and building envelopes of varying heights from three to up to twenty-one storeys. The proposal also includes a new road, landscaping, services and the provision of publicly accessible open space in the form of Doran Drive Plaza and a local park. An indicative yield of up to 1,620 dwellings is anticipated to be provided by the proposal.

More specifically, the Concept Proposal comprises:

- total gross floor area (GFA) of 166,486m² across all three development lots
- a maximum residential GFA of 152,546m² equating to 1,620 dwellings including a minimum of five percent for affordable housing
- maximum GFA for non-residential uses of 13,940m² (commercial, retail and community facilities)
- Doran Drive Plaza – minimum of 1,400m²
- a new public park to referred to as Precinct East Park – minimum of 3,500m²
- building envelopes, and allocation of GFA to the three development lots
- strategies for utilities and services provision, managing stormwater and drainage, achievement of ecologically sustainable development (ESD) and design excellence
- civil plan addressing the timing of future subdivision, construction, release and development of land
- concept principal subdivision of development Lot 56 DP 1253217 (Hills Showground Precinct East) into future major lots, public domain areas and roads.

No building or construction works are proposed to be undertaken as part of this Concept Proposal. Once the SSDA is approved, the successful purchasers of the development precincts and/or lots from Sydney Metro, will be responsible for submitting subsequent DAs for the design and construction of the buildings and public domain areas in accordance with the approved Concept.

The Site is bordered by the following:

- North and North-West – De Clambe Drive with a drainage basin Castle Hill and The Showground further North.
- West – De Clambe Drive and Cattai Creek riparian zone with commercial/industrial warehouses further west

- South to southeast – Carrington Road across which are low density residential developments, a child care and medical/physiotherapy
- East – Showground Road across which are low density residential development.



Figure 1a: Aerial Image of the Proposed Development Site

A survey of the local land topography around the site indicates that the terrain gradually rises to the north-east from the south-west of the development. An aerial image of the site and the local surroundings is shown in Figure 1a. The critical trafficable outdoor areas associated with the proposed development, which are the focus for pedestrian wind effects in this assessment, are shown in Figure 1b and detailed as follows:

- The pedestrian footpaths and accessible areas within and around the site.
- The existing western plaza east of the Hills Showground Car Park. (1)
- The proposed Doran Drive plaza at the north-west of Doran Drive Precinct. (2)

- The eastern and western station plazas south of the Doran Drive Precinct adjacent to the Showground Metro Station. (3)
- The east-west pedestrian link through Precinct East. (4)
- The communal open spaces between the towers and podia of Precinct East. (5)
- The proposed south-eastern Precinct East Park adjacent to the pedestrian link. (6)

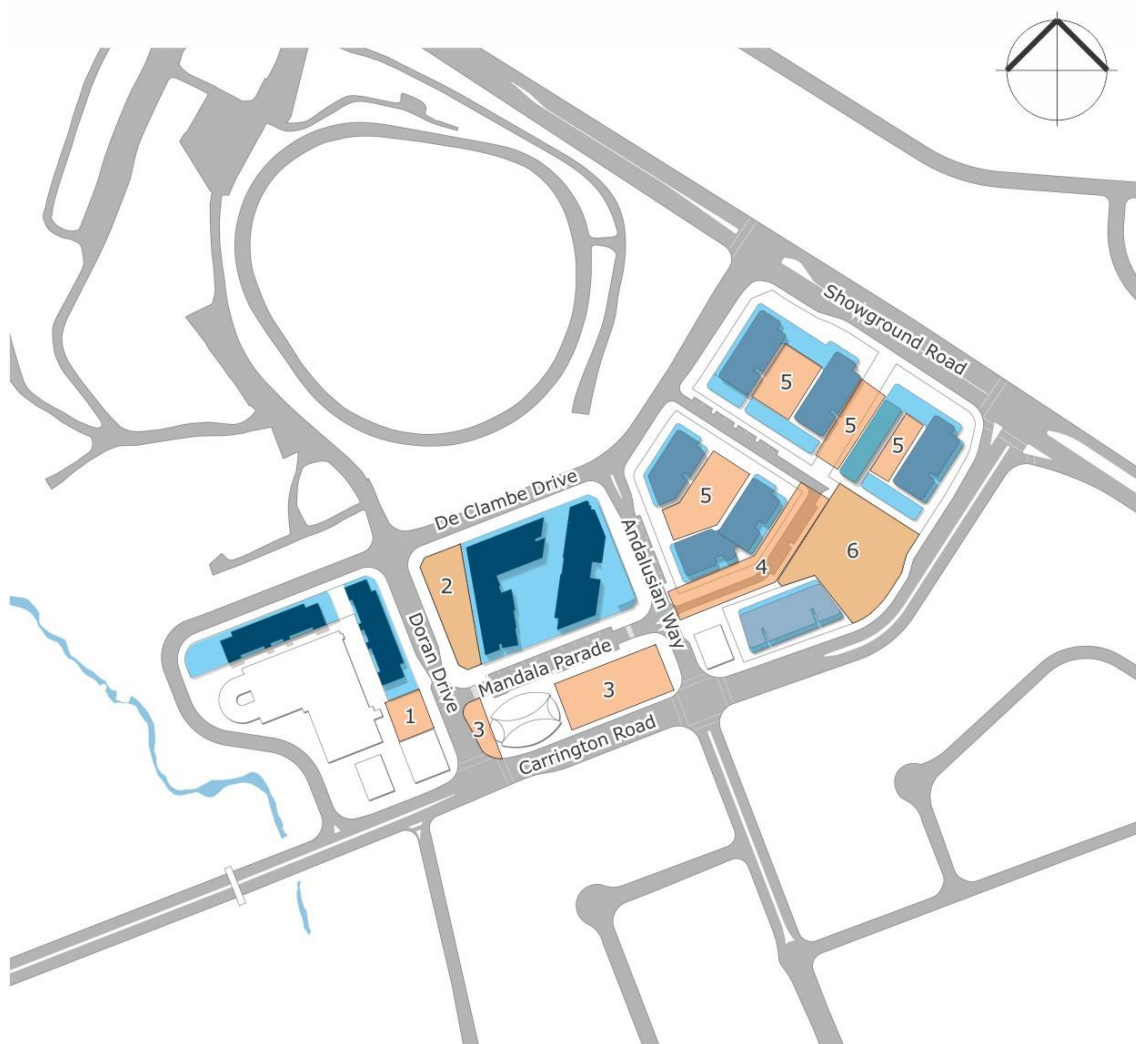


Figure 1b: Critical Trafficable Outdoor Areas within Proposed Development Site

3 REGIONAL WINDS

The regional winds of the Sydney Basin Region are governed by three principal wind directions. These winds prevail from the north-east, south-south-east and west.

These wind directions were determined from an analysis undertaken by Windtech Consultants of recorded directional wind speeds obtained at the meteorological station located at Bankstown Airport by the Bureau of Meteorology (recorded from 1993 to 2016). From this analysis, directional probabilities of exceedance and directional wind speeds for the region are determined. The directional wind speeds and corresponding directional frequencies of occurrence are presented in Figure 2.

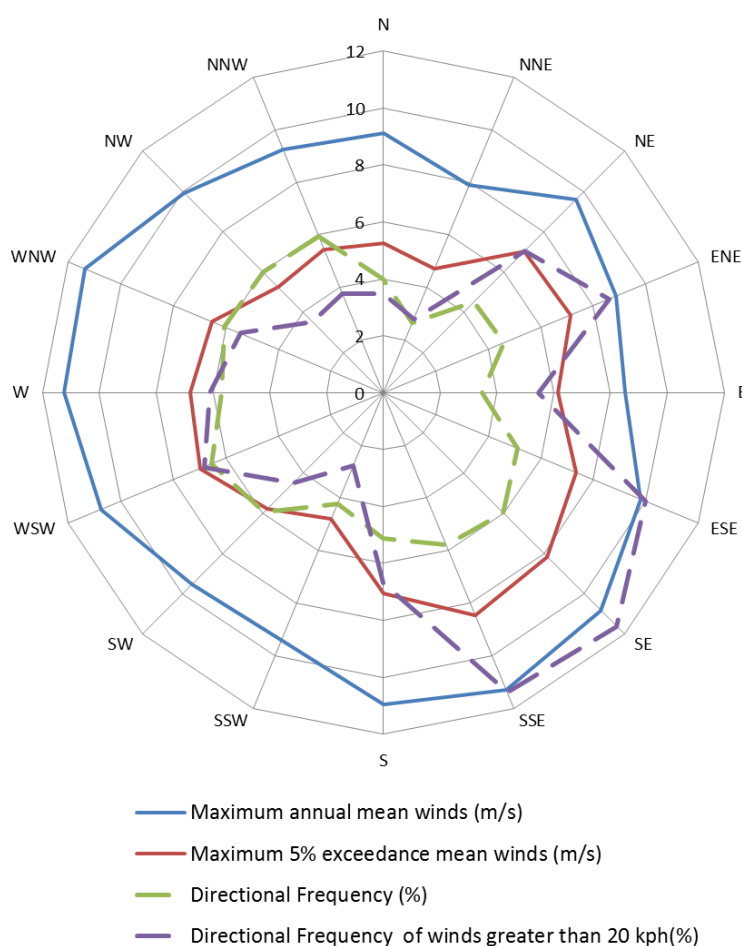


Figure 2: Annual and 5% Exceedance Hourly Mean Wind Speeds, and Frequencies of Occurrence, for the Sydney Basin Region (referenced to 10m above ground in standard open terrain)

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 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 (rather than referencing specific wind speeds). 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 are discussed in the following sub-sections of this report for the various outdoor areas within and around the subject development, for each of the prevailing wind directions for the Sydney Basin Region. The interaction between the wind and the building morphology in the area was considered, and important features taken into account include the distances between the building forms, their overall heights and bulk, as well as the landform. Note that only the potentially critical wind effects are discussed in this report.

Although this assessment is of a qualitative nature, the below criteria are considered when assessing the wind environment impacts.

- In walkways and pedestrian transit areas and streets where pedestrians do not generally stop, sit, stand, window shop and the like, the gust equivalent mean (GEM) should not exceed 7.5 m/s, with 5% probability of exceedance
- In areas where pedestrians are involved in stationary short-exposure activities such as window shopping, standing or sitting (including areas such as bus stops, public open space and private open space, cafes) the gust equivalent mean (GEM) should not exceed 5.5 m/s, with 5% probability of exceedance
- In areas for stationary long-exposure activity, such as outdoor fine dining or outdoor amphitheatres, the gust equivalent mean (GEM) should not exceed 3.5 m/s, with 5% probability of exceedance
- All areas accessible by the general public or building occupants also need to satisfy the following safety limit for wind from any direction: annual maximum 3s gust wind speed of 23 m/s.

5.1 Site Location

The development site is located at the north-eastern edge of a low-rise industrial area, with residential buildings to the south of the site. The low-rise industrial building developments are not expected to offer significant shielding due to their relatively low height, and distance away from the site. Similarly, the low-rise residential buildings to the south are not expected to shield the site from the prevailing winds to any significant extent. These low-rise residential buildings are expected to be redeveloped in the future to mid-rise residential buildings which, once redeveloped, are expected to provide shielding to the proposed development from southerly prevailing winds. The adjacent Hills Showground car park building is expected to provide some shielding from the westerly winds to the central site area. The rise in terrain from the south-west to north-east may accelerate the westerly and southerly winds, however, this effect is expected to be minimal. The proposed buildings of the development are expected to shield areas within the development itself from the prevailing winds.

5.2 North-Easterly Sector Winds

The north-easterly winds prevail throughout the summer months, and impact the site directly. The expected paths of the north-easterly wind flows and hotspots are shown in Figure 3. These prevailing winds are also expected to accelerate around the corners of buildings along De Clambe Drive. These flows are expected to side-stream along the adjacent building facades along De Clambe Drive to the north, Carrington Road to the south, and from De Clambe Drive into Doran Drive and Andalusian Way within the site.

Due to the orientation of the towers at the north-east of the proposed development, the prevailing north-easterly winds are expected to funnel along the sides of the towers and along the ground level between the north-eastern podiums affecting the communal open spaces (5), the pedestrian site-link (4) and the proposed Precinct East Park (6). The communal open spaces at the north-east of the site where buildings are proposed around the perimeter are expected to experience less of the funnelling effect due to the creation of a more stagnant region.

Down wash is also expected at these north-eastern towers, due to their height, along their north-eastern aspect impacting the pedestrian ground level areas along Showground Road.

Further downstream, funnelling is expected to occur along the pedestrian site-link (4) adjacent to Andalusian Way. While the buildings of the development are expected to provide shielding against the prevailing north-easterly winds to the station plazas (3), the funnelled winds previously mentioned are expected to travel across Andalusian Way and along the Mandala Parade impacting the plaza area.

The prevailing north-easterly winds are also expected to downwash off and side stream along the northern façade of the Doran Drive Precinct buildings and accelerate around the façade corner at the northern end of the proposed Doran Drive Plaza (2). These winds and the direct prevailing north-eastern winds are expected to create adverse wind conditions along the northern end of the plaza area.

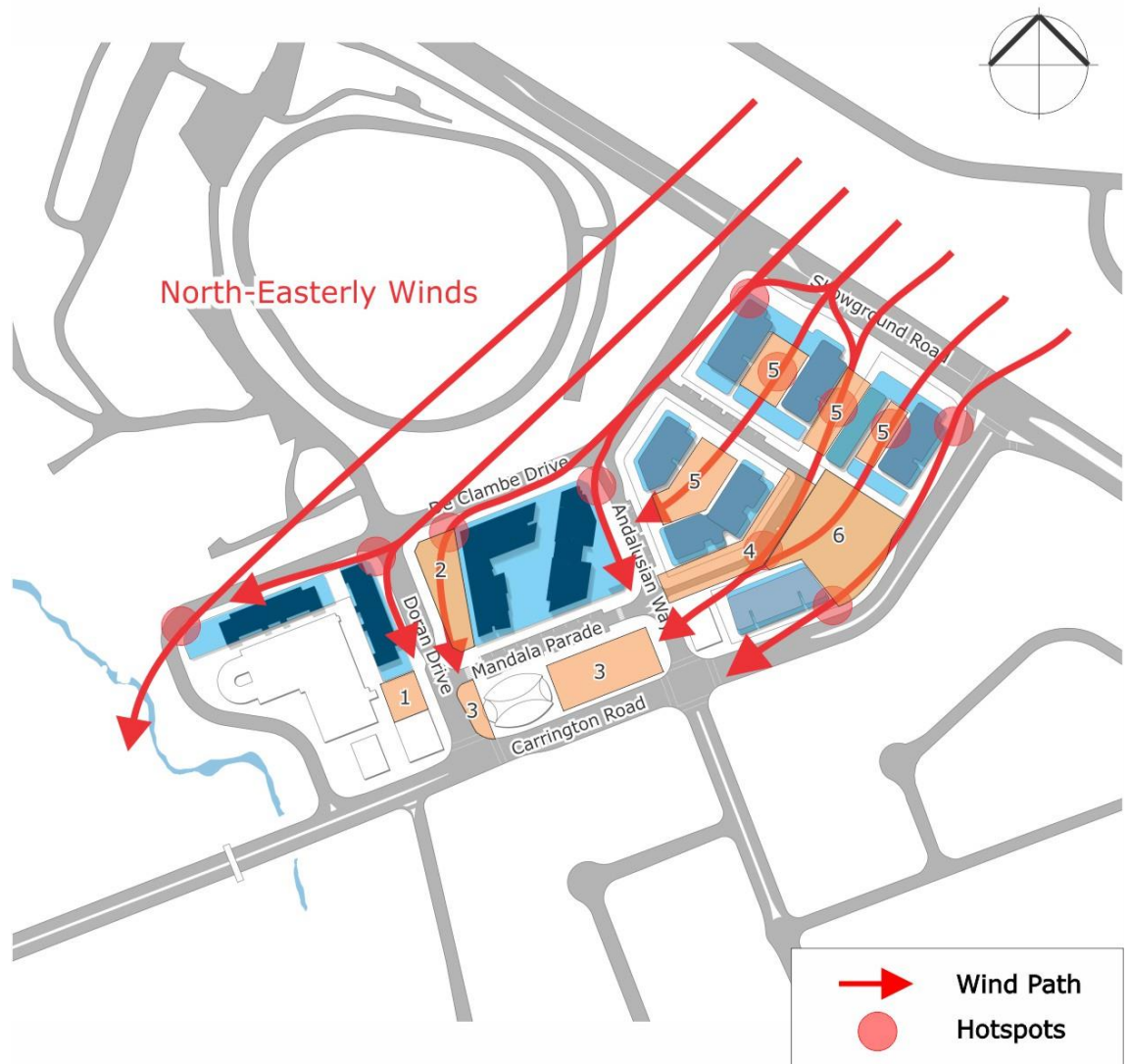


Figure 3: North-Easterly Wind Flow and Hotspots

5.3 South-South-Easterly Sector Winds

The south-south-easterly sector winds primarily occur throughout most of the year. These winds are expected to impact the development directly as the low-rise residential buildings to the south are not expected to offer any significant amount of shielding for the site, due to their small massing. It is noted that these low-rise residential buildings are expected to be redeveloped in the future to mid-rise residential buildings which, once redeveloped, are expected to provide shielding to the proposed development from southerly prevailing winds. The expected paths of the south-south-easterly wind flows and hotspots are shown in Figure 4.

The main wind effects that the south-south-easterly winds cause are accelerations at the south-eastern and south-western corners of the development, and funnelling between adjacent buildings on the southern aspect of the development. Corner accelerations at the western building of Precinct West, eastern corner along Showground Road and at the southern building

adjacent the proposed Precinct East Park are expected to be particularly strong. Due to the alignment of the buildings on the western half of the development and the streets, Doran Drive and Andalusian Way, the prevailing south to south-easterly winds are expected to funnel between the western buildings and side-stream along the east and west façade aspects. This wind effect is expected to affect the:

- existing western plaza (1)
- proposed north-western Doran Drive plaza (2)
- western station plaza area (3).

The direct south-south-easterly winds are also expected flow over the southern low-rise residential buildings and directly impact:

- eastern station plaza area (3)
- pedestrian site-link (4)
- proposed Precinct East Park (6).

Downwash from the prevailing south to south-easterly winds is also expected at the western building of Precinct West, southern buildings of the Doran Drive Precinct and the southern building of Precinct East adjacent the proposed park due to their exposed flat southern aspects. The downwash flows are expected to flow down to the ground level areas along the northern perimeter of the western carpark, the Precinct East Carrington Street frontage and along Mandala Parade at the northern end of the eastern station plaza area (3). These flows are expected to combine with the abovementioned side-streamed, direct and funnelled winds and exacerbate conditions further.



Figure 4: South-South-Easterly Wind Flow and Hotspots

5.4 Westerly Winds

Westerly winds typically occur during the winter months of the year for the Sydney Basin region. These winds are particularly undesirable due to the negative impact upon the human perception of comfort as a result of the cooler winds. It is anticipated that certain areas of the development may be susceptible to undesirable wind effects as a result of these winds. The expected paths of the westerly wind flows and hotspots are shown in Figure 5.

The prevailing westerly winds are expected to accelerate around the corners of buildings along De Clambe Drive and Carrington Road. Downwash is also expected to occur on the western façades of the eastern building of Precinct West due to its flat exposed western aspect and height that places it above the rest of the development. Similarly, some downwash is expected from the north-western aspects of the north-eastern towers of Precinct East that are

exposed to the westerly winds potentially impacting the open communal areas (5) adjacent to the tower base.

The station plazas (3) at the centre of the site are exposed to the direct westerly winds due to the lack of directly upstream existing and proposed buildings. These westerly winds are expected to flow around the commuter car park and service facility box through to the station plaza. The alignment of Mandala Parade and Carrington Road to the west also allows these prevailing winds to funnel along the northern and southern perimeter of the station area. These funnelled winds are expected to continue past Andalusian way along the pedestrian site-link (4) and through the proposed Precinct East Park (6). The direct westerly winds are also expected to flow through the northern end of the proposed north-western Doran Drive plaza (2) potentially creating adverse wind conditions.

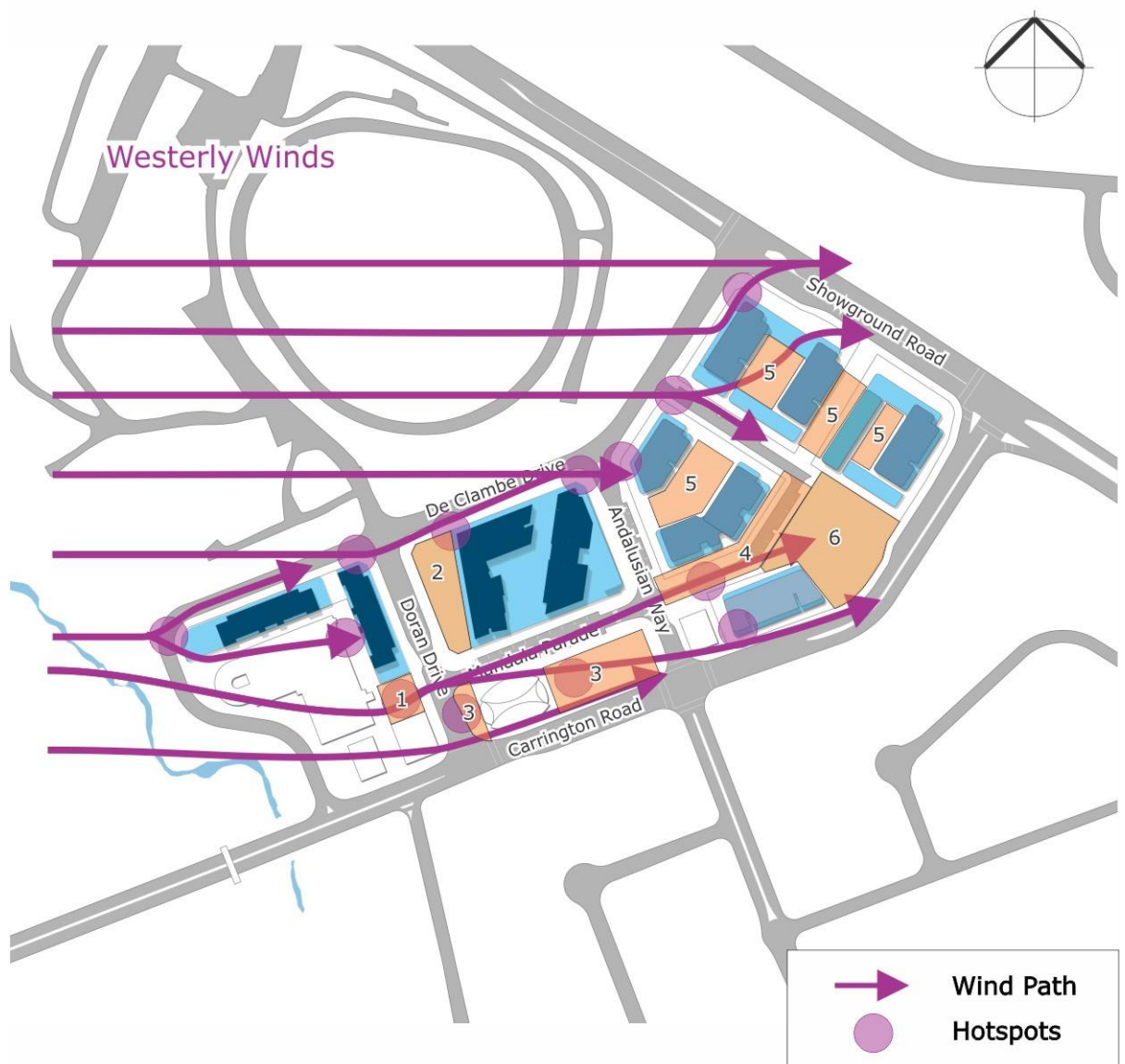


Figure 5: Westerly Wind Flow and Hotspots

5.5 Future Developments

The site adjoins Castle Hill Showground, which is currently undergoing a masterplan design by The Hills Shire Council. The draft masterplan is depicted in Figure 6. The future developments to the north of the site, as depicted in Figure 6, are expected to provide some shielding from the north-easterly and westerly prevailing winds for the proposed development site. The heights for the majority of these developments are not significant relative to the buildings in the proposed development. As such they are not expected to exacerbate the wind conditions as described in the previous sections.

The future residential buildings to the north-east and south of the site, if constructed, are expected to provide shielding to the proposed development site from the north-easterly and southerly prevailing winds improving the wind conditions within the site. It is noted that there is the possibility that developments south of Carrington Road may be built to a height of 12 storeys which would provide significant shielding to the southern end of the development site from the south-south-easterly winds.



Figure 6: Future Developments

Castle Hill Showground is currently undergoing a masterplan design by The Hills Shire Council. This diagram is indicative only and subject to change.

Source: <https://www.thehills.nsw.gov.au/Contact-Us/Have-Your-Say/Castle-Hill-Showground-Master-Plan>

5.6 General Recommendations

The proposed landscaping, podium and tower setbacks and general layout of buildings within the Concept Masterplan, provided in Figure 7, is expected to be very effective in mitigating adverse wind conditions throughout the site. The proposed planting within the open communal spaces, plazas, along the through-site link, around and throughout the proposed Precinct East Park is expected to provide mitigation to the expected wind effects however localised screening and/or additional planting may be required in areas for longer exposure activities. Podium and tower setbacks are also expected to assist in redirecting the down washed flows to the proposed tree lines adjacent to building facades. To further improve the wind conditions within the critical trafficable areas the following general wind mitigation treatments are recommended.

For tree planting/landscaping to be effective as a wind mitigation device, the species should be of a densely foliating evergreen variety to ensure year-round effectiveness, particularly for the areas that are expected to be impacted by westerly winds, which prevail during the winter months. Trees should also be planted in clusters with interlocking canopies to effectively absorb incident winds. In sensitive areas or hotspots where strong winds are expected, mature trees should be used as immature trees have difficulty establishing themselves in strong wind conditions. If immature trees are initially planted, the inclusion of porous screens around these tree plantings, or temporary wind screens is recommended to provide some wind mitigation while the trees develop and also provide some protection as the trees establish. Conditions can be further improved through the use of low-level vegetation such as shrubs/hedges or planter boxes. When utilised below a tree canopy, they provide protection from low level winds, especially for more sensitive areas where longer duration activities are expected. In general, landscaping can help mitigate adverse wind conditions caused by winds directly impacting an area, or side streaming winds by slowing the winds upstream.

In areas where stronger winds are expected, wind screens may be required. These can be in the form of impermeable screens, porous screens, signage, artwork etc. which are strategically located to mitigate winds at a particular location. In areas where longer duration stay is expected, such as café or restaurant seating areas, or communal recreation areas, additional localised screening, tenancy-operated screening deployable during windy conditions, or additional planting may be required.

Downwash is most likely to occur at the base of tall buildings that present a flat façade to the prevailing winds. This is especially true for the north-eastern street frontage along Showground Road for the north-easterly winds, along Mandala Parade for the south-south-easterly winds and along pedestrian walkways at the western buildings of Precinct West from the westerlies and south-south-easterly prevailing winds. The majority of the proposed setbacks in the various towers of the development are at least 3m in depth and expected to be effective in breaking up the downwash flows. In areas where the tower setback is less than 3m, mitigation treatments such as tree planting adjacent to the façade line, continuous impermeable awnings and canopies along the affected aspect can be used to deflect the winds away from pedestrian accessible areas. Generally, for impermeable awnings and canopies to be effective in wind

amelioration, a depth of at least 2.5m would be required. Awnings combined with tree planting alongside to absorb the deflected winds would be particularly effective in mitigating this wind effect. Wrap-around awnings at the corners of buildings can also prevent the down washed winds from combining with winds side streaming around the corners of the development. To reduce the ability of winds to downwash along the tower facades, horizontal feature elements and other façade elements that create a discontinuous façade surface can also be included.

Through-site links and tower aspects should be oriented to avoid direct alignment with the prevailing winds, incorporate bends, planting or screens in order to mitigate funnelling effects between buildings and tower massings. The funnelling between buildings may be severe enough for further mitigation measures such as a baffle screen arrangement. This tends to reduce the severity of winds affecting a particular area by redirecting it around obstacles, and thus reducing the wind speed.

A summary of the above general wind mitigation treatments is provided:

Landscaping

- Planting and vegetation as densely foliating and evergreen species throughout the site. Undergrowth such as shrubs or hedges are expected to further improve wind conditions.
- Impermeable/porous screens signage, artwork, sculptures around areas subjected to stronger winds
- Localised screening around areas where longer duration activities are expected
- Operable screening to be utilised by the various retail tenancy owners for patron flexibility.
- Wind screens or planting within through site links, and at corners of buildings.

Building location and orientation

- Orient through-site links and tower aspects to avoid direct alignment with the prevailing winds and/or incorporate bends.
- Locate areas intended for long duration exposure away from building corners, walkways that are aligned to prevailing winds and large open areas.

Building Articulation and design

- Tower setbacks from podium aspects should be at least 3m in depth or incorporate ground level down-wash mitigation through an impermeable awning or tree/vegetation planting.
- Inclusion of impermeable continuous awnings over trafficable areas below towers or podia of a significant height which are exposed to the prevailing winds and wrap around the corners of the development where side-streaming winds are expected.

- Horizontal feature elements and other façade elements that create a discontinuous façade surface along tower aspects

We have reviewed the Concept Proposal and consider the design to be capable of conforming to the recommendations within this report. It should be noted that wind tunnel testing is required for buildings 8 or more storeys in height or over 25 metres in height as stipulated in Part D Section 19 of the Hills Development Control Plan for the Showground Station Precinct. Hence it is recommended that wind tunnel testing is conducted during the detailed design stage to provide quantitative results, verify the wind conditions and enable more detailed feedback and design of the potential wind mitigation measures.



Figure 7: Proposed Concept Masterplan