PEDESTRIAN WIND ENVIRONMENT STATEMENT

ARTHUR PHILLIP SCHOOL, PARRAMATTA

WC769-01AF03(REV1) - WS REPORT

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DOCUMENT CONTROL

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EXECUTIVE SUMMARY

This report is in relation to the proposed developments of Arthur Phillip High School and Parramatta Public School, located in Parramatta, and presents an opinion on the likely impact of the proposed design on the local wind environment to the critical outdoor areas within and around the subject development. The effect of wind activity is examined for the three predominant wind directions for the Sydney region; namely the north-easterly, southerly and westerly winds. The analysis of the wind effects relating to the proposed development was 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 Schematic Design architectural drawings provided by the project architect, Grimshaw Architects. Please note that this is only a preliminary assessment, and serves to provide an indication of areas within and around the two developments that are prone to adverse wind conditions. A wind tunnel study is currently underway which will provide a more quantitative and definitive assessment. As such, 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 a number of ground level pedestrian trafficable areas are exposed to the southerly and westerly winds due to the orientation of the two developments with respect to these two prevailing wind directions. The developments themselves do benefit from partial shielding to the north-east, south and west directions due to surrounding mid-rise commercial and residential buildings.

The critical areas for the Arthur Phillip High School are the secondary entrances on the upper ground level and the connecting north/south thoroughfare that leads to the future road on the northern aspect. It is anticipated that this corridor will have the effect of funnelling incident southerly and westerly winds, and may prove uncomfortable for frequent pedestrian use. A similar flow effect has the potential to occur along the southern aspect and western aspect on the ground floor where the secondary entrances are located. It is expected that suitable wind conditions for these areas can be achieved through the inclusions of the following set of recommendations which are summarised as follows:

- A landscaped edge with a 2.1m perimeter fence with large native trees along the southern perimeter, 3 of which are the existing mature eucalyptus trees on site.
- A canopy over the yard area on the east-most side of the outdoor recreational area.
- The extension of an awning level with the gymnasium roof over the top of the north/south walkway.
- The extension of an awning level with the Level 1 floor slab over the stepped walkway on the southern aspect of the building.

- The retention of existing trees and planting of similar trees parallel with Macquarie Street on the southern side of the development.
- Planting low level vegetation approximately 1m in height in the areas set aside for soft scaping.
- A blade wall or row of trees of a similar height at the south eastern corner of the gymnasium to shield the entry area.

With regard to the Parramatta Public School development, the critical areas are the assembly and courtyard areas due to their inherent orientation with the west direction, as well as the open rooftop trafficable area, and open garden balconies and overhead walkways on Levels 2 and 3. Treatment strategies to address the potentially unfavourable wind conditions in these areas are summarised as:

- The strategic planting of densely foliating native evergreen trees capable of reaching a height of 15-20m as well as lower level foliage at the tree base in order to baffle westerly winds approaching the western open assembly area entrance.
- 1.8m perforated metal screens with no higher than 40% permeability along the perimeter of rooftop trafficable area.
- 1.8m perforated metal screens with no higher than 40% permeability along the western edge of the garden balconies on levels 2 and 3.
- 1.8m perforated metal screens with no higher than 40% permeability along the western edge of the overhead crosswalks on levels 2 and 3.

With the inclusion of the abovementioned recommendations, it is expected that wind conditions for the outdoor and upper level trafficable areas within and around the two subject developments will be suitable for their intended uses. However, note that this preliminary assessment is currently in the process of being verified through wind tunnel testing.

1 DESCRIPTION OF THE DEVELOPMENT AND SURROUNDINGS

The development at Arthur Phillip School in Parramatta consists of two sites on opposite sides of Macquarie Street. The north-most development is bound by Barrack Lane to the west and a future street to the north and east. The south-most development is bound by Little Street and Charles Street to the south and east respectively, with Smith Street to the West. Situated in Parramatta's central business district, there are a number of mid-rise commercial and residential buildings surrounding all aspects of the proposed development. The local topography of the surrounding area is generally flat, with an eastward downhill gradient on the eastern side of the development, and a northward downhill gradient on the north-western side of the development. An aerial image of the subject site and local surroundings is shown in Figure 1.

The north-most development, Arthur Phillip High School, consists of a 2 storey gymnasium structure with a 17 storey building on the eastern aspect, with a future road on the eastern and northern aspects providing pick up/drop off points for vehicles and a small car park. The south-most development, Parramatta Public School, is a 4 storey U-shaped building at the eastern aspect of the site, with ground level outdoor recreational areas on the western aspect of the site.

Figure 1: Aerial Image of the Site Location

The critical trafficable areas associated with the proposed development, which are the focus of this assessment with regards to wind effects, are detailed as follows.

For Arthur Phillip High School:

- The eastern lower ground level entryway and adjacent car park.
- The upper ground level outdoor accessible areas, including pedestrian walkways surrounding the development and footpaths to main entryways.
- Outdoor walkways surrounding the gymnasium providing access to upper levels.
- Internal walkways inside the 17 storey building which are adjacent to the permeable outer façade.

For Parramatta Public School:

- The ground level and level 1 pedestrian accessible areas surrounding the development, including the entryways on the eastern aspect, the entryway adjacent to Macquarie Street, and the vehicle parking on Little Street.
- The ground level courtyard and assembly space.
- The outdoor pedestrian walkways on Levels 1, 2 and 3 of the development, as well as the overhead pedestrian walkways spanning the courtyard on levels 1, 2 and 3.
- The outdoor garden areas on the south-west of the development on levels 2 and 3.
- The rooftop trafficable areas.

2 WIND CLIMATE OF THE SYDNEY REGION

The Sydney region is governed by three principle wind directions, and these can potentially affect the subject development. These winds prevail from the north-east, south and west. A summary of the principal time of occurrence of these winds throughout the year is presented in Table 1 below. This summary is based on a detailed analysis undertaken by Windtech Consultants of recorded directional wind speeds obtained at the meteorological station located at Kingsford Smith Airport by the Bureau of Meteorology (recorded from 1939 to 2008). From this analysis, a directional plot of the annual and weekly recurrence winds for the Sydney region is also determined, as shown in Figure 2. The frequency of occurrence of these winds is also shown in Figure 2.

As shown in Figure 2, the southerly winds are by far the most frequent wind for the Sydney region, and are also the strongest. The westerly winds occur most frequently during the winter season for the Sydney region, and although they are typically not as strong as the southerly winds, they are usually a cold wind since they occur during the winter and hence can be a cause for discomfort for outdoor areas. North-easterly winds occur most frequently during the warmer months of the year for the Sydney region, and hence are usually welcomed within outdoor areas since they are typically not as strong as the southerly or westerly winds.

Table 1: Principle Time of Occurrence of Winds for Sydney

Month	Wind Direction		
	North-Easterly	Southerly	Westerly
January	X	X	
February	X	X	
March	X	X	
April		X	X
May			X
June			X
July			X
August			X
September		X	X
October	X	X	
November	X	X	
December	X	X	

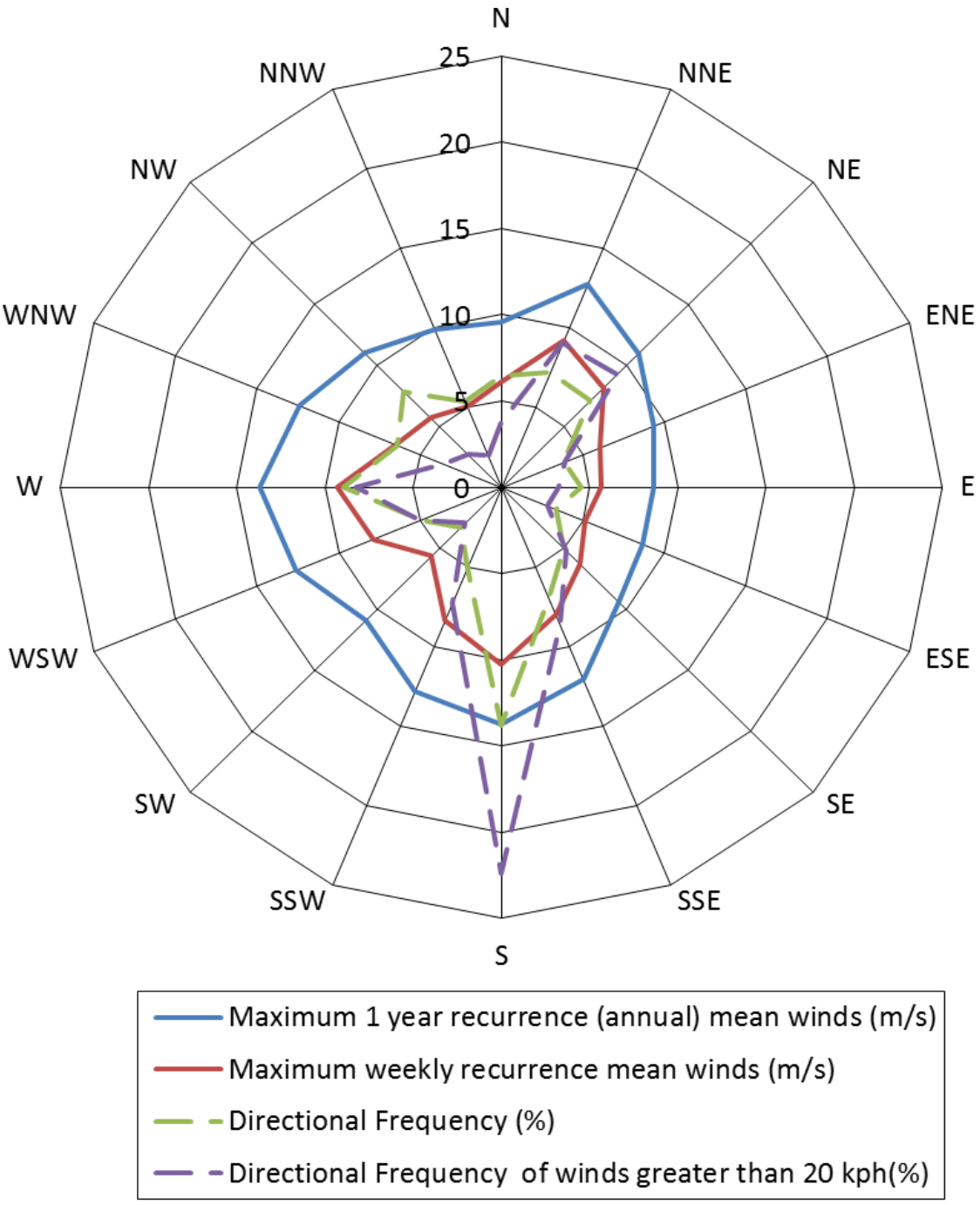

Figure 2: Annual and Weekly Recurrence Mean Wind Speeds, and Frequencies of Occurrence, for the Sydney Region (based on 10-minute mean observations from Kingsford Smith Airport from 1939 to 2008, corrected to open terrain at 10m)

3 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 Davenport, Lawson, Melbourne, Penwarden, etc, 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 in Australia.

The following table is an example, which was developed by Penwarden in 1975, and describes the effects of various wind intensities on people. Note that the applicability column relates to the indicated wind conditions occurring frequently (exceeded approximately once per week on average). Higher ranges of wind speeds can be tolerated for rarer events.

Table 2: Summary of Wind Effects on People (Penwarden, 1975)

Type of Winds	Mean Wind Speed (m/s)	Effects	Applicability
Calm, light air	0 - 1.5	Calm, no noticeable wind.	Generally acceptable for Stationary, long exposure activities such as in outdoor restaurants, landscaped gardens and open air theatres.
Light breeze	1.6 - 3.3	Wind felt on face.	
Gentle breeze	3.4 - 5.4	Hair is disturbed, Clothing flaps.	
Moderate breeze	5.5 - 7.9	Raises dust, dry soil and loose paper. Hair disarranged.	Generally acceptable for walking & stationary, short exposure activities such as window shopping, standing or sitting in plazas.
Fresh breeze	8.0 - 10.7	Force of wind felt on body.	Acceptable as a main pedestrian thoroughfare
Strong breeze	10.8 - 13.8	Umbrellas used with difficulty, Hair blown straight, Difficult to walk steadily, Wind noise on ears unpleasant.	Acceptable for areas where there is little pedestrian activity or for fast walking.
Near gale	13.9 - 17.1	Inconvenience felt when walking.	
Gale	17.2 -20.7	Generally impedes progress, Great difficulty with balance.	Unacceptable as a public accessway.
Strong gale	20.8 - 24.4	People blown over by gusts.	Completely unacceptable.

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.

4 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 three predominant wind directions for the Sydney region. The interaction between the wind and the building morphology in the area is considered and important features taken into account including the distances between the surrounding buildings and the proposed building form, their overall heights and bulk, as well as the surrounding landform. Note that only the potentially critical wind effects are discussed in this report.

4.1 Arthur Phillip High School

4.1.1 Lower Ground Level

The eastern drop off areas around the lower ground level entryway are expected to be suitable for their intended use. This area is effectively shielded from westerly winds by the development itself, and shielded from southerly winds by the proposed Parramatta Public School development on the other side of Macquarie Street. Similarly, the neighbouring buildings also provide shelter from any strong north-easterly winds.

4.1.2 Upper Ground Floor

The proposed future road that runs along the northern aspect of the gymnasium is effectively shielded from the three prevailing wind directions and thus expected winds in this area, including around the access ramps and stairs to higher floors, should remain below the threshold for pedestrian discomfort.

The café on the corner of the future road and Barrack Lane is exposed to the dominant southerly wind and will likely experience unfavourable conditions as this southerly wind is accelerated around the eastern side of the development. A potential remedy for this undesirable flow effect would involve installing a line of densely foliating evergreen trees 3m in height, or extending a blade wall eastward on the southern aspect in order to baffle the southerly winds approaching the café. This is shown at the bottom of Figure 3 on page 12.

The north/south thoroughfare that runs between the gymnasium and the building is susceptible to both southerly and westerly winds. This passage would have the effect of funnelling incident airflow from these two directions through this corridor and would likely be uncomfortable for frequent pedestrian usage. In addition, the secondary entrances on the western base of the building are exposed to a similar effect from westerly winds. The potential detrimental effect of these winds could be minimised for both cases by including an overheard canopy on the east-most side of the outdoor recreational area. Similarly, the extension of an awning over this region, level with the gymnasium roof, will also help to mitigate undesirable wind conditions around this upper ground floor region. These potential treatments are shown in Figure 3.

The downhill stepped walkway on the southern aspect that runs parallel to Macquarie Street is also exposed to the westerly wind. The soft scaping as depicted in the architectural drawings should consist of low level vegetation around 1m in height. Similarly, an awning extended out from the level 01 floor slab over this area will also serve to mitigate any undesirable wind effects. These potential remedies are also indicated in Figure 3.

The outdoor recreational area will benefit from the retention of existing trees as described in the architectural drawings, and a line of densely foliating trees along the soft scaping parallel with Macquarie Street will further improve the wind comfort in this area. These trees will also have the effect of baffling winds approaching the western secondary entrances and north/south thoroughfare, and are shown in Figure 3.

It should be noted that the columns spaning the Ground levels and Level 2 on the southern and western aspects of the building, may have a detrimental effect on wind comfort in these areas, and this will be investigated during wind tunnel testing.

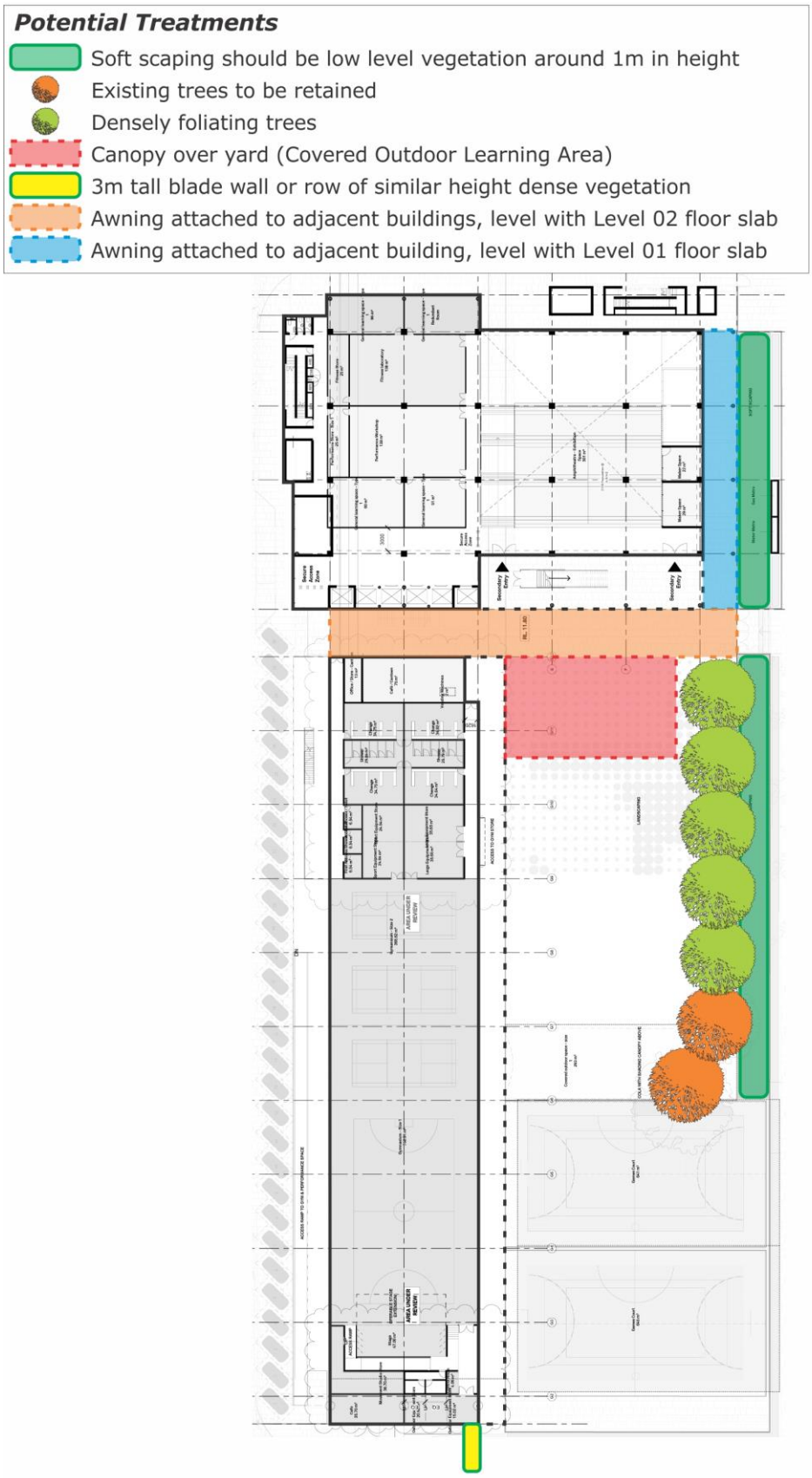

Figure 3: Potential Treatments – APHS Upper Ground Level

4.1.3 Permeable Outer Façade on the 17 storey building

The building itself benefits from partial shielding due to surrounding mid-rise buildings in the north-east, south and west directions, although is more exposed to incident winds coming from the south-west. However, the permeable design of the outer façade will have the effect of slowing these incident winds and preventing the formation of any significant side-streams. As such, it is unlikely that the interior walkways between the inner and outer façade of the building will experience any detrimental wind effects.

4.2 Parramatta Public School

4.2.1 Assembly and Courtyard Area

This outdoor area is inherently sheltered from southerly and north-easterly winds by the development itself. To minimise exposure to the westerly winds however, it will be necessary to ensure densely foliating evergreen trees as well as lower level vegetation are strategically planted to shield the western entrance to this area so as to baffle approaching westerly winds. Details of these potential treatments are shown in Figure 4.

4.2.2 Outdoor Garden Areas

The garden balconies on Levels 2 and 3 are exposed to westerly winds. To ensure comfortable wind conditions in these areas, 1.8m perforated metal screens with no higher than 40% permeability should be installed along the western edge of these garden terraces, as shown in Figure 5.

4.2.3 Rooftop Area

The NSW Police Headquarters building situated directly south of the development is expected to sufficiently shield the rooftop areas from southerly winds. The rooftop is however, exposed to westerly winds due to the relatively open terrain immediately in this direction, and is partially exposed to north-easterly winds. To mitigate the potential negative effects of winds from these directions, flow alleviating devices such as 1.8m perforated metal screens with no higher than 40% permeability should be installed around the perimeter of the accessible roof area, as shown in Figure 5. Note that the inclusion of an awning over the courtyard as per the architectural drawings will also serve to improve wind comfort on the rooftop.

Potential Treatments

Densely foliating evergreen trees capable of growing to a height of 15-20m

1-1.5m hedges or similar height evergreen vegetation, at the tree baseline

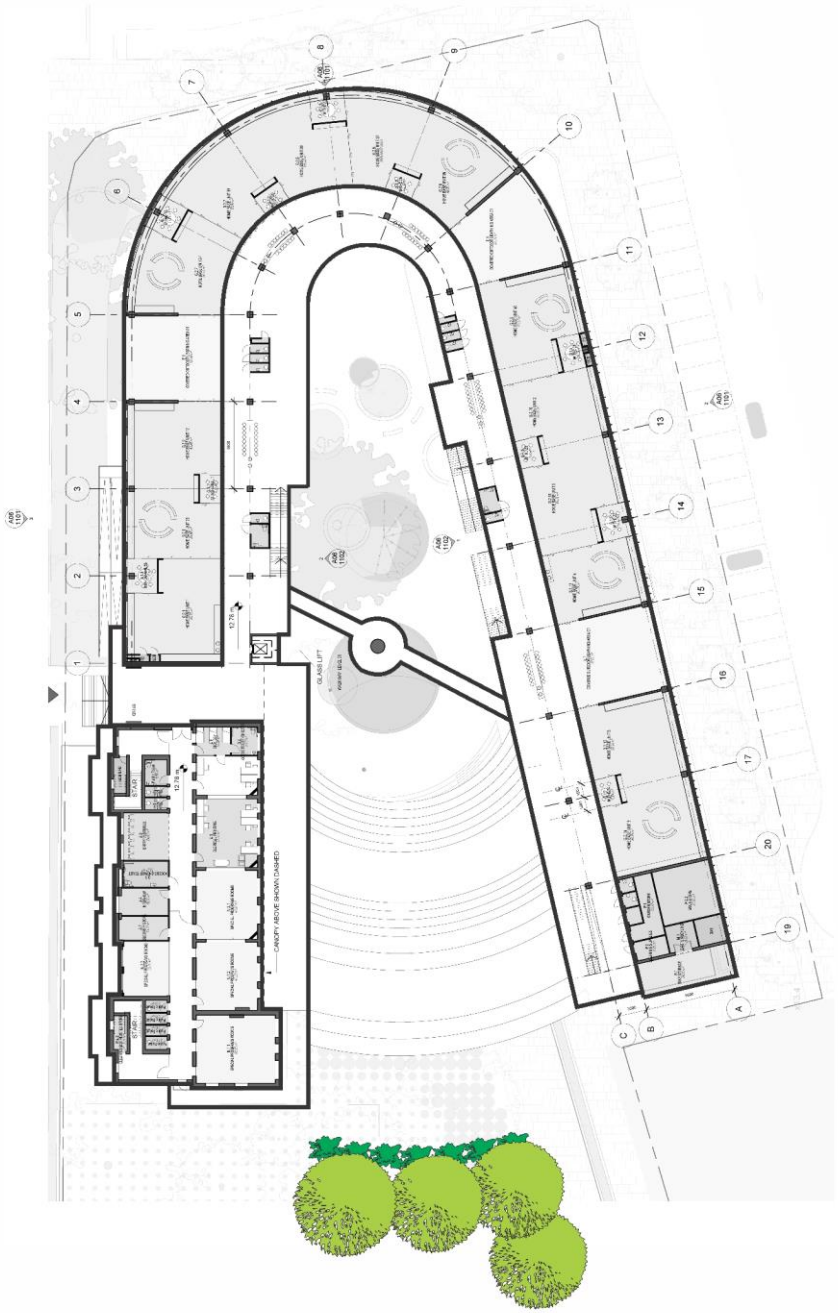

Figure 4: Potential Treatments – PPS Level 01

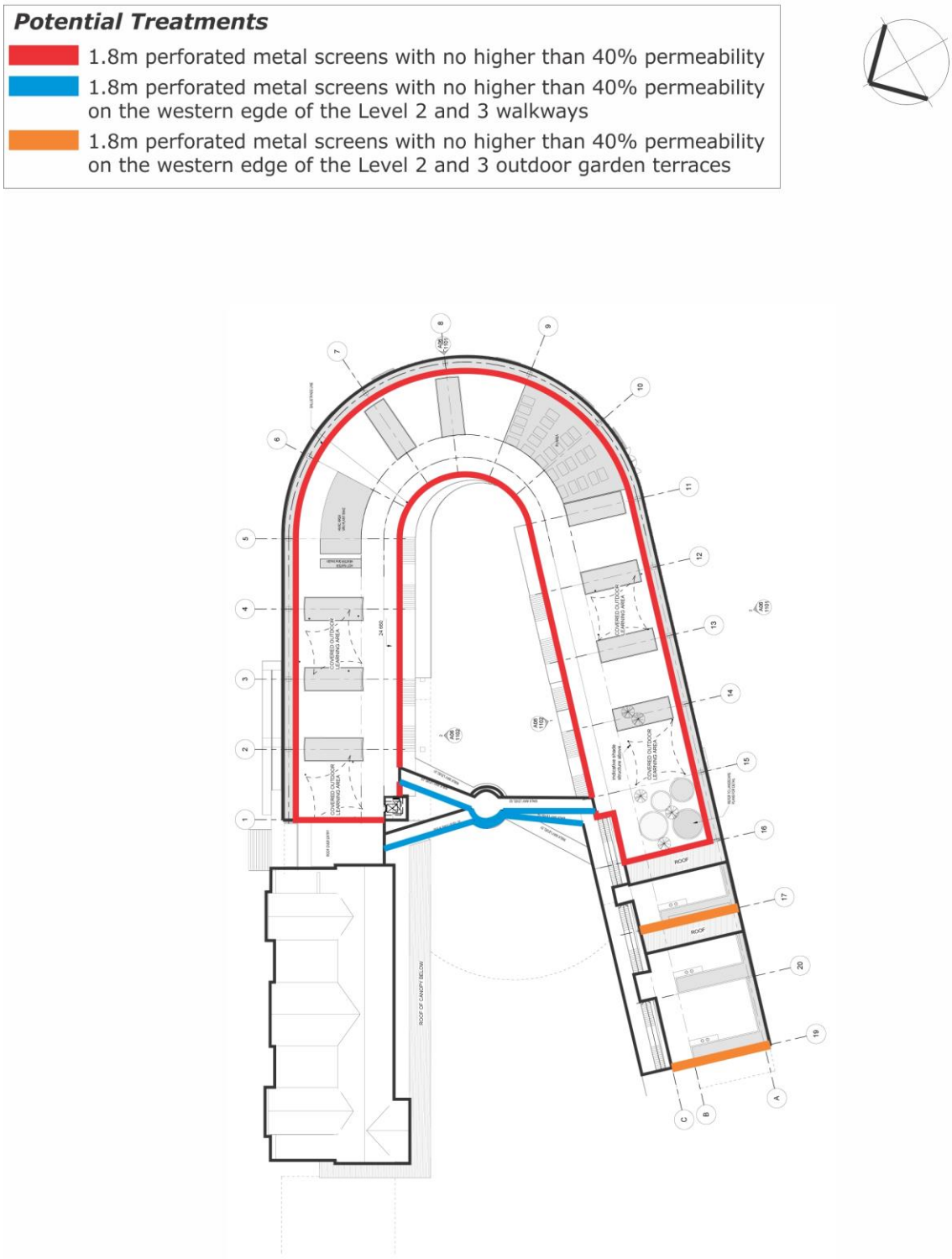

Figure 5: Potential Treatments – PPS Rooftop

4.2.4 Open Walkway Areas

The open air internal walkways and connecting stairways on the inside of the development should be suitable for frequent pedestrian use. These areas will benefit from the overhead canopies between each level which should provide effective shelter from winds. The overhead walkways that span the courtyard however, are likely to be more prone to westerly winds as they are more exposed in this direction. To ensure adequate shielding for these areas, it would be necessary to ensure that the trees planted immediately west of the assembly area, are capable to reach a 15-20m height so as to shield the top Level 3 walkway. Alternatively, 1.8m perforated metal screens with no higher than 40% permeability, on the western sides of the Level 2 and 3 overhead walkways would also effectively shield pedestrians using these overpasses. These recommended treatments are highlighted in Figure 5.

4.2.5 Ground Level and Level 1 Pedestrian Footpaths

The footpaths surrounding the development on Macquarie Street, Charles Street and Little Street are expected to be suitable for pedestrian use. The thoroughfare connecting Macquarie Street to the courtyard area may experience a funnelling effect as westerly winds entering the courtyard are accelerated through this corridor. However, the strategic placement of foliage on the western side of the assembly as depicted in Figure 5 should help to mitigate this effect.

5 CONCLUSION

This report is in relation to the proposed developments of Arthur Phillip High School and Parramatta Public School, located in Parramatta, and presents an opinion on the likely impact of the proposed design on the local wind environment to the critical outdoor areas within and around the subject development. The effect of wind activity is examined for the three predominant wind directions for the Sydney region; namely the north-easterly, southerly and westerly winds. The analysis of the wind effects relating to the proposed development was 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 Schematic Design architectural drawings provided by the project architect, Grimshaw Architects. Please note that this is only a preliminary assessment, and serves to provide an indication of areas within and around the two developments that are potentially prone to adverse wind conditions. A wind tunnel study is currently underway which will provide a more quantitative and definitive assessment. As such, 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 a number of ground level pedestrian trafficable areas are exposed to the southerly and westerly winds due to the orientation of the two developments with respect to these two prevailing wind directions. The critical areas for the Arthur Phillip High School are the secondary entrances on the upper ground level and the connecting north/south thoroughfare that leads to the future road on the northern aspect. It is anticipated that this corridor will have the effect of funnelling incident southerly and westerly winds, and may prove uncomfortable for frequent pedestrian use. A similar flow effect has the potential to occur along the western aspect on the ground floor where the secondary entrances are located. To remedy this flow effect, the installation of an overheard canopy on the east-most side of the outdoor recreational area should help to alleviate the incident southerly and westerly winds. In addition, the potential extension of an awning over the pedestrian walkways along the eastern and southern aspects will also serve to improve wind conditions in these areas. Regions marked for soft scaping in the architectural drawings should consist of low level vegetation around 1m in height as this will further help to shield southerly winds. A blade wall or dense vegetation of a similar height installed at the south-east corner of the gymnasium will help to baffle southerly winds approaching the outdoor café area on the western aspect of the development.

With regard to the Parramatta Public School development, the critical areas are the assembly and courtyard areas due their inherent orientation with the west direction. The inclusion of evergreen trees along western side of the assembly stairway should serve to shelter these frequently used areas from the westerly winds. These trees should also be able to grow to a height of 15-20m as this will also help to subsequently shield the three overhead walkways that

span the courtyard area. The assembly area would also benefit from low-level dense foliage such as hedges or shrubs planted near the base of these trees, especially if the area is expected to be used as a seating area for students. The rooftop area is exposed to the prevailing north-easterly and westerly wind directions, with partial shielding from the southerly winds achieved due to the developments proximity with the NSW Police Headquarters building. To ensure wind conditions are acceptable on the trafficable roof areas, 1.8m perforated metal screens with no higher than 40% permeability will need to be installed around the perimeter of the roof area. Note that the roof level awnings that shade Level 3 will also improve wind conditions on the roof by mitigating any strong winds from accelerating from beneath and over the rooftop area. In addition, the west-facing garden balconies on Level 2 and 3 as well as the overhead walkways spanning the courtyard would also benefit from 1.8m perforated metal screens with no higher than 40% permeability, installed along the western edges to baffle incident westerly winds.

Wind conditions for pedestrian accessible areas surrounding the development have the potential to be further improved with the addition of densely foliating vegetation in the form of trees or shrubs. Recommendations have been made within the report to ensure that suitable conditions are provided for the ground level and open upper level pedestrian accessible areas that are expected to experience frequent use. Note that this preliminary assessment is in the process of being verified through wind tunnel testing.