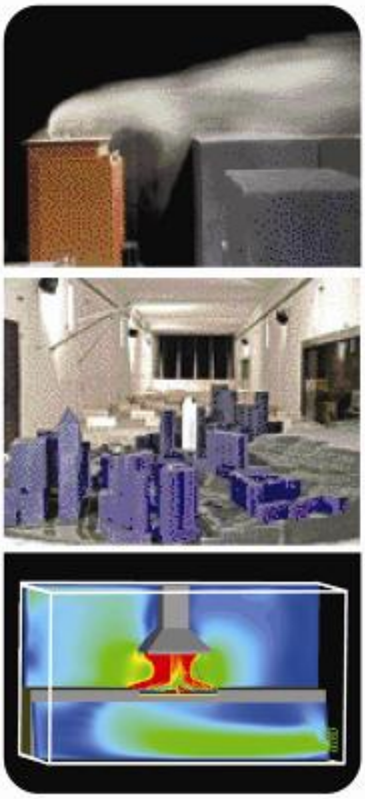
cpp

CERMAK
PETERKA
PETERSEN

WIND ENGINEERING AND AIR QUALITY CONSULTANTS

FINAL REPORT



Wind Assessment for:

CAMPBELLTOWN HOSPITAL

Campbelltown, NSW, Australia

Health Infrastructure
c/- Capital Insight
Level 6, 77 Berry Street
North Sydney, NSW 2060
Australia

February 2012

CPP Project: 6035

CPP
Unit 2, 500 Princes Highway
St. Peters, NSW 2044, Australia
info-syd@cppwind.com
www.cppwind.com

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

Introduction

Cermak Peterka Petersen Pty. Ltd. has been engaged by Health Infrastructure to provide an opinion based assessment of the impact of the proposed redevelopment of Campbelltown Hospital on the pedestrian level local wind environment in and around the proposed development.

The site is located to the east of the block bounded by Parkview Crescent, Hyde Parade, Appin Road, and Therry Road and is surrounded by similar sized low to medium-rise buildings, Figure 1. There is a two storey existing building on the site. Topography surrounding the site is essentially flat.

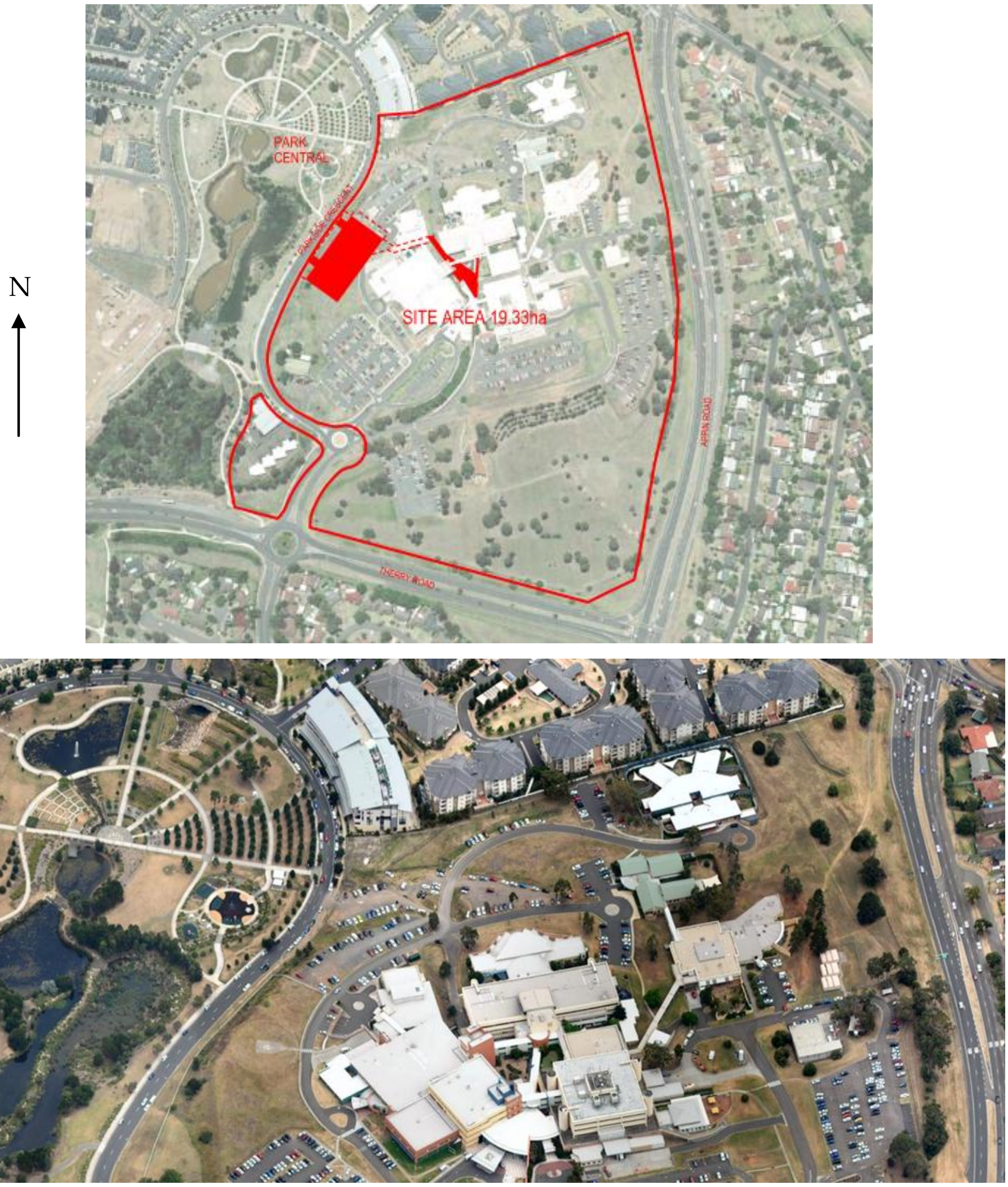


Figure 1 Location of the proposed development and aerial view from the south (Near Map, 2011)

Campbelltown Wind Climate

The proposed development lies approximately 10 km to the east-south-east of Camden Airport Bureau of Meteorology anemometer. The wind rose for the airport is shown in Figure 2 and is considered to be representative of prevailing winds at the site. It is evident that the prevailing strong winds come from the south-west quadrant. Strong winds from the south tend to be cold and are generally associated with large frontal systems that can last several days and occur throughout the year. Winds from the west are the strongest of the year and are associated with large weather patterns and thunderstorm activity. These winds occur throughout the year and can be cold or warm depending on the inland conditions.

This wind assessment is focused on these prevailing wind directions.

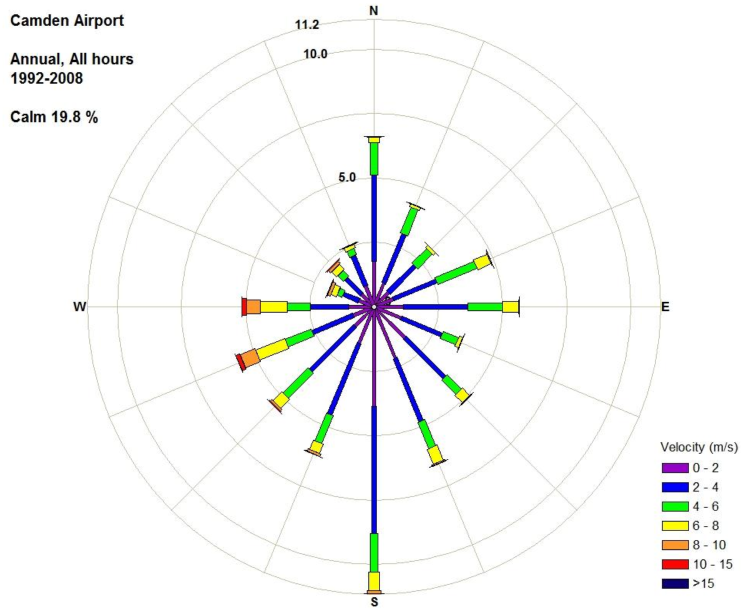


Figure 2: Wind rose for Camden Airport

Environmental Wind Speed Criteria

It is generally accepted that wind speed and the rate of change of wind velocity are the primary parameters that should be used in the assessment of how wind affects pedestrians. Local wind effects can be assessed with respect to a number of environmental wind speed criteria established by various researchers. Despite the apparent differences in numerical values and assumptions made in their development, it has been found that when these are compared on a probabilistic basis, there is remarkably good agreement.

Campbelltown City council has no specific wind assessment criteria. The wind assessment criteria used in this study are based upon the research of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress. The benefits of these criteria over many in the field are that they use both a mean and gust equivalent mean (GEM) wind speed to assess the suitability of specific locations. The criteria based on the mean wind speeds define when the steady component of the wind causes discomfort, whereas the GEM wind speeds define when the wind gusts cause discomfort.

Comfort (maximum wind speed exceeded 5% of the time)	
<2 m/s	Outdoor dining
2 - 4 m/s	Pedestrian sitting (considered to be of long duration)
4 - 6 m/s	Pedestrian standing (or sitting for a short time or exposure)
6 - 8 m/s	Pedestrian walking
8 - 10 m/s	Business walking (objective walking from A to B or for cycling)
> 10 m/s	Uncomfortable
Distress (maximum wind speed exceeded 0.022% of the time, twice per annum)	
<15 m/s	General access area
15 - 20 m/s	Acceptable only where able bodied people would be expected; no frail people or cyclists expected
>20 m/s	Unacceptable

The wind speed is either a mean wind speed or a gust equivalent mean (GEM) wind speed. The GEM wind speed is equal to the 3 s gust wind speed divided by 1.85.

Table 1: Pedestrian comfort criteria for various activities

In relation to the Campbelltown wind climate 5% of the time the mean wind speed exceeds 7 m/s at 10 m height in open country terrain. This corresponds to approximately 5 m/s at ground level, which would be classified as suitable for 'pedestrian standing'. Thus for outdoor café style activities, shielding from surrounding buildings or local amelioration devices are required to create a suitable wind environment.

Wind Flow Mechanisms

When the wind hits an isolated building, the wind is accelerated down and around the windward corners, Figure 3; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward and sides of the building. In Figure 3 smoke is being released into the wind flow to allow the wind speed, turbulence, and direction to be visualised. The image on the left shows smoke being released across the windward face, and the image on the right shows smoke being released into the flow at about third height in the centre of the face.

Techniques to mitigate the effects of downwash winds on pedestrians include the provision of horizontal elements, the most effective being a podium to divert the flow away from pavements and building entrances. Awnings along street frontages perform a similar function and the larger the horizontal element the more effective it will be in diverting the flow.

Channelling occurs when the wind is accelerated between two buildings or along straight streets with buildings on either side.

Figure 3 shows wind at mid and upper levels on a building is accelerated substantially around the corners of the building. When balconies are located on these corners they are likely to be breezy, and will be used less by the owner due to the regularity of stronger winds. Owners quickly become familiar with when and how to use their balconies. If the corner balconies are deep enough, articulated, or have regular partition privacy fins then local calmer conditions can exist.

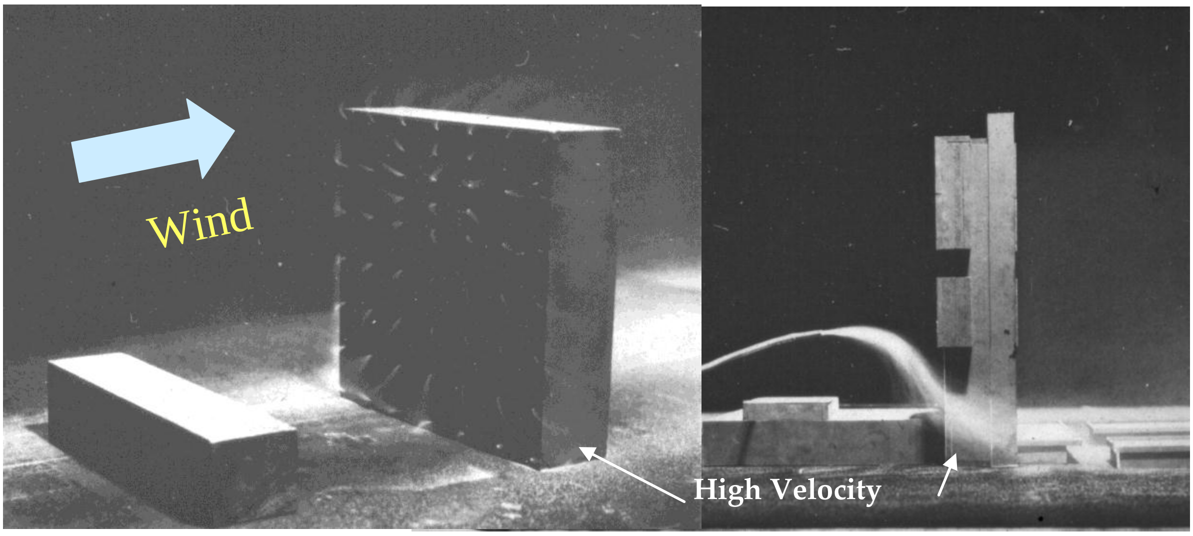


Figure 3: Flow visualisation around a tall building

Environmental Wind Assessment

The proposed development is located to the east of the existing Campbelltown Hospital Block A, Figure 4. The proposed development consists of a 5-storey building rising approximately 20 m above ground level, Figure 5. Floor plans are shown in Figure 6 indicating the outdoor area on Level 2.

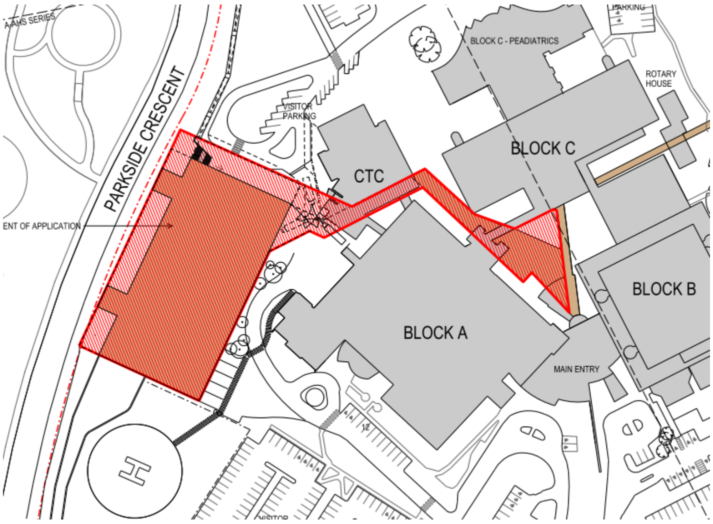


Figure 4: Site plan of the proposed development

The proposed development is surrounded by several similar sized buildings to the immediate east and north-east and is relatively exposed to winds from the west and south, Figure 1. From a wind engineering perspective, topography surrounding the site is relatively flat. Winds in such complex surrounds tend to be channelled along the streets with local effects being dictated by exposed similar sized building and local topography. Wind conditions around the Campbelltown Hospital precinct are known to be acceptable for use as a main public accessway.

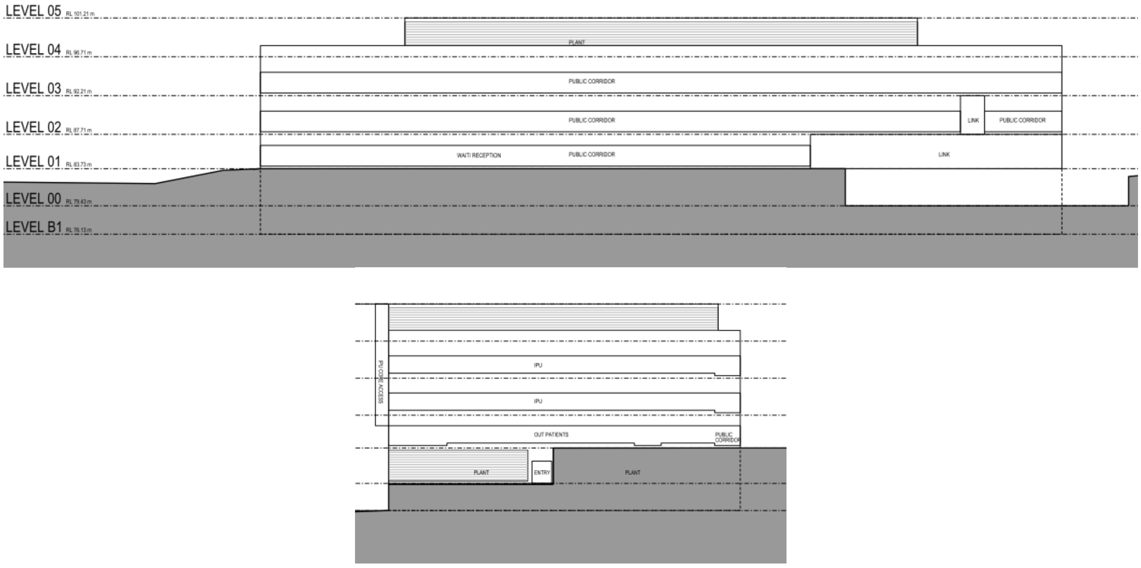


Figure 5: North-east and south-east elevations of the proposed building

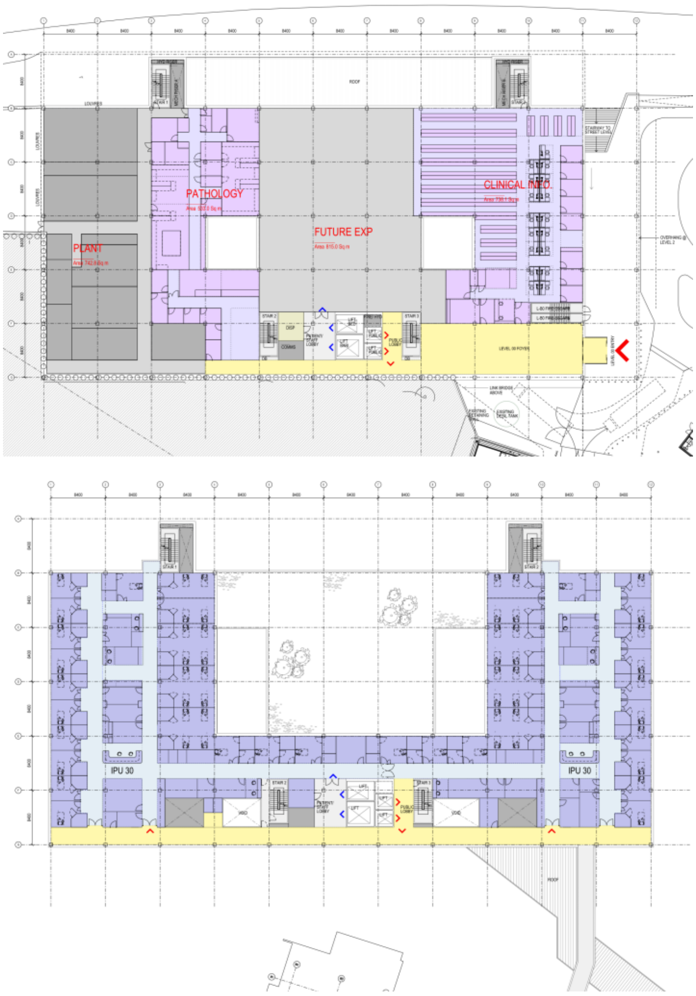


Figure 6: Ground and second floor plan of the proposed development

In general the wind climate for Campbelltown is relatively mild and all the areas around the development are expected to be suitable for main public accessways. The strongest winds are from the south-west quadrant. During these events the wind will stagnate on the exposed south-west façade and accelerate down and around the windward corners creating local windier conditions. The flow will then accelerate along the exposed north-west façade to the northern corner. The open area on the north-west façade above level 2, Figure 6, will reduce the wind acceleration along the face, and for winds from the west will eliminate downwash reaching ground level. The wind conditions although slightly stronger at the corners are expected to remain acceptable for use as a main public accessway.

The entrance to the building in the centre of the south-west façade has the potential to cause internal flow issues during strong winds from the south-west if the main entrance doors on the north-east façade are also open. There is an air-lock arrangement on the main door on ground level. These doors are too close to act as an effective air-lock. The travel distance between the doors is too short hence the doors will be open at the same time making the air lock ineffective. It is recommended that one set of doors is deleted (preferably the interior set), or the distance between the double doors increased. The distance between doors depends on the typical speed of person travelling between the doors, the speed of door opening and closing, and the expected number of pedestrians, but generally requires 8-10 m with low traffic volume to be effective. The extension to the external doors is beneficial as the wind induced pressure at the opening reduces resulting in reduced flow to the interior. For the majority of wind directions, the wind induced pressure at the main entrance is expected to be lower than the internal conditioned air pressure so flow will exit the building rather than drive flow and debris into the building. Winds from the north-west will accelerate along the north-east façade and expand into the building once the main door is open. Retaining the 4 m extension with the outer doors is expected to reduce the flow expanding into the building. If there is a reception area planned for the foyer area, door orientation and internal partitioning can be designed to divert the flow away from the desk otherwise staff complaints can become prevalent every time the door is opened.

The triangular café area to the east of the development is linked to the main building by an enclosed walkway. The café has an outdoor area that will be opened during suitable environmental conditions. This area is shielded by surrounding buildings and the wind conditions are expected to be suitable for outdoor sitting activities. If the area is to be used for formal dining additional screening may be required.

Helipad wind conditions

The temporary helipad is located in close proximity to the south of the proposed building, Figure 4. As wind flows around a building it creates significant additional wind shear and turbulence that can be problematic to helicopter landing. Guidelines on the location of helipads relative to buildings are provided in Federal Aviation Administration (1984). For winds from the north-west, the turbulence zone created by the building is shown highlighted in Figure 7. The other coloured marked areas represent zones of higher turbulence for winds orthogonal to the faces of the building.

Although the regularity of the winds from the north-west quadrant is not high, they are relatively strong winds. The regularity of winds from the north-east is high, but the wind speed is low and would not be expected to cause issues to landing aircraft. The helipad lies partly within the zone of influence for winds from the north-west, and almost entirely in the area for winds from the north-east. From a turbulence perspective it may be recommended to move the helipad to the south, or to the opposite side of Parkside Crescent to avoid this potential turbulence issue. The proposed location of the wind indicator is also located in the zone of higher turbulence and would be better located to the west of the helipad.

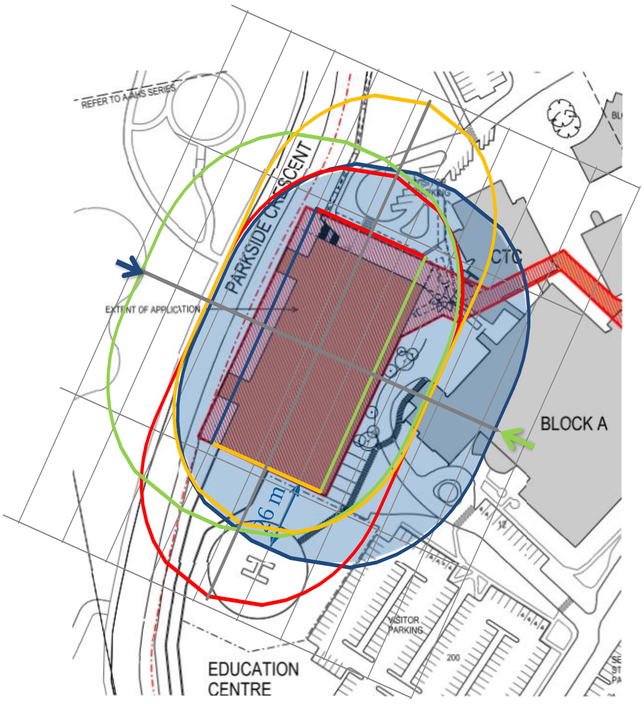


Figure 7: High turbulence zone around the proposed building for winds from the north-west

The proposed helicopter approach and departure routes are shown in Figure 8. With reference to Figure 2, strong winds are from the south-west quadrant resulting in a significant component of cross- and/or tail-wind for approach and departure operations on both designated approaches.

There are louvre walls to the mechanical plant room on the south-west corner of the building, Figure 9. Aviation fuel odour contamination of the plant rooms generally occurs when the helicopter is on the helipad as the rotor wash mixes the contaminants. The rooftop louvre bank is located remote from the building line. The lower louvre sections are located below the helipad and it is considered highly unlikely that there would be a wind speed and direction that would concentrate the aviation fuel odours at the inlet locations. As the helipad was only used twice in the previous year, the risk of any contamination is exceptionally small.

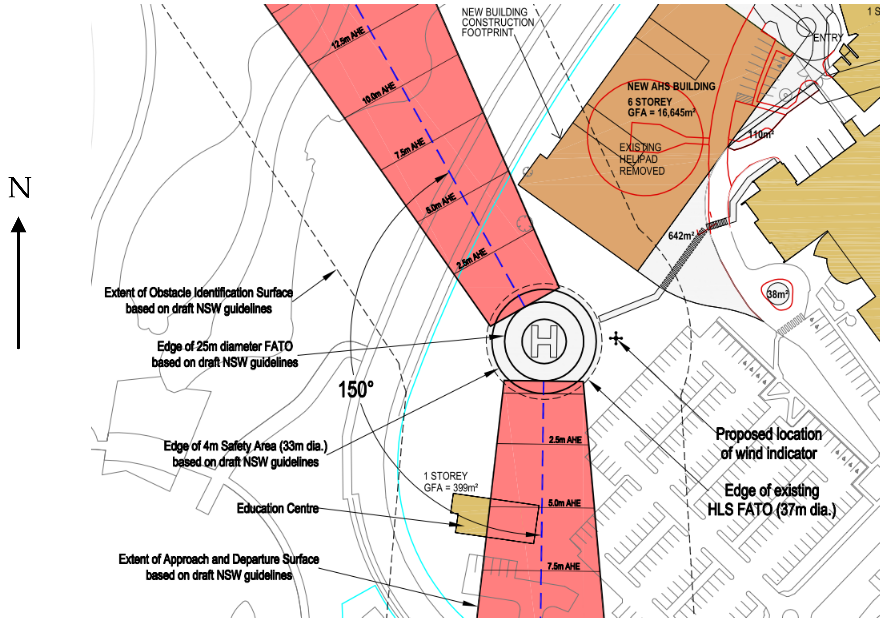


Figure 8: Proposed helicopter landing approaches (Rehbein Airport Consulting, 2011)

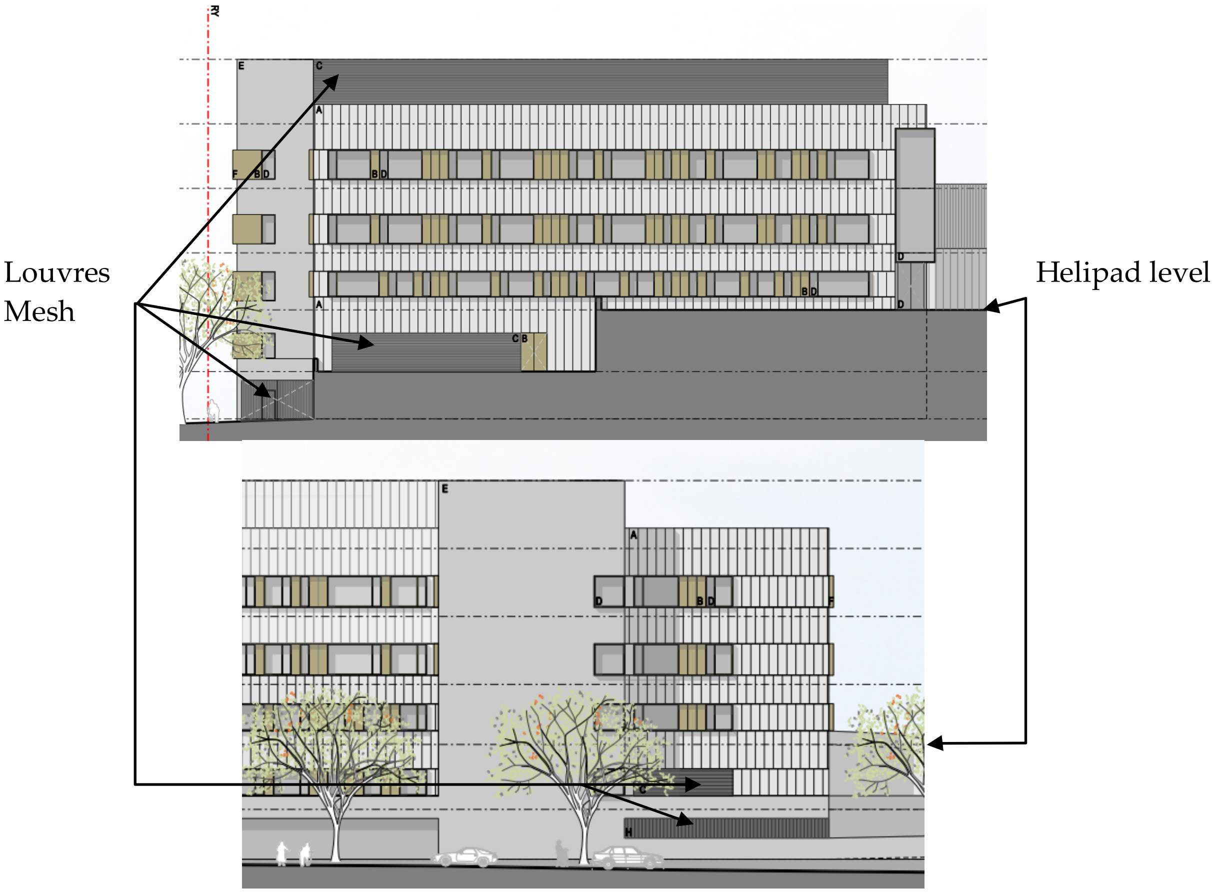


Figure 9: South-west and north-west elevation of the AHS building

Conclusions

Cermak Peterka Petersen Pty. Ltd. has provided an opinion based assessment of the impact on the local wind environment of the proposed development Campbelltown Hospital. The relatively benign wind climate and surrounding buildings offer significant protection to the proposed building. Wind conditions at pedestrian level around the development are expected to be similar to those currently experienced hence suitable for use as a public accessway. The building will provide shielding to the footpaths in the vicinity of the development and would be classified as acceptable for pedestrian walking.

The location of the helipad is partially within the high turbulent area created by the proposed building. During strong prevailing winds, the proposal approach and departure paths will experience significant tail-wind and/or cross-wind.

References

Federal Aviation Administration (1984), Evaluating wind flow around buildings on heliport placement, Technical Report DOT/FAA/PM-84/25.

Lawson, T.V., (1990), The determination of the wind environment of a building complex before construction, *Department of Aerospace Engineering, University of Bristol*, Report Number TVL 9025.

Rehbein Airport Consulting, (2011), Campbelltown Hospital Redevelopment Helipad Assessment.

Appendix 1: Discussion on Wind Shear and Turbulence

Paragraph 2.2.1 from ICAO (2005) states:

'In the explanation of wind shear given in Chapter 1, the changes in wind speed and/or direction concern changes in the mean (or prevailing) wind from one reference point in space to another. Short-term fluctuations of the wind about a mean direction and/or speed are normally referred to as "variations" from the prevailing wind. Such variations of the wind, individually at least, are temporary, like eddies; while eddies clearly involve wind shear; because they are on a much smaller scale than an aircraft, they tend to affect the aircraft as bumpiness or turbulence. The scale on which the wind shear operates, in relation to the overall size of the aircraft concerned, is therefore of fundamental importance.'

From the above it can be appreciated that wind shear is based on a difference in mean wind speed between two locations, whereas turbulence is the natural variation in the wind speed and direction due to the flow over the ground.

The "variations" mentioned above are generally called turbulence in the wind engineering community and will be used in this document. Turbulence intensity is a term used to quantify turbulence and is calculated as the standard deviation of wind speed divided by the mean wind speed. This does not give an indication of the size or variation of the gusts. A spectral analysis would be required to extract the frequency structure of the gusts from which a measure of the size could be inferred. This is considered beyond the scope of the current discussion, and would be impractical to monitor full-scale.

To emphasise the difference between wind shear and turbulence, a brief discussion on the driving mechanisms involved in generating turbulence and low level wind shear in the form of a thunderstorm downburst is included. Low level, in wind engineering terms, is defined as below about 500 m from ground level.

The typical atmospheric boundary layer created by synoptic wind events is created by friction at the ground surface, and therefore changes from the ground up. The boundary layer typically extends about 500 to 1000 m above ground level. Increasing friction caused by ground objects causes a decrease in the near ground mean wind speed and an increase in turbulence intensity. The ratio of mean wind speed at 500 m to that at 10 m is typically about 1.6 for winds over open terrain, and 2.1 times for winds over suburbia. The mean wind speed at 500 m over open terrain is about 10% higher than that over suburbia. Turbulence intensity ratios between 500 m and 10 m are typically about 0.4, with winds over suburbia having about 1.3 times the turbulence intensity of those created over open land.

Using Standards Australia (2011) to develop a boundary layer profile creating ICAO defined 'moderate' and 'strong' wind shear in the lowest 30 m of the boundary layer, the gust wind speed at 10 m would have to be in excess of 11 m/s (22 kt), and 20 m/s (40 kt) respectively; at these higher wind speeds specific operating procedures for the airport would generally be employed. Based on safe landing records in what would be classified as severe wind shear conditions, there is some debate over the practicality of these levels of wind shear and paragraph 5.2.8 of ICAO (2005) indicates that larger aircraft could withstand a wind shear of 1.6 m/s per s (6 kph per s, 3 kt/s). Assuming mean wind flow conditions, this would require to a 10 m mean wind speed of 118 m/s (236 kt), which would evidently never occur.

Turbulence intensity is wind speed dependent and the lower the mean wind speed the higher the turbulence intensity. However, once the mean wind speed exceeds about 10 m/s (20 kt) the turbulence statistics become relatively less sensitive to wind speed. At the lower wind speeds turbulence intensity is not a significant issue to aircraft as the change in relative air speed between the aircraft and the wind is negligible. Turbulence is also a function of the meteorological event; local pressure driven winds such as a summer onshore winds contain much smoother flow than winds associated with a large frontal system, even if they come from the same direction.

The most likely cause of low level wind shear would be from a thunderstorm downdraft, or some form of temperature inversion. Low level wind shear in thunderstorms is created by a descending column of generally cold air reaching the ground, then being turned by the ground plane, Figure 10. These events are called thunderstorm downdrafts. Thunderstorm downdrafts have a central diameter of between 400 m and 4 km. The dashed white line starting on the left of Figure 10 at an elevation 1 k ft (300 m) is a typical glide slope for a landing aircraft. The concern for aviation is that a landing aircraft initially experiences a significant headwind (in excess of 20 m/s, 40 kt), which changes into a tailwind after passing through the impingement point, at the centre of the descending column of air where the wind is coming vertically downward. The headwind causes the aircraft to rise, whereby the pilot will lower the throttle causing the aircraft to descend back to the glide slope, but then tailwind causes a reduction in lift causing the aircraft to land short of the runway. Thunderstorm downdraft events typically last for only a few minutes and therefore have the spatial and temporal size to create large localised wind shear.

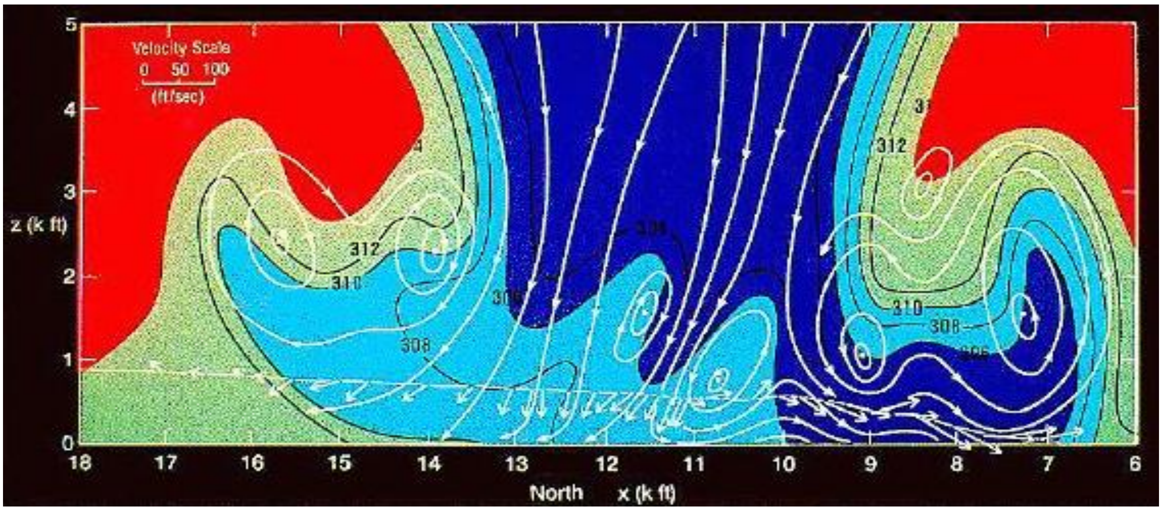


Figure 10: Image of a thunderstorm downburst

Combining the above with the discussion on the flow over a building, it is evident that the wind shear situation for flow over a structure is completely different to that for a thunderstorm downdraft and unless the aircraft were to fly directly through one of the small recirculating regions then it would not experience any wind shear.

This discussion is in agreement with the ICAO Manual which in section 3.2.2 states:

'…This means that while the buildings are comparatively low, they present a wide and solid barrier to the prevailing surface wind flow. The wind flow is diverted around and over the buildings causing the surface wind to vary along the runway. Such horizontal wind shear, which is normally very localised, shallow and turbulent, is of particular concern to light aircraft operating into smaller aerodromes, but has also been known to affect larger aircraft.'

In assessing the influence of the wind on aircraft operations, only strong wind events (gusting to over 10 m/s (20 kt)) need to be considered, because wind events with a lower wind speed would not be expected to appreciably influence the lift and drag characteristics of a landing aircraft moving at a minimum of 30 m/s (58 kt).

Discussion on Convection

Convection has the capability of altering the flow pattern around structures. Only a limited amount of research has been conducted on the flow around buildings, as convection is generally only an issue in light wind speeds. Ruck 1993, Carvalho and Borges, 1998, and Richards et al., 2006, all indicate that the flow pattern around a heated surface is governed by the Grashov and Reynolds number. Using the data contained in these papers, and assuming a 20°C temperature difference between the building surface and the surrounding air, the flow pattern around a typical building would only be influenced by convection effects in ambient wind speeds of up to 2.5 m/s (5 kt) to a distance of about 3 building heights downstream. This wind speed is considered insignificant for aircraft moving in the region of 30 m/s (58 kt) and therefore the fact that convection effects have been ignored in this study is irrelevant.

REFERENCES

Carvalho, J.L., & A.R.J. Borges, 1998, Interaction of a surface mounted hot body with a turbulent boundary-layer, *Journal of Wind Engineering and Industrial Aerodynamics*, Vol. 74-76, pp.475-483.

ICAO (International Civil Aviation Organization), 2005, Manual *on low-level wind shear*.

Peterka, J.A., R.N. Meroney & K.M. Kothari, 1985, Wind Flow Patterns About Buildings, *Journal of Wind Engineering and Industrial Aerodynamics*, Vol. 21, pp.21-38.

Richards, K., M. Schatzmann, & B. Leitl, 2006, Wind tunnel experiments modelling the thermal effects within the vicinity of a single block building with leeward wall heating, *Journal of Wind Engineering and Industrial Aerodynamics*, Vol. 94, pp.621-636.

Ruck, B., 1993, Wind-tunnel measurements of flow field characteristics around a heated model building, *Journal of Wind Engineering and Industrial Aerodynamics*, Vol. 50, pp.139-152.

Standards Australia, 2011, *Structural design actions, Part 2: Wind actions*, AS/NZS1170.2