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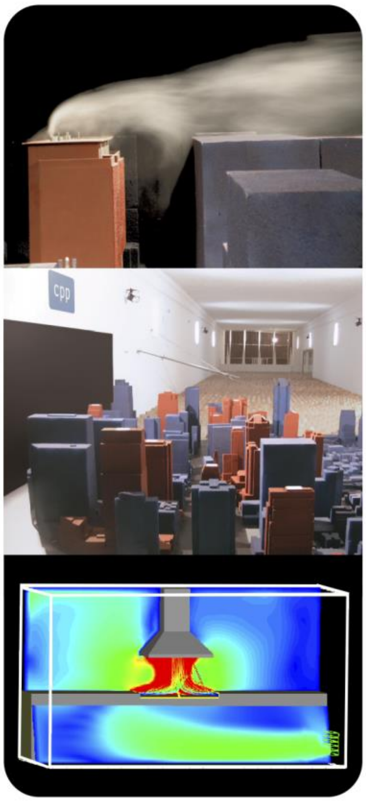
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



Qualitative Wind Assessment for:

WaterVue

643-651 Hunter Street

Newcastle, NSW

Prepared for:

Bloc

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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Bloc to provide a qualitative assessment of the impact of the proposed WaterVue development at 643-651 Hunter Street, Newcastle, on the wind conditions in the surrounding areas.

The proposed development is located in Newcastle on a block bounded by Hunter Street, Steel Street, and King Street, Figure 1. The proposed development consists of a single mixed-use tower, rising to approximately 62 m above ground level, Figure 2. As the tower is the largest massing within the surrounding structures, the addition of the proposed development is assessed for impact on the local wind conditions, with the outcome discussed in this report.

Figure 1: Aerial view of the proposed development site (Google Earth, 2022)

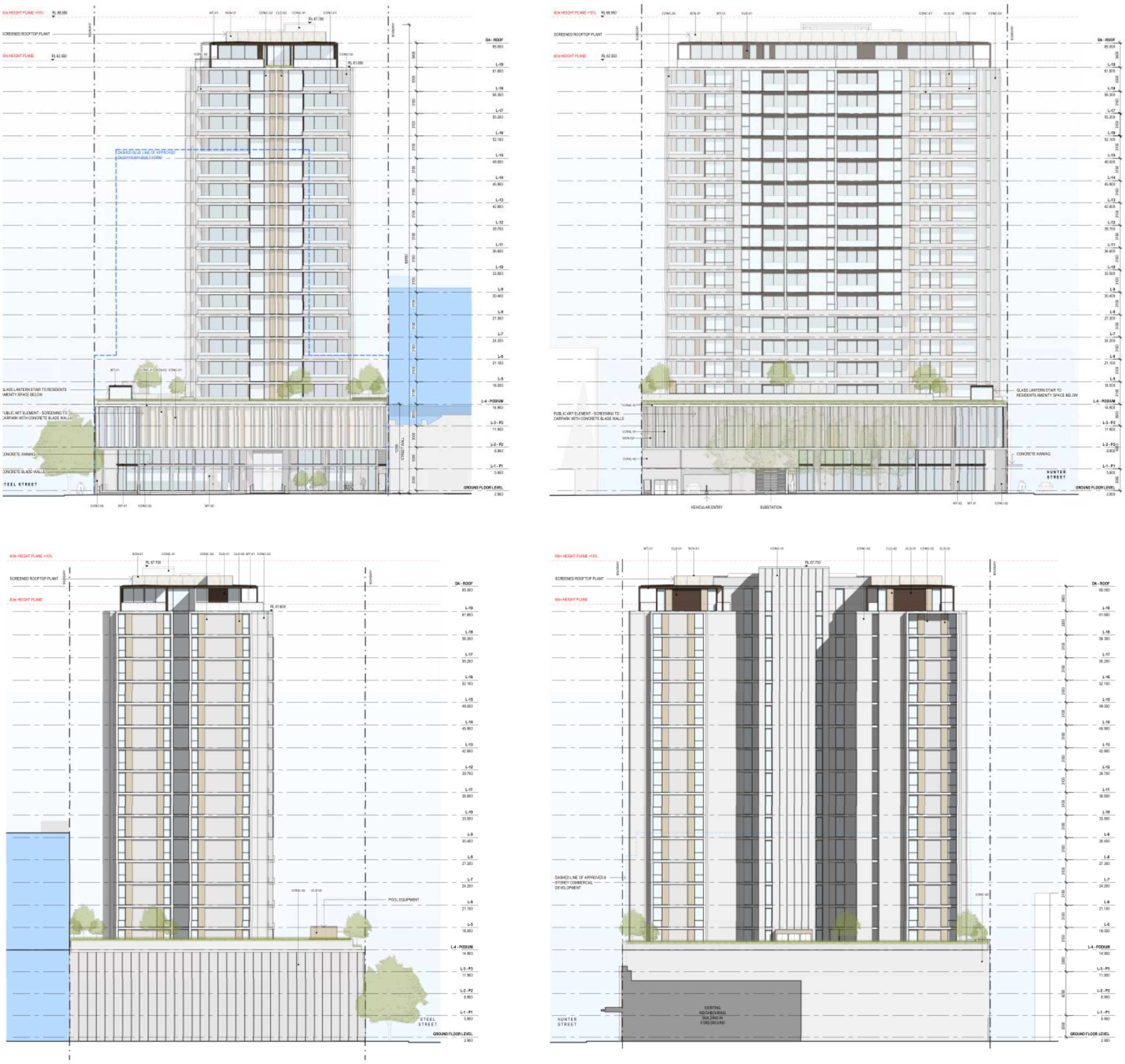

Figure 2: North elevation (top left), east elevation (top right), south elevation (bottom left) and west elevation (bottom right) of the proposed development (Stewart Architecture, 2022)

2 NEWCASTLE WIND CLIMATE

The proposed development lies approximately 4 km to the south-west of the Bureau of Meteorology anemometer on a small, raised headland at Nobbys Head. To enable a qualitative assessment of the wind environment, the wind frequency and direction information measured by the BOM at a standard height of 10 m at Nobbys Head from 2002 to 2015 have been used in this analysis. The wind rose for Nobbys Head is shown in Figure 3 and is considered to be representative of prevailing winds at the site. Strong prevailing winds are organised into three main groups which centre about the east, south and north-west. This wind assessment is focused on these prevailing strong wind directions.

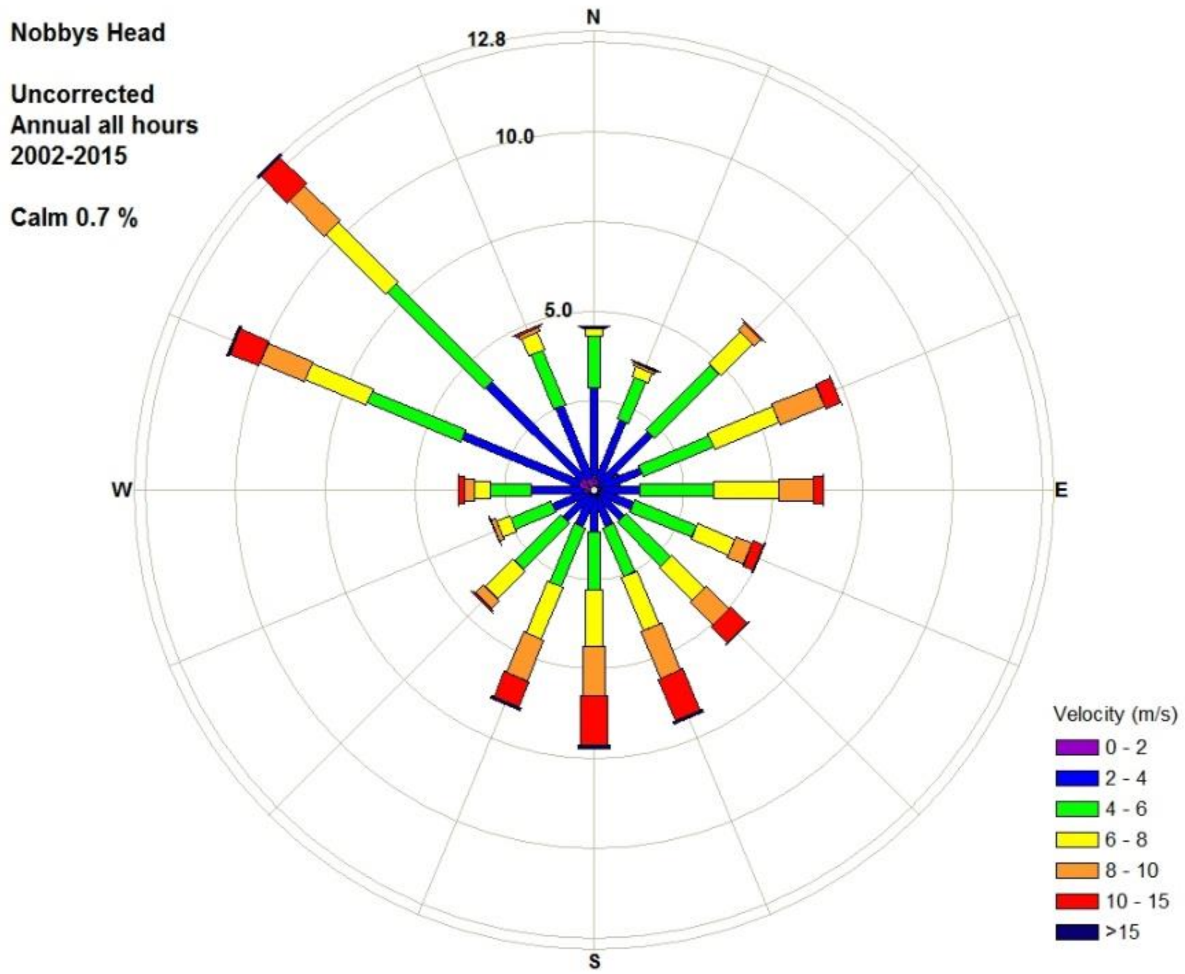

Figure 3: Wind rose for Nobbys Head

3 ENVIRONMENTAL WIND 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.

The current Newcastle City Council (2012) DCP has no specific controls for wind assessment. The wind assessment criteria that will be used in this study will be based upon the criteria of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress/safety. 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. The level and severity of these comfort categories can vary based on individual preference, so calibration to the local wind environment for all wind directions is recommended when evaluating with Lawson ratings. Another benefit of these from a comfort perspective is that the 5% of the time event is appropriate for a precinct to develop a reputation from the general public.

Furthermore, interpretation of these wind levels can be aided by the description of the effects caused by winds of various magnitudes on people. The earliest quantitative description of wind effects was established by Sir Francis Beaufort in 1806, for use at sea; the Beaufort scale is reproduced in Table 2 including qualitative descriptions of wind effects.

Table 1: Pedestrian comfort criteria for various activities.

Comfort (max. 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/Safety (max. 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 an hourly 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 2: Summary of wind effect on people, Penwarden (1973)

Description	**Beaufort Number**	**Speed (m/s)**	**Effects**
Calm, light air	0, 1	0–2	Calm, no noticeable wind.
Light breeze	2	2–3	Wind felt on face.
Gentle breeze	3	3–5	Wind extends light flag. Hair is disturbed. Clothing flaps
Moderate breeze	4	5–8	Raises dust, dry soil, and loose paper. Hair disarranged.
Fresh breeze	5	8–11	Force of wind felt on body. Drifting snow becomes airborne. Limit of agreeable wind on land.
Strong breeze	6	11–14	Umbrellas used with difficulty. Hair blown straight. Difficult to walk steadily. Wind noise on ears unpleasant. Windborne snow above head height (blizzard).
Near gale	7	14–17	Inconvenience felt when walking.
Gale	8	17–21	Generally impedes progress. Great difficulty with balance in gusts.
Strong gale	9	21–24	People blown over by gusts.

4 ENVIRONMENTAL WIND ASSESSMENT

The development site is surrounded in most directions by low-rise buildings, with some isolated medium-rise buildings. Topography surrounding the site relatively flat from a wind perspective. The surrounding street pattern is aligned with the prevailing north-west wind direction, which will promote channelled flow along Hunter Street for winds from this direction The proposed mixed-use building will rise to 20 storeys above ground level, with a 16 storey residential tower sitting atop a 4 storey podium level, including 3 levels of carpark and commercial tenancy at ground and mezzanine level, facing Hunter Street, Figure 2. The tower is setback significantly from the east and west façade lines of the podium, making space for a recreation and pool deck on the eastern side of the podium and a garden pavilion area on the west. Several wind flow mechanisms such as downwash and channelling flow are described in Appendix 1, and the effectiveness of some common wind mitigation measures are described in Appendix 2.

Figure 4: Ground floor plan of the proposed development (Stewart Architects, 2022)

4.1 Winds from the east

Prevailing winds from the east will approach over suburban Newcastle and a portion of the city centre, before impinging on the broad eastern façades of the proposed development. Downwash generated from winds impinging on the east façade would be accelerated around the north-east and south-east corners of the tower at podium level, as shown in Figure 5. The setback of the tower from the podium will allow wind conditions at ground level along Steel St and Hunter St to remain similar to existing conditions for winds from the east. The pool area and landscape courtyard on the eastern podium level would experience stronger wind conditions resulting from downwash off the eastern façade, particularly close to the tower corners. Including awnings or canopies over areas on the eastern podium level that are desired for poolside seating or stationary recreation activities would be beneficial in allowing wind conditions in these spaces to remain comfortable for winds from the east. The covered pool terrace in the south-east corner of the podium is somewhat protected by planned landscaping from direct winds and by the cover from direct impact of downwash winds and would be expected to experience relatively mild wind conditions. If milder wind conditions are desired elsewhere, cabanas or otherwise partially protected seating areas would provide localised protection from strong winds on the eastern podium level. Planting and trees on the podium level may also assist in providing some amelioration for wind conditions on the recreation deck and should be retained. The walls on the podium-level courtyards at the tower corners, marked in red in Figure 6 will prevent strong winds resulting from downwash from accelerating through these courtyard spaces.

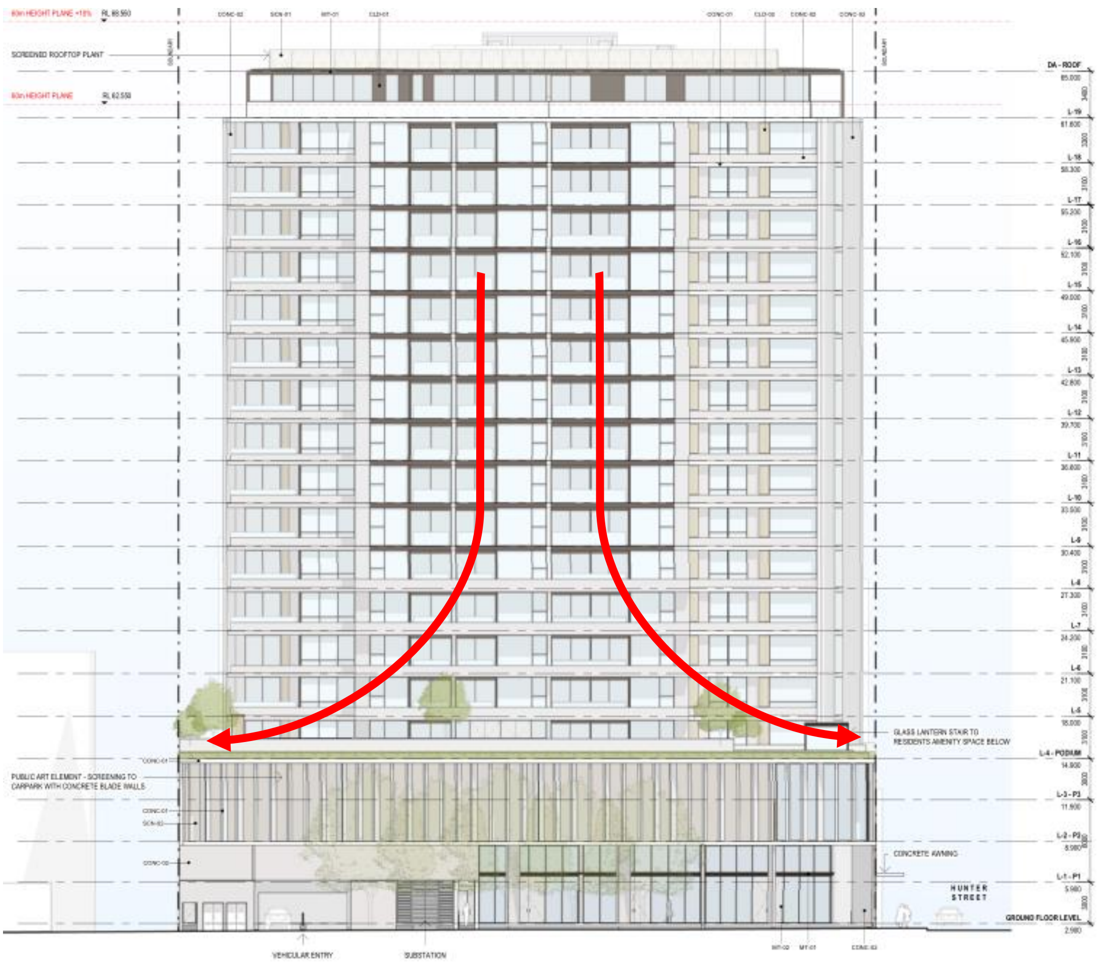

Figure 5: Winds from the east impinging on broad facade will generate downwash

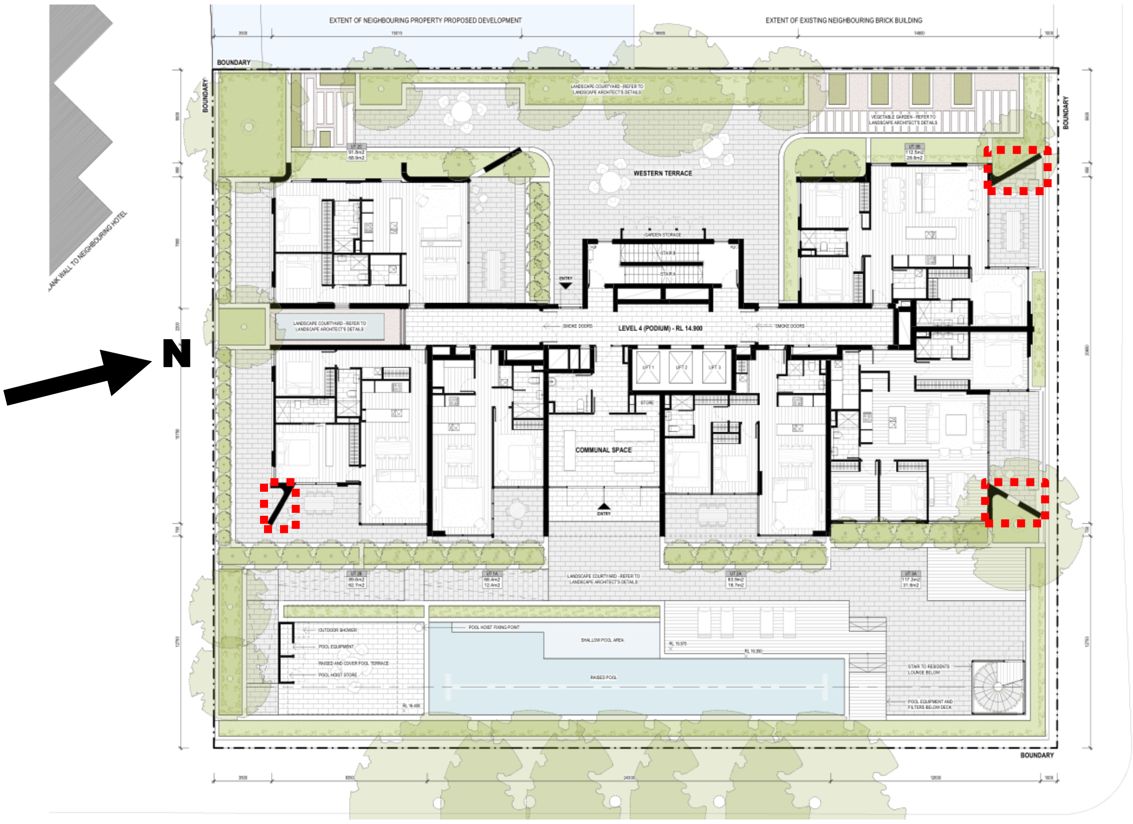

Figure 6- Podium level plan view.

4.2 Winds from the south

Winds from the south reach the subject development over low-rise suburban housing. The Travel Lodge to the south of the proposed development will provide some shielding from winds from the south for the western side of the podium terrace, providing protection from direct winds from the south. The narrow south façade of the tower is expected to generate some downwash, which will accelerate around the south-east and south-west corners of the tower on the podium level. If milder conditions are desired on areas on the southern side of the eastern podium terrace, an awning around the south-eastern corner of the tower could be implemented to keep downwash off the south façade elevated. Wind conditions on the ground plane are expected to remain similar to existing for winds from the south.

4.3 Winds from the north-west

North-west winds will impinge on the broad west and narrow north façades of the proposed development. Similar to winds from the east, the tower setback will allow most of the downwash generated by more westerly winds on the west façade to accelerate around the tower corners at podium level. The inset part in the centre of the western podium is expected to experience milder wind conditions than the outer portions of this terrace for winds from the north-west. The oblique angle for more northerly winds with the narrow north façade of the tower will encourage flow horizontally around the north-east corner of the tower, with limited downwash. Some acceleration of flow around the south-west corner of the tower would be expected to create slightly windier conditions on the southern side of the podium terrace, close to the corner of the tower. Local mitigation such as vertical screening could be implemented during the detailed design phase if calmer conditions are desired in this location. The majority of the pool and landscape deck on the eastern podium will be shielded from winds from the north-west by the tower, and conditions would remain relatively calm. Wind conditions on the ground plane would be expected to remain similar to existing for winds from the north-west.

4.4 Wind conditions on the ground plane

With the exception of a narrow section of the north façade, the tower is set back from the ground plane with most of the downwash generated by winds impinging on the façades of the tower dispersing at podium level. The north façade is not aligned with regular strong prevailing winds and significant downwash is not expected to be generated off this façade. The alignment of Hunter Street and Steel Street with prevailing winds from the east and the south respectively will encourage some channelling of flow down these streets, however wind conditions along these streets are expected to remain largely similar to existing conditions, suitable for pedestrian walking style activities under the Lawson comfort criteria, in line with the general intended use of the area as public accessway. If areas of the covered colonnade are to be used for stationary activities, such as seating or café style dining, temporary screening would be beneficial to provide local amelioration on windy days. The recessed entryway is considered to be beneficial from a wind comfort perspective with calmer conditions to be expected in this area. All locations on the ground plane are expected to satisfy the Lawson safety/distress criteria.

4.5 Wind conditions on upper levels

Balconies on buildings significantly taller than their surrounding massing, have the potential to experience uncomfortably windy conditions for a significant portion of the time, particularly if they are positioned on the tower corners. Balconies for the proposed development generally appear to be enclosed on both sides, restricting wind flow through and limiting adverse wind conditions. The corner balcony walls, similar to those highlighted in red at podium level in Figure 6, are considered beneficial, as these function as inset balconies from a wind perspective. The walls prevent strong cross-flows through these balconies, allowing conditions on the corner balconies to remain relatively mild.

Rooftop or elevated terraces tend to be among the windiest locations on tall buildings, due to their relative exposure to prevailing winds and acceleration of flow over the terrace edges. The penthouse apartments are exposed to the prevailing wind directions, with balconies and terrace areas on the north, east, and south not enclosed by walls at the building corners. Full height vertical screens, particularly along the western ends of the penthouse terraces, would be recommended if these areas are to be frequently used for long-term stationary activity. The dividing screen in between the large balconies on the eastern side of the penthouse level will provide local protection in this area, with milder conditions expected here on windy days compared to the corner balconies. Both penthouse residences would be expected to have a useable balcony space most of the time, varying with the prevailing wind direction. Over time residents tend to learn to determine the useability of their balconies based on the seasonal weather conditions.

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed WaterVue project at 643-651 Hunter Street on the local wind environment in and around the development site. Due to the significant tower setback at podium level, the proposed development is not expected to have any significant effects on the wind conditions in the public domain at ground level. Consequently, wind conditions around the development are expected to remain the same from a pedestrian comfort and safety perspective. Localised mitigation including awnings, cabanas and protected seating areas would be recommended for locations on the pool deck on the eastern side of the podium where seating and stationary activities are intended. Full height vertical screens (1.8m) would be recommended for the western private terraces on the penthouse level if frequent long-term stationary activities are desired.

6 REFERENCES

Newcastle City Council (2012), “Newcastle Development Control Plan 2012”.

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.

Penwarden, A.D., (1973), "Acceptable wind speeds in towns", Building Science, Vol.8, pp. 259-267.

Appendix 1: Wind flow mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 7; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward corners and sides of the building. In Figure 7, 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 8 shows the wind at mid and upper levels on a building being 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.

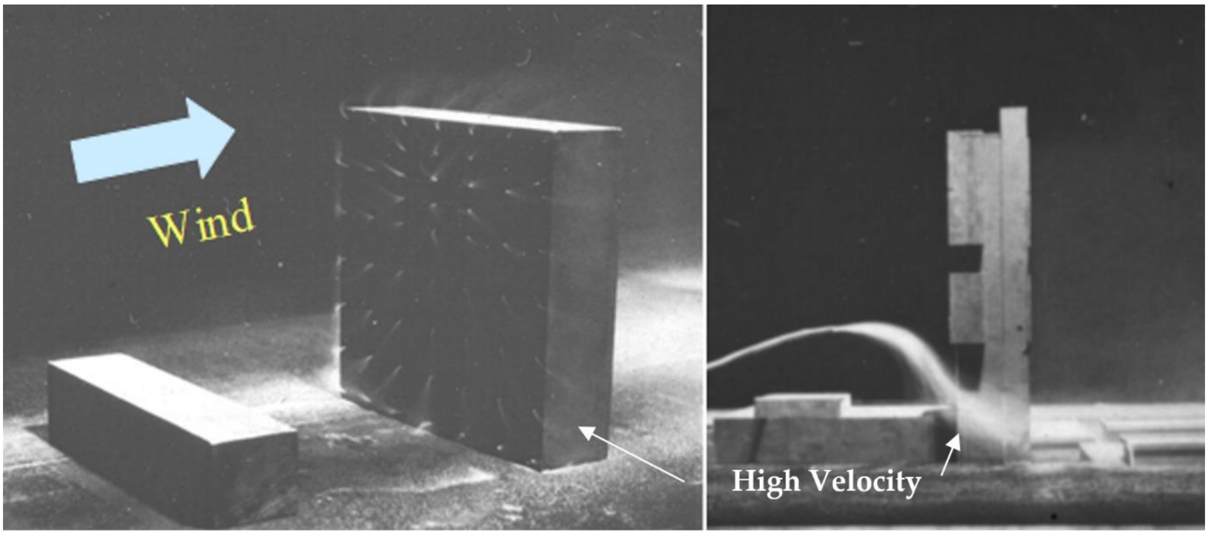

Figure 7: Flow visualisation around a tall building.

Figure 8: Visualisation through corner balconies (L) and channelling between buildings (R).

Appendix 2: Wind Impact Planning Guidelines

It is well known that the design of a building will influence the quality of the ambient wind environment at its base. Below are some suggested wind mitigation strategies that should be adopted into precinct planning guidelines and controls (see also Cochran, 2004).

Building form – Canopies

A large canopy may interrupt the flow as it moves down the windward face of the building. This will protect the entrances and sidewalk area by deflecting the downwash at the second storey level, Figure 9. However, this approach may have the effect of transferring the breezy conditions to the other side of the street. Large canopies are a common feature near the main entrances of large office buildings.

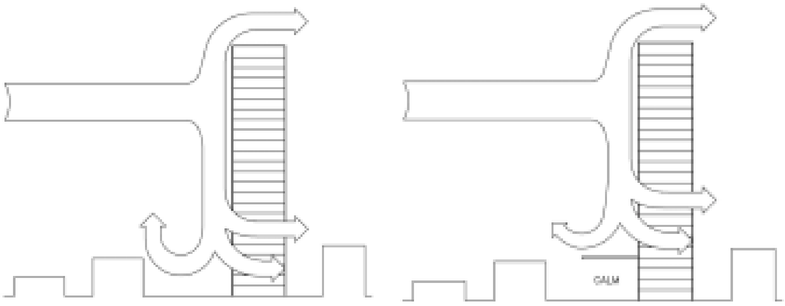

Figure 9: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

Building form – Podiums

The architect may elect to use an extensive podium for the same purpose if there is sufficient land and it complies with the design mandate, Figure 10. This is a common architectural feature for many major projects in recent years, but it may be counterproductive if the architect wishes to use the podium roof for long-term pedestrian activities, such as a pool or tennis court.

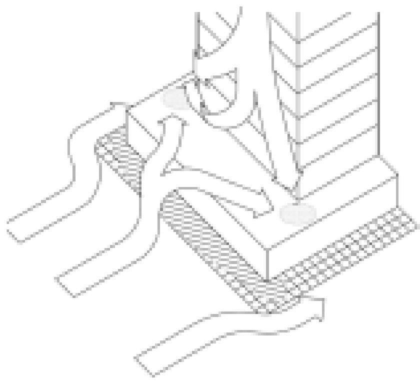

Figure 10: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

Building form – Arcades

Another massing issue, which may be a cause of strong ground-level winds, is an arcade or thoroughfare opening from one side of the building to the other. This effectively connects a positive pressure region on the windward side with a negative pressure region on the lee side; a strong flow through the opening often results, Figure 11. The uninvitingly windy nature of these open areas is a contributing reason behind the use of arcade airlock entrances (revolving or double sliding doors).

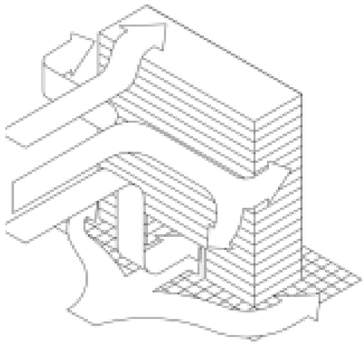

Figure 11: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure 12(L). In some cases, a canopy may not be necessary with this scenario, depending on the local geometry and directional wind characteristics. The same undercut design at a building corner is usually quite unsuccessful, Figure 12(R), due to the accelerated flow mechanism described in Figure 7 and the ambient directional wind statistics. If there is a strong directional wind preference, and the corner door is shielded from those common stronger winds, then the corner entrance may work. However, it is more common for a corner entrance to be adversely impacted by this local building geometry. The result can range from simply unpleasant conditions to a frequent inability to open the doors.

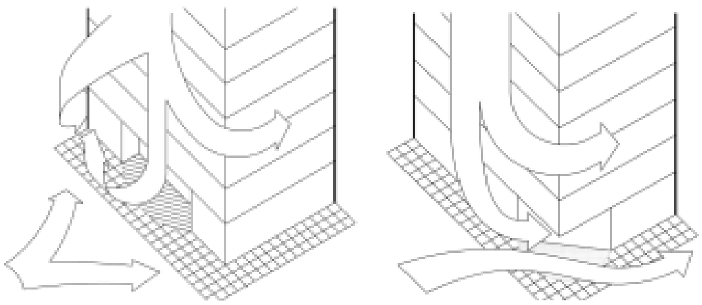

Figure 12: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

Building form – Façade profile and balconies

The way in which a building's vertical line is broken up may also have an impact. For example, if the floor plans have a decreasing area with increased height the flow down the stepped windward face may be greatly diminished. To a lesser extent the presence of many balconies can have a similar impact on ground level winds, although this is far less certain and more geometry dependent. Apartment designs with many elevated balconies and terrace areas near building ends or corners often attract a windy environment to those locations. Mid-building balconies, on the broad face, are usually a lot calmer, especially if they are recessed. Corner balconies are generally a lot windier and so the owner is likely to be selective about when the balcony is used or endeavours to find a protected portion of the balcony that allows more frequent use, even when the wind is blowing.

Use of canopies, trellises, and high canopy foliage

Downwash Mitigation – As noted earlier, downwash off a tower may be deflected away from ground-level pedestrian areas by large canopies or podium blocks. The downwash then effectively impacts the canopy or podium roof rather than the public areas at the base of the tower, Figure 10. Provided that the podium roof area is not intended for long-term recreational use (e.g. swimming pool or tennis court), this massing method is typically quite successful. However, some large recreational areas may need the wind to be deflected away without blocking the sun (e.g. a pool deck), and so a large canopy is not an option. Downwash deflected over expansive decks like these may often be improved by installing elevated trellis structures or a dense network of trees to create a high, bushy canopy over the long-term recreational areas. Various architecturally acceptable ideas may be explored in the wind tunnel prior to any major financial commitment on the project site.

Horizontally accelerated flows between two tall towers, Figure 8(R), may cause an unpleasant, windy, ground-level pedestrian environment, which could also be locally aggravated by ground topography. Horizontally accelerated flows that create a windy environment are best dealt with by using vertical porous screens or substantial landscaping. Large hedges, bushes or other porous media serve to retard the flow and absorb the energy produced by the wind. A solidity ratio (i.e. proportion of solid area to total area) of about 60-70% has been shown to be most effective in reducing the flow's momentum. These physical changes to the pedestrian areas are most easily evaluated by a model study in a boundary-layer wind tunnel.

References

Cochran L., (2004) Design Features to Change and/or Ameliorate Pedestrian Wind Conditions, Proceedings of the ASCE Structures Congress, Nashville, Tennessee, May 2004.