Annexure R:
Wind Impact Assessment

SydneyOlympicPark

CPP WIND ENGINEERING CONSULTANTS

Wind Comfort Study for SOPA Master Plan 2050

Sydney Olympic Park, New South Wales
CPP 18036 | Revision R03 | 15 February 2024

Prepared for:
SJB
L2, 490 Crown Street,
Surry Hills NSW 2010

cppwind.com

Document Control

REVISION HISTORY				
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15 February 2024	Interim Report R03	-	Vijay Veera Senior CFD Engineer vveera@cppwind.com	-

BASIS OF REPORT – CLIENT PROVIDED DOCUMENTATION			
DOCUMENT DATE	PROVIDED DATE	DRAWING NAME	FILENAME
-	5-April-2023	-	6645_SOPA_Built Form.3dm
-	23-November-2023	-	6645_SOPA_Mastermodel_13.3dm

Executive Summary

CPP was commissioned by SJB to conduct a wind comfort assessment for the proposed Sydney Olympic Park 2050, located in Sydney, Australia. The scope of this study focuses exclusively on wind comfort, omitting assessments of safety or distress.

In the Urban Centre Neighbourhood, wind comfort at street level varies from Outdoor Dining in sheltered areas to *Pedestrian Standing* along major streets. Comfort conditions on Sarah Durack Ave could be enhanced by implementing localized measures, such as sheltered seating, to increase wind comfort by approximately one level.

Locations within areas rated *Outdoor Dining* are suitable for outdoor dining activities while areas rated *Pedestrian Sitting* are suitable with mild mitigation. With moderate mitigation, areas rated *Pedestrian Standing* can be made amenable for dining. Areas rated *Pedestrian Walking* or worse are not recommended for dining.

For the Stadia Precinct, wind comfort predominantly ranges from *Pedestrian Sitting* to *Pedestrian Standing*. In Cathy Freeman Park, targeted landscaping is expected to improve comfort criteria by about one level. It is advised to program stationary activities away from the intersection of Grand Pde and Orana Pde.

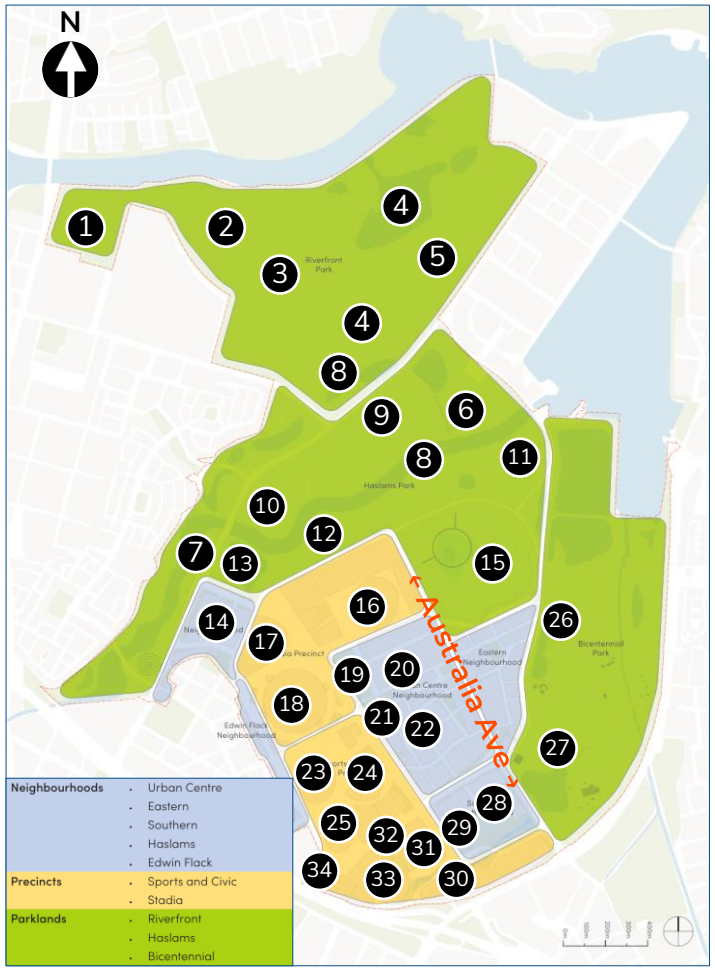
In the Sports and Civic Precinct, wind comfort is rated as *Pedestrian Standing* or better. Dense natural planting along Birnie Ave and Carter St is anticipated to decrease wind speeds, thereby improving comfort conditions by up to one level.

In the Eastern Neighbourhood, wind comfort is primarily rated as *Pedestrian Sitting*, with some areas of *Pedestrian Standing* due to localized flow accelerations, such as downwash. These conditions are deemed suitable for short-term standing activities.

For the Southern Neighbourhood and Sports and Civic Precinct, wind comfort at street level is rated as *Pedestrian Standing* or better, generally accommodating outdoor activities.

Lastly, in the Haslams Neighbourhood, Edwin Flack Neighbourhood, and Stadia Precinct, wind comfort conditions are rated as *Pedestrian Standing* or better.

Site Context & Areas of Interest

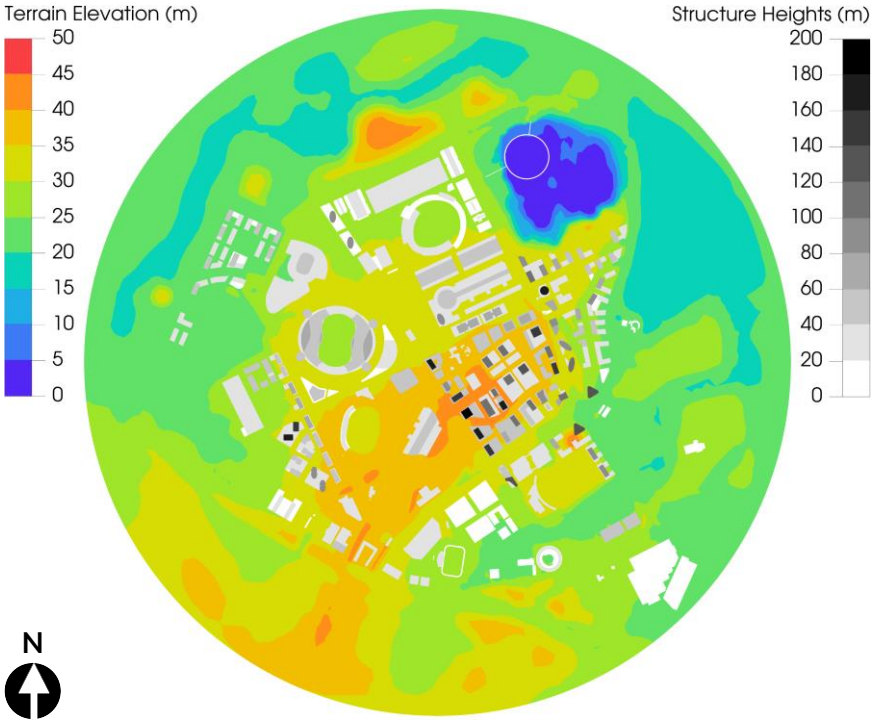


Project location relative to the nearest major roads and landmarks

The project area under assessment is divided into 34 individual developments, numbered in **black**, and bisected by Australia Ave. It encompasses the Urban Centre, Eastern, Southern, Haslam, and Edwin Flack neighbourhoods, along with the Sports & Civic and Stadia precincts, and includes the Riverfront, Haslams, and Bicentennial parklands. Comfort conditions in parkland areas are not reported, owing to limited pedestrian activity.

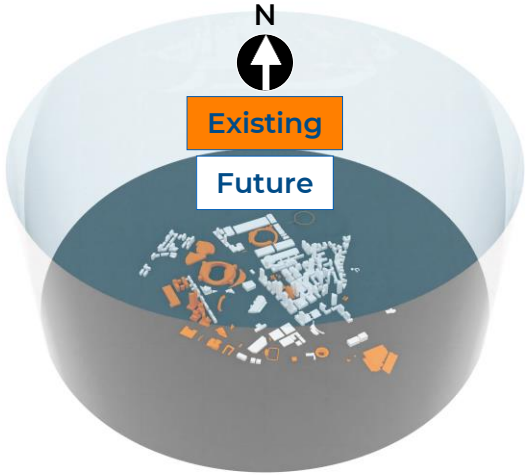
1 Cricket Centre
2 Blaxland Riverside Park
3 Newington Armory
4 Newington Nature Reserve
5 Woo-la-ra
6 Sydney Olympic Park Archery Centre
7 Haslams Creek
8 Narawang Wetlands
9 Wave park (under construction)
10 2KY site (outside site)
11 Wentworth Common
12 Kronos Hill
13 The Pyramid
14 Industrial waste facility
15 Brickpit
16 Showground Stadium
17 Sydney Superdome
18 Stadium Australia
19 Cathy Freeman Park
20 Sydney Olympic Park Train Station
21 Former Abattoir heritage buildings
22 Metro station (under construction)
23 Sydney Olympic Park Athletic Centre
24 Sydney Olympic Park Aquatic Centre
25 Sydney Olympic Park Athletics Warm Up Arena
26 Badu Mangroves
27 Bicentennial Park
28 Tom Wills community field
29 Sports oval
30 Sydney Olympic Park Tennis Centre
31 Netball Central
32 Quaycentre
33 Sydney Olympic Park Hockey Centre
34 Sydney Olympic Park Place Management Centre

Simulation Geometry



Modelled surrounds and terrain, colored by elevation

The modelled area features dense development, with the tallest structures reaching approximately 200 meters. Building heights range from low-rise to high-rise. The study includes general hard landscaping but excludes natural vegetation and trees around the site from the analysis. This exclusion is due to the variable effectiveness of vegetation and trees, which depends on wind speed and season. Therefore, the results presented offer conservative estimates of pedestrian comfort in areas that will include planting.



Entire simulation domain, viewed from south

South elevation showing masterplan's exposure to a prevailing wind direction

Local Wind Climate

Wind climate statistics were sourced from Bankstown Airport (BWU, YSBK), which is located 11 km southeast of the project surrounds. An approach roughness correction was applied to the data[1] to account for the differences between airport and site surroundings.

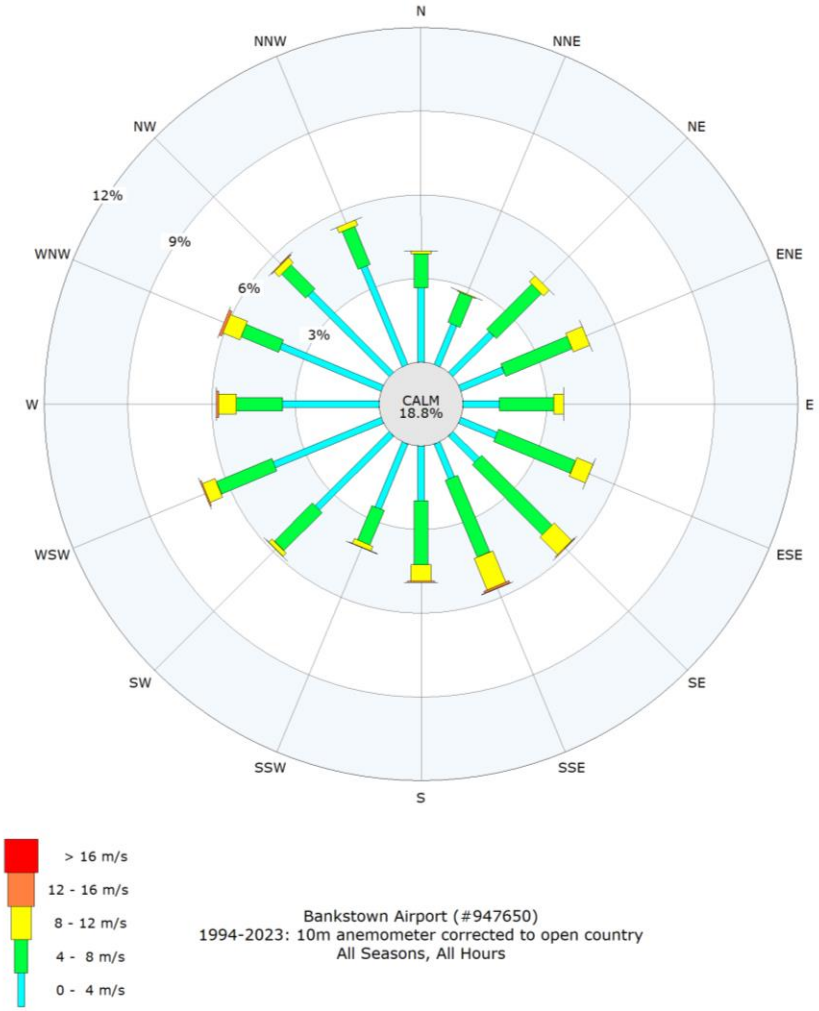
The arms of the wind roses point in the direction from where the wind is blowing, the width and colour of the arm represent the wind speed, and the length of the arm indicates the percent of the time that the wind blows for that combination of speed and direction.

The wind comfort analysis presented in this report is based on the annual all-hours wind climate.

Winds are calm approximately 19% of the time.

The wind climate predominantly deviates from the north-east quadrant, showing a bias towards other quadrants with varying wind intensities: strong winds (orange/red), moderate winds (yellow), and light winds (blue/green).

In open country terrain, the wind speed that is exceeded 5% of the time is 6 m/s, indicating a moderate wind climate.



1 - ESDU 01008 (2010) "Computer program for wind speeds and turbulence properties: flat or hilly sites in terrain with roughness changes," Engineering Sciences Data Unit, London, UK.

Comfort Assessment

The Computational Wind Engineering simulations were conducted for 16 wind directions. These simulations generate estimates of mean wind speed and turbulent kinetic energy that can be combined with the wind climate statistics presented previously to determine the probability of a specific wind speed being exceeded, for each wind direction.

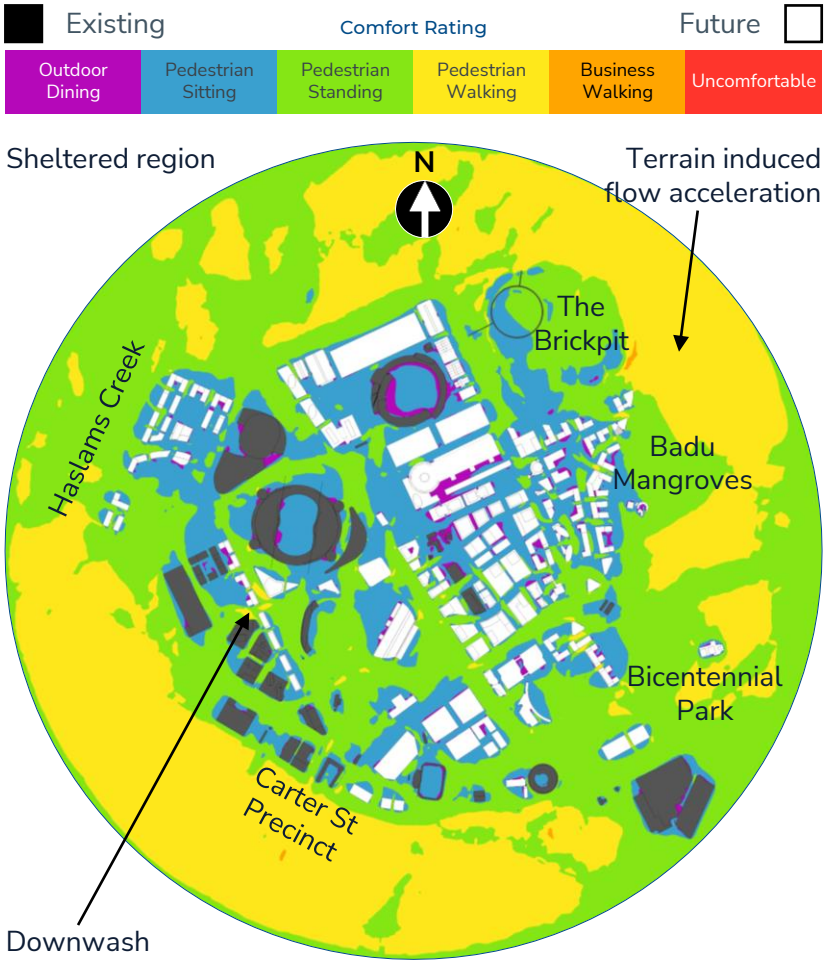
The Lawson criteria establish a relationship between the maximum of the mean or "gust-equivalent" mean and the level of comfort that can be expected from that location when the speed is below a threshold at least 95% of the time. The gust equivalent mean factors down the predicted gust speed so it can be compared against the same criteria.

This report presents results at all relevant locations as coloured contour plots showing the Lawson rating. These are defined in the table to the right, with examples of activities that would be appropriate in each level.

THRESHOLD (M/S)	LAWSON RATING	EXAMPLE ACTIVITIES
0-2	Outdoor Dining*	Long-term sitting with high expectations of comfort, and with little or no opportunity to move to another location. Napkins should not blow away and hair is not ruffled. Mitigation is unnecessary.
2-4	Pedestrian Sitting	Casually eating food, reading a magazine on a bench, quick coffee, pool decks. Short term mitigation such as screening and landscaping with planters is often sufficient to make the space amenable for dining.
4-16	Pedestrian Standing	Short-term standing activities, such as queueing or waiting for a bus. Pedestrians will feel comfortable enough to stop and look into shop windows. Permanent mitigation measures such as awnings and vertical screening are required for dining.
6-8	Pedestrian Walking	In transit, but some wind comfort desired, e.g., walking through a park. Dining comfort unlikely achieved without semi-enclosing dining areas.
8-10	Business Walking	Any activities where the person intends to transit through the space where comfort and leisure is not a requirement, such as crossing a road. Dining not recommended.
> 10	Uncomfortable	People will purposefully avoid the space. Dining not recommended.

* Experience based rating developed by CPP

Wind Comfort – Surrounds



Plan view of the project surrounds coloured by Lawson Comfort rating

Comfort ratings for the modelled area are provided to illustrate the varying conditions throughout Project Area[1].

Wind conditions at distant street level locations are primarily influenced by winds originating from the south and west quadrants. In most open street level areas, the wind comfort is rated as *Pedestrian Standing*, while more sheltered spots between buildings are rated as *Pedestrian Sitting*. The more exposed areas on the site are classified as *Pedestrian Walking* due to higher wind exposure.

The dense cluster of buildings and sports stadiums around the site acts as a shield against winds from most directions. Ratings of *Pedestrian Walking* are noted at building corners, where local wind flow is accelerated by downwash. Similar ratings are observed in areas where the terrain induces flow acceleration.

1 – Results on the perimeter of the modelled domain are less reliable than those within the turntable near the site for which the simulations are optimized.

Wind Comfort – Urban Centre Neighborhood

Plan view of the project surrounds coloured by Lawson Comfort rating

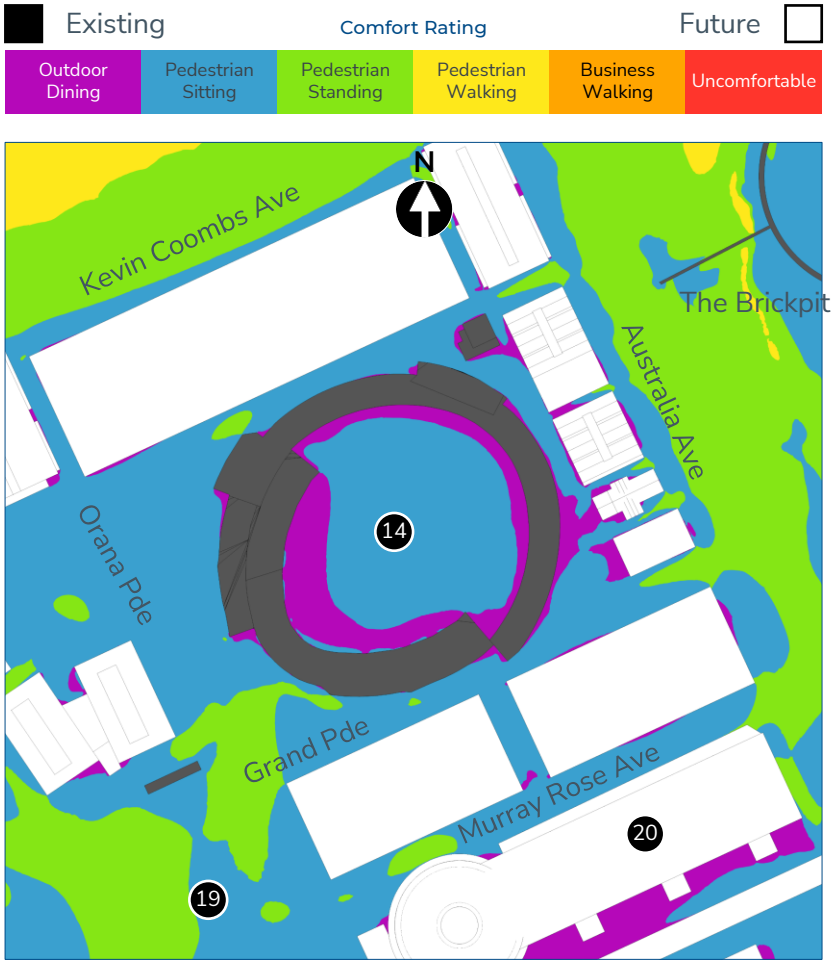
At street level in the Urban Centre Neighbourhood, wind comfort varies from *Outdoor Dining* in sheltered areas to *Pedestrian Standing* along major streets, conditions generally suitable for most outdoor activities.

On Australia Ave, wind comfort is rated *Pedestrian Standing* or better, apt for short-term standing activities. Sarah Durack Ave to the south and Olympic Blvd to the west of the precinct are predominantly rated *Pedestrian Standing*. Comfort conditions on Figtree Dr, Herb Elliot Ave, and Dawn Fraser Ave are largely *Pedestrian Standing* or better. This is primarily due to winds from the west channelling between buildings.

In the interior regions of these streets, the ratings improve to *Pedestrian Sitting*, thanks to the shelter provided by the massing of the buildings. Specifically, at the corner of Olympic Blvd and Herb Elliot Ave, ratings reach *Pedestrian Walking* due to the downwash effect created by the buildings when winds blow from the south.

Recommendation and Outdoor Dining Opportunities: To enhance wind comfort on Sarah Durack Ave, it is advised to implement localized measures, such as installing sheltered seating. This strategy aims to create areas with improved wind conditions, potentially increasing comfort by up to one level, making these spaces more suitable for stationary activities. In addition to areas rated *Outdoor Dining*, areas rated *Pedestrian Sitting* are suitable for dining activities with moderate levels of wind mitigation. With more permanent windbreak mitigation measures such as awnings and vertical screening, areas rated *Pedestrian Standing* can be made amenable for dining.

Wind Comfort – Stadia Precinct



Plan view of the project surrounds coloured by Lawson Comfort rating

At street level within the Stadia Precinct, wind comfort predominantly ranges from *Pedestrian Sitting* to Pedestrian Standing. Kevin Coombs Ave, to the north of this area, generally receives ratings of *Pedestrian Standing* or better. Areas of this street near building facades are particularly suitable for stationary activities. Winds originating from the east and north-northwest contribute to the *Pedestrian Standing* or better ratings along Australia Ave. Sections of this avenue close to building massing are ideal for stationary activities. Sydney Olympic Park Station (**20**), located along Murray Rose Ave, is primarily rated *Pedestrian Sitting*, making it well-suited for seated activities. Similarly, Cathy Freeman Park (**19**), along Olympic Blvd, is rated *Pedestrian Standing* or better. In the vicinity of Showground Stadium (**14**), positioned along Grand Pde and Orana Pde, the wind comfort is primarily *Pedestrian Sitting*. However, the intersection of these streets experiences comparatively windier conditions, resulting in a rating of *Pedestrian Standing*.

Recommendation and Outdoor Dining Opportunities: For Cathy Freeman Park (**19**), it is suggested to employ localized measures like installing vertical porous screens or targeted landscaping. These interventions are anticipated to enhance comfort along the boulevard by approximately one level, thereby facilitating some seated activities. Additionally, areas of Kevin Coombs Ave near building facades should be considered for stationary activities. To ensure optimal comfort, it is recommended that such stationary activities be planned away from the windier intersection of Grand Pde and Orana Pde. Murray Rose Ave and Orana Pde are suitable for dining activities with mild mitigation. With moderate mitigation, areas along Australia Ave and Kevin Coombs Ave can be made amenable for dining.

Wind Comfort – Sports and Civic Precinct

Plan view of the project surrounds coloured by Lawson Comfort rating

Wind comfort in the Sports and Civic Precinct is assessed as *Pedestrian Standing* or better, making these conditions appropriate for short-term standing activities. Similarly, comfort levels along Edwin Flack Ave are rated as *Pedestrian Standing* or better. The wind comfort on Birnie Ave and Carter St mirrors this rating. The predominant drivers of comfort conditions on these streets are winds originating from the south and west quadrants. These winds tend to channel down streets that align with these directions. As such, pedestrian activity in these areas is anticipated to be comfortably accommodated.

18. Cathy Freeman Park
19. Train Station
20. Former Abattoir Heritage Buildings
21. Metro Station
22. Athletic Centre
23. Aquatic Centre
24. Warm Up Arena
30. Tennis Centre
31. Netball Central
32. Quaycentre
33. Hockey Centre
34. Place Management Centre

Recommendation and Outdoor Dining Opportunities: To enhance wind comfort by up to one level on Birnie Ave and Carter St, it is recommended to employ mitigation strategies such as dense natural planting. This approach will help reduce wind speeds channelling down these streets. Along the Western Motorway, where conditions are rated as *Pedestrian Walking*, no mitigation measures are advised due to the expected minimal pedestrian activity in this area. Areas rated *Pedestrian Sitting* are suitable for dining activities with mild mitigation. With more permanent windbreak mitigation measures such as awnings and vertical screening, areas rated *Pedestrian Standing* can be made amenable for dining.

Wind Comfort – Southern Neighborhood + Sports and Civic Precinct

Plan view of the project surrounds coloured by Lawson Comfort rating

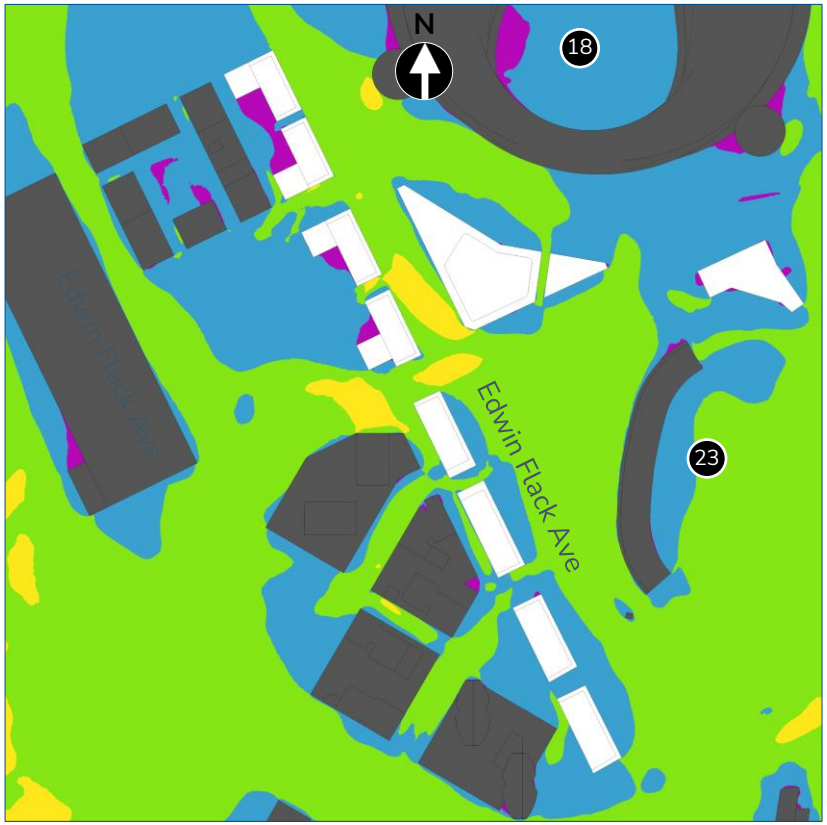
Wind comfort at street level locations in the Southern Neighbourhood and the Sports and Civic Precinct is rated as *Pedestrian Standing* or better. Such ratings are typically appropriate for various outdoor activities.

On Dawn Fraser Ave, the comfort conditions are also rated as *Pedestrian Standing* or better, aligning well with the intended use of the space. Similarly, Olympic Blvd is primarily rated as *Pedestrian Standing* or better, making it suitable for outdoor activities. Edwin Flack Ave and Darwin Fraser Ave share this rating, indicating their suitability for similar outdoor uses.

18. Stadium Australia
19. Cathy Freeman Park
20. Train Station
21. Former Abattoir Heritage Buildings
22. Metro Station
23. Athletic Centre
24. Aquatic Centre
25. Warm Up Arena
30. Tennis Centre
31. Netball Central
32. Quaycentre
33. Hockey Centre
34. Place Management Centre

Recommendation and Outdoor Dining Opportunities: No mitigation measures are deemed necessary in this precinct, as the current comfort ratings of *Pedestrian Standing* or better are adequately suited for the anticipated pedestrian usage. Dining activities could be planned on Olympic Blvd, Birnie Ave, Carter St and Edwin Flack Ave with more permanent windbreak mitigation measures such as awnings and vertical screening. It is recommended that the areas rated *Pedestrian Walking* are not considered for dining activities.

Wind Comfort – Edwin Flack Neighbourhood



Plan view of the project surrounds coloured by Lawson Comfort rating

Wind comfort at street level locations in the Edwin Flack Neighbourhood is rated as *Pedestrian Walking* or better. Such ratings are typically appropriate for various outdoor activities.

18. Stadium Australia
23. Athletic Centre

Recommendation and Outdoor Dining Opportunities: No mitigation measures are deemed necessary in this precinct, as the current comfort ratings of *Pedestrian Standing* or better are adequately suited for the anticipated pedestrian usage. Areas of Edwin Flack neighbourhood rated *Pedestrian Standing* to *Pedestrian Sitting* are suitable for planning dining activities with moderate and permanent windbreak mitigation measures. Areas rated *Pedestrian Walking* or worse are not recommended for dining.

Wind Comfort – Eastern Neighborhood

Plan view of the project surrounds coloured by Lawson Comfort rating

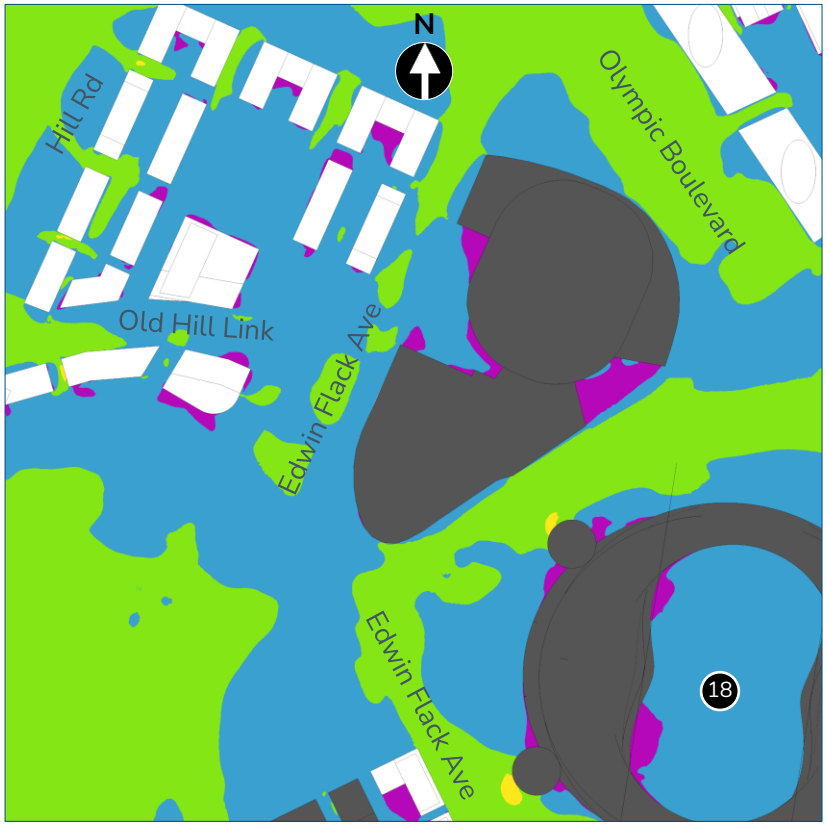
Wind comfort in the Eastern Neighbourhood is predominantly rated as *Pedestrian Sitting*, but some areas experience *Pedestrian Standing* due to localized flow accelerations, such as downwash from buildings. These conditions are still appropriate for short-term standing activities.

Focusing on specific streets, Parkview Dr to the north, Bennelong Pkwy to the east, and Australia Ave to the west, each demonstrates suitable wind comfort for stationary activities. Parkview Dr benefits from the sheltering effects of surrounding structures, Bennelong Pkwy's orientation and exposure yield a mild wind climate, and Australia Ave's layout with surrounding buildings effectively mitigates wind impacts.

These street-level wind comfort assessments reflect a suitable balance between building placement, street layout, and prevailing winds, ensuring a conducive environment for various pedestrian activities.

Recommendation and Outdoor Dining Opportunities : No additional measures are recommended since the existing wind comfort levels are expected to be suitable for pedestrian thoroughfare. Locations within this neighbourhood rated *Pedestrian Sitting* are suitable for dining activities with mild mitigation. With permanent windbreak mitigation measures, areas rated *Pedestrian Standing* can be made amenable for dining.

Wind Comfort – Haslams Neighbourhood + Stadia Precinct



Plan view of the project surrounds coloured by Lawson Comfort rating

Wind comfort conditions in the Haslams Neighbourhood and Stadia Precinct, particularly near Stadium Australia (**18**) in the masterplan quarter, are rated as Pedestrian Standing or better. This assessment indicates that the wind speeds and patterns in these areas are conducive to comfortable pedestrian movement.

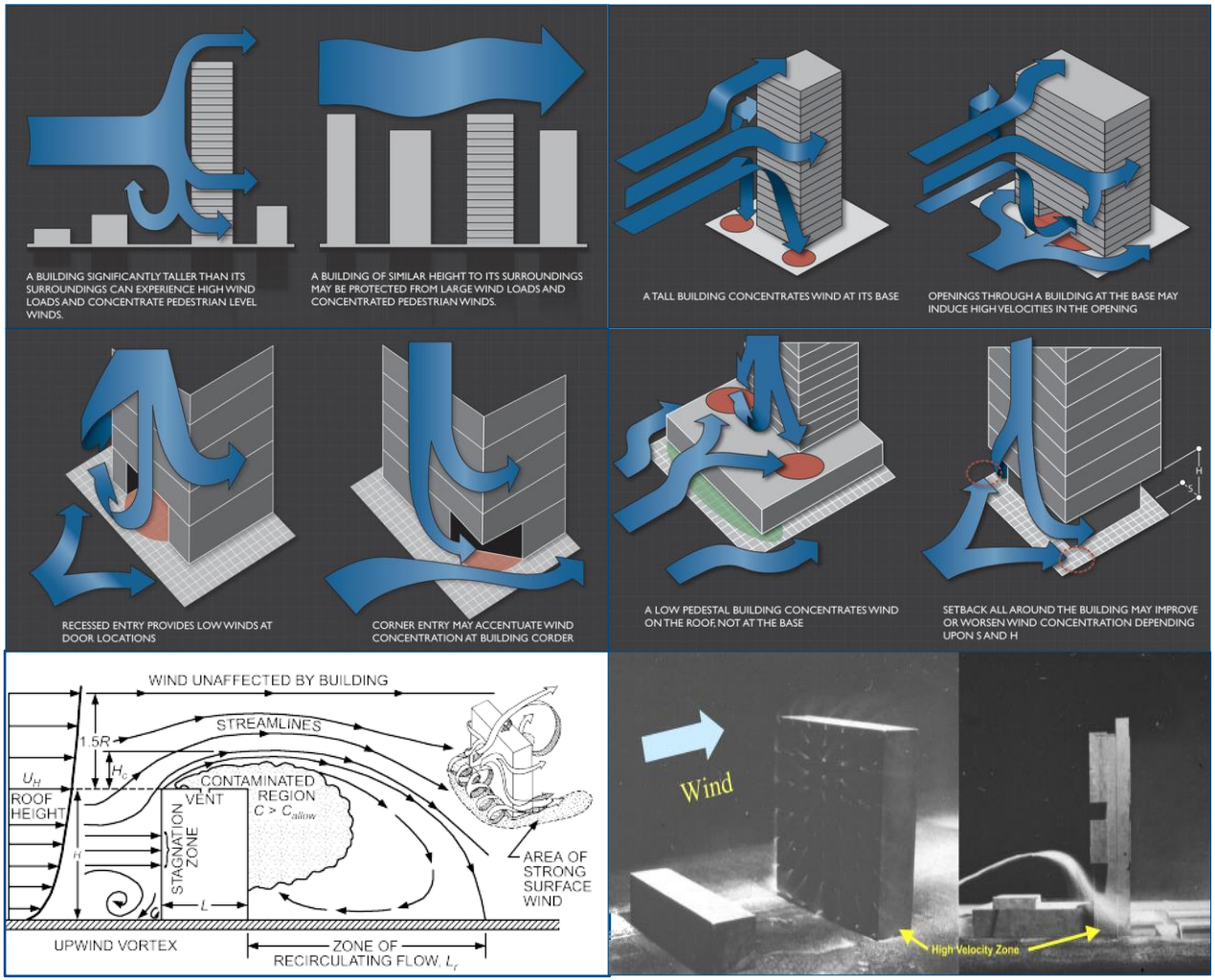
The *Pedestrian Standing* or better rating suggests that the wind forces are not strong enough to impede typical pedestrian activities such as walking or standing. This is a crucial factor for areas near a major venue like Stadium Australia, where large crowds are expected, and ease of movement is essential.

The wind comfort assessment considers various factors such as the height and orientation of buildings, open spaces, and prevailing wind directions. The favourable ratings in these precincts imply that the urban design and architectural considerations have been effective in creating an environment where wind conditions support the expected levels of pedestrian thoroughfare, enhancing the overall usability and comfort of these public spaces.

Recommendation and Outdoor Dining Opportunities: No additional measures are recommended since the existing wind comfort levels in this precinct are expected to be suitable for pedestrian thoroughfare. Old Hill Link, Hill Rd and regions of Edwin Flack Ave rated *Pedestrian Sitting* are suitable for dining activities with mild mitigation. With permanent windbreak mitigation measures, areas of Olympic Blvd and Edwin Flack Ave rated *Pedestrian Standing* can be made amenable for dining.

Appendices

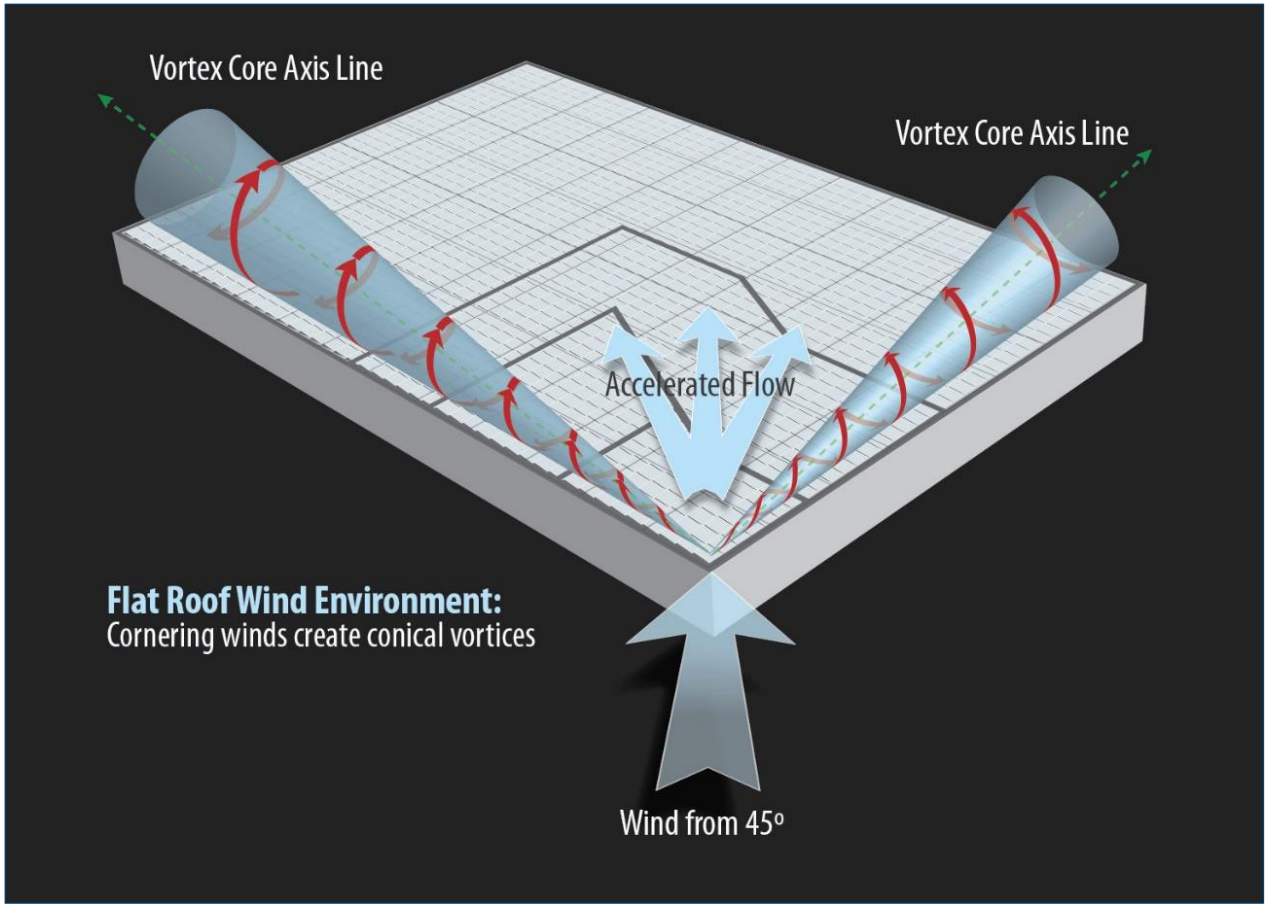
Downwash



When wind impinges on an isolated building, it is forced down the face of the structure and accelerated around the windward corners. This flow mechanism causes the windiest conditions at ground level on the windward corners and sides of the building.

High turbulence, lower speed cavities are also formed on the roof and downwind of the building.

Corner Vortices



Roof corner vortices produce high wind speeds on the roof and reduces plume rise, possibly resulting in higher concentrations, when stacks are near corners and intakes are roughly along the 45° angle.

Passageways

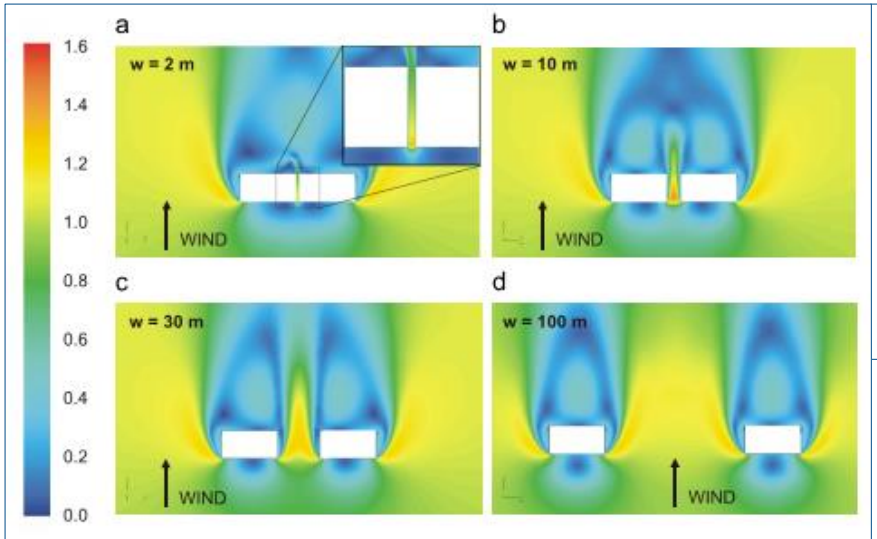


Fig. 9. Contours of amplification factor K in a horizontal plane at pedestrian level ($y = 2$ m) for four passage widths.

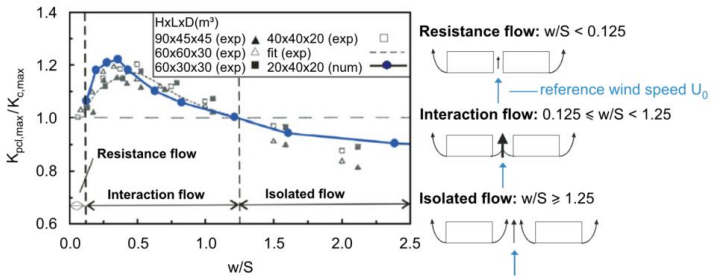
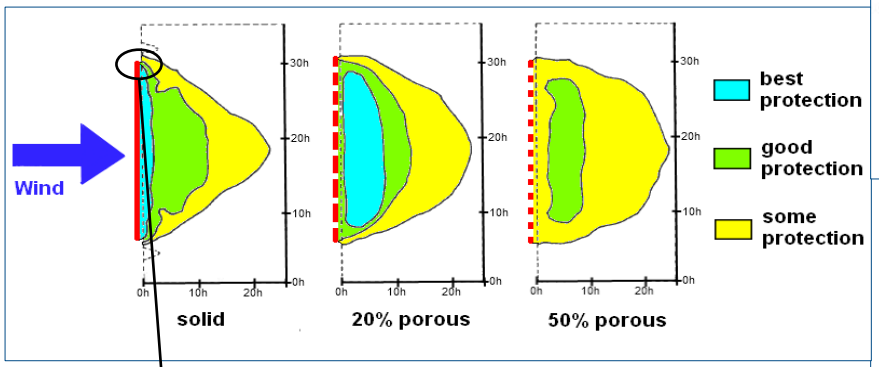


Fig. 10. Definition and schematic representation (right, top views) of the three flow regimes for pedestrian-level wind speed in passages.

The figure on the left is from Blocken, et al (2007). $S = (B_L B_S^2)^{\frac{1}{3}}$ and w is the passage width in the figure on the right.

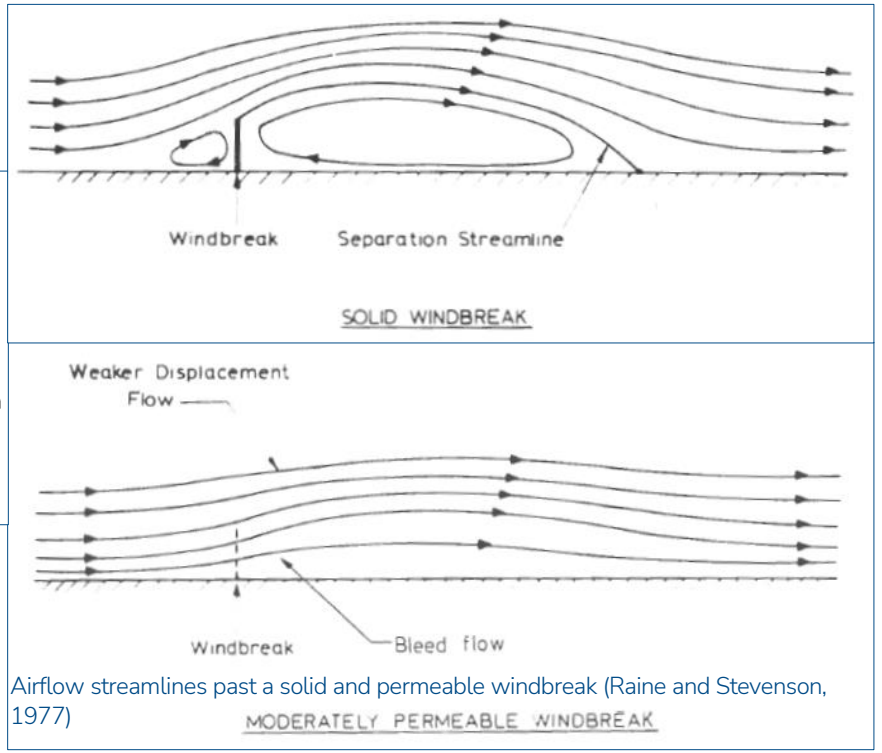
Channeling occurs when the wind is accelerated between two buildings. A wake cavity region is created on the downwind (lee) side of the building. The cavity region is characterized by reduced wind velocities but increased turbulence. In general, the wake cavity region is considered to be “sheltered” to about 3 to 5 building heights (or heights of the sheltering object such as trees, screens, etc.) downwind.

Windbreaks & Screens



Accelerated flow around edge of solid wind break

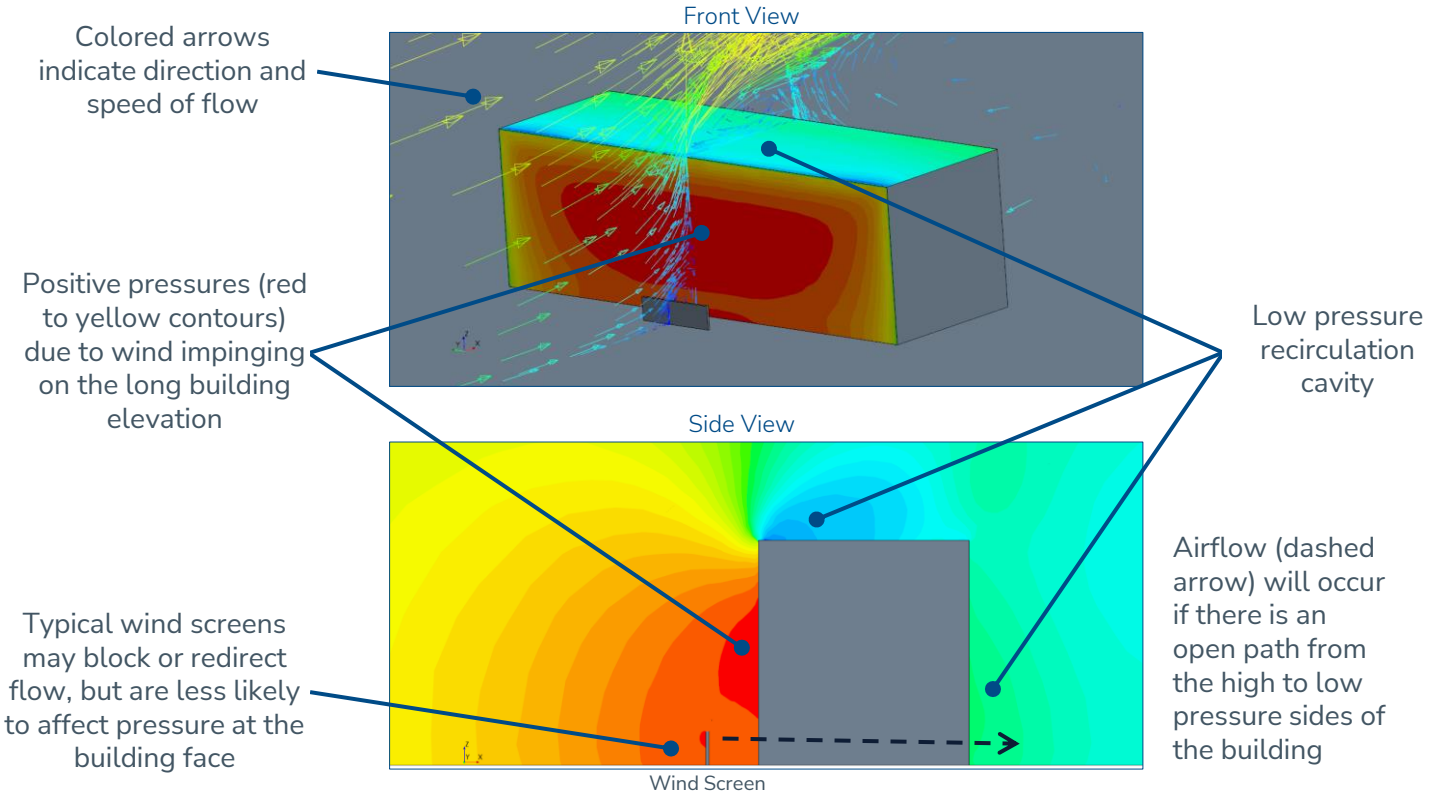
Plan view of sheltered area downwind of a vertical wind break (adapted from Gandemer, 1981)



Airflow streamlines past a solid and permeable windbreak (Raine and Stevenson, 1977)

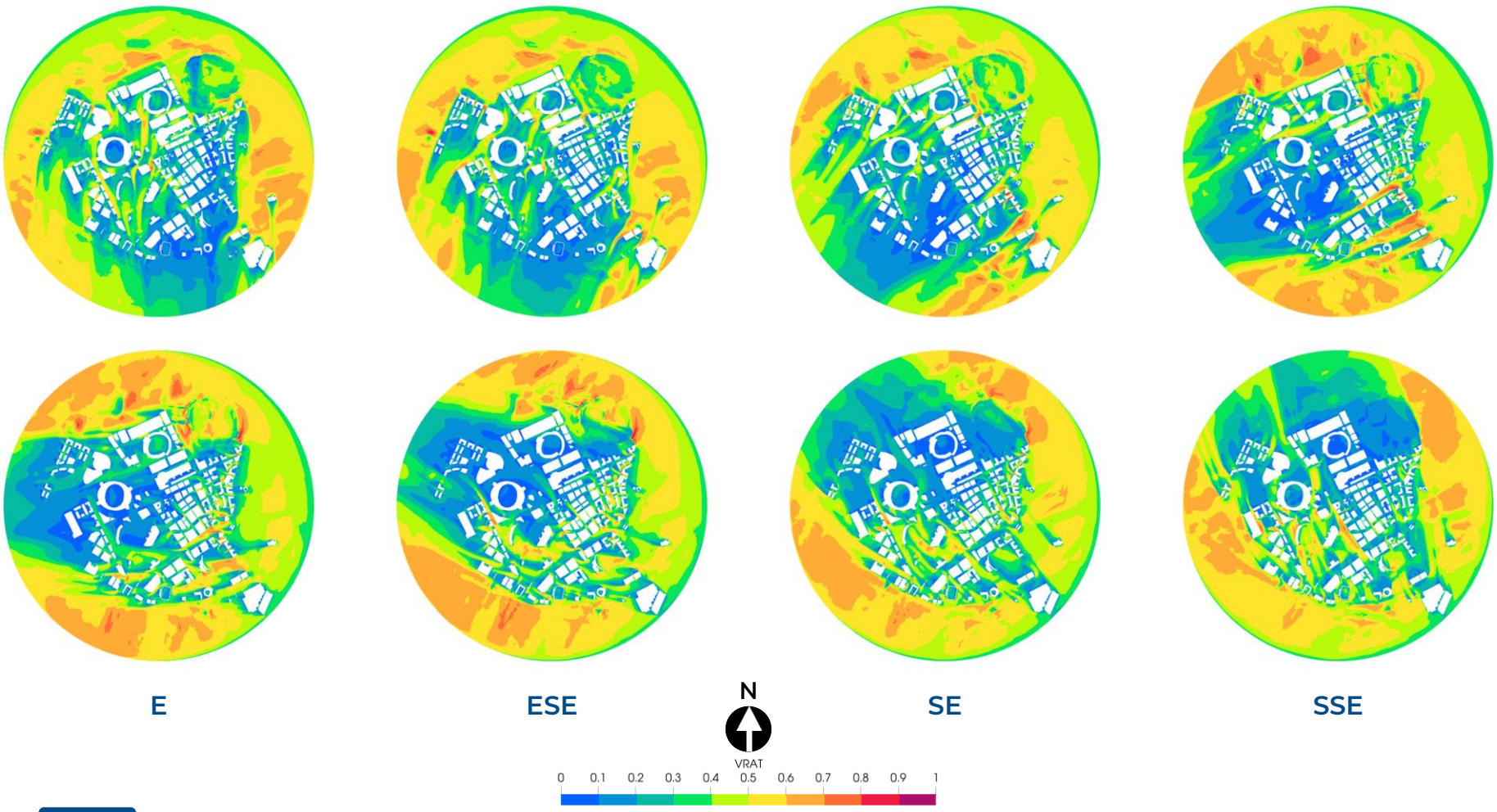
Long, continuous windbreaks are preferred over short sections that may cause acceleration of the mean velocity in between gaps. The best protection is achieved when the wind blows perpendicular to the windbreak. Good protection is achieved up to 10 wind break heights downwind of a 20% porous barrier. The protected area moves and decreases as the wind direction changes.
Windbreaks can be an effective measure to mitigate strong winds that affect pedestrian comfort. A review of the relevant literature indicates that the most effective windbreak has a porosity between 10% and 30%. Porosity is defined as the ratio of open area to the total area of the screen. A solid windbreak provides better protection directly downwind of the windbreak, but the protected region extends farther downwind from a porous windbreak (see figure above). The solid wind break creates more turbulence as well as flow acceleration around the sides. With increasing porosity, the wake cavity (high turbulence region) size decreases because the “bleed flow” increases. However, mean velocities also increase with increasing porosity, reducing the overall effect of the wind break. At 70% porosity and above, little to no protection occurs. A 20% porous fence (or equivalent vegetation) gives the best overall compromise between mean velocity reduction and increased turbulence.

Door Operability

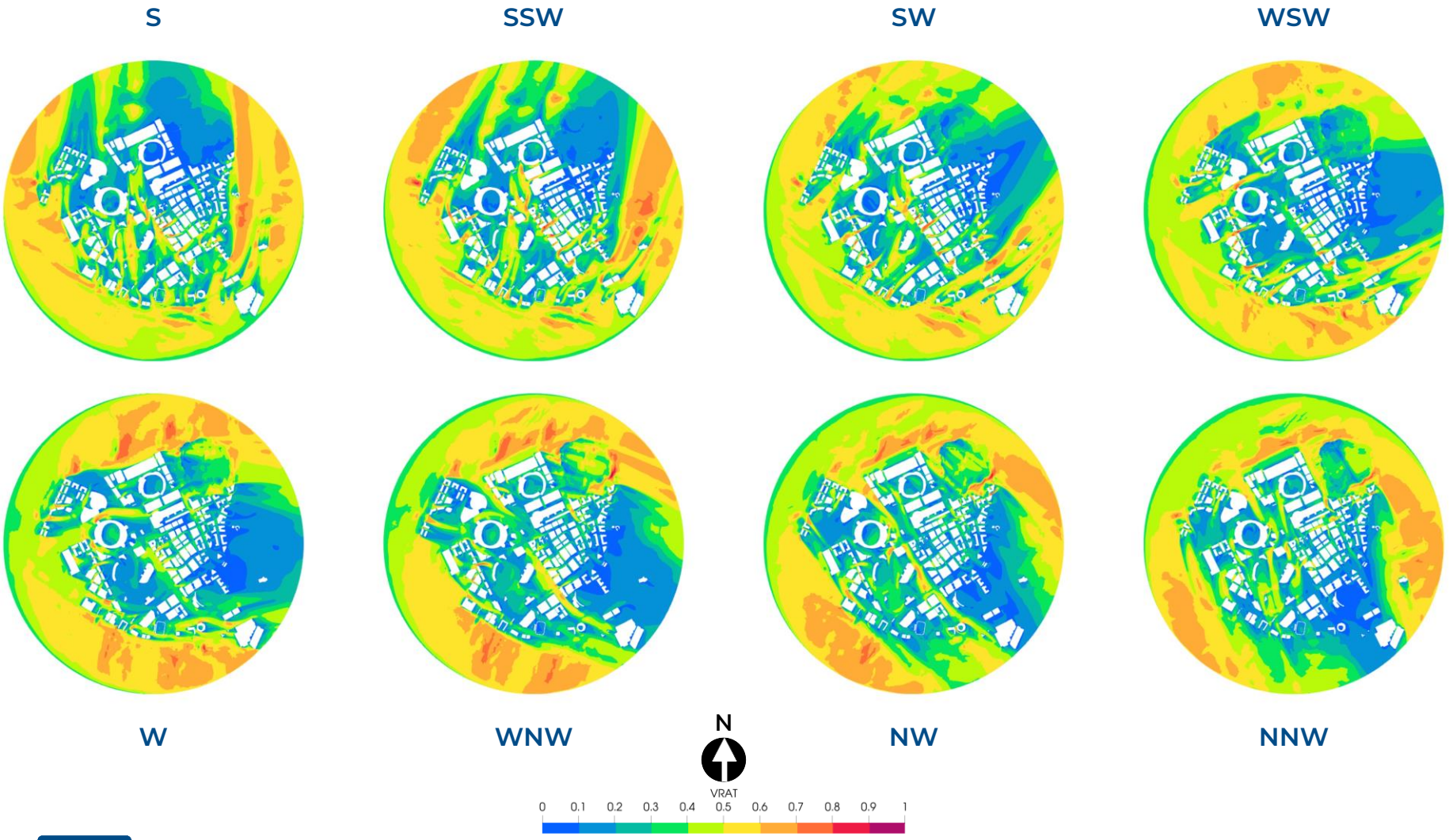


Doors which link areas of significantly different pressures (for example opposite sides of a building) can pose operability issues where they can be difficult to open or close sometimes during surprisingly calm conditions. Alternatively, they can flutter open despite robust door closers being installed. Wind screens and low external wind speeds do not mitigate against this issue, which is driven by the pressure field created by the building massing. Vestibules are the most effective mitigation.

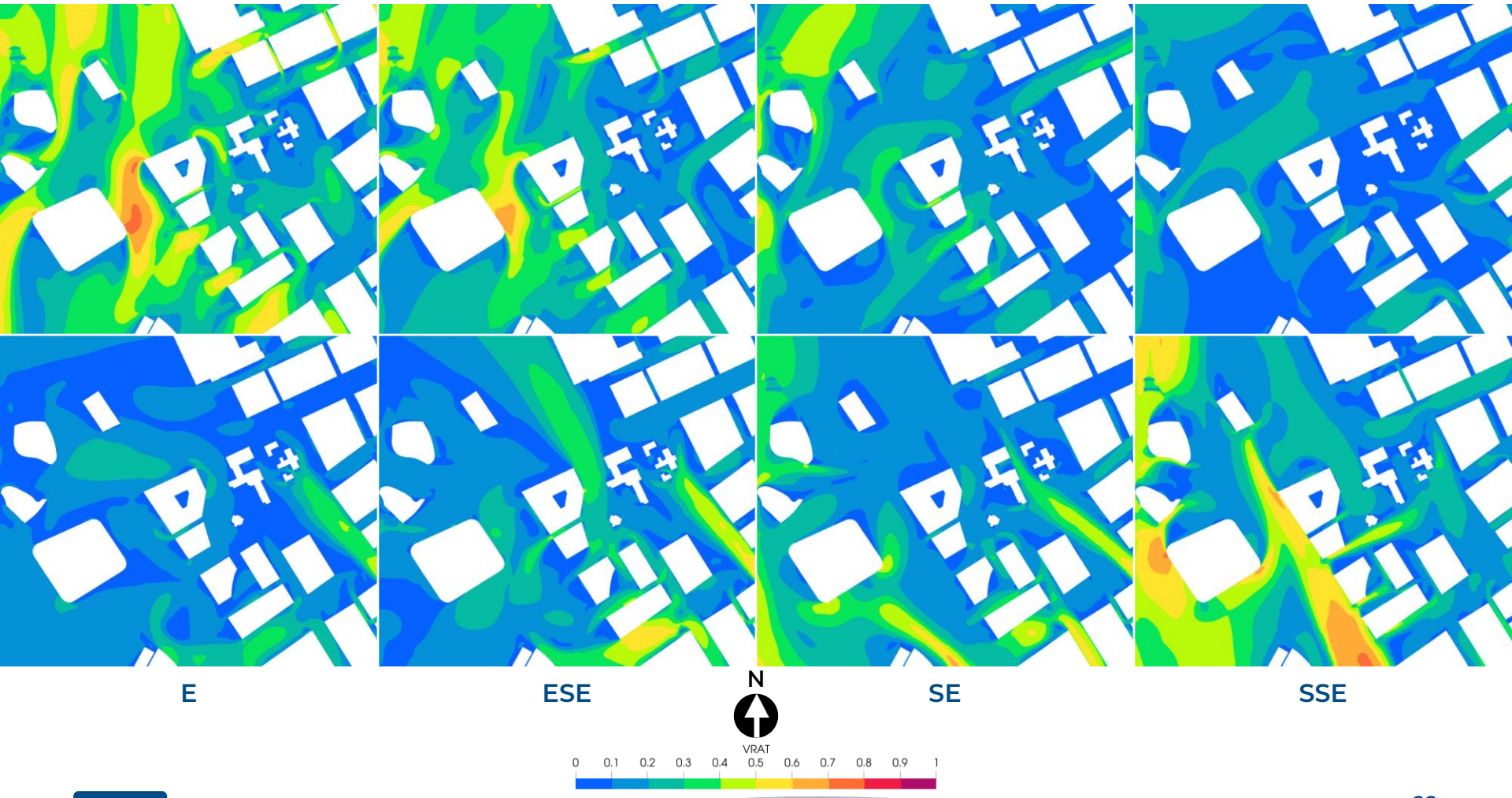
Velocity Ratios – Surrounding Area



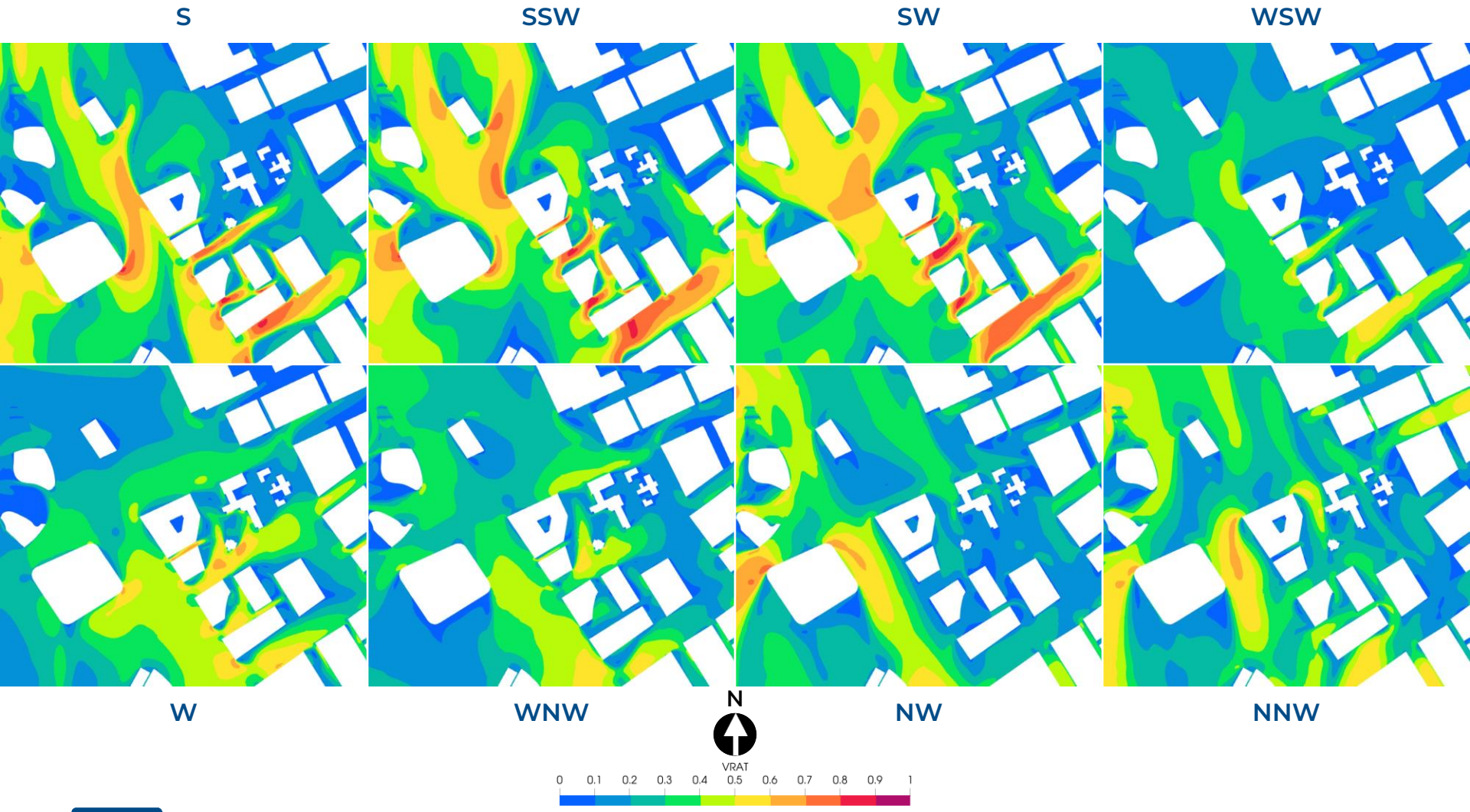
Velocity Ratios – Surrounding Area



Velocity Ratios – Centre Close-Ups



Velocity Ratios – Centre Close-Ups



Wind Climate and Site Roughness Corrections

Dir (°)	A	k	C (m/s)	$C_{ref,site}$ (m/s)	C_1 [1,2]	C_2 [1,2]	z_0 [1,2]
0	0.040	1.787	3.23	5.57	0	1	0.3
22.5	0.028	2.078	3.20	5.62	0	1	0.3
45	0.046	2.543	4.31	7.49	0	1	0.15
67.5	0.049	2.845	4.88	7.83	0	1	0.3
90	0.036	2.815	4.70	8.20	0	1	0.3
112.5	0.050	2.713	5.39	8.41	0	1	0.3
135	0.058	2.613	5.84	8.54	0	1	0.3
157.5	0.056	2.455	6.05	9.44	0	1	0.3
180	0.049	1.985	4.87	7.67	0	1	0.3
202.5	0.041	1.568	3.38	5.52	0	1	0.3
225	0.059	1.779	3.44	5.29	0	1	0.3
247.5	0.069	1.696	3.74	5.85	0	1	0.3
270	0.058	1.790	4.33	7.02	0	1	0.3
292.5	0.061	1.660	4.19	6.88	0	1	0.3
315	0.056	1.527	3.27	5.52	0	1	0.3
337.5	0.055	1.608	3.09	5.11	0	1	0.3

Probability of the wind speed v exceeding V m/s:

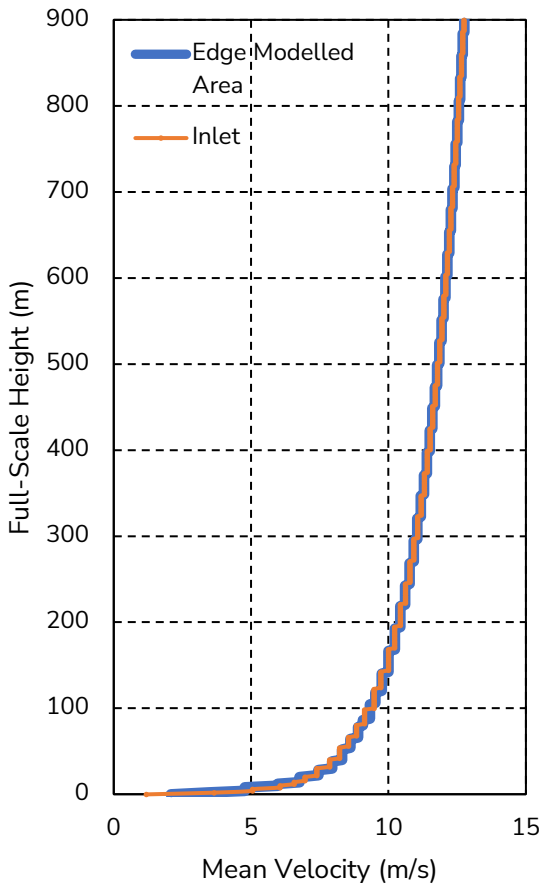
$$\Pr(v > V) = \sum_{1}^{16} A_i \exp\left[-\left(\frac{V}{C_{\text{ref,site},i} V_{r,i}}\right)^{k_i}\right]$$

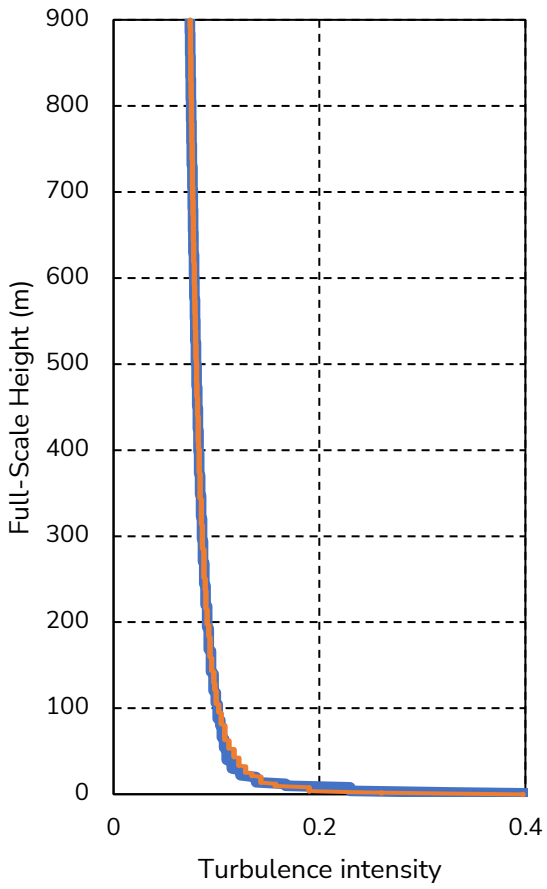
where V_r is the velocity ratio, as obtained from the CFD simulations.

H_{ref}	161 m
$\bar{V}_{\text{ref}}$	10 m/s

1. *American Society of Civil Engineers (2022), Wind Tunnel Testing for Buildings and Other Structures (ASCE/ SEI 49–21).*
2. *Yi Yang, Ming Gu, Suqin Chen, and Xinyang Jin. New inflow boundary conditions for modelling the neutral equilibrium atmospheric boundary layer in computational wind engineering. Journal of Wind Engineering and Industrial Aerodynamics,*

Atmospheric Boundary Layer Calibration



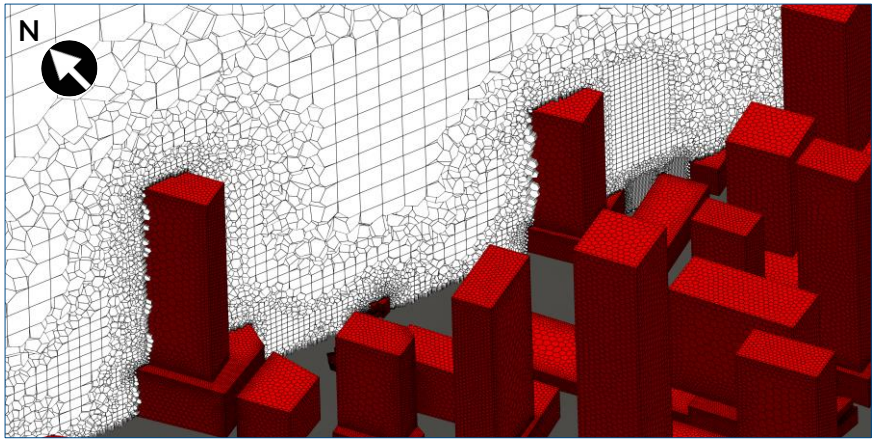


The left plot shows an example of the variation of wind speed with height on approach to the explicitly modelled area for a prevailing wind direction WSW, as required by ASCE 49[1] compared to the domain's inlet boundary condition.

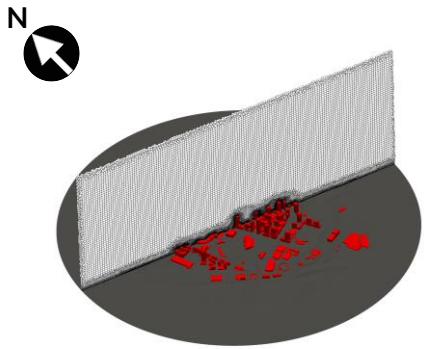
The right plot shows the variation of turbulence intensity with height. Turbulence kinetic energy does decay near the ground in this model. The sensitivity of the study conclusions and recommendations to this has been evaluated and is minor.

1-Richards and Hoxey (1993), Appropriate boundary conditions for computational wind engineering models using the k-ϵ turbulence model

CFD Mesh

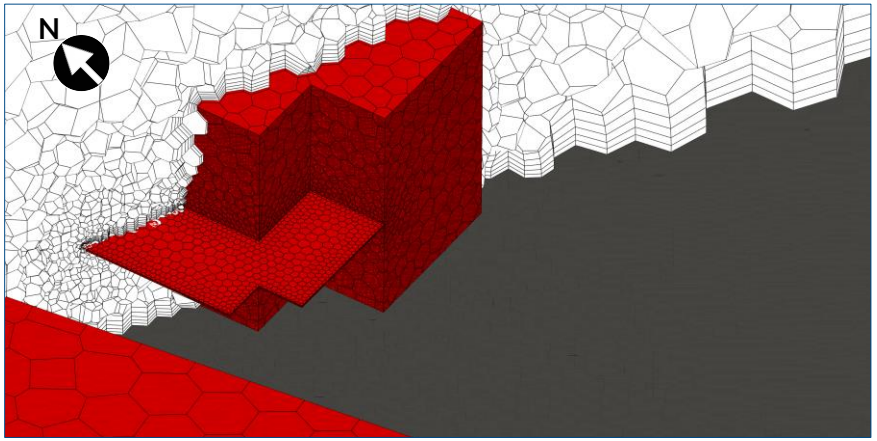


Volumetric Mesh showing refinement around building edges and areas of interest



Vertical Slice through northeast of the domain showing whole volume mesh

- Refined mesh resolution on areas around the site to capture the flow mechanisms in the areas of interest.
- Five inflation layers on all walls to adequately resolve near wall velocity gradients.



Volumetric mesh showing inflation layers on walls

Simulation Details

Numerics

- Wind directions: 16 equally spaced
- Turbulence model: Realizable k-epsilon (steady-state)
- Pressure and turbulence gradients: 2nd order blended
- Momentum divergence: 2nd order blended
- Pressure-velocity coupling: semi-implicit pressure linked equations
- Point monitors for convergence monitoring: 10
- Iterations for convergence: 2000

Atmospheric Boundary Layer

- Velocity profile follows a log-law with z_0 parameter derived from nearest local code profile category to predicted profile from ESDU roughness analysis[1]
- Turbulent kinetic energy constant with height[2]
- Turbulent dissipation rate derived[2] from turbulent kinetic energy and z_0.

Domain Geometry

- Sized for blockage ratio < 5 %
- Cylindrical domain
- Terrain gradually blended to a constant elevation beyond turntable to domain perimeter
- Distance from boundary conditions to modelled structures is at least the greatest of all combinations of 5H where H is each building height.

Mesh Resolution

Total cells: 29 million

- Ground:
  - Maximum lateral size: 5 m
  - Maximum vertical size: 0.6 m
  - Cells below 1.5 m: at least 3
- Street canyons and structures:
  - Cells across each dimension: at least 10 (min. 1 m in size)
  - Smaller features resolved with at least 3 cells

1 - ESDU 92032 (2010) "Computer program for wind speeds and turbulence properties: flat or hilly sites in terrain with roughness changes," Engineering Sciences Data Unit, London, UK.
2-Richards and Hoxey (1993), Appropriate boundary conditions for computational wind engineering models using the k-ϵ turbulence model.