

One Lord Street Wind Microclimate

Client: Linear Living Limited

Prepared by ArcAero

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Executive Summary

Wind microclimate studies assess how new developments alter local wind conditions. They estimate how often wind speeds at pedestrian level exceed thresholds for safety and comfort, helping to determine whether areas are suitable for their intended use, or if design changes are needed.

The One Lord Street development was assessed by ArcAero using Computational Fluid Dynamics (CFD) and the London Docklands Development Corporation (LDDC) variant of the Lawson criteria. The study predicts pedestrian wind conditions following the introduction of the proposed buildings and evaluates their suitability for public comfort and safety.

- The wind conditions at the existing site comply with the safety and comfort criteria for existing pedestrian activities.
- Following the introduction of the proposed development into the existing surrounds, wind conditions remain safe and largely comfortable for intended uses within and around the site.
- With the introduction of the cumulative developments, wind conditions within and around the site are entirely safe and comfortable for their intended use, with the exceedance on the terrace level fully resolved.

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1. Project Introduction

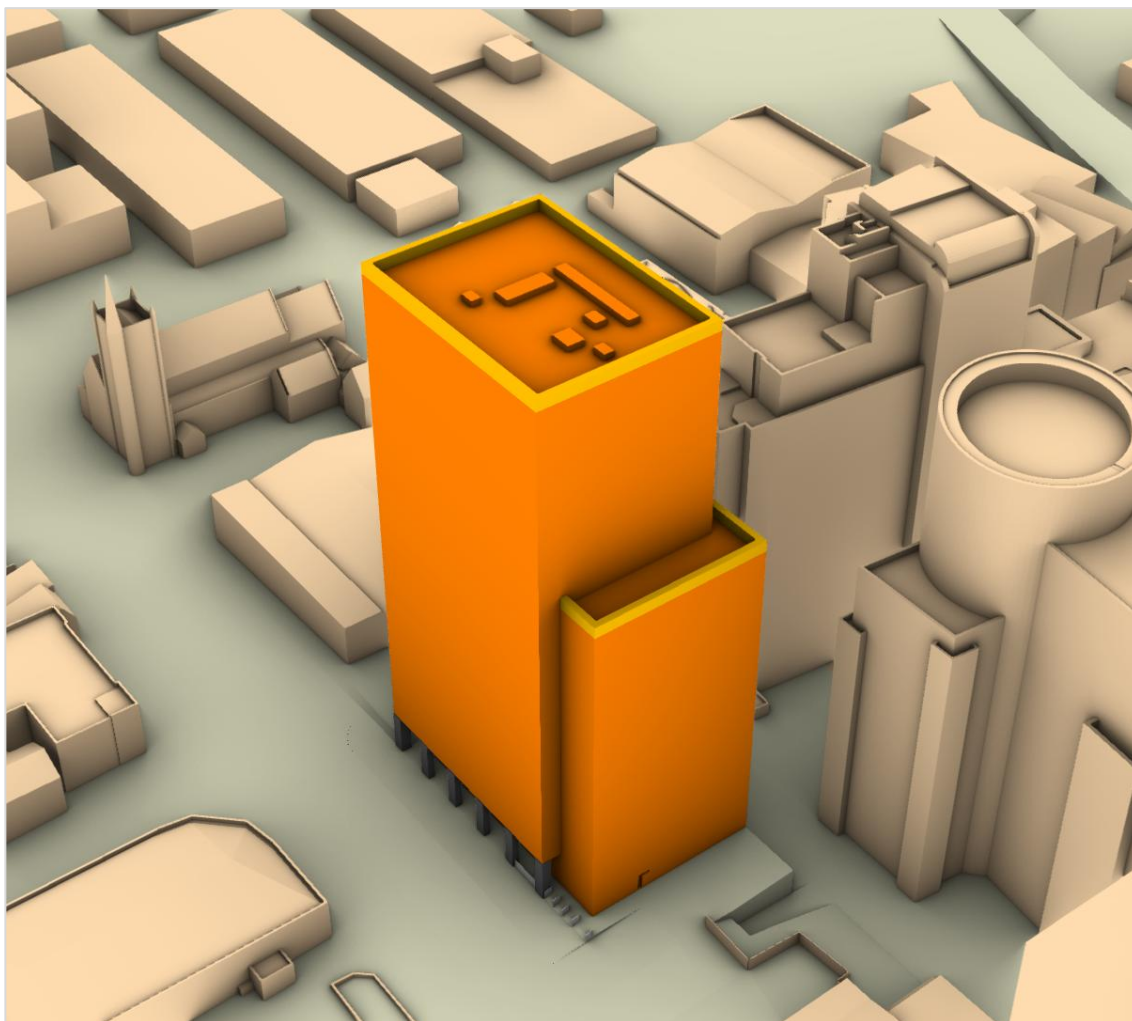


Figure 1: Representation of the proposed development

Overview

This report summarises the results of a CFD study, commissioned by Linear Living Limited, to assess the wind microclimate for the detailed proposals for the One Lord Street development in Manchester, UK.

The assessment focuses on pedestrian safety and comfort, with particular attention to entrances, walkways, seating areas, and outdoor amenity spaces, including elevated terraces.

Predictions have been made using Computational Fluid Dynamics (CFD), based on the Lawson (LDDC) criteria, refinement and planning compliance, ensuring that wind conditions are appropriate for the intended year-round use of public and private external spaces.

One Lord Street

The One Lord Street development site is bordered by Lord Street to the north, Fernie Street to the east, the Texaco petrol station to the south, and Cheetham Hill Road to the west.

Further afield, the development is largely characterized by medium to high rise developments to the east and northeast, with low-rise buildings more prevalent from southwest to north.

The proposed scheme comprises a 24-storey residential tower, reaching an approximate height of 76 meters, with a communal amenity terrace located on level 15.

Demolition of existing structures and erection of a residential apartment development comprising 251 no. dwellings (Use Class C3) with landscaping and associated works.

Digital models used in this study are based on project-specific drawing information, detailed in Appendix A.

2. Modelling Approach

CFD Methodology

Computational Fluid Dynamics (CFD) modelling was undertaken using a steady-state Reynolds-Averaged Navier-Stokes (RANS) approach. This method employs turbulence models to approximate the effect of wind gusts by predicting fluctuations about the mean wind speed.

Key aspects of the modelling setup include:

- The Shear Stress Transport (SST) $k-\omega$ turbulence model was used for its accuracy in near-wall regions and flow separation.
- All architectural features greater than 0.5 metres in scale were explicitly included in the model geometry.
- A refined mesh resolution was applied in critical areas, with cell sizes as small as 0.2 metres.
- At pedestrian level (1.5 metres height), a minimum of five vertical cell layers were used to accurately resolve ground-level wind conditions.
- 16 wind directions were assessed at 22.5° increments, capturing a full compass range of prevailing and secondary winds.

Mean wind speeds and gust-equivalent mean wind speeds were derived from the simulations, following accepted industry guidance. Analysis was carried out using the Lawson criteria (LDDC variant)^[1] for wind comfort and safety, in accordance with industry standard practice.

Further technical detail is provided in Appendix B.

Digital Model Domain

A detailed 3D model of the site and its surroundings was used for the CFD simulations. The study domain extended up to 460 m in all directions from the site, incorporating all existing and planned built forms or topographical features likely to influence airflow patterns.

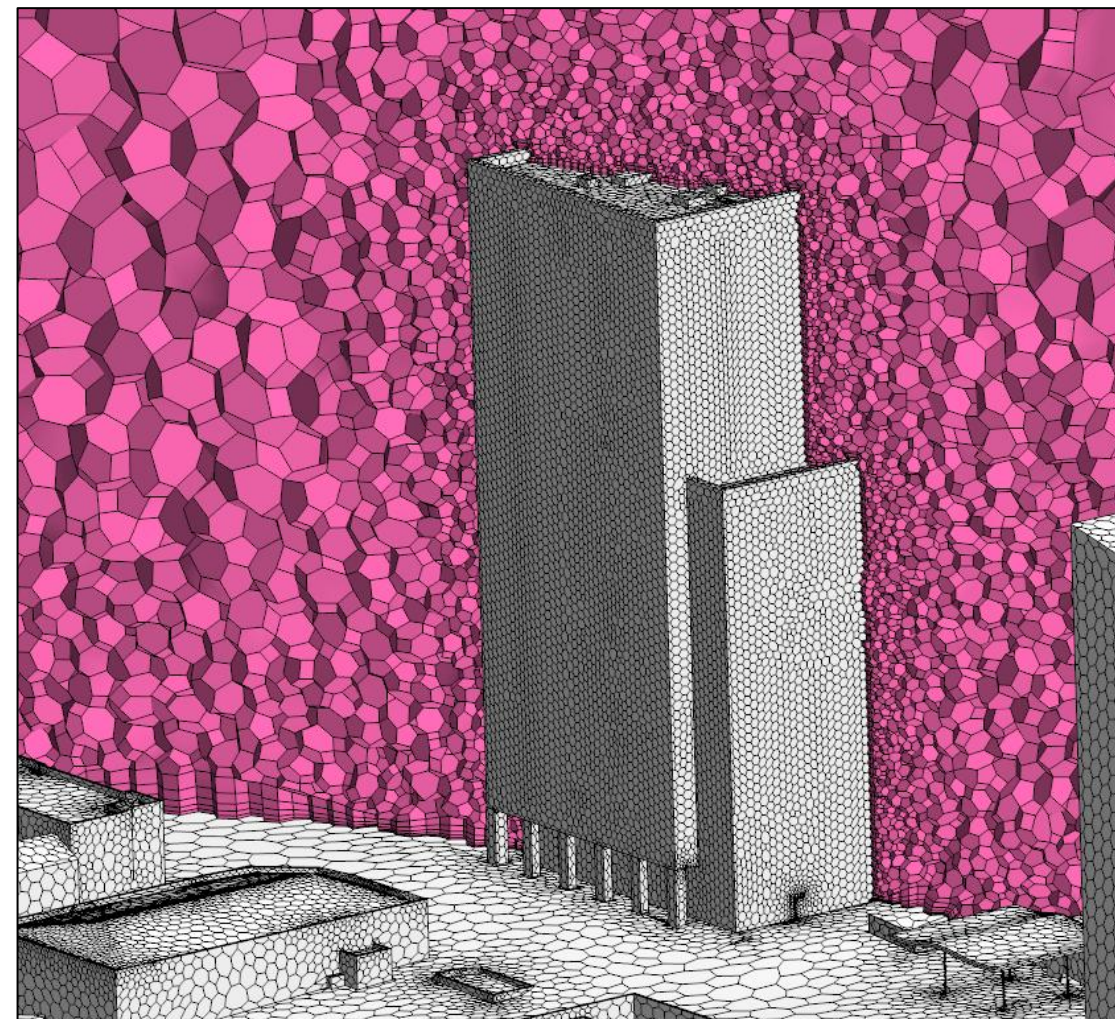


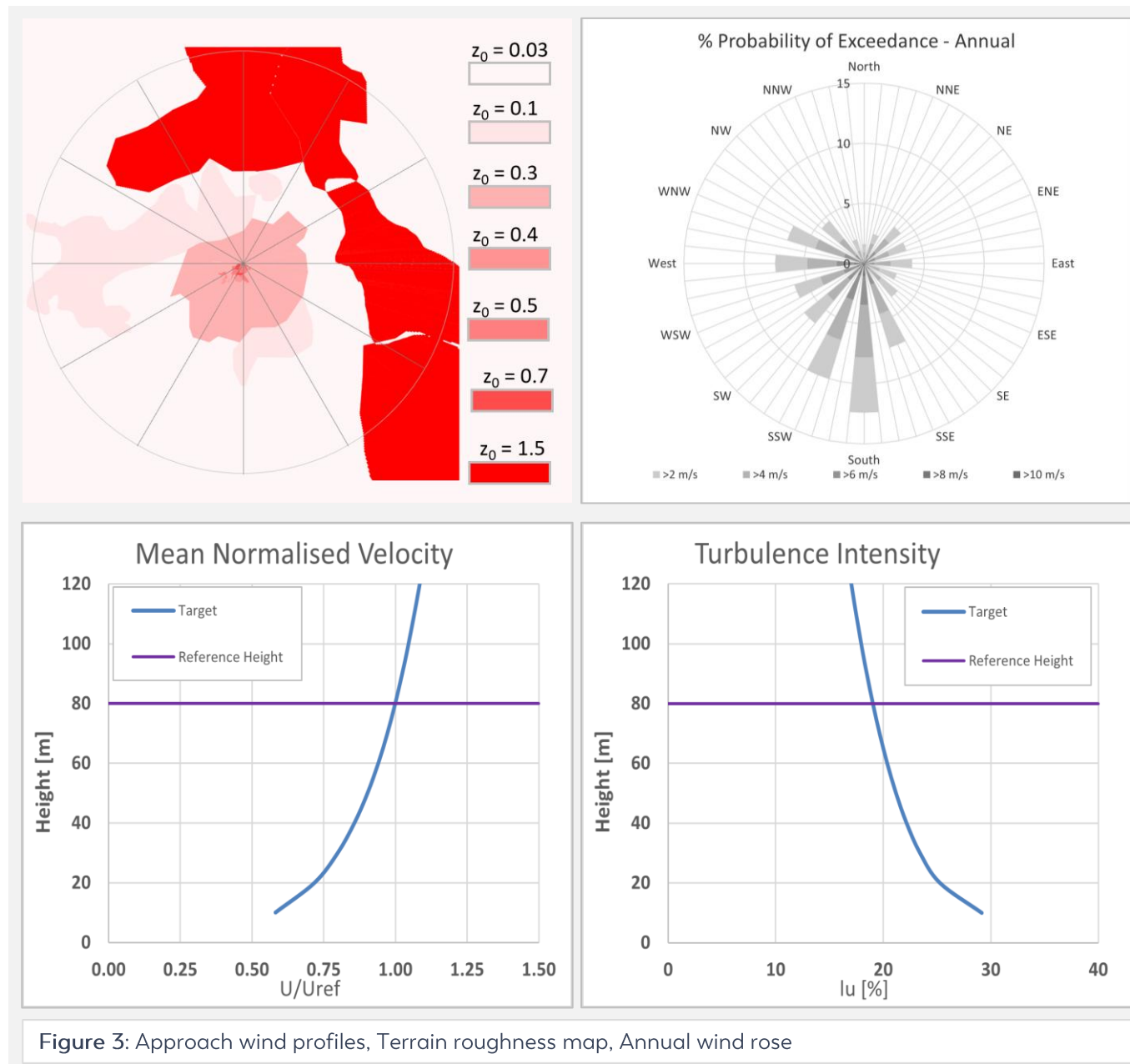
Figure 2: Computational mesh for CFD simulations

ABL & Wind Climate Data

Wind frequency and direction statistics were derived from long-term meteorological data obtained from Manchester Airport.

- Wind data was transposed to the site location and adjusted for local terrain roughness.
- The atmospheric boundary layer (ABL) and wind speed profiles were modelled using methods set out in ESDU Item 01008^[2], consistent with best industry practice for microclimate analysis.
- Seasonal variation in wind intensity and directional frequency was accounted for to distinguish worst-case winter safety conditions and seasonal comfort conditions.

ArcAero's terrain roughness assessment, resulting approach wind profiles and annual wind rose are presented in Figure 3.



3. Understanding Wind Comfort and Safety Criteria

The Lawson Criteria

Pedestrian wind conditions are assessed using the Lawson ‘LDDC’ criteria^[1], which define thresholds for safety, and separate comfort thresholds based on typical outdoor activities. These thresholds are compared against predicted wind speeds using long-term meteorological data.

For safety, a 15 m/s threshold is typically applied. Wind speeds exceeding this level more than once per year (~0.022% ≈ 2 hours per year) may destabilise vulnerable individuals and are considered a risk to pedestrian safety.

For comfort, wind speeds should not exceed activity-specific thresholds more than 5% of the time. Stricter criteria are applied in areas where pedestrians are expected to pause, wait, or linger, such as café seating, waiting areas, entrances, or playparks. In contrast, higher thresholds apply to routes where continuous movement is expected.

Comfort conditions are assessed seasonally:

- Worst-seasonal conditions are used to evaluate spaces with year-round use, such as entrances, footpaths, and through-routes. This ensures windiness is acceptable during the windiest part of the year, which typically occurs in winter, but sometimes in spring, or autumn.
- Summer amenity conditions are typically applied to seasonal-use areas, such as external seating terraces and roof gardens, using climate statistics for June, July and August.

Table 1 sets out the LDDC variant of the Lawson comfort criteria, with Figure 4 providing visual examples of the primary activities reflected.

Figure 4: Visual examples of typical outdoor activities



	Threshold Wind Speed (m/s)	Lawson Classification	Examples
	4	Long-term sitting	Bar / café
	6	Standing / short-term sitting	Bus stop, school pick-up point, playpark, viewing terrace
	8	Strolling	Residential routes, public realm, shopping streets
	10	Walking	Commuter routes, business district
	>10	Uncomfortable	Unsuitable for regular pedestrian use

Table 1: Lawson comfort criteria

4. Assessment Scenarios

The following scenarios have been modelled:

- i. Existing site conditions, Existing surrounding context (EinE)
- ii. Proposed development, Existing surrounding context (PinE)
- iii. Proposed development, Cumulative surrounding context (PinC)

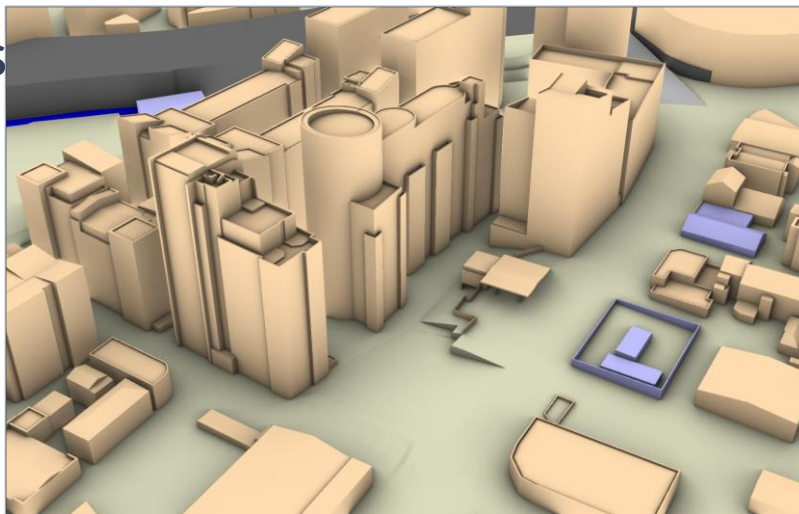


Figure 4.4.1:EinE Closeup from north



Figure 4.4.2:EinE Surrounds from north

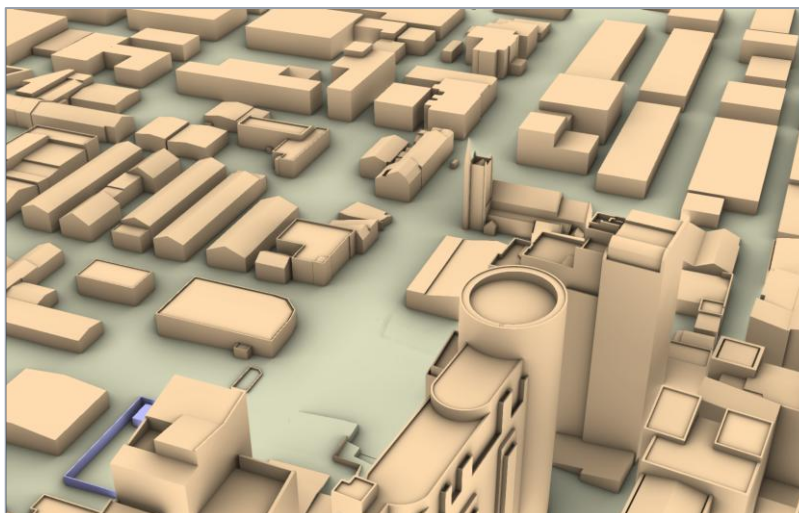


Figure 4.4.3:EinE Closeup from south

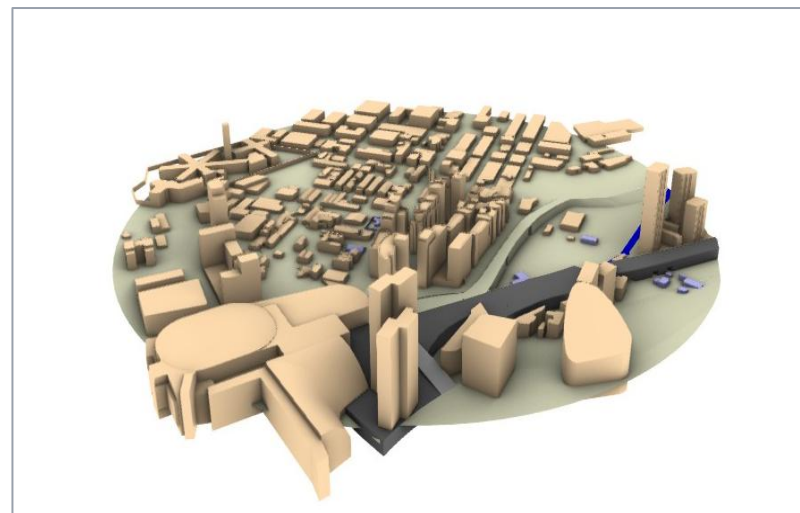


Figure 4.4.4:EinE Surrounds from south

The following scenarios have been modelled:

- i. Existing site conditions, Existing surrounding context (EinE)
- ii. Proposed development, Existing surrounding context (PinE)
- iii. Proposed development, Cumulative surrounding context (PinC)

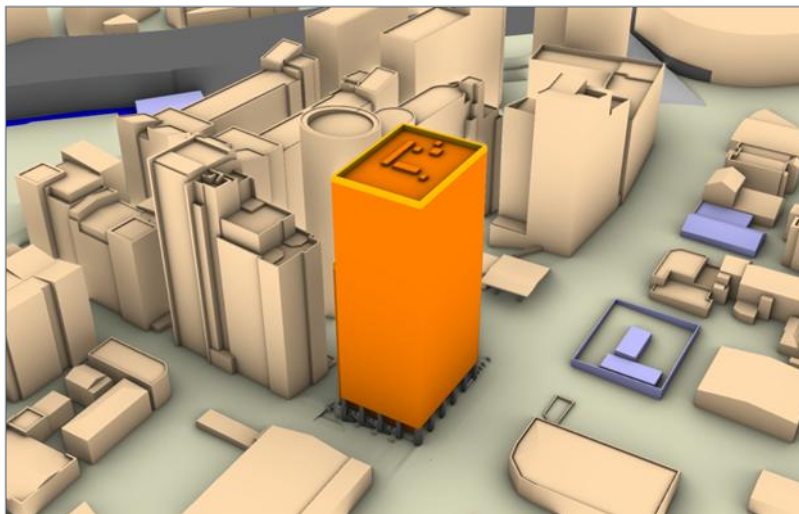


Figure 4.5.1:PinE Closeup from north

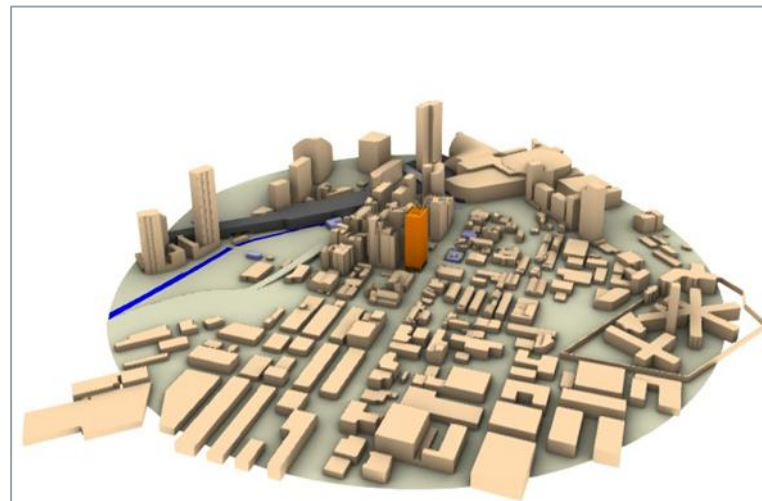


Figure 4.5.2:PinE Surrounds from north

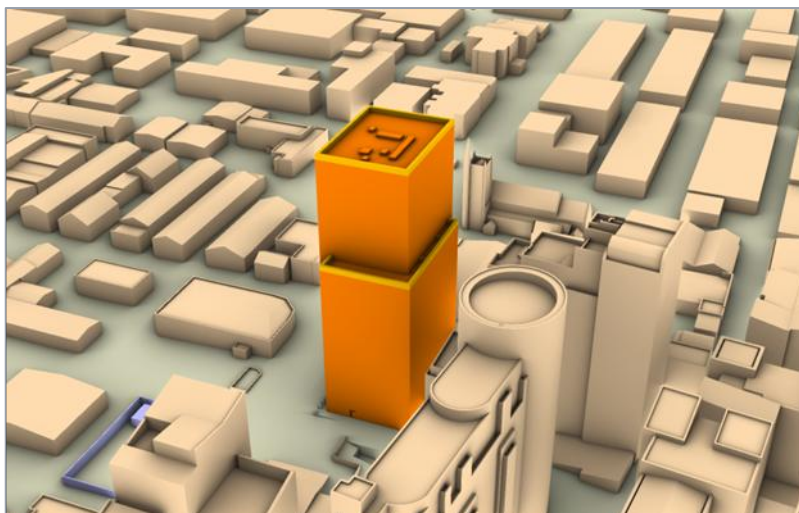


Figure 4.5.3:PinE Closeup from south



Figure 4.5.4:PinE Surrounds from south

The following scenarios have been modelled:

- i. Existing site conditions, Existing surrounding context (EinE)
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- iii. Proposed development, Cumulative surrounding context (PinC)

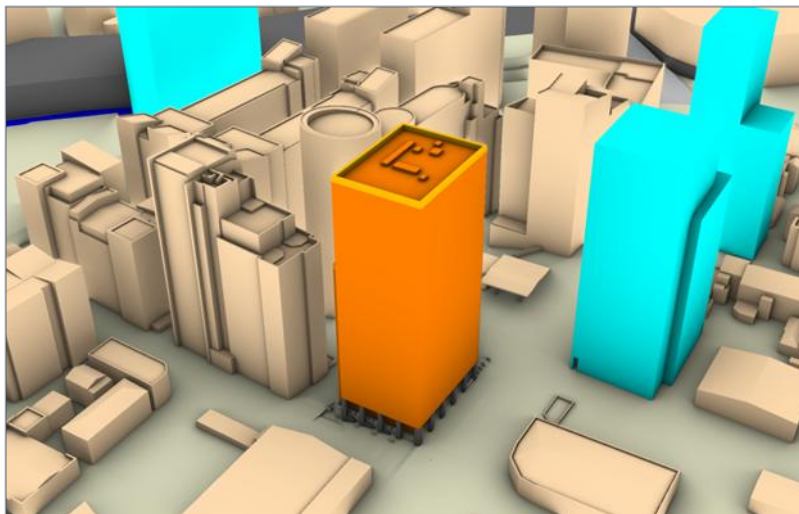


Figure 4.6.1:PinC Closeup from north

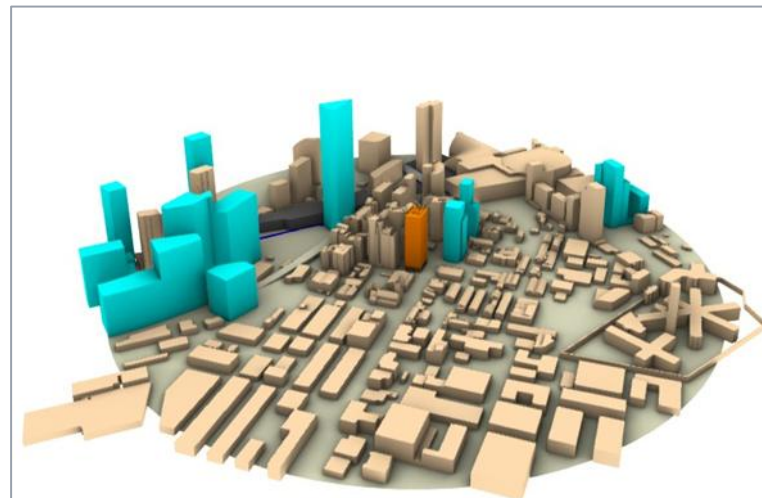


Figure 4.6.2:PinC Surrounds from north



Figure 4.6.3:PinC Closeup from south

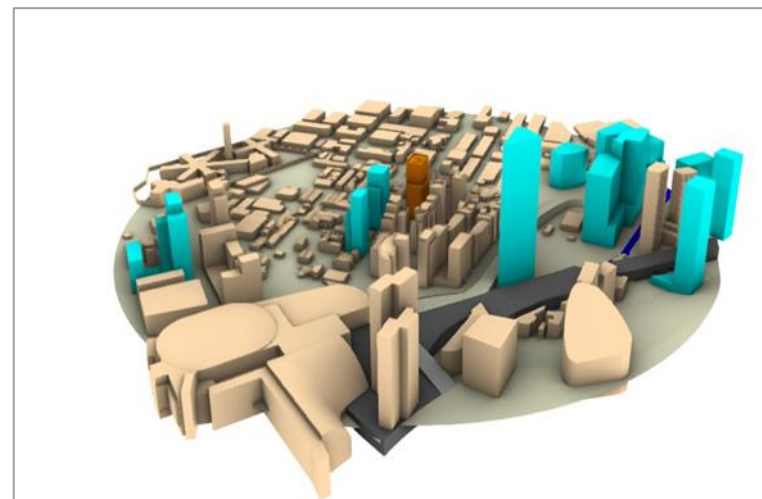


Figure 4.6.4:PinC Surrounds from south

Modelling of Nearby Developments With Planning Consent

Several cumulative schemes have been included in the assessment. These are presented visually in Figure 5 and in tabular format in Table 2.

Developments with planning consent that are substantially under construction have been treated as existing and included within the existing surrounds scenario. These are detailed in Table 3.

Cumulative schemes that fall outside the study radius and are therefore excluded from all modelled scenarios are listed in Table 4.

Table 2: Cumulative developments		
Number	Development Name	Planning Reference
1	Land bounded by the Travelodge and surface level carparking to the north, further surface level carparking to the east, Manchester College to the south and Bury New Road to the west, Manchester	137941/FO/2023
2	Red Bank Victoria	136812/OO/2023 136814/FO/2023
3	Land at 33 - 41 Cheetham Hill Road Manchester M4 4FT	138696/FO/2023
4	1 Park Place Manchester M4 4EZ	138302/FO/2023
5	Angel Meadows	116366/FO/2017

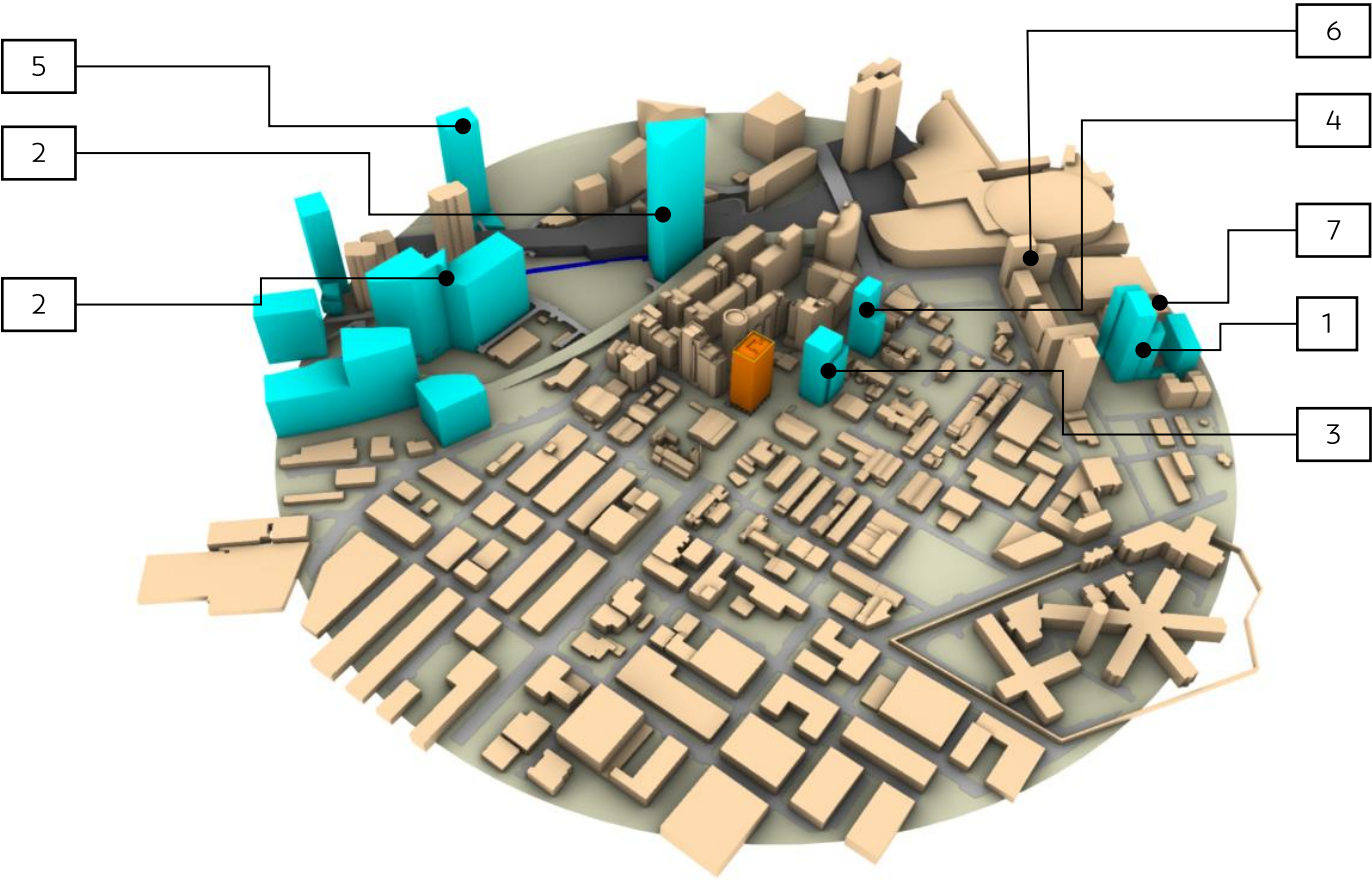


Figure 5: Cumulative developments

Table 3: Built or under-construction cumulative sites treated as existing

Number	Development Name	Planning Reference
6	Former Boddingtons Brewery Site Dutton Street Manchester M3 1LE	118831/FO/2018
7	Manchester College	136492/FO/2023

Table 4: Cumulative schemes beyond the modelling extent

Number	Development Name	Planning Reference
8	Land Bounded By Great Ducie Street And Mirabel Street Manchester M3 1PJ	122280/FO/2019
9	Land Adjacent To The Junction Of Fairy Lane And Bury New Road Manchester	128359/OO/2020
10	Land Bound By Greengate, Collier Street, Queen And King Street And Gravel Lane , M3 7BN	22/80890/REM
11	Land Corner New Bridge Street And, Greengate, Salford	19/74205/FULEIA

5. Results

Pedestrian Uses

Assessments of this nature predict the proportion of time an area will experience wind speeds in excess of threshold values associated with comfortable use once the development is introduced. It is therefore important to have an adequate understanding of the expected uses of the various areas in & around the site.

For the current study, anticipated pedestrian uses are presented graphically in Figure 6.

Results

Results are presented as follows, for safety, worst-seasonal comfort and summertime comfort respectively, at ground level, plus summertime comfort above ground:

- Existing site conditions , Existing surrounding context (EinE) – Figures 7-9
- Proposed development, Existing surrounding context (PinE) – Figures 10-14
- Proposed development, Cumulative surrounding context (PinC) – Figures 15-19

	General Movement
	Primary Entrances
	Townhouse Entrances
	Maintenance Entrances/Exit

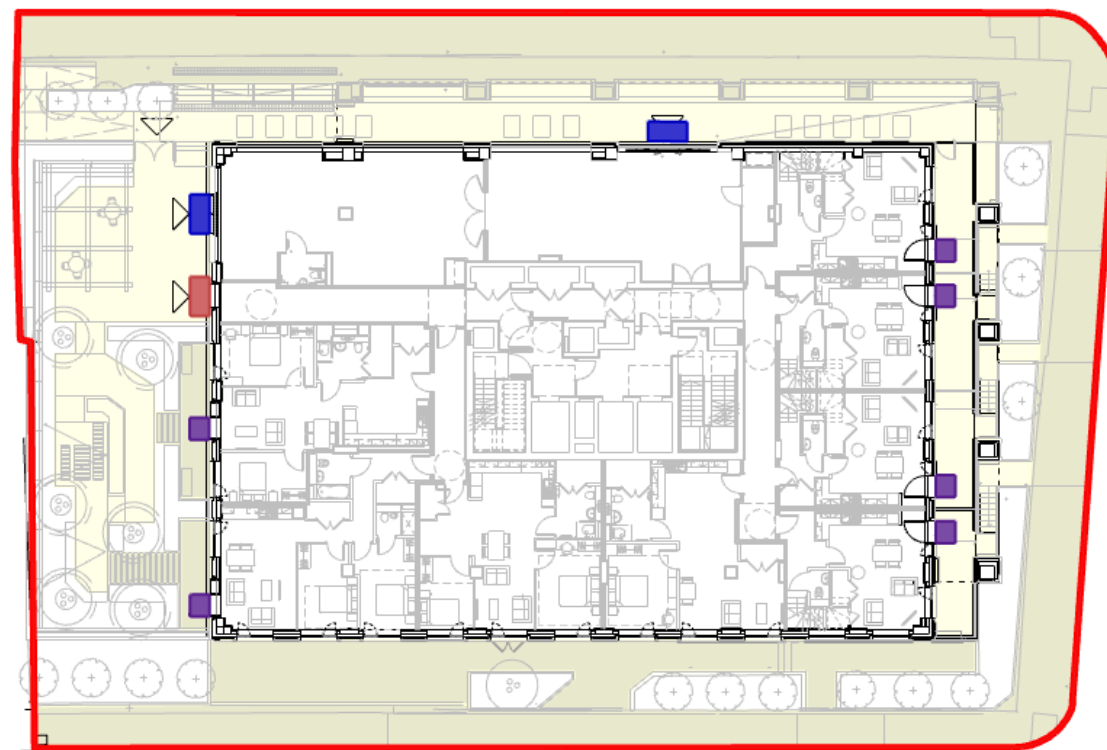


Figure 6: Site wide pedestrian uses

Safety | EinE | Ground

- Wind conditions within and around the existing site satisfy the criteria for pedestrian safety.



Figure 7: Safety | EinE | Ground

Worst-Seasonal Comfort | EinE | Ground

- Wind conditions within the site and immediate surrounding areas are generally suitable for at least short-term standing or sitting, with a small area of strolling conditions to the northeast of the site.
- Thus, wind conditions within and around the site are suitable for their intended uses, including at entrances and along thoroughfares.

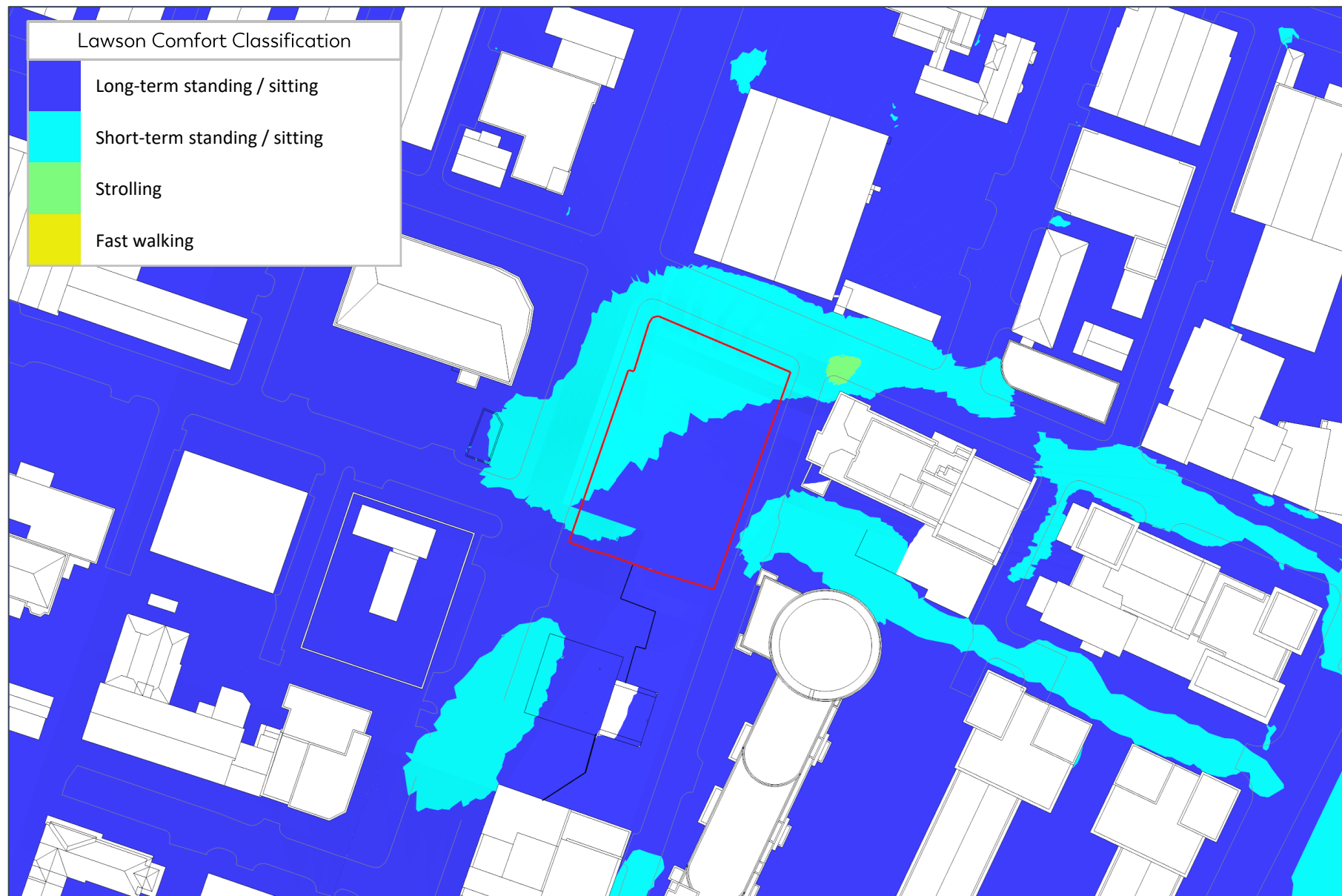
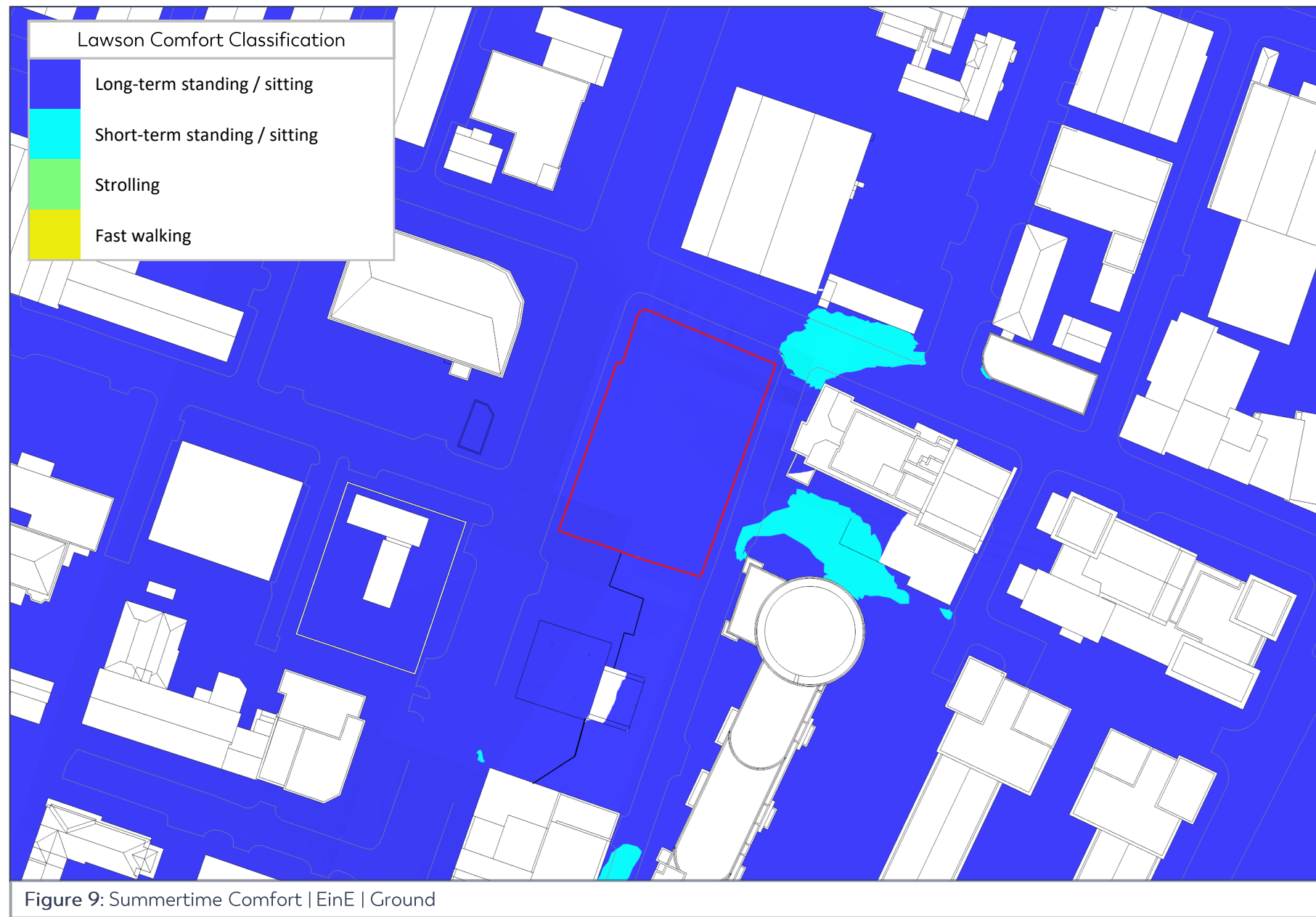


Figure 8: Worst-Seasonal Comfort | EinE | Ground

Summertime Comfort | EinE | Ground

- Wind conditions within the site and the immediate surrounding areas are suitable for at least short-term standing or better.



Safety | PinE | Ground

- Following the introduction of the proposed development, wind conditions within the site and immediate surrounds satisfy the Lawson safety criteria.



Figure 10: Safety | PinE | Ground

Safety | PinE | Terrace

- The wind conditions at the level 16 communal terrace satisfy the Lawson safety criteria.

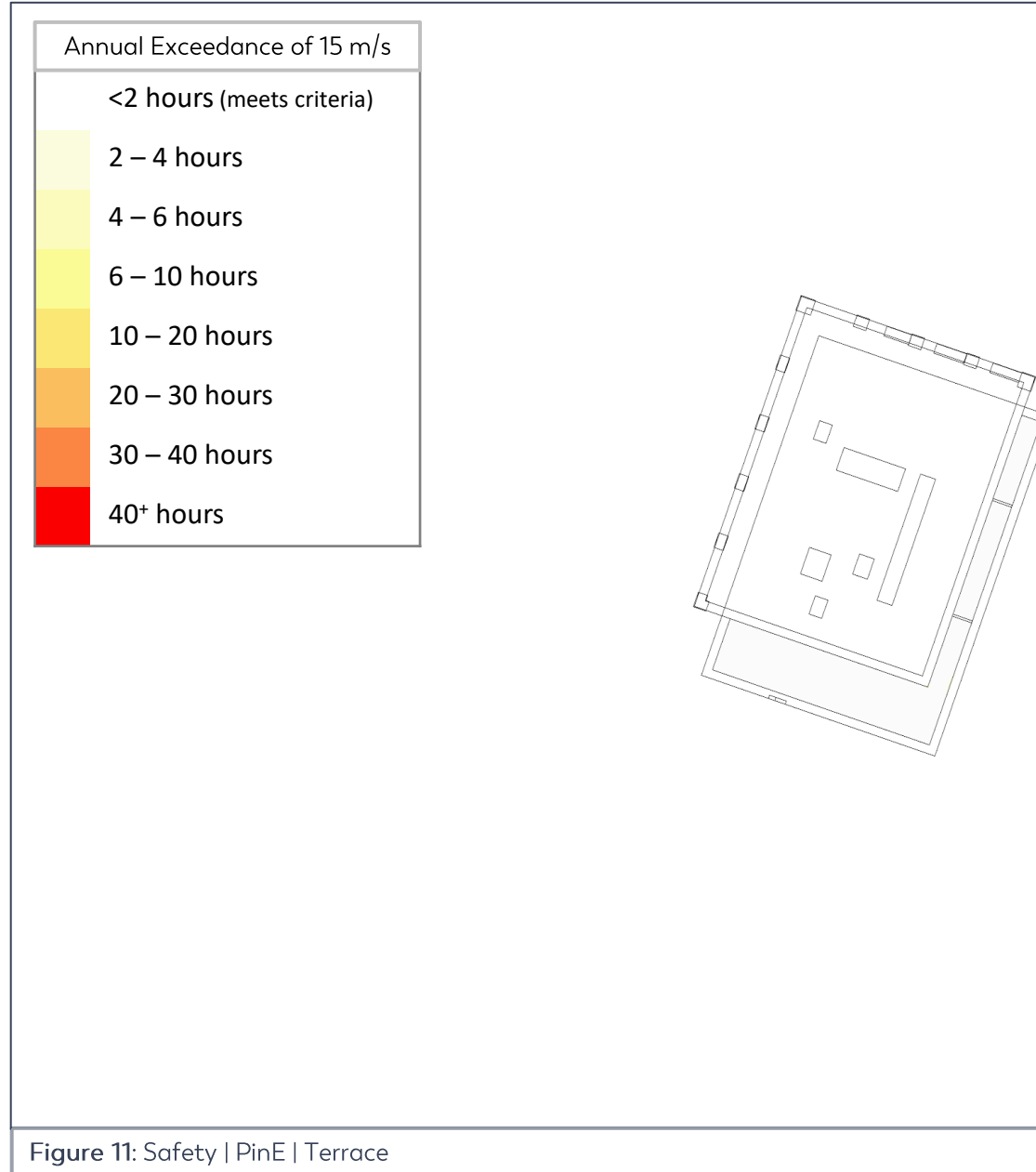


Figure 11: Safety | PinE | Terrace

Worst-Seasonal Comfort | PinE | Ground

- The wind conditions within the site are generally suitable for at least short-term standing / sitting at ground level.
- Wind conditions at the entrances leading into the proposed development are suitable for at least short-term sitting / standing throughout the year and therefore are comfortable for pedestrian ingress and egress.
- Wind conditions on thoroughfares within the site remain suitable for pedestrian strolling or better and are thus comfortable for pedestrian access to and passage through the site.
- Within the surrounding areas, wind conditions remain generally suitable for at least strolling or better all year round. Thus, wind conditions at all entrances and thoroughfares within the surrounding area remain comfortable for their intended uses.

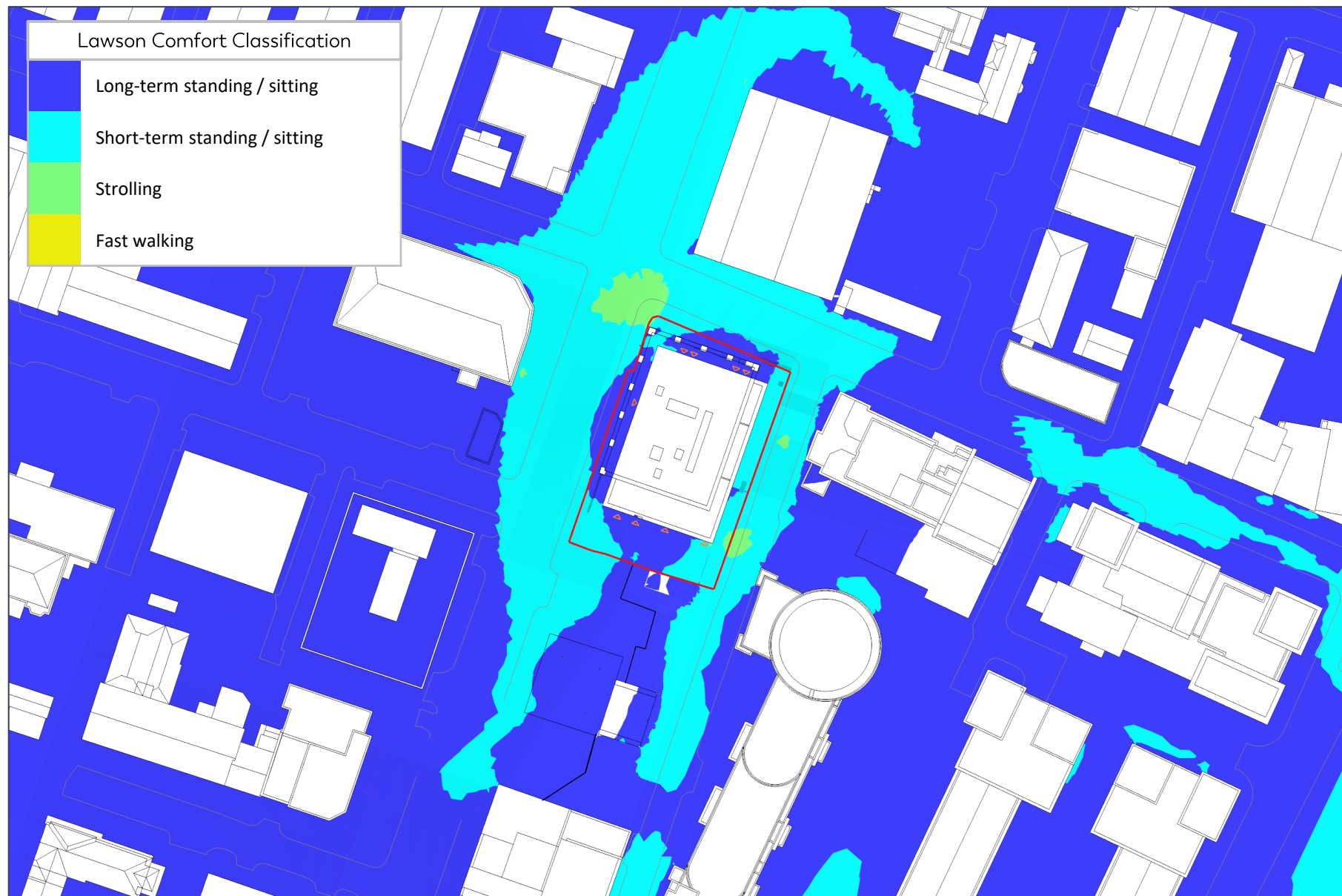


Figure 12: Worst-Seasonal Comfort | PinE | Ground

Summertime Comfort | PinE | Ground

- The wind conditions within the site and around its immediate surrounds are suitable for at least short-term standing / sitting.

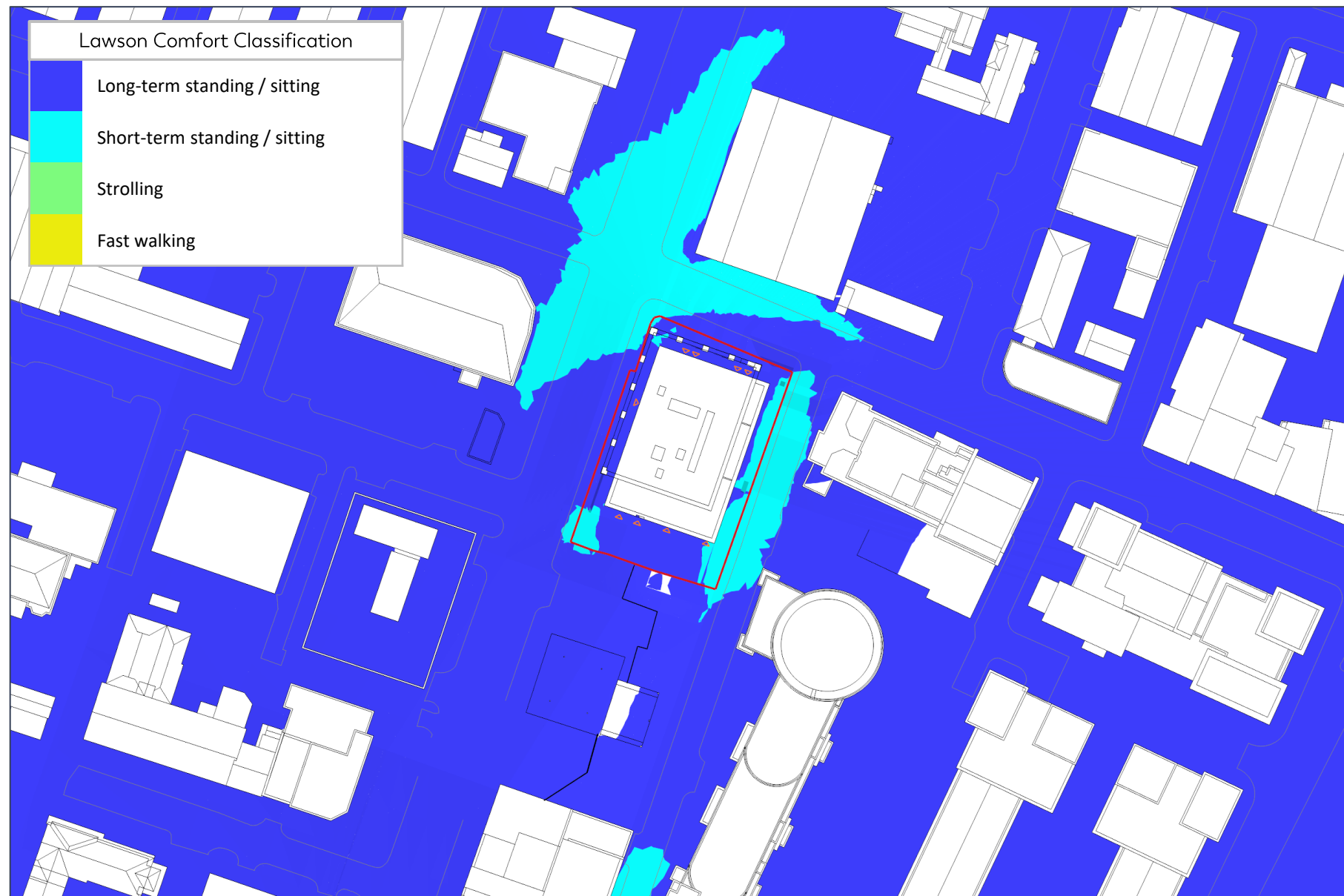
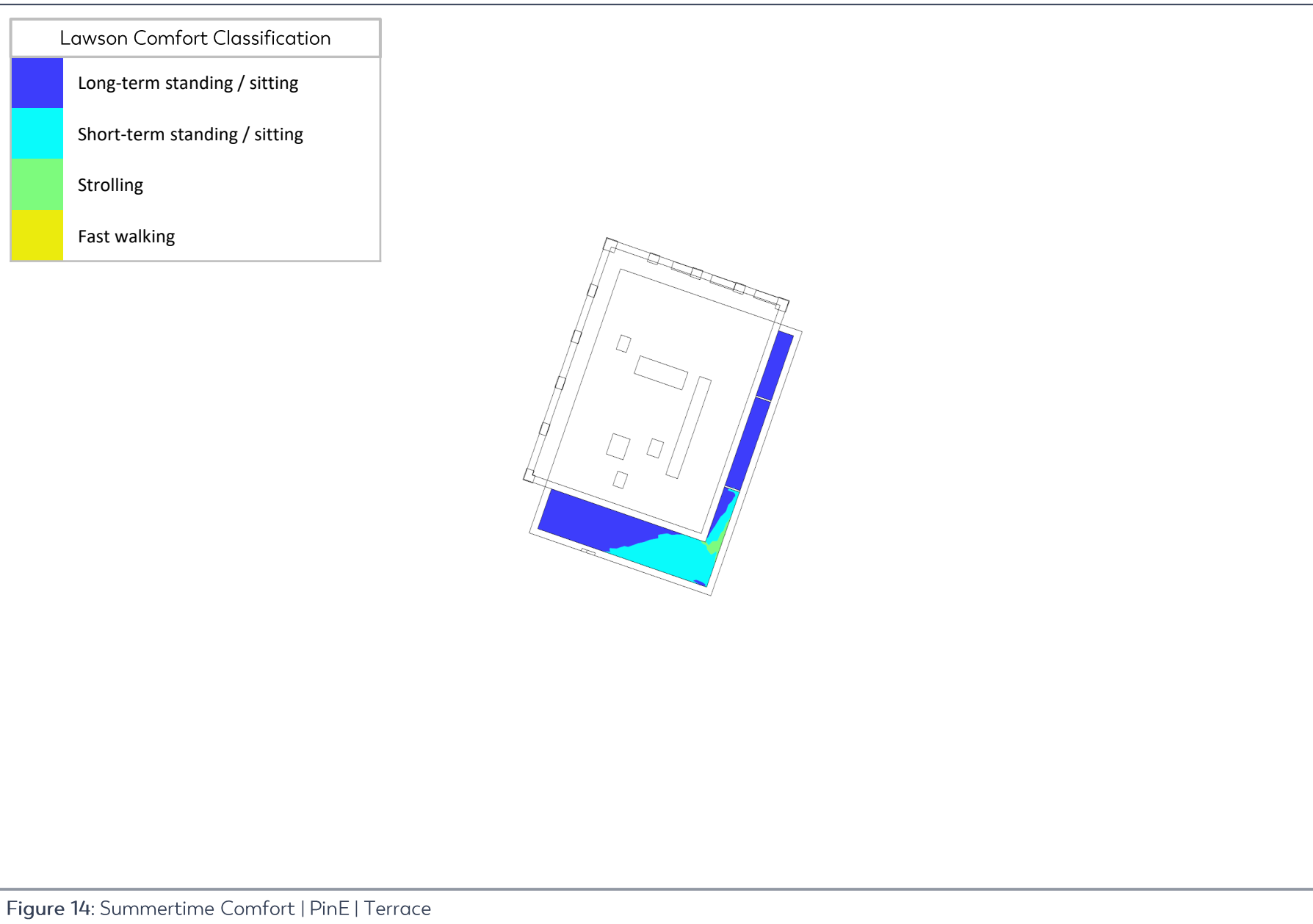


Figure 13: Summertime Comfort | PinE | Ground

Summertime Comfort | PinE | Terrace

- The wind conditions at the terrace are generally suitable for short-term standing / sitting or better with a large portion of long-term standing/sitting.
- Typical features, such as benches and planting would likely further improve conditions predicted.



Safety | PinC | Ground

- Upon the introduction of the cumulative surrounds, the wind conditions within the site and immediate surrounds satisfy the Lawson safety criteria.

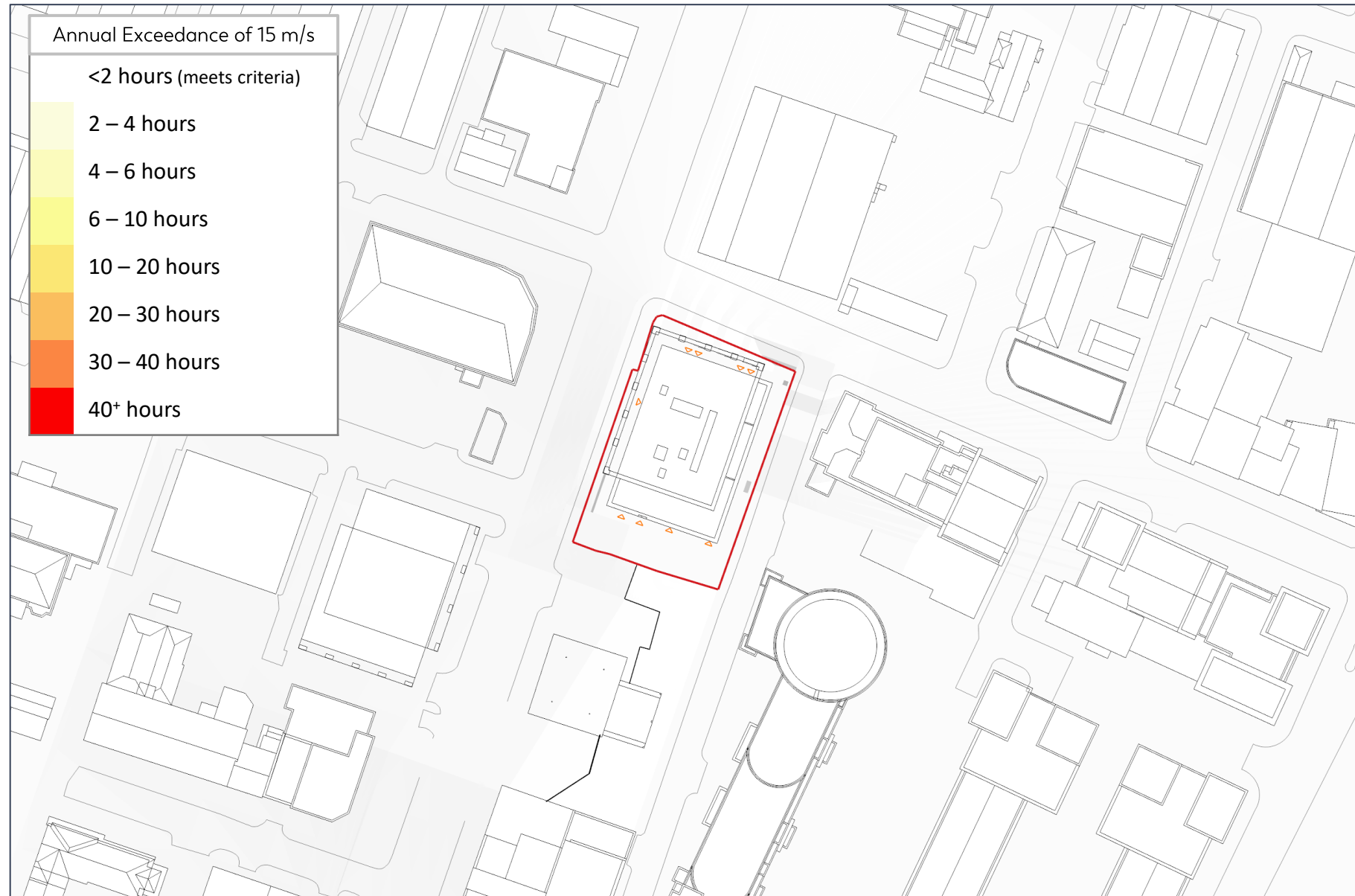


Figure 15: Safety | PinC | Ground

Safety | PinC | Terrace

- The wind conditions at the terrace satisfy the Lawson safety criteria.

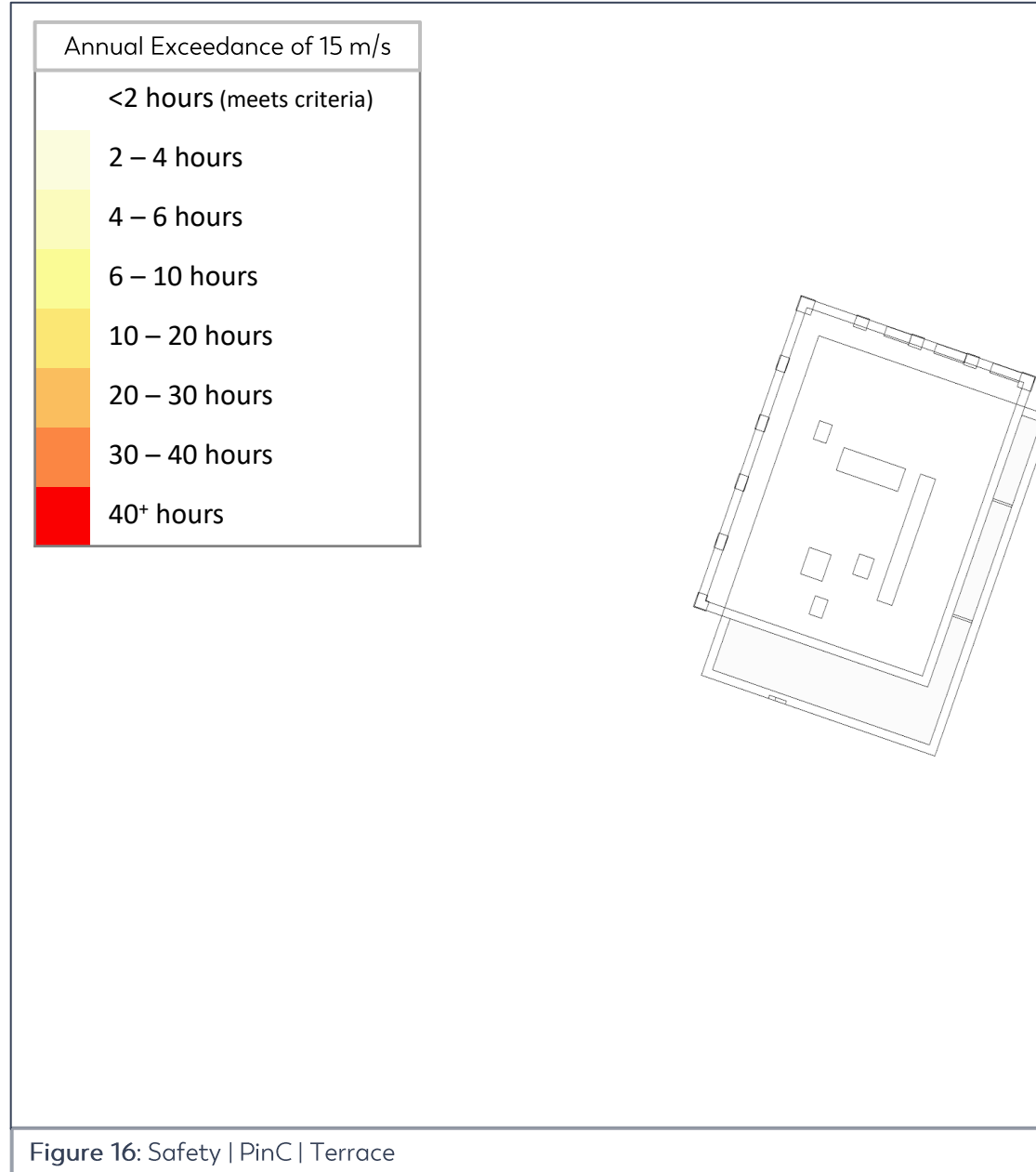


Figure 16: Safety | PinC | Terrace

Worst-Seasonal Comfort | PinC | Ground

- Upon the introduction of the cumulative surrounds, wind conditions are materially similar to the existing surrounds scenario.
- Thus, conclusions drawn from the proposed development within existing surrounds scenario for worst-seasonal comfort are equally applicable to the cumulative surrounds scenario.

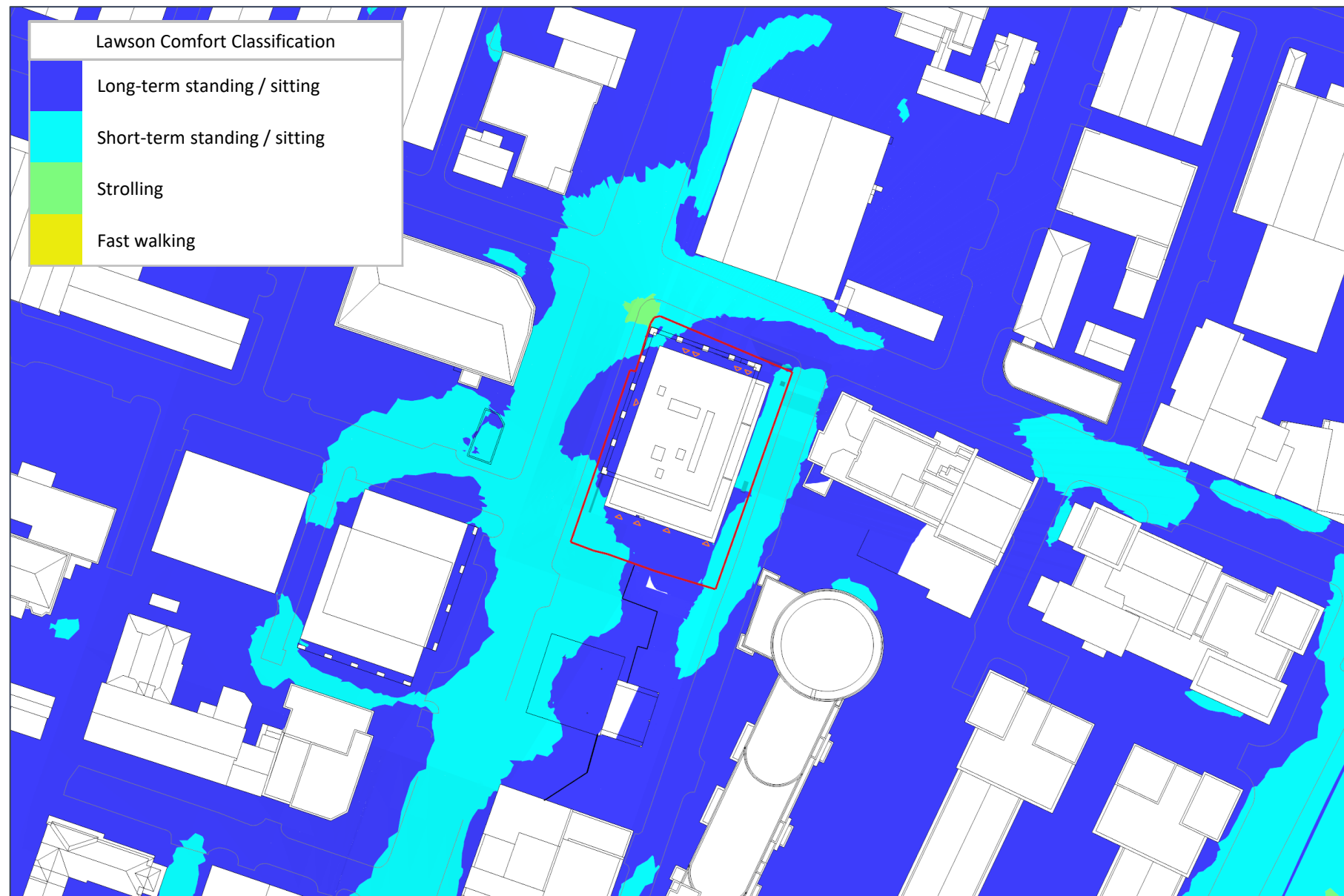


Figure 17: Worst-Seasonal Comfort | PinC | Ground

Summertime Comfort | PinC | Ground

- With the inclusion of the cumulative surrounding developments, the wind conditions do not materially change when compared to the existing surrounds scenario.

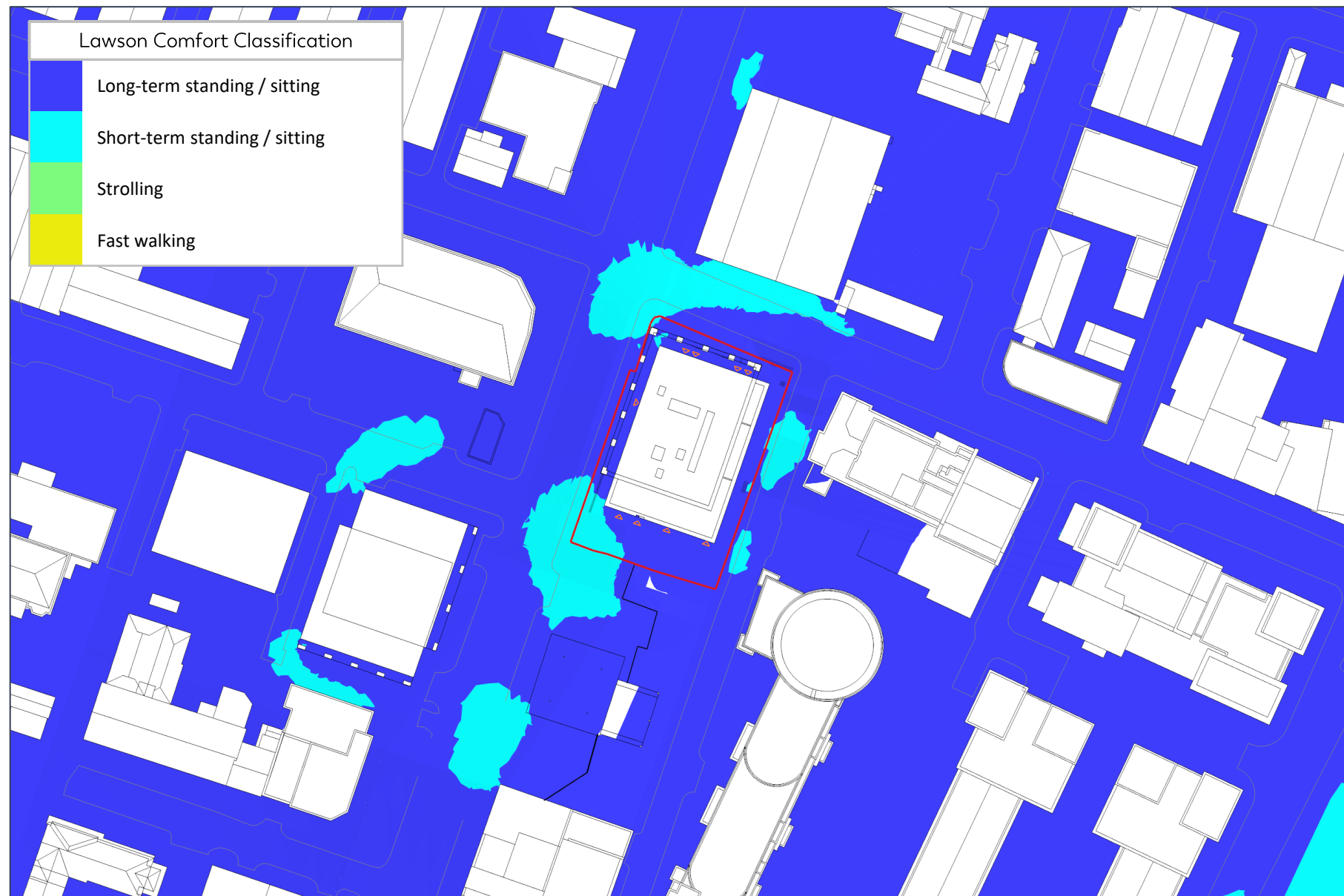
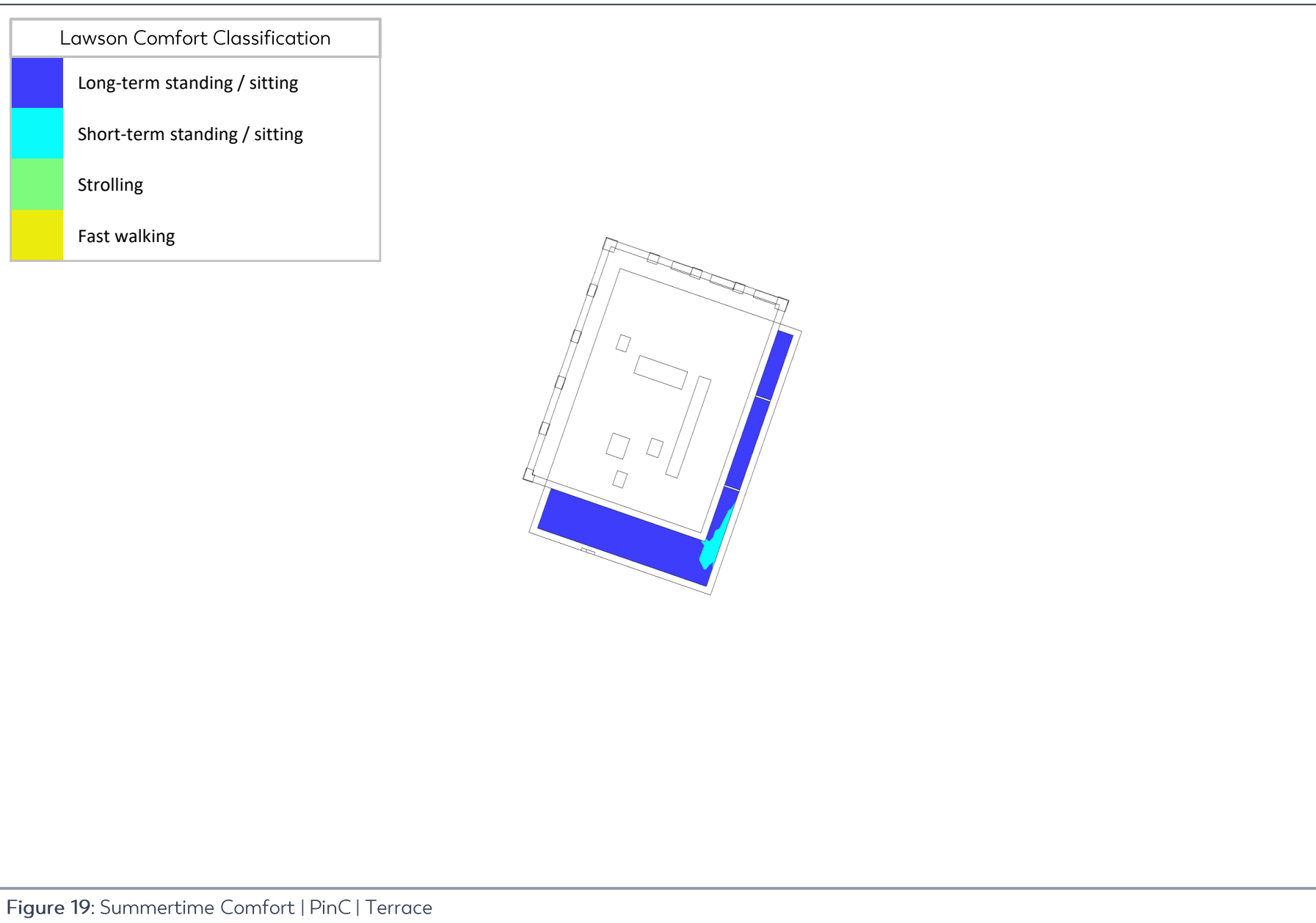


Figure 18: Summertime Comfort | PinC | Ground

Summertime Comfort | PinC | Terrace

- With the introduction of the cumulative surrounding developments, wind conditions at the terrace have improved and are now suitable for short-term standing / sitting or better.
- Thus, the terrace is suitable for recreational use during the summer.



6. Conclusions

Wind microclimate studies assess how new developments alter local wind conditions. They estimate how often wind speeds at pedestrian level exceed thresholds for safety and comfort, helping to determine whether areas are suitable for their intended use, or if design changes are needed.

The One Lord Street development was assessed by ArcAero using Computational Fluid Dynamics (CFD) and the Lawson criteria. The study predicts pedestrian wind conditions following the introduction of the proposed buildings and evaluates their suitability for public comfort and safety.

- The wind conditions at the existing site comply with the safety and comfort criteria for existing pedestrian activities.
- Following the introduction of the proposed development into the existing surrounds, wind conditions remain safe and largely comfortable for intended uses within and around the site.
- With the introduction of the cumulative developments, wind conditions within and around the site are entirely safe and comfortable for their intended use, with the exceedance on the terrace level fully resolved.

7. References

- [1] Lawson, T.V. The determination of the wind environment of a building complex before construction. Bristol : University of Bristol, Department of Aeronautical Engineering, 1990.
- [2] ESDU (Engineering Science Data Unit). Item 01008. Computer Program for wind speeds and turbulence properties: flat or hilly sites in terrain with roughness. 2001.
- [3] F, Menter. Zonal Two Equation $k-\omega$ Turbulence Models for Aerodynamic Flows. 1993. AIAA Paper 93-2906.
- [4] F, Menter. Turbulence Modelling for Engineering Flows. s.l. : ANSYS Inc., 2011.
- [5] Richards, P.J. and Hoxey, R.P. Appropriate boundary conditions for computational wind engineering models using the $k-\epsilon$ turbulence model. s.l. : Journal of Wind Engineering and Industrial Aerodynamics, 1993. vol. 46 & 47, pg. 145 - 153.
- [6] Blocken, B. and Carmeliet, J. Pedestrian wind environment around buildings: Literature review and practical examples. s.l. : Journal of Thermal Envelope and Building Science, 2004.

Appendix A: Preparation of Digital Models

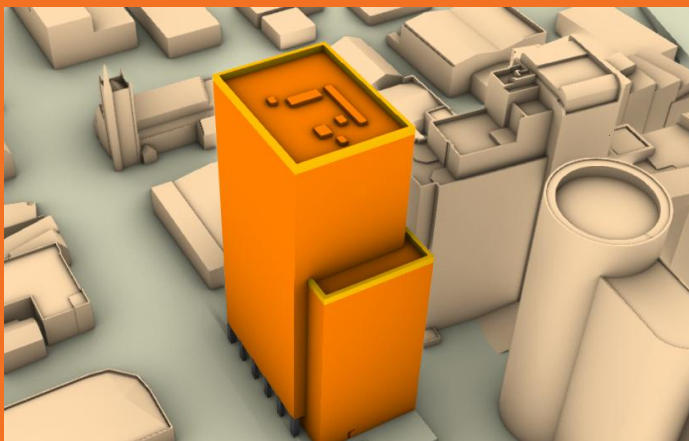


Figure A.1: Proposed Development, close-up

Digital models used in this study were prepared using project-specific drawing information, provided by AEW Architects on the 23rd October 2025, listed below.

- NO1LOR-AEW-B1-ZZ-M3-A-0005-S2-P01-3D Model.dwg

The simulations executed for this report were carried out in the absence of any soft landscaping proposals.

Figures A.1 and A.2 present the Proposed Development in detail, as modelled.

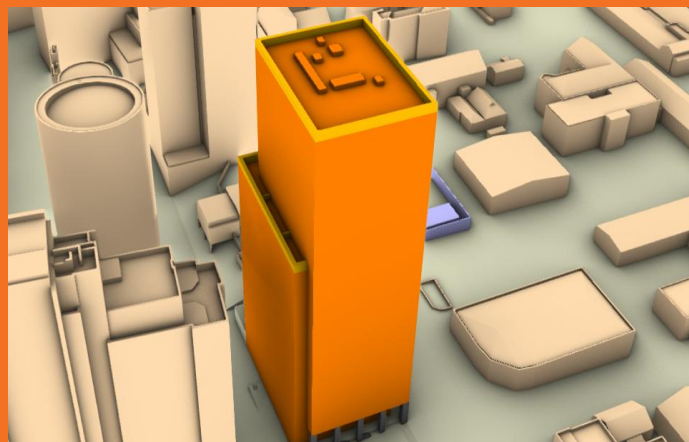


Figure A.2: Proposed Development, close-up

Appendix B: CFD Modelling

Spatial Discretization

The computational domain was discretised using polyhedral cells for the core mesh and low aspect-ratio prism cells adjacent to solid boundaries, including building walls and the ground surface. Separate computational meshes were constructed for each of the three study configurations.

The domain includes the Proposed Development site along with surrounding buildings and topographical features, explicitly modelled within a 460m radius. The overall domain extends to 1500 m in the along-wind direction, 1100 m across-wind, and 450 m vertically.

To resolve detailed architectural features and flow structures, the Proposed Development and its immediate surroundings were meshed with a minimum cell size of 0.2 m. Pedestrian-level surfaces were meshed with a five-layer prism mesh, which increases in thickness near buildings to reach a total height of 1.5 m above ground level.

Figure B.1 illustrates the computational domain.

Figures B.2 to B.4 provide examples of mesh resolution and distribution.

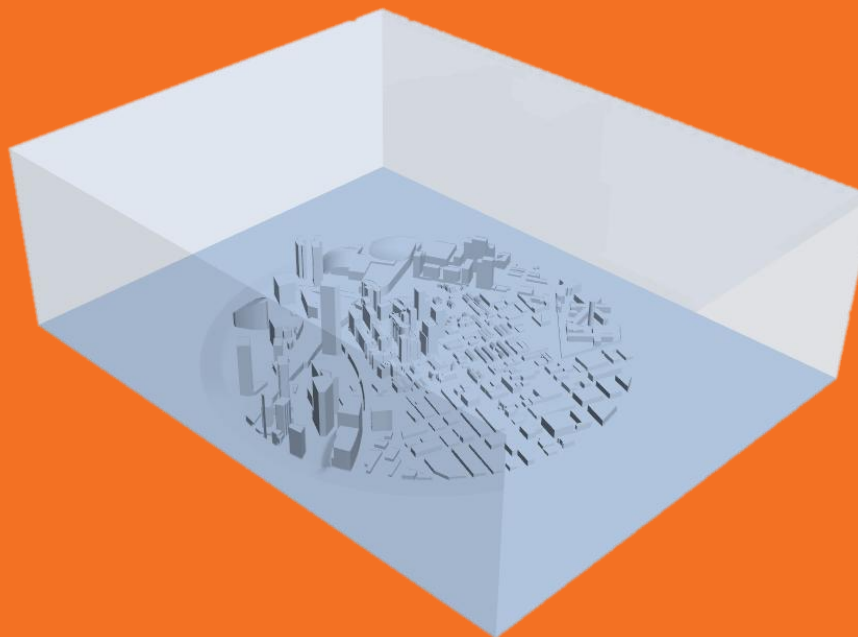
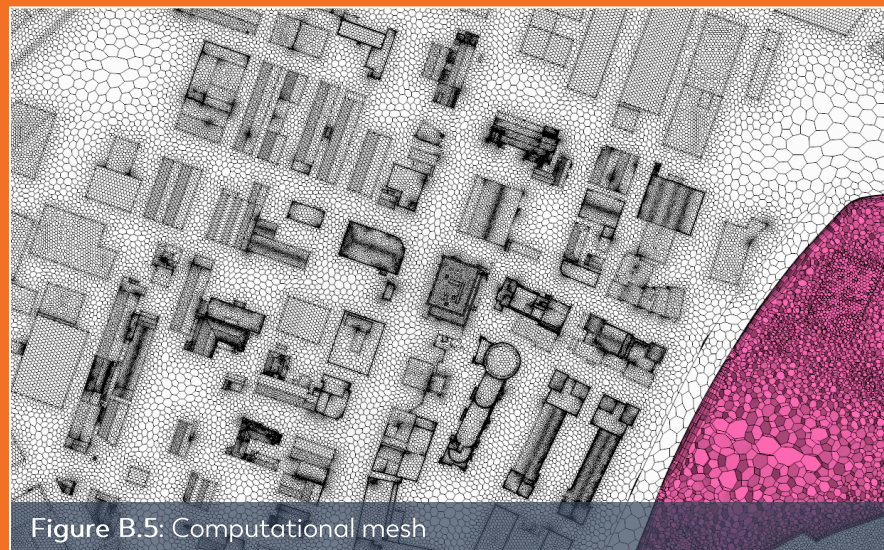
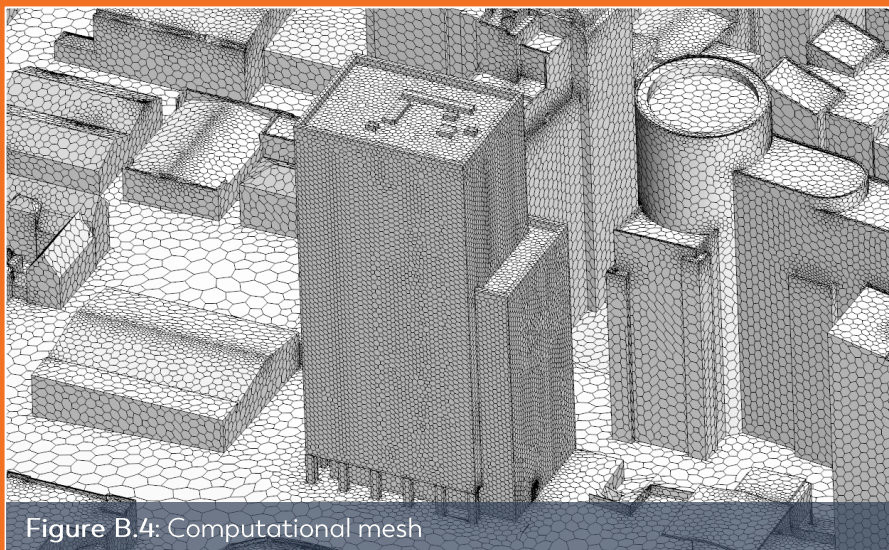
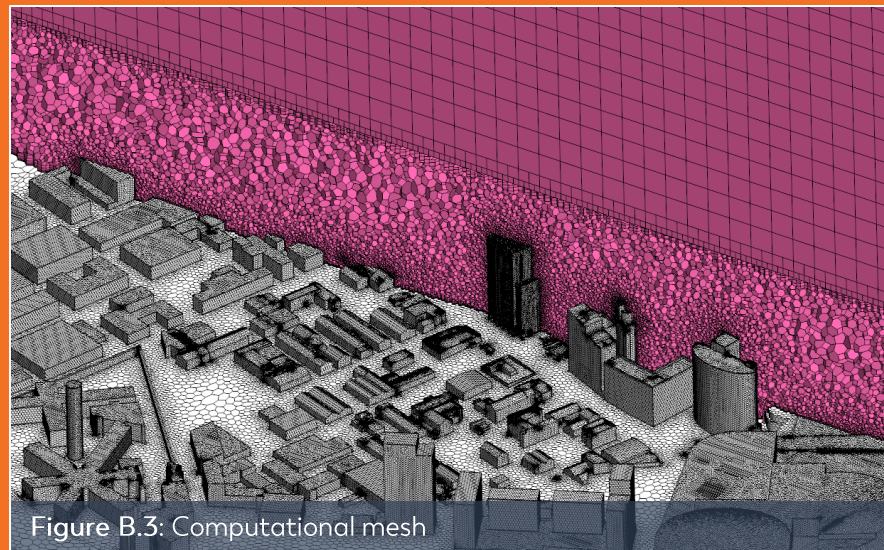
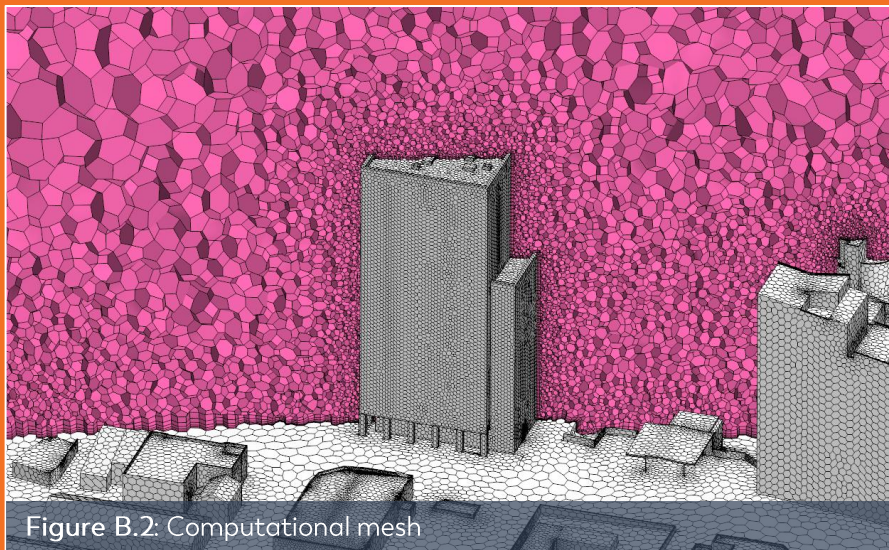


Figure B.1: Computational domain



Solution Method

The modelling of incompressible fluid flow was carried out using variants of the Semi-Implicit Method for Pressure-Linked Equations (SIMPLE) algorithm. Turbulent flow features were simulated using the Shear Stress Transport (SST) $k-\omega$ turbulence model.

Originally proposed by Menter^[3], the SST $k-\omega$ model is a two-equation eddy-viscosity model that blends the advantages of both the $k-\omega$ and $k-\varepsilon$ formulations. It applies the $k-\omega$ model near wall boundaries for accurate resolution of boundary layers, while transitioning to a $k-\varepsilon$ -like behaviour in the free-stream regions to improve robustness and accuracy in separated flows. Further detail on the formulation and application of the SST $k-\omega$ turbulence model can be found in the work of Menter^[3, 4].

Initial and Boundary Conditions

The atmospheric boundary layer flow was simulated by implementing a logarithmic velocity profile model presented by Richards and Hoxey^[5], with the following main assumptions:

- The vertical velocity component at the domain boundary is negligible
- The pressure gradient and shear stress are constant

The model implies the following equation for the mean inlet velocity at the CFD domain:

$$U(z) = \frac{U^*}{\kappa} \cdot \ln\left(\frac{z + z_0}{z_0}\right)$$

where:

- κ - is the von Karman's constant
- z - is the distance from the ground surface in vertical direction
- z_0 - is the ground surface roughness length in metres

The friction velocity U^* is calculated by the following equations:

$$U^* = \kappa \frac{U_{ref}}{\ln\left(\frac{z_{ref} + z_0}{z_0}\right)}$$

where:

- z_{ref} – is the reference height in metres
- U_{ref} - is the reference velocity in m/s measured at z_{ref}

The turbulent velocity fluctuations at the domain inlet are induced by constant shear stress with height, maintained by the turbulent kinetic energy k equation below:

$$k(z) = \frac{U_{ref}^2}{\sqrt{C_\mu}}$$

where:

- $C_\mu = 0.09$ - is a k - ϵ turbulence model constant

All surface boundary conditions were modelled as smooth walls with a no-slip condition. A no-slip wall boundary condition with a varying roughness length height based on the terrain analysis for the site was applied on the ground surface outside the explicit surrounds area of the domain.

Gust Equivalent Mean Calculation

The presence of gusts in the wind flow is a major component that may lead to additional instability and discomfort to that caused by the mean wind flow. Thus, the gust wind speed is accounted for by a calculation of the short-duration gust wind speed, considering the standard deviation of the mean wind speed, and in particular the turbulent kinetic energy, k :

$$\sigma = \sqrt{\frac{2}{3}k}$$

The Gust Equivalent Mean (GEM) is then calculated as:

$$U_{GEM} = \frac{U_{mean} + 3.5\sigma}{k_g}$$

where gust factor, $k_g = 1.85$

The final wind speed ratio (speed-up) used in the Lawson criteria assessment corresponds to the worst-case value derived from both the time-averaged mean wind speed and the gust equivalent mean wind speed. Once known, it is applied in conjunction with the the Weibull cumulative distribution function to calculate the probability of exceedance:

$$P(V > v) = \exp \left[- \left(\frac{v^k}{c} \right) \right]$$

Where v is the wind speed threshold, c is the scale (or dispersion) parameter, and k is the shape parameter. To this formulation, the directional probability of occurrence pp for each wind direction is incorporated. This allows the exceedance probability to be calculated for each wind direction and for each month of the year, providing a directional and temporal profile of wind comfort conditions in accordance with the Lawson criteria.

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Version 02 – Issued 26th January 2026

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