City House

For

Macar Living (City House) Limited

Wind Microclimate Report

0540534rep2v1

08 January 2024

Architectural Aerodynamics Ltd.

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Issue History

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Executive Summary

Background

A study has been carried out by Architectural Aerodynamics Ltd. (ArcAero) to assess the wind microclimate for the proposed City House development in London, United Kingdom.

The study has employed computational modelling (CFD) to predict the strength of wind speeds that will occur following the introduction of the proposed development.

This suitability of wind conditions is determined using the widely accepted industry standard Lawson criteria to determine the suitability of wind conditions on site and the impact of the proposed development on the surrounding area.

Conclusions

The following conclusions have been drawn:

- Upon the introduction of proposed development, wind conditions remain safe and comfortable for intended uses, both on the ground within and around the Site, as well as at the amenity spaces on the fifth floor terraces.
- With the introduction of the cumulative surrounds, wind safety and comfort conditions remain materially similar to that of the proposed development within existing surrounds scenario.

1 Introduction

A microclimate is defined as the distinctive climate of a small-scale area. The weather variables in a microclimate, such as wind, may be different to the conditions prevailing over the area as a whole. Wind microclimate assessments consider the wind conditions that would result upon the introduction of a new development into an existing space.

Such assessments predict the proportion of time an area will experience wind speeds in excess of threshold values associated with safe and comfortable use by pedestrians and occupants once the development is introduced. It can therefore be shown within the various parts of a new proposal and neighbouring properties whether wind conditions are suitable or unsuitable, and whether design adjustment or mitigation measures are required. It is for this purpose that wind microclimate assessments are undertaken.

This report summarises the results of a CFD study, commissioned by Macar Living (City House) Limited, to assess the wind microclimate for the proposed City House development in London, United Kingdom.

2 The Project

2.1 Site Location and Surrounding Area

The City House site is bounded by Cheam Road to the north, Sutton Park Road to the west, Sutton Baptist Church to the east and the Geeks Limited building to the south.

Further afield, the development is largely characterized by low rise residential developments, with some low to medium-rise development to the southeast and northeast.

2.2 The Proposed Development

The proposed development will comprise of a two-block residential building, rising approximately 20 to 45 metres above local ground level.

2.3 Drawing Information Describing the Proposed Development

Assessment models have been constructed on the basis of the following drawings received from Wimshurst Pelleriti Architects on 30th November 2023:

- 2023-11-29 Model Zero Coordinates.skp

The existing surrounding area was based upon information supplied by Wimshurst Pelleriti Architects and supplemented by Ordnance Survey details for the area. Cumulative surrounds were based upon information contained within the London Borough of Sutton planning portal.

2.4 Soft Landscaping

The wind microclimate has been assessed for the proposed development with current soft landscaping proposals and existing surrounding soft landscaping features. Soft landscaping proposals were based upon the following information provided by Philip Cave Associates on 18th December 2023:

- 546- Landscape GF GA Plan with Existing parking.dwg
- 546- Landscape PODIUM GA Plan 1.1.dwg

2.5 Cumulative Schemes

A number of cumulative schemes have been considered in the assessment. These schemes are presented in tabular format in Table 2-1.

Table 2-1 – Cumulative Schemes

Development Name	Planning Reference
8-25 Beech Tree Place And 29-35 West Street Sutton	DM2021/02331
Sutton High School For Girls 55 Cheam Road Sutton	DM2020/01874
10-12 Cheam Road Sutton	DM2020/00570

3 Assessment Methodology

3.1 Overview

CFD modelling has employed a steady-state RANS approach This method employs turbulence models to approximate the magnitude of velocity fluctuations about the average wind speeds predicted, in order to derive an estimation of the effect of gusts.

Full details on this approach are provided in Appendix A of this report - salient highlights of this approach are:

- the Shear Stress Transport k-ω turbulence model has been employed.
- Architectural features of 0.5 metres or more have been captured within the geometry modelled.
- Cell sizes of as small as 0.2 metres were utilised to capture flow behaviour in critical locations.
- The region of interest closest to the ground (1.5 metres) incorporated 5 layers of cells.

Modelling has derived mean and gust equivalent mean wind speeds, in accordance with best industry practice. In doing so 16 wind directions were assessed, in 22.5° increments.

The industry standard criteria for wind microclimate assessments, the LDDC variant of the Lawson criteria (1), has been employed for the study.

3.2 Computational Model

A digital model of the site and surrounds was used for the study. The surrounding area was modelled up to a distance of 450 m and all features which are likely to impact the wind flow to and through the site have been replicated. Details of the model, including the configurations tested, are presented within Appendix B of this report.

3.3 Wind Climate Analysis

Wind microclimate studies require that meteorological data is transposed from a nearby weather station with sufficient wind data to produce accurate wind frequency statistics. The current study uses data from London Heathrow Airport.

Full details of the wind climate relevant to the site, the wind properties approaching the site and the modelling of those wind properties in the CFD models are provided in Appendix C of this report. All analysis of wind data and the atmospheric boundary layer has employed the methods of ESDU item 01008 (2), in accordance with best industry practice.

3.4 The LDDC Lawson Criteria

The industry standard criteria for such assessments are commonly referred to as the Lawson criteria. Architectural Aerodynamics use the London Docklands Development Corporation (LDDC) variant of the Lawson Criteria (1).

The LDDC variant of the Lawson criteria applies a single percentage probability of exceedance of a range of wind speeds related to different pedestrian uses.

3.4.1 Safety

A wind speed of 15 metres-per-second occurring once per year is rated as unsafe, with the potential to de-stabilise the less able members of the public including the elderly, cyclists and children.

3.4.2 Comfort

The LLDC variant of the Lawson criteria (1) dictates that wind conditions are suitable for a given activity when the threshold is exceeded no more than 5% of the time in seasons relevant to the activities that will take place in a given area. The value of 5% has been established as giving a reasonable allowance for extreme and relatively infrequent winds that are tolerable within each category. These threshold wind speed values are presented in Table 3-1.

Table 3-1 – LLDC Wind Comfort Thresholds

Threshold Wind Speed [m/s]	Comfort Rating / Activity	
4	C4	Long-term sitting
6	C3	Standing / short-term sitting
8	C2	Strolling
10	C1	Walking
> 10	C0	Uncomfortable

4 Results

4.1 Existing Site Conditions

The results for the existing site conditions are presented graphically within Figure 4.1 for safety, and Figure 4.2 and Figure 4.3 for worst-seasonal and summer conditions respectively.

4.1.1 Safety

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

4.1.2 Comfort

Within the existing site and immediate surrounding areas, wind conditions are substantially suitable for short-term sitting or better with a region of strolling conditions present along Sutton Park Road. Thus, wind conditions are comfortable for intended uses as pedestrian ingress / egress at all entrances, and leisure thoroughfare use for all thoroughfares through and around the site.

4.2 Proposed Development with Soft Landscaping within Existing Surrounds

The results for the proposed development with soft landscaping within existing surrounds are presented graphically within Figure 4.4 and Figure 4.5 for safety, Figure 4.6 and Figure 4.7 for worst-seasonal and Figure 4.8 and Figure 4.9 for summer comfort respectively.

4.2.1 Safety

Following the introduction of proposed development, the wind safety criteria are met within and around the site.

4.2.2 Comfort

4.2.2.1 Thoroughfares

Wind conditions at thoroughfares within the site are suitable for short-term standing or better throughout the year, with pockets of strolling conditions to the south of the development during the winter months. These conditions meet the comfort criteria for leisure thoroughfare and are thus comfortable for pedestrian access to and passage through the site.

4.2.2.2 Entrances

Wind conditions at all entrances of the proposed development are suitable for short-term standing or better throughout the year and thus comfortable for pedestrian ingress / egress.

4.2.2.3 Recreational Spaces

Within the recreational spaces at ground floor, wind conditions are largely suitable for long periods of sitting throughout the year and thus suitable for general recreation.

On the fifth-floor terrace, wind conditions are substantially suitable for short periods of sitting from spring to autumn, with much of the amenity space being further suitable for long-term sitting in summer. Wind conditions are thus suitable for intended uses.

4.2.2.4 Balconies

Wind conditions at balconies throughout the development are substantially suitable for short-term sitting or better from spring to autumn and thus suitable for their intended uses.

4.2.2.5 Surrounding Area

Within the surrounding areas, wind conditions are generally suitable for short-term standing or better all year round. Thus, the comfort criteria for a leisure throughfare use and ingress / egress at entrances continues to be met throughout the surrounding area.

4.3 Proposed Development within Cumulative Surrounds

The results for the proposed development within cumulative surrounds are presented graphically within Figure 4.10 and Figure 4.11 for safety, Figure 4.12 and Figure 4.13 for worst-seasonal and Figure 4.14 and Figure 4.15 for summer comfort respectively.

Upon the introduction of cumulative surrounds, wind conditions remain materially similar to the proposed development in existing surrounds scenario. Thus, all conclusions drawn from the proposed development within existing surrounds scenario are equally applicable to the cumulative scenario.

5 Conclusions

The following conclusions have been drawn:

- Upon the introduction of proposed development with soft landscaping in place, wind conditions remain safe and comfortable for intended uses, both on the ground within and around the Site, as well as at the amenity spaces on the fifth floor terraces.
- With the introduction of the cumulative surrounds, wind safety and comfort conditions remain materially similar to that of the proposed development within existing surrounds scenario.

6 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-ω Turbulence Models for Aerodynamic Flows.* 1993. AIAA Paper 93-2906.

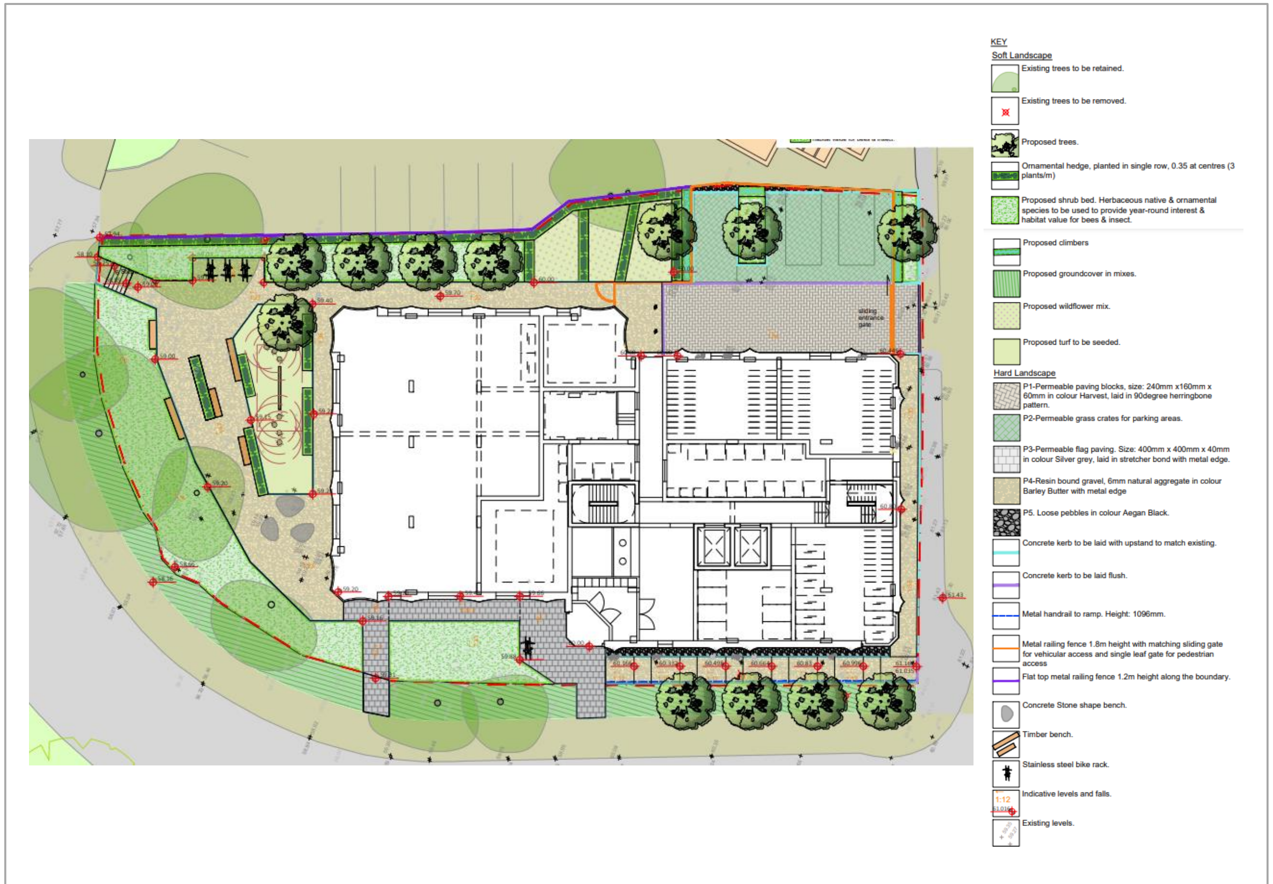
4. **F, Menter.** *Turbulence Modelling for Engineering Flows.* s.l. : ANSYS Inc., 2011.

5. **Richards, P.J. and Hoxey, R.P.** *Appropriate boundary conditions for computational wind engineering models using the k-ε turbulence model.* s.l. : Journal of Wind Engineering and Industrial Aerodynamics, 1993. vol. 46 & 47, pg. 145 - 153.

6. **Blocken, B. and Carmeliiet, J.** *Pedestrian wind environment around buildings: Literature review and practical examples.* s.l. : Journal of Thermal Envelope and Building Science, 2004.

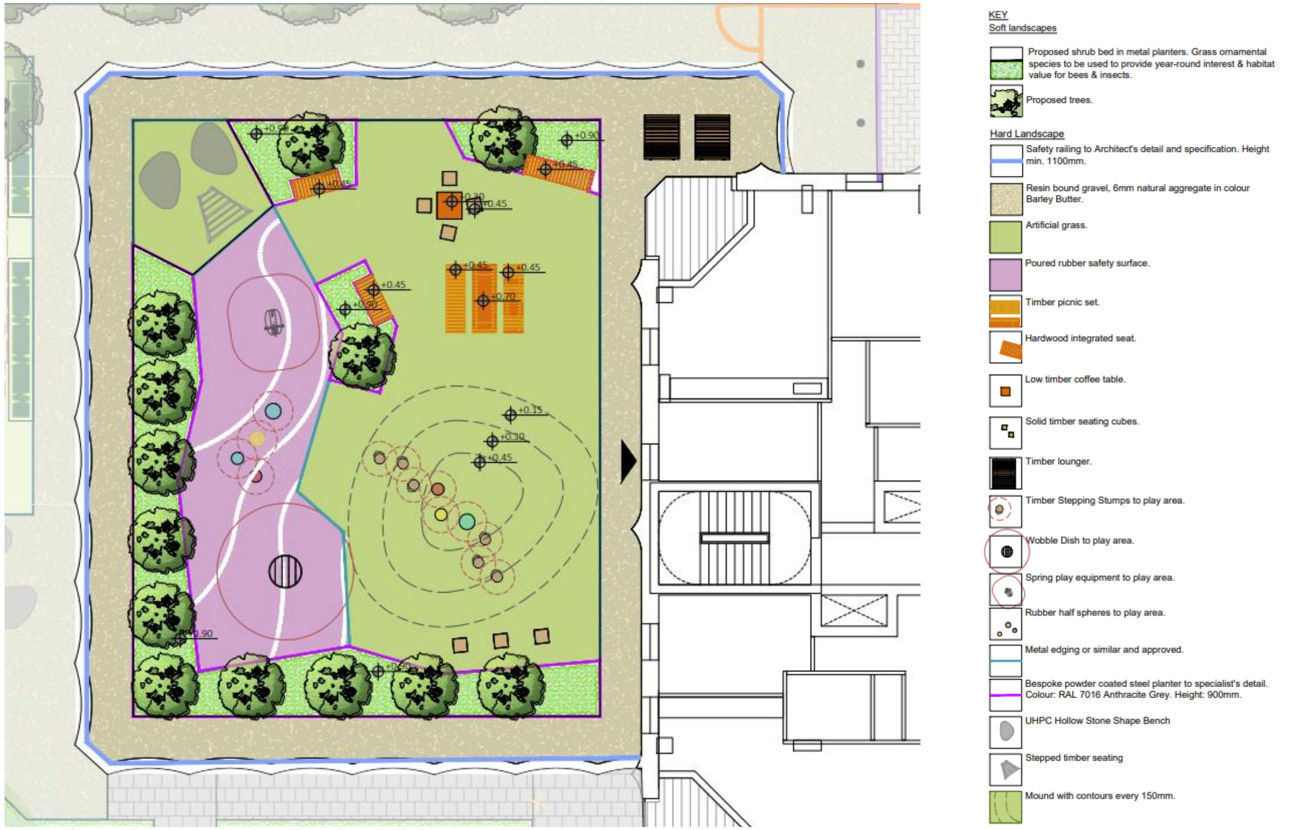
7 Figures

Figure 2.1 - Proposed Soft Landscaping on Ground Level



0540534 – City House Proposed Soft Landscaping on Ground Level	Drawing No: 0540534/ 2.1	Date: 03/01/2024	arcaero

Figure 2.2 - Proposed Soft Landscaping on Level 5 terrace.

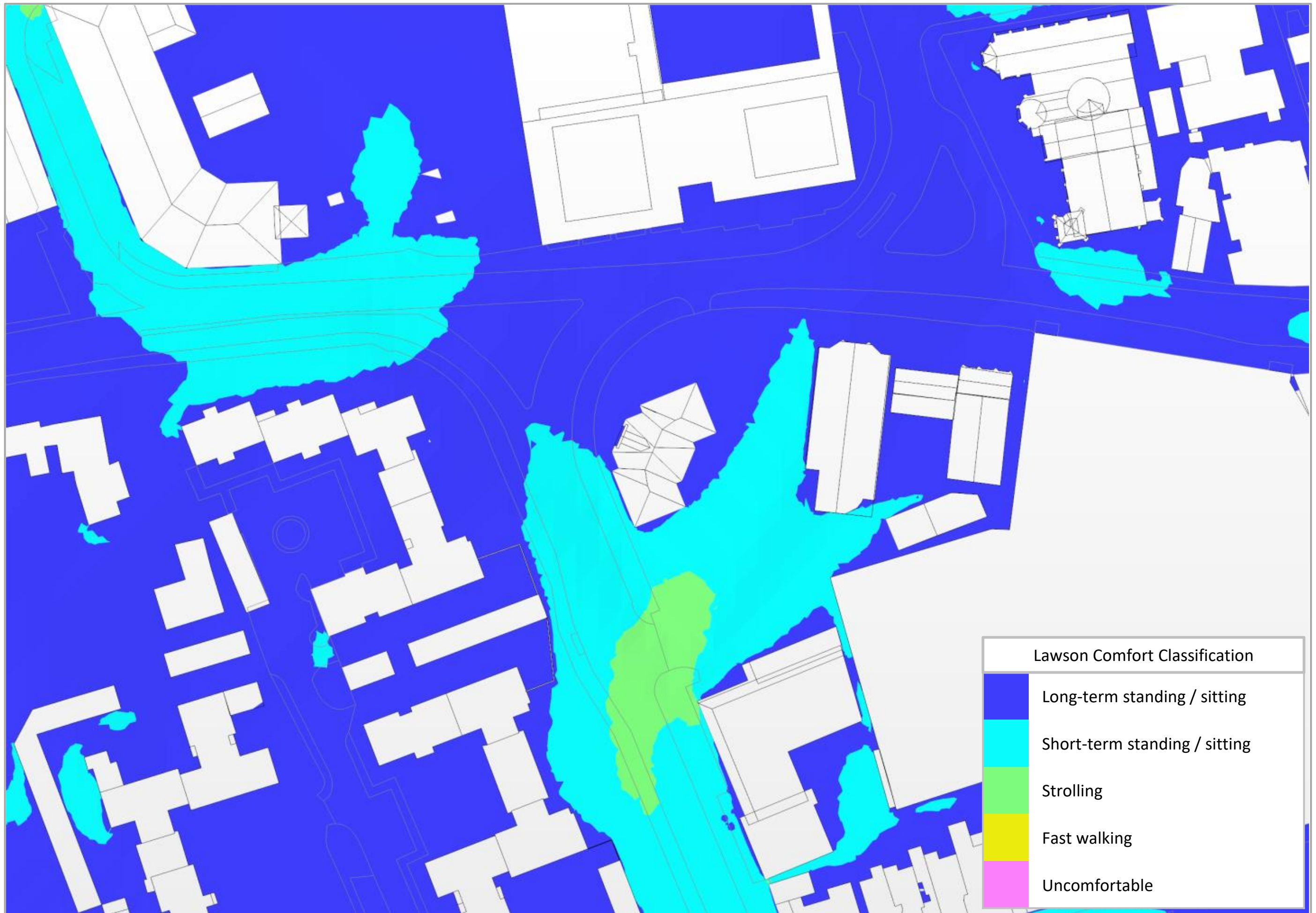


0540534 – City House Proposed Soft Landscaping on Level 5 terrace	Drawing No: 0540534/2.2	Date: 03/01/2024	arcaero

Figure 4.1 – Pedestrian wind conditions, existing site within existing surrounds, annual safety

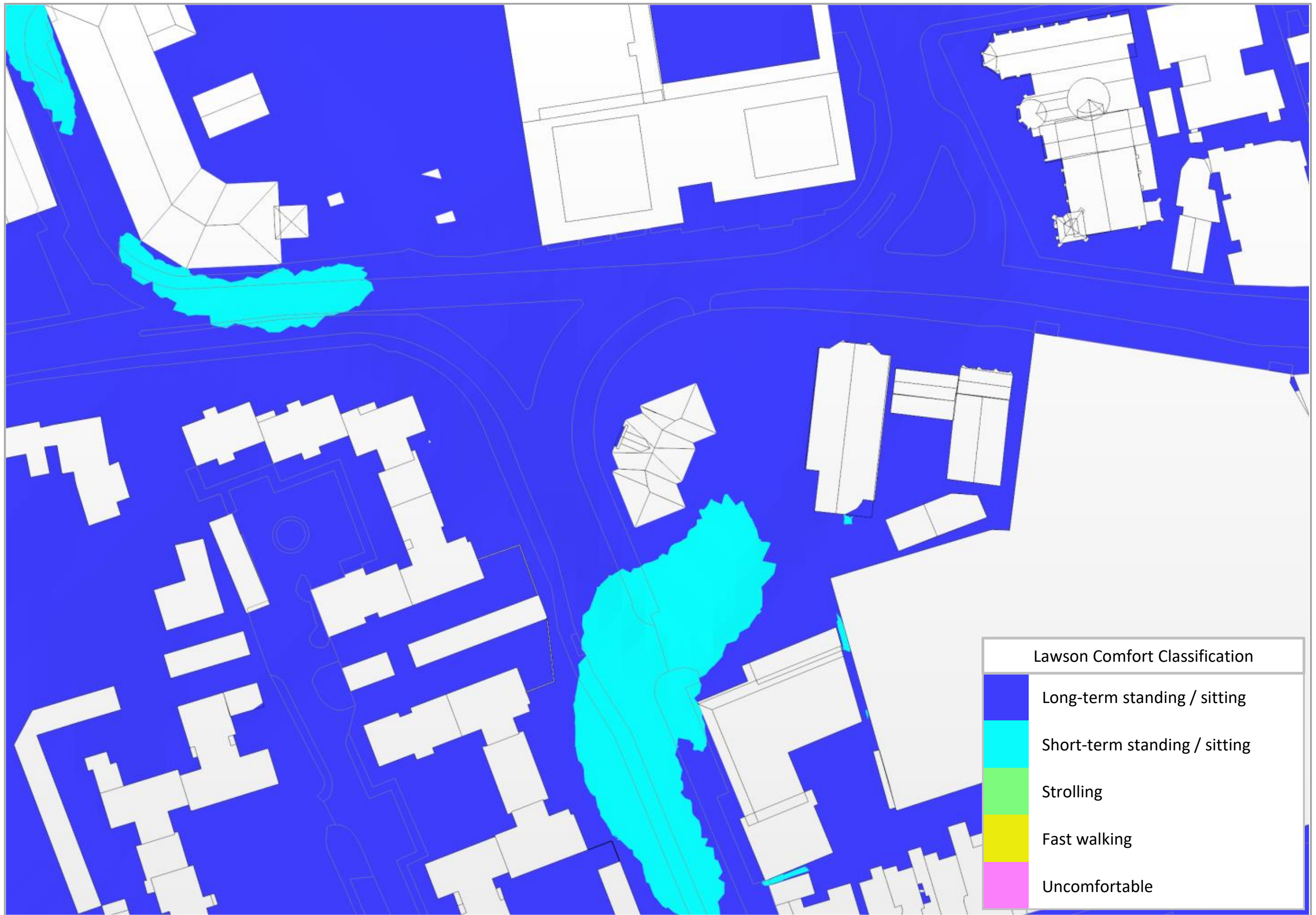
0540534 – City House Safety – Existing Site in Existing Surrounds: Ground	Drawing No: 0540534/4.1	Date: 03/01/2024	arcaero

Figure 4.2 - Pedestrian wind conditions, existing site within existing surrounds, worst case season



0540534 – City House Worst Seasonal Comfort – Existing Site in Existing Surrounds: Ground	Drawing No: 0540534/4.2	Date: 03/01/2024	arcaero

Figure 4.3 – Pedestrian wind conditions, existing site within existing surrounds, summer season



0540534 – City House Summer Comfort – Existing Site in Existing Surrounds: Ground	Drawing No: 0540534/4.3	Date: 03/01/2024	arcaero

Figure 4.4 – Pedestrian wind conditions, proposed development within existing surrounds with soft landscaping, annual safety – ground level

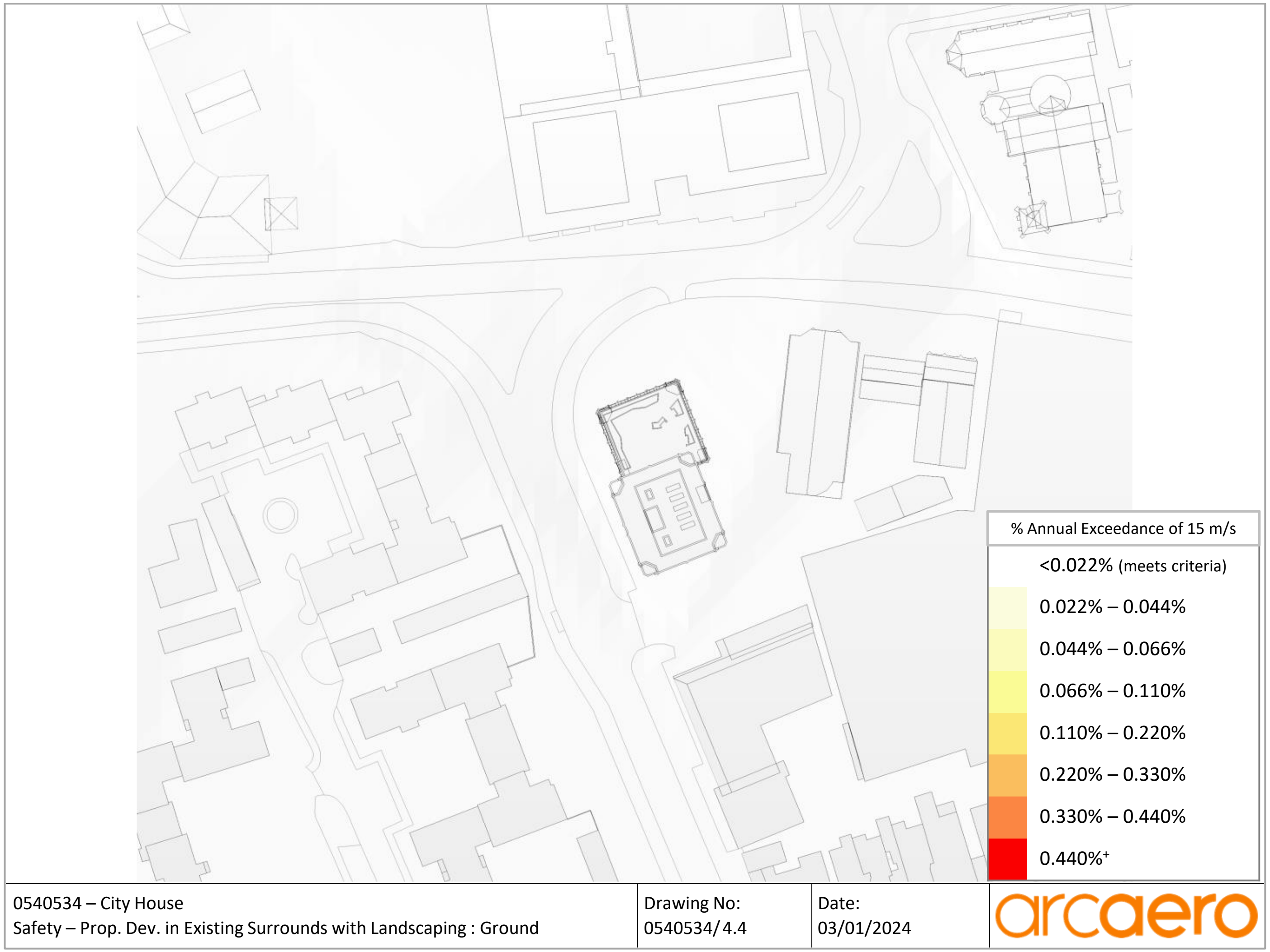


Figure 4.5 – Pedestrian wind conditions, proposed development within existing surrounds with soft landscaping, annual safety – terrace / balcony level

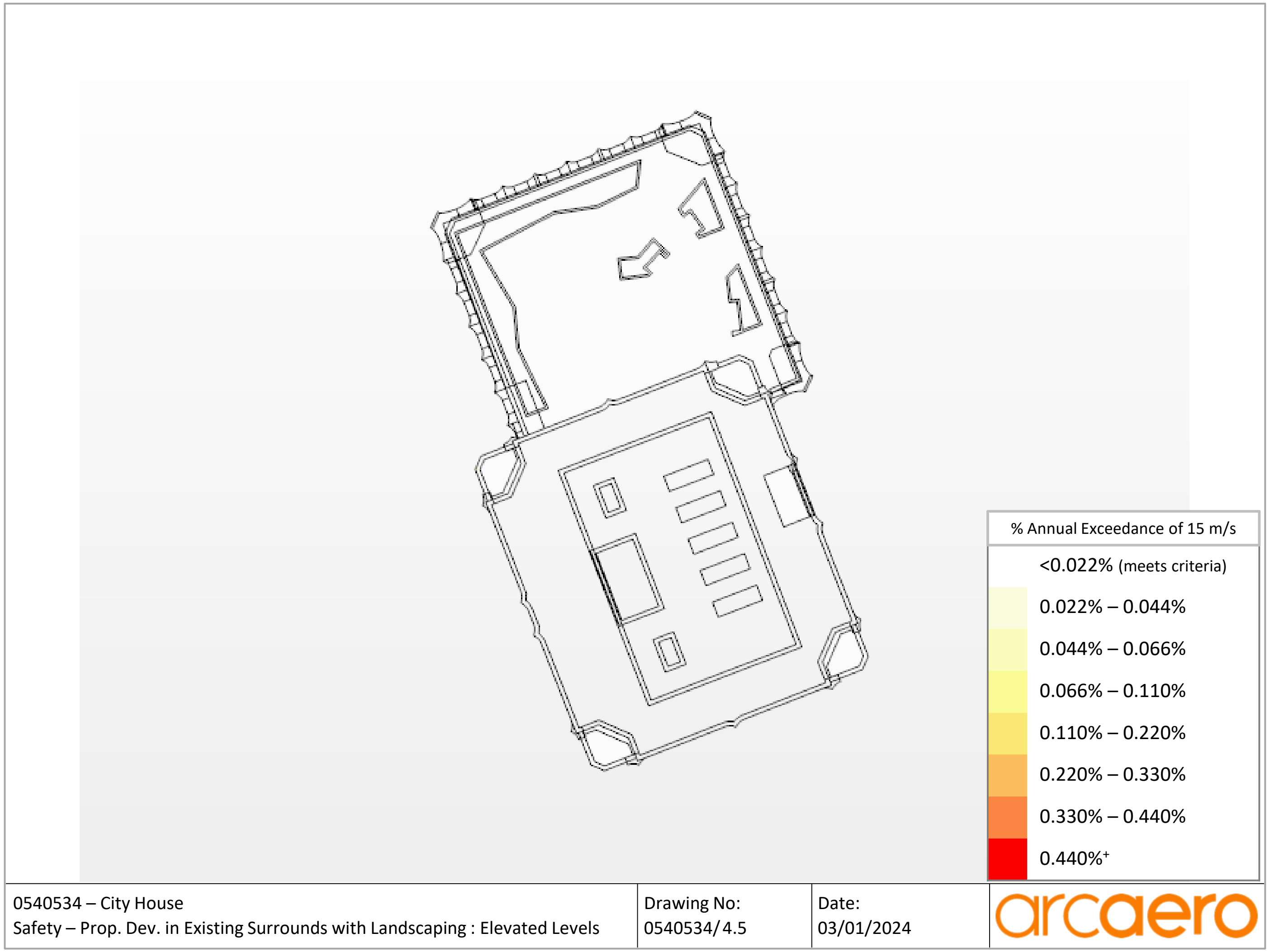
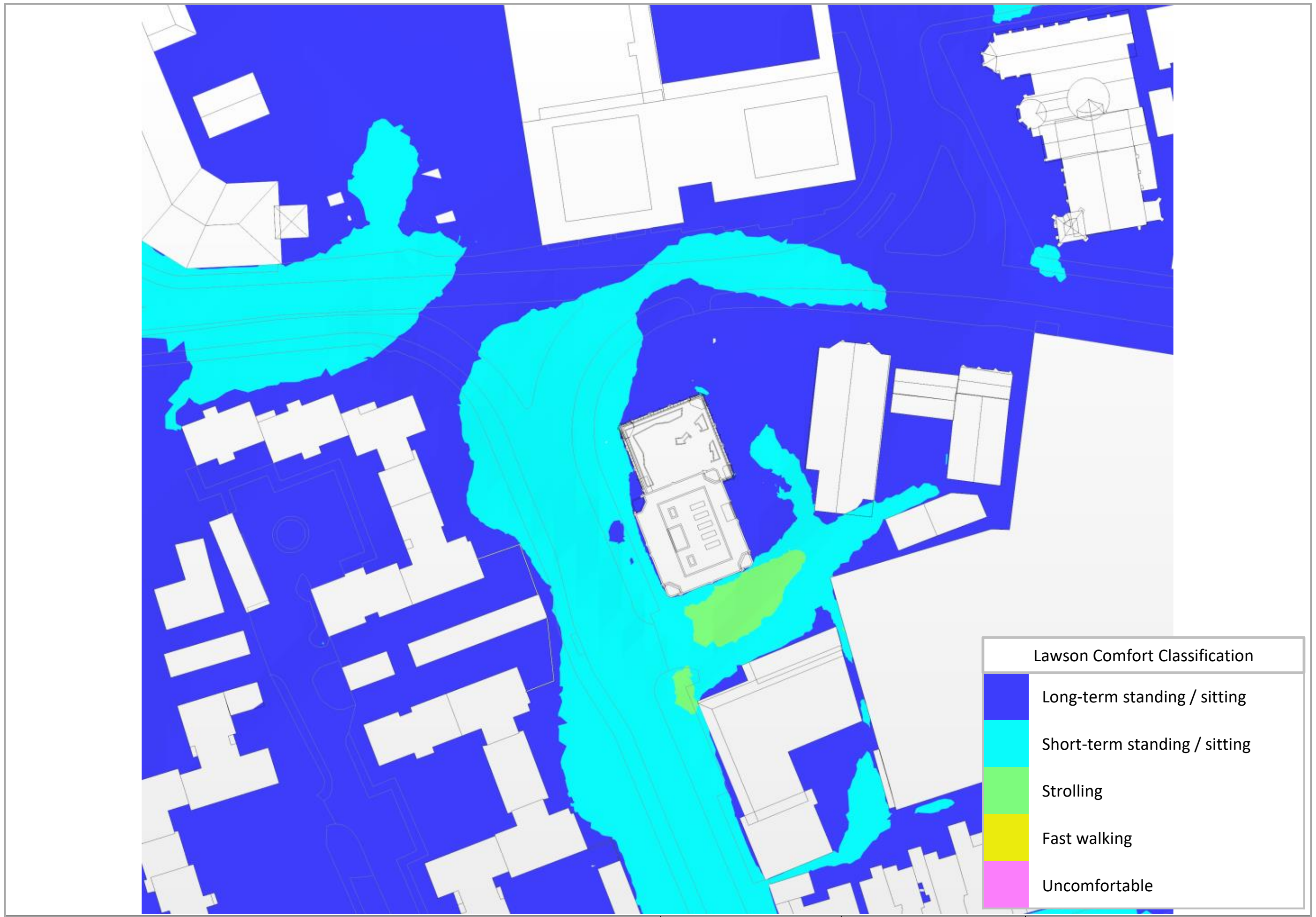


Figure 4.6 – Pedestrian wind conditions, proposed development within existing surrounds with soft landscaping, worst case season – ground level

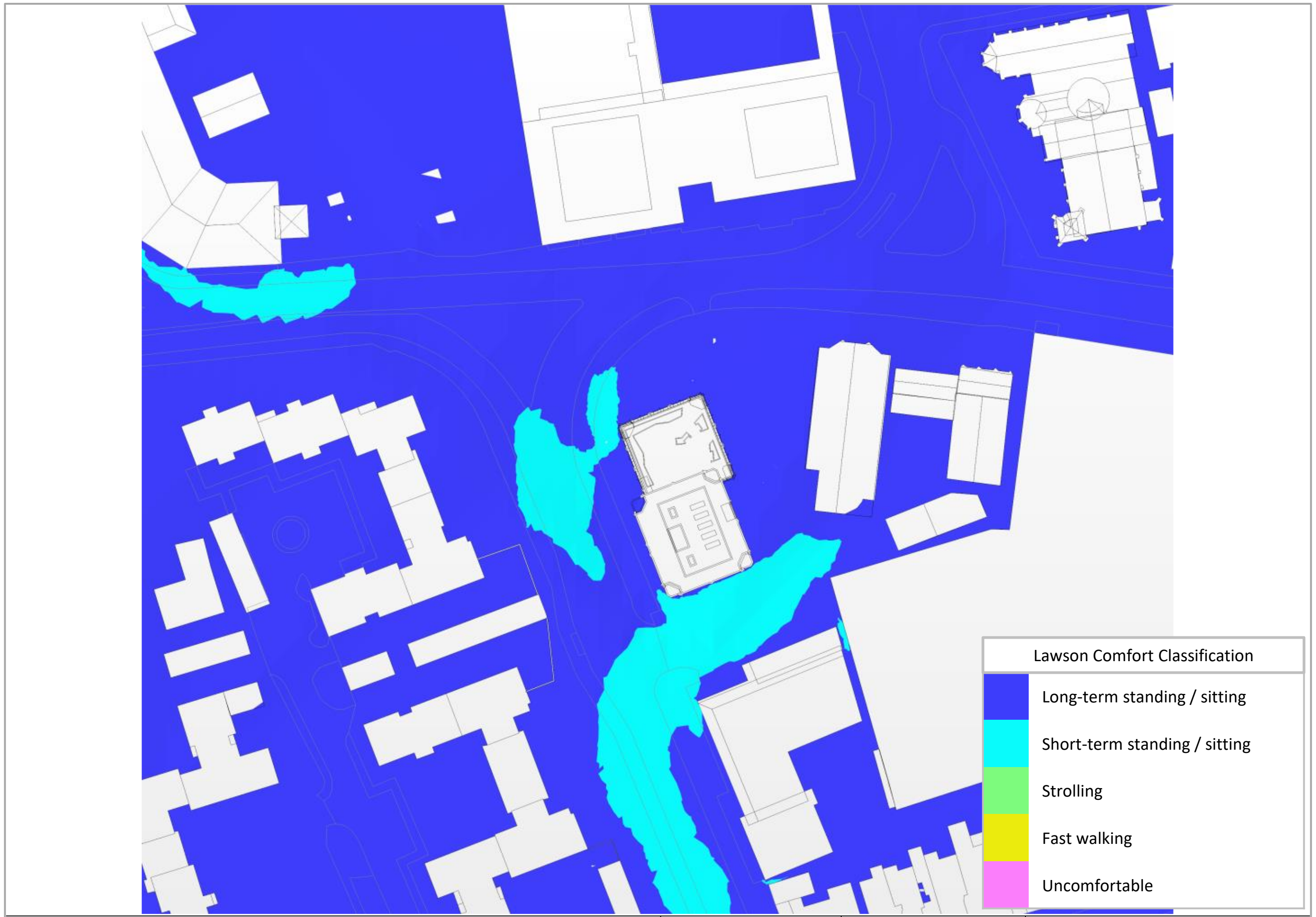


0540534 – City House Worst Seasonal Comfort – Prop. in Existing with Landscaping : Ground	Drawing No: 0540534/4.6	Date: 03/01/2024	arcaero

Figure 4.7 – Pedestrian wind conditions, proposed development within existing surrounds with soft landscaping, worst case season – terrace / balcony level

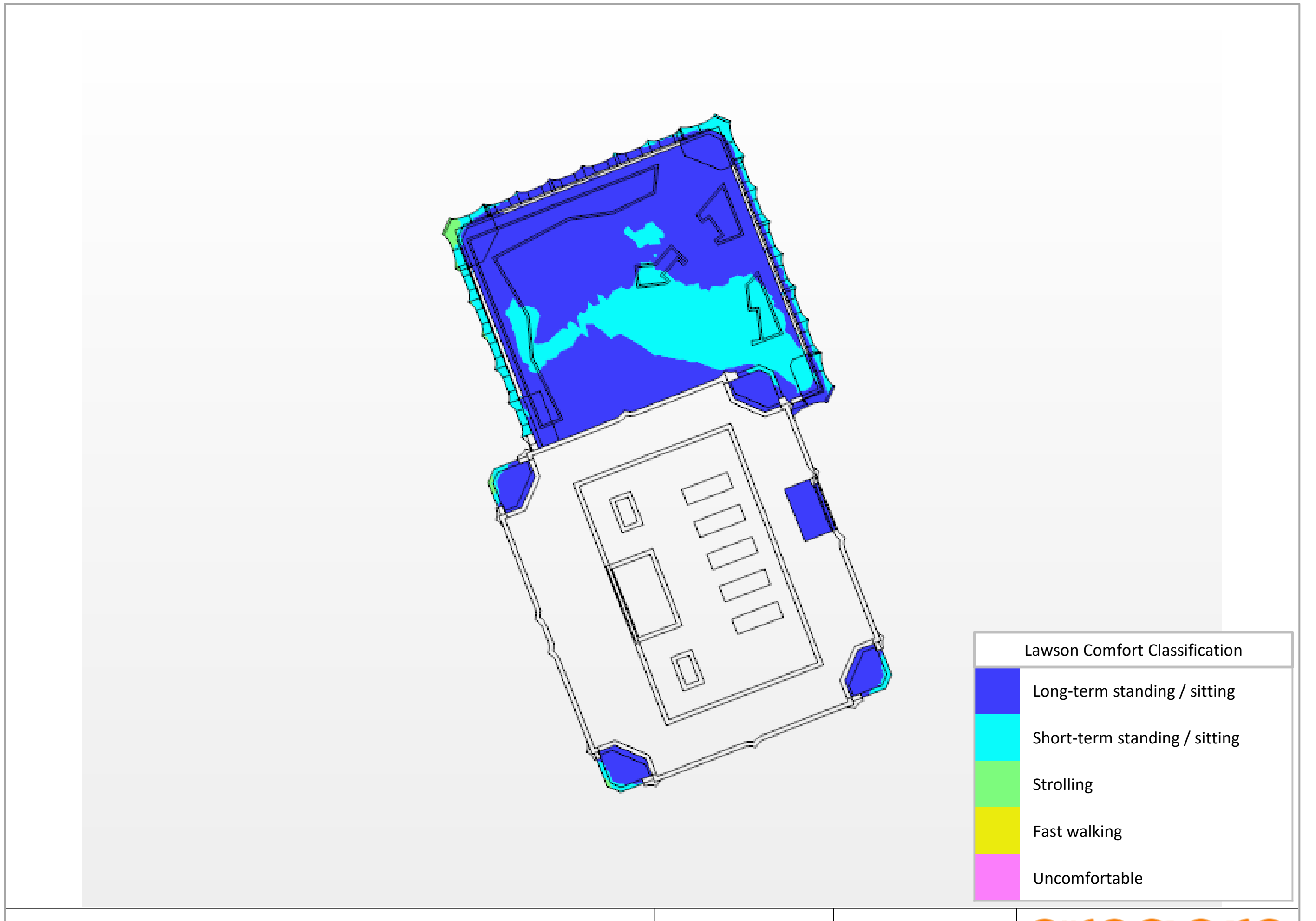
0540534 – City House Worst Seasonal Comfort – Prop. in Existing with Landscaping : Elevated Levels	Drawing No: 0540534/4.7	Date: 03/01/2024	arcaero

Figure 4.8 – Pedestrian wind conditions, proposed development within existing surrounds with soft landscaping, summer season – ground level



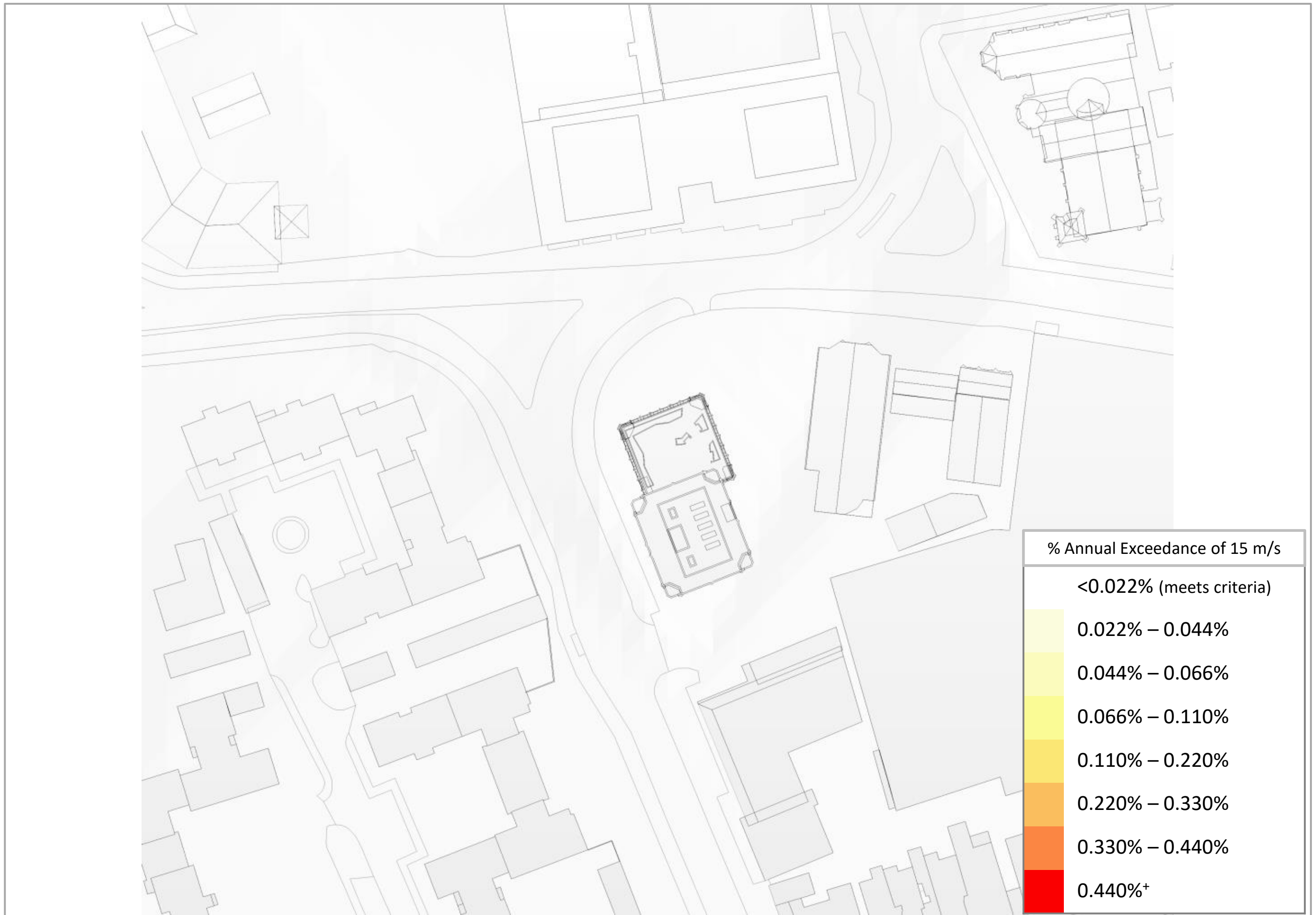
0540534 – City House Summer Comfort – Prop. Dev. in Existing with Landscaping : Ground	Drawing No: 0540534/4.8	Date: 03/01/2024	arcaero

Figure 4.9 – Pedestrian wind conditions, proposed development within existing surrounds with soft landscaping, summer season – terrace / balcony level



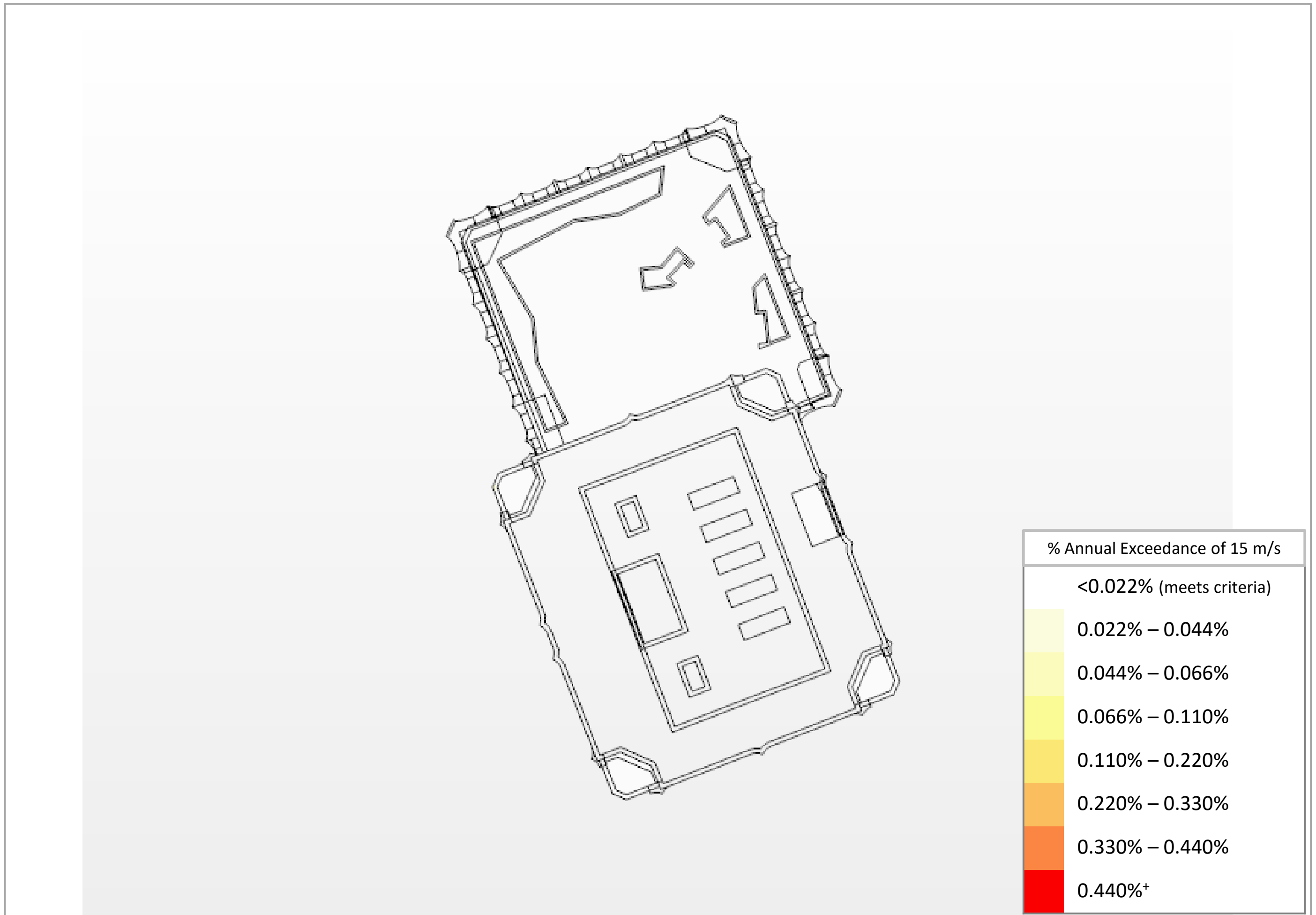
0540534 – City House Summer Comfort – Prop. in Existing with Landscaping : Elevated Levels	Drawing No: 0540534/4.9	Date: 03/01/2024	arcaero

Figure 4.10 – Pedestrian wind conditions, proposed development within cumulative surrounds with soft landscaping, annual safety – ground level



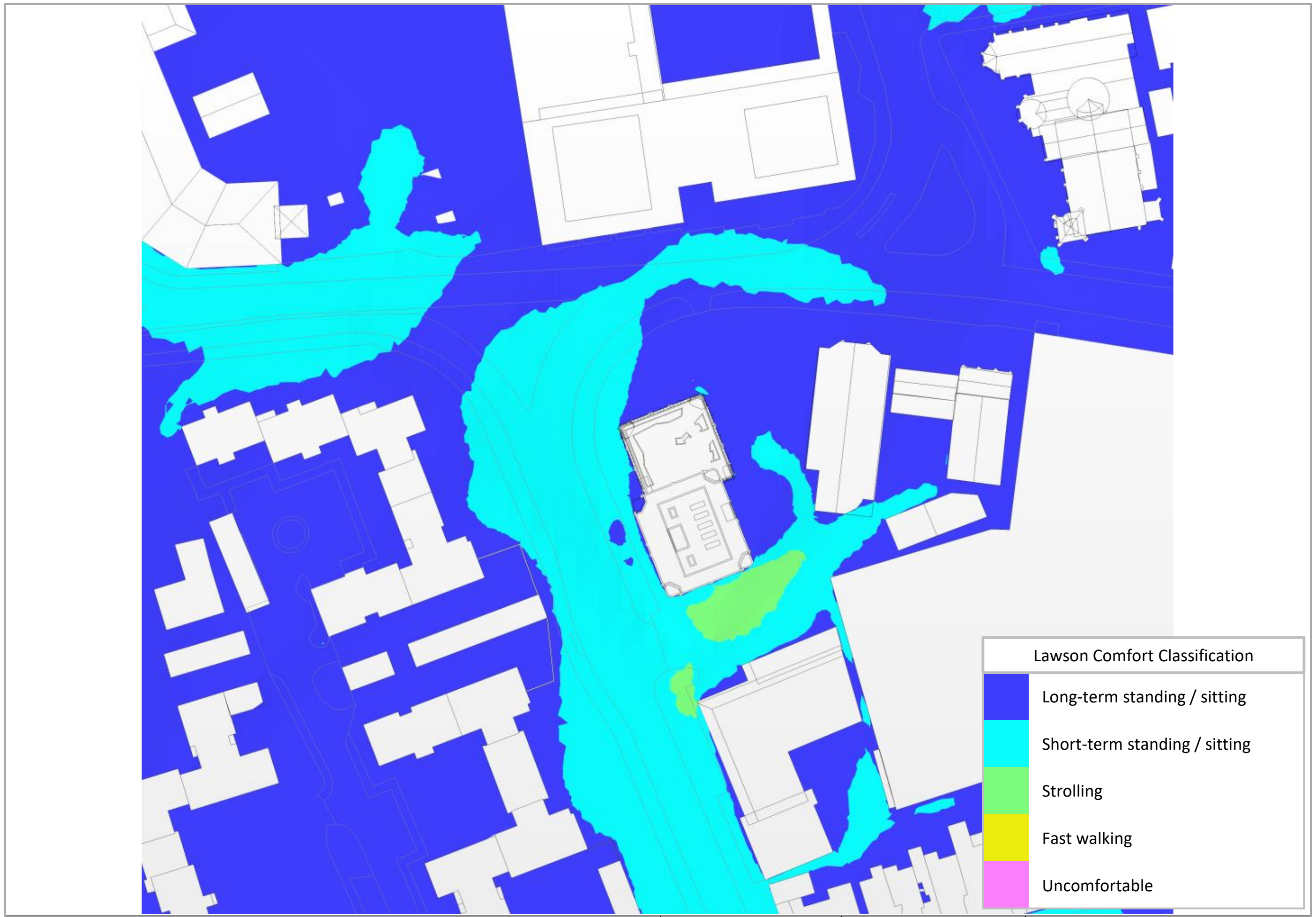
0540534 – City House Safety – Prop. Dev. in Cumulative Surrounds with Landscaping: Ground	Drawing No: 0540534/4.10	Date: 03/01/2024	arcaero

Figure 4.11 – Pedestrian wind conditions, proposed development within cumulative surrounds with soft landscaping, annual safety – terrace / balcony level



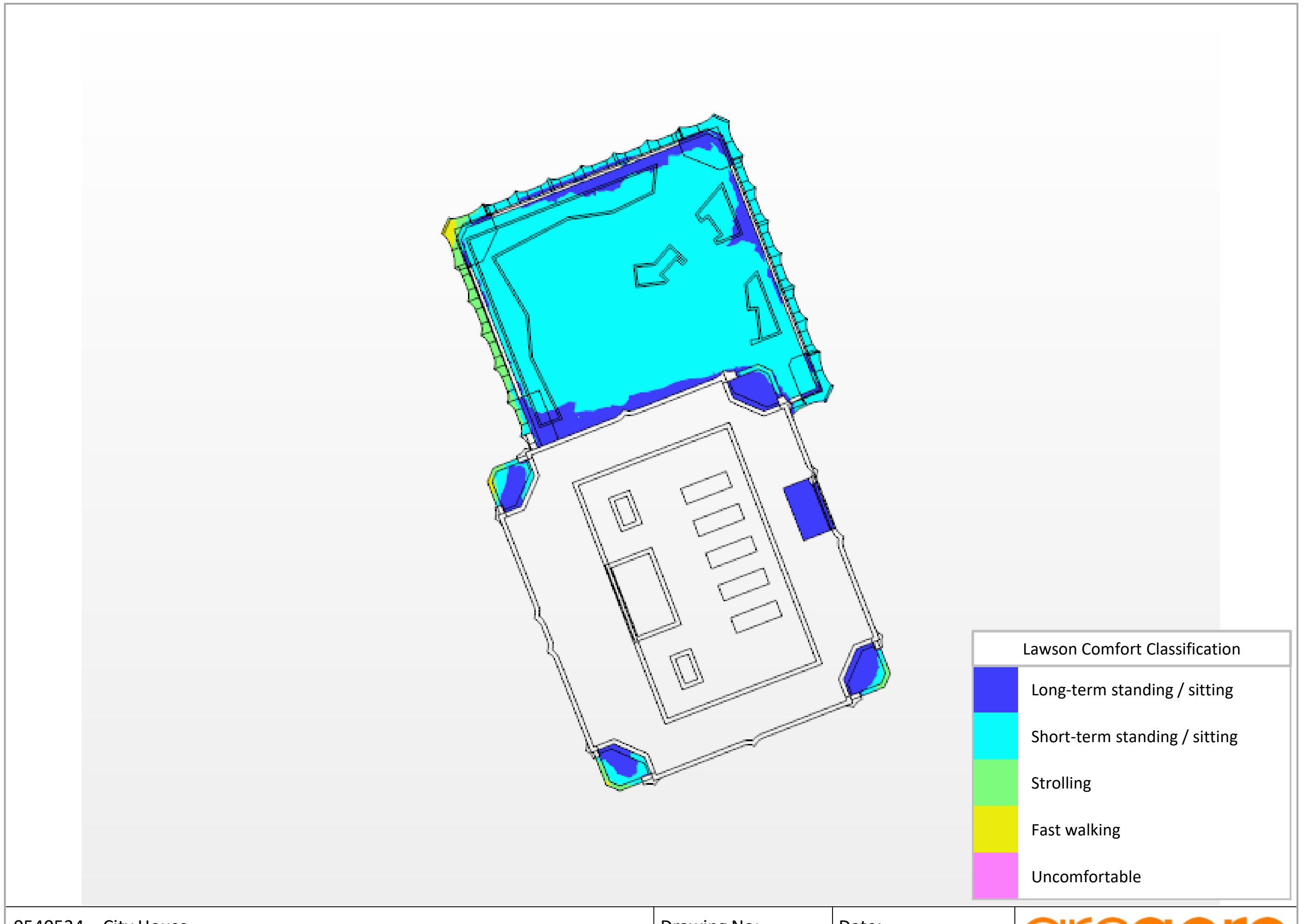
0540534 – City House Safety – Prop. Dev. in Cumulative with Landscaping : Elevated Levels	Drawing No: 0540534/4.11	Date: 03/01/2024	arcaero

Figure 4.12 – Pedestrian wind conditions, proposed development within cumulative surrounds with soft landscaping, worst case season – ground level



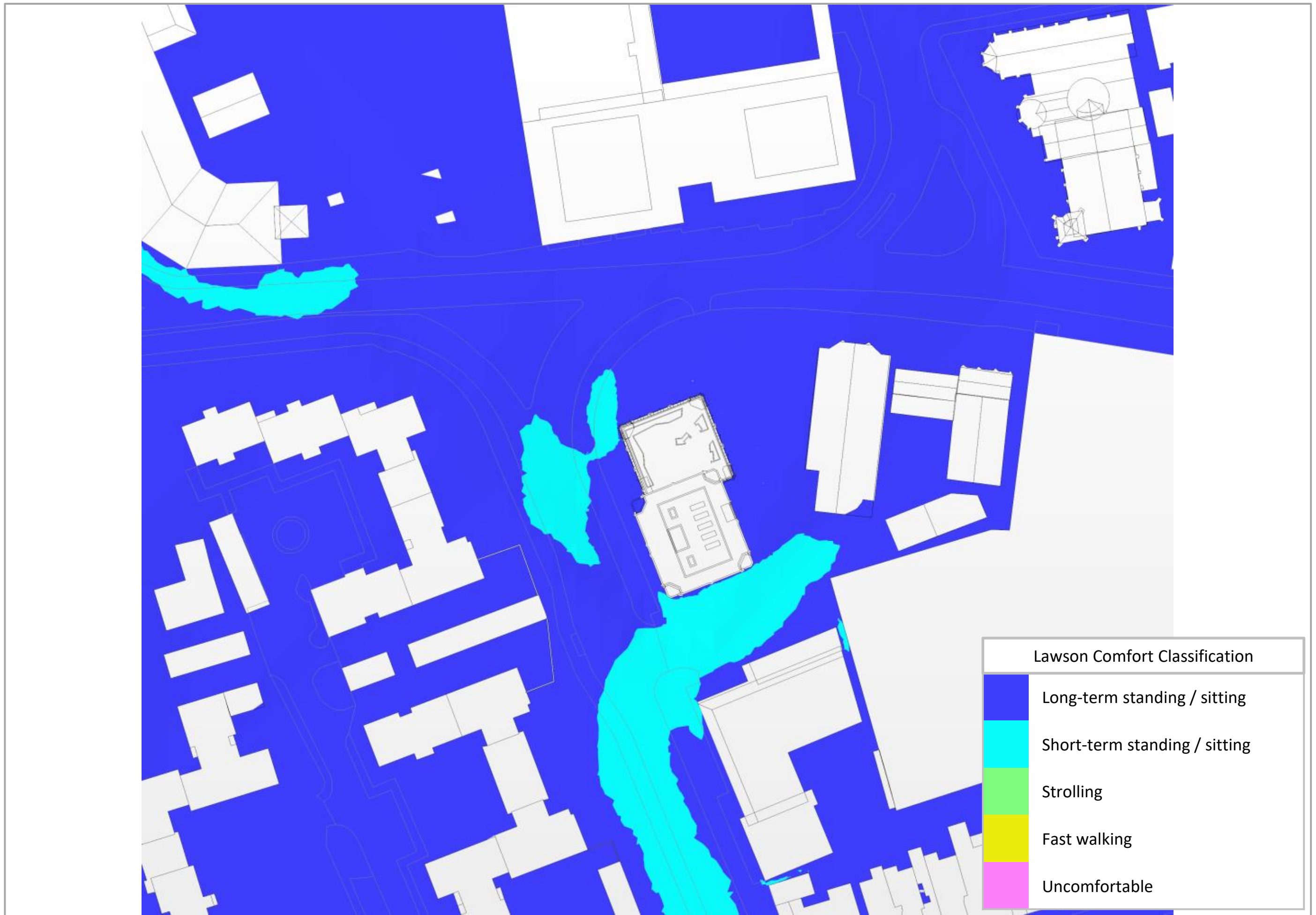
0540534 – City House Worst Seasonal Comfort – Prop. in Cumulative with Landscaping: Ground	Drawing No: 0540534/4.12	Date: 03/01/2024	arcaero

Figure 4.13 – Pedestrian wind conditions, proposed development within cumulative surrounds with soft landscaping, worst case season – terrace / balcony level



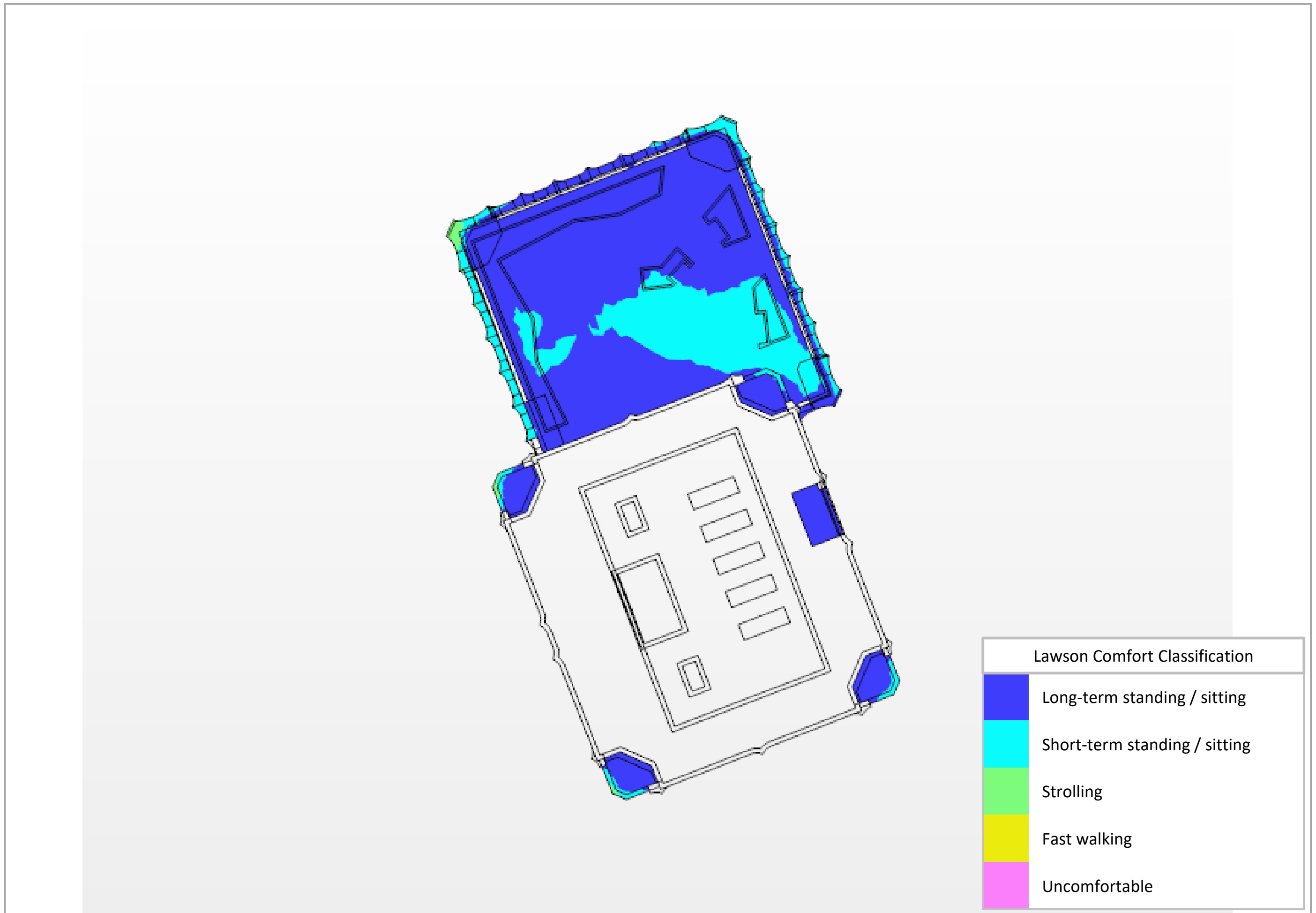
0540534 – City House Worst Seasonal Comfort – Prop. in Cumulative with Landscaping: Elevated	Drawing No: 0540534/4.13	Date: 03/01/2024	arcaero

Figure 4.14 – Pedestrian wind conditions, proposed development within cumulative surrounds with soft landscaping, summer season – ground level



0540534 – City House Summer Comfort – Prop. in Cumulative with Landscaping: Ground	Drawing No: 0540534/4.14	Date: 03/01/2024	arcaero

Figure 4.15 – Pedestrian wind conditions, proposed development within cumulative surrounds with soft landscaping, summer season – terrace / balcony level



0540534 – City House Summer Comfort – Prop. in Cumulative with Landscaping : Elevated Levels	Drawing No: 0540534/4.15	Date: 03/01/2024	arcaero

Appendix A CFD Modelling

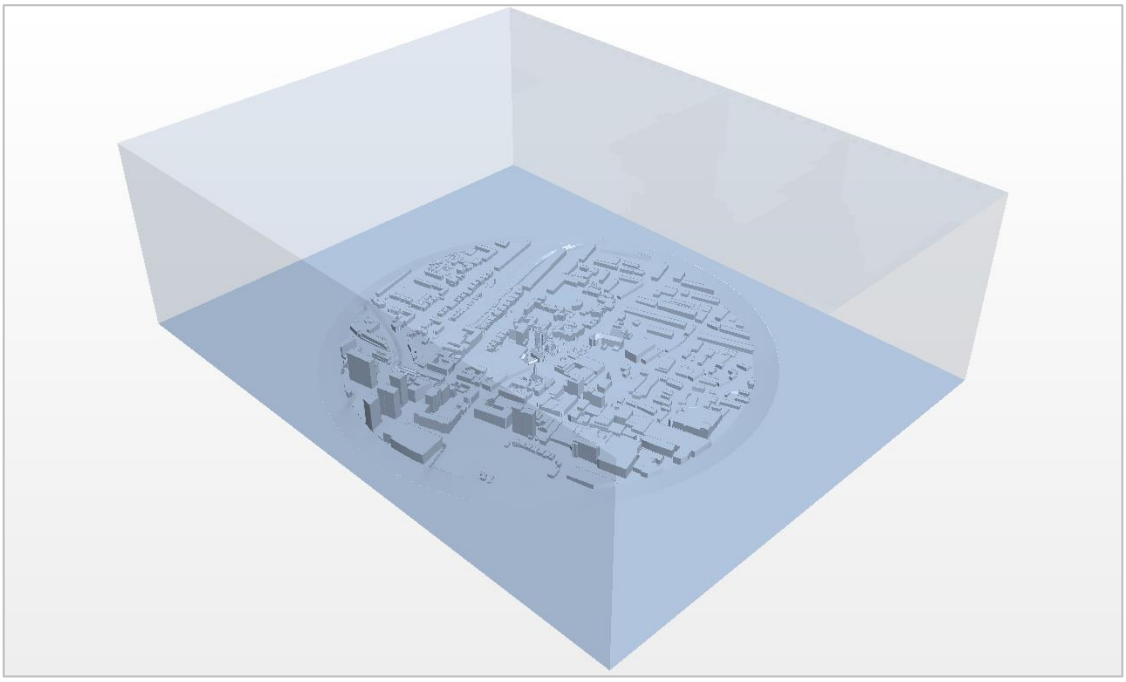
A.1 Spatial discretization

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

The computational domain includes the proposed development site, with surrounding buildings and topographical features within a 450m radius represented explicitly. The full computational domain extends to 1500m in the along-wind direction, 1100m in the across-wind direction, and 450m vertically.

The proposed development and immediate vicinity were meshed down to a cell size of 0.2m in order to capture the detailed geometric features and resulting flow artefacts. The pedestrian ground level surfaces were meshed with a prism layer mesh of 5 layers, which, in the vicinity of the building rise up to a total height of 1.5m above the ground.

Figure A.1 – Computational Domain



A.2 Solution Method

The modelling of an incompressible fluid flow was completed with combinations of semi-implicit method for pressure-linked equations (SIMPLE) algorithms. The resulting flow turbulent features were modelled with introduction of the Shear Stress Transport (SST) k-ω turbulence model. This model was suggested by Menter (3) and is based on a two-equation eddy-viscosity approach, where the SST model formulation combines the use of a k-ω in the inner parts of the boundary layer, but also switches to a k-ε behaviour in the free-stream regions of the solutions. Further details for the selected turbulence model are provided in the work of Menter (4).

A.3 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_o - is the ground surface roughness length in meters

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

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

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 the constant shear stress with height, maintained by the turbulent kinetic energy k equation below:

$$k(z) = \frac{(U^*)^2}{\sqrt{C_\mu}}$$

where:

- Cµ = 0.03 - 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.

A.4 Gust Equivalent Mean Calculation

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

$$\sigma = \sqrt{(k * 2/3)}$$

The GEM is them calculated as:

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

Where gust factor, k_g= 1.85

The final speedup used in the Lawson criteria is the worst case from U_{GEM} and U_{Mean}.

Appendix B Computational Model

A digital model of the site and surrounds was used for the study. The surrounding area was modelled up to a distance of 450m and all features which are likely to impact the wind flow to and through the site have been replicated. The model was reviewed and approved by the design team prior to the study.

B.1 Model Images

Images of the computational model are presented as follows:

-
- Figure B.1 and Figure B.2: Existing site and surrounds
- Figure B.3 and Figure B.4: Proposed development within existing surrounds with soft landscaping
- Figure B.5 and Figure B.6: Proposed development within cumulative surrounds with soft landscaping
- Figure B.7 and Figure B.8: Close-ups of the proposed development

Figure B.1 - Existing site and surrounds, viewed from north

Figure B.2 - Existing site and surrounds, viewed from west

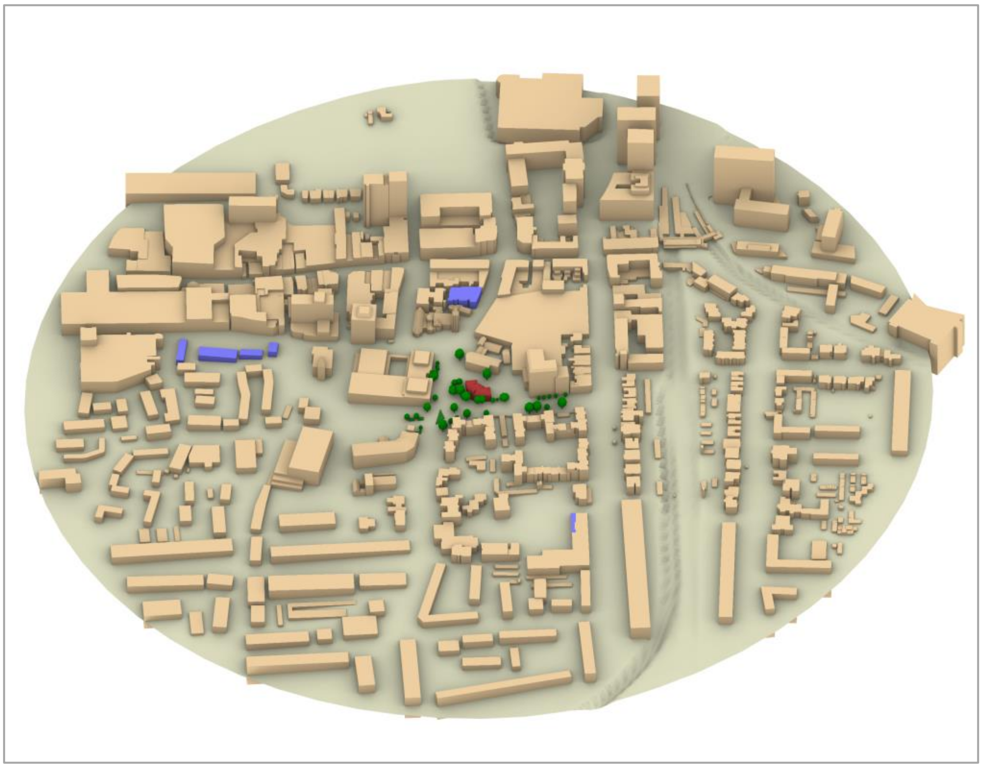


Figure B.3– Proposed development within existing surrounds, viewed from north

Figure B.4 – Proposed development within existing surrounds, viewed from west

Figure B.5 – Proposed development within cumulative surrounds, viewed from north

Figure B.6 – Proposed development within cumulative surrounds, viewed from west

Figure B.7 – Proposed development, close-up from north

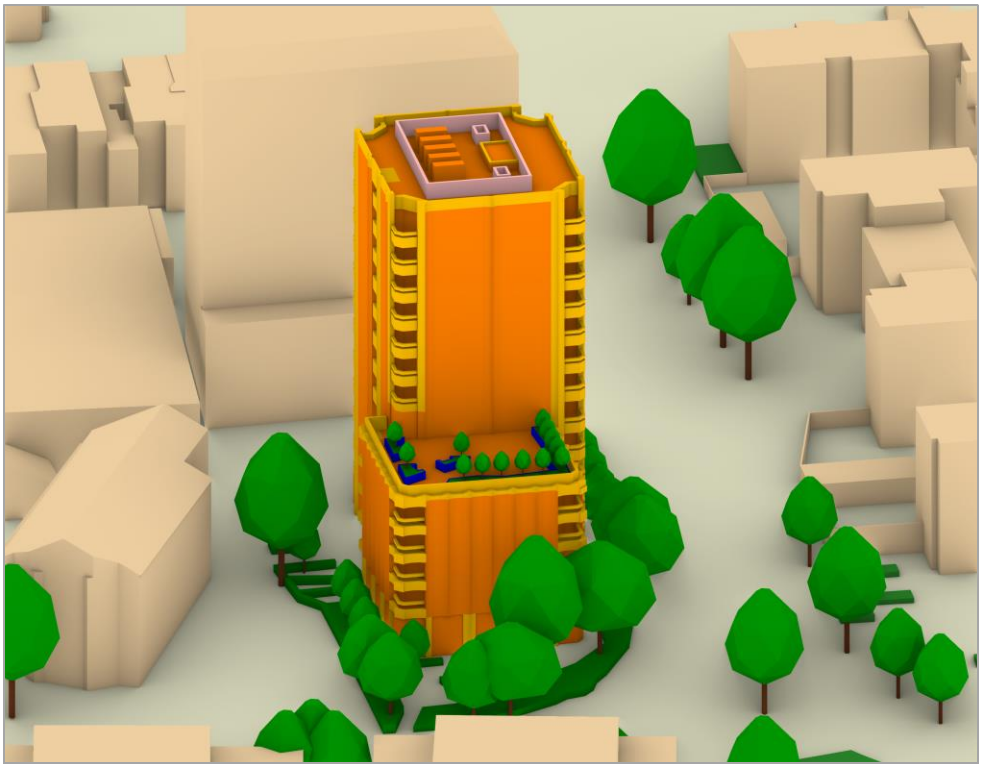


Figure B.8 – Proposed development, close-up from west

Appendix C Wind Climate Analysis

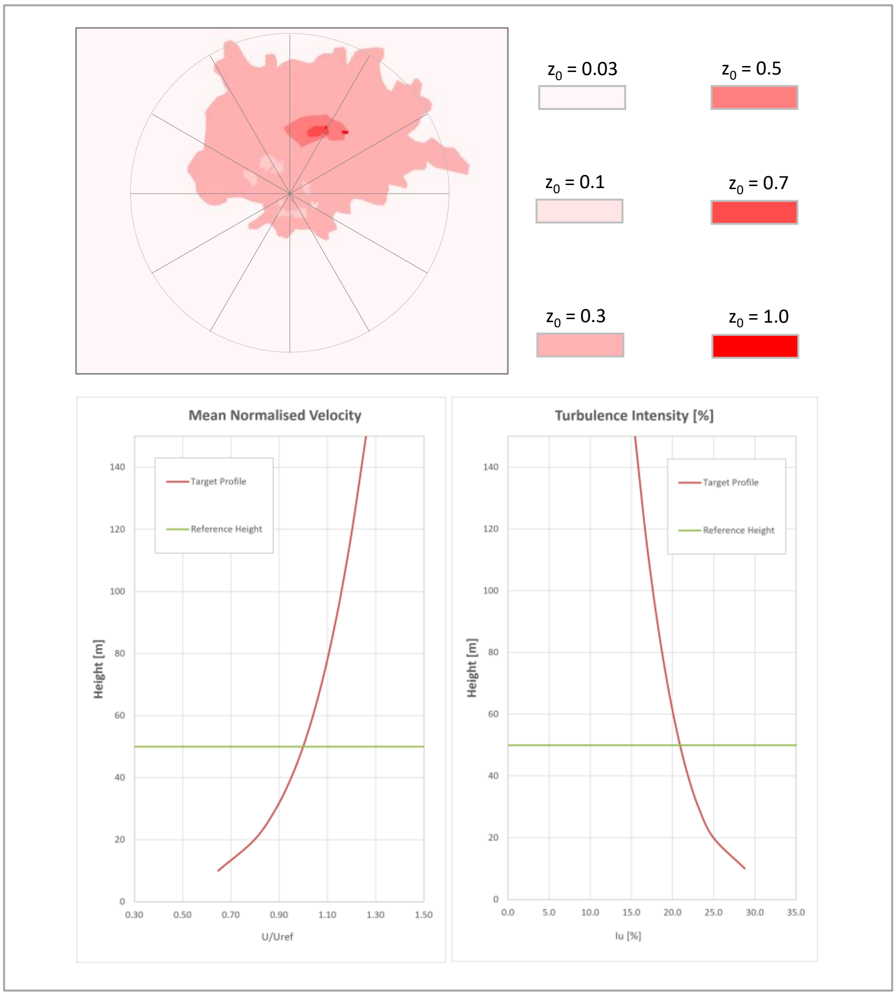
C.1 Surrounding Terrain Assessment

A detailed analysis, based on the widely accepted Deaves and Harris model of the atmospheric boundary layer, as defined in ESDU Item 01008 (2), has been carried out to determine the wind properties at the site. From this analysis, a representative profile was defined as a target profile for the CFD simulations.

C.2 Wind Properties at the Site

Upon conducting the ESDU analysis, each angle was replicated within the CFD model. As each angle exhibited very similar wind profiles, a generic wind profile used in the study is presented within Figure C.1.

Figure C.1 – Mean wind speed and turbulence intensity profiles



C.3 Wind Frequency Data

Wind microclimate studies require that meteorological data is transposed from a nearby weather station with sufficient wind data to produce accurate wind frequency statistics. The current study uses data from London Heathrow Airport. The cumulative wind speed probability distributions, transposed to building height at site are provided in Figure C.2 to Figure C.6.

Figure C.2 – Cumulative wind speed probability distribution at site, annual

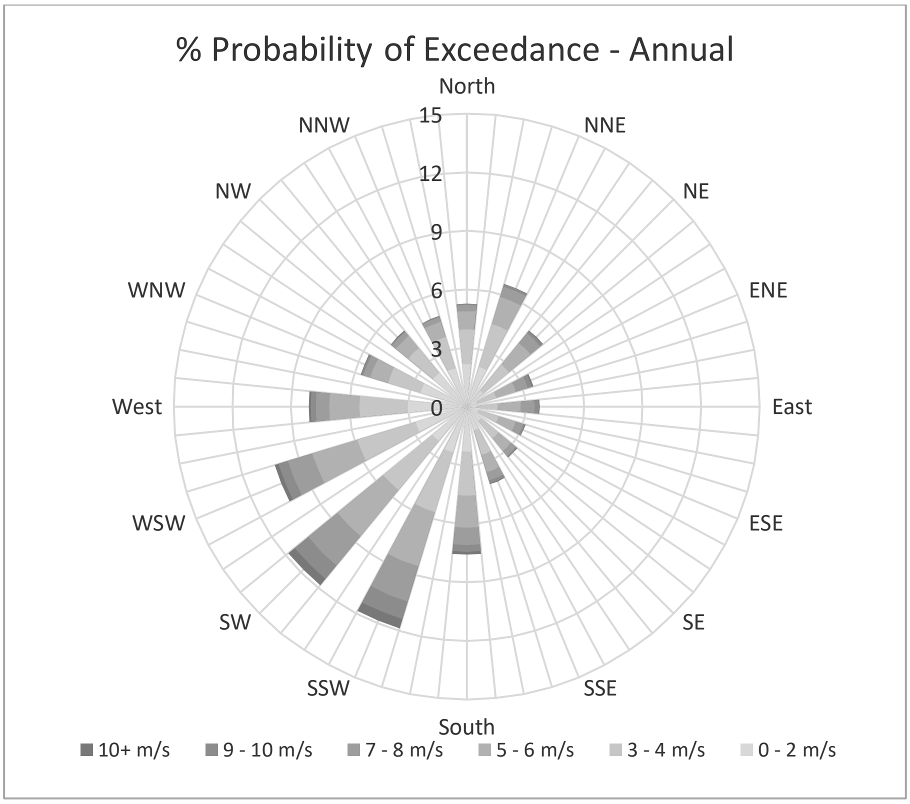


Figure C.3 – Cumulative wind speed probability distribution at site, spring

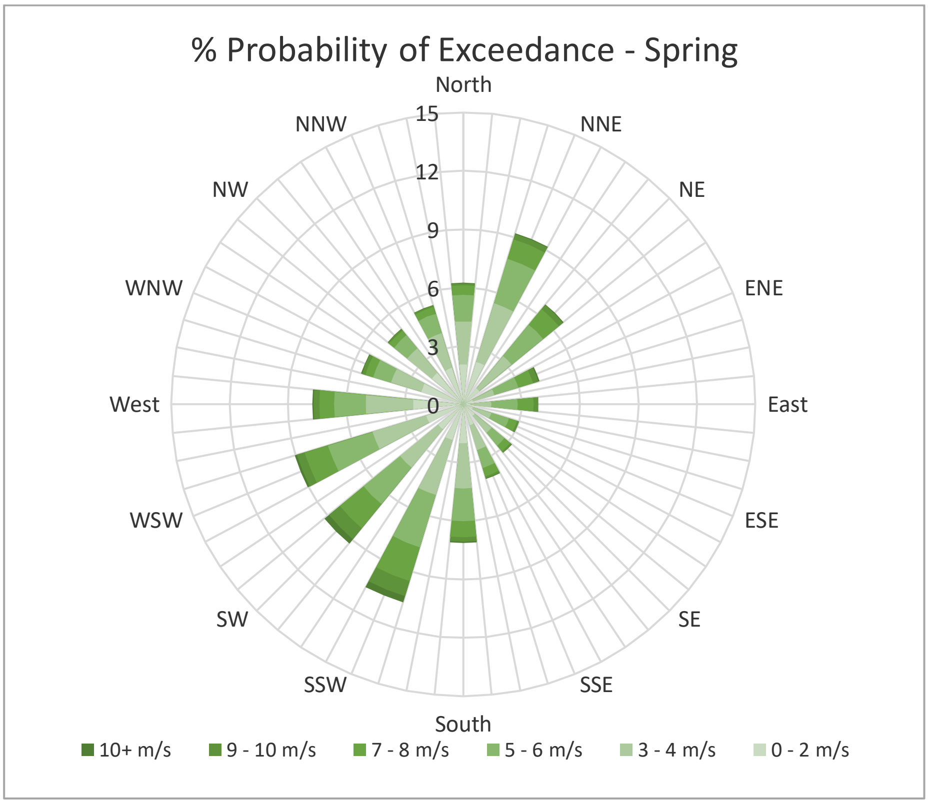


Figure C.4 – Cumulative wind speed probability distribution at site, summer

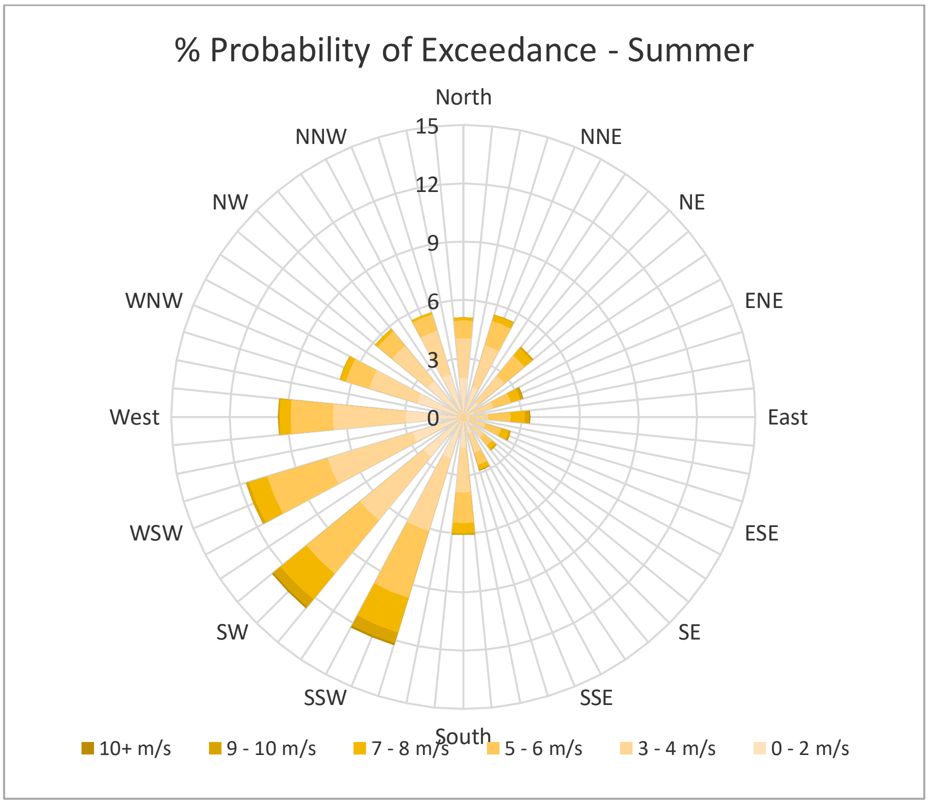


Figure C.5 – Cumulative wind speed probability distribution at site, autumn

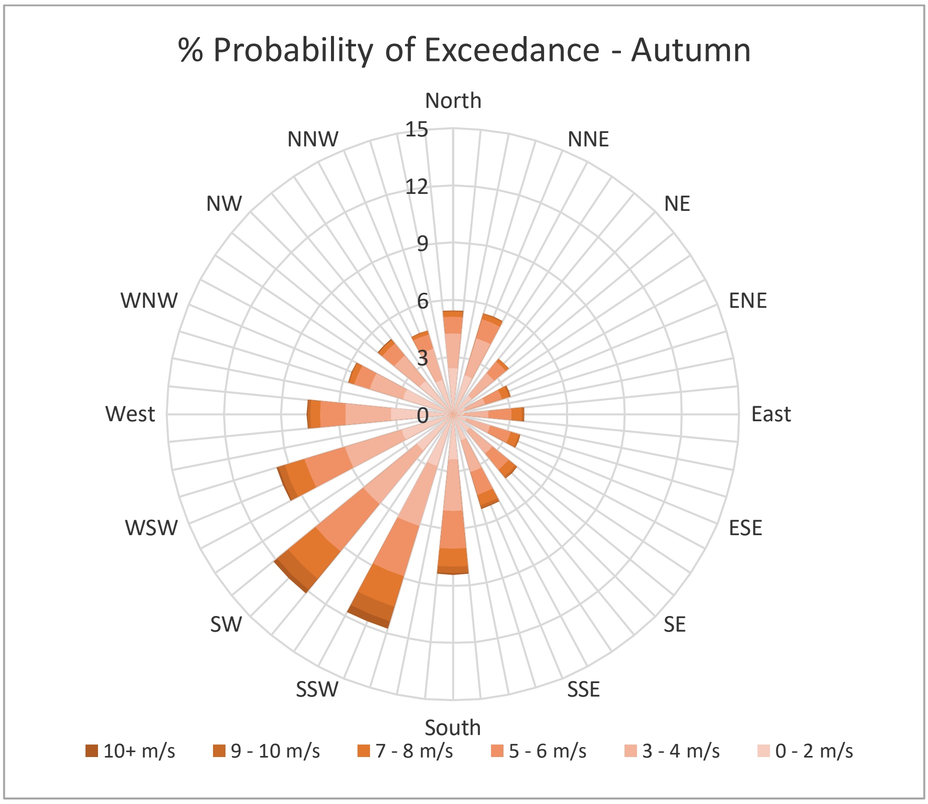


Figure C.6 – Cumulative wind speed probability distribution at site, winter