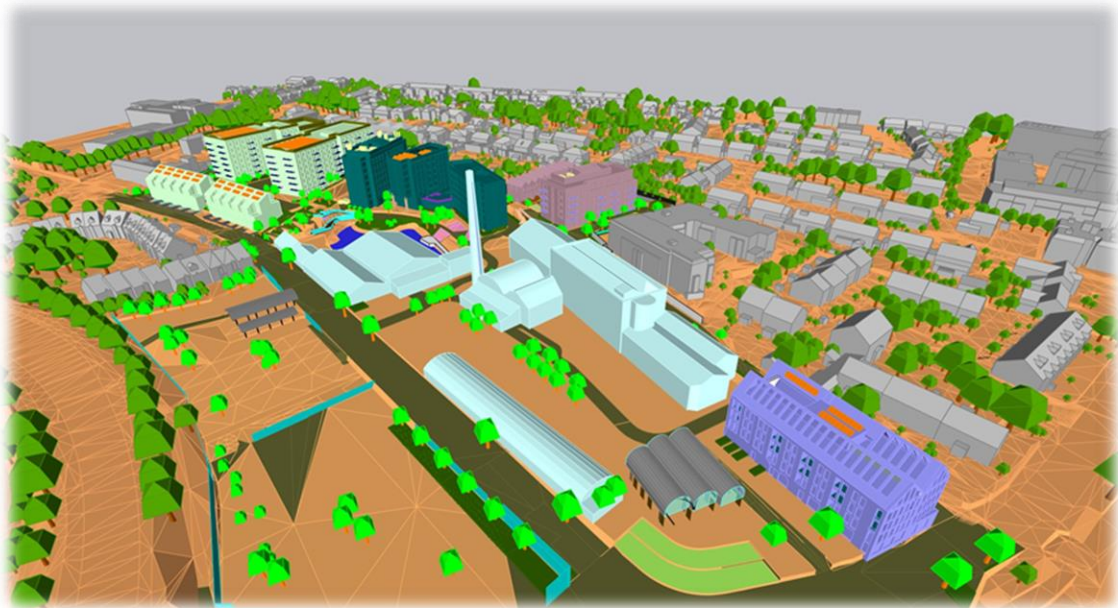




Cleeves Site LTT - CFD

Wind Microclimate Study



Project No: 18451

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1 Introduction and Methodology

IES Consulting have been commissioned to investigate the potential impact of wind around the proposed development in Limerick.

The analysis is conducted to analyse the impact of the Proposed Development on pedestrian comfort and safety for people using public and various amenity spaces around the site. The analysis will look at the air movement around the buildings for eight wind directions (SW, W, NW, N, NE, E, SE and S) with the wind velocity set to the mean value obtained from the weather file.

The following simulation report describes the modelling methodology used in the study, including assumptions made and calculations used to determine the boundary conditions and results obtained from the simulations.

2 Executive Summary

In summary, the analysis resulted in the following:

1. Sitting and Standing Comfort Criteria

a. Ground Amenities: Excellent compliance – No mitigation required

- Salesians Massing
 - Community Garden
 - Play Area
 - Nursery Play Space
 - Viewing Area
- Quarry PBSA
 - Podium Amenities
 - Fitness Court
 - View Terrace
 - Rock Climbing Area
 - Amenities in front of the Reservoir
- Stonetown Terrace
 - Communal Open Space
- O'Callaghan Strand (OCS)
 - Roof Amenities
 - Outdoor Seating Spaces
- Seating locations on the Riverfront
- Amenities within the Flaxmill Square
- Amenities within the Shipyard

b. Balcony Spaces: Excellent compliance – No mitigation required

- Salesians Massing
- Stonetown Terrace
- O'Callaghan Strand (OCS)

2. Walking Comfort Criteria: Excellent compliance – No mitigation required.

3. Safety Criteria: Excellent compliance with Lawson's Normal and Sensitive Pedestrian Safety Criteria.

The micro-siting of the plant on the roof infrastructure of one of the buildings would not affect the conclusions of this assessment.

3 Key Findings

For the analysis, eight steady-state Computational Fluid Dynamics (CFD) simulations were performed for the main wind directions (N, NE, E, SE, S, SW, W, and NW) and the annual average wind speed obtained from the Shannon Airport weather dataset. The results obtained from the simulations were extrapolated along the annual weather data to obtain the most probable local air speed for each hour of the year. Statistical analysis was performed on this dataset to check compliance against Lawson's Pedestrian Comfort criterion.

The following table provides values for Lawson's Pedestrian Comfort Assessment criteria for various activities.

Category	Pedestrian Activity	Threshold mean hourly wind speed not to be exceeded for more than 5% of the time (m/s)
C1	Business Walking	10
C2	Leisurely Walking	8
C3	Standing	6
C4	Sitting	4

Table 1: Lawson's Pedestrian Comfort Assessment Criteria for various activities

The following table provides values for Lawson's Pedestrian Safety Assessment criteria.

Category	Pedestrian Type	Threshold mean hourly wind speed not to be exceeded more than once per annum (m/s)
S1	Typical Pedestrian	20
S2	Sensitive Pedestrian	15

Table 2: Lawson's Pedestrian Safety Assessment Criteria

The results are presented in the form of false-colour contour images showing the percentage of the year that the local air speed is likely to exceed a certain value at every point on the area of interest. The air speed threshold value is noted in the title of the colour legend within the top left corner of each image. Note that the scale for the result images of the comfort criteria ranges from 0.1% to 100% (as a percentage of the year). This is with reference to Table 1 above. The scale for the result images for the safety criteria ranges from 0.001% to 1% (as a percentage of the year). This is with reference to Table 2 above. These criteria are explained in detail in [section 7.1](#).

The median wind speed recorded was more than 5 m/s for Limerick's climatic conditions. That means for 50% of the year, the wind speed is higher than 5 m/s for Limerick. The Lawson's Sitting Criterion requires the local air speed to be no more than 4m/s for 95% of the year. Thus, the Lawson's Sitting Criterion presents the task of improving 10 times over the climatic conditions at the location of interest within Limerick. This can be achieved by appropriate landscaping and wind mitigation measures.

3.1 Collective Results

[Figure 1](#) shows the collective results of wind comfort for the 5% threshold as noted above. These results were summed to calculate the total number of hours that a given pedestrian activity class exceeds the 5% yearly threshold based on the hierarchy of wind speed. [Figure 1](#) illustrates the collective results of wind comfort for the 10% threshold. These results were summed to calculate the total number of hours that a given pedestrian activity class exceeds the 10% yearly threshold. The sitting comfort indicates that the wind speed was lower than 4m/s, while the rest of the classes were above this threshold. It is worth noting that when a space is classified under a certain activity class, it will also meet the requirements of all activity classes above it in the hierarchy scale. For example, if a space is comfortable for sitting activities, it will also be comfortable for standing and walking activities.

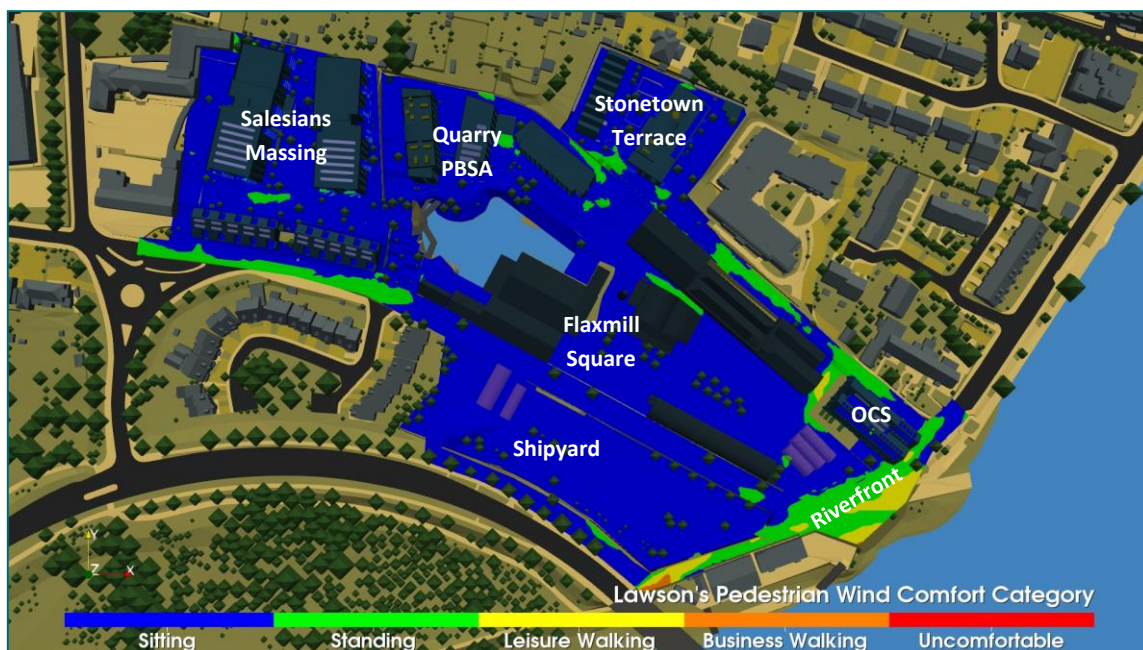


Figure 1: Collective Results: 5% Threshold

The entire site showed good compliance with the Sitting, Standing and Walking activities.

No location exhibited completely uncomfortable conditions anywhere around the site at 5% threshold limits.

It is worth noting that a pedestrian activity class is merely a statistical assessment of the local wind climate. When a region is classified as a certain class, this does not mean that the people are prevented from doing that activity for a long period of time. Rather, it only means that for more than 5% of the time (per year), the wind speed for this activity could result in an uncomfortable environment. However, during the remaining times of the year, this activity can be considered comfortable.

3.2 Sitting and Standing Comfort Results

The Lawson's Sitting Comfort Criterion states that the local air speed at designated locations should not exceed 4 m/s for more than 5% of the duration analysed. The Lawson's Standing Comfort Criterion states that the local air speed at designated locations should not exceed 6 m/s for more than 5% of the duration analysed.

The results of the annual analysis for sitting and standing criteria are observed at the bottom of the images presented throughout this report.

3.2.1 Overall Site

[Figure 2](#) and [Figure 3](#) illustrate Lawson's Sitting and Standing Comfort Criteria results for the amenities designed at various locations throughout the site. The results are good and meet the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The wind speed is generally lower than 4m/s and 6m/s for more than 95% of the year as per the criteria's requirement.

Some of the locations visible in yellow and orange colour contours on the riverfront showed limited compliance with the requirements of Lawson's Sitting Comfort Criterion. The local air speed is likely to exceed 4m/s for up to 50% of the year at these locations. This space was affected due to the prevailing winds.

When comparing the results for these locations to Lawson's Standing Comfort Criterion results, they demonstrate excellent compliance, i.e., the local air speed does not exceed 6 m/s for more than 5% of the year, see Figure 11. Of the 20% of the year when the local air speed exceeds 4m/s, three-quarters of that collective time (i.e. 15% of the year), it does not exceed 6m/s. The local air speed in these spaces will be less than 4 m/s for 80% of the year and between 4 and 6 m/s for 15% of the year.

Any exceedance noted can be considered very marginal, and it will not lead to an environment which is unpleasant to use. The local air speed is only going to be greater than a gentle breeze, but frequently less than a moderate breeze. Such conditions are unlikely to affect the usability of this space for personal recreation.

No mitigation measures are recommended.

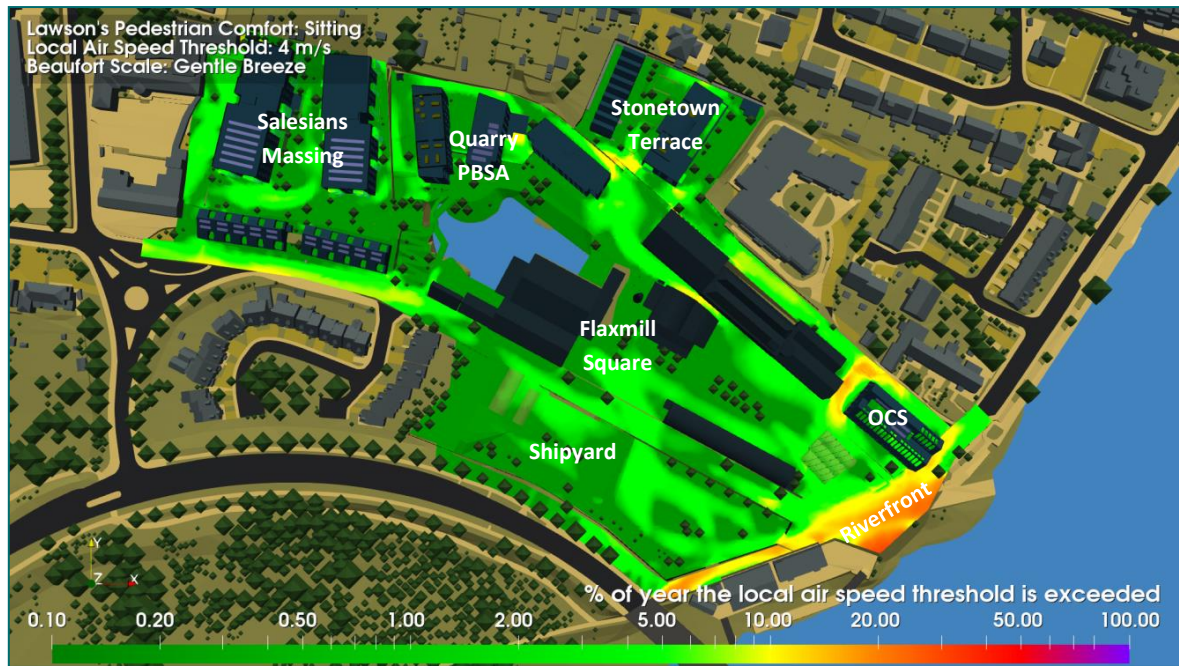


Figure 2: Sitting Comfort Criterion: Ground Amenities: Overall Site

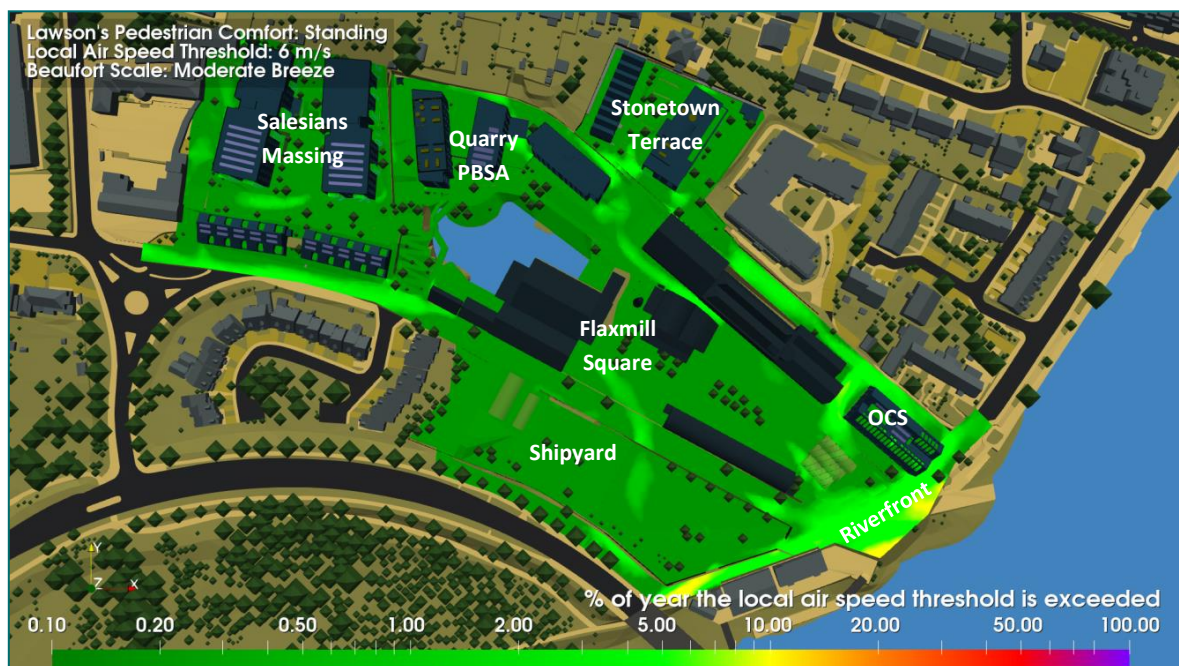


Figure 3: Standing Comfort Criterion: Ground Amenities: Overall Site

3.2.2 Salesians Massing

3.2.2.1 Balcony Spaces

[Figure 4](#) to [Figure 9](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the balcony spaces of the apartment blocks of the Salesians Massing.

The results showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.



Figure 4: Sitting Comfort Criterion: Salesians Massing: Balconies: View from the southeast

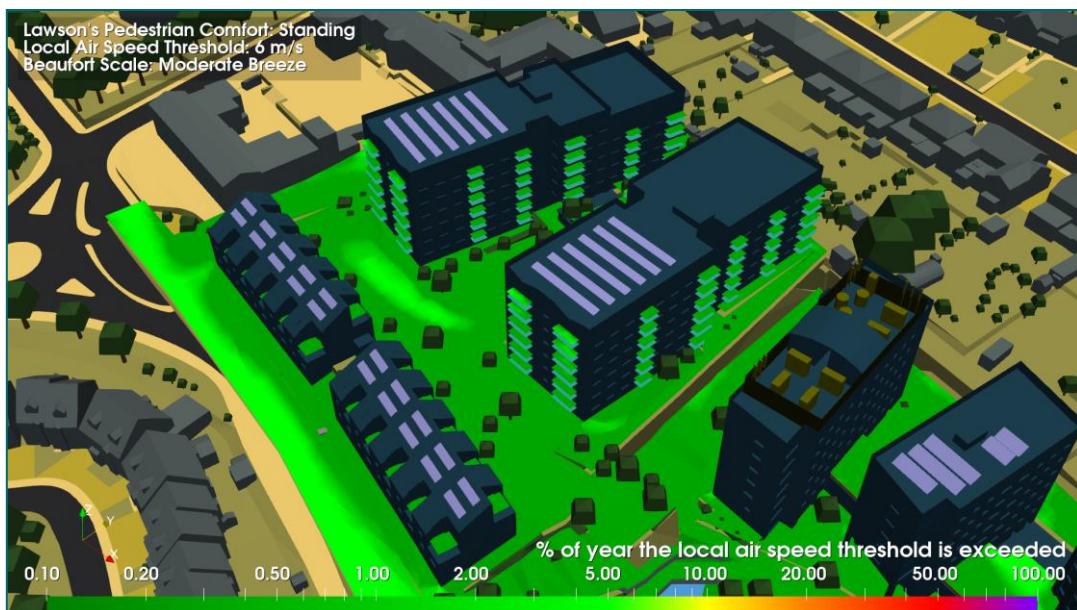


Figure 5: Standing Comfort Criterion: Salesians Massing: Balconies: View from the southeast

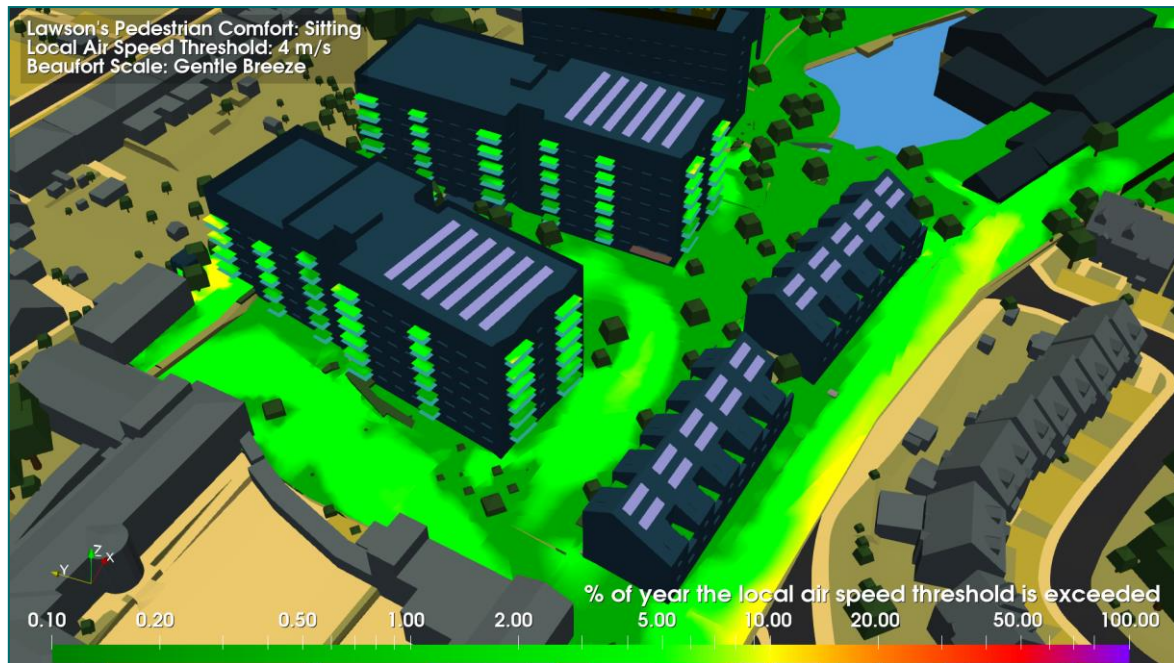


Figure 6: Sitting Comfort Criterion: Salesians Massing: Balconies: View from the southwest

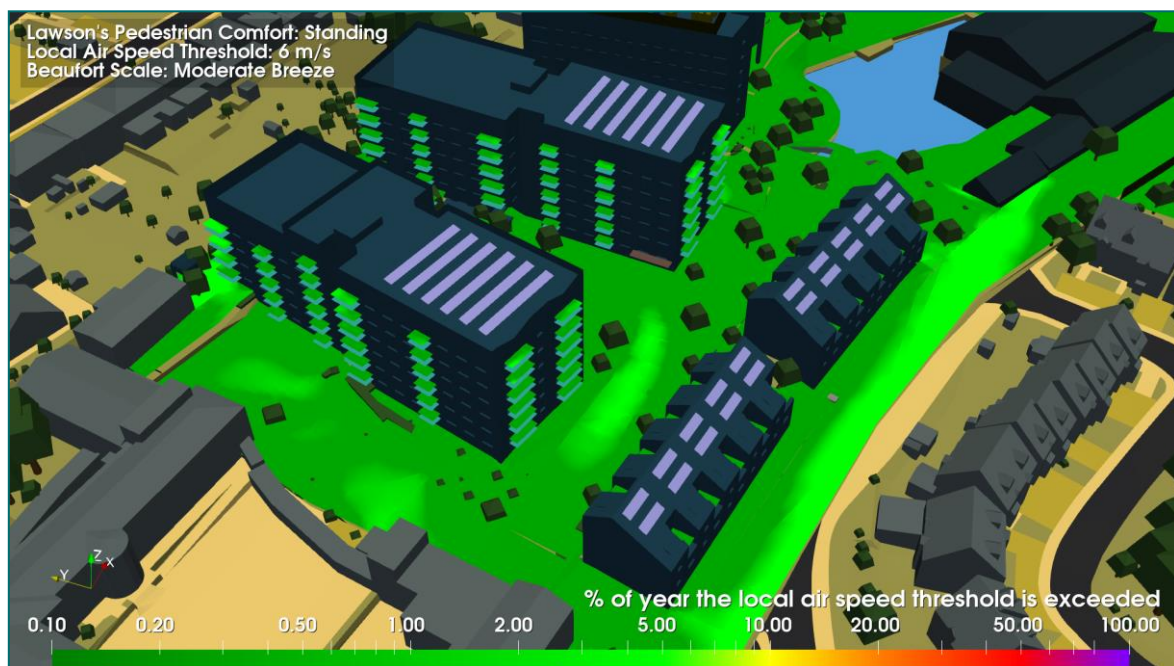


Figure 7: Standing Comfort Criterion: Salesians Massing: Balconies: View from the southwest

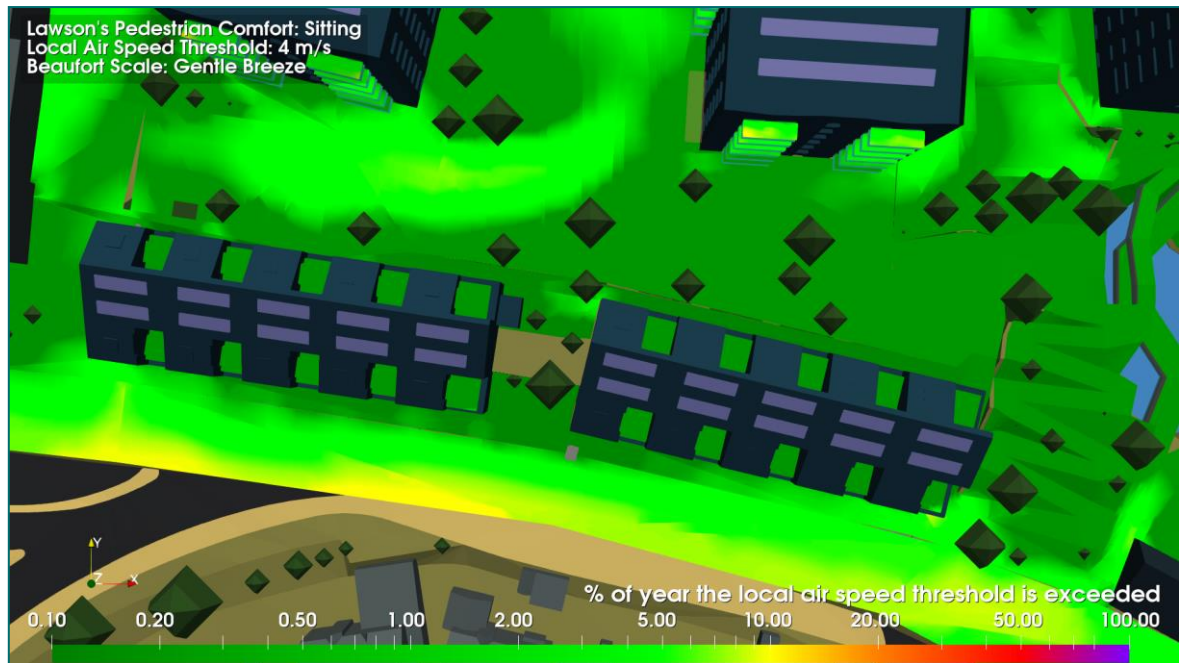


Figure 8: Sitting Comfort Criterion: Salesians Massing: Balconies: View from the top



Figure 9: Standing Comfort Criterion: Salesians Massing: Balconies: View from the top

3.2.2.2 Ground Amenities

[Figure 10](#) and [Figure 11](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the following amenity spaces located within the Salesians massing towards the northwest of the Cleeves site.

- Communal Garden space outlined in white
- Nursery Play space outlined in yellow
- Play area outlined in orange

The results on these amenity spaces showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.



Figure 10: Sitting Comfort Criterion: Salesians Massing: Ground Amenities



Figure 11: Standing Comfort Criterion: Salesians Massing: Ground Amenities

3.2.2.3 Viewing Area towards southeast

[Figure 12](#) and [Figure 13](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the viewing area located towards the southeast of the Salesians massing.

The results showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.



Figure 12: Sitting Comfort Criterion: Salesians Massing: Viewing Area



Figure 13: Standing Comfort Criterion: Salesians Massing: Viewing Area

3.2.3 Quarry and Reservoir

3.2.3.1 Podium Spaces

[Figure 14](#) and [Figure 15](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the podium spaces of the Quarry PBSA Blocks.

The results showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

A portion of the podium space, visible in yellow colour contouring in [Figure 14](#), showed exceedance of the requirements of Lawson's Sitting Comfort Criterion. The local air speed is likely to exceed 4m/s for up to 10% of the year at these locations. This space was affected due to the prevailing southwesterly and westerly winds.

When comparing the results for these locations to Lawson's Standing Comfort Criterion results, they demonstrate excellent compliance, i.e., the local air speed does not exceed 6 m/s for more than 5% of the year, see [Figure 15](#). Of the 10% of the year when the local air speed exceeds 4m/s, half of that collective time (i.e. 5% of the year) does not exceed 6m/s. The local air speed on this portion will be less than 4 m/s for 90% of the year and between 4 and 6 m/s for 10% of the year.

Any exceedance noted can be considered very marginal, and it will not lead to an environment which is unpleasant to use. The local air speed is only going to be greater than a gentle breeze, but frequently less than a moderate breeze. Such conditions are unlikely to have any impact on the usability of this space for personal recreation.

No mitigation measures are recommended.



Figure 14: Sitting Comfort Criterion: Quarry0 PBSA: Podium



Figure 15: Standing Comfort Criterion: Quarry PBSA: Podium

3.2.3.2 Amenities towards the west of the Quarry PBSA

[Figure 16](#) and [Figure 17](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the following amenity spaces located towards the west of the Quarry blocks.

- Fitness Court
- Rock Climbing Area
- View Terrace

The results on these amenity spaces showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.

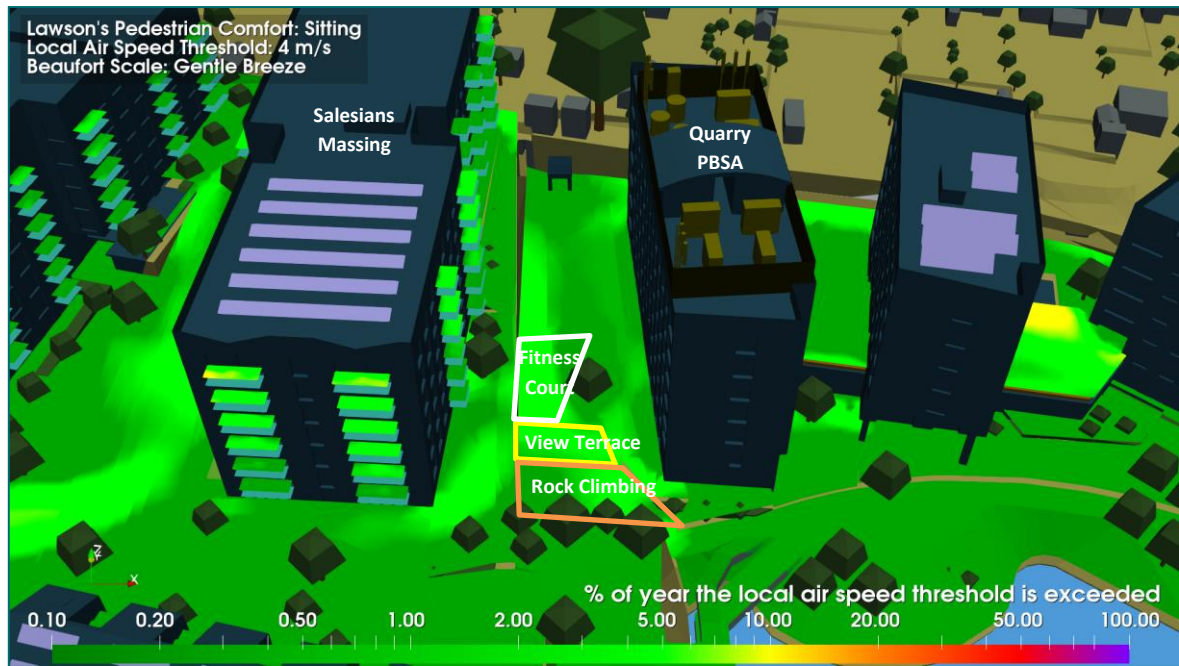


Figure 16: Sitting Comfort Criterion: Quarry PBSA: Ground Amenities

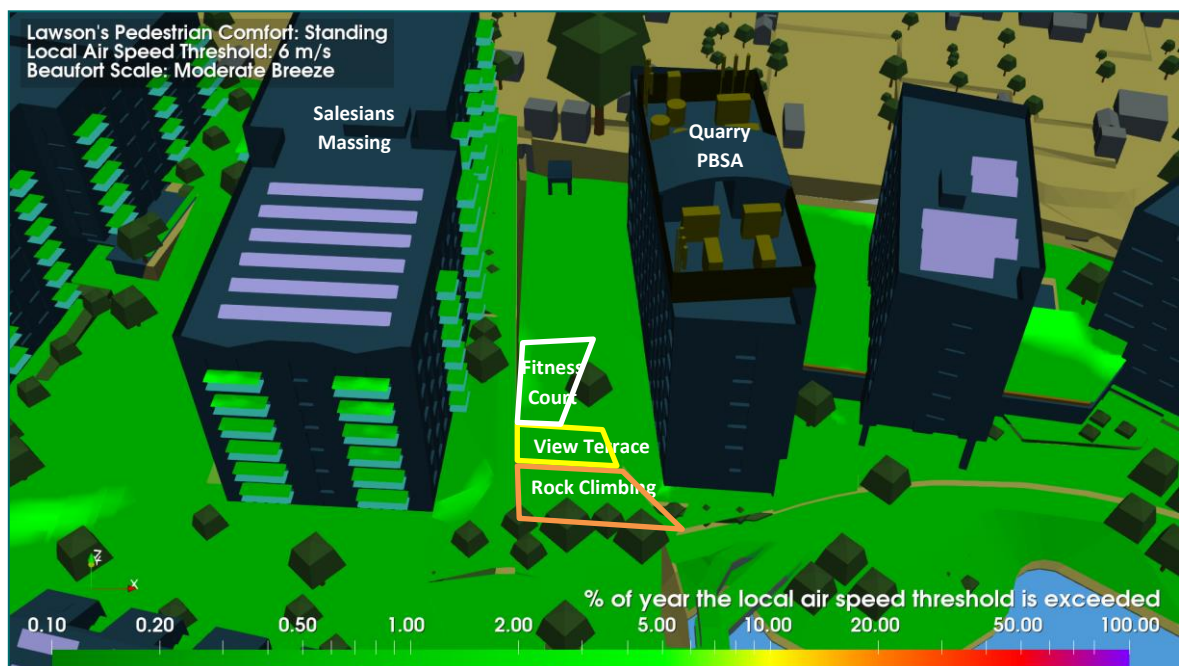


Figure 17: Standing Comfort Criterion: Quarry PBSA: Ground Amenities

3.2.3.3 Amenities in front of the Reservoir

[Figure 18](#) and [Figure 19](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the amenity spaces located in front of the reservoir and towards the south of the Quarry PBSA Blocks.

The results showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.



Figure 18: Sitting Comfort Criterion: Quarry PBSA: Amenities in front of the Reservoir



Figure 19: Standing Comfort Criterion: Quarry PBSA: Amenities in front of the Reservoir

3.2.4 Stonetown Terrace

3.2.4.1 Balcony Spaces

[Figure 20](#) to [Figure 23](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the balcony spaces of the apartment blocks of the Stonetown Terrace.

The results showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.

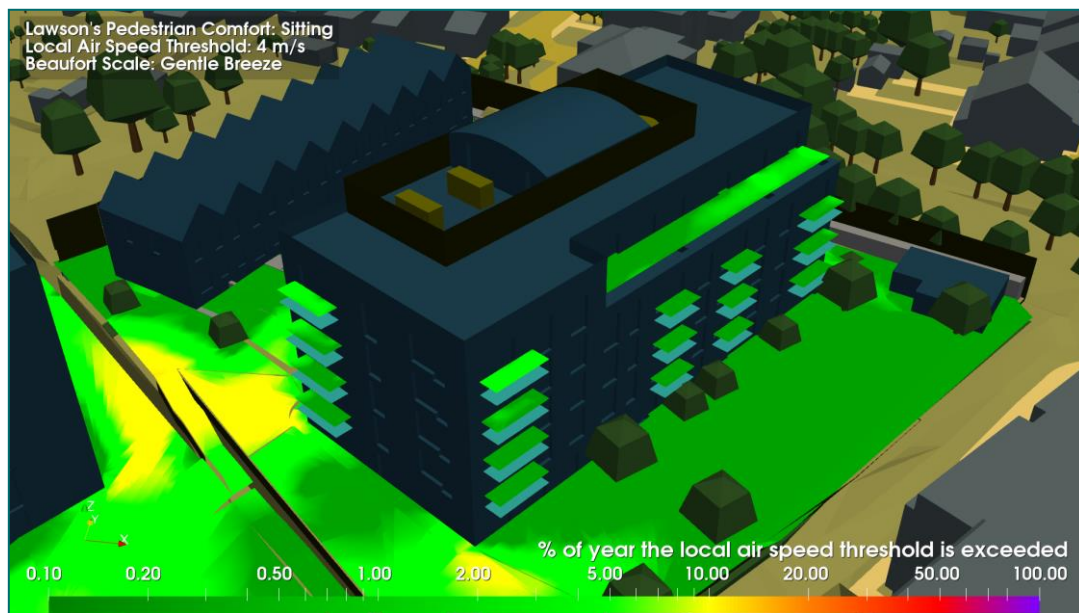


Figure 20: Sitting Comfort Criterion: Stonetown Terrace: Balconies: View from the southeast

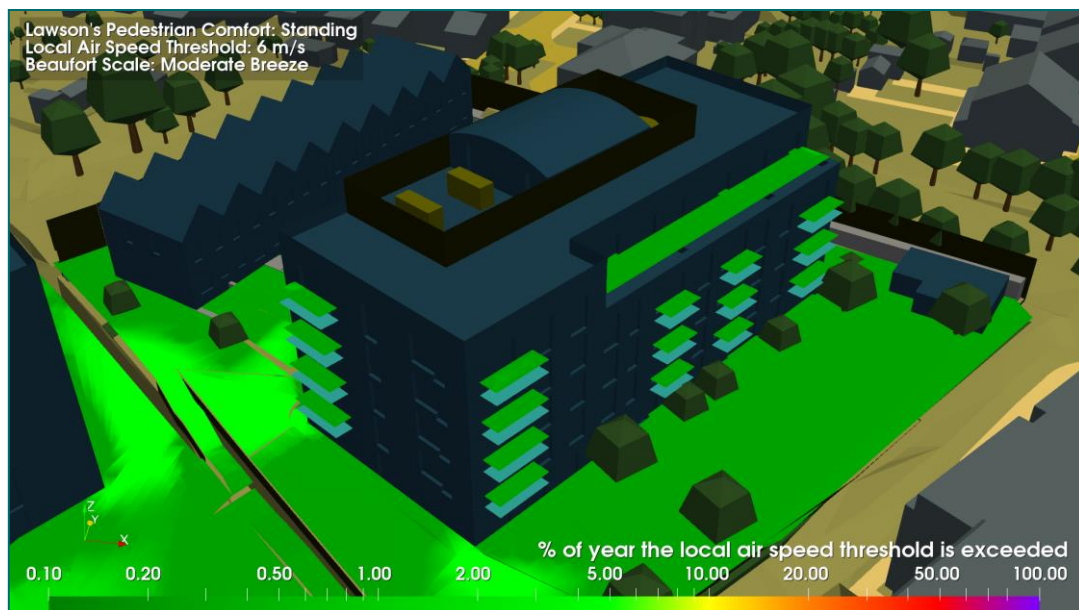


Figure 21: Standing Comfort Criterion: Stonetown Terrace: Balconies: View from the southeast

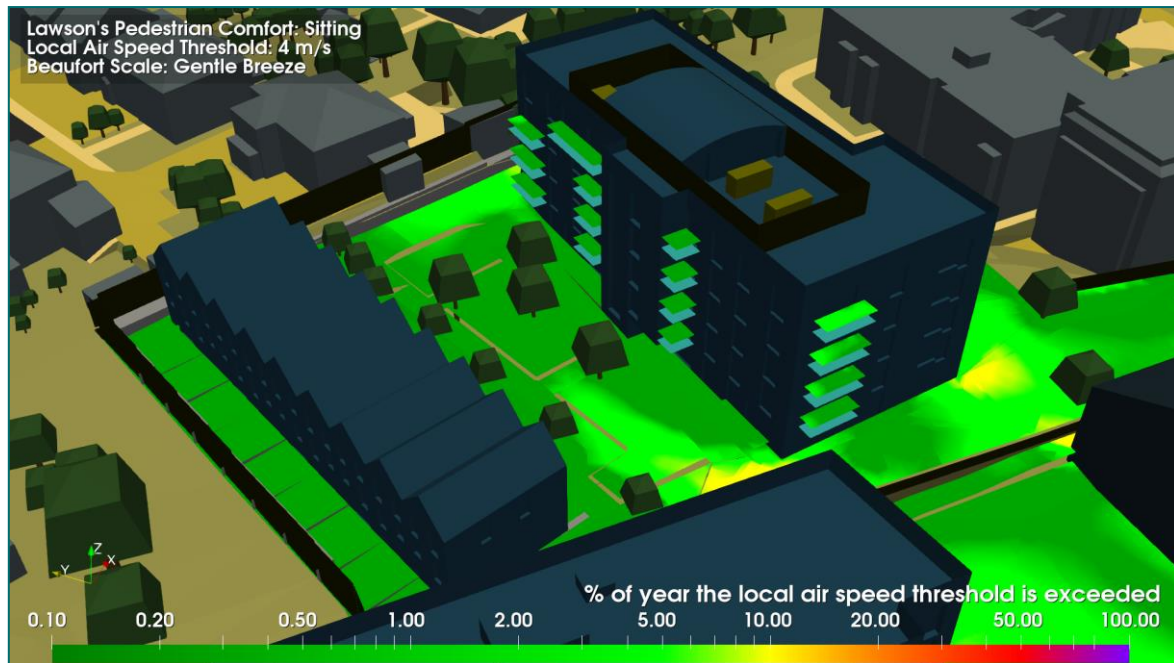


Figure 22: Sitting Comfort Criterion: Stonetown Terrace: Balconies: View from the southwest

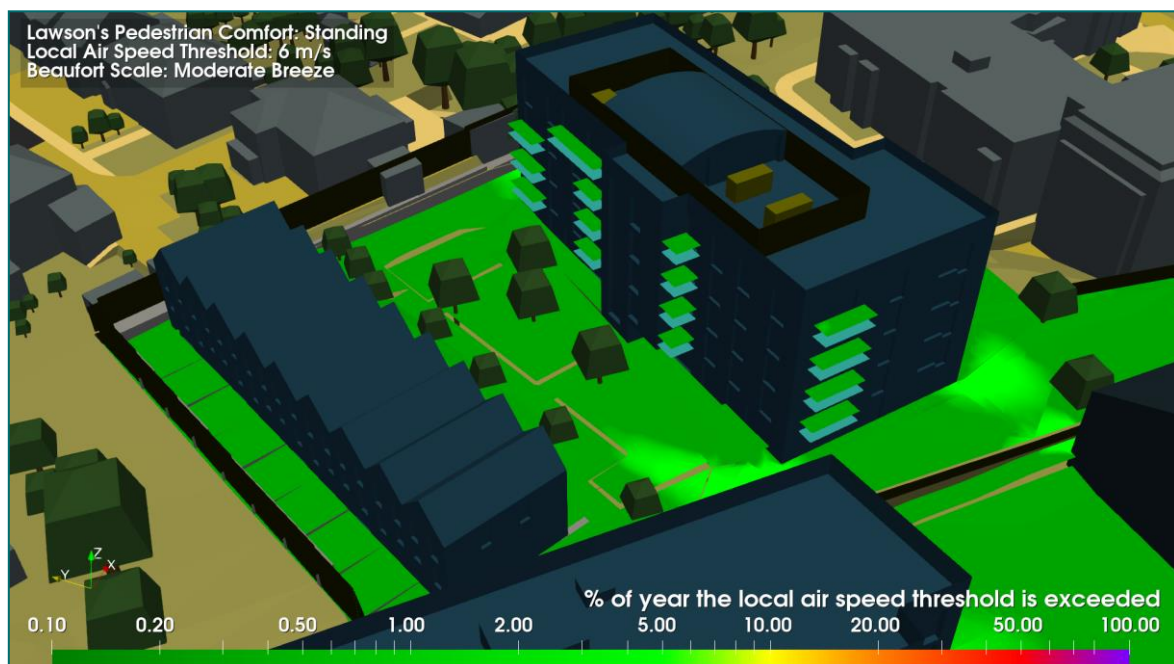


Figure 23: Standing Comfort Criterion: Stonetown Terrace: Balconies: View from the southwest

3.2.4.2 Communal Open Space

[Figure 24](#) and [Figure 25](#) show Lawson's Sitting and Standing Comfort Criteria results on the Communal Open Space located within the Stonetown Terrace.

The results on these amenity spaces showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.

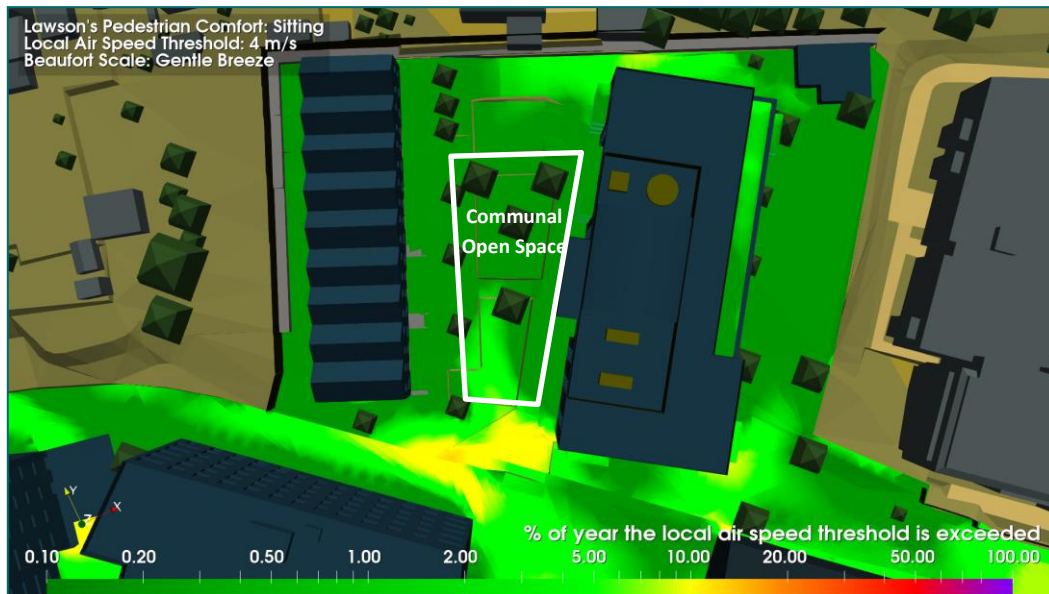


Figure 24: Sitting Comfort Criterion: Stonetown Terrace: Communal Open Space



Figure 25: Standing Comfort Criterion: Stonetown Terrace: Communal Open Space

3.2.5 O'Callaghan Strand (OCS)

3.2.5.1 Balcony Spaces

[Figure 26](#) to [Figure 29](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the balcony spaces of the O'Callaghan Strand (OCS) Block.

The results showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.



Figure 26: Sitting Comfort Criterion: OCS Block: Balconies: View from the southwest

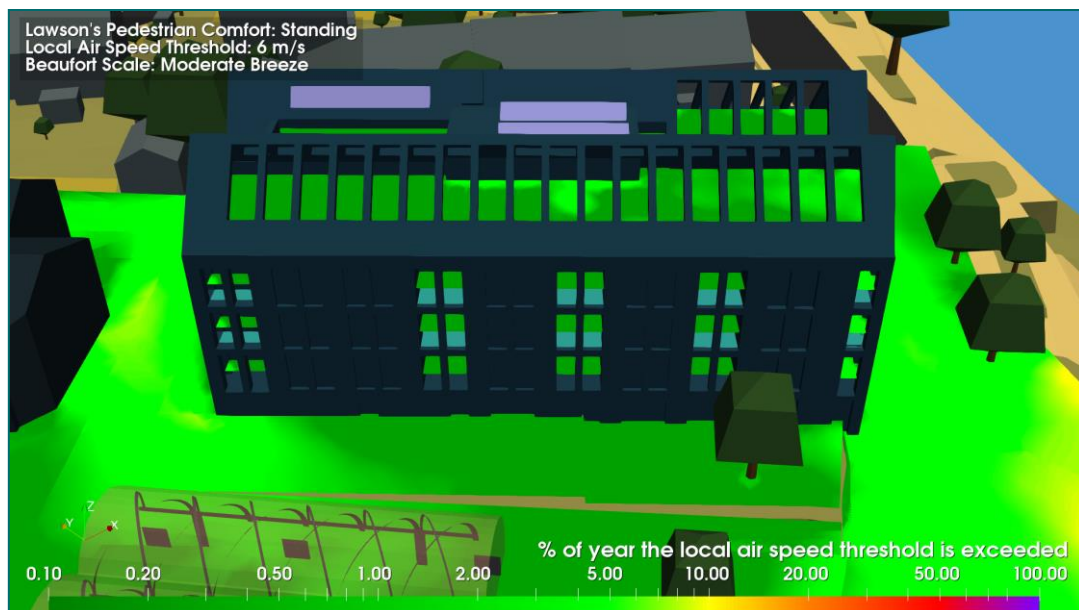


Figure 27: Standing Comfort Criterion: OCS Block: Balconies: View from the southwest

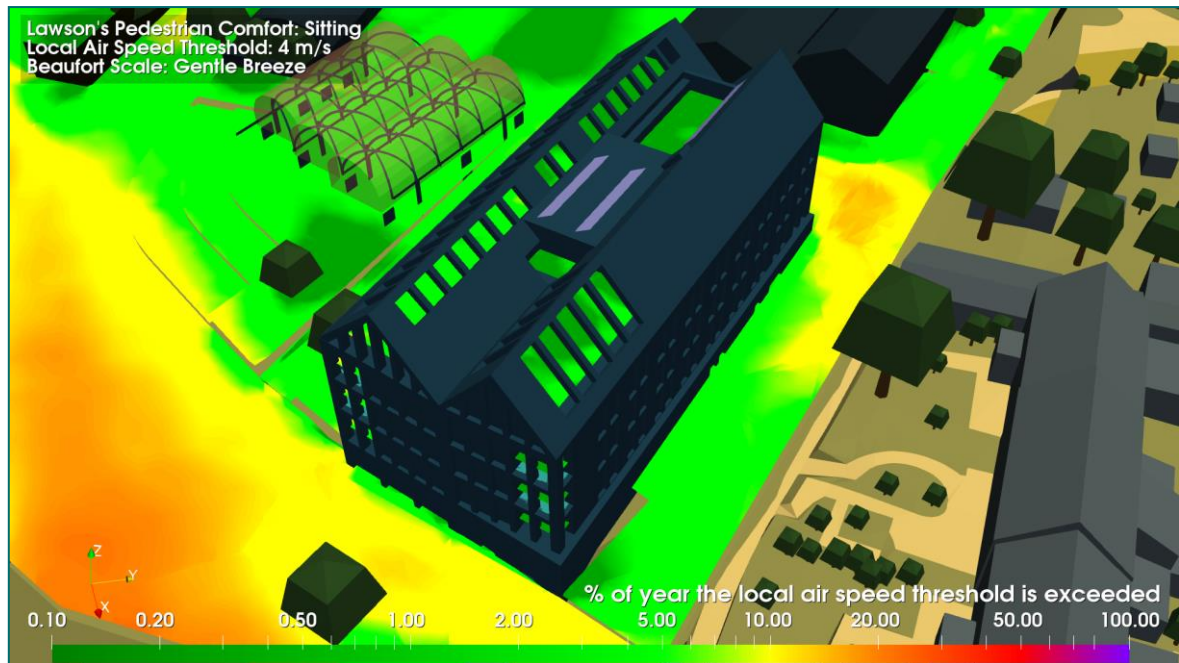


Figure 28: Sitting Comfort Criterion: OCS Block: Balconies: View from the southeast

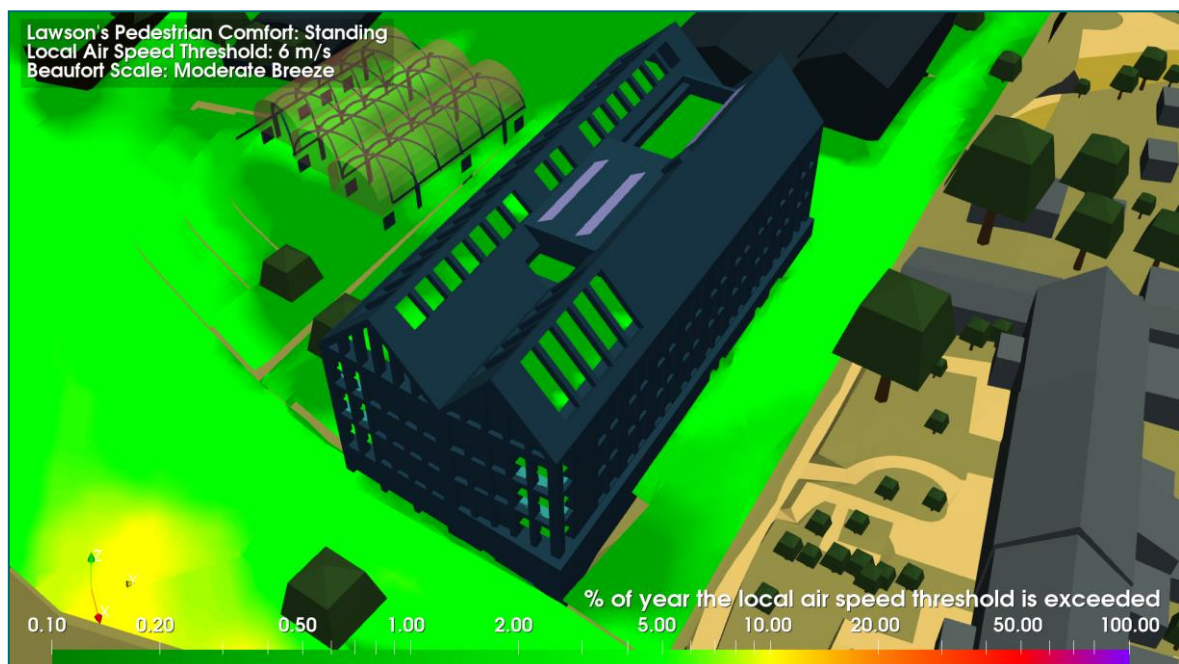


Figure 29: Standing Comfort Criterion: OCS Block: Balconies: View from the southeast

3.2.5.2 Roof Amenities

[Figure 30](#) and [Figure 31](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the roof spaces of the O'Callaghan Strand (OCS) Block.

The results showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.

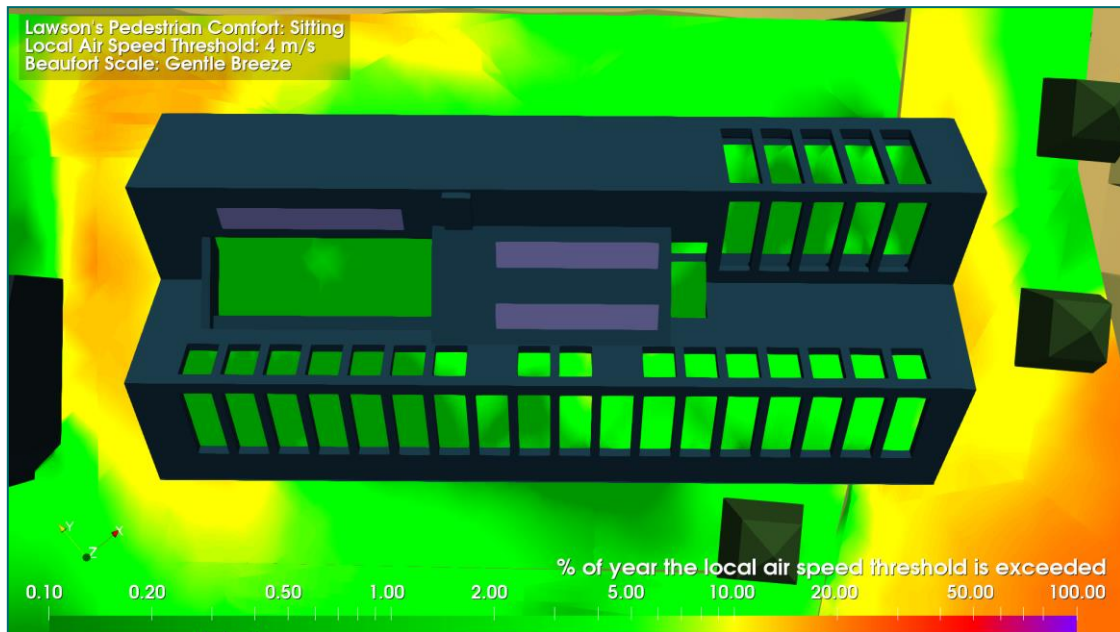


Figure 30: Sitting Comfort Criterion: OCS Block: Roof Amenities

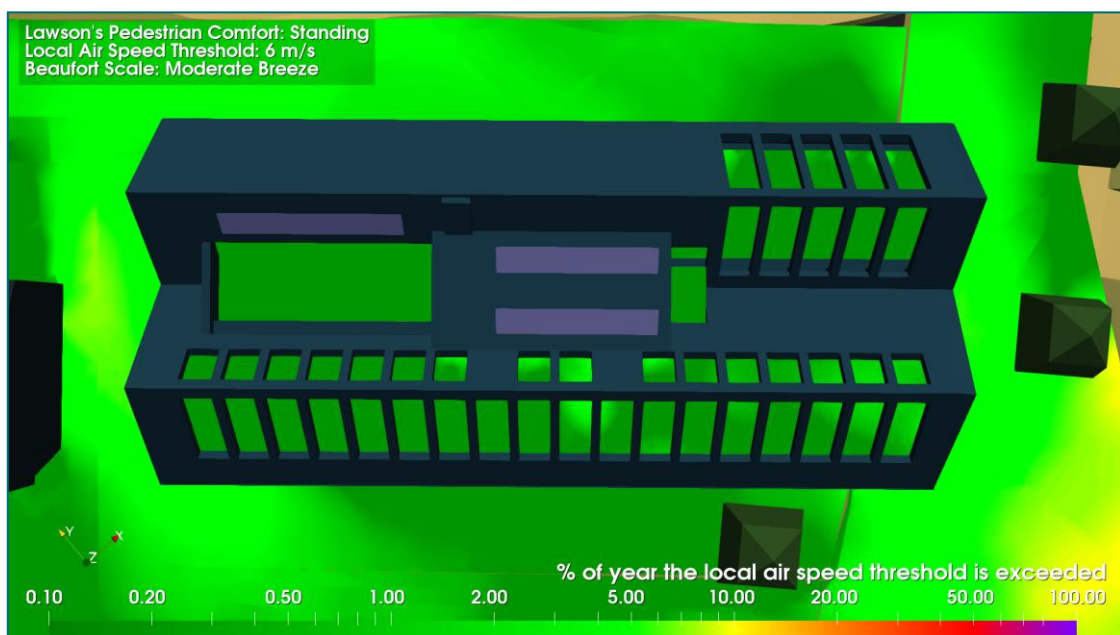


Figure 31: Standing Comfort Criterion: OCS Block: Roof Amenities

3.2.5.3 Outdoor Seating Spaces

[Figure 32](#) and [Figure 33](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the outdoor seating spaces located towards the south of the O'Callaghan Strand (OCS) Block.

The results showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.

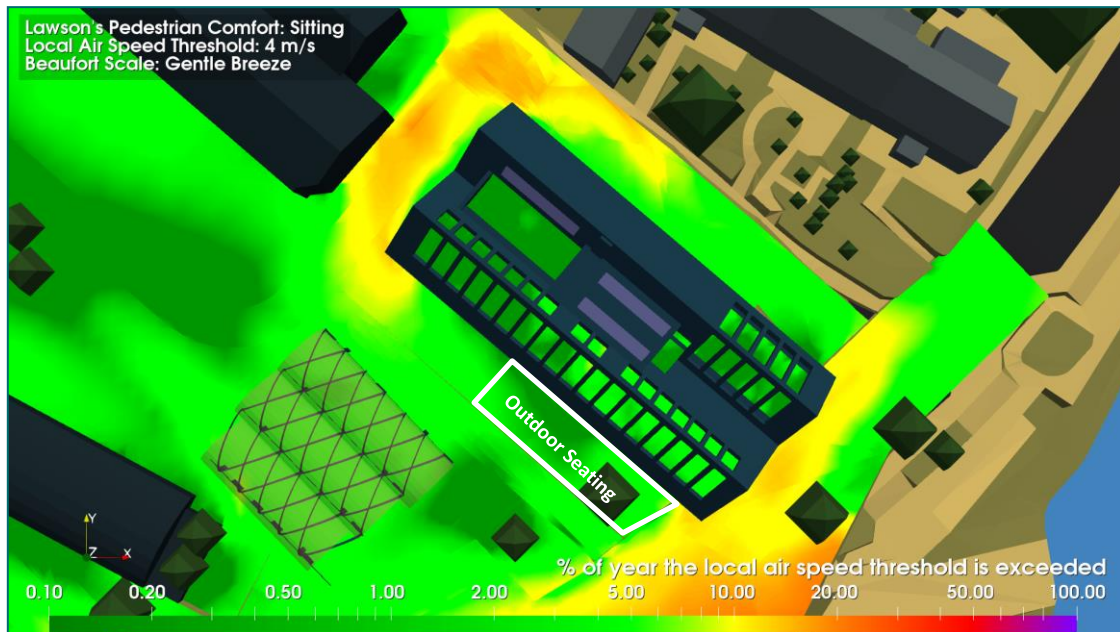


Figure 32: Sitting Comfort Criterion: OCS Block: Outdoor Seating

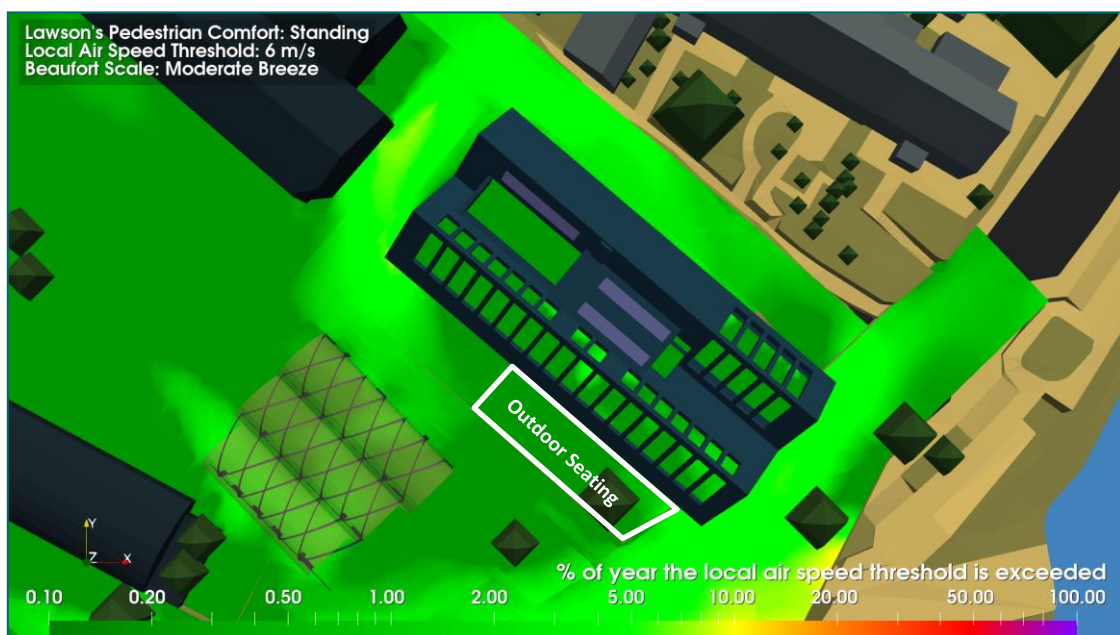


Figure 33: Standing Comfort Criterion: OCS Block: Outdoor Seating

3.2.6 Riverfront

[Figure 34](#) and [Figure 35](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the amenity spaces of the Riverfront located towards the southeast of the Cleeves site.

The seating spaces showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

A portion of the riverfront amenities, visible in yellow colour contouring in [Figure 34](#), showed exceedance of the requirements of Lawson's Sitting Comfort Criterion. The local air speed is likely to exceed 4m/s for up to 20% of the year at these locations. This space was affected due to the prevailing southwesterly and westerly winds.

When comparing the results for these locations to Lawson's Standing Comfort Criterion results, they demonstrate excellent compliance, i.e., the local air speed does not exceed 6 m/s for more than 5% of the year, see [Figure 35](#). Of the 20% of the year when the local air speed exceeds 4m/s, three-quarters of that collective time (i.e. 15% of the year) does not exceed 6m/s. The local air speed on this portion will be less than 4 m/s for 90% of the year and between 4 and 6 m/s for 15% of the year.

Any exceedance noted can be considered very marginal, and it will not lead to an environment which is unpleasant to use. The local air speed is only going to be greater than a gentle breeze, but frequently less than a moderate breeze. Such conditions are unlikely to have any impact on the usability of this space for personal recreation.

The majority of this space is designed for the standing and walking activities, for which the results are excellent and fully meet the requirements of Lawson's Standing and Walking Comfort Criteria.

No mitigation measures are recommended.

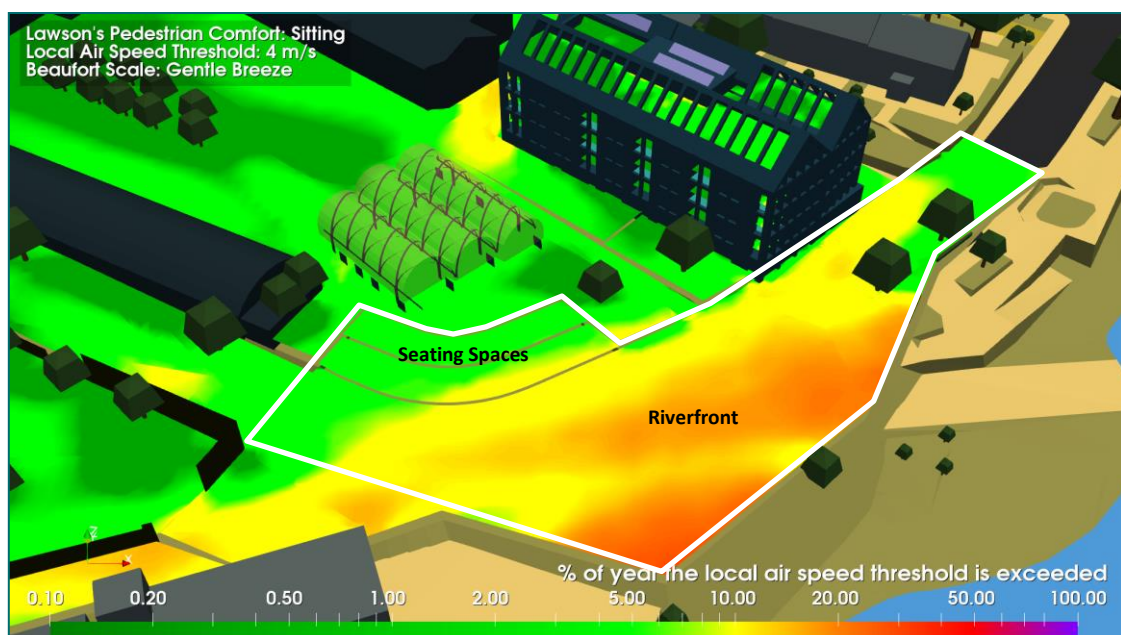


Figure 34: Sitting Comfort Criterion: Riverfront Amenities

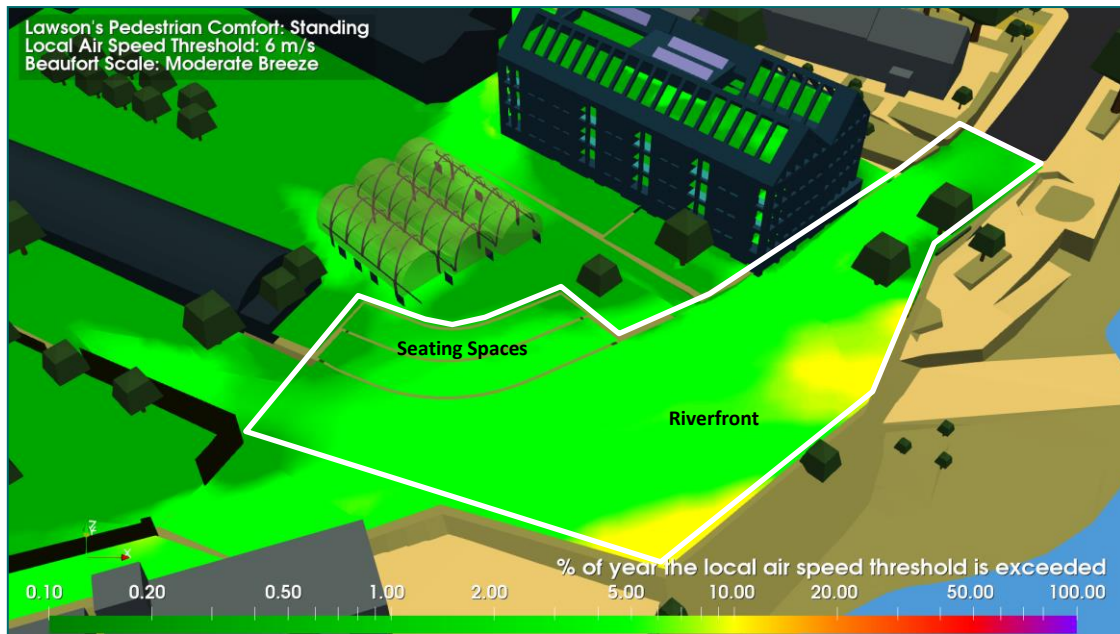


Figure 35: Standing Comfort Criterion: Riverfront Amenities

3.2.7 Flaxmill Square

[Figure 36](#) and [Figure 37](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the amenities of the Flaxmill Square, located towards the southeast of the Reservoir.

The results showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.

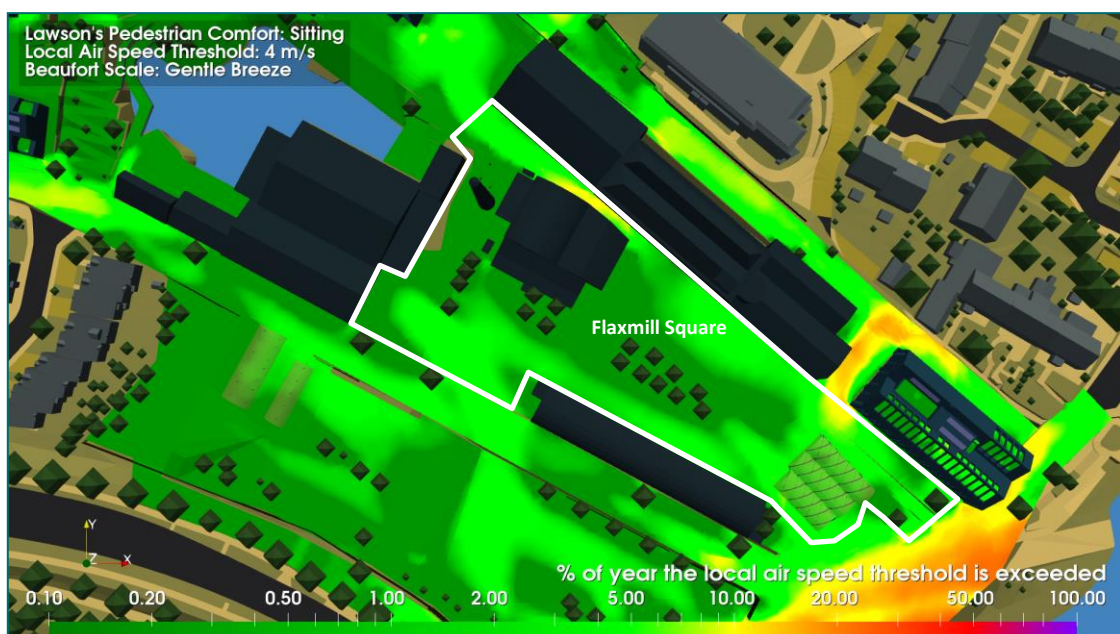


Figure 36: Sitting Comfort Criterion: Flaxmill Square

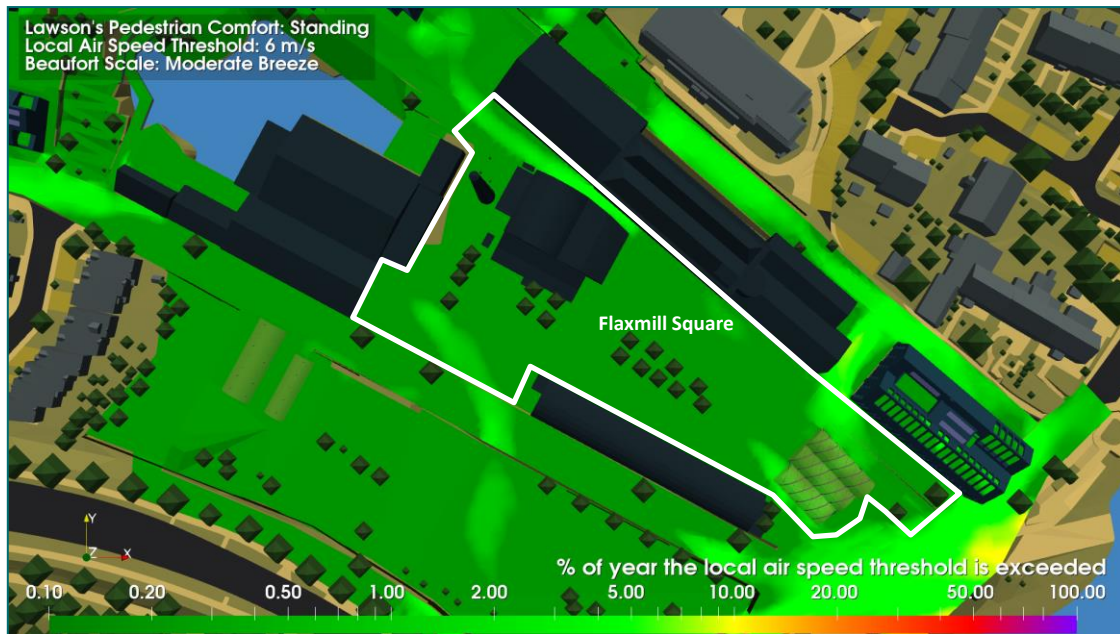


Figure 37: Standing Comfort Criterion: Flaxmill Square

3.2.8 Shipyard

[Figure 38](#) and [Figure 39](#) illustrate Lawson's Sitting and Standing Comfort Criteria results on the amenities of the Shipyard located towards the south of the Cleeves site.

The results showed excellent compliance and fully met the requirements of Lawson's Sitting and Standing Comfort Criterion for the full year. The local air speed does not exceed 4m/s and 6m/s for more than 5% of the year as per the criterion's requirement.

No mitigation measures are recommended.

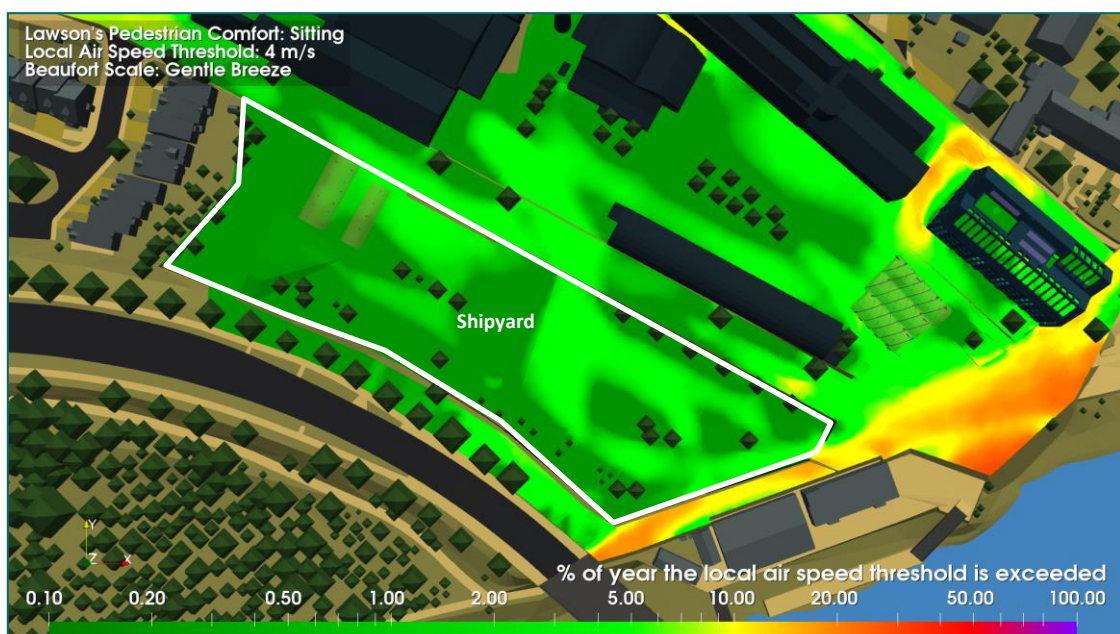


Figure 38: Sitting Comfort Criterion: Shipyard

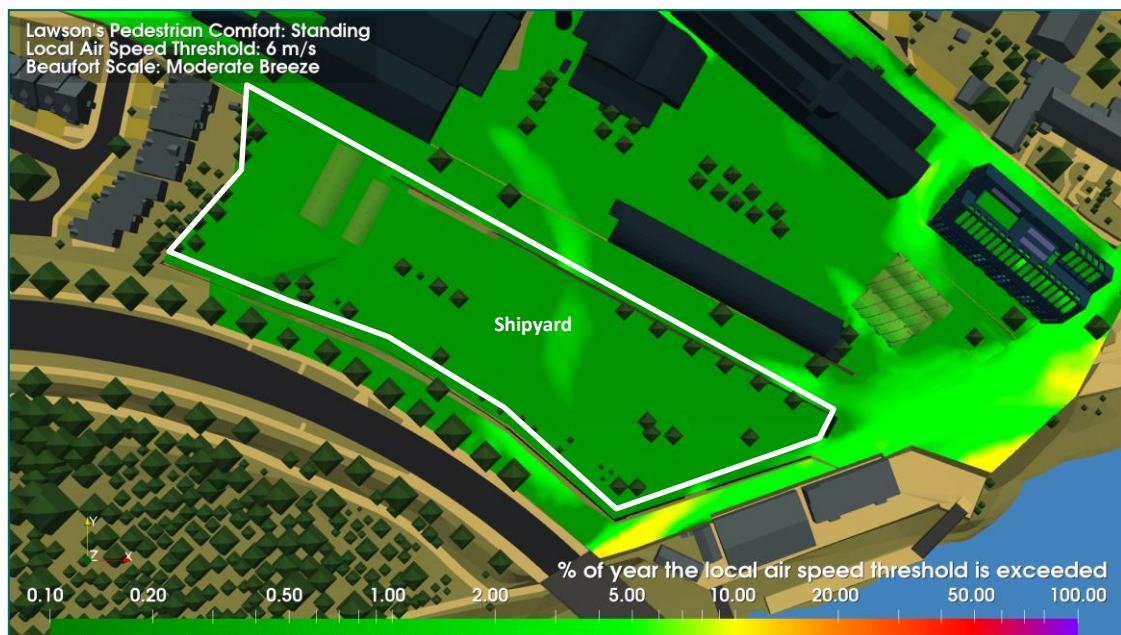


Figure 39: Standing Comfort Criterion: Shipyards

3.3 Walking Comfort Results

The Lawson's Leisure Walking Comfort Criterion states that the local air speed at designated locations should not exceed 8 m/s for more than 5% of the duration analysed, on the various paths around the development. Additionally, the Lawson's Business Walking Comfort Criterion states the local air speed at designated locations should not exceed 10 m/s for more than 5% of the duration analysed, on the various paths around the development. These show excellent compliance with the requirements of Lawson's Leisure Walking and Business Walking Comfort Criterion. The local air speed does not exceed 8 m/s and 10 m/s for more than 5% of the year, respectively. [Figure 40](#) and [Figure 41](#) below show the results of walking comfort criteria.



Figure 40: Leisure Walking Comfort Criterion: View from the top

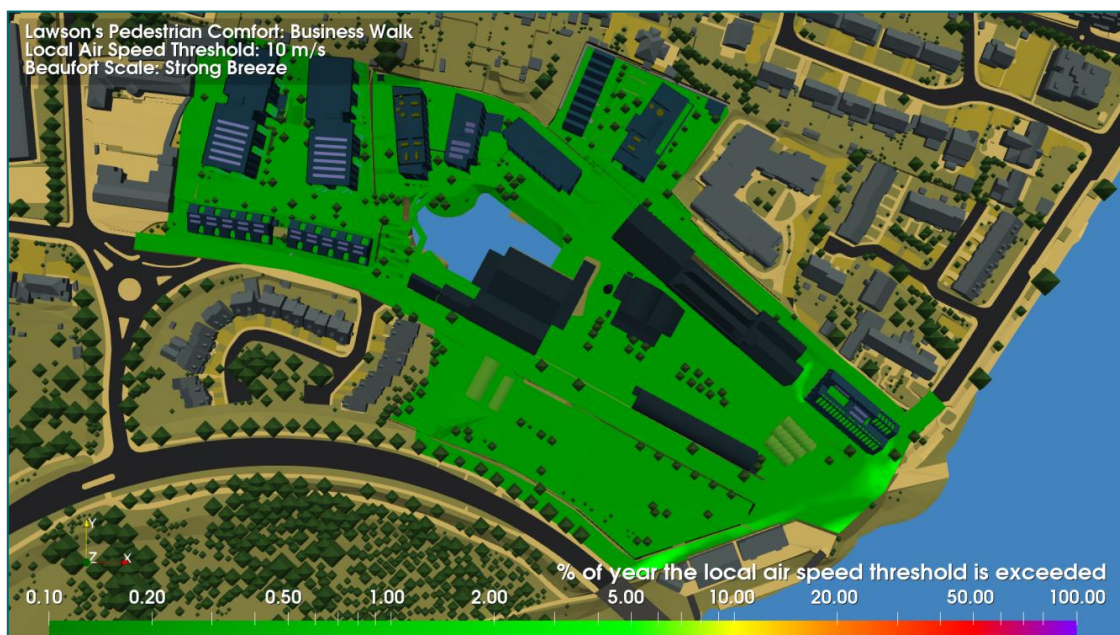


Figure 41: Business Walking Comfort Criterion: view from the top

3.4 Safety Criteria

The Lawson's Normal Pedestrian Safety Criterion states that the local air speed at designated locations should not exceed 20 m/s for more than 0.01% of the duration analysed. Additionally, the Lawson's Sensitive Pedestrian Safety Criterion states the local air speed at designated locations should not exceed 15 m/s for more than 0.01% of the duration analysed. The Sensitive Pedestrian Safety Criterion applies to the vulnerable population, such as pensioners and children. Note the limit of the criterion is 0.01% and not 5% as with the comfort criterion.

These criteria are also intended for various paths and grounds around the development, as access is always required, irrespective of weather conditions, to enter or exit the various buildings. [Figure 42](#) and [Figure 43](#) show the results of the safety criteria assessment. The results of the normal and sensitive pedestrian are observed to be below 0.01% of the year.

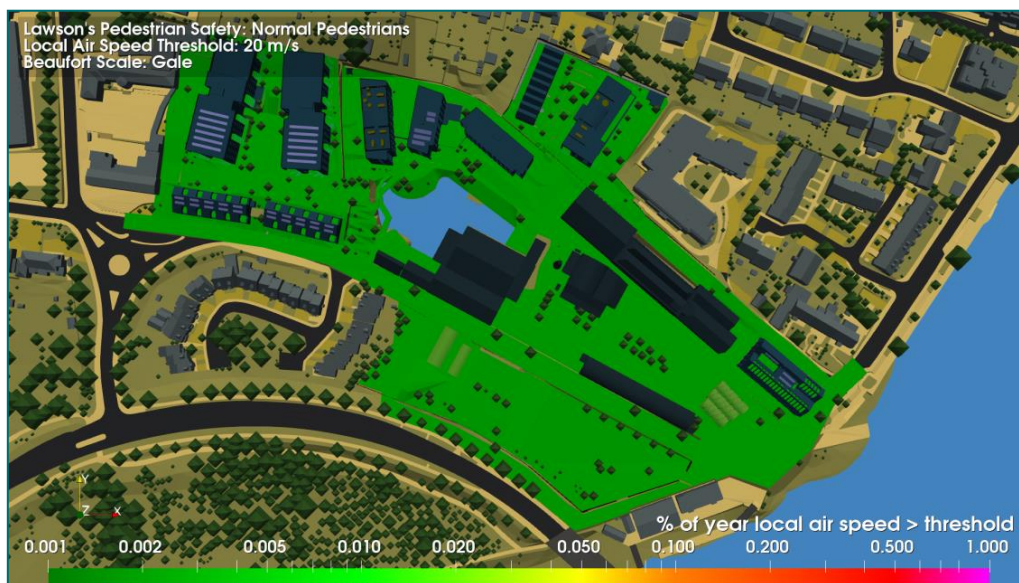


Figure 42: Normal Pedestrian Safety Criterion: View from the top

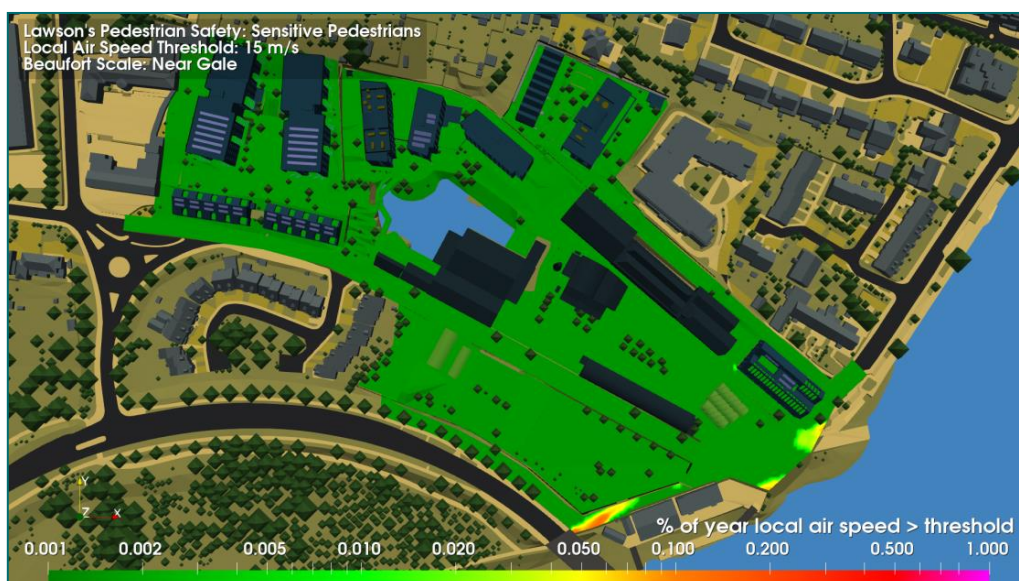


Figure 43: Sensitive Pedestrian Safety Criterion: View from the top

4 Weather Data

The analysis is based on the 'IRL_ST_Shannon.AP.039620_TMYx.2009-2023.epw' weather file. The variation of wind speed recorded in the weather file is illustrated in [Figure 44](#) below. [Figure 45](#) illustrates the wind direction variation, and [Figure 46](#) illustrates the wind rose.

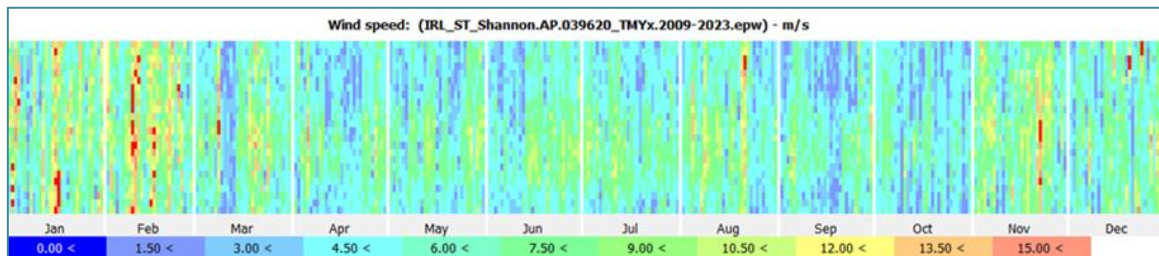


Figure 44: Wind speed variation

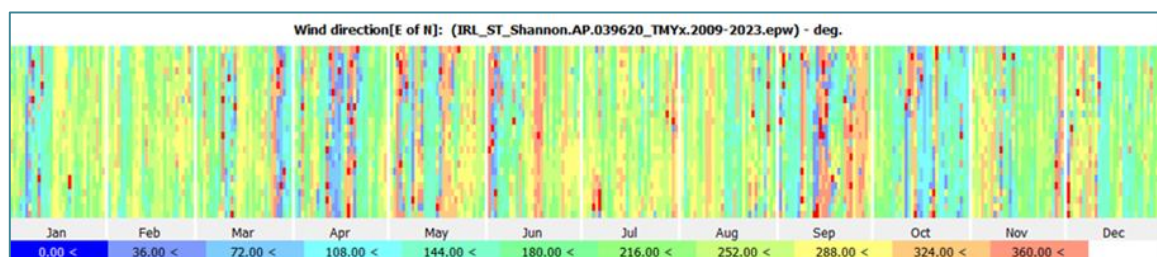


Figure 45: Wind direction variation

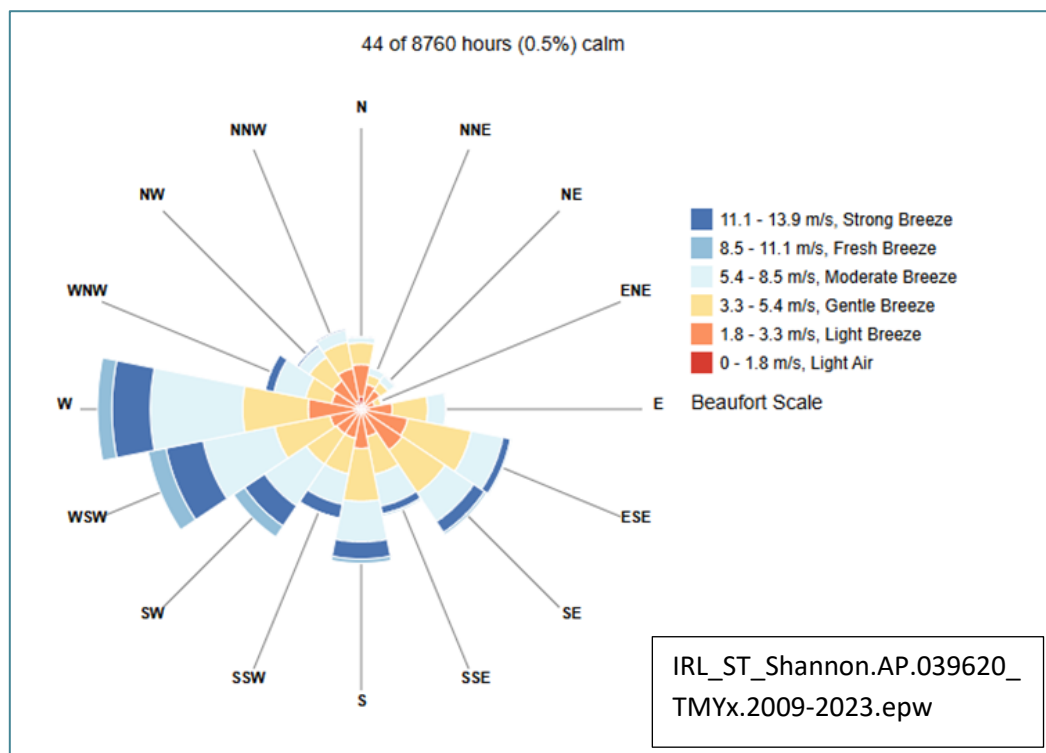


Figure 46: Wind rose

Based on this, the mean wind speed recorded was **5.3m/s** with a westerly prevailing direction.

5 Wind Boundary Layer

In an atmospheric boundary layer, wind speed increases with height due to the influence of surface roughness (i.e. the presence of buildings, trees, roads, etc., on the ground), see [Figure 47](#).

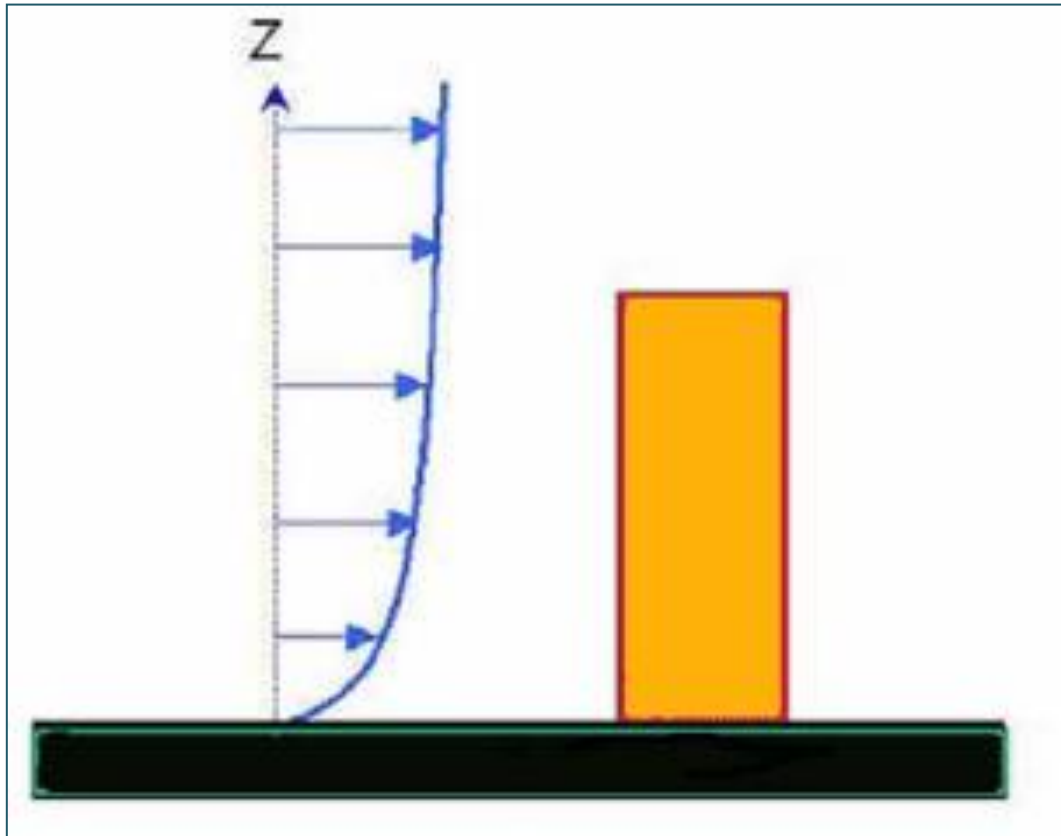


Figure 47: Typical velocity profile of an atmospheric boundary layer

In the current CFD modelling, the velocity profile was generated according to the parameterised ASHRAE methodology described below. This allows for different wind profiles across various terrain types: open country, urban, and city centre.

The wind speed U_H at height H above the ground is given by:

$$U_H = U_{met} \left(\frac{\delta_{met}}{H_{met}} \right)^{a_{met}} \left(\frac{H}{\delta} \right)^a \dots \dots \dots (Eq. 1)$$

Where,

- a** = Exponent in power law wind speed profile for local building terrain
- δ** = fully developed strong wind atmospheric boundary layer thickness (m)
- a_{met}** = Exponent for the meteorological station

δ_{met} = Atmospheric boundary thickness at the meteorological station (m)

H_{met} = Height at which meteorological wind speed was measured (m)

U_{met} = Hourly meteorological wind speed, measured at height H_{met} (m/s)

The parameters for different types of terrain are given in Table 1.

Table 1: Atmospheric boundary layer parameters

Terrain Category	Description	a	δ
1	Large city centres have 50% of buildings above 21m over a distance of at least 2000m upwind.	0.33	460
2	Urban, suburban, wooded areas.	0.22	370
3	Open, with scattered objects generally less than 10m high.	0.14	270
4	Flat, unobstructed areas exposed to wind flowing over a large water body (no more than 500m inland).	0.10	210

For the current project, we used the atmospheric boundary layer corresponding to terrain category 2, i.e., an urban/suburban type of site. The met data was taken on category 3 terrain at a height of 10m.

6 Methodology for Pedestrian Comfort Calculation

The methodology for the analysis was as follows:

- 1) The annual mean wind speed was determined from the 'IRL_ST_Shannon.AP.039620_TMYx.2009-2023.epw' weather file.
- 2) 8 steady state CFD simulations were performed corresponding to the 8 directions – SW, W, NW, N, NE, E, SE and S, respectively.
- 3) The local air speed at various designated locations around the site was recorded for each of the simulations.
- 4) This value was compared to the meteorological wind speed used, and the magnification factor at that location for the corresponding wind direction was determined.
- 5) The magnification factor was used to determine the air speed at the designated locations for the various recorded values of the wind speed and direction in the weather file, thus generating the local air speeds at designated locations for a year.
- 6) These recorded values were compared to the Lawson Pedestrian Comfort/Safety Criteria.

6.1 Lawson Pedestrian Comfort/Safety Criteria

The Lawson Criteria¹ were used as a reference to assess the wind effects. It is the most widely used reference for assessing pedestrian comfort. It considers the air speed at the location as well as the frequency of the occurrence of this air speed. It consists of two assessment criteria:

1. The first criteria assess whether the air movement will be comfortable for the pedestrian for different types of activities.
2. The second criteria assess the feeling of safety or distress by the pedestrian at higher air speeds.

The following table gives the values for Lawson's Pedestrian Comfort Assessment Criteria for various activities.

Category	Pedestrian Activity	Threshold mean hourly wind speed not to be exceeded for more than 5% of the time (m/s)
C1	Business Walking	10
C2	Leisurely Walking	8
C3	Standing	6
C4	Sitting	4

The following table gives the values for Lawson's Pedestrian Safety Assessment criteria.

Category	Pedestrian Type	Threshold mean hourly wind speed not to be exceeded more than once per annum ² (m/s)
S1	Typical Pedestrian	20
S2	Sensitive Pedestrian	15

¹T. V. Lawson (2001) *Building Aerodynamics*, Imperial College Press, London.

²Once per annum means the safety threshold is not to be exceeded more than 0.01% of the year.

The median wind speed recorded was 5.3 m/s for Limerick's climatic conditions. That means, for 50% of the year, the wind speed is higher than 5 m/s. The Lawson's Sitting Criterion requires the local air speed to be more than 4 m/s for no more than 5% of the year. Thus, the Lawson's Sitting Criterion presents a task of being 10 times better than the climatic conditions at the location of interest.

7 CFD Model

The CFD model was created based on the CAD drawings provided.

7.1 Model Geometry

[Figure 48](#) to [Figure 61](#) show the geometry as modelled.



Figure 48: Plan view of the full site



Figure 49: View of the full site from the south



Figure 50: View of the full site from the west



Figure 51: View of the full site from the north



Figure 52: View of the full site from the east

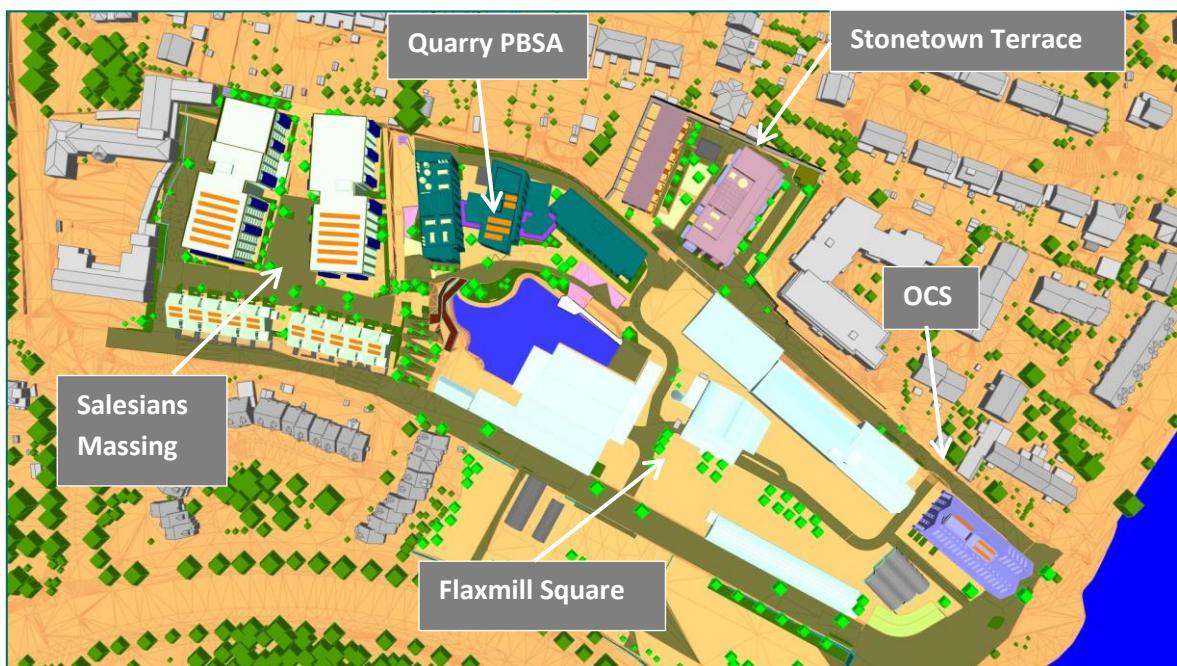


Figure 53: View of the Cleeves site from the top



Figure 54: View of the Salesians Massing and Quarry PBSA from the southwest



Figure 55 View of the Stonetown Terrace from the southeast



Figure 56: Closer view of the Stonetown Terrace block from the southwest

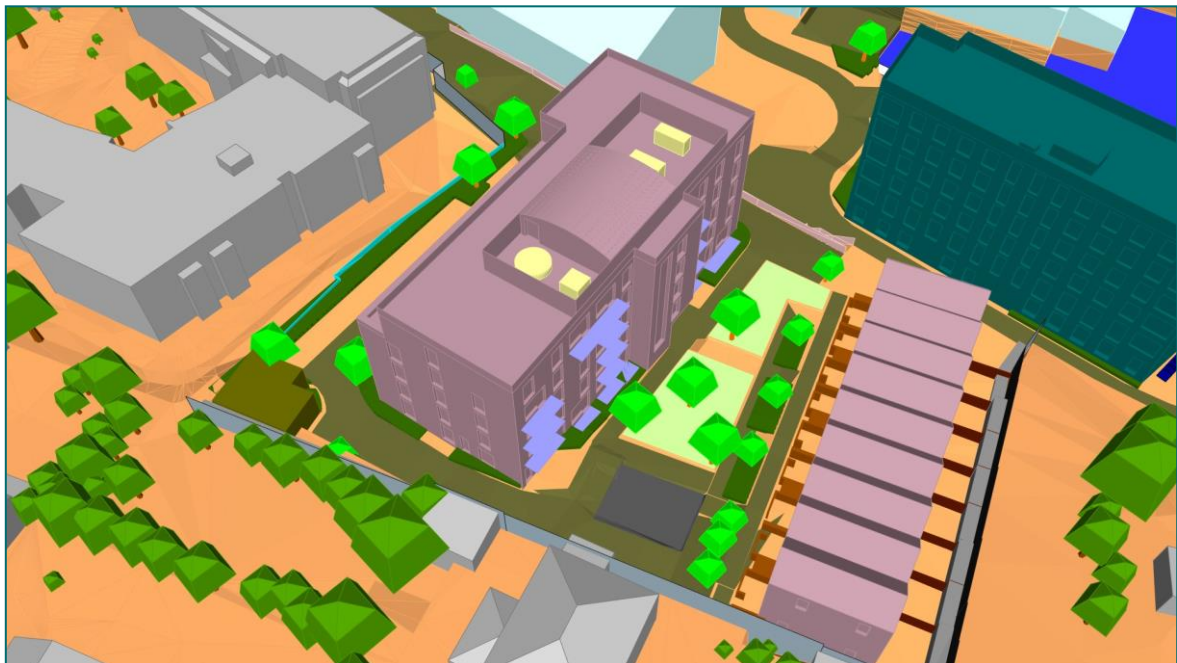


Figure 57: View of the Stonetown Terrace from the north

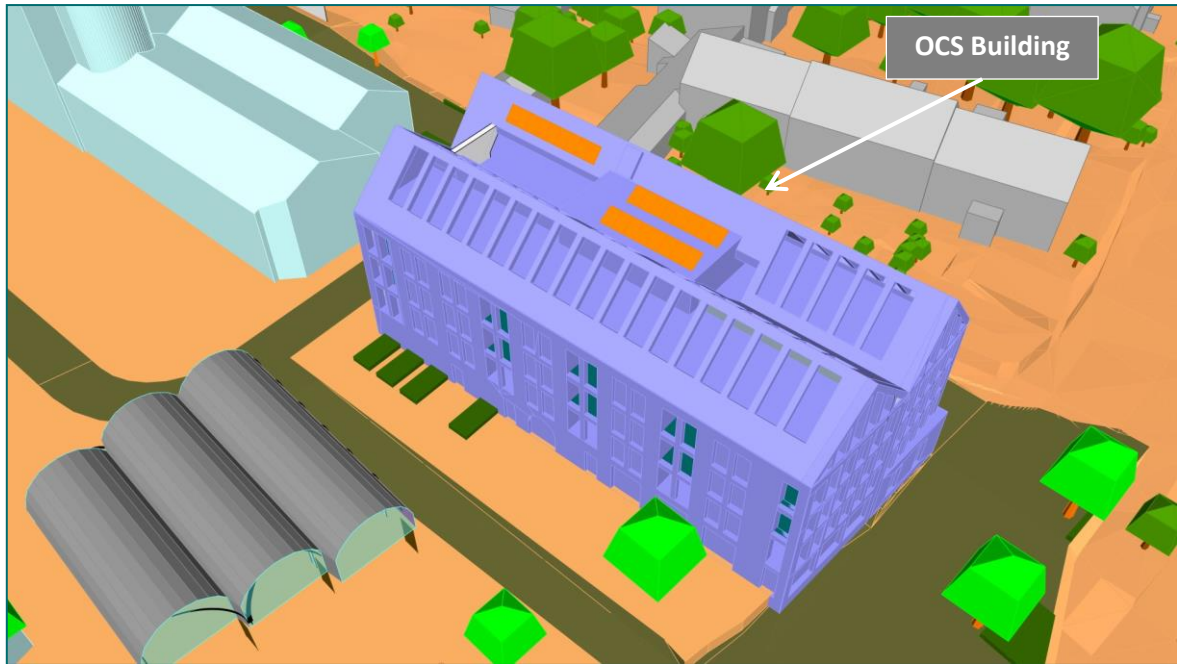


Figure 58: Closer view of the O'Callaghan Strand

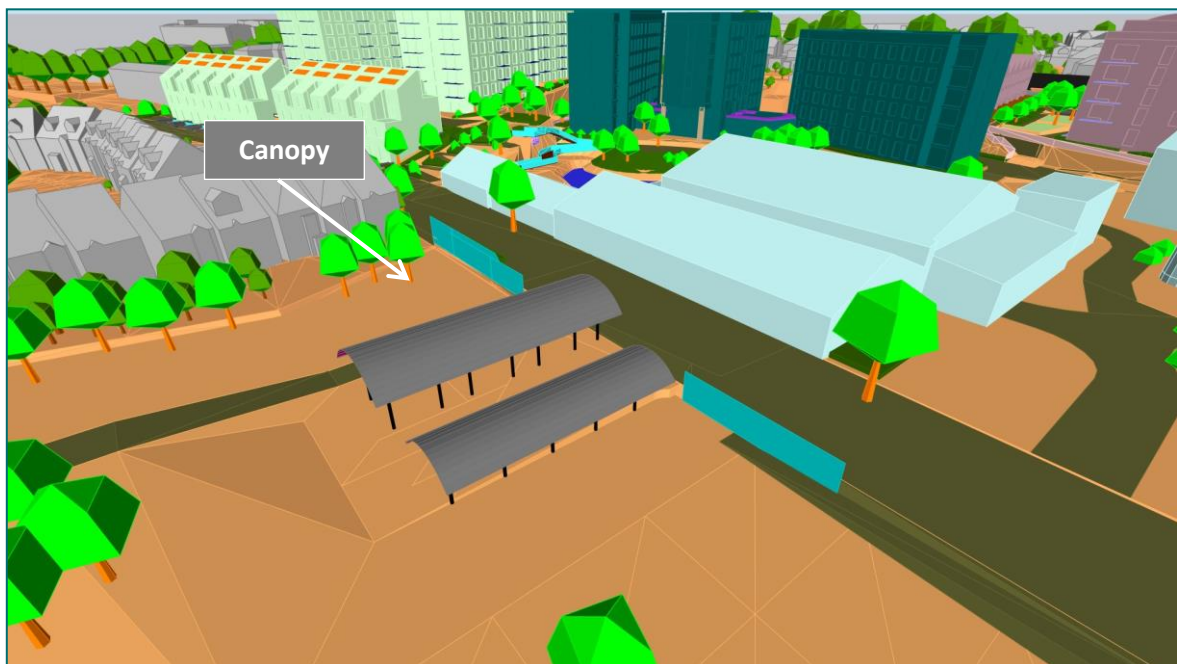


Figure 59: View of the Canopy on the Shipyard

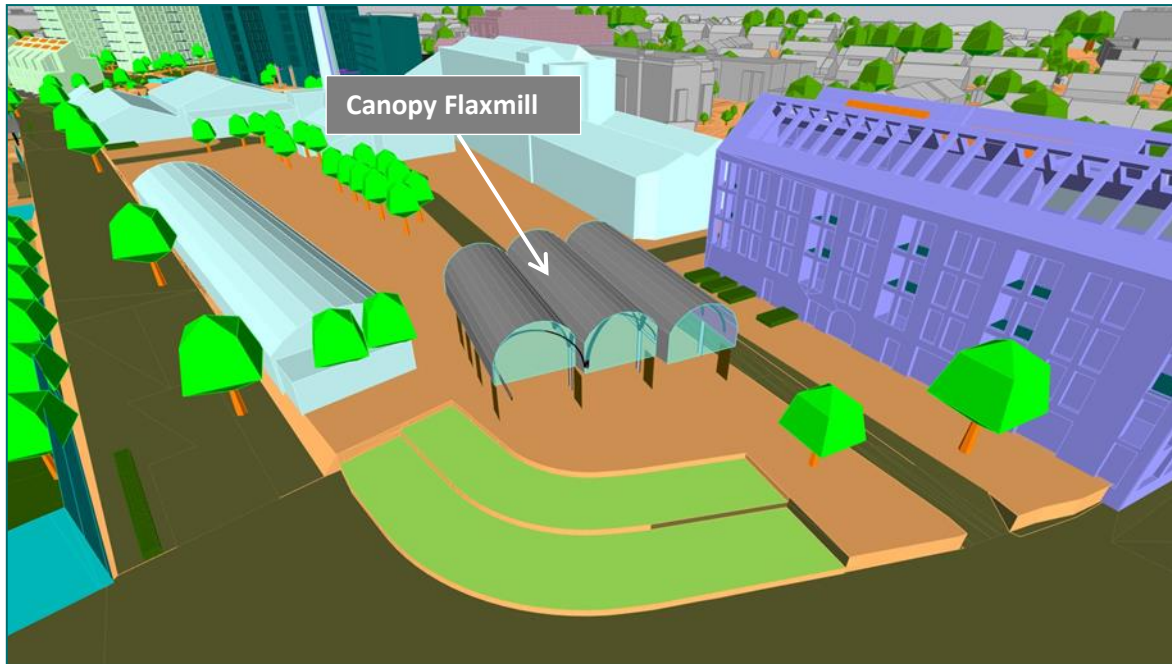


Figure 60: View of the Seating spaces near the Riverfront



Figure 61: View of the Flaxmill Square

8 Conclusion

The site shows the typical behaviour of any site in Limerick with direct exposure to the southern to western arc of winds, which account for 80% of the total winds. The landscape design and site layout result in the site performing well from the wind comfort perspective.

It was observed that,

1. The following amenities showed excellent results and fully met the requirements of the Sitting and Standing Comfort criteria.
 - Salesians Massing
 - Community Garden
 - Play Area
 - Nursery Play Space
 - Viewing Area
 - Quarry PBSA
 - Podium Amenities
 - Fitness Court
 - View Terrace
 - Rock Climbing Area
 - Amenities in front of the Reservoir
 - Stonetown Terrace
 - Communal Open Space
 - O'Callaghan Strand (OCS)
 - Roof Amenities
 - Outdoor Seating Spaces
 - Seating locations on the Riverfront
 - Amenities within the Flaxmill Square
 - Amenities within the Shipyaed
2. The balconies of the following blocks showed excellent results and fully met the requirements of the Sitting and Standing Comfort criteria.
 - Salesians Massing
 - Stonetown Terrace
 - O'Callaghan Strand (OCS)
3. Some of the locations of the Riverfront amenities located towards the southeast of the Cleeves site showed limited compliance with Lawson's Sitting Comfort Criterion. However, they show excellent compliance with Lawson's Standing Comfort Criterion.
4. Overall results of the walking comfort show excellent compliance with Lawson's Leisure Walking and Business Walking Comfort criteria.

5. The Lawson's Normal and Sensitive Pedestrian Safety Criteria are achieved throughout the site.

The site meets the requirements of Lawson's Standing and Sitting criteria in conjunction with each other in most of the amenity spaces. It also meets the Lawsons' Walking criteria requirements on all pathways.

9 Appendix

9.1 Comfort Criteria

Figure 62 to Figure 70 show the percentage of the year the hourly wind speed exceeds the threshold value for the comfort criteria, such as Sitting, Standing, Leisurely Walking and Business Walking for all seasons. The threshold values are 4 m/s, 6 m/s, 8 m/s and 10 m/s respectively.

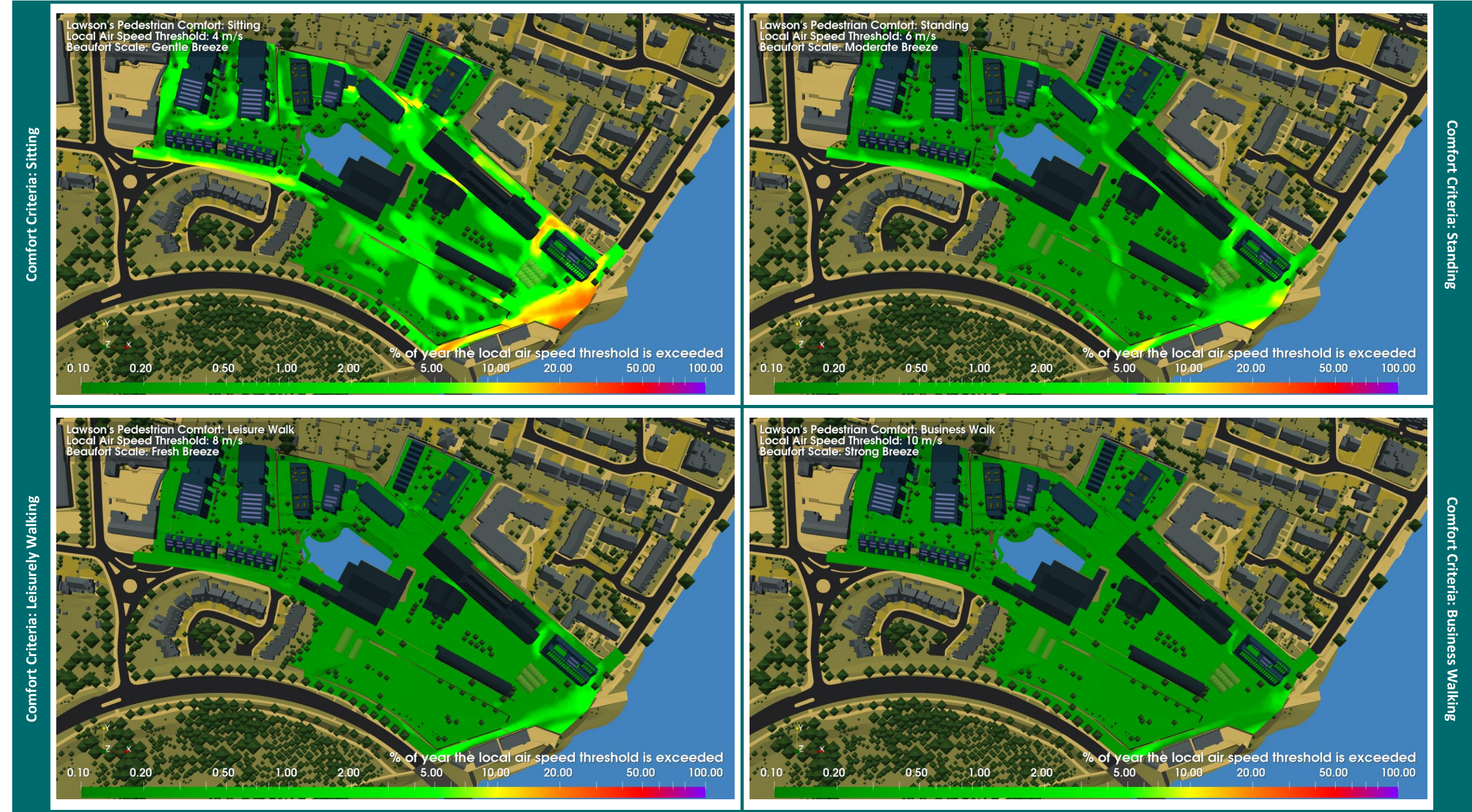


Figure 62: Comfort Criteria: All Seasons: Plan view

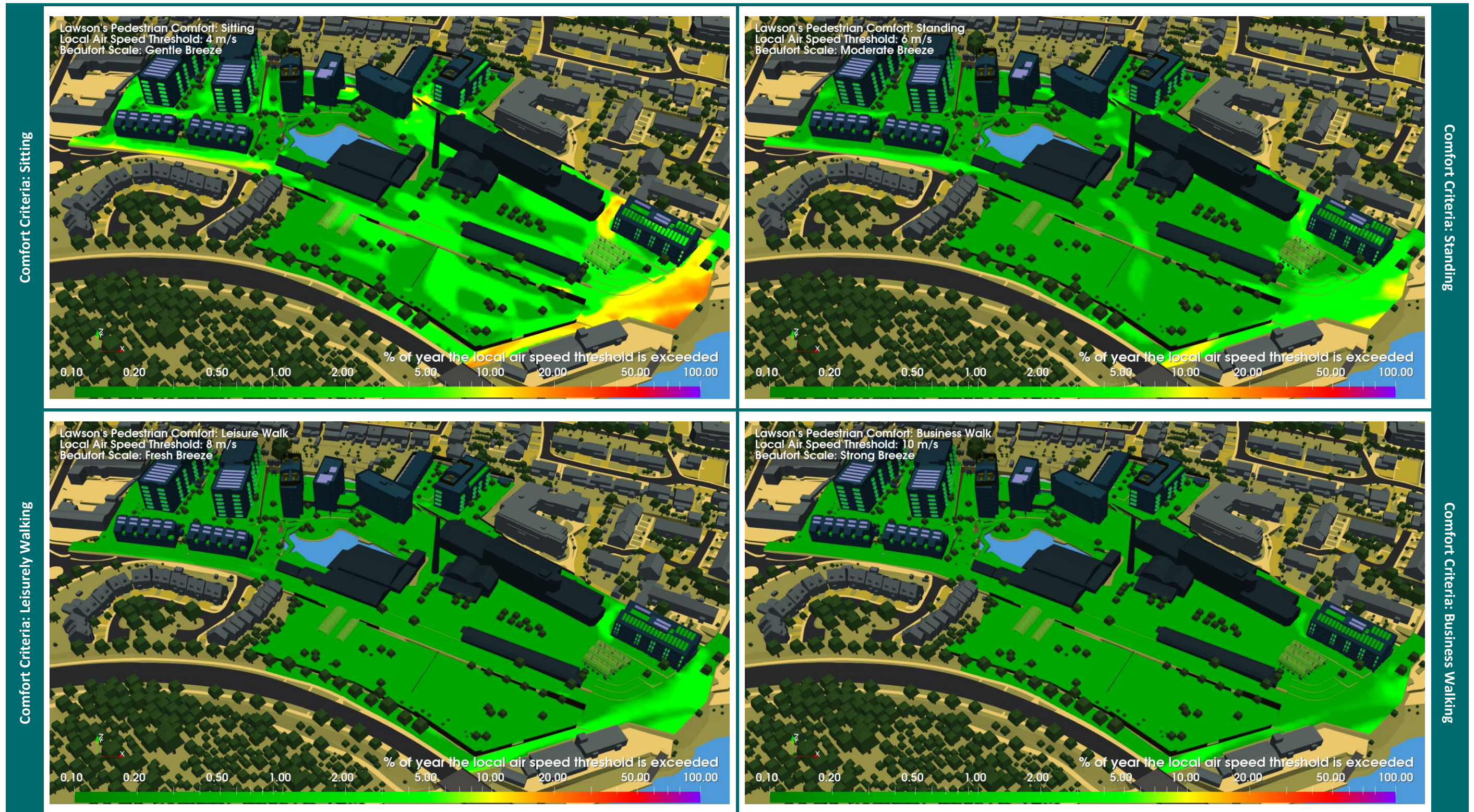


Figure 63: Comfort Criteria: View from the south

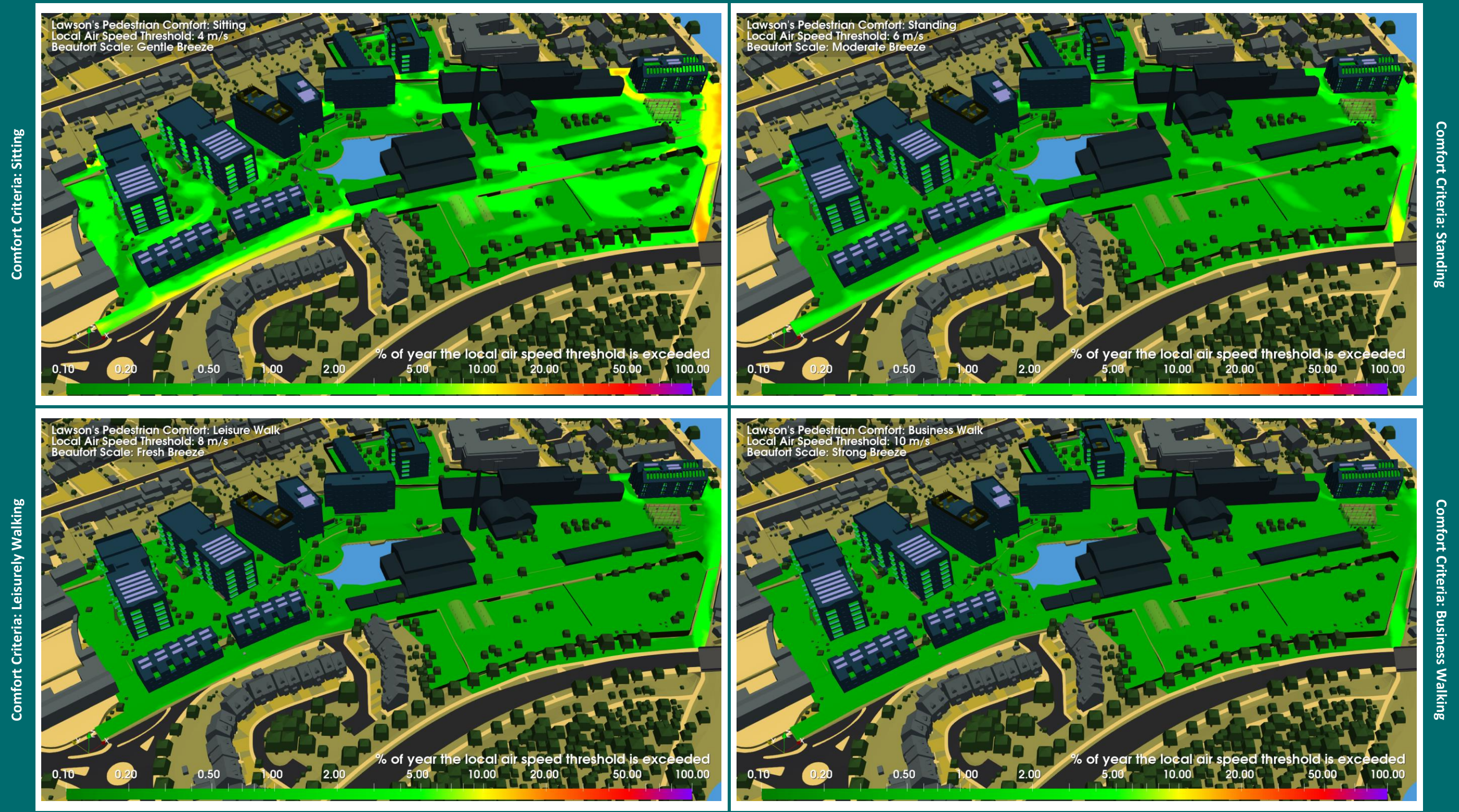


Figure 64: Comfort Criteria: View from the southwest

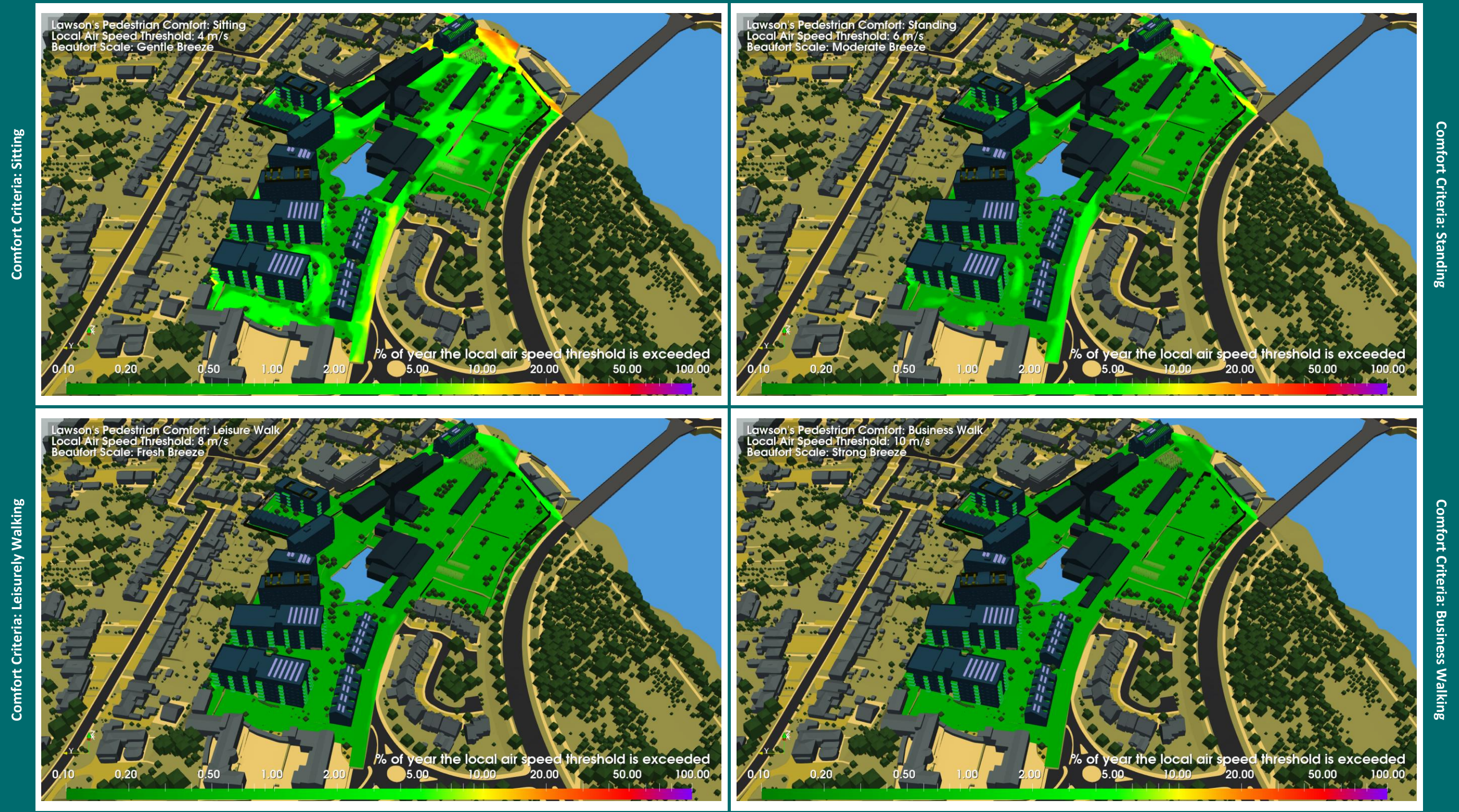


Figure 65: Comfort Criteria: View from the west

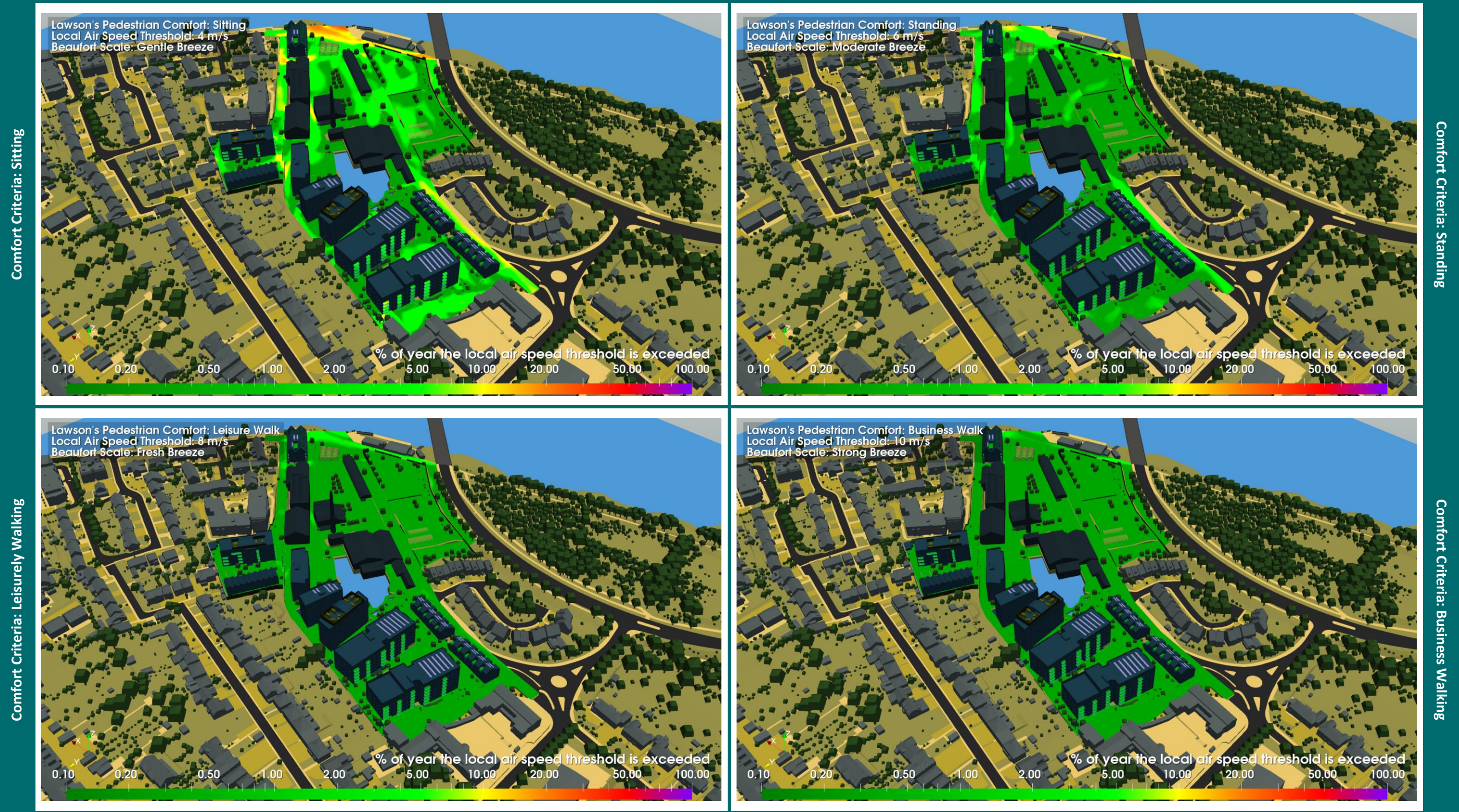


Figure 66: Comfort Criteria: View from the northwest

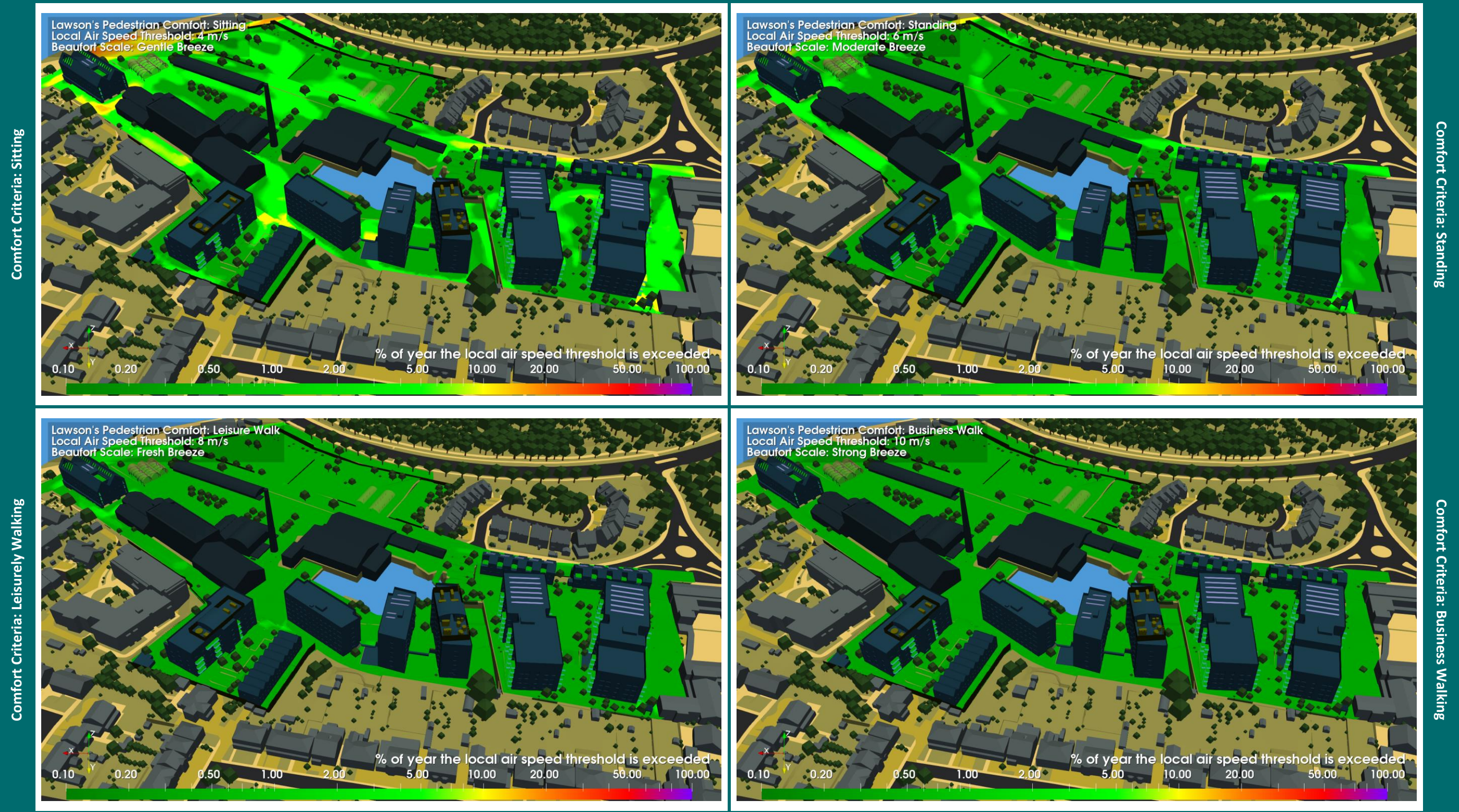


Figure 67: Comfort Criteria: View from the north

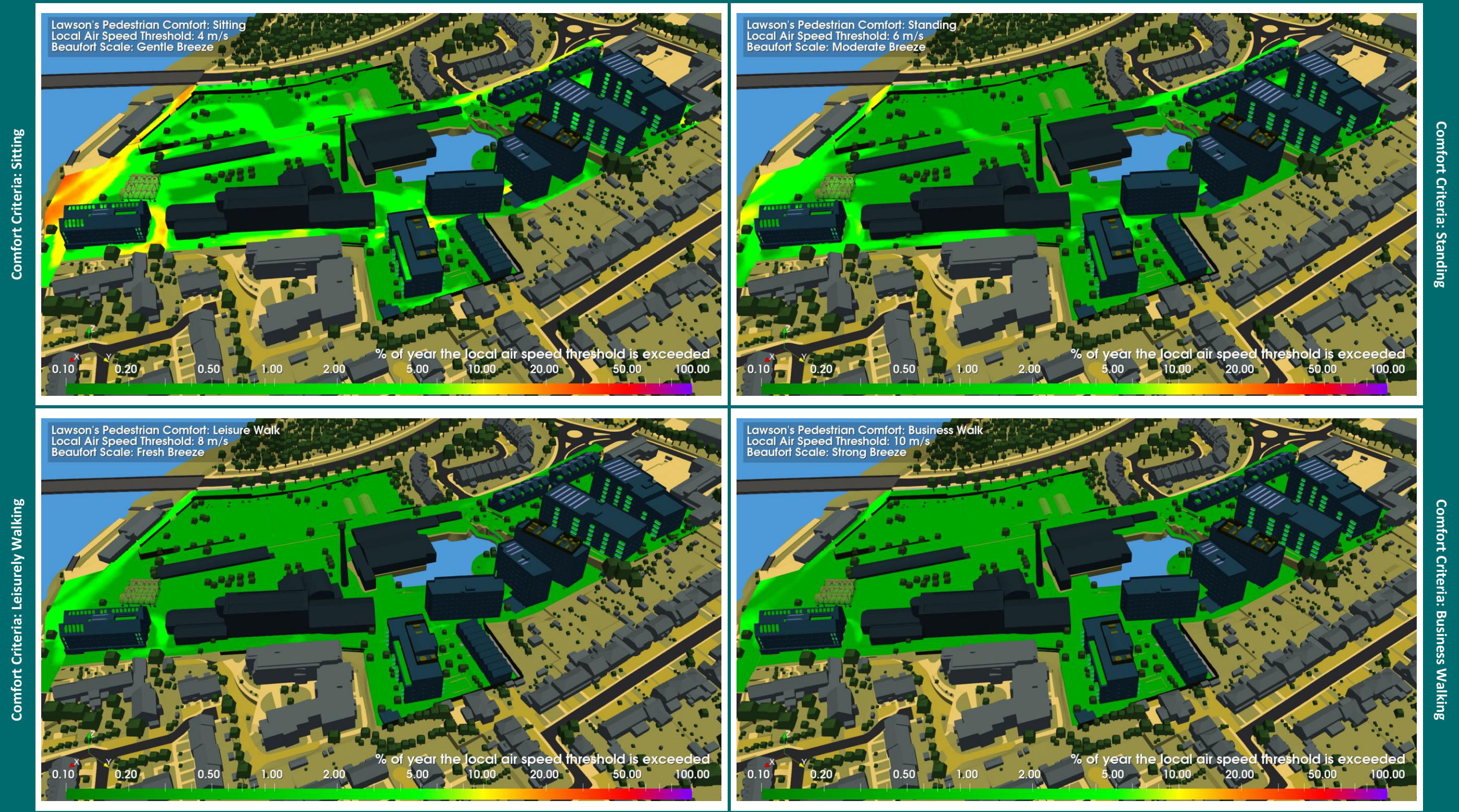


Figure 68: Comfort Criteria: View from the northeast

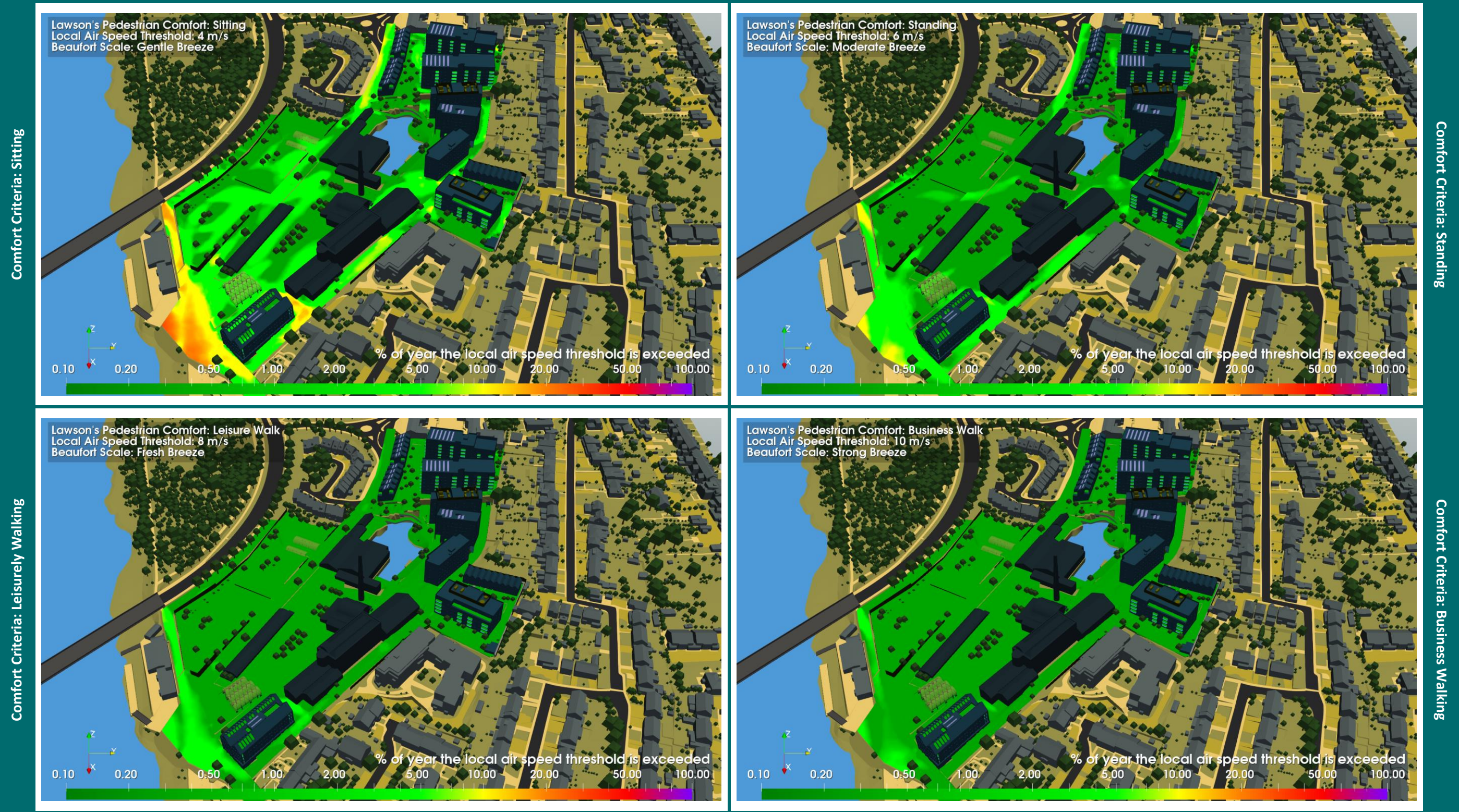


Figure 69: Comfort Criteria: View from the east

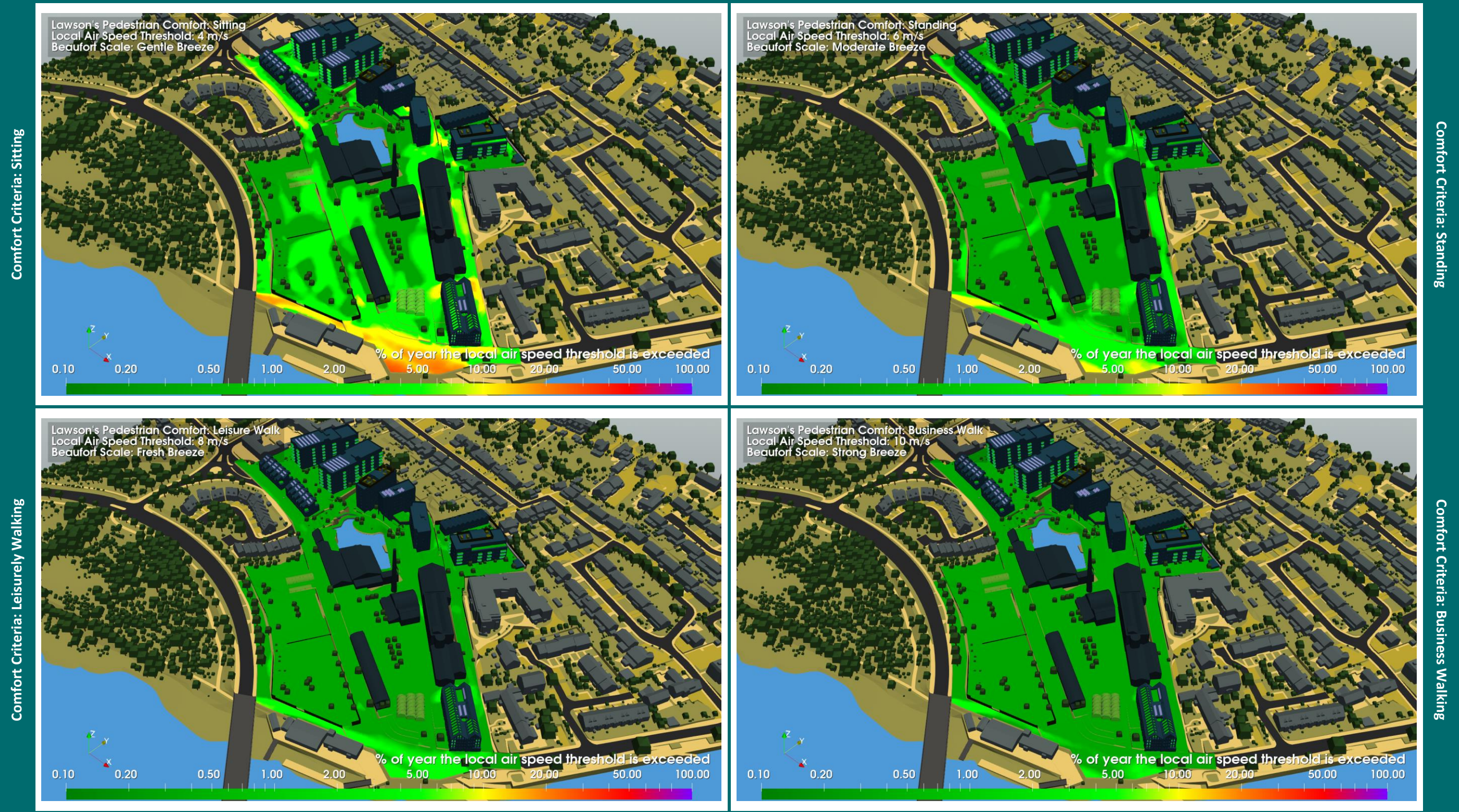


Figure 70: Comfort Criteria: View from the southeast

9.2 Safety Criteria

Figure 71 to Figure 79 show the percentage of the year the hourly wind speed exceeds the threshold value for the safety criteria for all seasons. The threshold values are 20 m/s for a normal pedestrian and 15 m/s for a sensitive pedestrian.

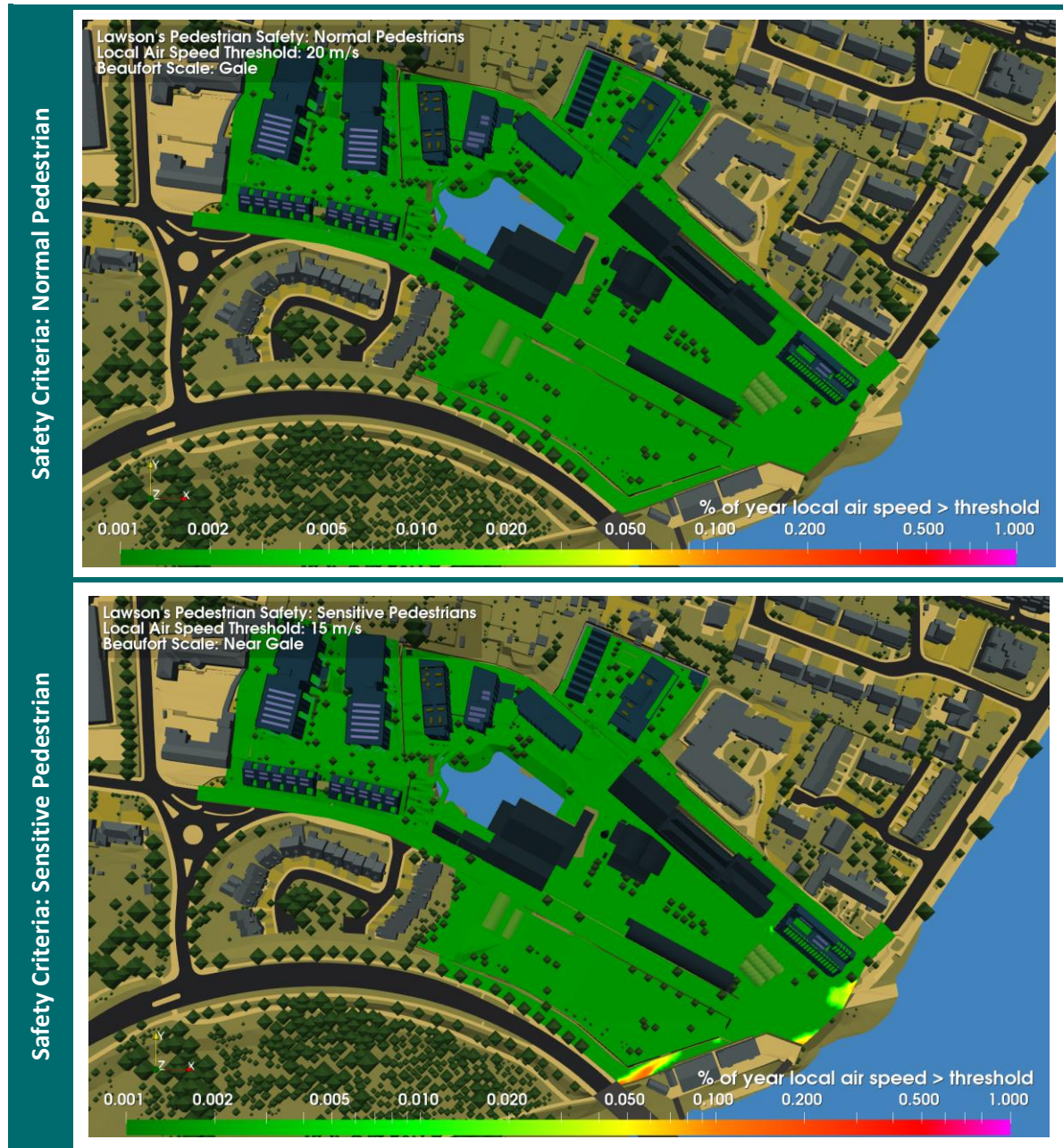


Figure 71: Safety Criteria: Plan view

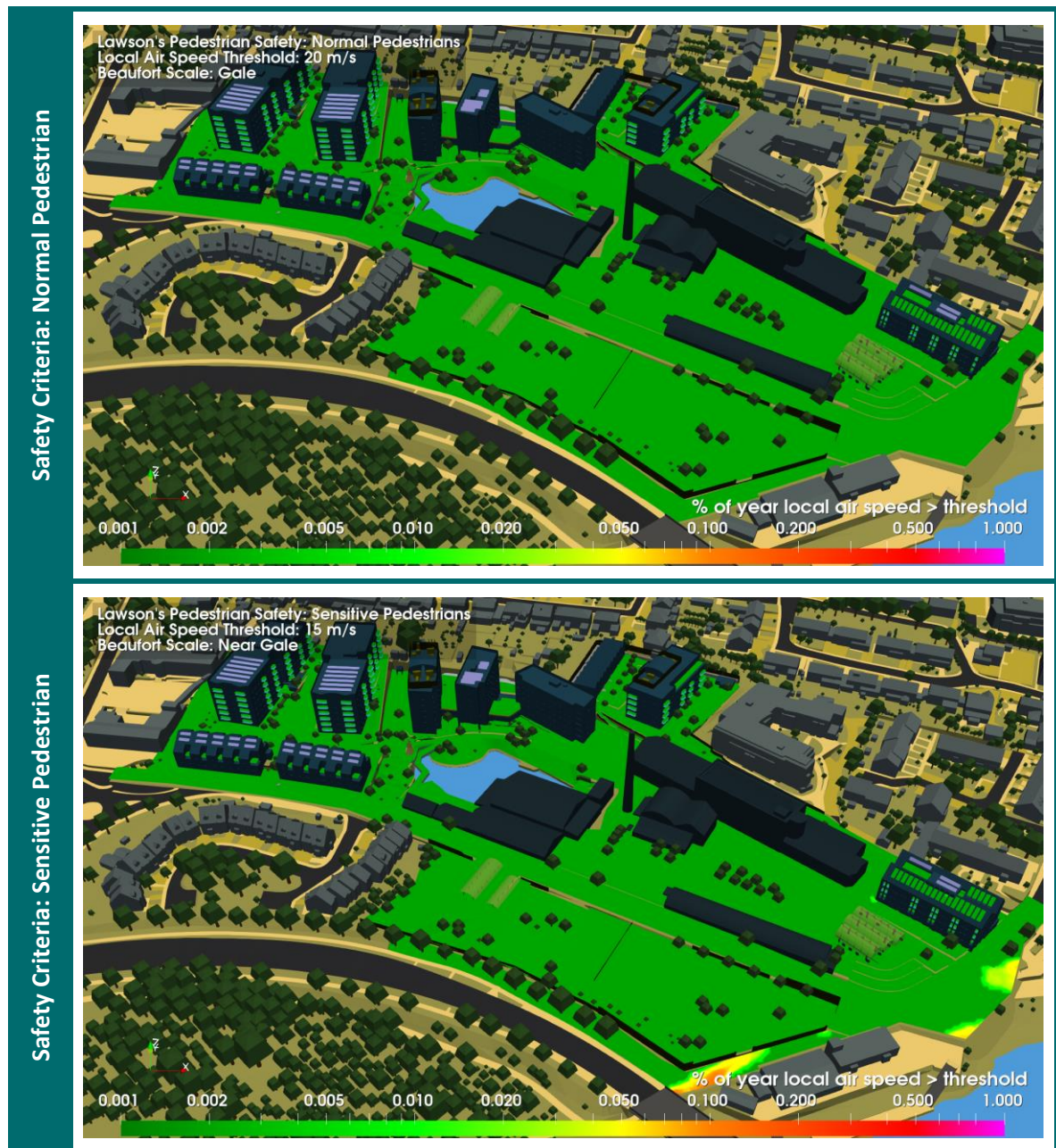


Figure 72: Safety Criteria: View from the south

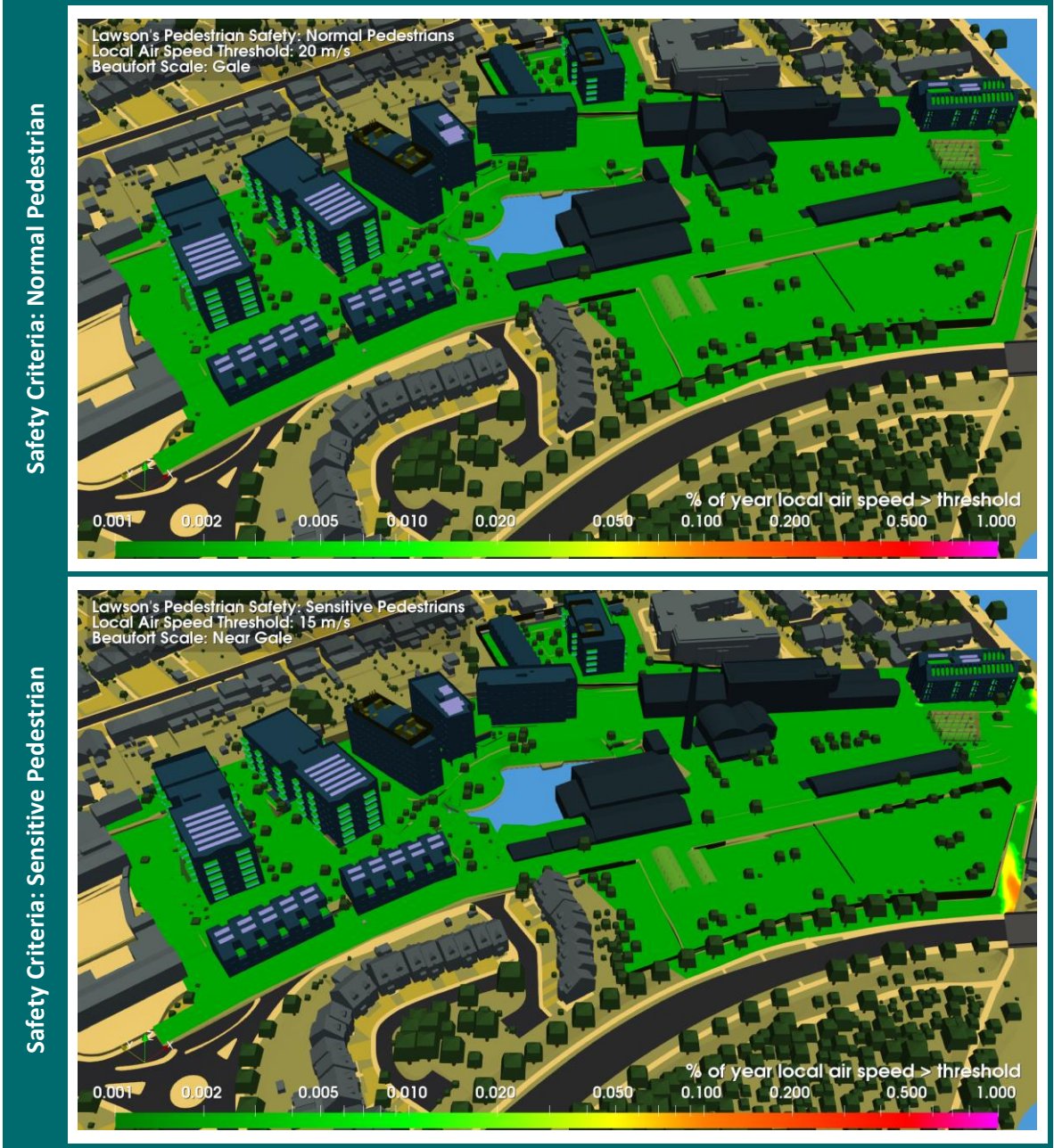


Figure 73: Safety Criteria: View from the southwest

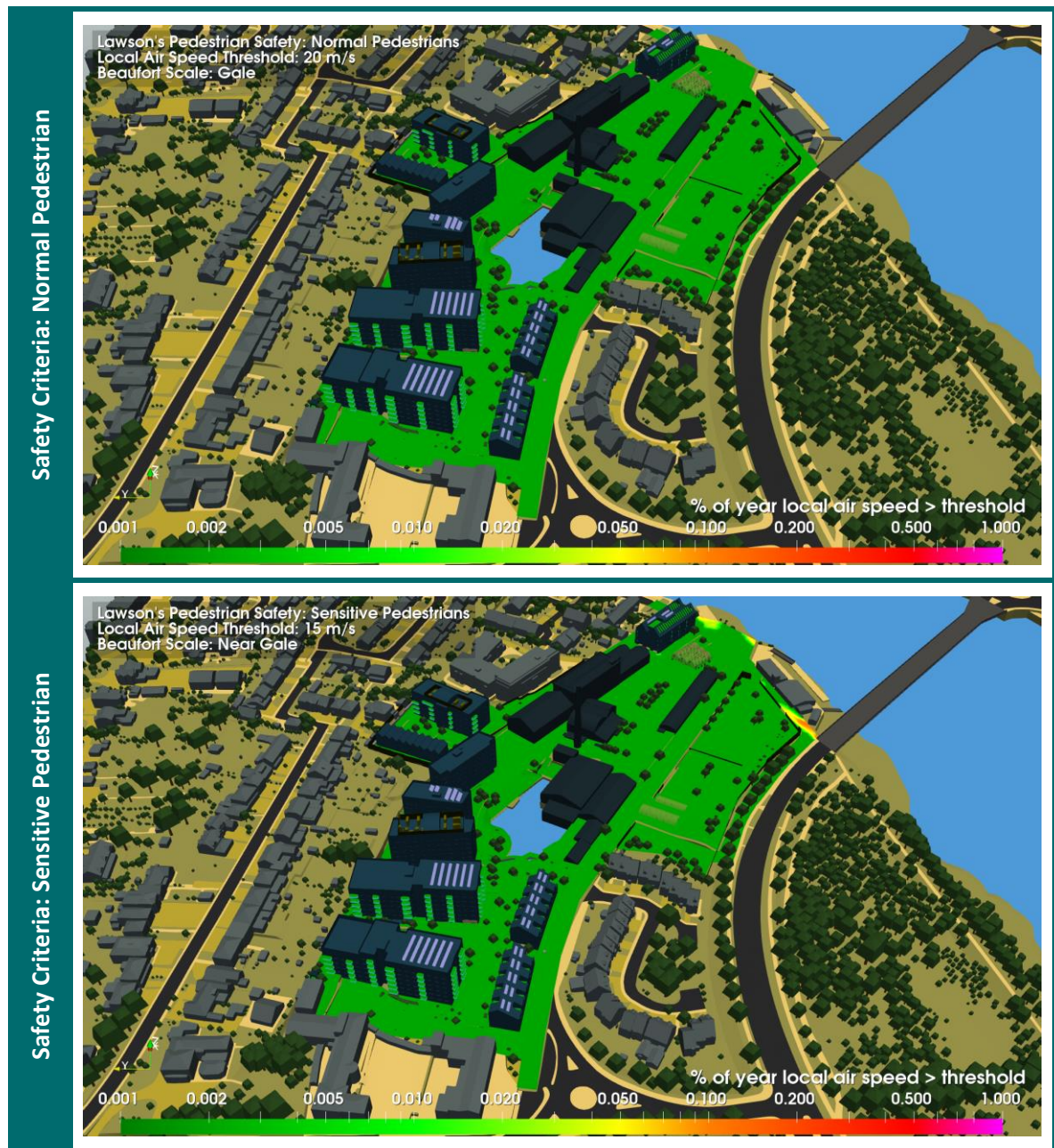


Figure 74: Safety Criteria: View from the west

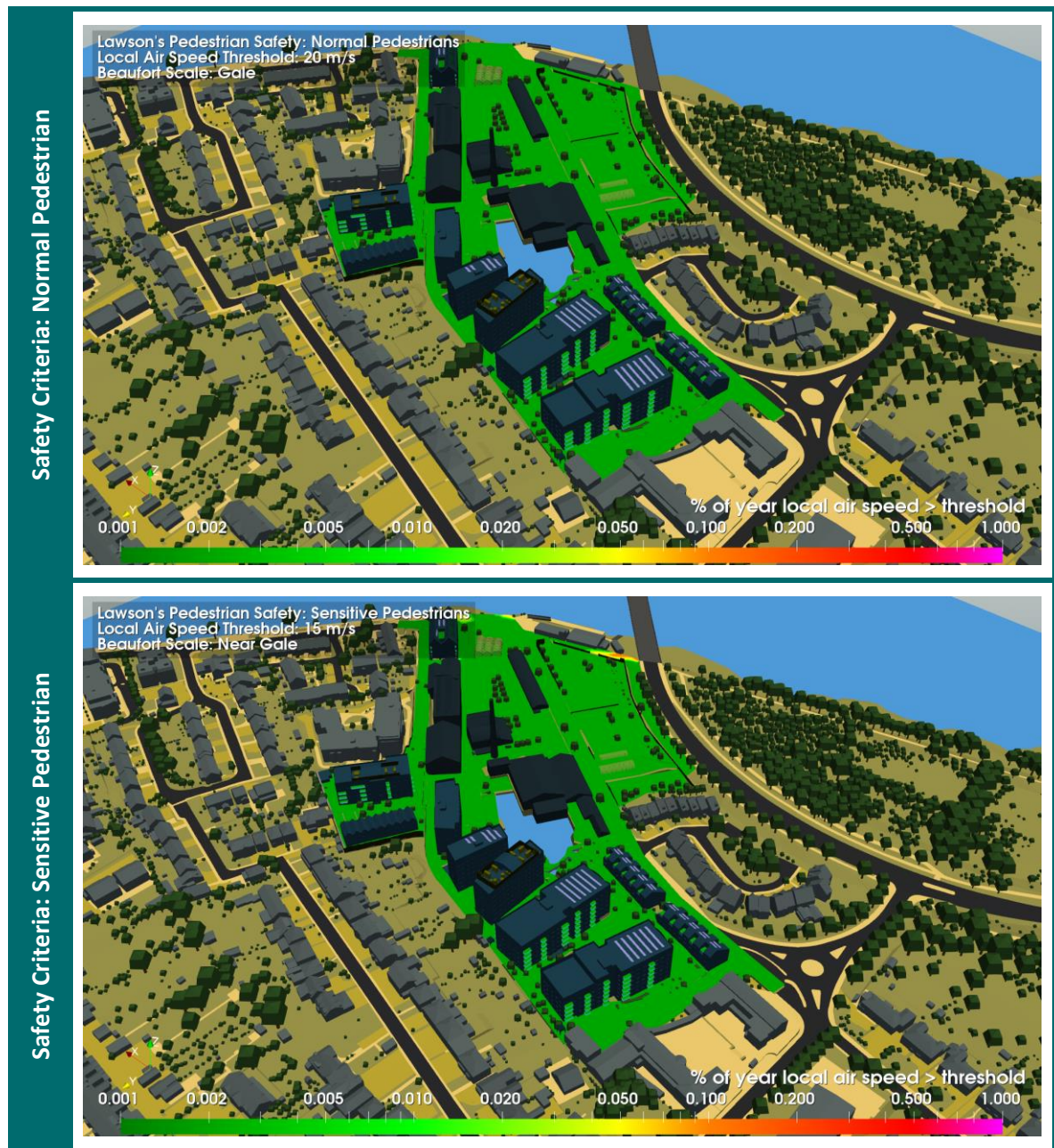


Figure 75: Safety Criteria: View from the northwest

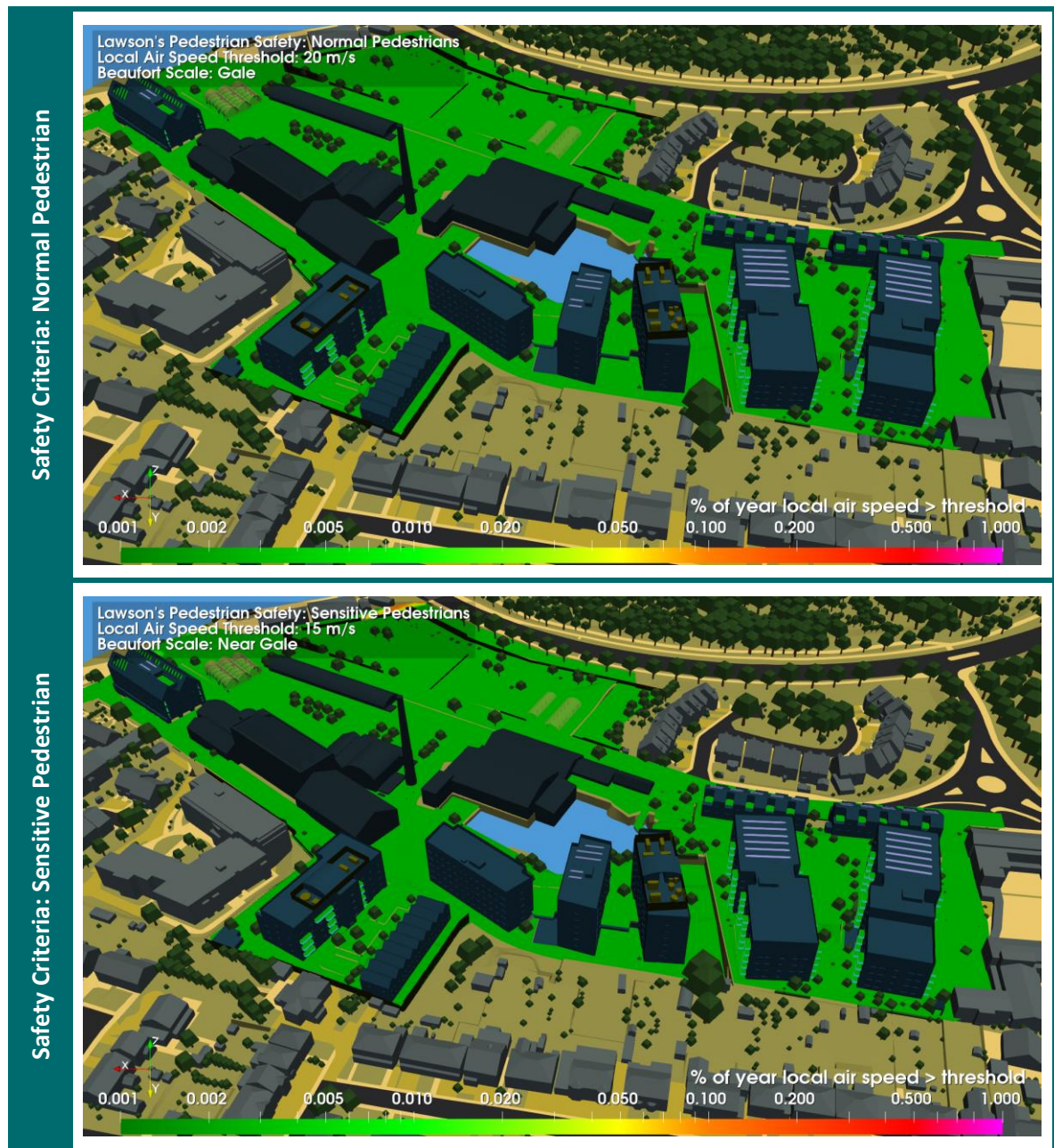


Figure 76: Safety Criteria: View from the north

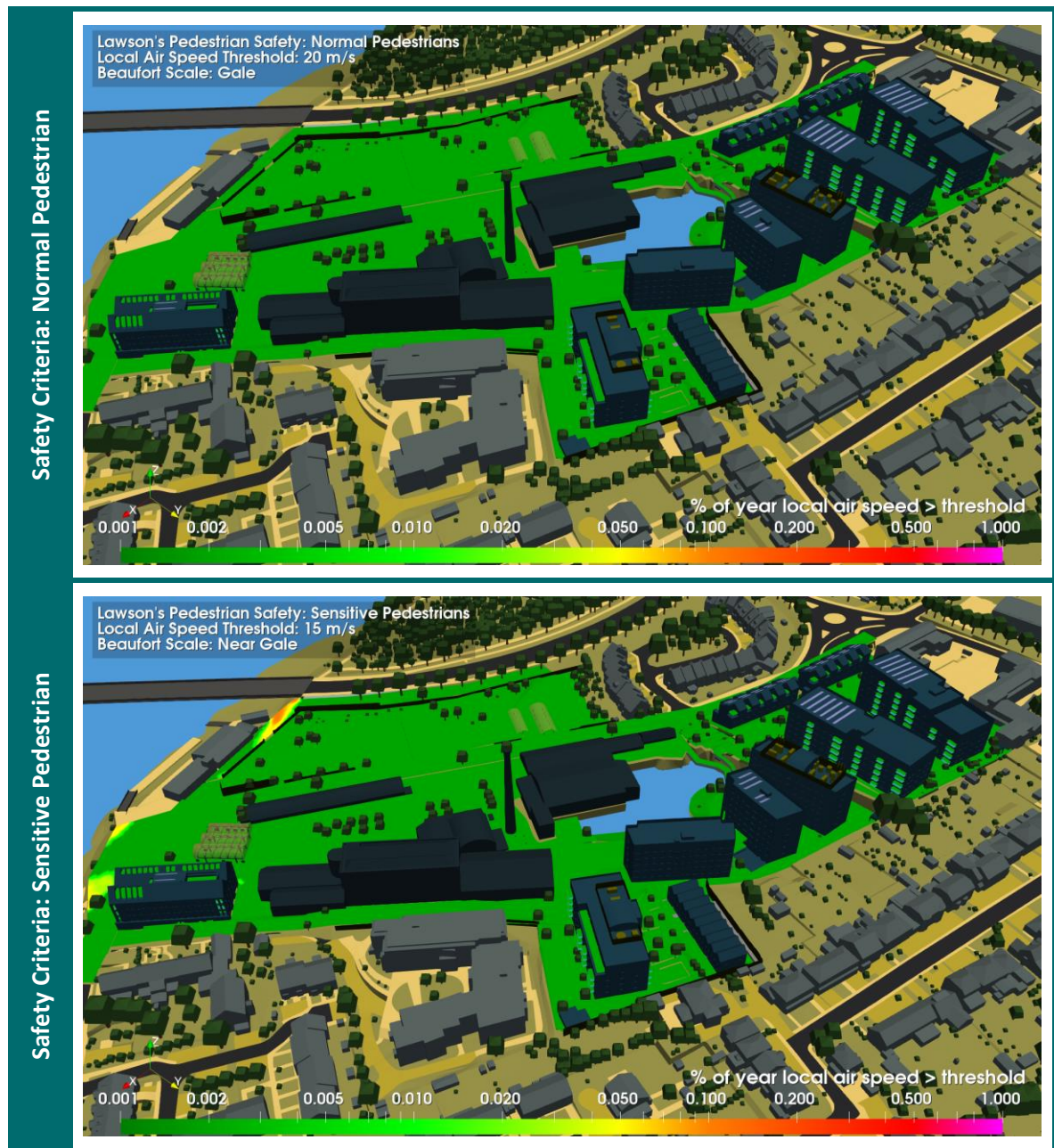


Figure 77: Safety Criteria: View from the northeast

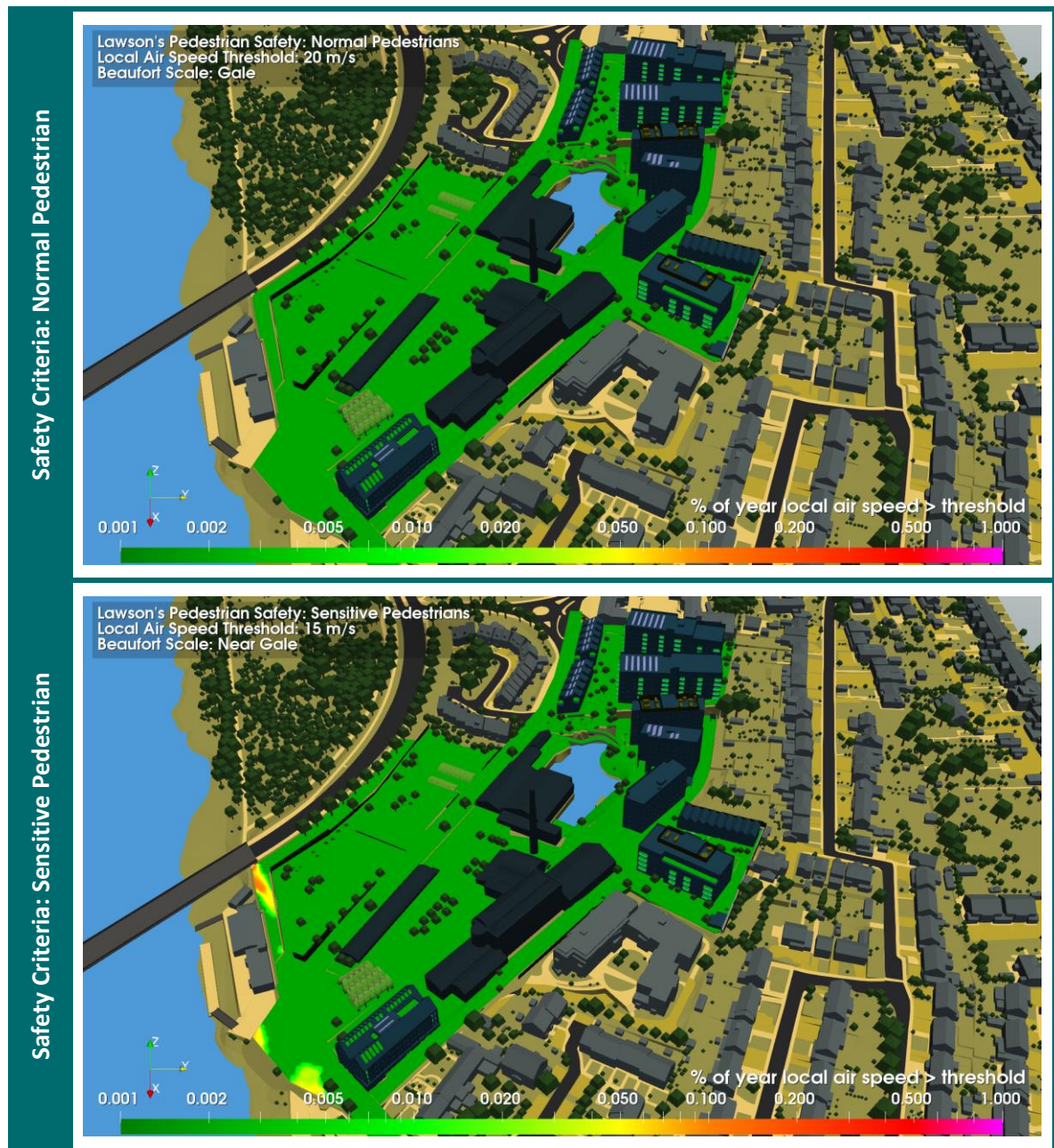


Figure 78: Safety Criteria: View from the east

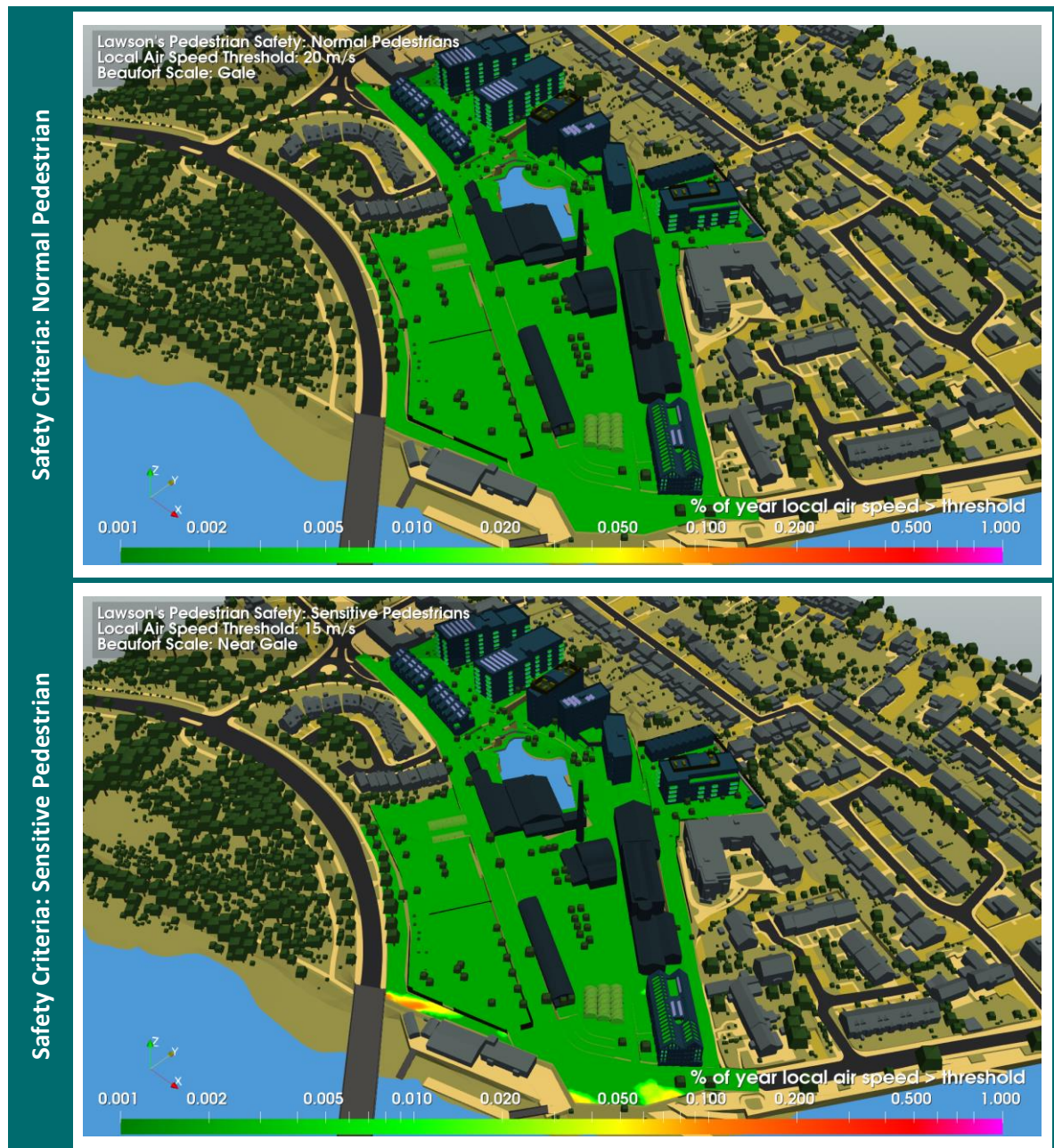


Figure 79: Safety Criteria: View from the southeast

