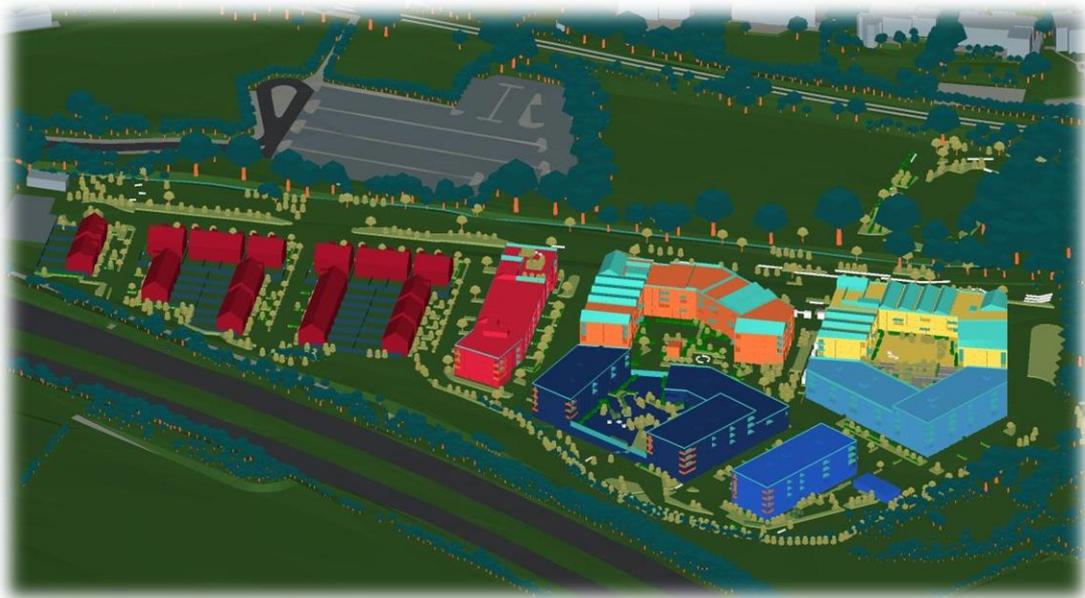




Priorsland SHD Wind Study

Wind Microclimate Study



Report For: Priorsland

Project No: 16104



Version History

Document created by:

Integrated Environmental Solutions Limited

International Sustainability Consulting Developers of the IES <Virtual Environment>

Issued For:	Prepared by:	Checked by:	
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Version:	Date:	Revision Details:	Approved by:
P1-01	04/04/2022	First Draft	Colin Rees

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1 Executive Summary

IES Consulting have been commissioned to investigate the impact from wind around the proposed development of the Priorsland Campus located close to the Carrickmines LUAS stop in south-east Dublin. The development consists of 8 blocks of varying heights.

For the analysis, 8 steady state Computational Fluid Dynamics (CFD) simulations were performed for the main wind directions (N, NE, E, SE, S, SW, W and NW) and annual average wind speed obtained from the Casement Aerodrome weather data set. 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 the Lawson's Pedestrian Comfort criterion.

The following table provides values for the 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 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 ² (m/s)
S1	Typical Pedestrian	20
S2	Sensitive Pedestrian	15

The results are presented in the form of false colour contour images of the percentage of year that the local air speed is likely to exceed a certain value at every point on the locations of interest. The air speed threshold value is mentioned in the title of the colour legend at the top right corner of each image. Do note that the scale for the images for results of the comfort criteria goes from 0.1% to 100%, and the scale for images for results of the safety criteria goes from 0.001% to 1%.

The median wind speed recorded was more than 5 m/s for weather location's climatic conditions. That means, for 50% of year, the wind speed is higher than 5 m/s. The Lawson's Sitting Criterion requires the local air speed be more than 4m/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 location of interest.

1.1 Sitting and Standing Comfort Criteria

The Lawson's sitting comfort criteria states that the local air speed at designated locations should not exceed 4m/s for more than 5% of the duration analysed. The Lawson's standing comfort criteria states the local air speed at designated locations should not exceed 6m/s for more than 5% of the duration analysed.

The results of the annual analysis for sitting and standing criterion are observed in the top left and right corners of the images in [section 7.1](#) respectively.

1.1.1 Balconies

It was observed that almost 94% of balconies show excellent results and fully meet requirements of the Lawson's sitting and standing criterion for the full year. The local air speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. The remaining 6% of balconies show limited compliance with the requirements of the Lawson's Sitting Comfort criterion, i.e. the local air speed exceeds 4m/s for more than 5% of the year. These balconies lie on the south and southwest corner of Blocks C, D, E and F. The local air speed is likely to exceed 4m/s for up to 20% of the year at these locations. These balconies are impacted due to prevailing southwesterly and westerly wind.

However, on comparing the results for these locations to Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6m/s for more than 5% of the year. The local air speed on balconies will be less than 4m/s for 90% of the year and between 4-6m/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.

1.1.1.1 Block A

[Figure 1](#) and [Figure 2](#) show the balconies on Block A with results for the Lawson's Sitting and Standing Comfort Criteria assessment. These show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion, i.e. the local air speed does not exceed 4m/s for more than 5% of the year. There are unlikely to be any effects on the private amenity spaces here, with no further mitigation measures required.

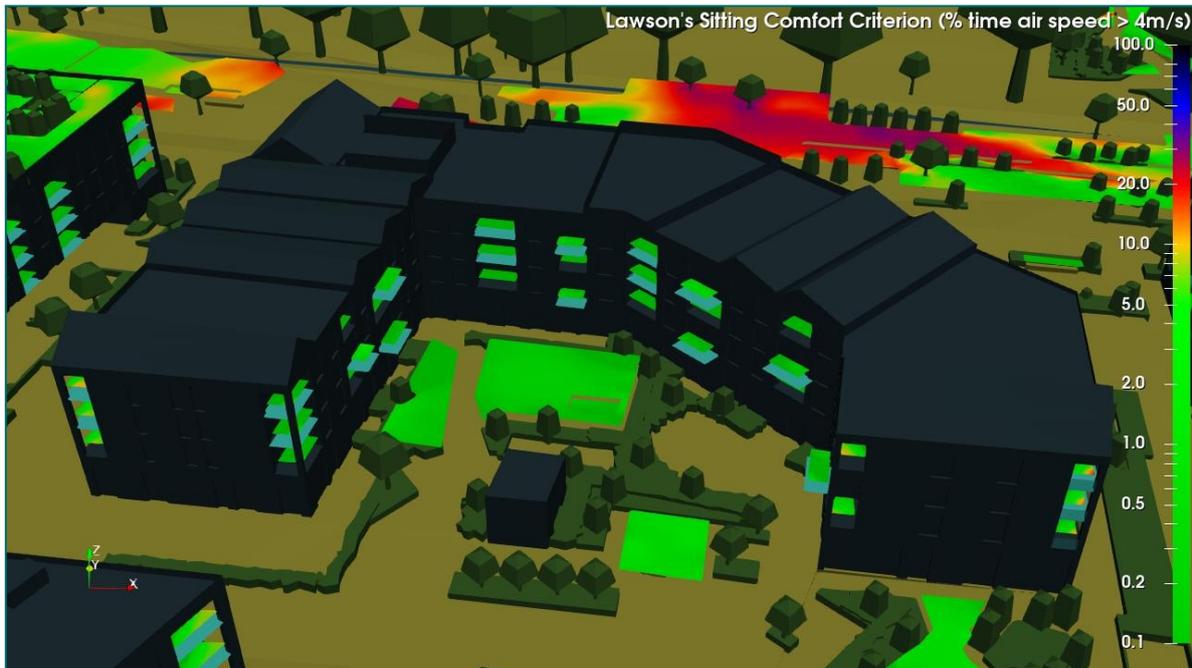


Figure 1: Sitting Comfort Criterion: Balconies of block A

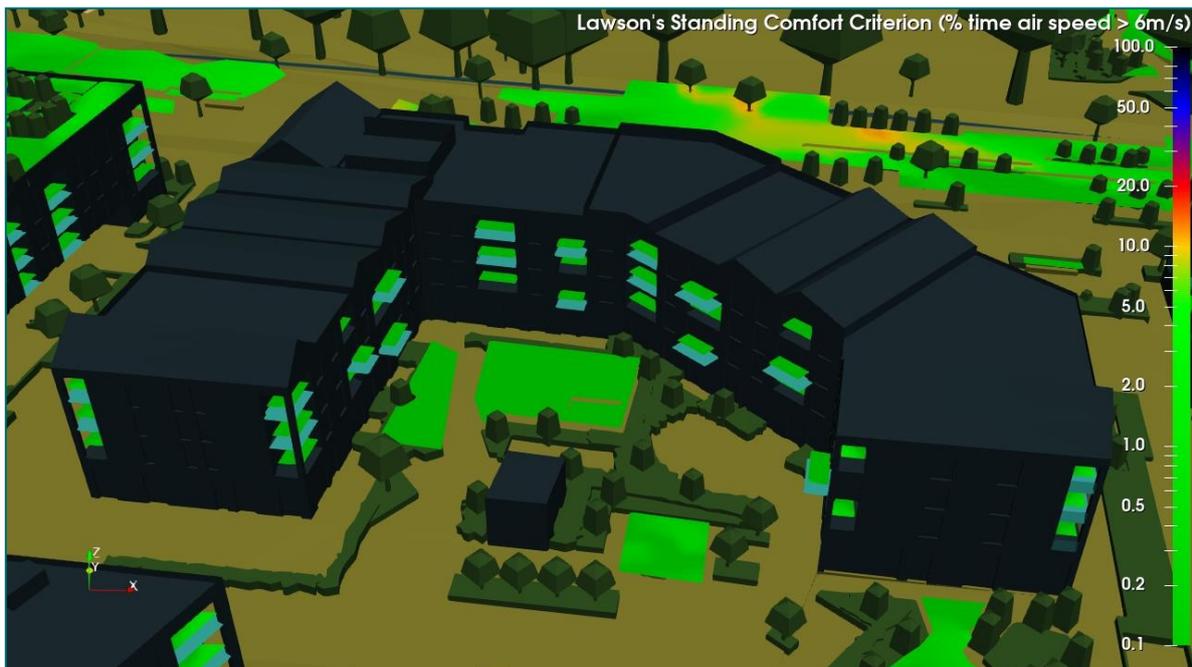


Figure 2: Standing Comfort Criterion: Balconies of block A

1.1.1.2 Block B

[Figure 3](#) and [Figure 4](#) show the balconies on Block B with results for the Lawson's Sitting and Standing Comfort Criteria assessment. These show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion, i.e. the local air speed does not exceed 4m/s for more than 5% of the year. There are unlikely to be any effects on the private amenity spaces here, with no further mitigation measures required.

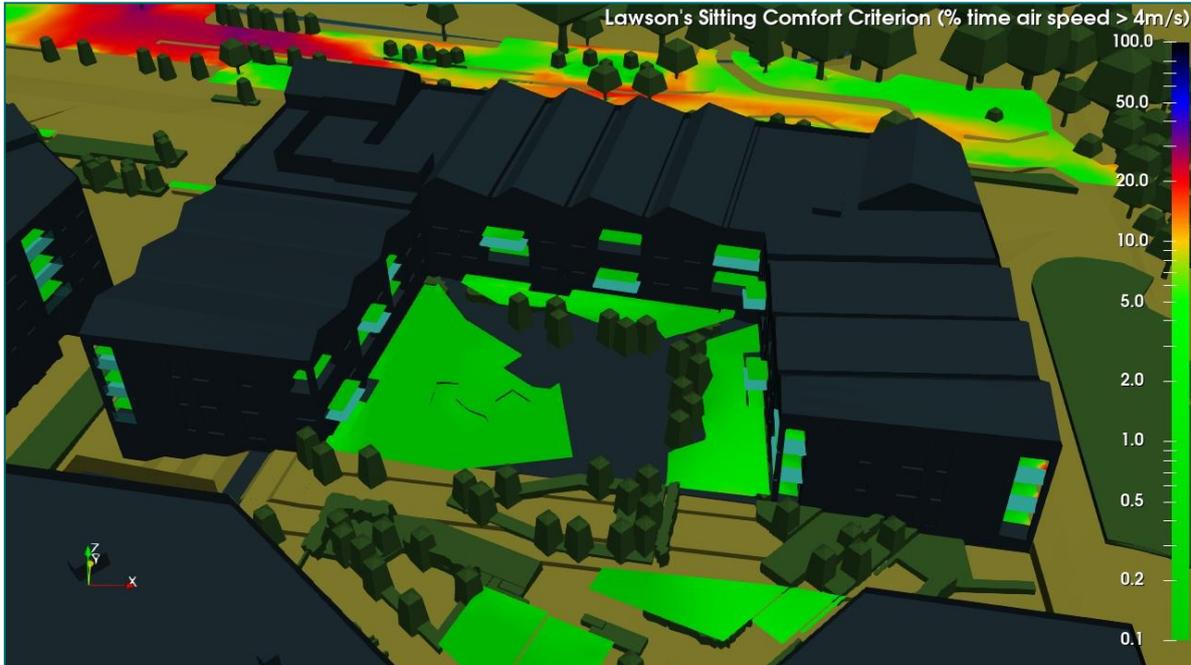


Figure 3: Sitting Comfort Criterion: Balconies of block B

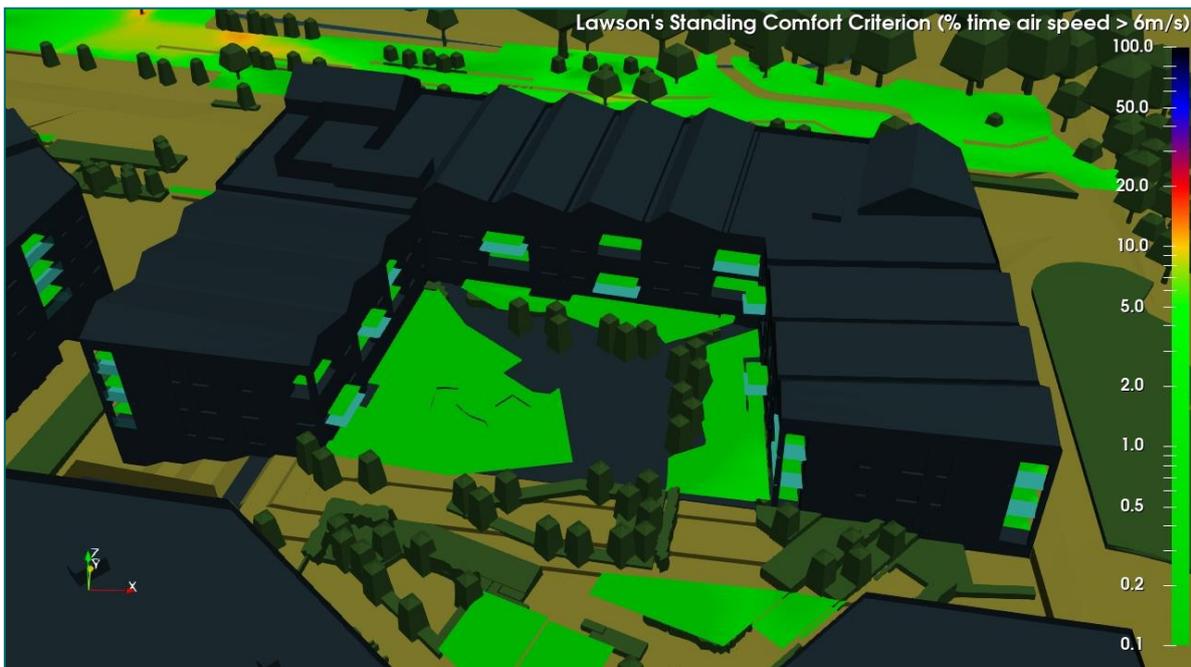


Figure 4: Standing Comfort Criterion: Balconies of block B

1.1.1.3 Block C

[Figure 5](#) and [Figure 6](#) show the southeast and southwest facing balconies of Block C. Balconies on the south corner show the limited compliance with the requirements of the Lawson's Sitting Comfort criterion. These balconies are marked in yellow circles in [Figure 5](#) and [Figure 6](#) below. The local air speed is likely to exceed 4m/s for up to 20% of the year at these locations. These balconies are impacted due to prevailing southwesterly and westerly wind and are subject to acceleration that can occur due to flow through narrow passage between Block C and the existing adjacent building. The balconies at the north corner of Block A are directly affected by prevailing southwesterly wind.

However, on comparing the results for these locations to Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6m/s for more than 5% of the year. See [Figure 6](#). Of the 20% of 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 on balconies will be less than 4m/s for 80% of the year and between 4-6m/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 most frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of this private space for personal recreation.

A portion of these balcony spaces demonstrate the local air speed exceeding 6m/s for more than 5% of the year, see [Figure 6](#). However, the rest of the balcony space is excellent to use as a sitting or standing purpose as the wind speed is within the threshold limit of standing criteria. No further mitigation measures required as the balcony spaces are the private spaces which are used by the people residing in the respective flat. They can use it by their own choice by judging the comfortable climatic conditions. It is not a space that can be treated as a public open space where people have to use it frequently.

The remainder of the balconies are fully compliant with the requirements of the Lawson's Sitting and Standing Comfort Criteria, i.e. the local air speed does not exceed 4m/s for more than 5% of the year.



Figure 5: Sitting Comfort Criterion: Balconies of block C



Figure 6: Standing Comfort Criterion: Balconies of block C

1.1.1.4 Block D

[Figure 7](#) and [Figure 8](#) show the south facade balconies of Block D. These balconies show the limited compliance with the requirements of the Lawson's Sitting Comfort criterion. These balconies are marked in yellow circles in [Figure 7](#) and [Figure 8](#). The local air speed is likely to exceed 4m/s for up to 20% of the year at these locations. These balconies are impacted due to prevailing southwesterly and westerly wind and are subject to acceleration that can occur due to flow through narrow passage between Block C and existing adjacent building. The balconies at the north corner of Block A are directly affected by prevailing southwesterly wind.

However, on comparing the results for these locations to Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6m/s for more than 5% of the year. See [Figure 8](#). Of the 20% of 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 on balconies will be less than 4m/s for 80% of the year and between 4-6m/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 most frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of this private space for personal recreation.

A portion of these balcony spaces demonstrate the local air speed exceeding 6m/s for more than 5% of the year, see [Figure 8](#). However, the rest of the balcony space is excellent to use as a sitting or standing purpose as the wind speed is within the threshold limit of standing criteria. No further mitigation measures required as the balcony spaces are the private spaces which are used by the people residing in the respective flat. They can use it by their own choice by judging the comfortable climatic conditions. It is not a space that can be treated as a public open space where people have to use it frequently.

The remainder of the balconies are fully compliant with the requirements of the Lawson's Sitting and Standing Comfort Criteria, i.e. the local air speed does not exceed 4m/s for more than 5% of the year.



Figure 7: Sitting Comfort Criterion: Balconies of block D



Figure 8: Standing Comfort Criterion: Balconies of block D

1.1.1.5 Block E

[Figure 9](#) and [Figure 10](#) show the south facade balconies of Block E. These balconies show the limited compliance with the requirements of the Lawson's Sitting Comfort criterion. These balconies are marked in yellow circles in [Figure 9](#) and [Figure 10](#). The local air speed is likely to exceed 4m/s for up to 20% of the year at these locations. These balconies are impacted due to prevailing southwesterly and westerly wind and are subject to acceleration that can occur due to flow through narrow passage between Block C and existing adjacent building. The balconies at the north corner of Building A are directly affected by prevailing southwesterly wind.

However, on comparing the results for these locations to Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6m/s for more than 5% of the year. See [Figure 10](#). Of the 20% of 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 on balconies will be less than 4m/s for 80% of the year and between 4-6m/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 most frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of this private space for personal recreation.

No further mitigation measures required as the balcony spaces are the private spaces which are used by the people residing in the respective flat. They can use it by their own choice by judging the comfortable climatic conditions. It is not a space that can be treated as a public open space where people have to use it frequently.

The remainder of the balconies are fully compliant with the requirements of the Lawson's Sitting and Standing Comfort Criteria, i.e. the local air speed does not exceed 4m/s for more than 5% of the year.



Figure 9: Sitting Comfort Criterion: Balconies of block E



Figure 10: Standing Comfort Criterion: Balconies of block E

1.1.1.6 Block F

[Figure 11](#) and [Figure 14](#) show the south facade balconies of Block F. These balconies show the limited compliance with the requirements of the Lawson's Sitting Comfort criterion. These balconies are marked in yellow circles in [Figure 11](#) and [Figure 12](#). The local air speed is likely to exceed 4m/s for up to 20% of the year at these locations. These balconies are impacted due to prevailing southwesterly and westerly wind and are subject to acceleration that can occur due to flow through narrow passage between Block C and existing adjacent building. The balconies at the north corner of Building A are directly affected by prevailing southwesterly wind.

However, on comparing the results for these locations to Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6m/s for more than 5% of the year. See [Figure 13](#) and [Figure 14](#). Of the 20% of 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 on balconies will be less than 4m/s for 80% of the year and between 4-6m/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 most frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of this private space for personal recreation.

No further mitigation measures required as the balcony spaces are the private spaces which are used by the people residing in the respective flat. They can use it by their own choice by judging the comfortable climatic conditions. It is not a space that can be treated as a public open space where people have to use it frequently.

The remainder of the balconies are fully compliant with the requirements of the Lawson’s Sitting and Standing Comfort Criteria, i.e. the local air speed does not exceed 4m/s for more than 5% of the year.

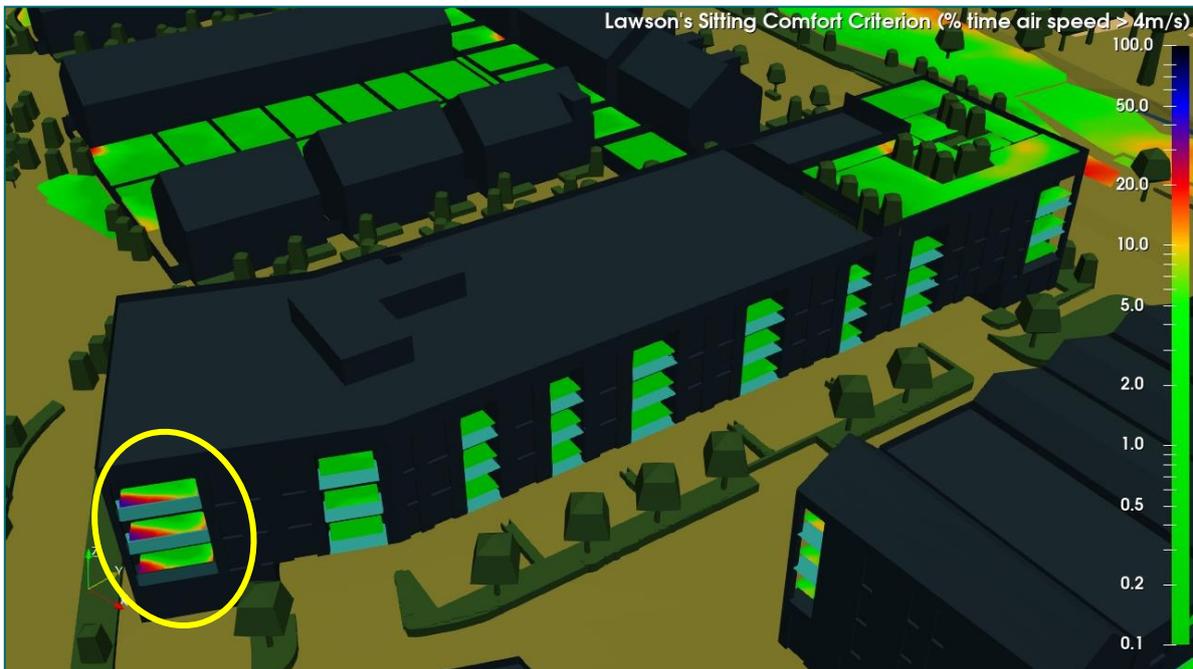


Figure 11: Sitting Comfort Criterion: Balconies of block F: View from the southeast



Figure 12: Sitting Comfort Criterion: Balconies of block F: View from the southwest

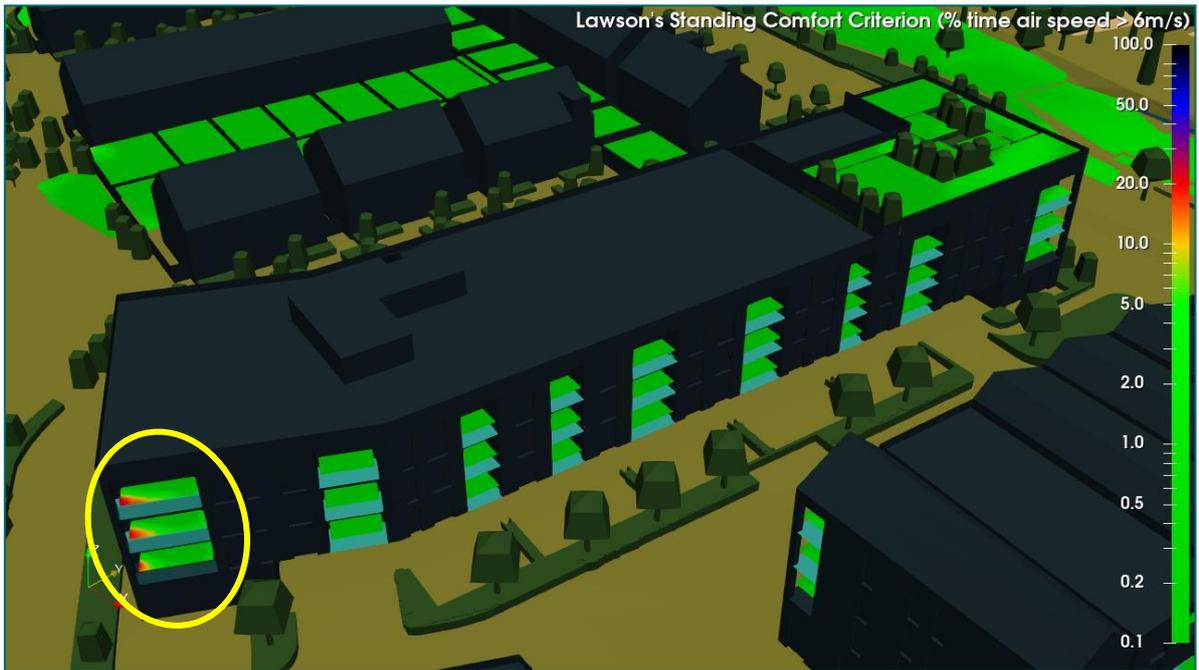


Figure 13: Standing Comfort Criterion: Balconies of block F: View from the southeast

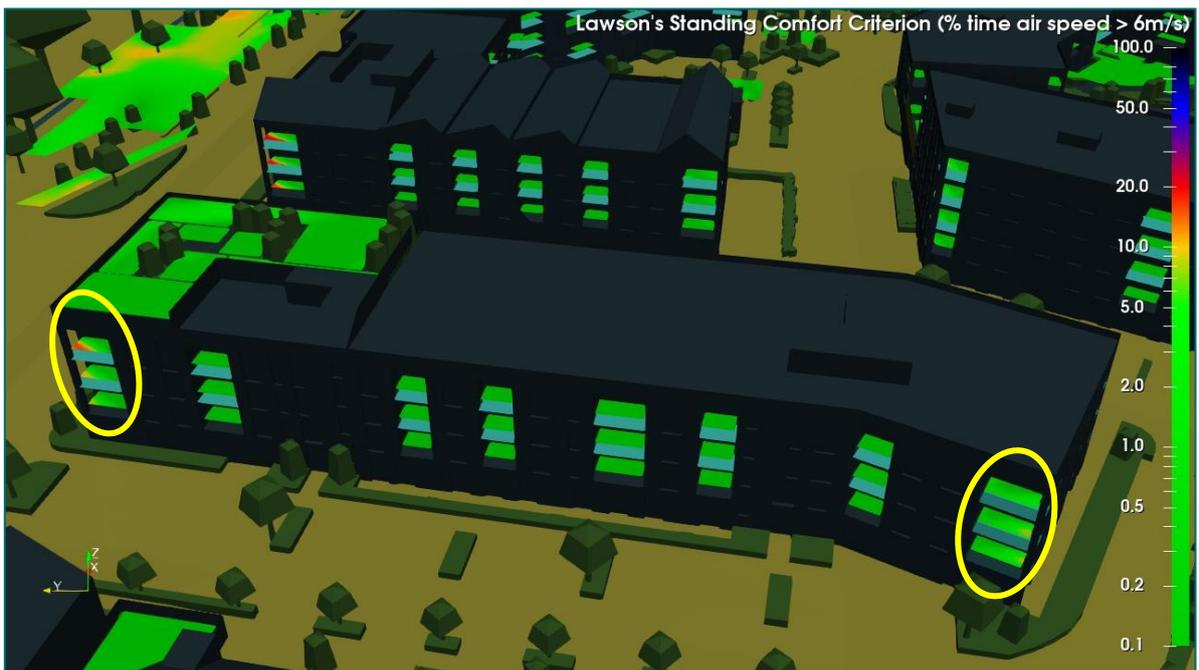


Figure 14: Standing Comfort Criterion: Balconies of block F: View from the southwest

1.1.2 Ground Amenities

1.1.2.1 Ground Amenities Around Blocks

It was observed most of the ground amenity spaces around the blocks show the excellent results and fully met requirements of the Lawson's sitting and standing comfort criterion for the full year. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement.

[Figure 15](#) and [Figure 16](#) below show the results of sitting and standing comfort of ground amenity spaces surrounded by the building blocks. Few locations of the ground amenity space in red and orange colour show limited compliance to the 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. These spaces are impacted due to prevailing southwesterly wind and are subject to acceleration that can occur due to flow through narrow passage between blocks. The spaces seen in orange, red band are activity areas and are not intended for the sitting purpose.

However, on comparing the results for these locations to Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6m/s for more than 5% of the year, see [Figure 16](#). For the 20% of 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 on these spaces will be less than 4m/s for 80% 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 most frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of space for recreation.

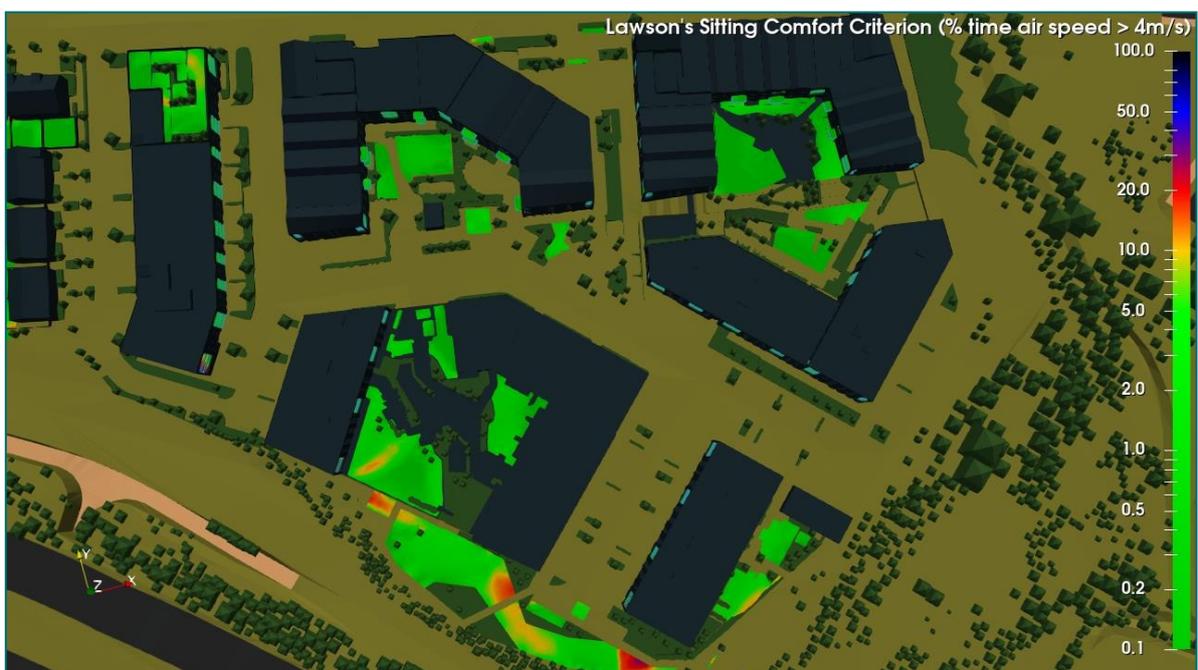


Figure 15: Sitting Comfort Criterion: Ground Amenities



Figure 16: Standing Comfort Criterion: Ground Amenities

No further mitigation measures required. Mitigation measures carried out for these ground amenity spaces worked well to create comfortable conditions. The spaces are fully compliant to the standing and walking comfort criteria.

1.1.2.2 Private Gardens on Plot G

[Figure 17](#) and [Figure 18](#) below show the results of sitting and standing comfort of ground amenity spaces surrounded by the independent houses on Plot G. These show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion, i.e. the local air speed does not exceed 4m/s for more than 5% of the year. There are unlikely to be any effects on the private amenity spaces here, with no further mitigation measures required. Mitigation measures carried out for these ground amenity spaces worked well to create comfortable conditions. The spaces are fully compliant to the standing and walking comfort criteria.



Figure 17: Sitting Comfort Criterion: Private gardens on plot G



Figure 18: Standing Comfort Criterion: Private gardens on plot G

1.1.2.3 Ground Amenities Around Linear Park

It was observed most of the ground amenity spaces on the linear park show the excellent results and fully met requirements of the Lawson's sitting and standing comfort criterion for the full year. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement.

[Figure 19](#) and [Figure 20](#) below show the results of sitting and standing comfort of ground amenity spaces around linear park. Some of the ground amenity space in red and orange colour show limited compliance to the 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. These spaces are impacted due to prevailing southwesterly and westerly wind. Most of these spaces are activity areas. Hence, these spaces are not intended for the sitting purpose.

However, on comparing the results for these locations to Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6m/s for more than 5% of the year, see [Figure 20](#). For the 20% of 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 on these spaces will be less than 4m/s for 80% 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 most frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of space for recreation.

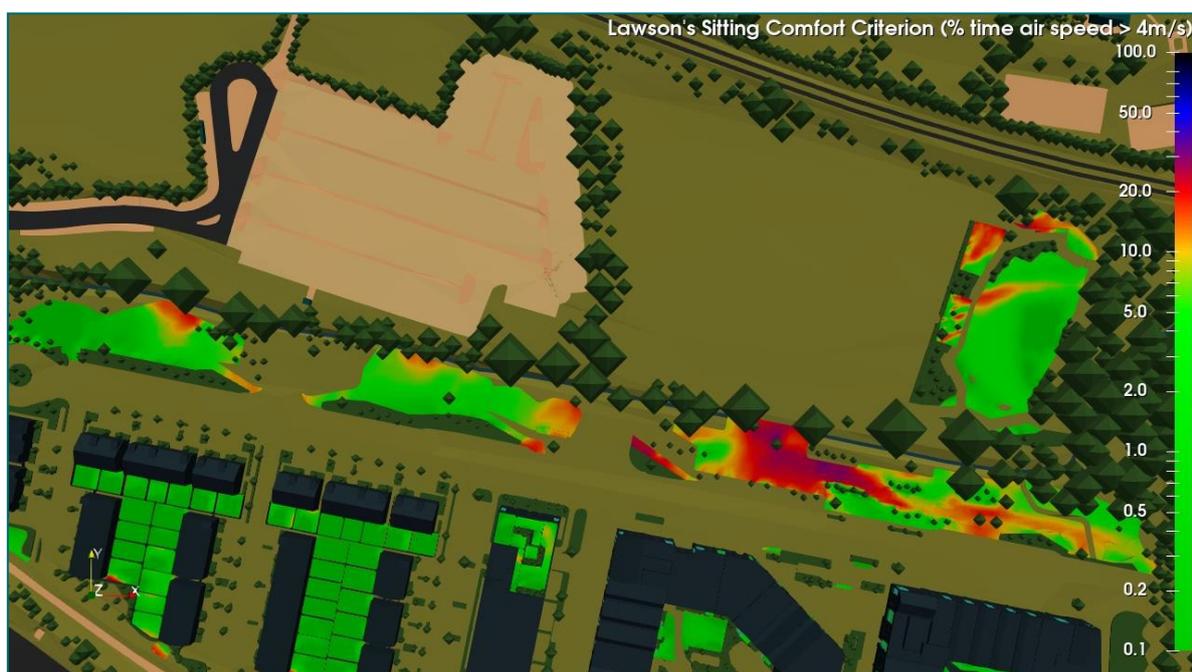


Figure 19: Sitting Comfort Criterion: Ground Amenities – Linear Park



Figure 20: Standing Comfort Criterion: Ground Amenities – Linear Park

No further mitigation measures are required. The spaces are fully compliant to the standing and walking comfort criteria.

1.1.3 Roof Amenities

[Figure 21](#) and [Figure 22](#) show the roof amenity on Block F with results for the Lawson's Sitting and Standing Comfort Criteria assessment. These show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion, i.e. the local air speed does not exceed 4m/s for more than 5% of the year. There are unlikely to be any effects on the roof amenity spaces here, with no further mitigation measures required. Mitigation measures carried out for these roof amenity spaces worked well to create comfortable conditions.

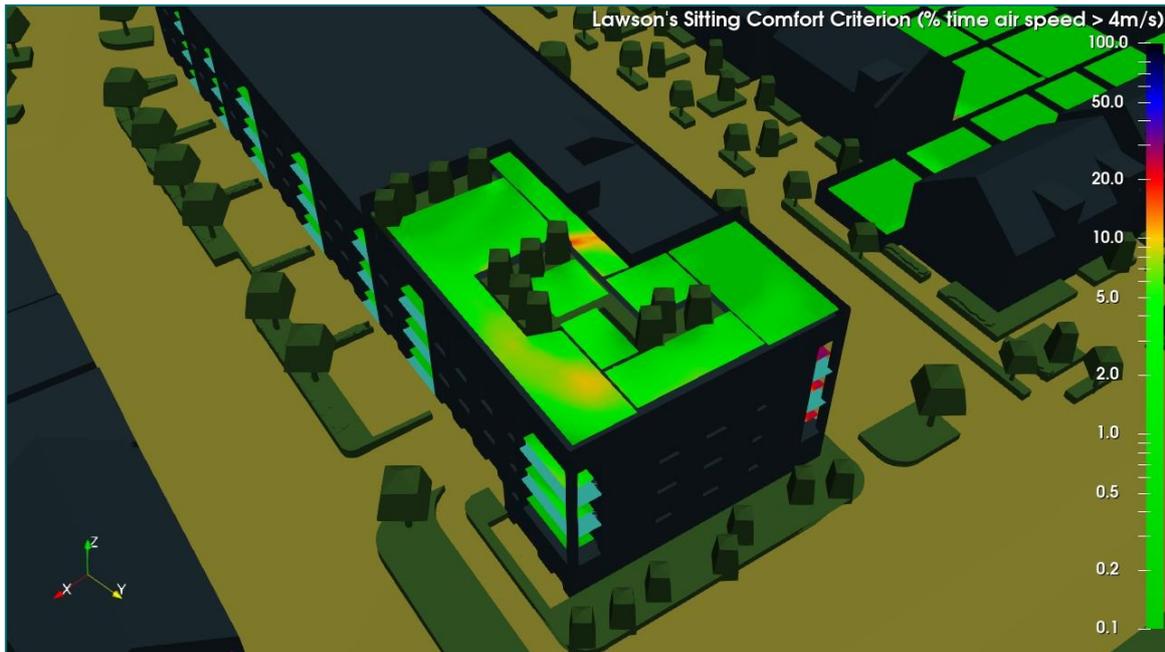


Figure 21: Sitting Comfort Criterion: Roof Amenities: Block F

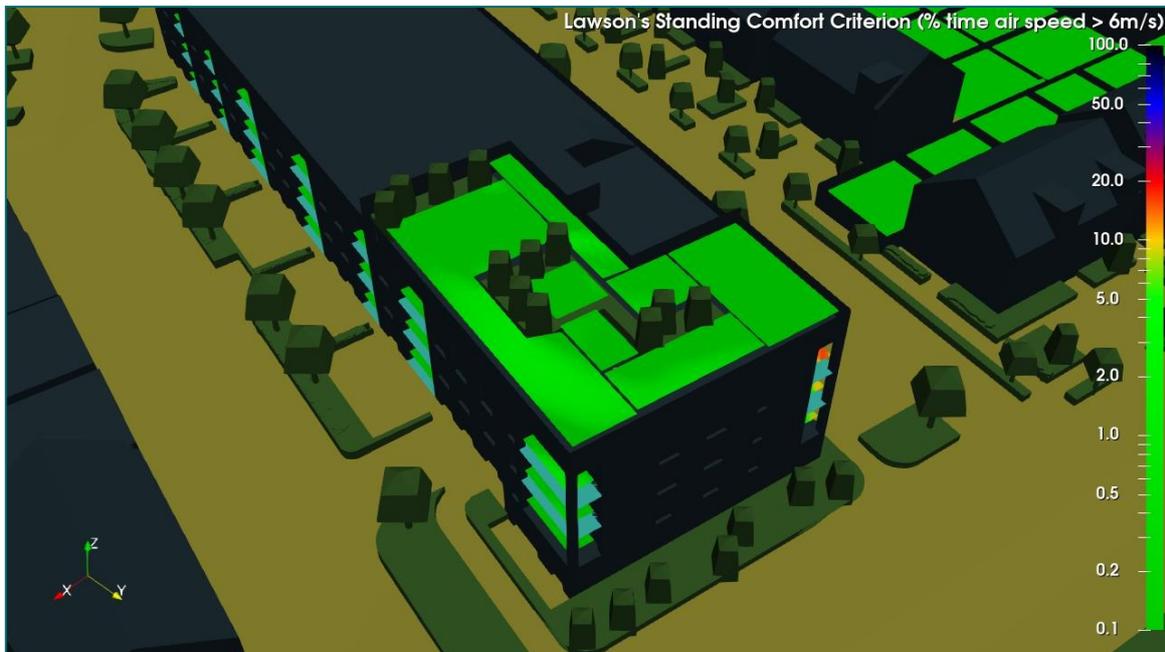


Figure 22: Standing Comfort Criterion: Roof Amenities: Block F

1.2 Walking Comfort

The Lawson's Leisure Walking comfort criteria states that the local air speed at designated locations should not exceed 8m/s for more than 5% of the duration analysed, on the various paths around the development. The Lawson's Business Walking comfort criteria states that the local air speed at designated locations should not exceed 10m/s for more than 5% of the duration analysed, on the various paths around the development.

[Figure 23](#) and [Figure 24](#) show the results of walking comfort criteria.



Figure 23: Leisure Walking Comfort Criterion: Top View



Figure 24: Business Walking Comfort Criterion: Top View

These show excellent compliance with the requirements of the Lawson's Leisure walking, and Business walking Comfort Criteria. The local air speed does not exceed 8m/s, and 10 m/s for more than 5% of the year, respectively.

1.3 Safety Criteria

The Lawson's Normal Pedestrian safety criteria states that the local air speed at designated locations should not exceed 20m/s for more than 0.01% of the duration analysed. The Lawson's Sensitive Pedestrian safety criteria states the local air speed at designated locations should not exceed 15m/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 required at all times irrespective of weather conditions to enter or exit the various buildings. [Figure 25](#) and [Figure 26](#) show the results of safety criteria assessment. The criterion for the Normal and Sensitive Pedestrian is achieved throughout the site. None of the paths around the development show even 0.01% prevalence of local air speeds exceeding 20m/s i.e. Normal Safety Criterion threshold.

The green areas in [Figure 25](#) and [Figure 26](#) are fully compliant with the requirements of the Sensitive Pedestrian Safety Criterion.

The site can be considered as safe for all residents including those that would be considered vulnerable.



Figure 25: Normal Pedestrian Safety Criterion: Top View



Figure 26: Sensitive Pedestrian Safety Criterion: Top View

2 Introduction

IES Consulting have been commissioned to study the impact from wind on pedestrian comfort around the proposed development of the Priorsland Campus located close to the Carrickmines LUAS stop in south-east Dublin.

The development consists of 8 blocks of varying heights.

The analysis is performed to study the effect from the building layout on pedestrian comfort as well as safety for people using the 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.

3 Weather Data

3.1 Location

We have used weather data recorded at Casement Aerodrome as the reference weather data for this analysis. This location is approximately 19 km east from the development.

This location was chosen over the Dublin Airport for reference data due to similar geographic location of Priorsland campus and Casement Aerodrome. Priorsland campus and Casement Aerodrome lie to the south edge of Dublin city. As such the south and south-westerly winds are prevalent for Dublin. Due to location at southern edge of city, both Casement and Priorsland campus will receive this winds unaffected by the urban expanse of Dublin. Dublin airport is located to the north of Dublin and will receive these winds with dampening effect of the urban expanse. [Figure 27](#) below shows the location analysis.

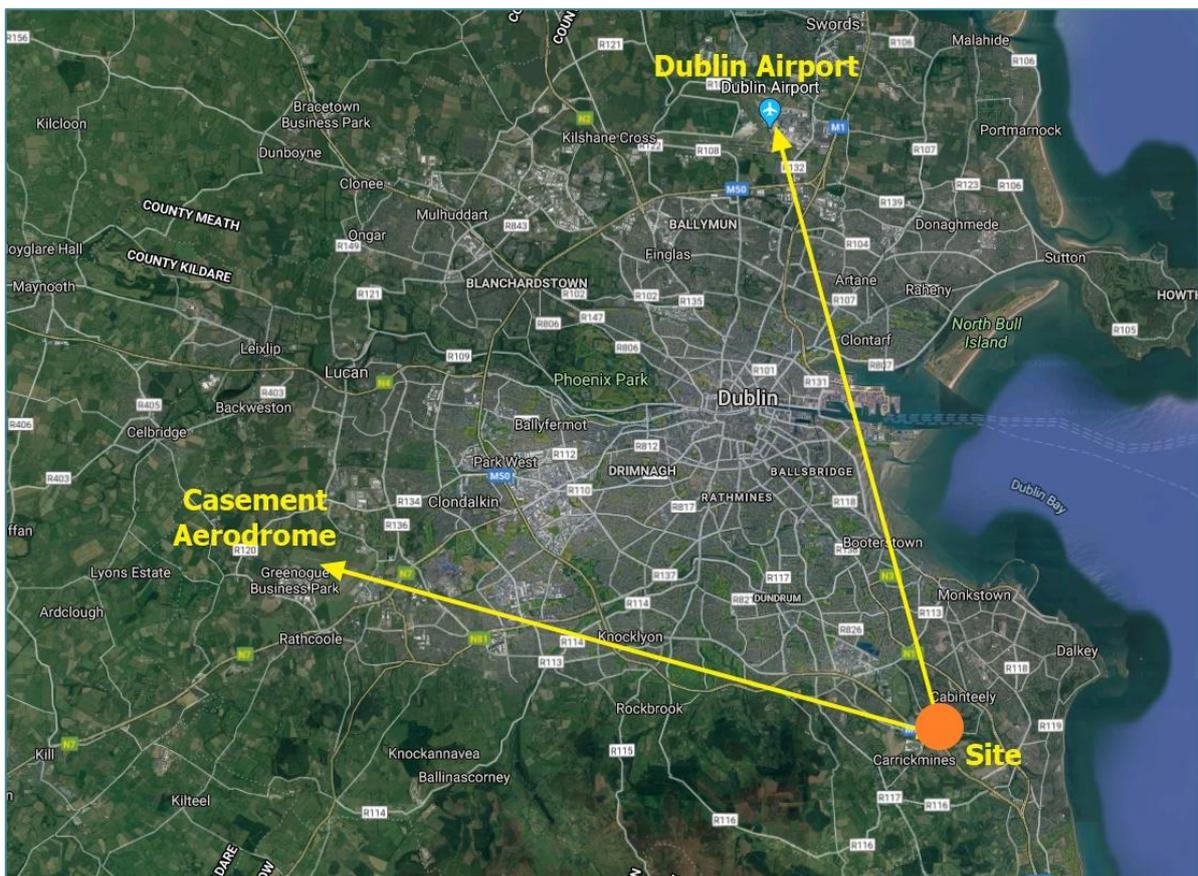


Figure 27: Choice of Weather file

3.2 Weather Data

The analysis is based on the 'IRL_EM_Casement.AP.039670_TMYx.2004-2018.epw' weather file. The variation of wind speed recorded in the weather file is shown in [Figure 28](#) below. [Figure 29](#) show the wind direction variation and [Figure 30](#) show the wind rose.

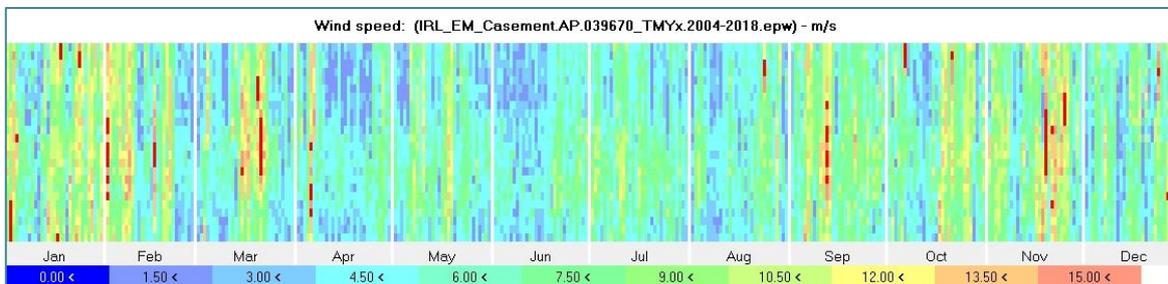


Figure 28: Wind speed variation as per IRL_EM_Casement.AP.039670_TMYx.2004-2018.epw

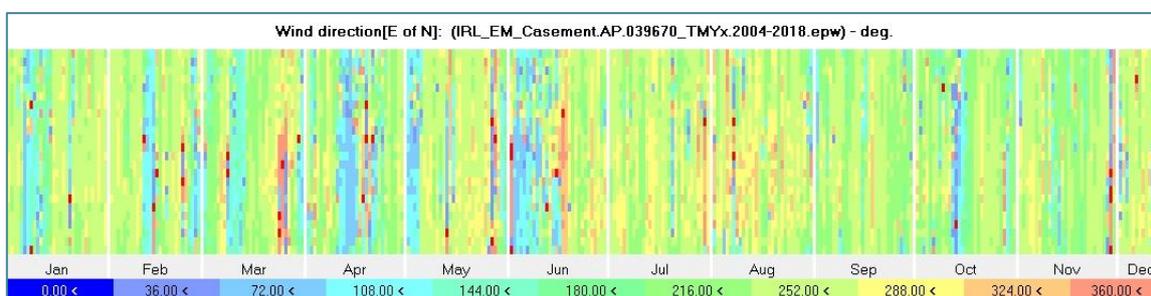


Figure 29: Wind direction variation as per IRL_EM_Casement.AP.039670_TMYx.2004-2018.epw

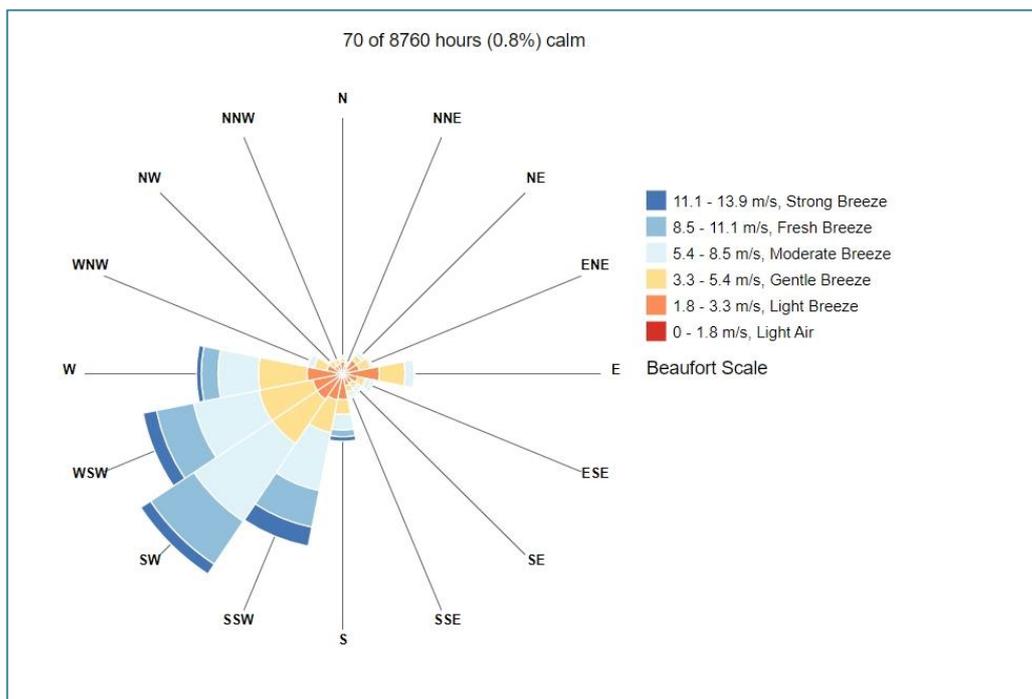


Figure 30: Wind rose as per IRL_EM_Casement.AP.039670_TMYx.2004-2018.epw

Based on this, the mean and median wind speed recorded was **5.66m/s** with a south-westerly prevailing direction.

4 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 31](#).

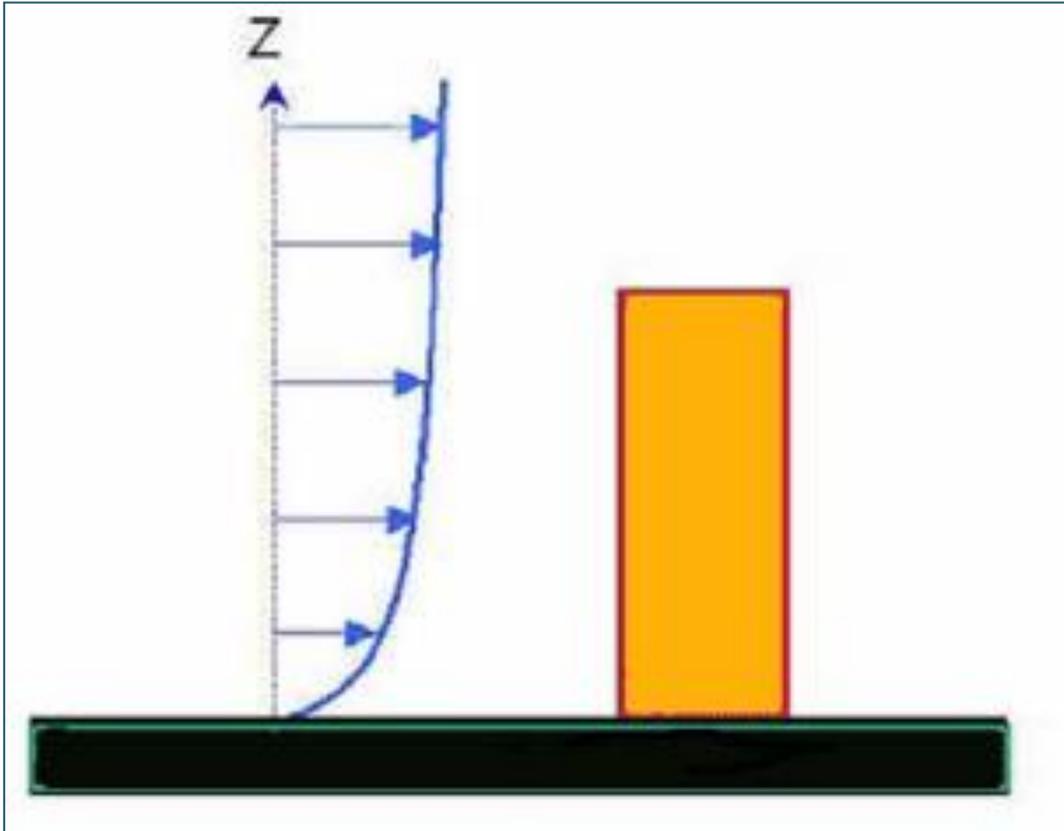


Figure 31: Typical velocity profile of an atmospheric boundary layer

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 as in table 1.

Table 1: Atmospheric boundary layer parameters

Terrain Category	Description	a	δ
1	Large city centres 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 the terrain category 2 i.e. Urban/Suburban type of site. The met data was taken on category 3 terrain at a height of 10m.

5 Methodology for Pedestrian Comfort Calculation

The methodology for the analysis was as follows:

- 1) The annual mean wind speed was determined from the 'casement_AMY_2018.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.

5.1 Lawson Pedestrian Comfort/Safety Criteria

The Lawson Criteria¹ was used as a reference to assess the wind effects. It is the most widely used reference for assessment of 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 the 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 be exceeded 0.01% of the year.

6 CFD Model

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

6.1 Model Geometry

[Figure 32](#) to [Figure 67](#) show the geometry as modelled.

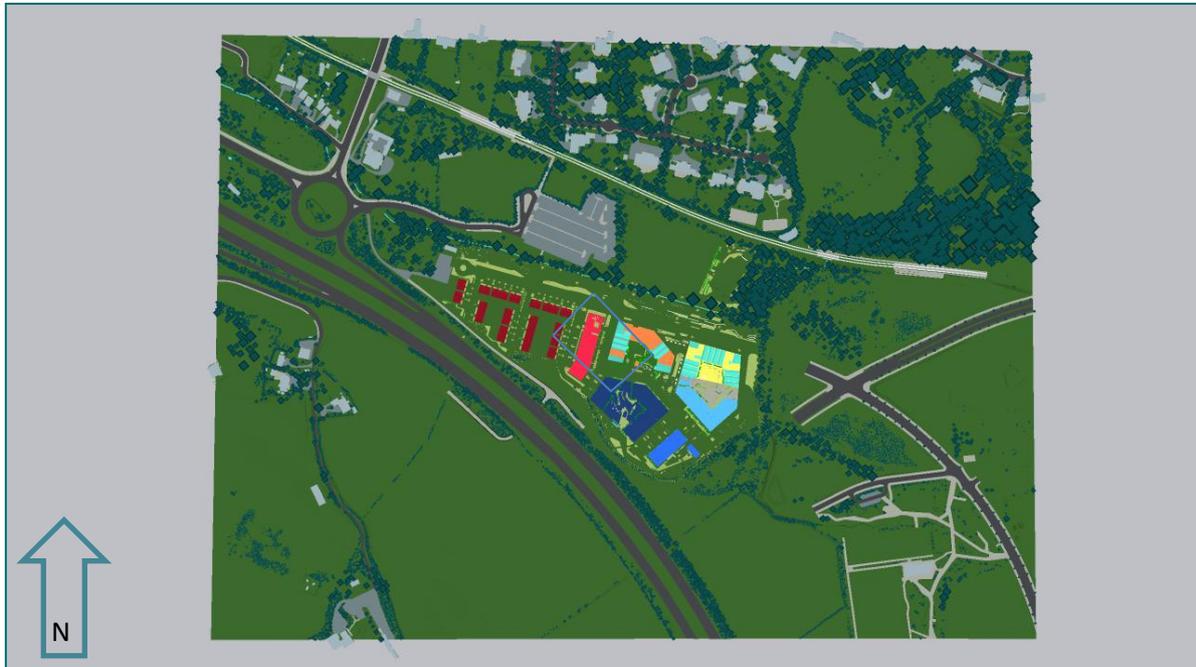


Figure 32: Plan view of the site

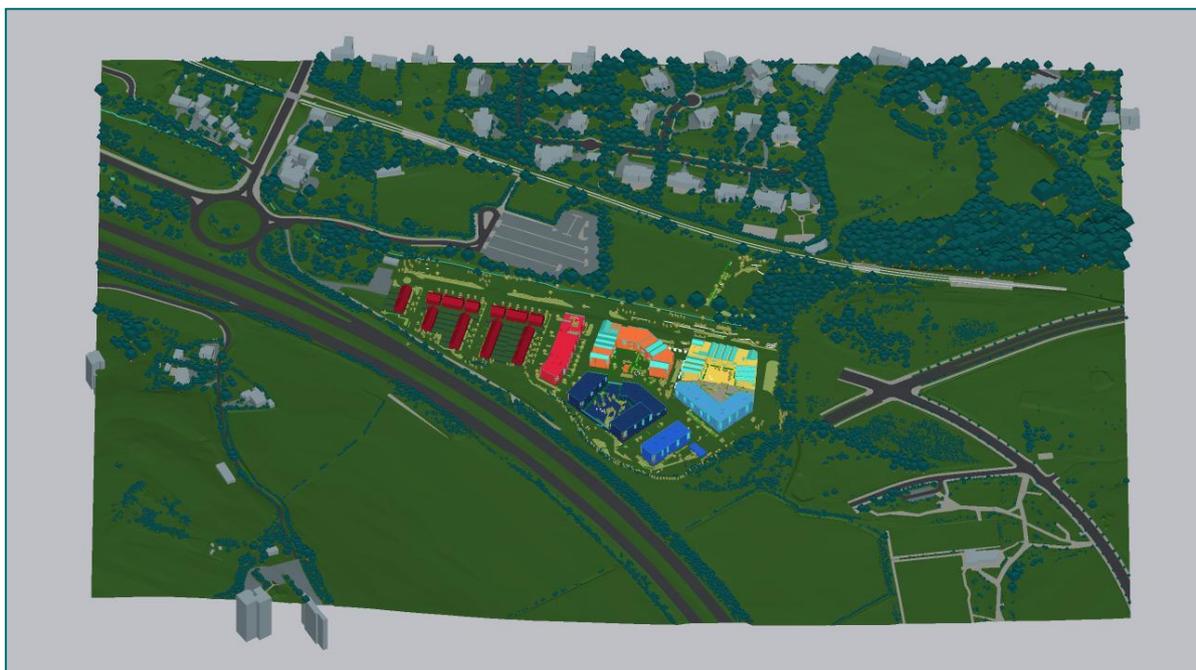


Figure 33: View of the site from the south

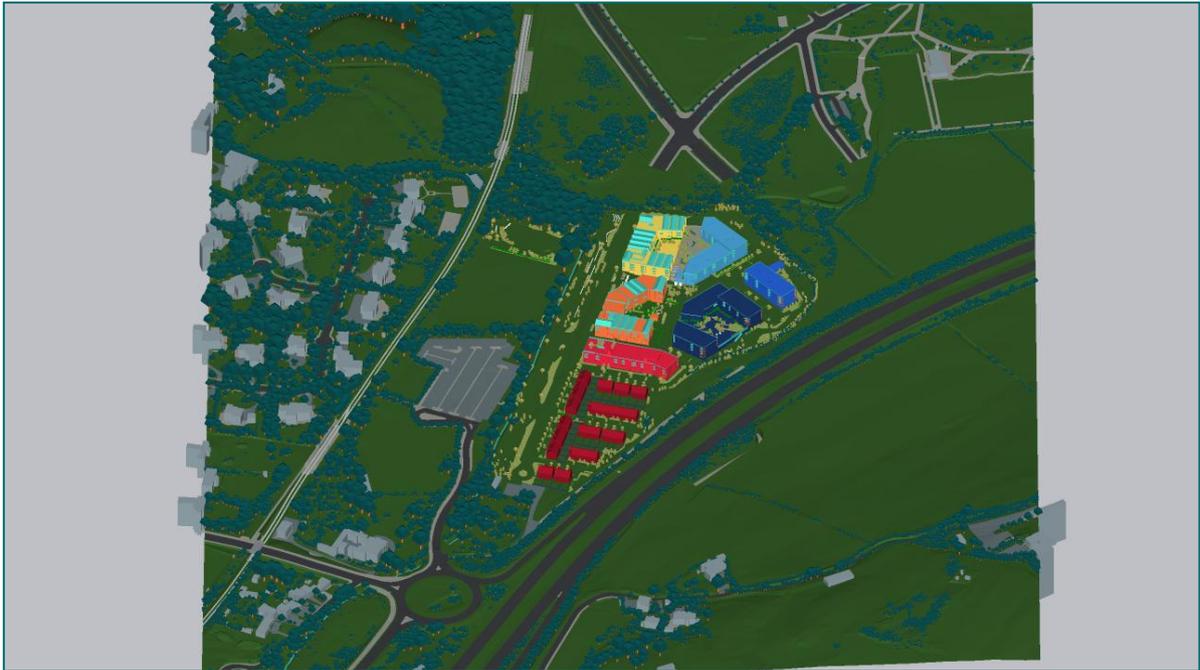


Figure 34: View of the site from the west

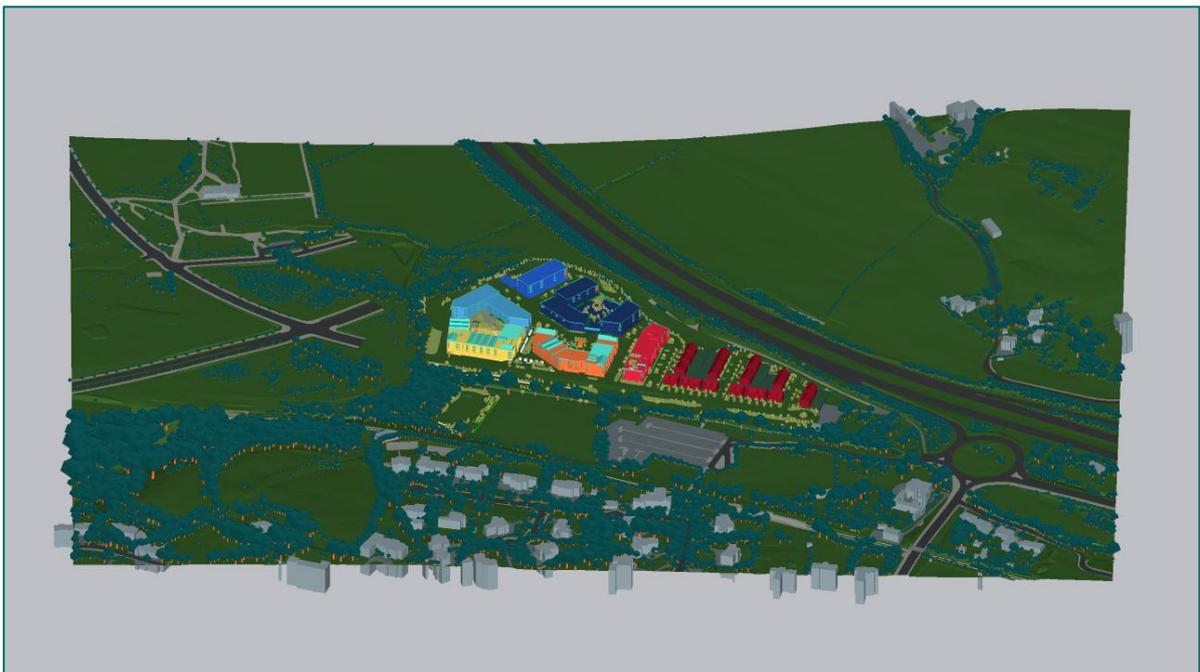


Figure 35: View of the site from the north



Figure 36: View of the site from the east

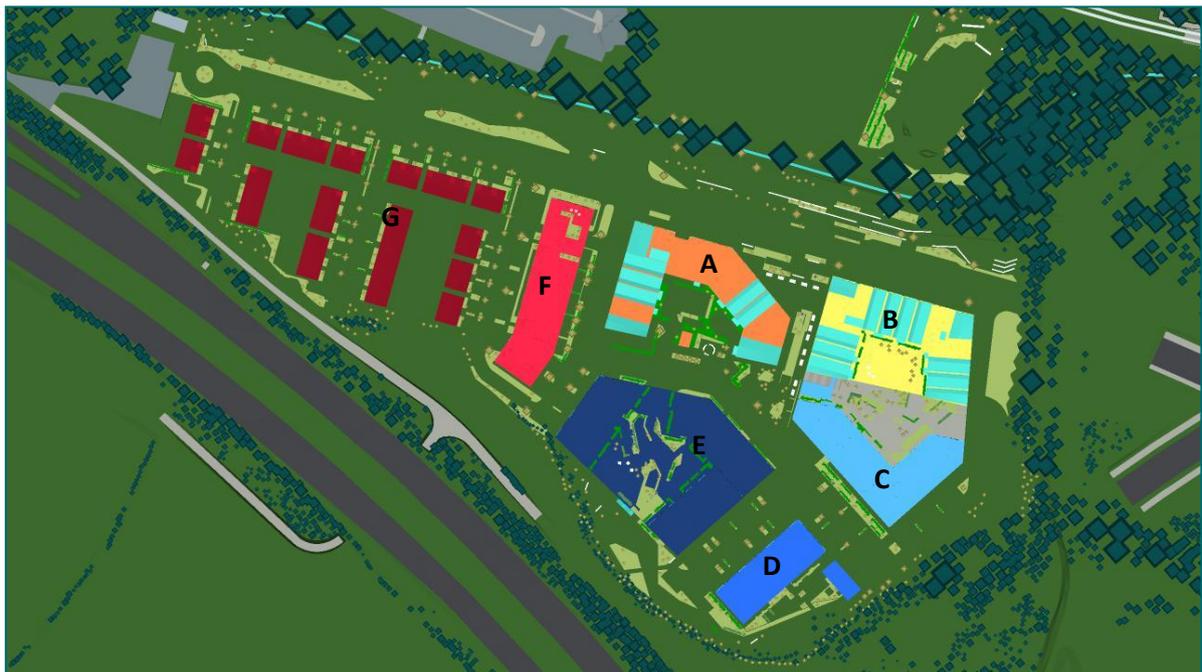


Figure 37: Closer view of the residential blocks from the top

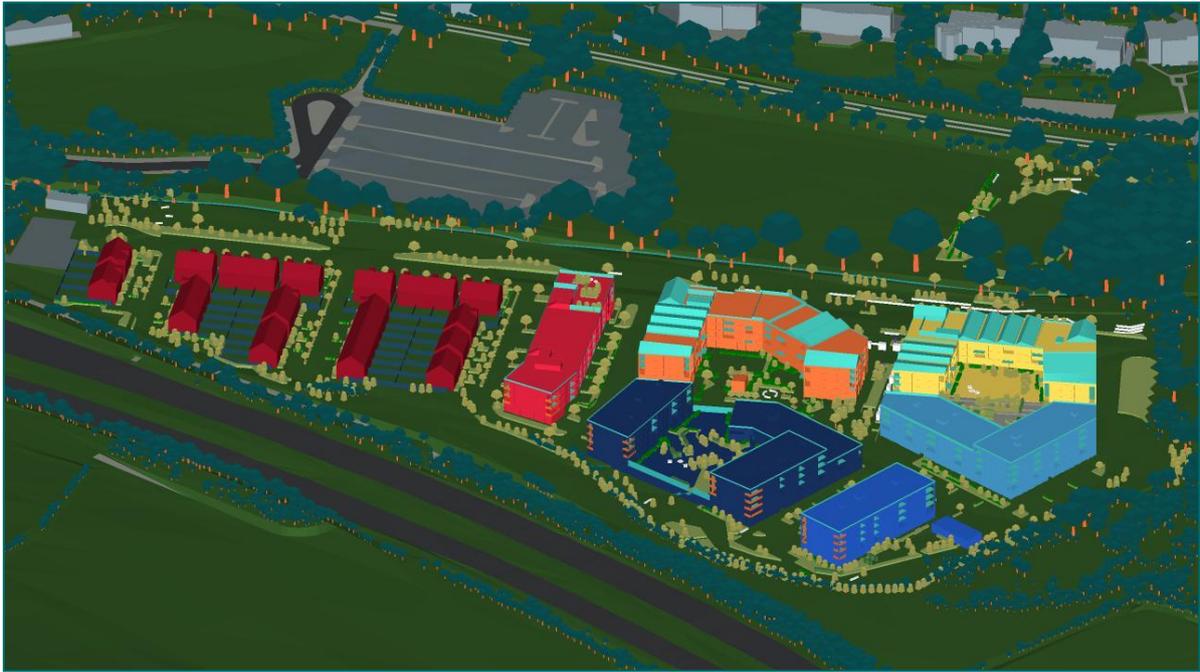


Figure 38: Closer view of the residential blocks from the south

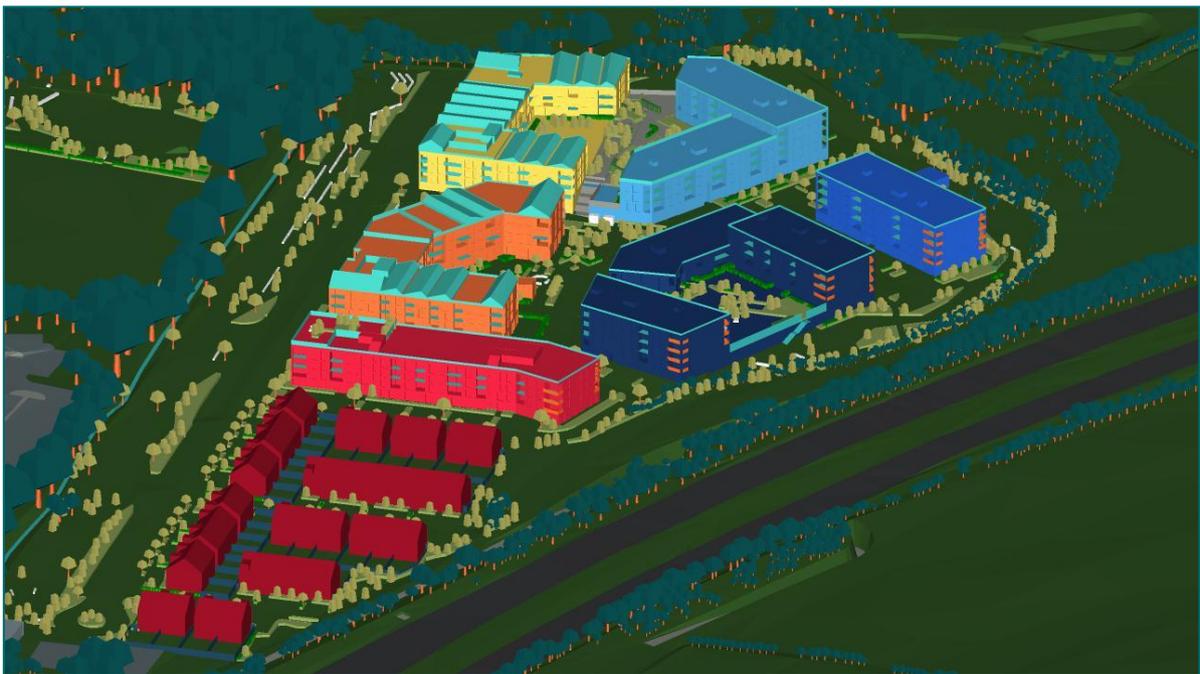


Figure 39: Closer view of the residential blocks from the west

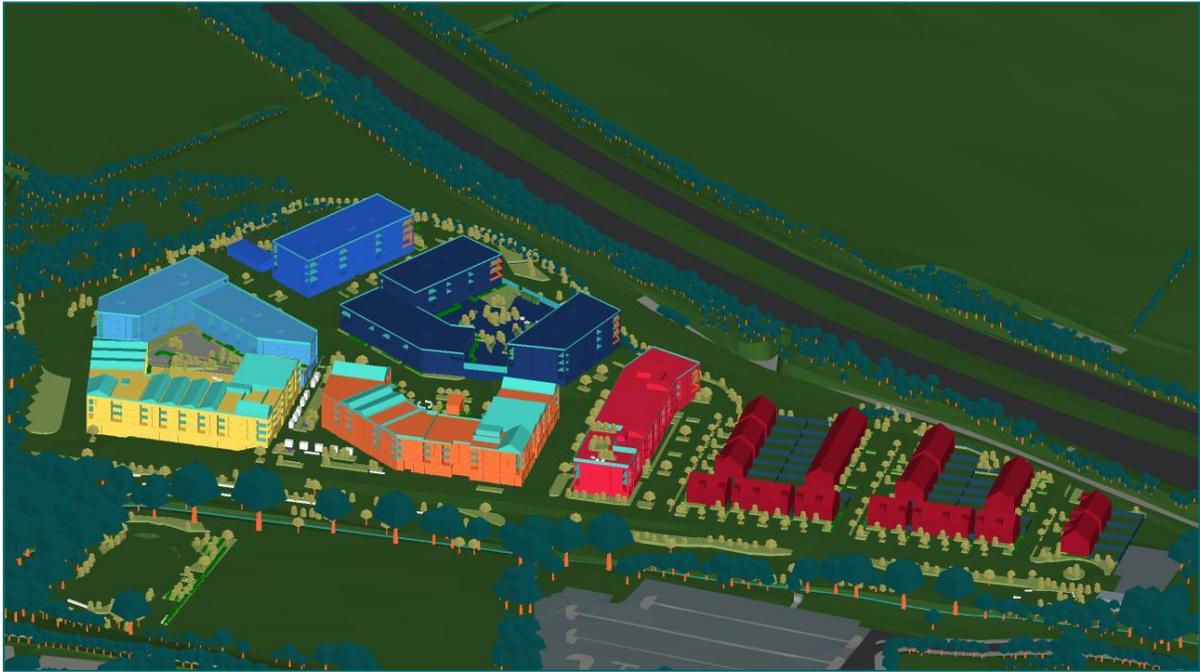


Figure 40: Closer view of the residential blocks the north

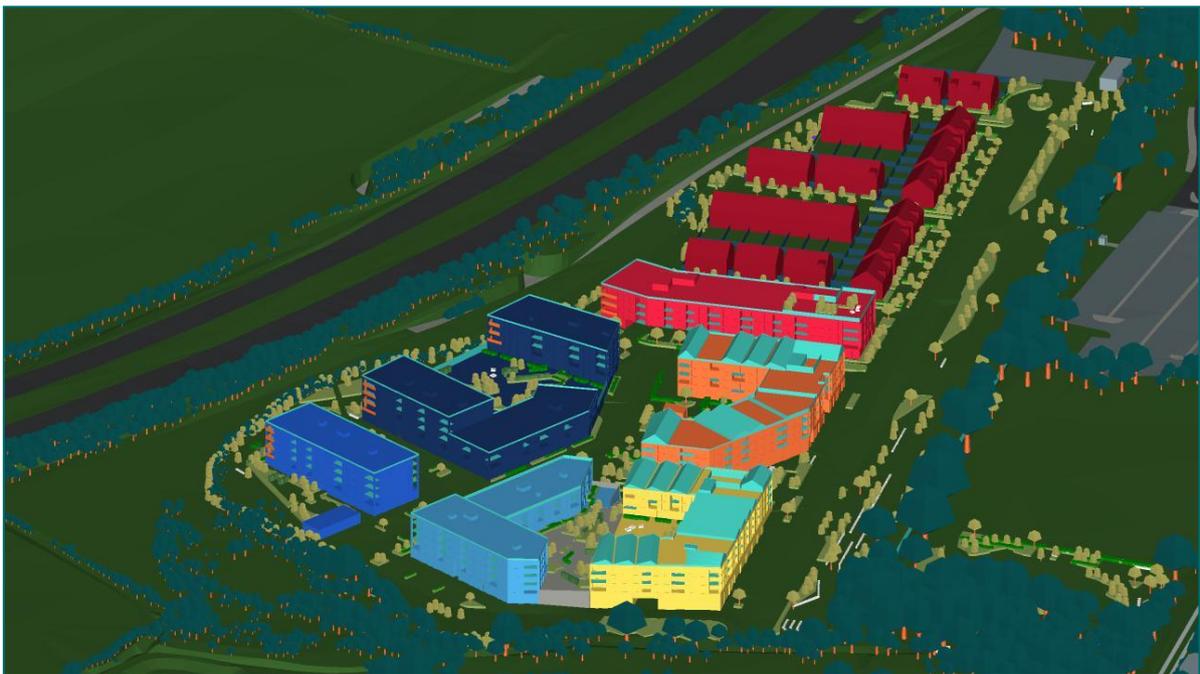


Figure 41: Closer view of the residential blocks from the east

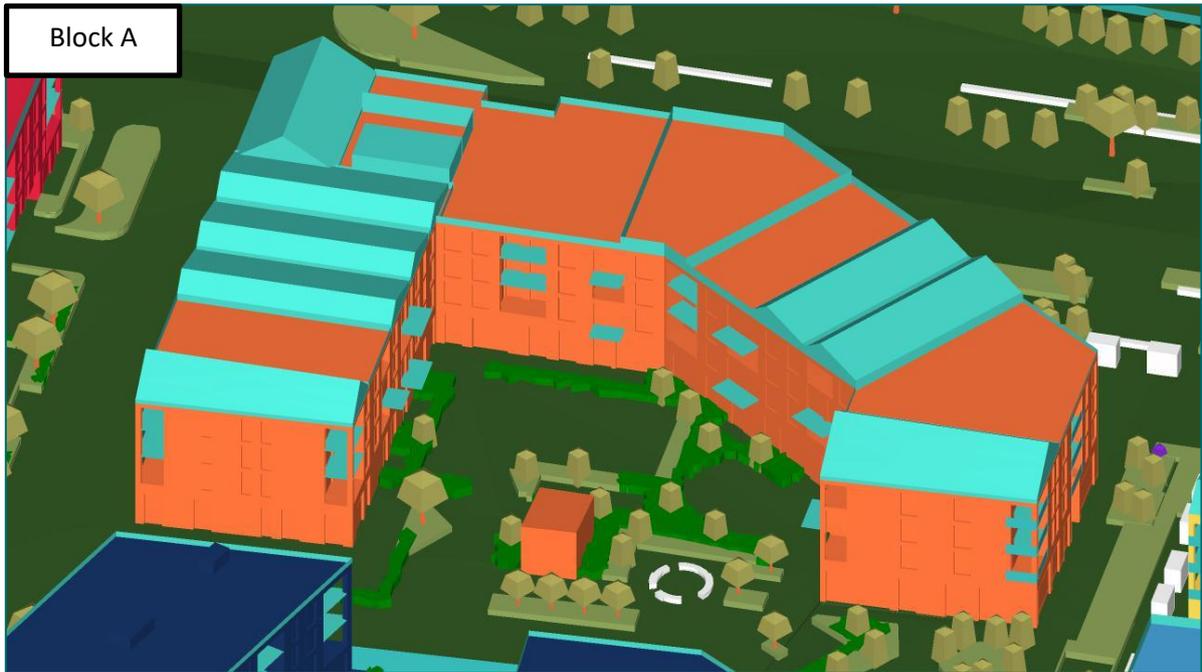


Figure 42: Closer view of the residential block-A from the south



Figure 43: Closer view of the residential block-A from the west

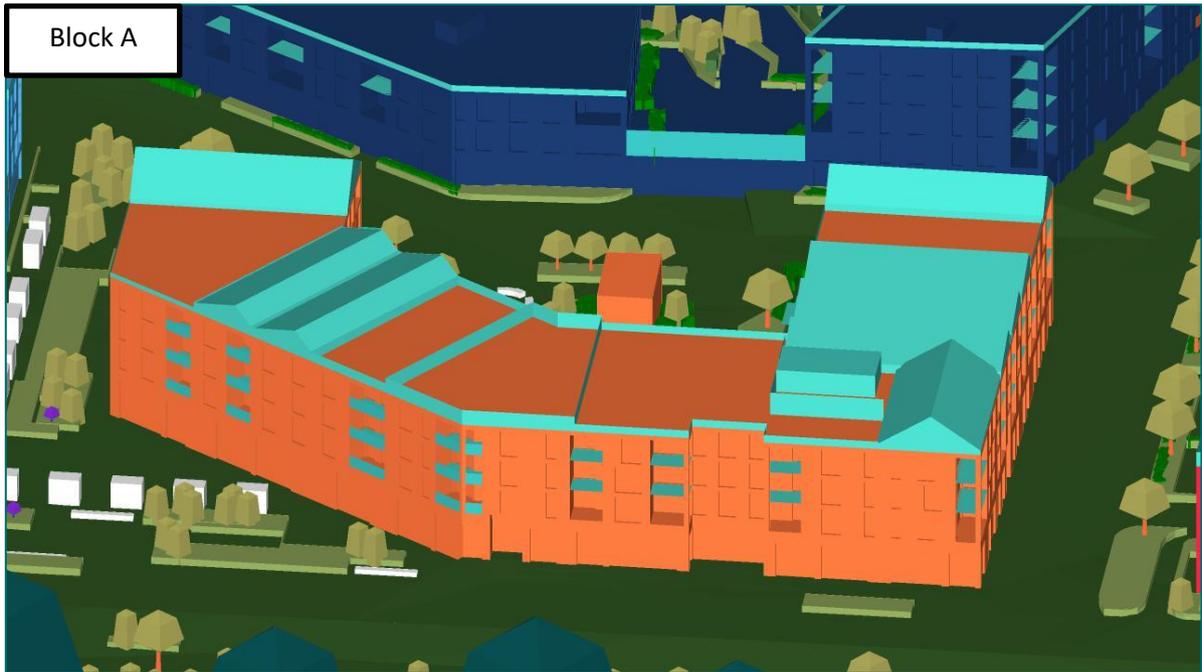


Figure 44: Closer view of the residential block-A from the north



Figure 45: Closer view of the residential block-A from the east

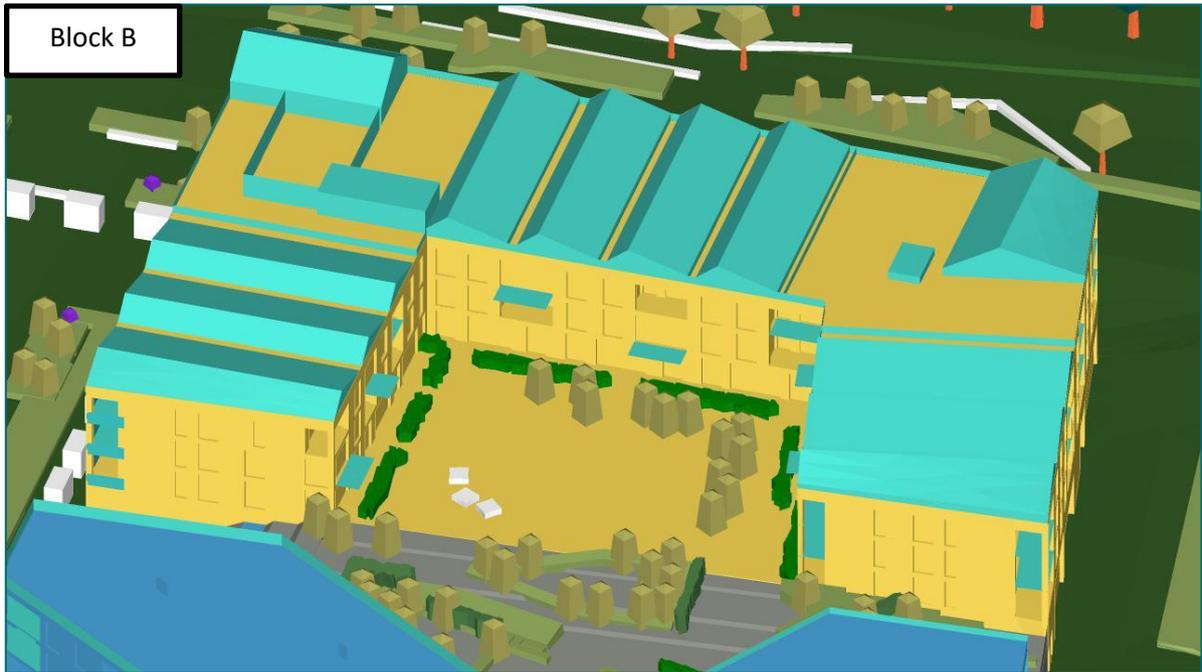


Figure 46: Closer view of the residential block-B from the south

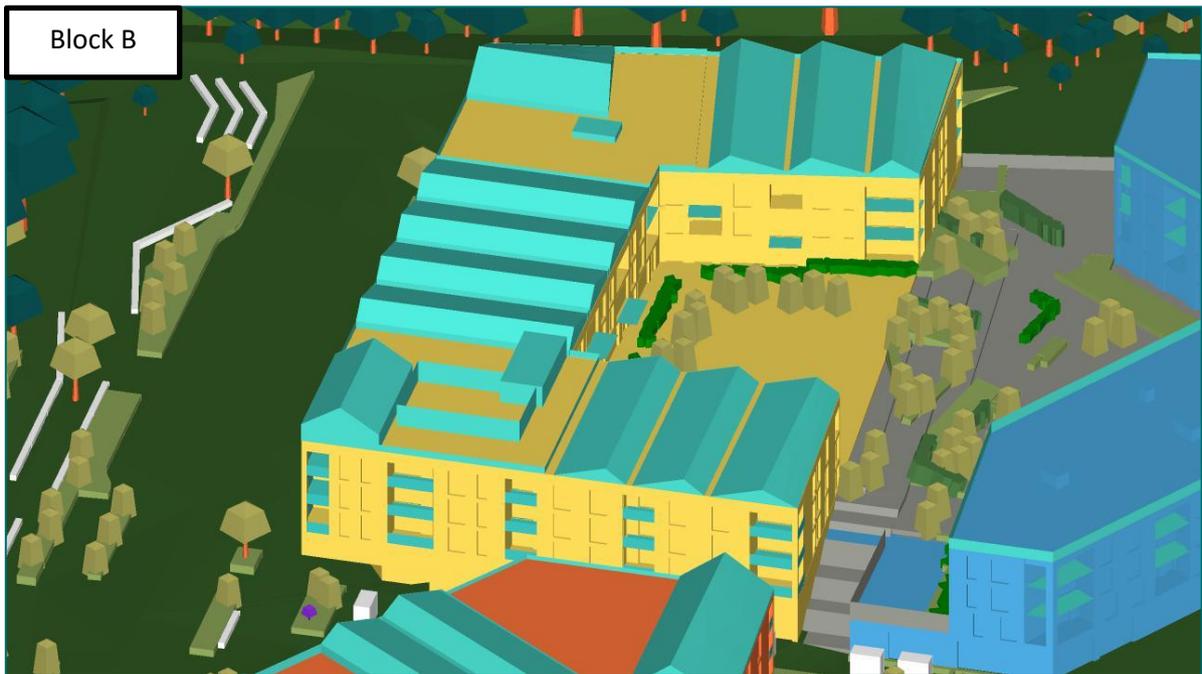


Figure 47: Closer view of the residential block-B from the west



Figure 48: Closer view of the residential block-B from the north



Figure 49: Closer view of the residential block-B from the east

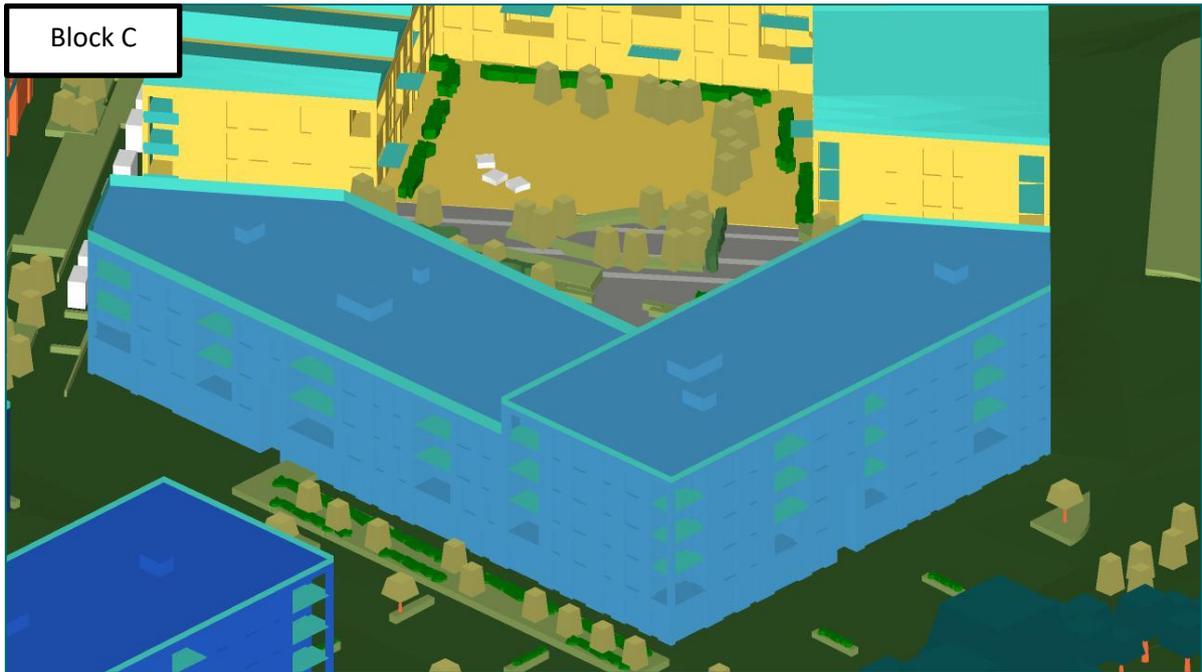


Figure 50: Closer view of the residential block-C from the south



Figure 51: Closer view of the residential block-C from the west

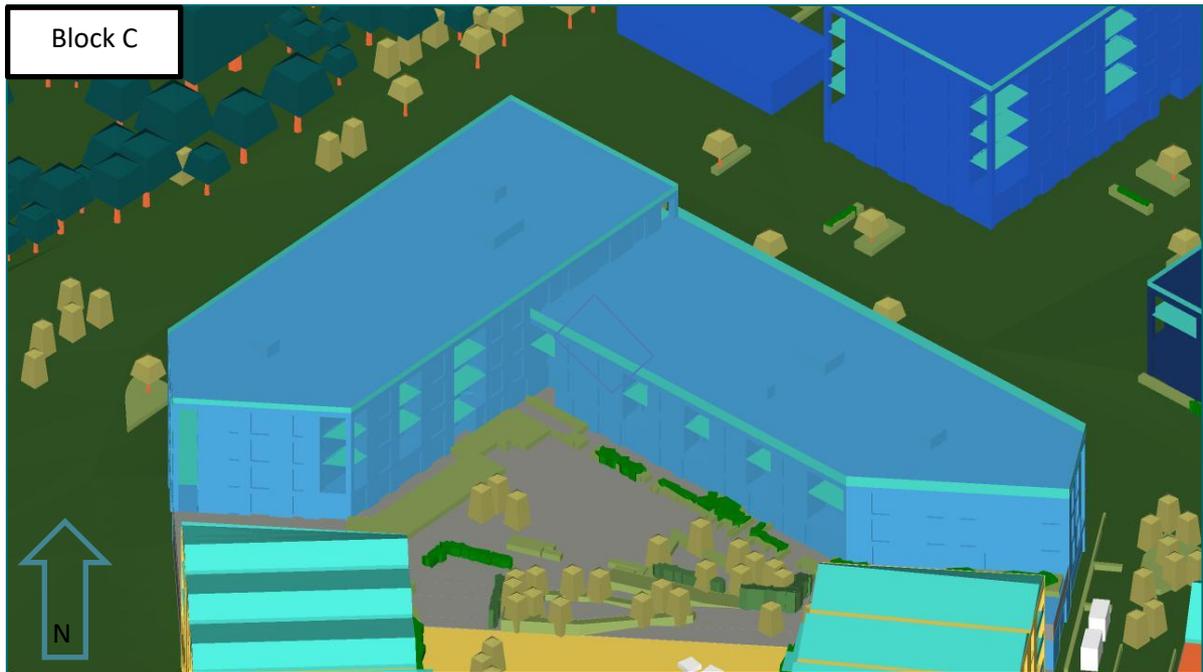


Figure 52: Closer view of the residential block-C from the north

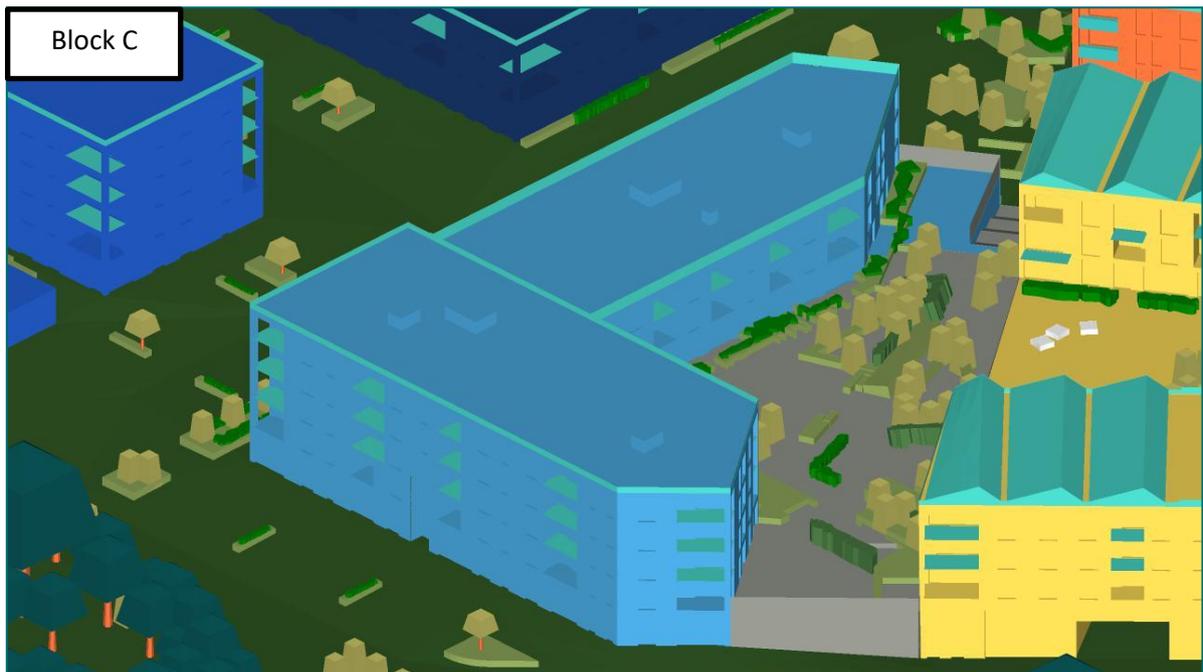


Figure 53: Closer view of the residential block-C from the east

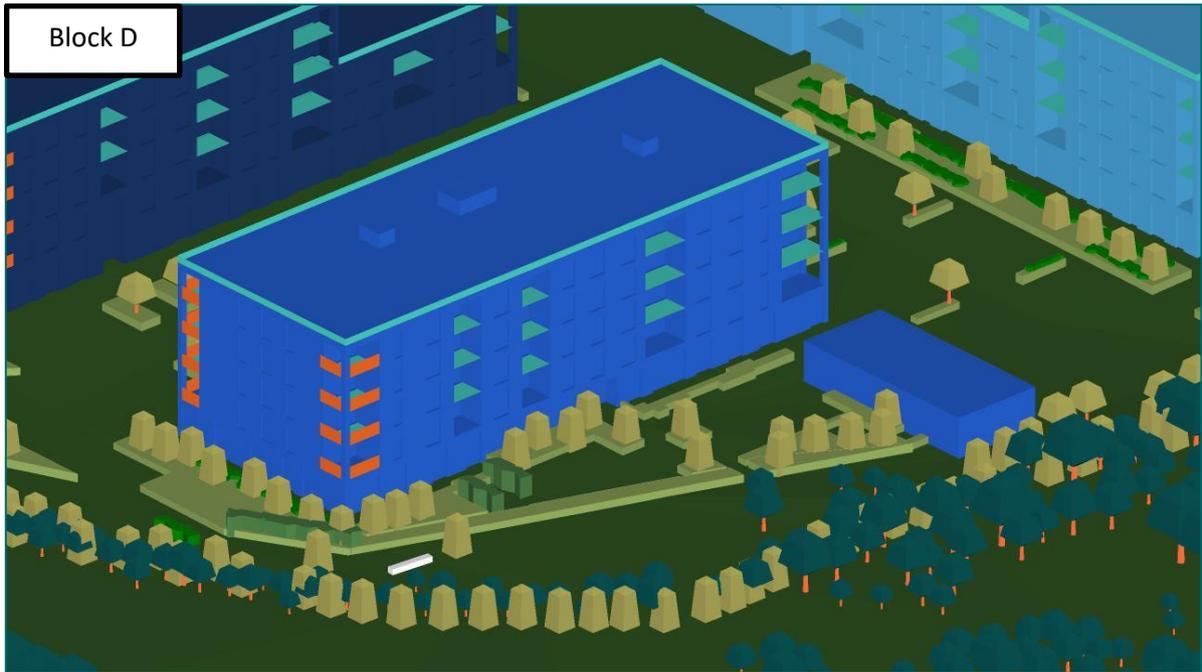


Figure 54: Closer view-1 of the residential block-D

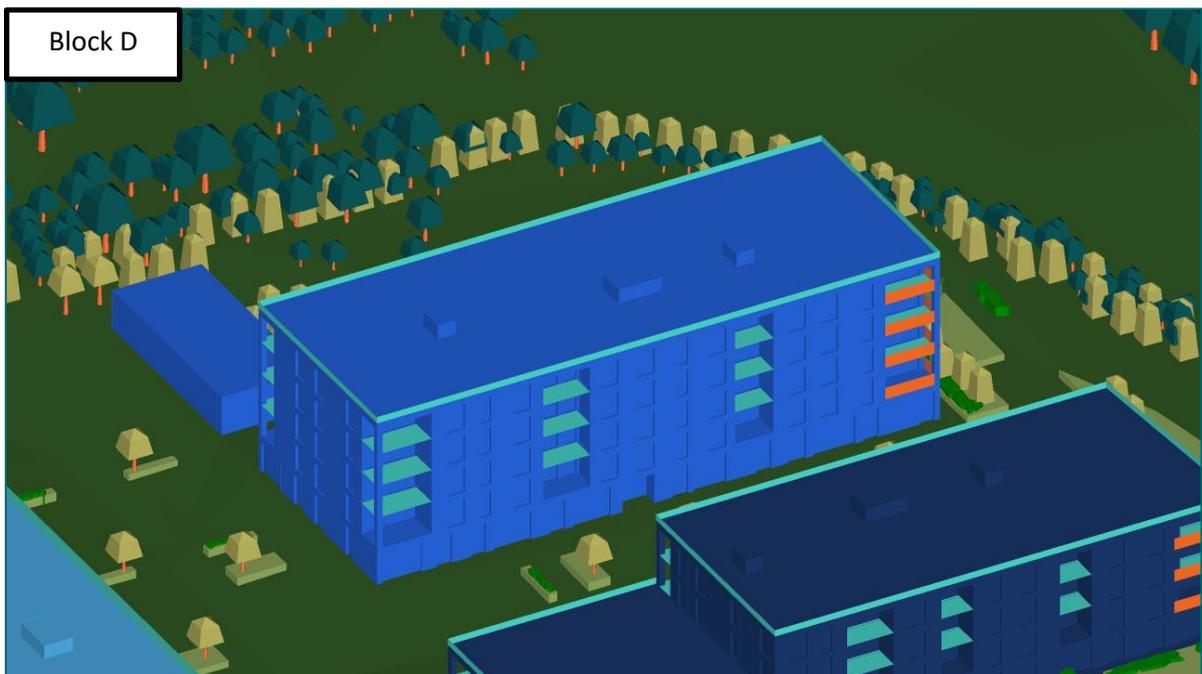


Figure 55: Closer view-2 of the residential block-D

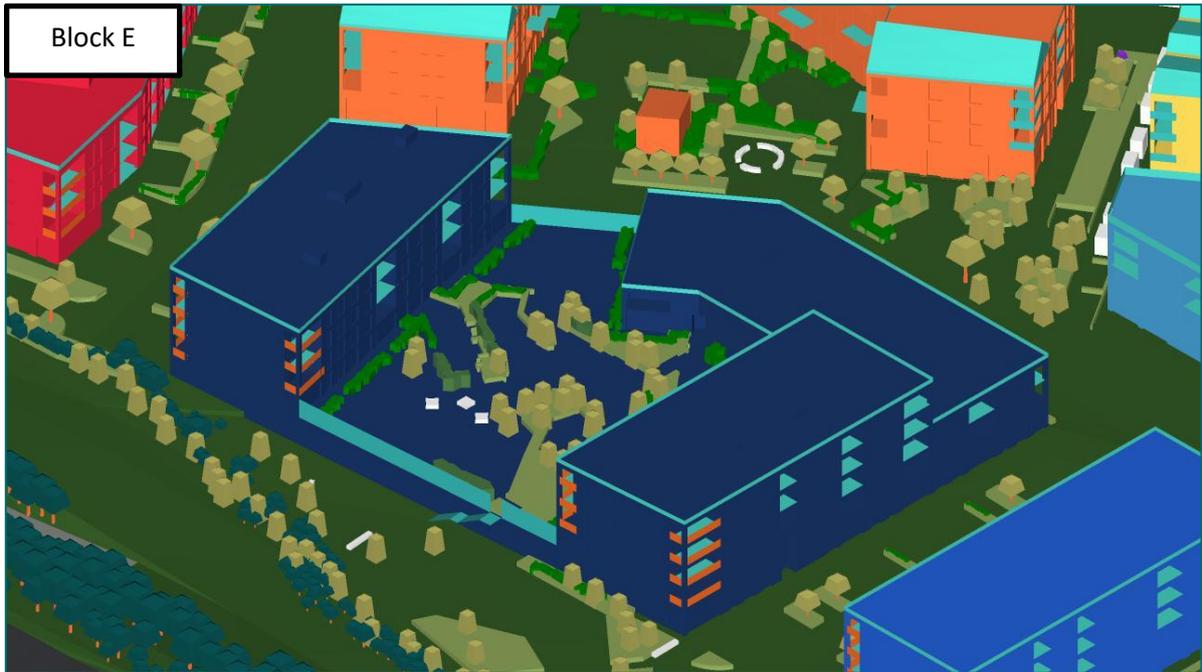


Figure 56: Closer view of the residential block-E from the south

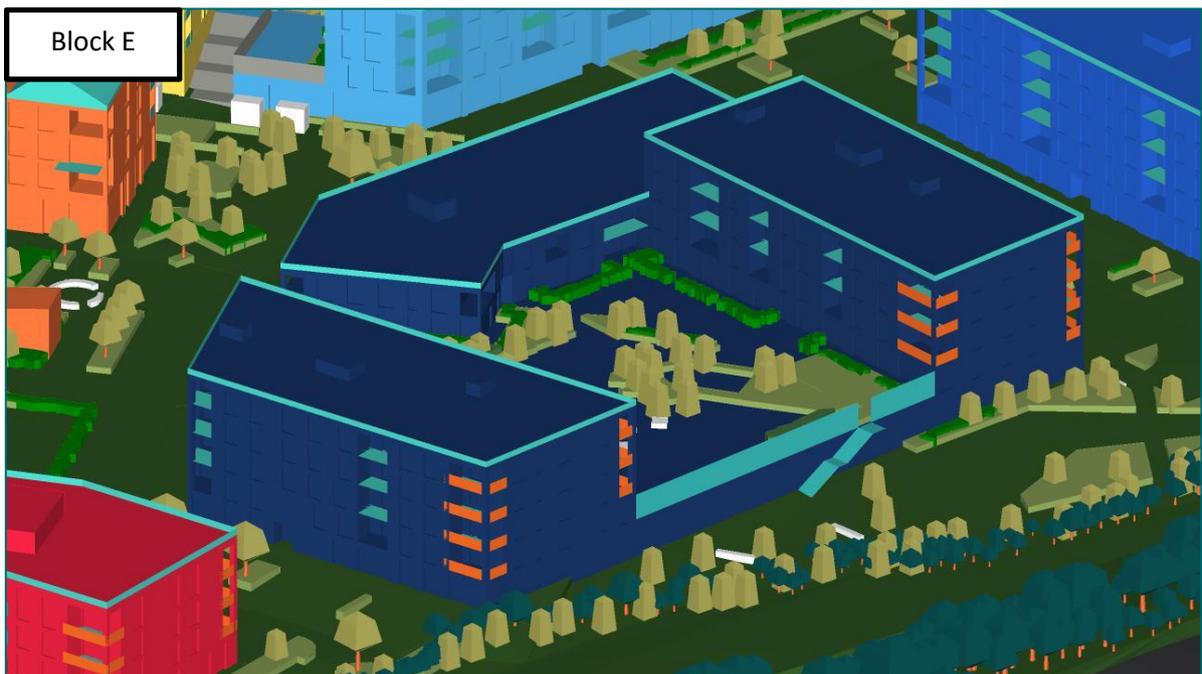


Figure 57: Closer view of the residential block-E from the west

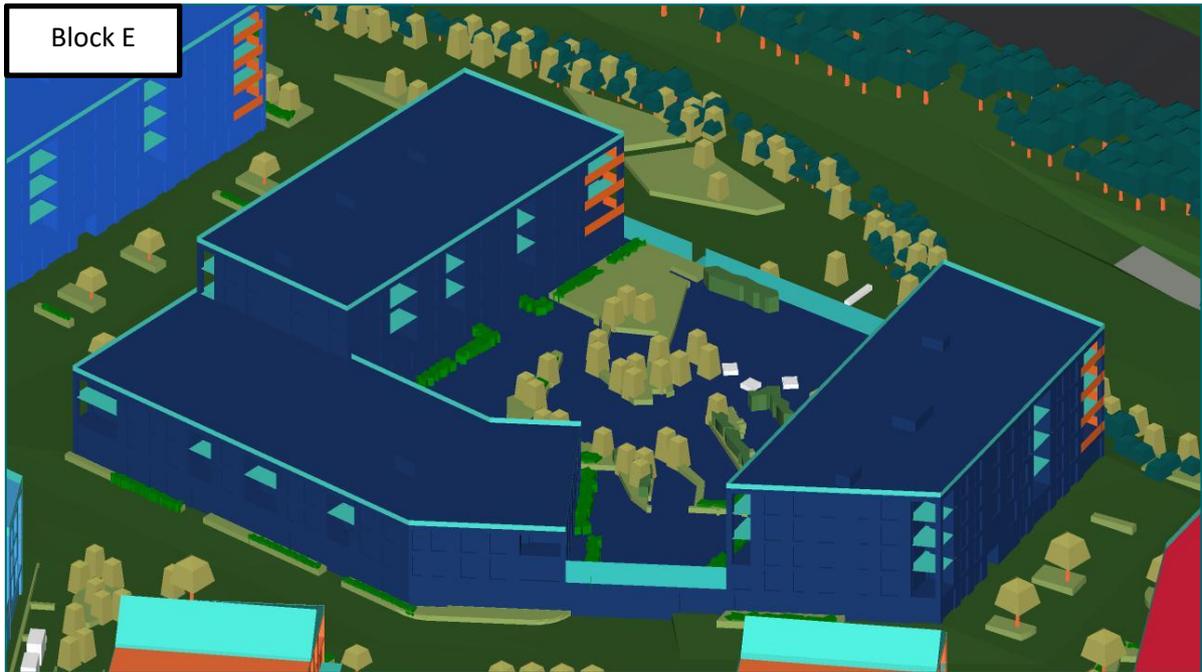


Figure 58: Closer view of the residential block-E from the north



Figure 59: Closer view of the residential block-E from the east

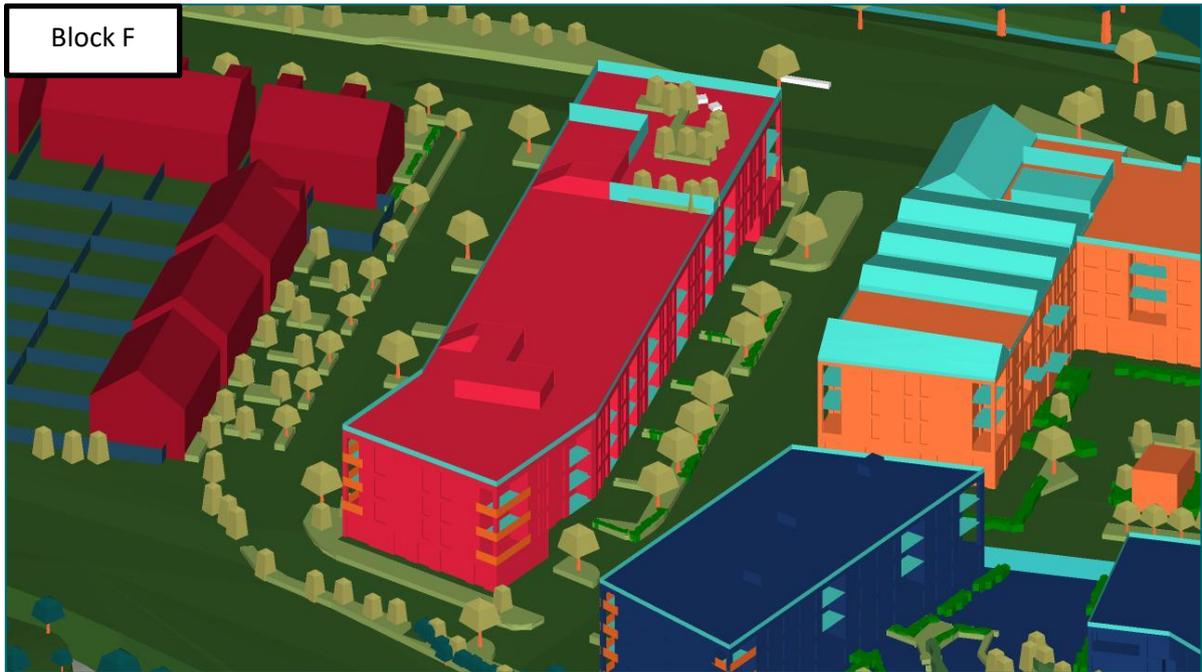


Figure 60: Closer view of the residential block-F from the south



Figure 61: Closer view of the residential block-F from the west



Figure 62: Closer view of the residential block-F from the north

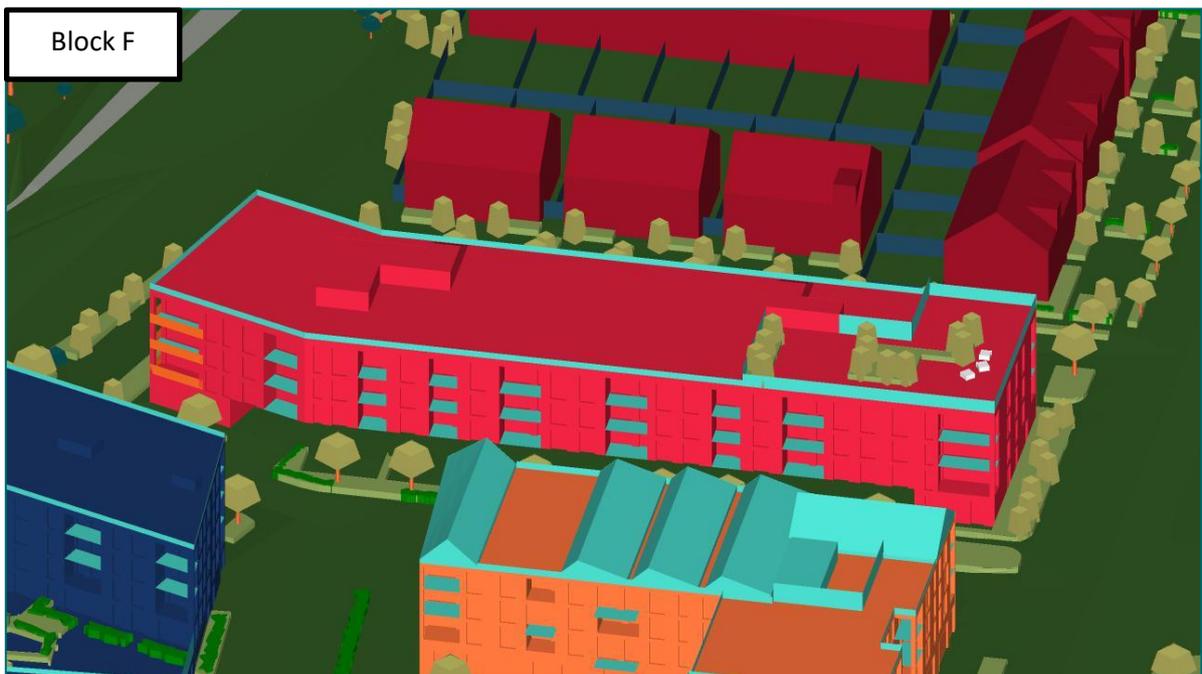


Figure 63: Closer view of the residential block-F from the east

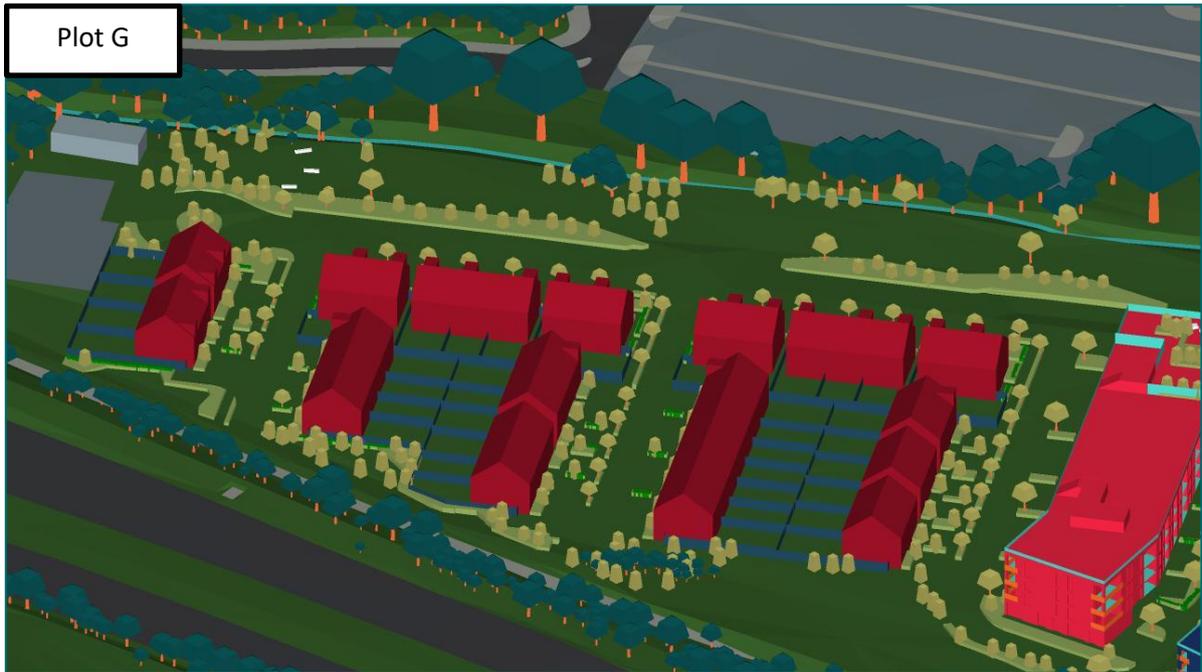


Figure 64: Closer view of the residential Plot-G from the south

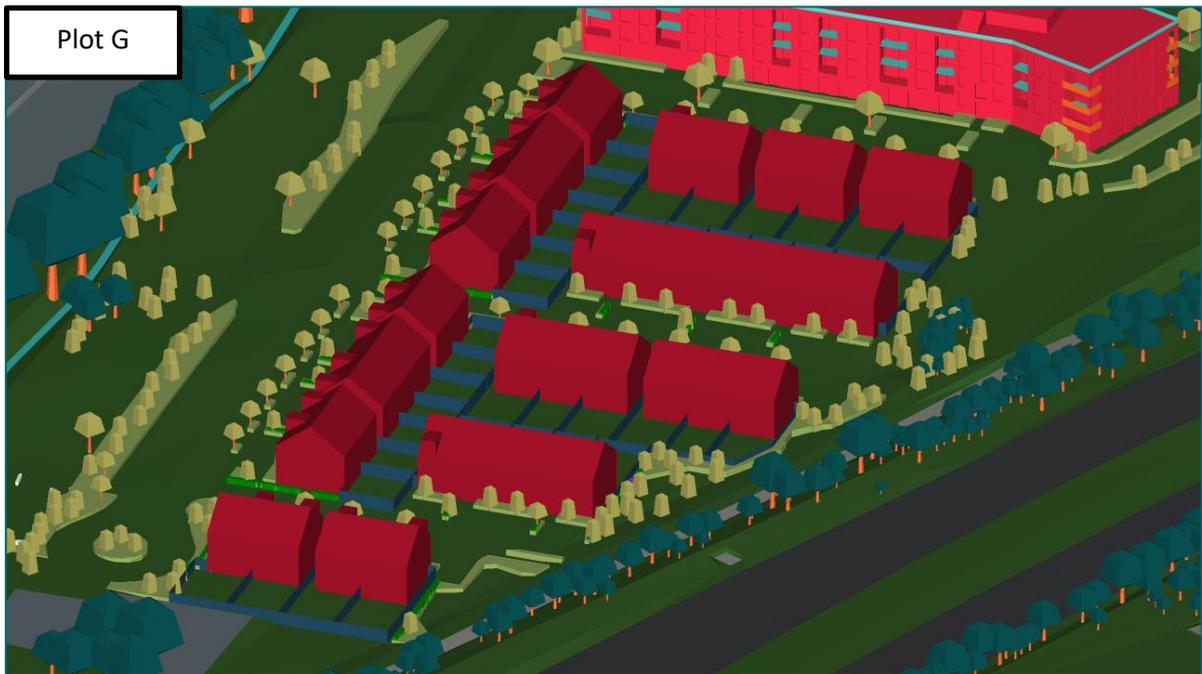


Figure 65: Closer view of the residential plot-G from the west



Figure 66: Closer view of the residential plot-G from the north

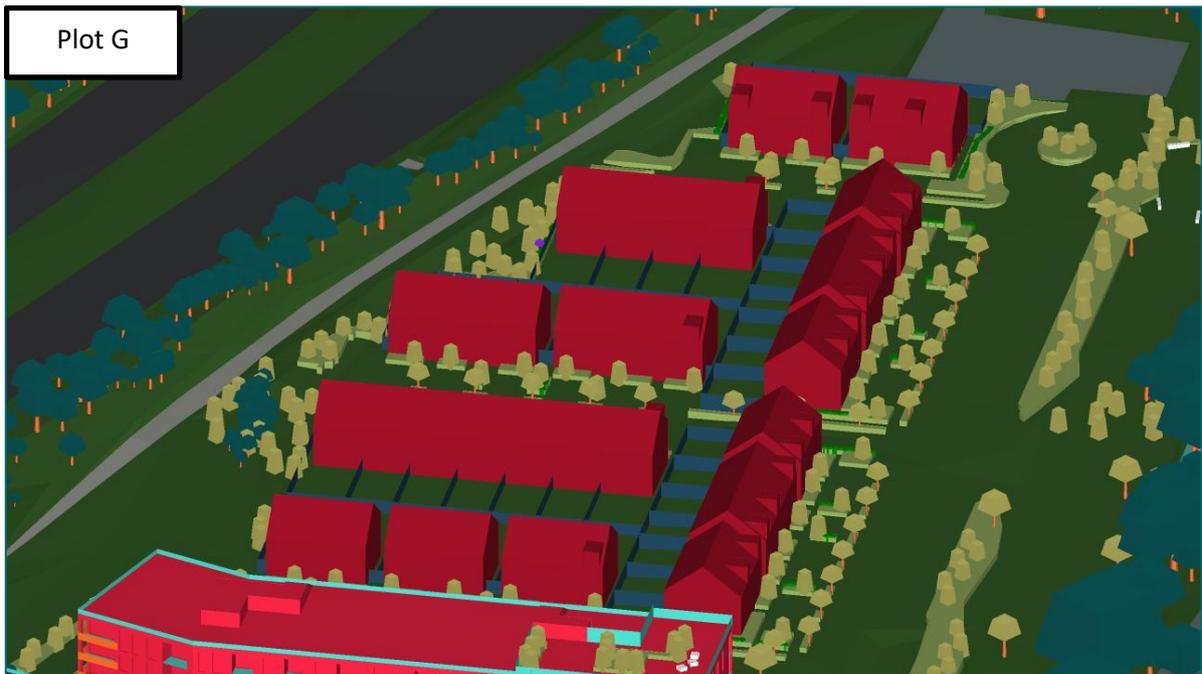


Figure 67: Closer view of the residential plot-G from the east

6.2 Designated Locations for Analysis

[Figure 68](#) to [Figure 76](#) show the designated locations with all lying 1.5m above the immediate ground/floor level.

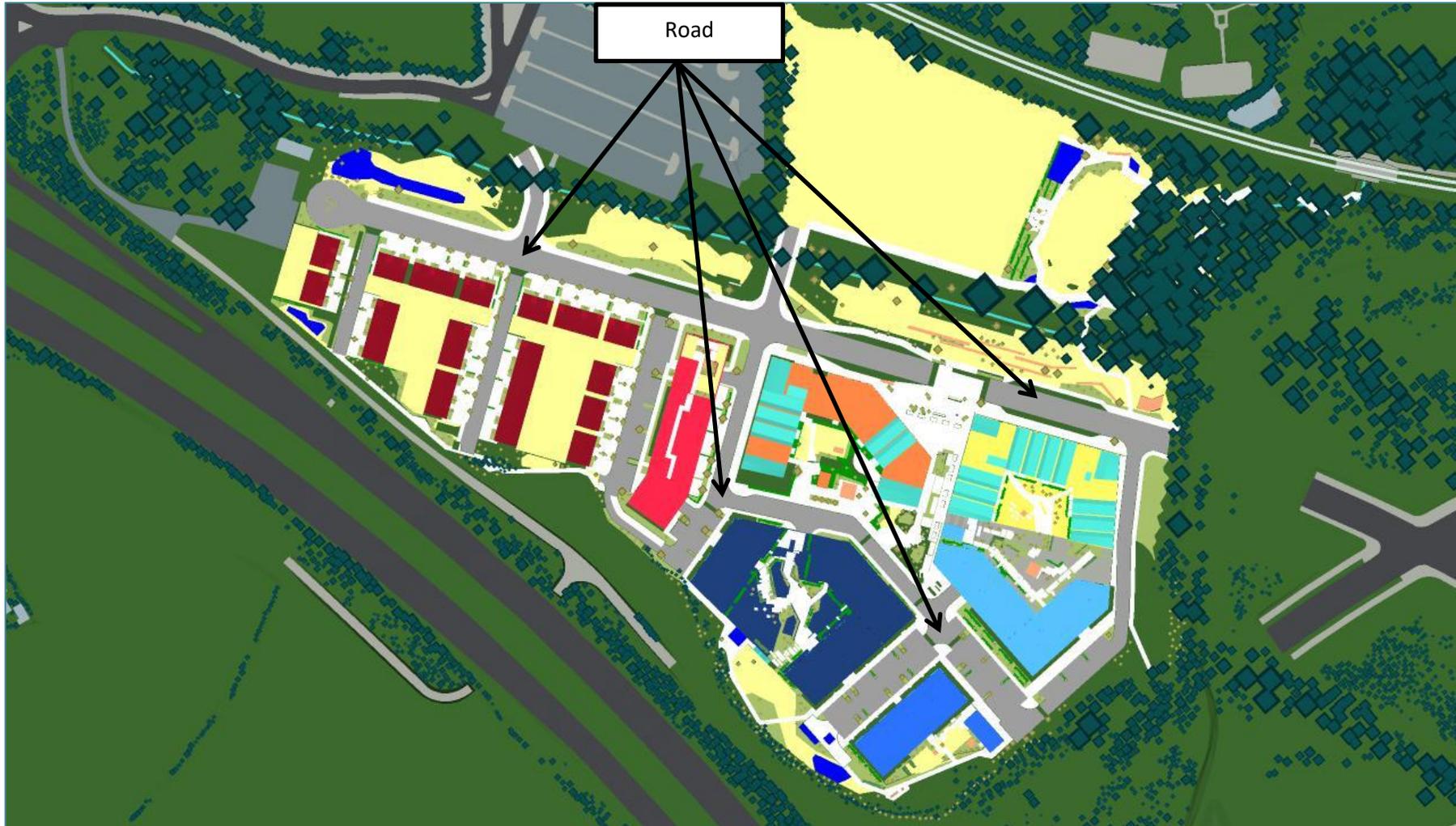


Figure 68 Designated locations for recording the air speed values

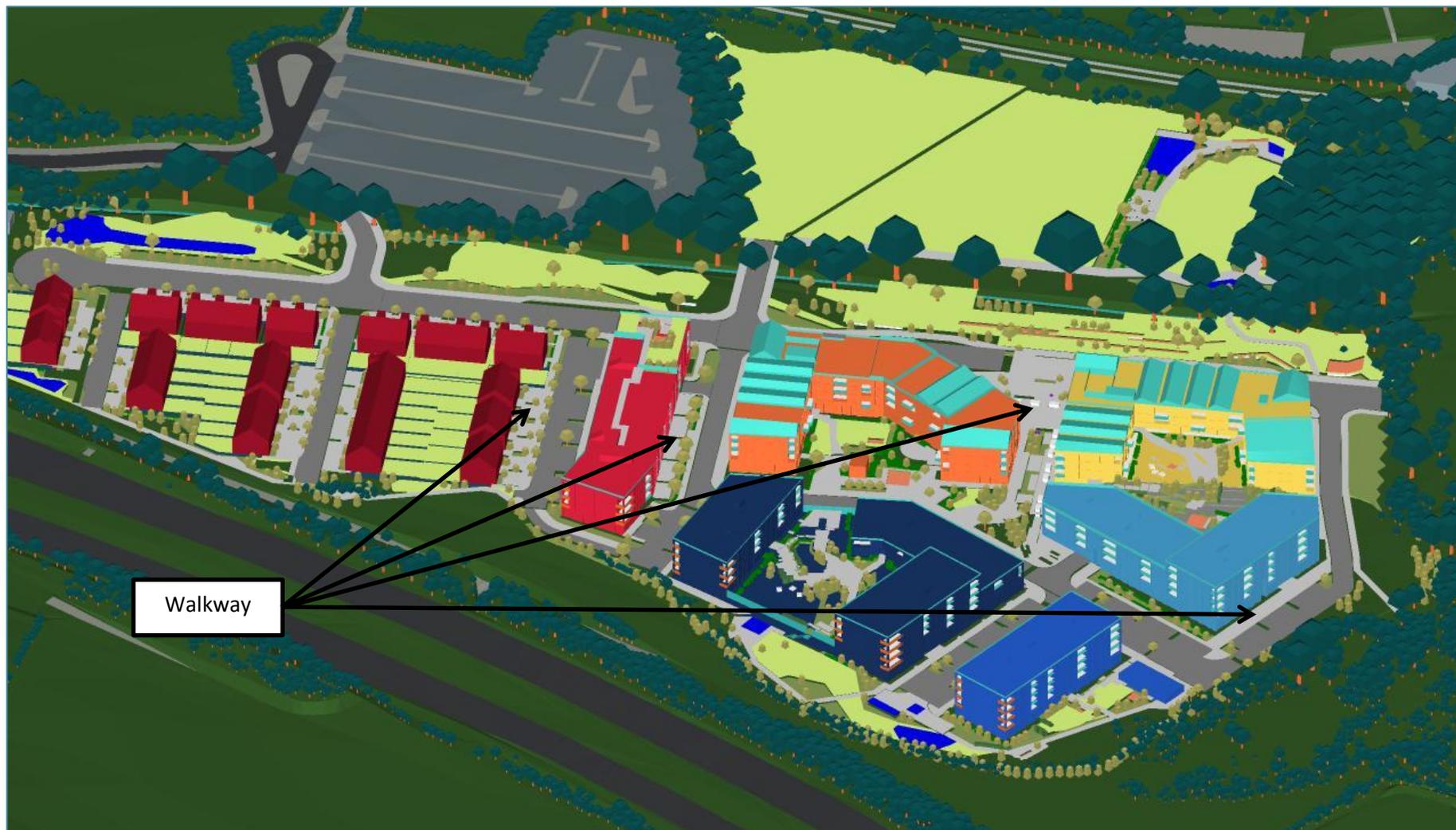


Figure 69 Designated locations for recording the air speed values



Figure 70 Designated locations for recording the air speed values



Figure 71 Designated locations for recording the air speed values: Ground Amenities



Figure 72 Designated locations for recording the air speed values: Ground Amenities

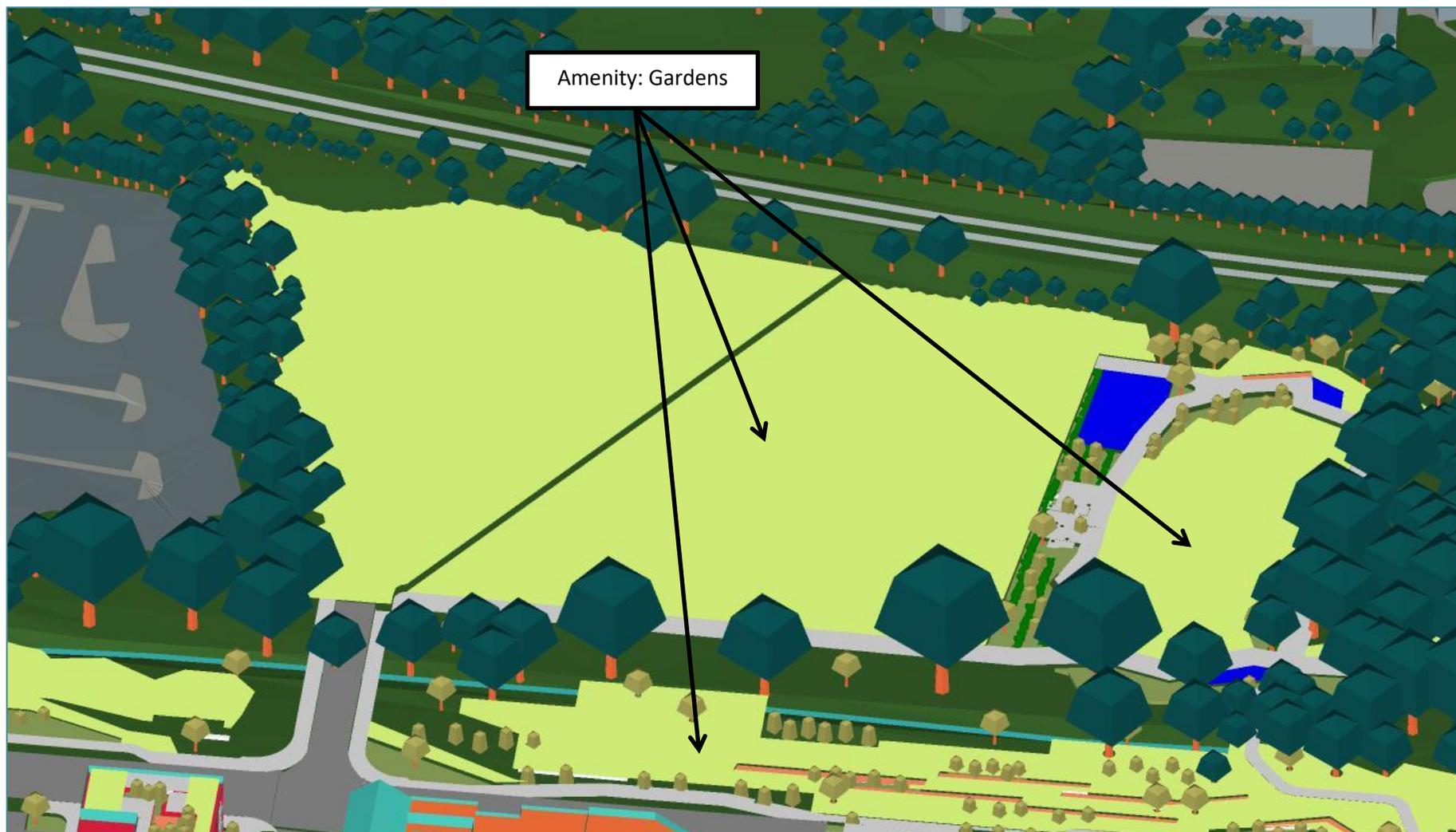


Figure 73 Designated locations for recording the air speed values: Ground Amenities

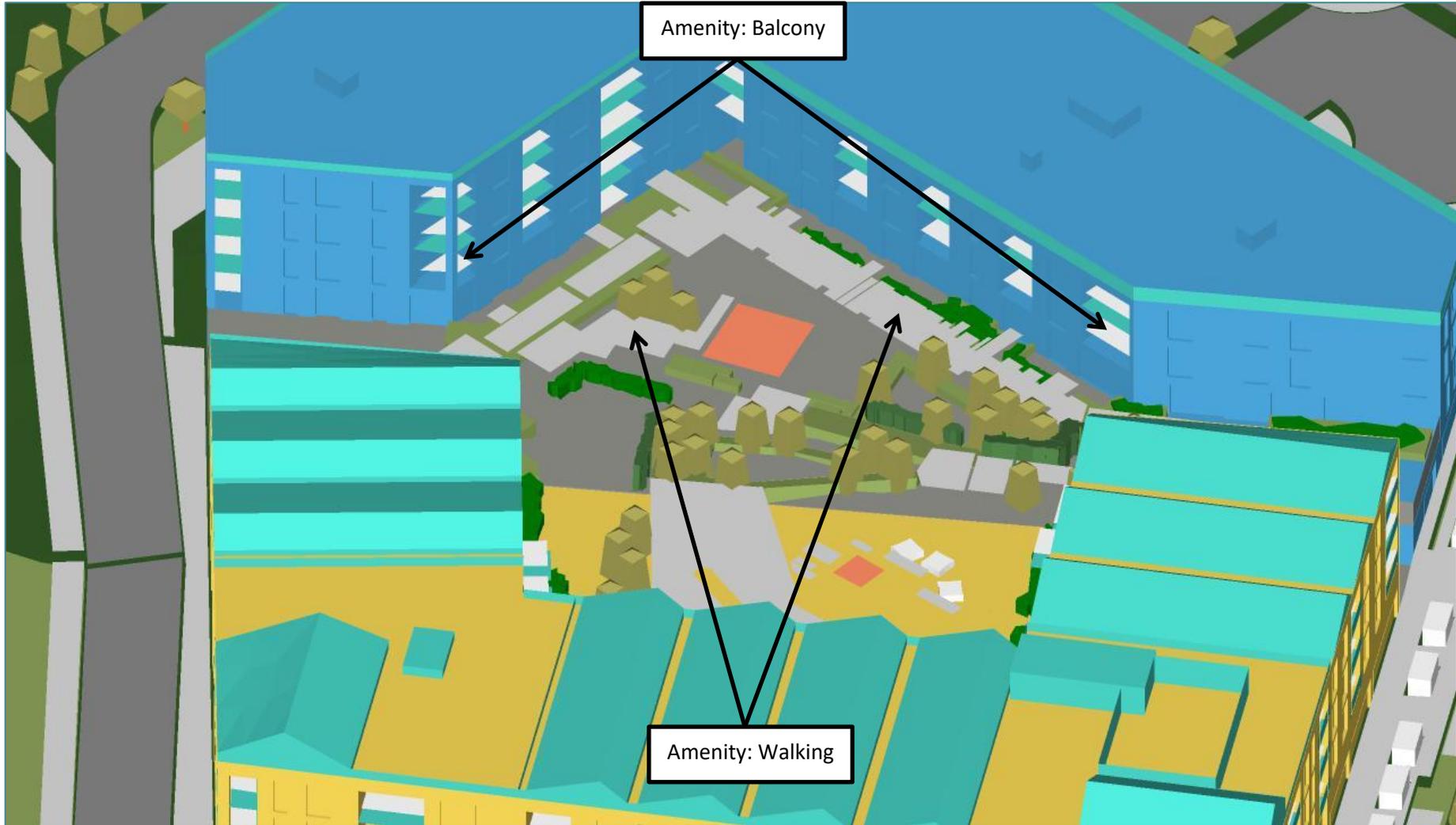


Figure 74 Designated locations for recording the air speed values: Ground Amenities



Figure 75 Designated locations for recording the air speed values



Figure 76 Designated locations for recording the air speed values: Ground Amenities

7 Results

7.1 Results

Figure 77 to Figure 85 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 4m/s, 6m/s, 8m/s and 10m/s respectively.

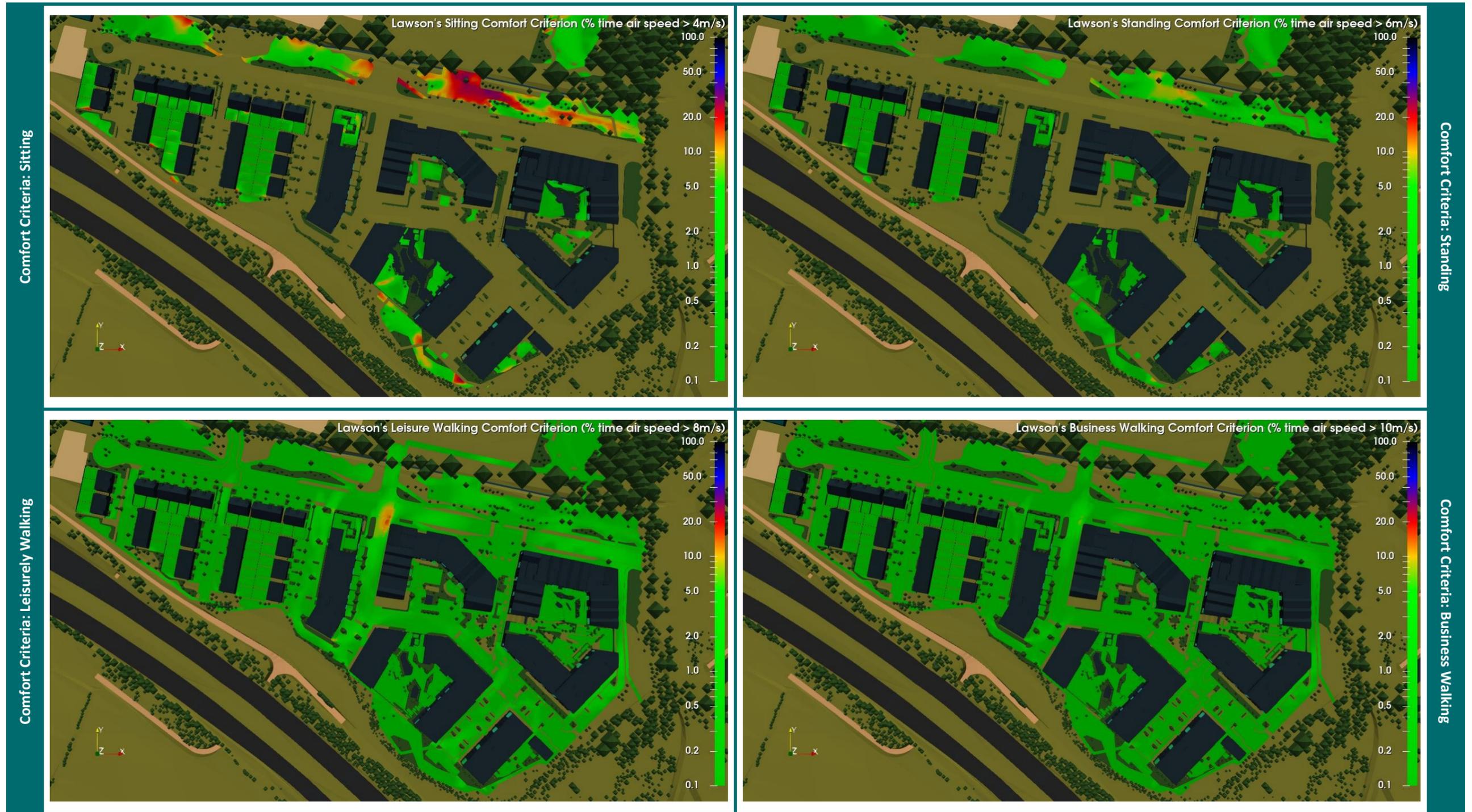


Figure 77: Comfort Criteria: All Seasons: View from the top

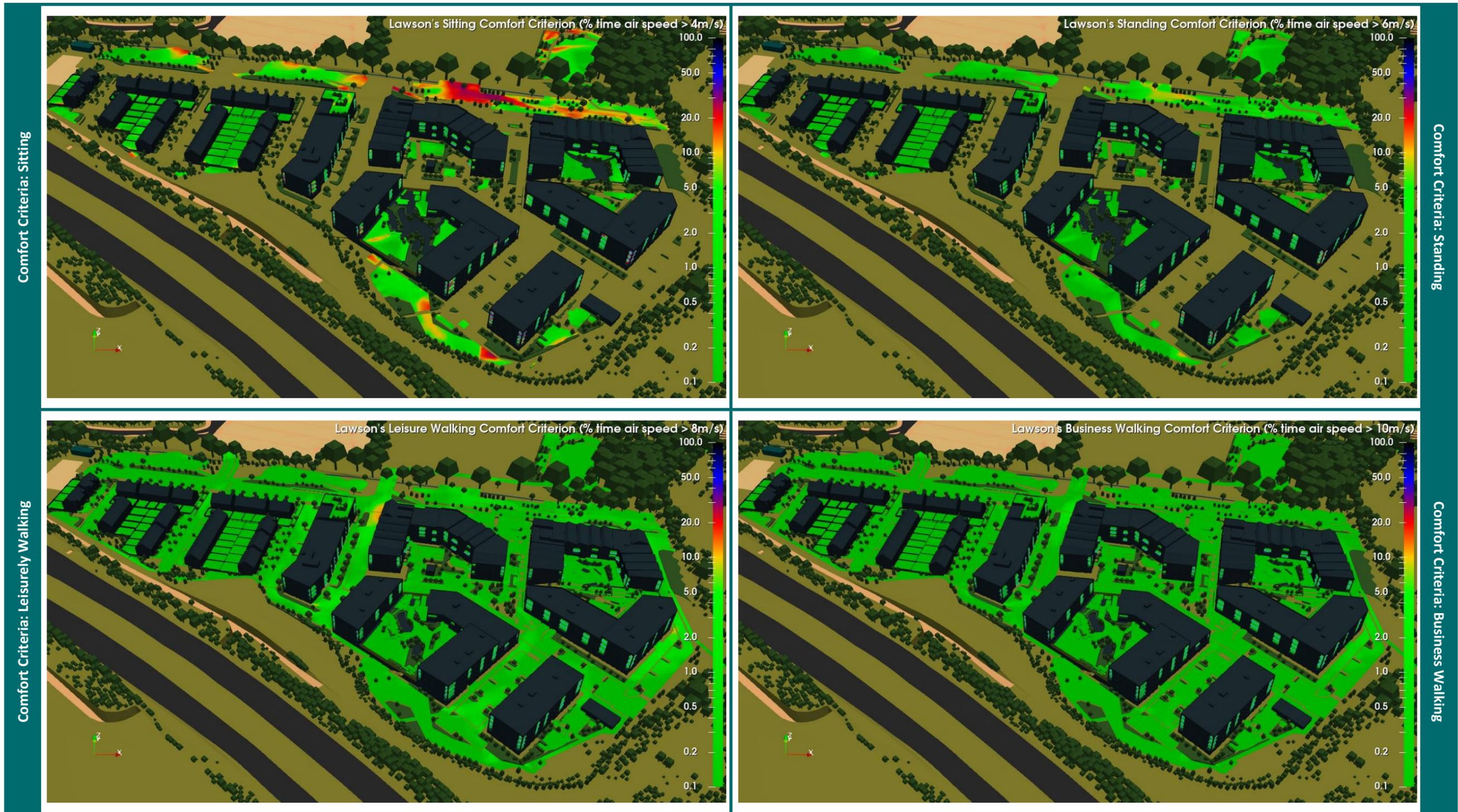


Figure 78: Comfort Criteria: All Seasons: View from the south

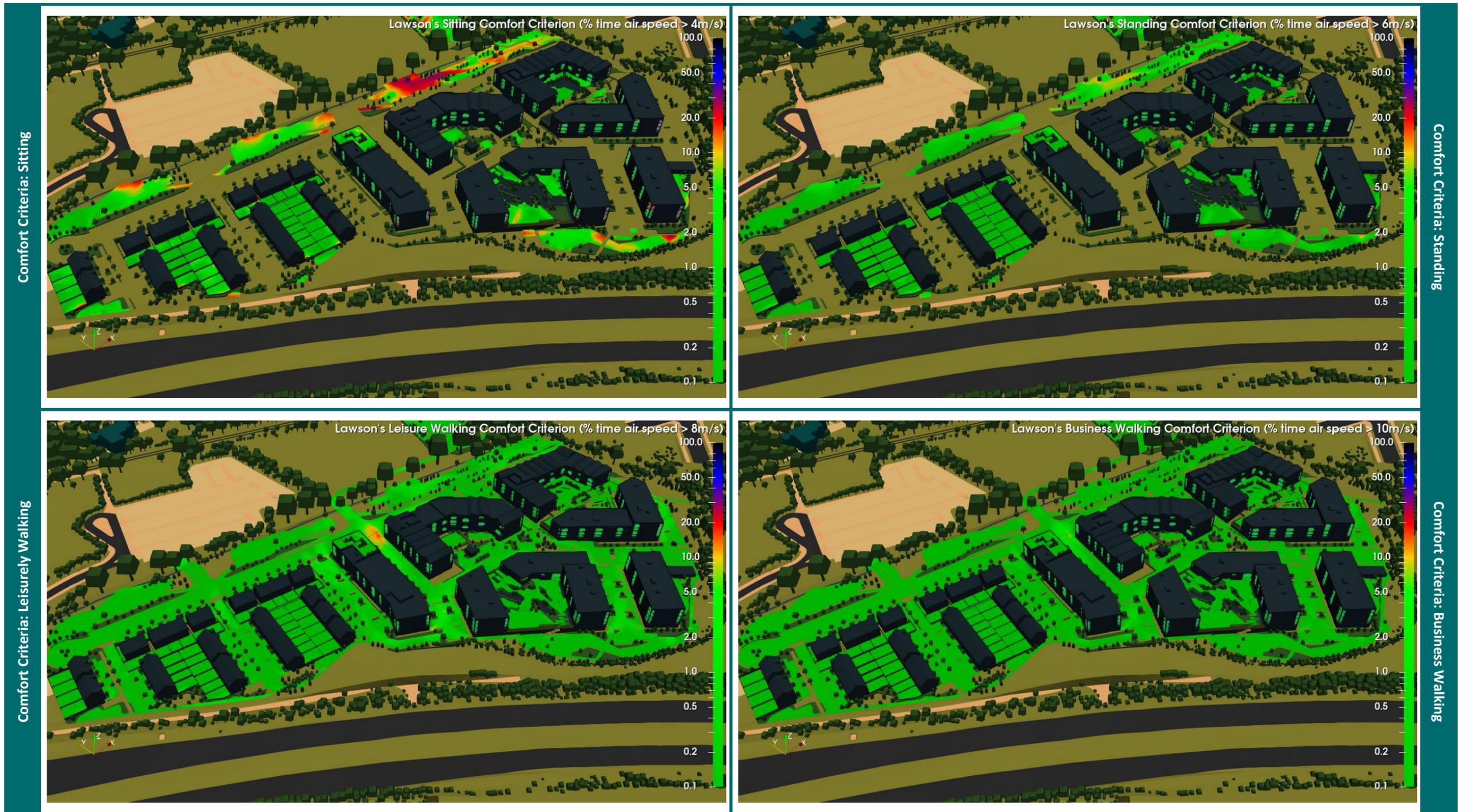


Figure 79: Comfort Criteria: All Seasons: View from the southwest

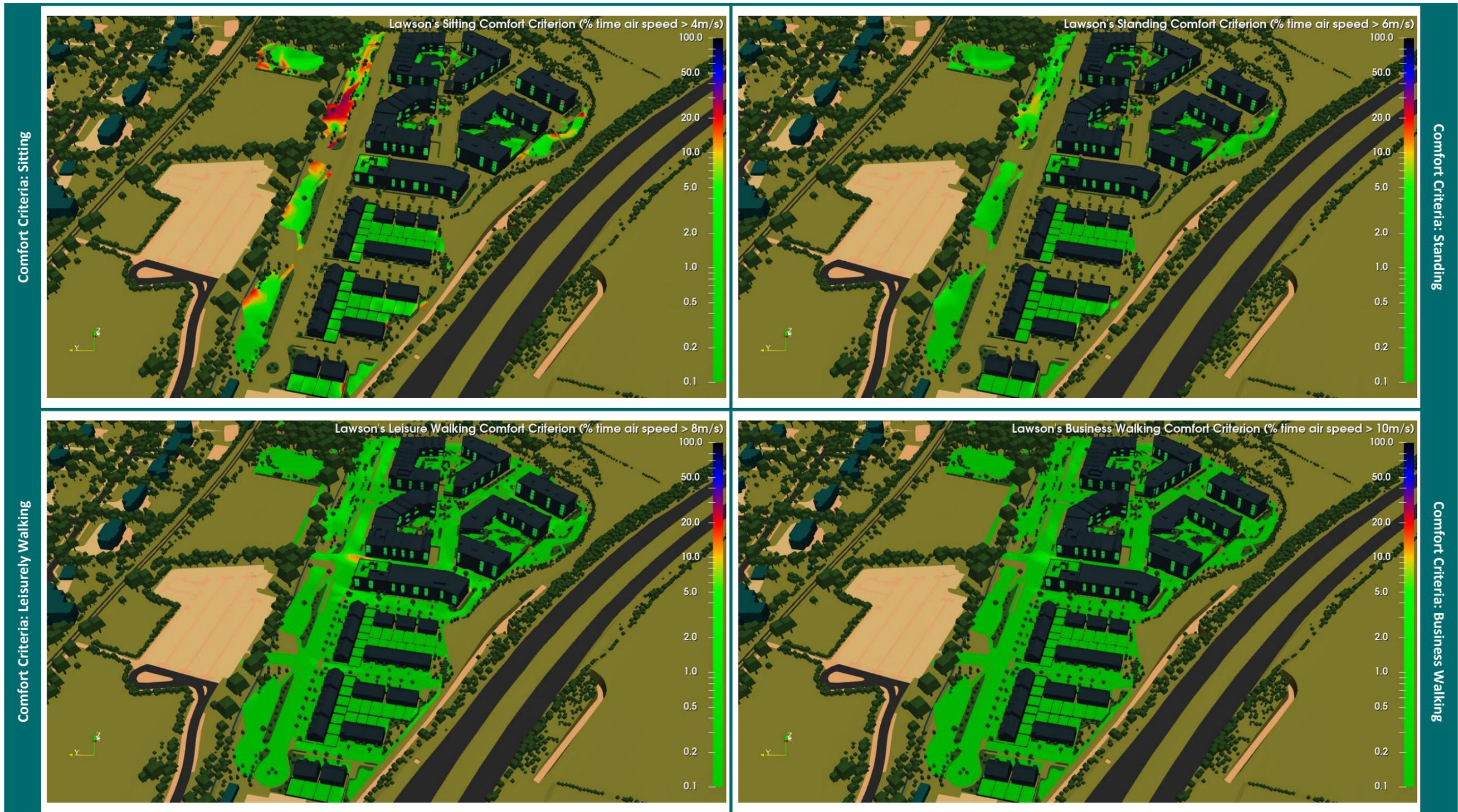


Figure 80: Comfort Criteria: All Seasons: View from the west

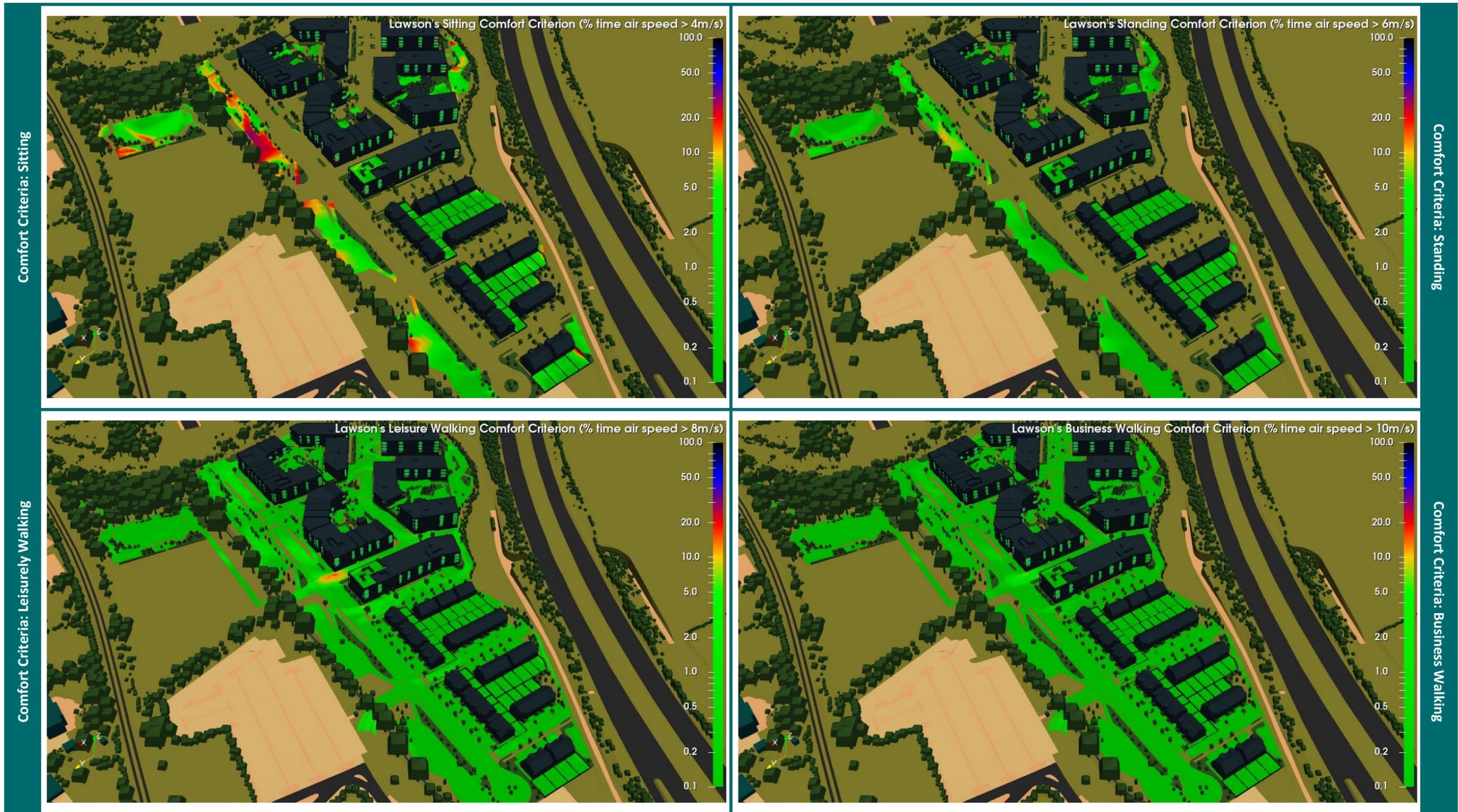


Figure 81: Comfort Criteria: All Seasons: View from the northwest

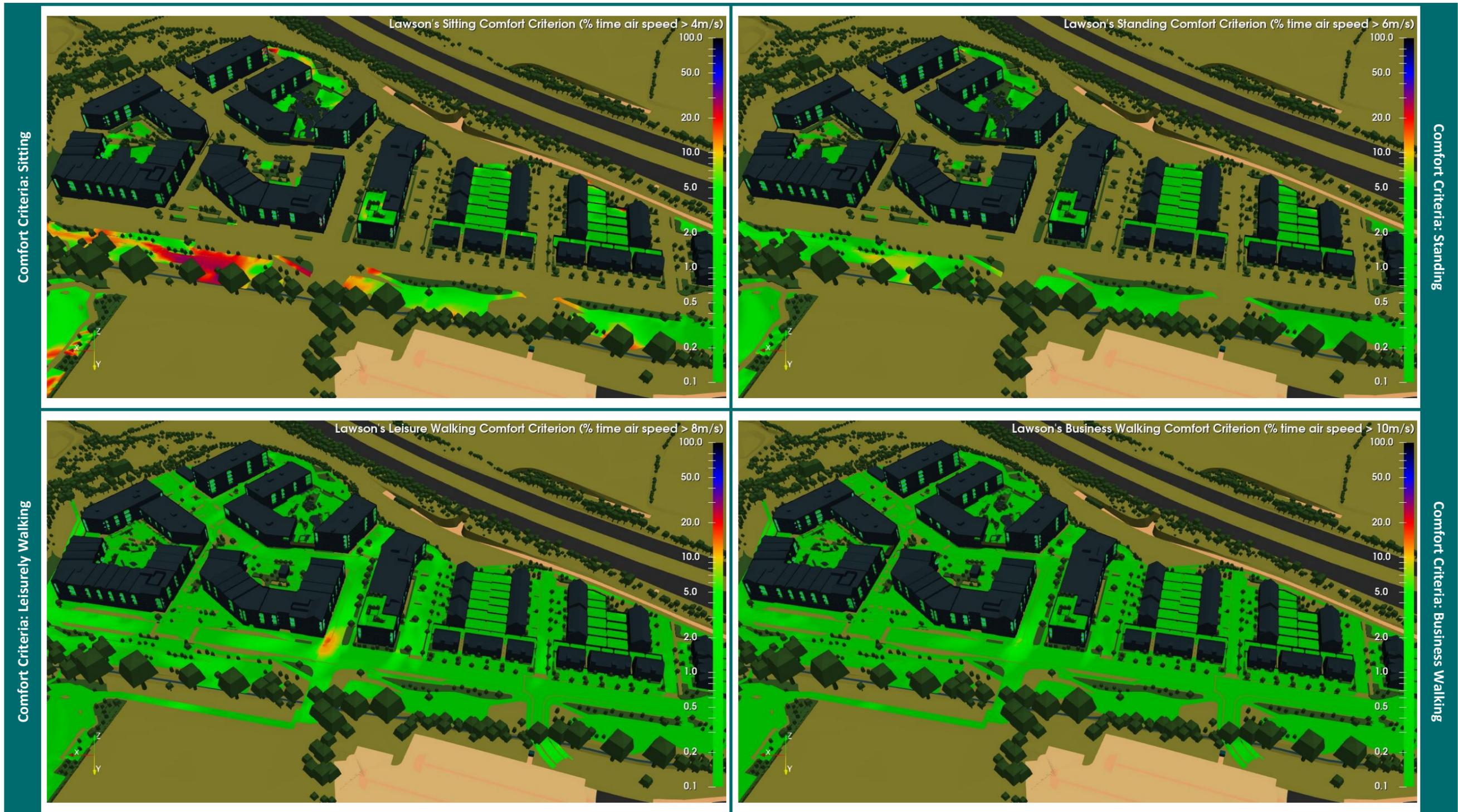


Figure 82: Comfort Criteria: All Seasons: View from the north

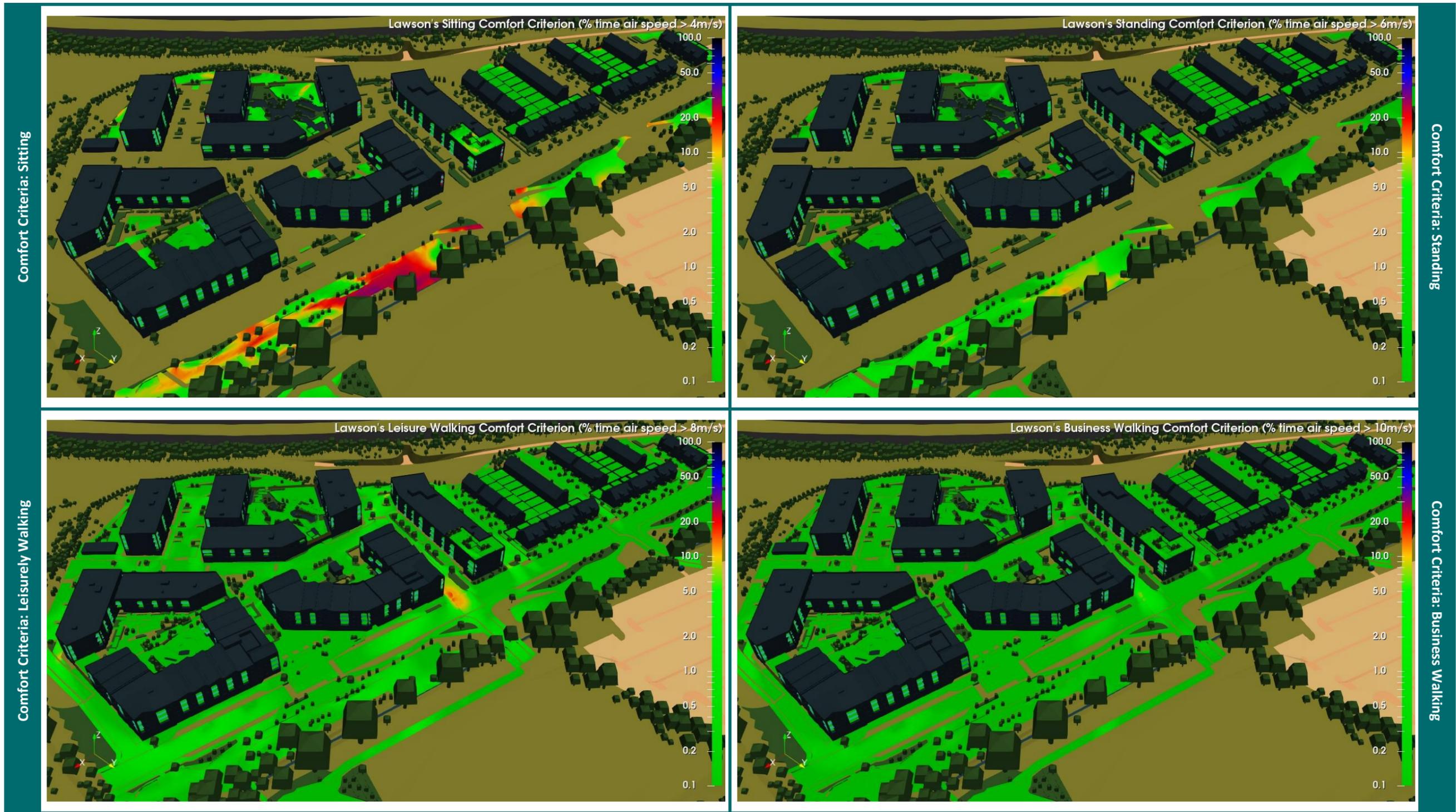


Figure 83: Comfort Criteria: All Seasons: View from the northeast

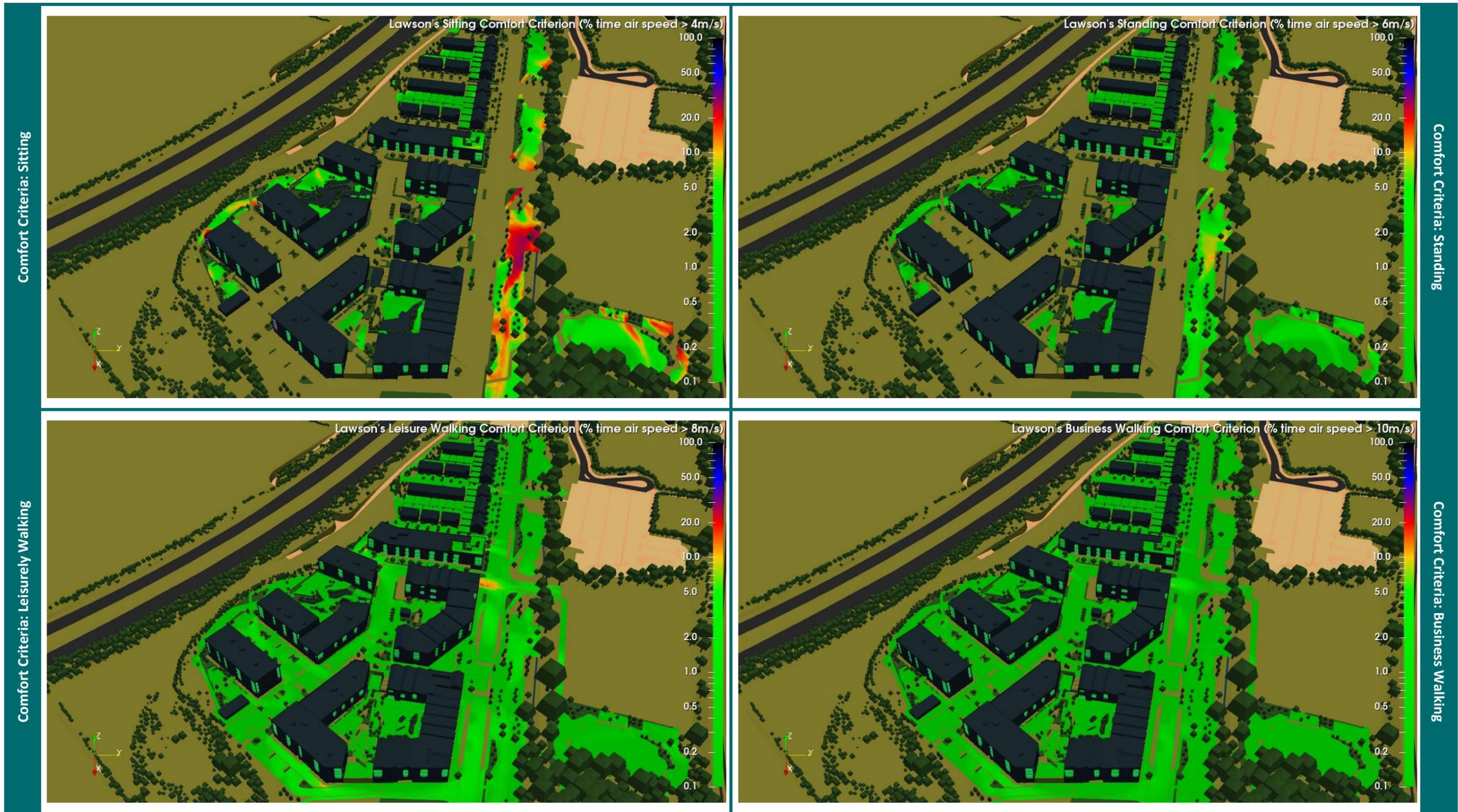


Figure 84: Comfort Criteria: All Seasons: View from the east

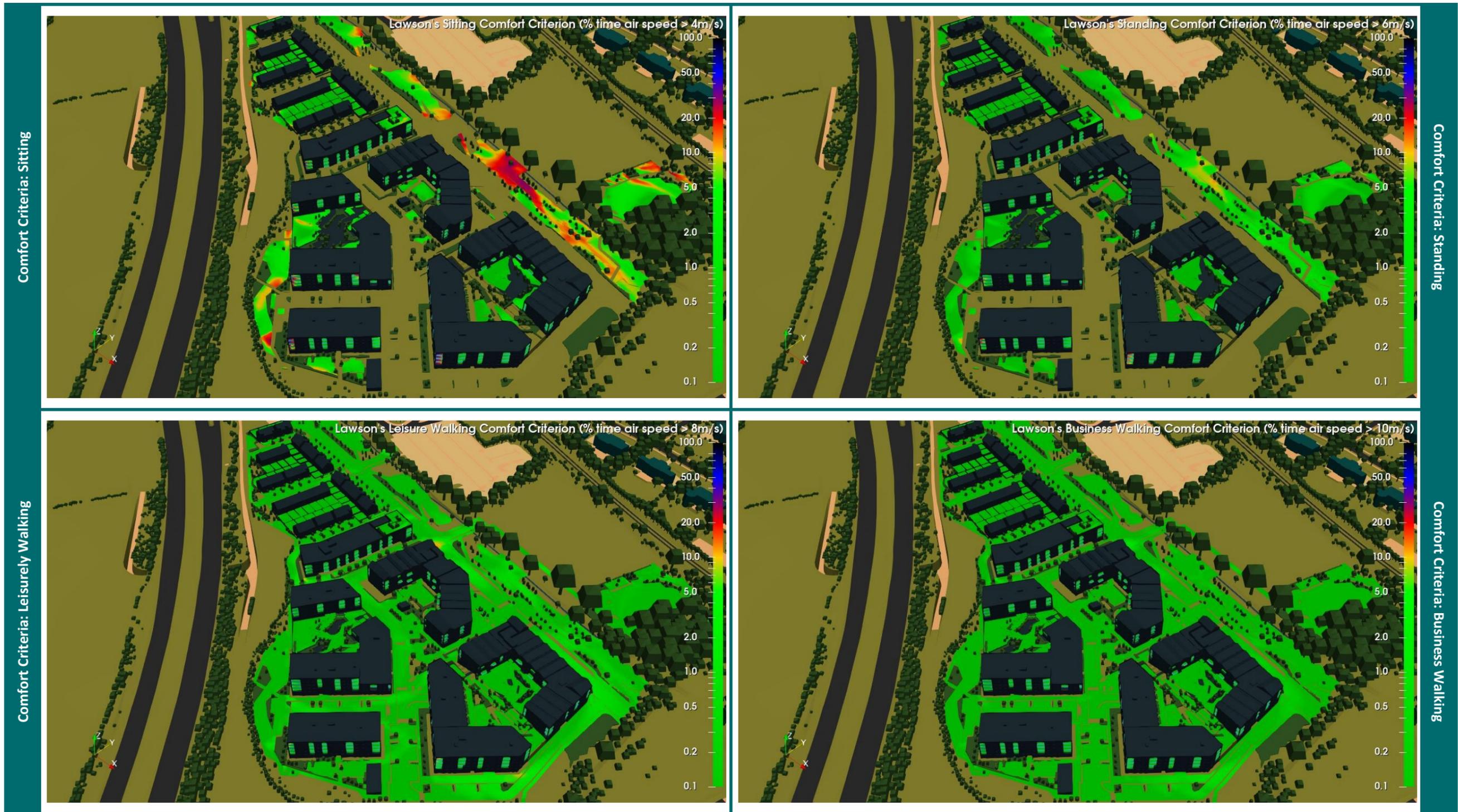


Figure 85: Comfort Criteria: All Seasons: View from the southeast

7.2 Safety Criteria

Figure 86 to Figure 94 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 20m/s for normal pedestrian and 15m/s for sensitive pedestrian.

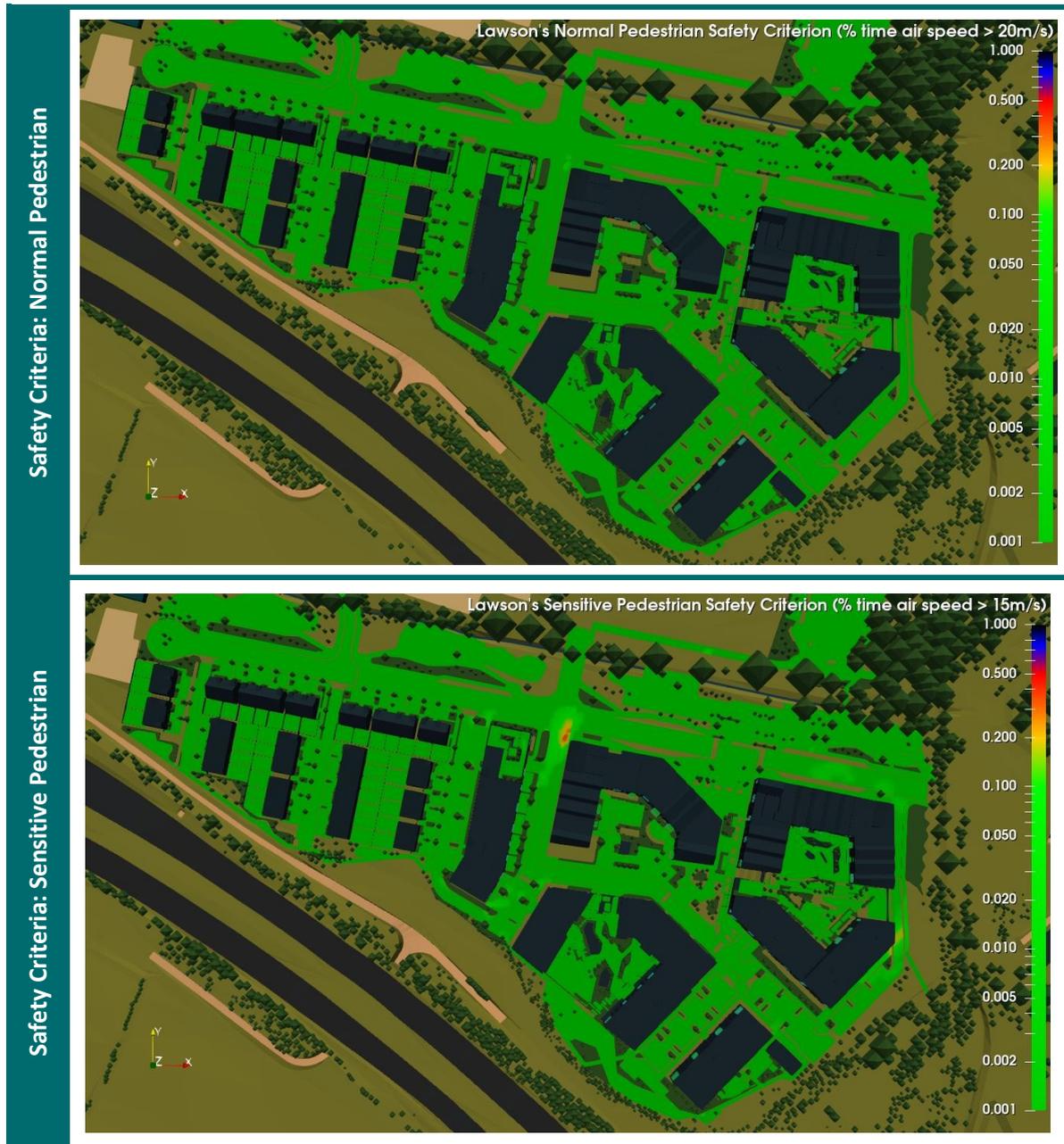


Figure 86: Safety Criteria: All Season: View from above

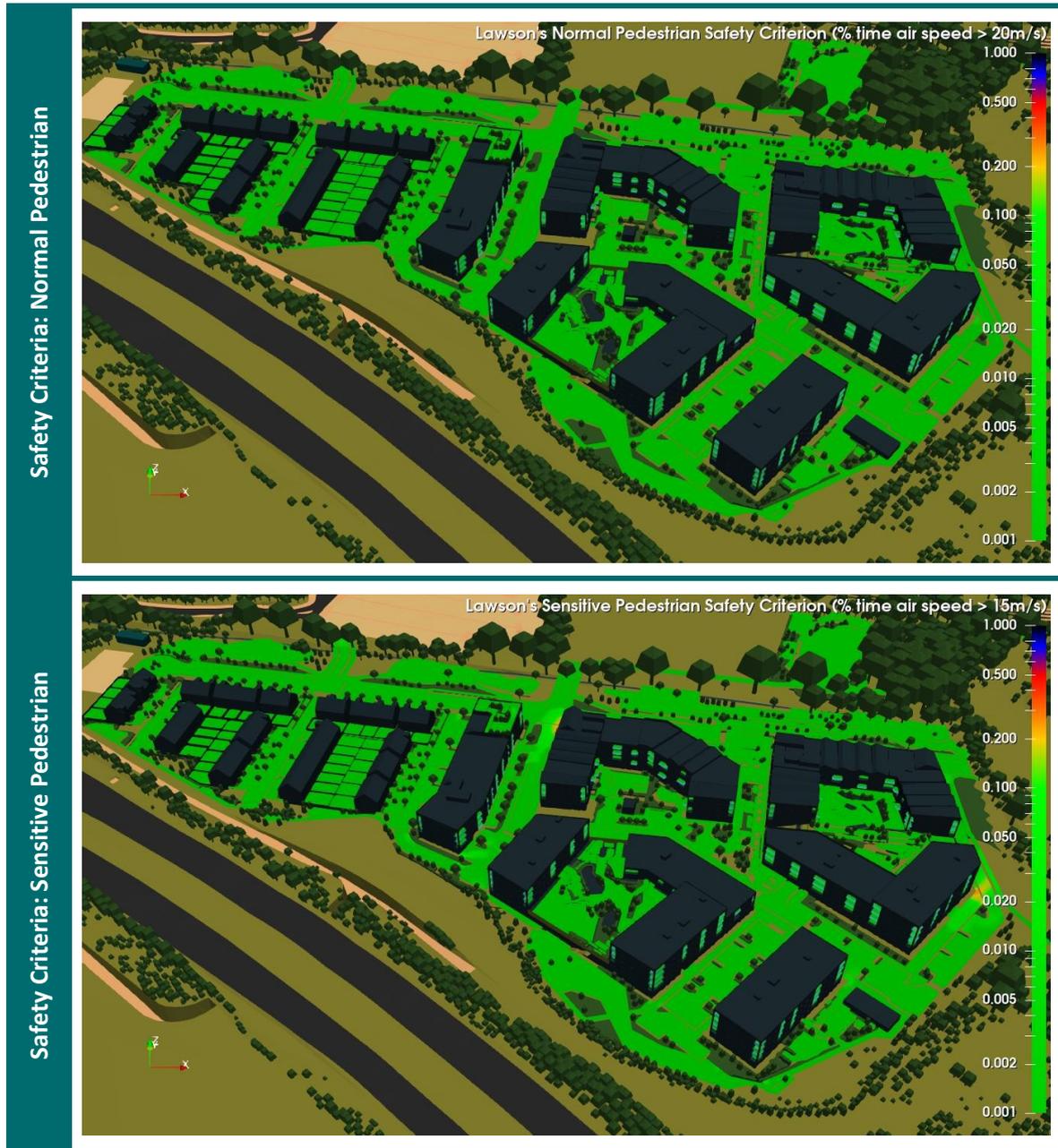


Figure 87: Safety Criteria: All Season: View from the south

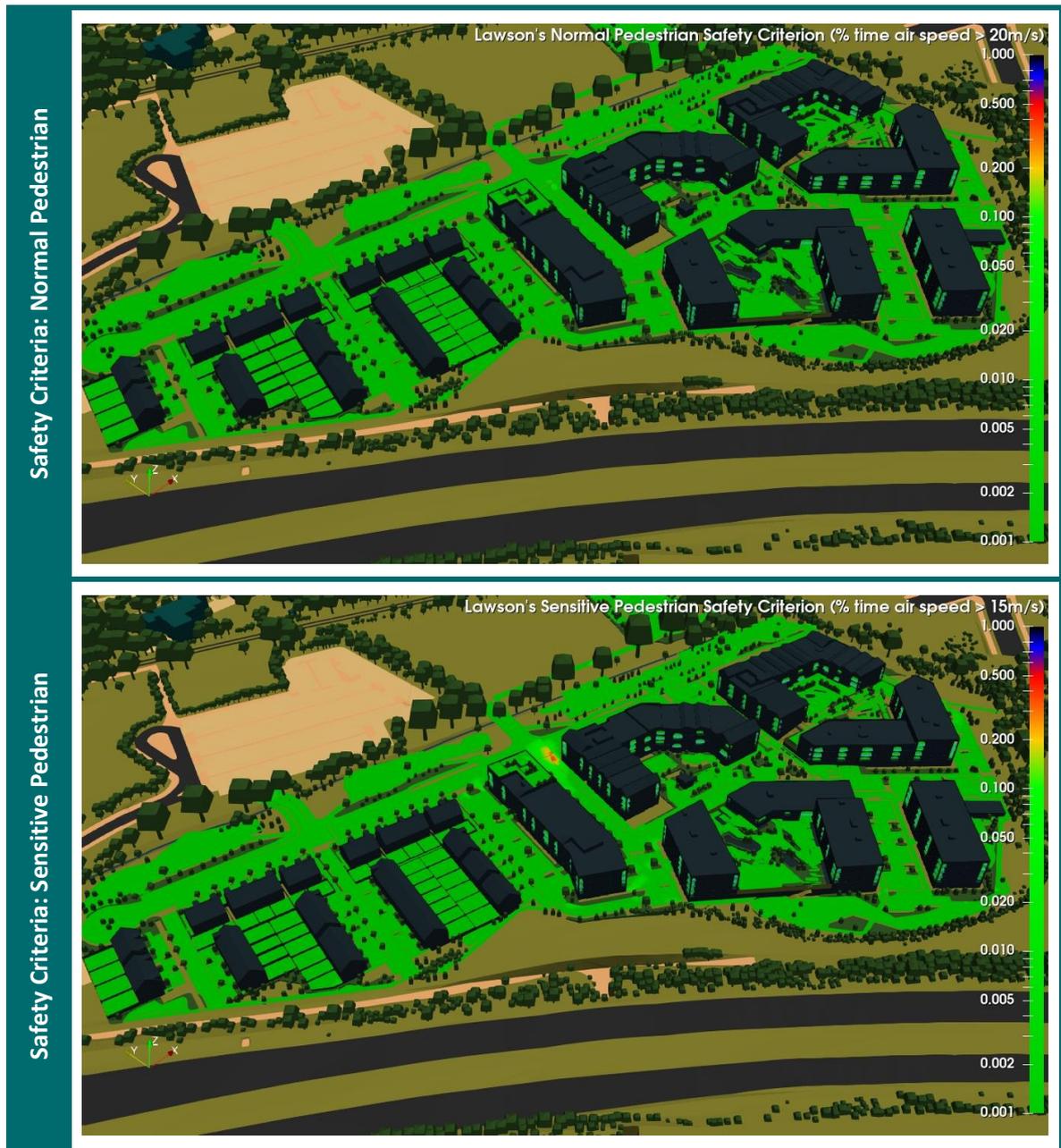


Figure 88: Safety Criteria: All Season: View from the southwest

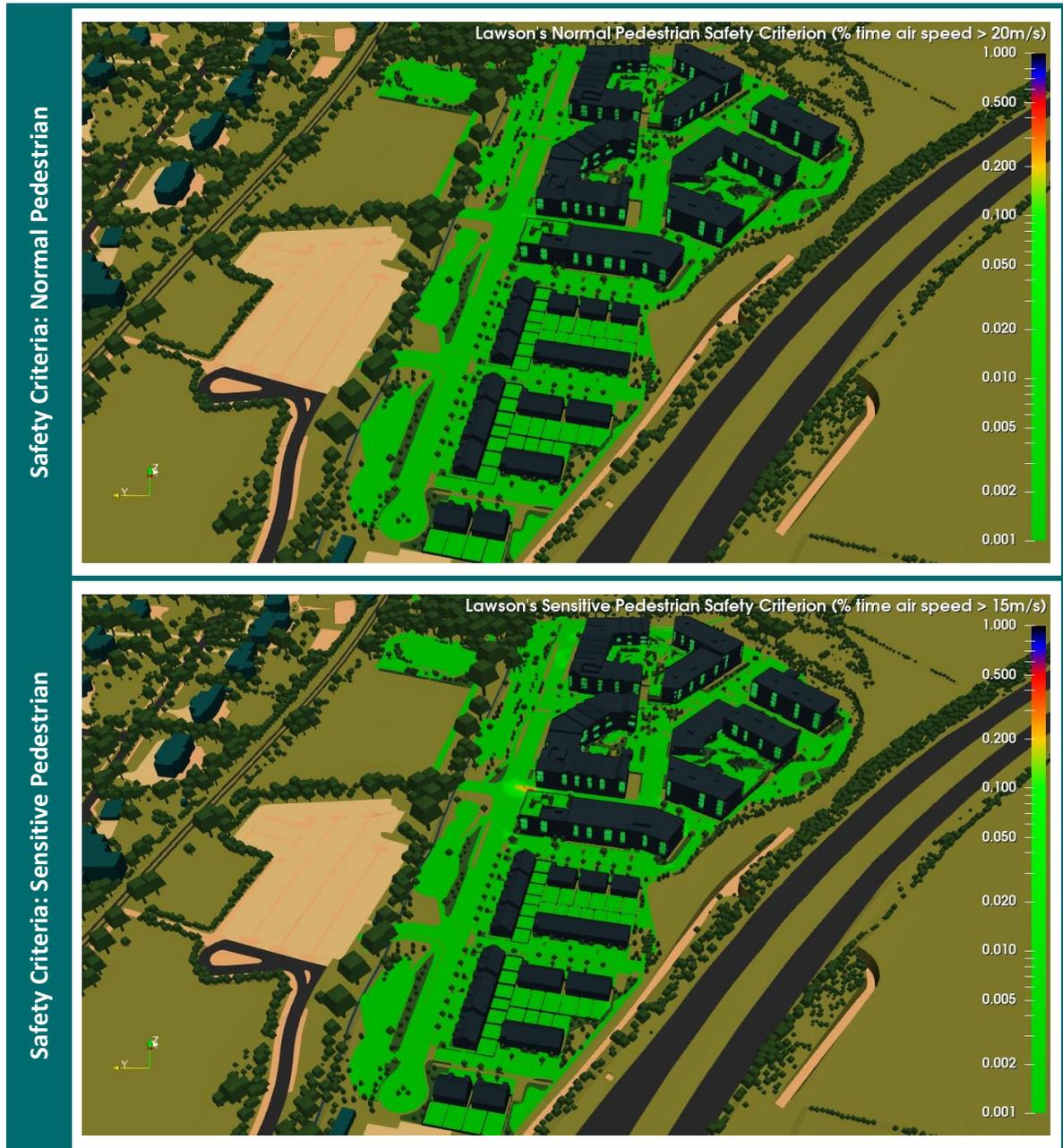


Figure 89: Safety Criteria: All Season: View from the west

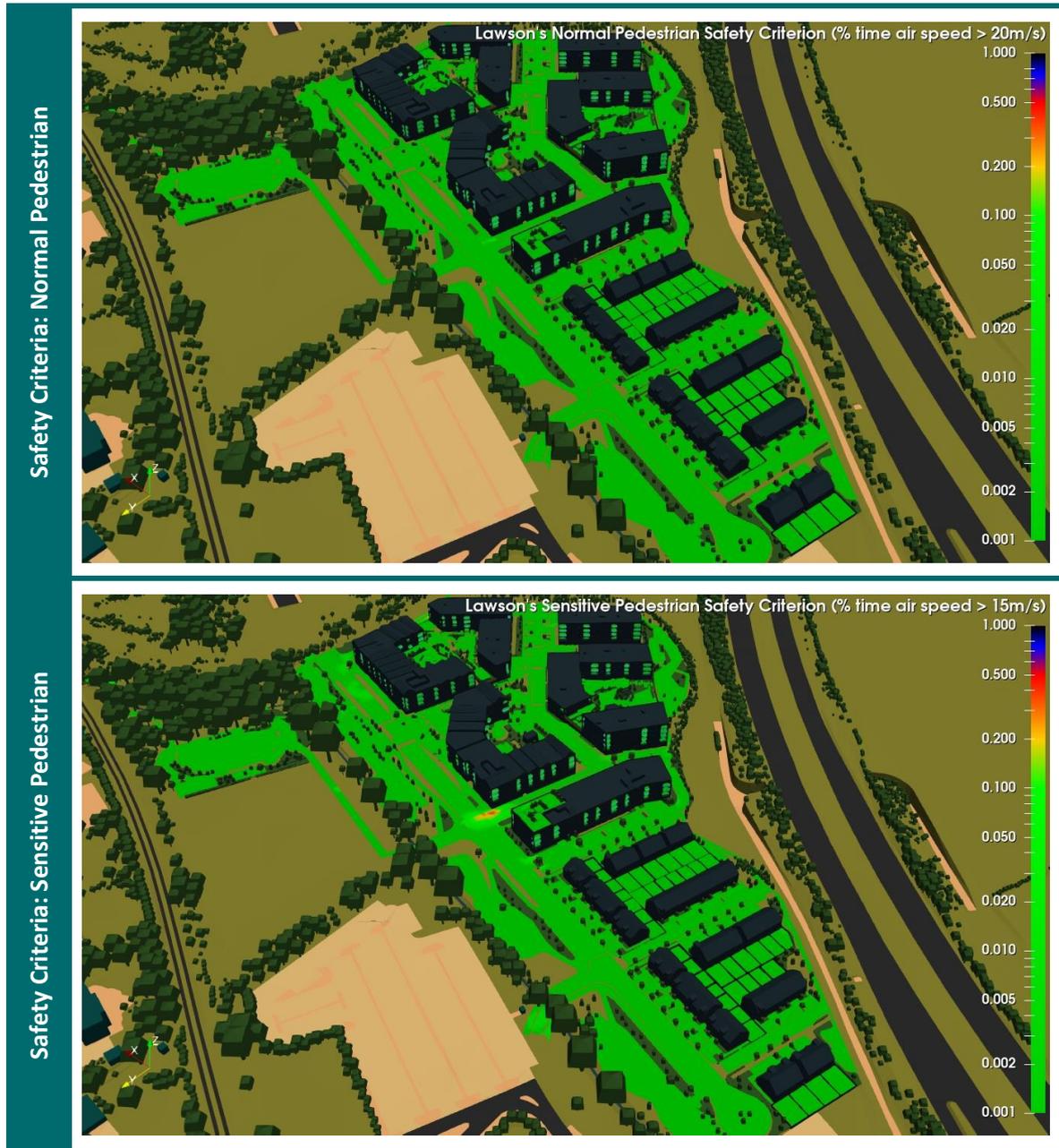


Figure 90: Safety Criteria: All Season: View from the northwest

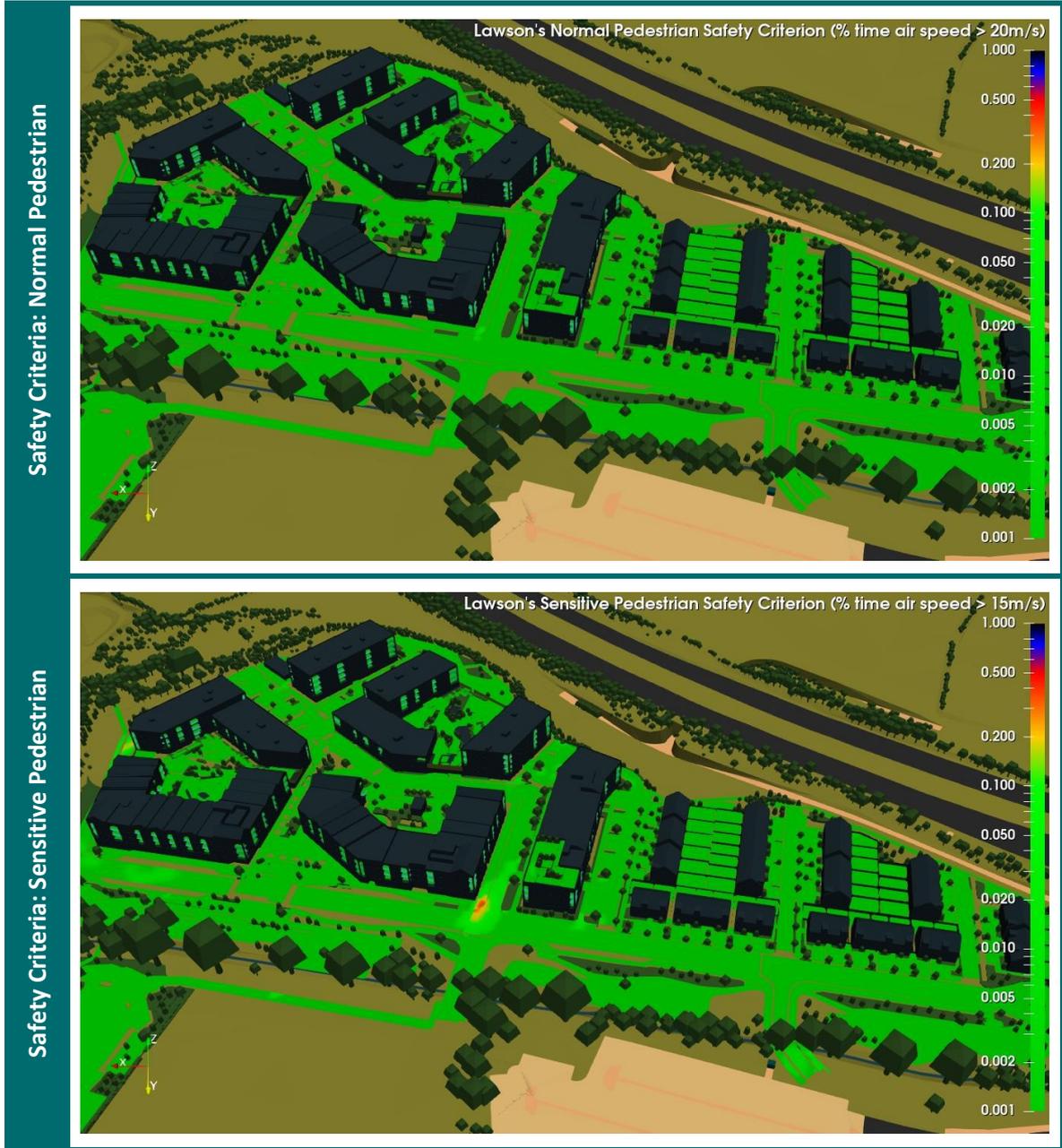


Figure 91: Safety Criteria: All Season: View from the north



Figure 92: Safety Criteria: All Season: View from the northeast

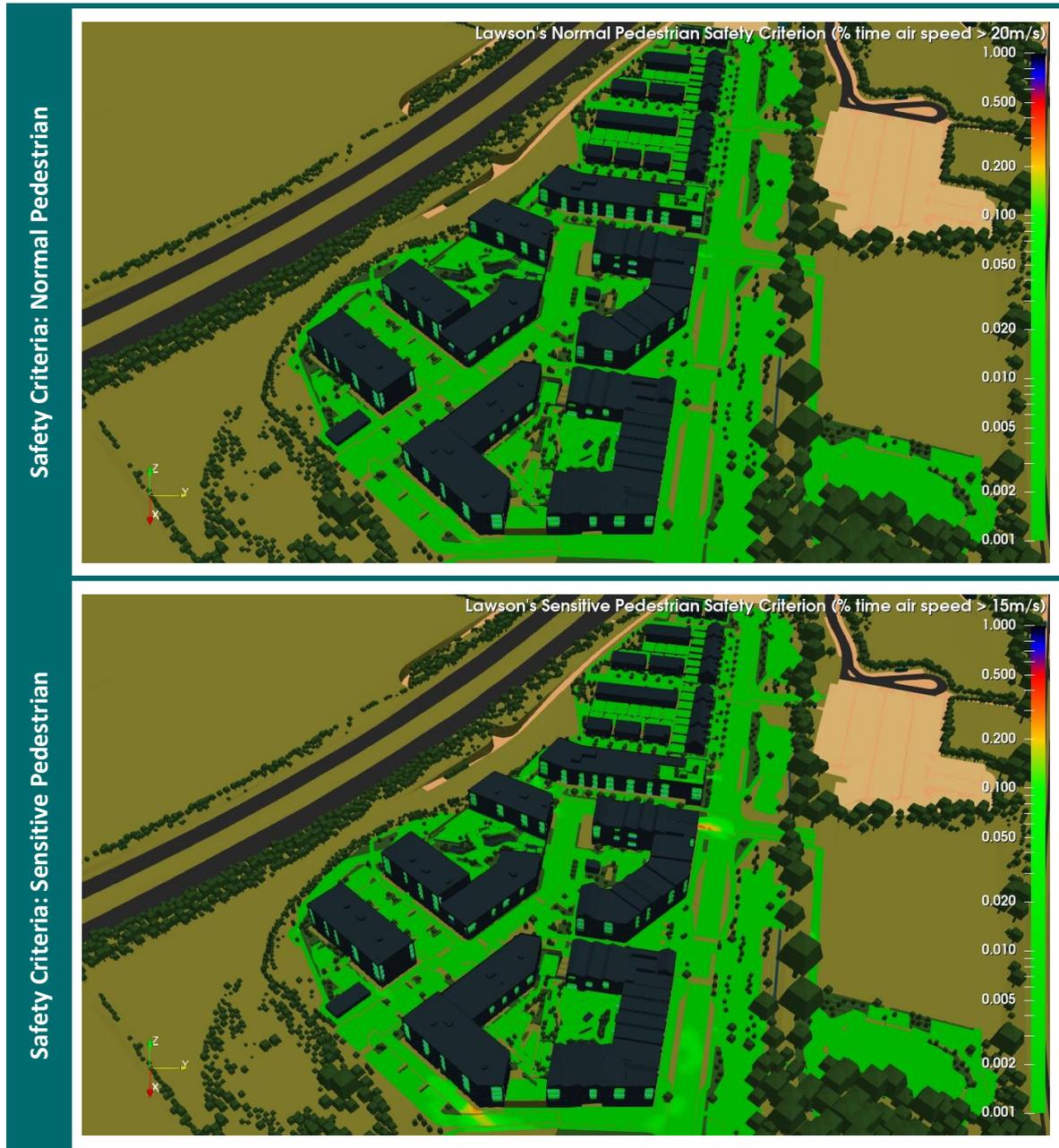


Figure 93: Safety Criteria: All Season: View from the east

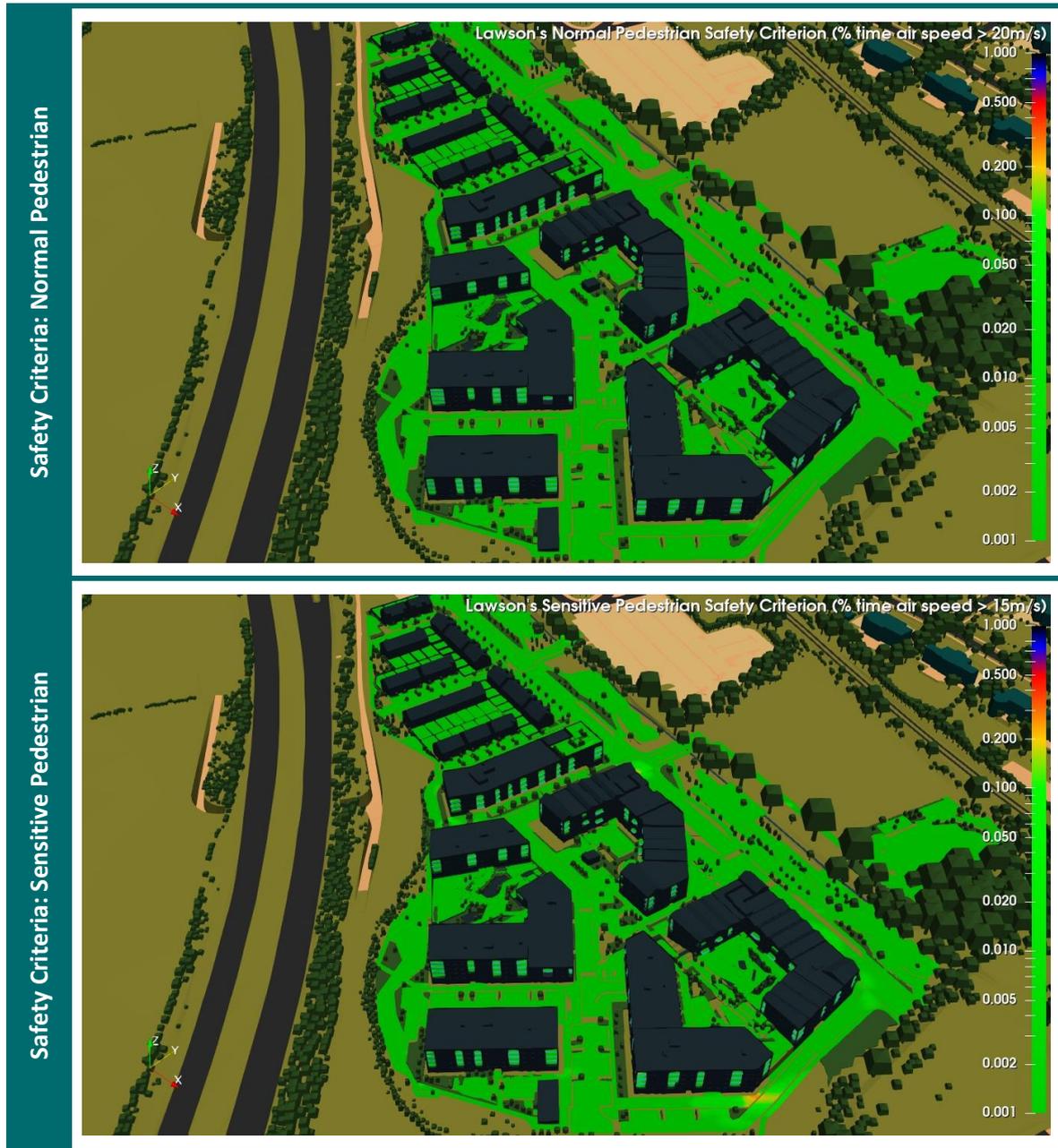


Figure 94: Safety Criteria: All Season: View from the southeast

