Cairn Home Properties Ltd

Blakes SHD Stillorgan

Wind Microclimate Assessment

P01

Issue | 14 March 2022

Job number 254226

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Contents

Executive Summary

The proposed Blakes SHD Stillorgan development will consist of the construction of a mixed use scheme of 377 no. “Built to Rent” BTR apartments, Community Sports Hall (933 sq. m), along with 5 no. restaurant/cafés (c. 841.2 sq.m), creche (c. 215 sq. m), office hub (195.3 sq m) and ancillary residents’ support facilities/services (1,016 sq. m) laid out in 6 no. blocks ranging in height from 3-9 storeys (over basement) comprising 21 no. studio apartments, 189 no. 1 bedroom apartments, 159 no. 2 bedroom apartments & 8 no. 3 bedroom apartments (selected no. with balconies), and public realm upgrades on a site of c. 1.41 hectares

This report assesses the impact of the proposed development on the wind conditions affecting pedestrian activities within and surrounding the development, and describes the methods used to assess these impacts in terms of pedestrian comfort and safety (distress). The assessment of discomfort and distress of pedestrians has been carried out in accordance with the Lawson Comfort Criteria [1]. The study is based on the drawings provided by O’Mahony Pike Architects and the landscaping plan provided by Kevin Fitzpatrick Landscape Architecture.

The objectives of the wind assessment are as follows:

- Evaluate the local microclimate that is experienced on site and examine the level of pedestrian comfort within the proposed development.
- Propose mitigation measure to alleviate the corresponding issues relating to pedestrian comfort and distress.
- Assessment of the effectiveness of the mitigation measures, which are adopted in the design, at alleviating pedestrian discomfort and distress.

The local wind climate was determined from historical meteorological data recorded at Dublin Airport. The prevailing wind in Dublin is from the southwest. These winds are relatively warm and often bring rain. The winds from the east are not as common as the westerlies, however, they are relatively cold, which can make them as annoying as the stronger westerlies. The Wicklow mountains to the south of Dublin influence the wind microclimate in the vicinity of Dublin and tend to shelter the city from southerly winds. In order to account for differences in the terrain exposure, the local wind data from Dublin Airport was transposed to the development site using the ESDU (Engineering Sciences Data Unit) methodology, which is compatible with Irish practice for wind loading.

The conclusions of the Blakes SHD Stillorgan wind microclimate study are as follows:

- Overall, the proposed development is expected to provide a suitable environment for pedestrians and occupants to carry out a wide variety of ‘sitting’, ‘standing’ and ‘strolling’ activities.
- Wind mitigation measures, have been adopted throughout the design to reduce the windiness across the site and to keep the wind conditions within acceptable limits. Mitigations include alterations to the building design and the landscaping plan.

- Most thoroughfares in and around the development with the proposed mature landscaping are expected to experience wind conditions that are suitable for their intended use.
- The wind conditions at the entrances of the proposed development meet the ‘standing’ limit for primary entrances.
- Most of the public seating spaces experience wind conditions within the ‘sitting’ to ‘standing’ range and are expected to be ‘comfortable’ for standing and short-term seating, like bench seating use. The wind conditions will improve as the landscaping matures.
- The introduction of the permitted Stillorgan Public Library development is expected to have a negligible impact on the wind conditions around the proposed development.

1 Introduction

1.1 Overview

The proposed development is located on the former Blakes and Esmonde Motors site in Stillorgan, Dublin, about 7.5 km southeast of Dublin City centre. It comprises a mixed-use scheme of 'Built to Rent (BTR)' apartments, commercial, childcare and residents' facilities laid out in 6 blocks ranging in height from 3 to 9 storeys.

Figure 1: Site context (Source of the base map: Google Earth Pro)

The windiness in and around the proposed development depends on both the massing of the buildings within their surroundings, their orientation with respect to the wind, and the local wind climate.

This report assesses the impact of the proposed development on the wind conditions affecting pedestrian activities within and surrounding the development, and describes the methods used to assess these impacts in terms of pedestrian comfort and safety (distress). The assessment of discomfort and distress of pedestrians has been carried out in accordance with the Lawson Comfort Criteria [1].

The study is based on the drawings provided by O'Mahony Pike Architects and the landscaping plan provided by Kevin Fitzpatrick Landscape Architecture.

1.2 Objectives

The objectives of the wind assessment are as follows:

- Evaluate the local microclimate that is experienced on site and examine the level of pedestrian comfort within the proposed development
- Propose mitigation measure to alleviate the corresponding issues relating to pedestrian comfort and distress
- Assessment of the effectiveness of the mitigation measures, which are adopted in the design, at alleviating pedestrian discomfort and distress.

2 Study Methodology

It is important to understand the wind microclimate around a proposed development in order to assess the level of pedestrian comfort. The assessment has been undertaken in the following key locations:

- Recreational areas
- Entrances
- Pedestrian access routes
- Pedestrian walkways
- Balconies

2.1 Lawson Comfort Criteria

The criteria used to describe windiness in this study are those of TV Lawson of Bristol University, extracted from “The evaluation of the windiness of a building complex before construction”, TV Lawson, London Docklands Development Corporation. These are used widely in Ireland, UK and around the world.

The acceptability of windy conditions is subjective and depends on several other factors, including but not limited to, normal clothing for the time of the year, expectations of the wind environment, air temperature, humidity and sunshine and most notably the activities to be performed in the area being assessed. The Lawson Criteria describe acceptability for particular activities in terms of 'comfort' and 'distress' (or safety). Acceptable conditions for various activities in order of increasing windiness are described in Table 1.

Gusts cause the majority of cases of annoyance and distress and are assessed in addition to average wind speeds. Gust speeds should be divided by 1.85 and these "gust equivalent mean" (GEM) speeds are compared to the same criteria as for the mean hourly wind speeds. This avoids the need for different criteria for mean and gust wind speeds.

2.1.1 Comfort Levels

The onset of discomfort depends on the activity in which the individual is engaged and is defined in terms of a mean hourly wind speed (or GEM, see above) which is exceeded for 5% of the time. The conditions, as described in Table 1, are the limiting criteria for comfort. For ideal conditions, the windiness will be a category better than outlined above. For more sensitive activities, such as regular use for external eating, conditions should be well within the 'sitting' category. Ireland is a windier climate than the UK, where these criteria were developed. It is generally accepted that residents in windier climates are more resilient to stronger winds. Therefore, a slight exceedance of the limiting criteria for comfort is not considered significant.

Table 1: Comfort Criteria as Defined by TV Lawson

Activity	Description	Wind speed to be exceeded less often than 5% of the year (m/s)				
		0 – 4	4 – 6	6 – 8	8 – 10	> 10
'sitting'	Regular use for reading a newspaper and eating and drinking					
'standing'	Appropriate for bus stops, window shopping, building entrances, and public amenity spaces such as parks					
'strolling'	General areas of walking and sightseeing					
'business walking'	Local areas around tall buildings where people are not expected to linger					

Note: *A classification of 'business walking' does not mean that a location will never be suitable for 'sitting', however, it is likely to occur relatively infrequently.*

Legend

Satisfactory

Tolerable

Uncomfortable

2.1.2 Distress Levels

There is a criterion to define the onset of distress. For the 'General Public', this is equivalent to an hourly mean speed of 15 m/s and a gust speed of 28 m/s to be exceeded **less often than once a year**. This is intended to identify wind conditions which less able individuals or cyclists may find physically difficult. Conditions in excess of this limit, may be acceptable for optional routes and routes which less physically able individuals are unlikely to use.

Table 2: Distress Criteria as defined by TV Lawson

Activity	Description	Wind speed threshold to be exceeded less often than once a year (m/s)
General Public Access	Above which the less able and cyclists may at times find conditions physically difficult	15
Able-bodied Access	Above which it may become impossible at times for an able-bodied person to remain standing	20

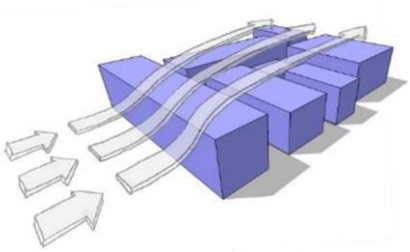
There is a further limiting distress criterion beyond which even 'Able-Bodied' individuals may find themselves in difficulties at times. This corresponds to a mean speed of 20 m/s and a gust speed of 37 m/s to be exceeded less often than once a year. Aerodynamic forces may exceed body weight in stormy conditions, which makes it difficult for anyone to remain standing. Where wind speeds exceed these values, pedestrian access should be limited.

2.2 Key Flow Mechanisms

There are certain flow patterns that can result in increased flow velocities. The main flow mechanisms of concern are described below:

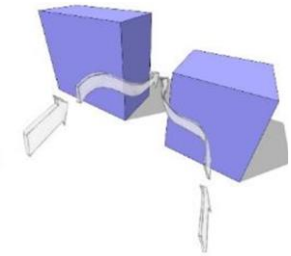
Exposure and Shelter

When buildings of similar height are in close proximity to each other, the first line of buildings can shelter the buildings behind from the wind. However, if the gap is relatively large, the building upstream may not provide adequate shelter. In this case, the higher velocity high level wind from above may descend to ground and therefore, this may create an inclement environment for pedestrians.



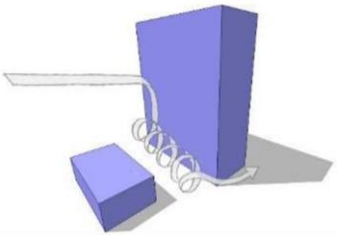
Funnelling/Channelling

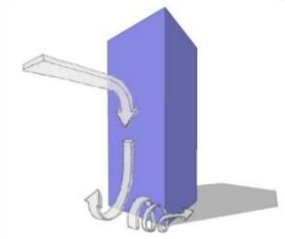
When the gap between buildings is relatively narrow in comparison to their overall width, a large volume of wind is forced through the narrow opening. It is necessary for the wind speed to increase through the opening, which can result in discomfort for pedestrians.



Downdraft

When buildings are considerably taller than the other buildings in their surroundings, they can re-direct the high-speed winds that they interact with at a high level down to ground in the form of a downdraft with standing vortex. The downdraft effect can be further exacerbated by lower-level buildings in close proximity upstream.





2.3 Computational Fluid Dynamics (CFD)

Computational Fluid Dynamics (CFD) is a numerical technique intended to simulate various phenomena related with fluid flow. The analysis includes three main stages: pre-processing, CFD simulations and post-processing. The CFD simulations performed in this study were made using the software OpenFOAM with a 3D steady-state Reynolds' Average Navier-Stokes (RANS) approach, commonly used in CFD studies of this kind.

3 Existing Receiving Environment

3.1 Site Location and Surrounding Area

The proposed development is located at the former Blakes and Esmonde Motors site in Stillorgan, Dublin, about 7.5 km southeast of Dublin City centre. The site of 1.41 hectares is bounded by Lower Kilmacud Road to the north, The Hill to the south and west and Stillorgan Road (N11) and Dún Laoghaire owned lands to the east. The site is accessible by car and public transport from these roads. The proposed development is surrounded by residential and commercial properties.

The area immediately to the north of Lower Kilmacud Road is undergoing change. The area includes the LeisurePlex development (currently under construction) to the north-west and the permitted Stillorgan Public Library development to the north-east. The entire LeisurePlex development has been included as part of the existing surroundings, while the permitted Stillorgan Public Library development has been considered as part of the cumulative (permitted) surroundings.

Figure 2: Site context (Source of the base map: Google Earth Pro)

3.2 Proposed Development

The proposed Blakes SHD Stillorgan development will consist of the construction of a mixed use scheme of 377 no. “Built to Rent” BTR apartments, Community Sports Hall (933 sq. m), along with 5 no. restaurant/cafés (c. 841.2 sq.m), creche (c. 215 sq. m), office hub (195.3 sq m) and ancillary residents’ support facilities/services (1,016 sq. m) laid out in 6 no. blocks ranging in height from 3-9 storeys (over basement) comprising 21 no. studio apartments, 189 no. 1 bedroom

apartments, 159 no. 2 bedroom apartments & 8 no. 3 bedroom apartments (selected no. with balconies), and public realm upgrades on a Site of c. 1.41 hectares

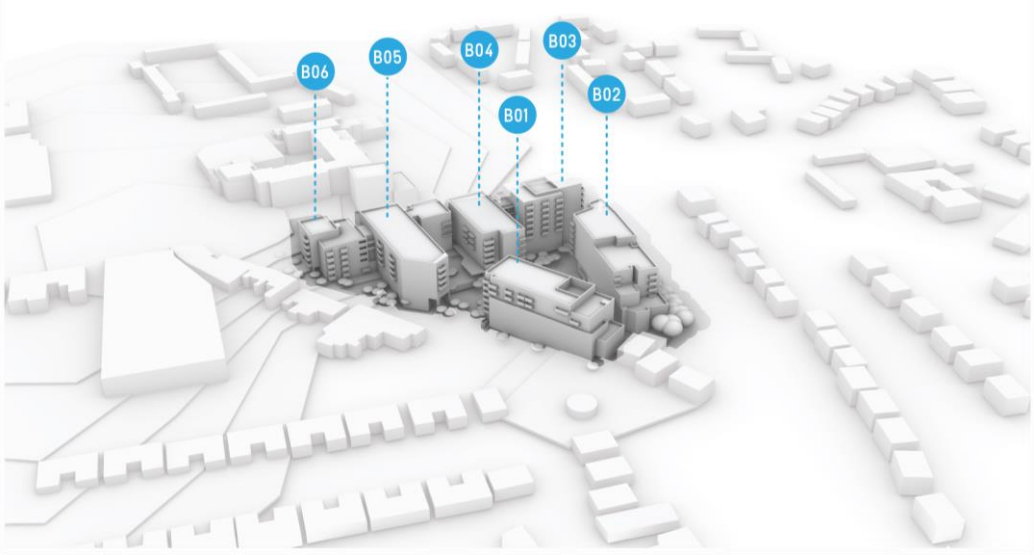


Figure 3: Proposed development in existing surroundings as represented in the CFD model (View from the south)

Figure 4 shows the main pedestrian thoroughfares around the development, the location of the primary entrances and the proposed sitting areas in the open spaces. The open spaces feature a public plaza on the Hill to the west of Building 5. Communal courtyards gardens are placed between Building 1 and 2, and between Building 3 and 4. The open spaces are connected through a main pedestrian and cycling route that crosses the site east-west.

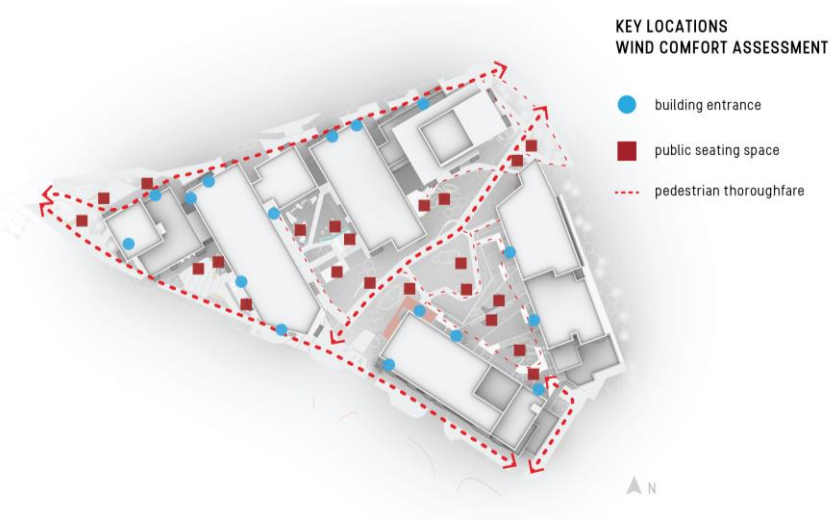


Figure 4: Location of the main thoroughfares, entrances and outdoor seating spaces around the proposed development.

3.3 Wind Microclimate

The local wind climate was evaluated based on historical meteorological data recorded at Dublin Airport (approximately 16 km to the north of the site). The expected statistics for wind strength and direction are based on historic wind data recorded at this weather station over the 30-year period between 1999 and 2020. The wind rose for Dublin Airport is shown in Figure 5 and illustrates the frequency and strengths of the recorded winds.

The prevailing winds in Dublin are from the southwest. These winds are relatively warm and often bring rain. The winds from the east are not as common as the westerlies, however, they are relatively cold, which can make them as annoying as the stronger westerlies. The Wicklow mountains to the south of Dublin influence the wind microclimate in the vicinity of Dublin and tend to shelter the city from southerly winds.

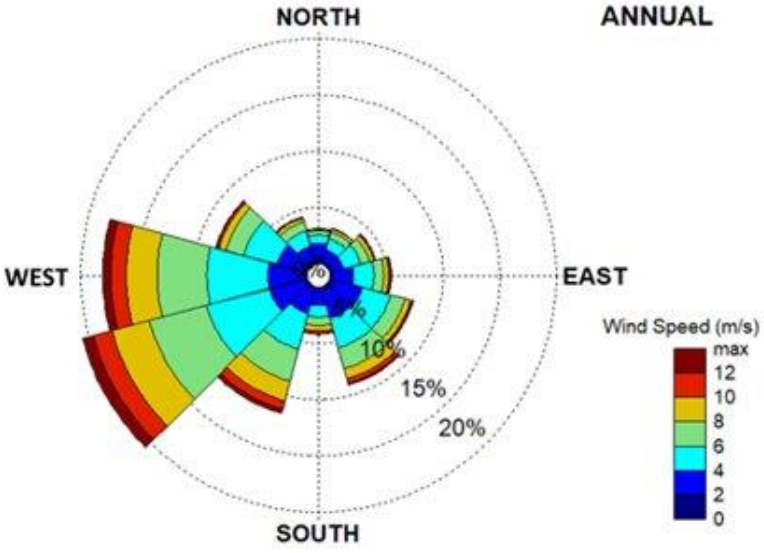


Figure 5: Dublin Airport wind rose

In this study, winds were considered to approach from twelve distinct sectors. A Weibull distribution was fitted to the wind data for each sector and the 95th percentile and 'once-a-year' wind speeds were derived from the subsequent cumulative Weibull distributions.

In order to account for differences in topography, the local wind data from Dublin Airport was transposed to the development site using the ESDU (Engineering Sciences Data Unit) methodology, which is compatible with Irish practice for wind loading. The transformation considers the exposure of the site, which is a measure of the terrain roughness (i.e. size and number of obstacles) upstream of the site. The exposure is dependent on the direction of the oncoming wind.

4 Proposed Development in Existing Surroundings (Baseline)

4.1 Overview

An analysis was undertaken to quantify the pedestrian comfort level at key locations in and around the proposed development using computational fluid dynamics (CFD).

The baseline scenario (Figure 6) comprises of the proposed development in its existing surroundings, including the LeisurePlex development currently under construction. The baseline scenario does not consider the effect of the proposed landscaping that will be discussed in Section 5, and cumulative (permitted) surroundings that will be discussed in Section 6.

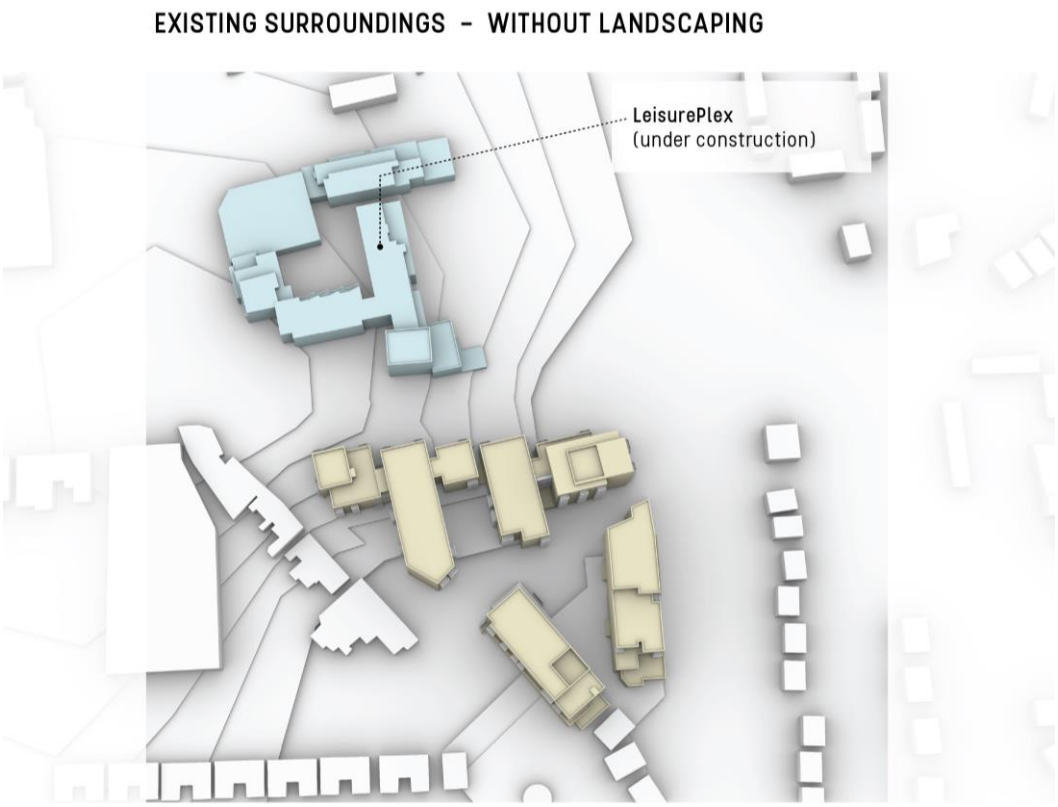


Figure 6: Top view of the proposed development in existing surroundings including the LeisurePlex development to the north.

Overall, the proposed Blakes development provides a suitable environment for pedestrian circulation along the surrounding pedestrian routes. The buildings, of similar height, create a cluster that shelters the communal courtyards from the prevailing winds. The western side of the development along the Hill is exposed to the prevailing winds that will create some windiness around the corners and at the western end of the pedestrian through-route. Pedestrians may find these conditions windy at times, but they are estimated to be within the reasonable limits for

pedestrian circulation. The wind conditions around the proposed development are expected to improve with the introduction of mature landscaping.

4.2 Thoroughfares

The wind speeds along most of the throughfares are estimated to be up to approximately 8 m/s. These conditions are in the ‘standing’ to ‘strolling’ range and suitable for a thoroughfare.

The prevailing southwesterly and westerly winds are likely to accelerate around the corners of the buildings along the Hill:

- The wind speeds near the southern corner of Building 1 are estimated up to approximately 8m/s. These conditions are within the comfortable range for ‘strolling’ and ‘business walking’ activities, which is reasonable for a thoroughfare.
- The car park entrance underneath the southern corner of Building 5 generates a slight flow acceleration with wind speeds reaching approximately up to 7m/s within the undercroft and downstream of it. Nevertheless, these conditions are still within the acceptable range for ‘strolling’.
- The wind speeds at the northwestern corner of Building 6 are estimated up to 6.5m/s and in the ‘strolling’ range. These conditions are suitable for the intended use.

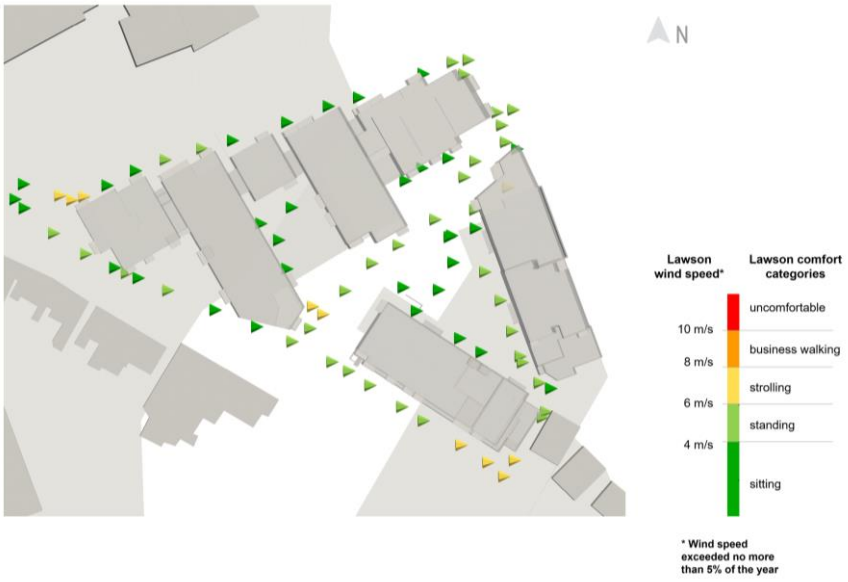


Figure 7**.** Lawson wind speeds at key locations along the thoroughfares (Baseline)

Figure 8. Lawson criteria at key locations along the thoroughfares (Baseline)

4.3 Entrances

Most entrances feature wind and rain protective elements such as a colonnade or a canopy with a side screen. The wind speeds at the entrances are estimated up to around 6m/s (Figure 9) and are thus suitable for their primary use (Figure 10). The entrance in the passage between Building 4 and 5 may experience a moderate increase of the wind speed at times due to the pressure differential on the two ends of the passage. These conditions are still estimated to be within reasonable limits.

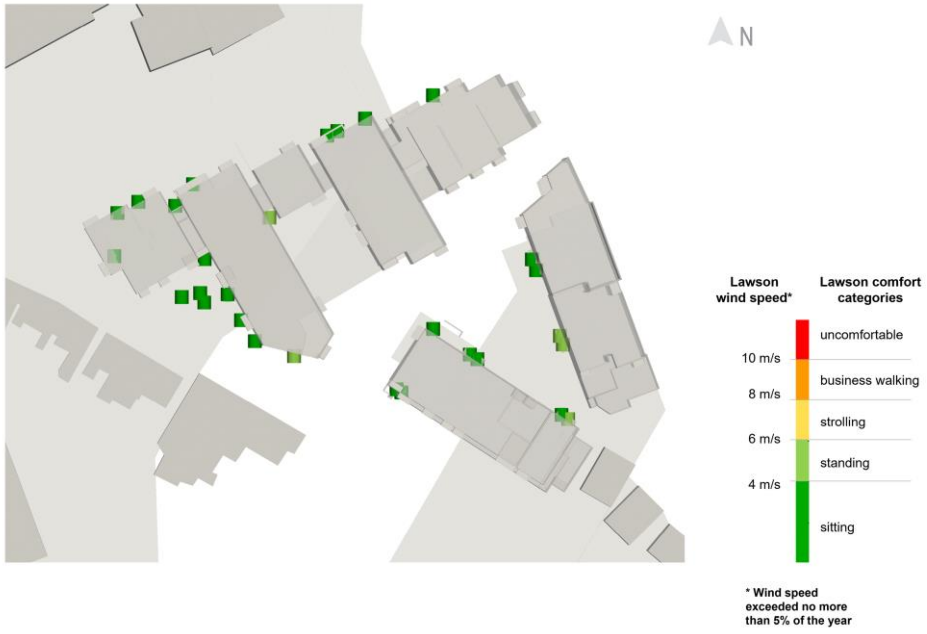


Figure 9. Lawson wind speeds at the primary entrances (Baseline)

Figure 10. Lawson criteria at the primary entrances (Baseline)

4.4 Public open spaces

The communal courtyards between Building 1 and 2, and between Building 4 and 5 are sheltered from the prevailing winds by the surrounding buildings. The wind speeds in the majority of the proposed outdoor seating areas are up to about 4m/s and are within the comfortable 'sitting' range. A few locations show slightly higher wind speeds up to about 5m/s, which is also tolerable for the intended sitting use. These wind conditions are very common in Dublin and are expected to be 'comfortable' for standing and short-term sitting, like bench seating use. There is an expectation to use these spaces in good-weather conditions, which would improve on the acceptability of the estimated windiness.

The wind speeds in the sitting spaces of the public plaza along the Hill are estimated below 4m/s. This space is designed to accommodate events and features large seating steps as well as outdoor amenity spaces for the adjacent café/restaurants. The estimated wind conditions are in the 'sitting' range and comfortable for the intended use.

The wind microclimate at the northwestern corner of Building 6 is expected to be affected by the acceleration of the prevailing winds. The wind speeds at the planter seating features are estimated up to approximately 6.5 m/s. These conditions are in the 'strolling' range and suitable for short-term seating use during good weather conditions.

The public seating area between Building 4 and 5 is well-sheltered from the prevailing winds by the building massing. Southwesterly winds are expected to accelerate underneath the car park entrance opening at the southern corner of Building 5, but these are diverted away from the public seating area by the sidewall. The wind conditions on the plaza itself are therefore expected to remain in the comfortable 'sitting' range.

The wind conditions at the benches on the eastern end of the through-route are affected by the slight wind acceleration in the gap between Building 2 and 3. The

wind speeds are estimated up to about 5m/s and in the comfortable to tolerable range for ‘sitting’. These conditions are reasonable for good weather use.

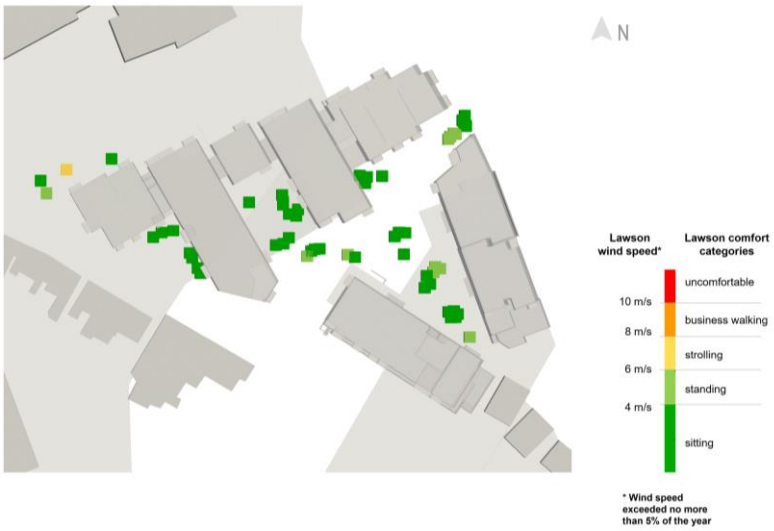


Figure 11. Lawson wind speeds at key locations of the public seating spaces (Baseline)

Figure 12. Lawson criteria at key locations of the public seating spaces (Baseline)

4.5 Balconies

The balconies are considered private spaces for the residents. Solid balustrades are provided at all the balconies along the site's perimeter – which are most exposed – in order to protect these spaces from the wind (Figure 13). Furthermore, some of the corner balconies include side screens. The resulting wind conditions on most balconies are in the 'sitting' to 'standing' range (Figure 14 and Figure 16). These conditions are 'comfortable' to 'tolerable' for sitting and, thus reasonable for the intended use.

The northern corner balconies of Building 1 as well as a few high-level balconies around the corner of Building 3 and on the western side of Building 6 may experience stronger wind conditions due to their exposure to the prevailing winds. These conditions are estimated in marginal exceedance of the 'standing' range and reasonable for good-weather use.

Figure 13: Overview of balcony arrangement

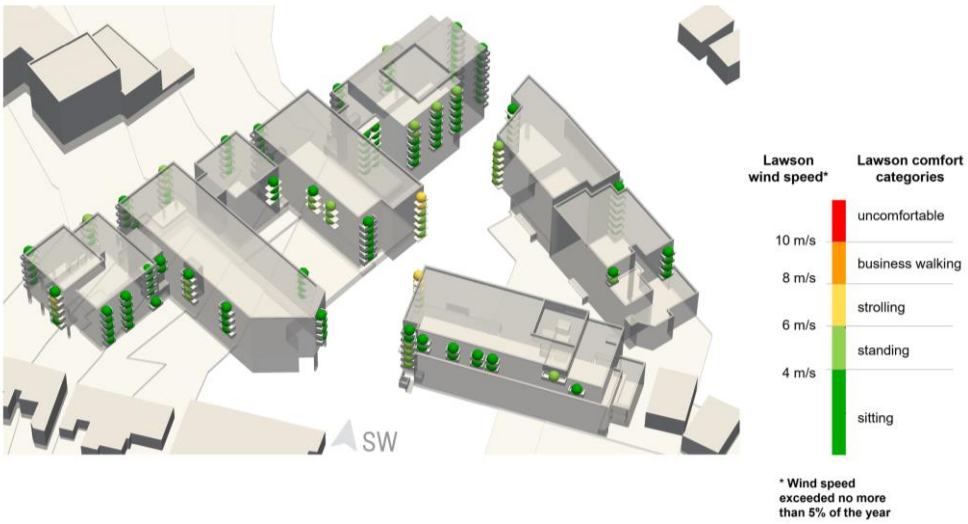


Figure 14: Lawson wind speeds at the balconies (view from southwest)

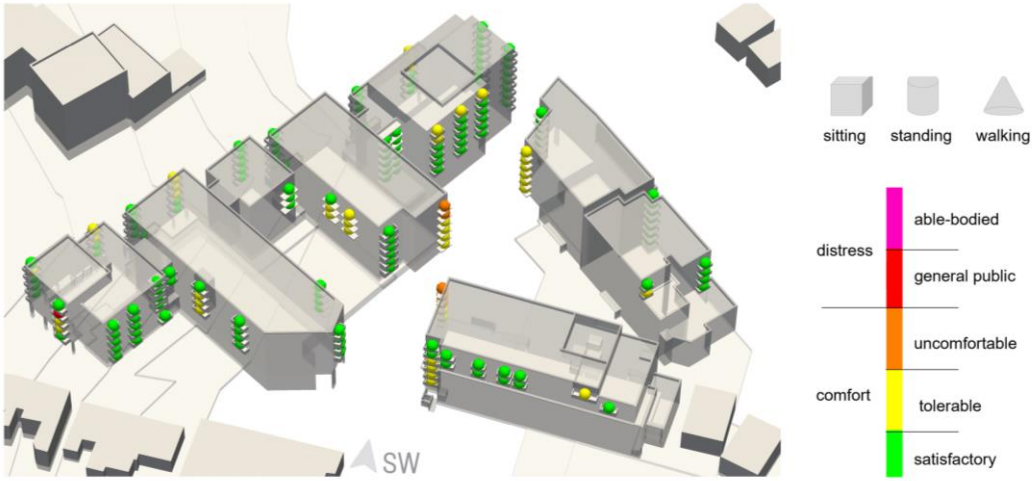


Figure 15: Lawson criteria at the balconies (view from southwest)

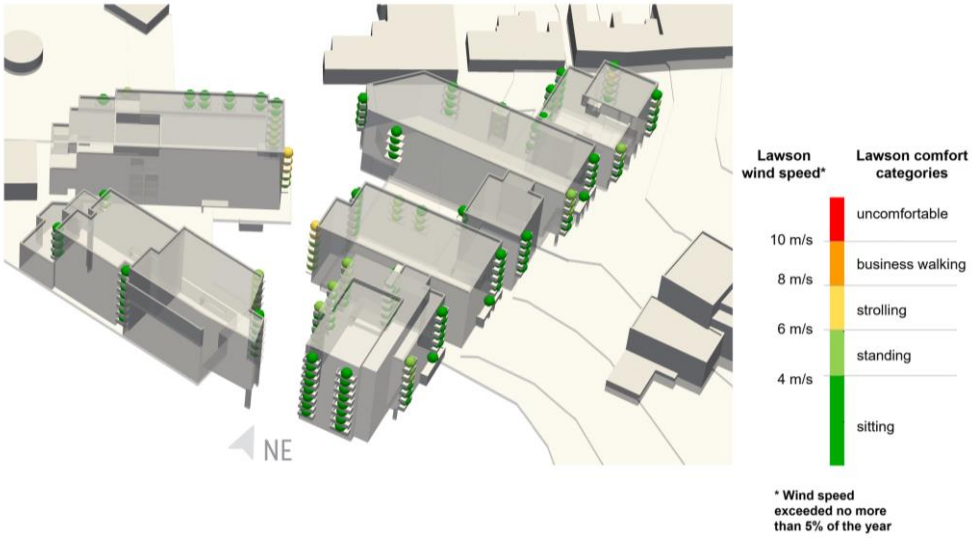


Figure 16: Lawson wind speeds at the balconies (view from northeast)

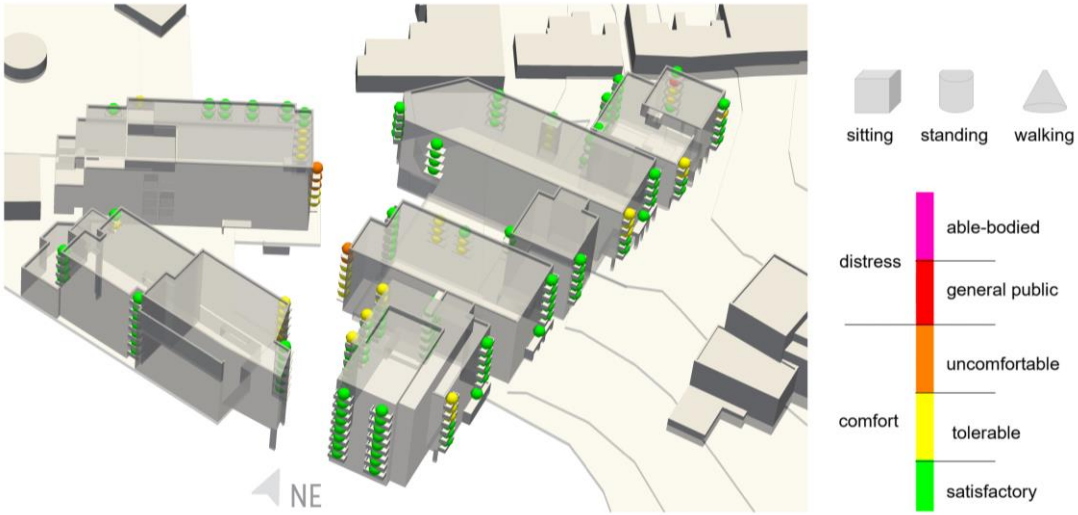


Figure 17: Lawson criteria at the balconies (view from northeast)

5 Proposed Development in Existing Surroundings with Mitigation

5.1 Overview

Design stage mitigations have been incorporated into the design process, both for the design of the building blocks and the landscaping. The building design features, part of the baseline model, include:

- Enclosing the passage between Building 5 and 6 (Figure 18)
- Protecting the southeastern end of Building 5

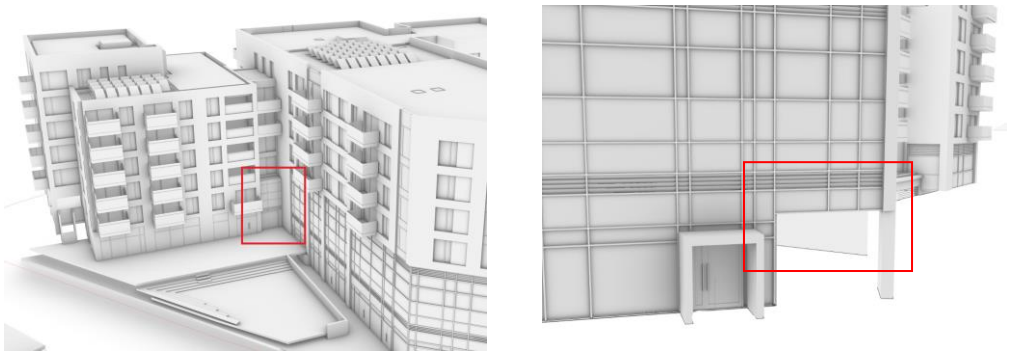


Figure 18: Wind mitigation measures developed during the design stage to reduce the wind conditions near the ground: passage between Buildings 5 and 6 (left); southeast corner of Building 5 (right)

The addition of a portal that encloses the entrance to the community sports hall in Building 5 has been considered to protect this space from the prevailing winds (Figure 19). The portal is included in the assessment of the proposed development with mitigation discussed in this section. Given the minimal benefit of the portal on the wind conditions, this feature has been excluded from the final design.

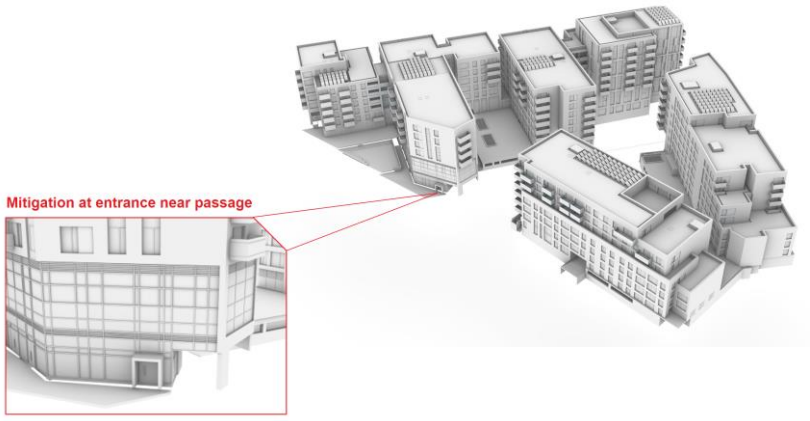


Figure 19: Portal enclosing the entrance to the community sports hall in Building 5. This mitigation was removed from the final design.

The effect of the landscaping plan on the wind microclimate is assessed in this section. The landscaping plan is shown in **Figure 20** and includes:

- The addition of a porous pergola on the southwest façade of Building 4
- The retention of existing trees along Stillorgan Road, where possible
- The addition of trees, shrubs and bamboo plantings around the development

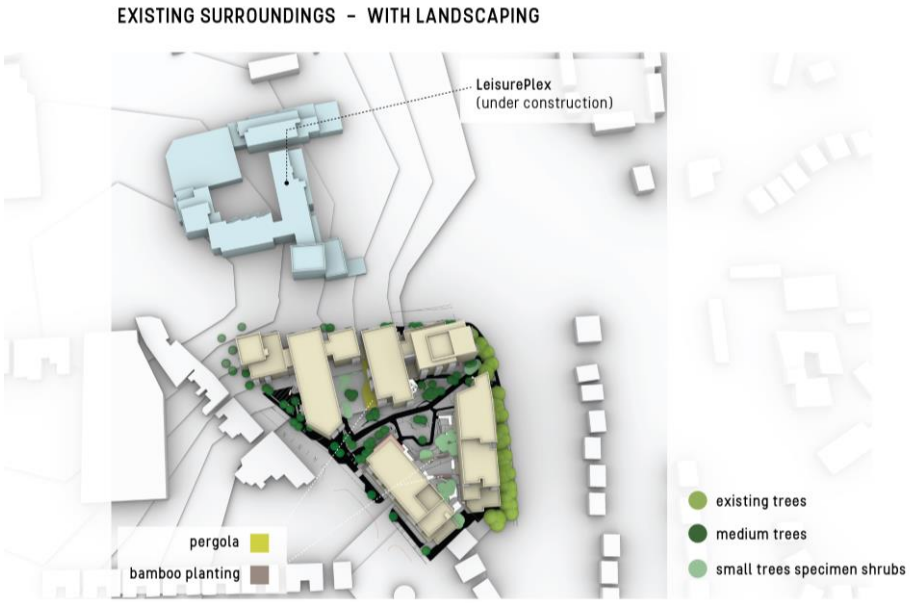


Figure 20: Overview of proposed development in existing surroundings with landscaping

5.2 Thoroughfares

The proposed mitigations significantly improve the wind conditions in between Building 1 and 5 and underneath/downstream the opening to the car park entrance.

The medium-size trees at the western end of the through-route help to dissipate the strength of the prevailing winds funnelling through the pedestrian thoroughfare between Building 1 and 5. The landscaping along the Hill contributes to sheltering the public spaces from the prevailing winds, reducing the wind in the public plaza and in the area to the south of Building 1.

Overall, the wind speeds along all thoroughfares are estimated up to about 8 m/s and suitable for the intended use. The mitigation measures show an improvement in the wind conditions on the thoroughfares on the site, in particular those along the northeast façade of Building 5, the main pedestrian thoroughfare between Building 1 and 5, and along the southwestern boundary of the site.

Figure 21: Lawson wind speeds at key locations along the thoroughfares (existing surroundings with landscaping)

Figure 22: Lawson criteria at key locations along the thoroughfares (existing surroundings with landscaping)

5.3 Entrances

The landscaping has a marginal impact on the wind conditions at the entrances. The wind speeds at the main building entrances are estimated up to approximately 5m/s and are within the suitable range for their intended (‘standing’) use.

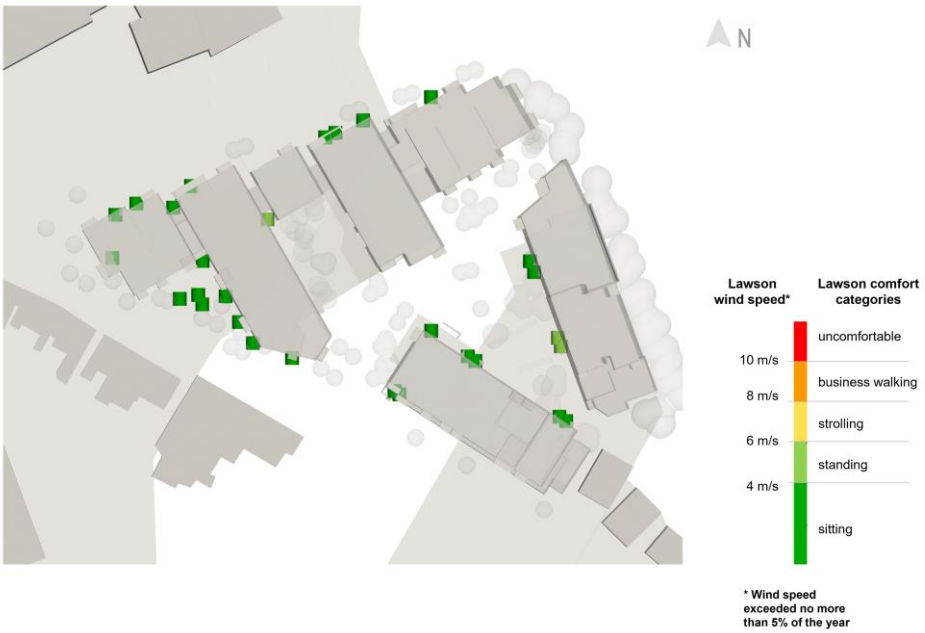


Figure 23: Lawson wind speeds at the primary entrances (existing surroundings with landscaping)

Figure 24: Lawson criteria at the primary entrances (existing surroundings with landscaping)

5.4 Public open spaces

The introduction of the landscaping plan has a positive impact on the wind conditions on the open spaces and help to extend the use of the seating areas throughout the year.

The proposed landscaping in the communal courtyards between Building 1 and 2 helps to reduce the windiness in this space.

The pergola on the southwestern façade of Building 4 also helps to mitigate downdraft along the façade, leading to improved wind comfort conditions on the public plaza in between Building 4 and 5. The results continue to show the wind conditions at the seating spaces are within the comfortable range for ‘sitting’.

The wind mitigation was found to have only a marginal impact near the northwestern corner of Building 6. The wind speeds are estimated up to approximately 6 m/s and in the ‘standing’ range. These conditions are suitable for occasional use of the planter seating features during good weather.

Figure 25: Lawson wind speeds at key locations of the public seating spaces (existing surroundings with landscaping)

Figure 26: Lawson criteria at key locations of the public seating spaces (existing surroundings with landscaping)

6 Proposed Development in Cumulative Surroundings with Mitigation

6.1 Overview

This section assesses the impact of wind microclimate around the proposed development in the context of the cumulative (permitted) surrounding developments. The assessment includes the proposed development and landscaping plan with the permitted Stillorgan Public Library development adjacent to the site on the opposite side of Lower Kilmacud Road (Figure 27).

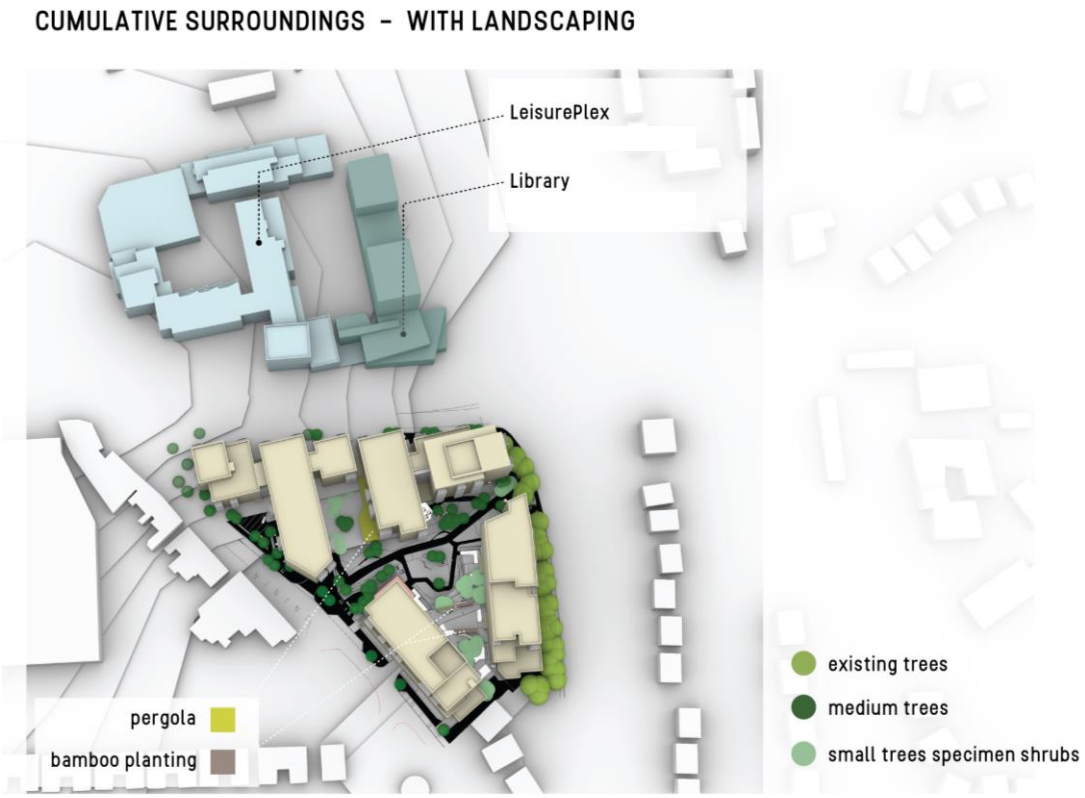


Figure 27: Overview of proposed development in cumulative surroundings with landscaping

6.2 Thoroughfares

The permitted Stillorgan Public Library development has a marginal positive impact on the wind conditions on the thoroughfares along Lower Kilmacud Road, to the north of the proposed development. Overall, the wind conditions along the thoroughfares are suitable for the intended use.

Figure 28: Lawson wind speeds at key locations along the thoroughfares (cumulative surroundings with landscaping)

Figure 29: Lawson criteria at key locations along the thoroughfares (cumulative surroundings with landscaping)

6.3 Entrances

The permitted Stillorgan Public Library development has a negligible impact on the wind conditions at the entrances of the proposed development, which are suitable for the intended use.

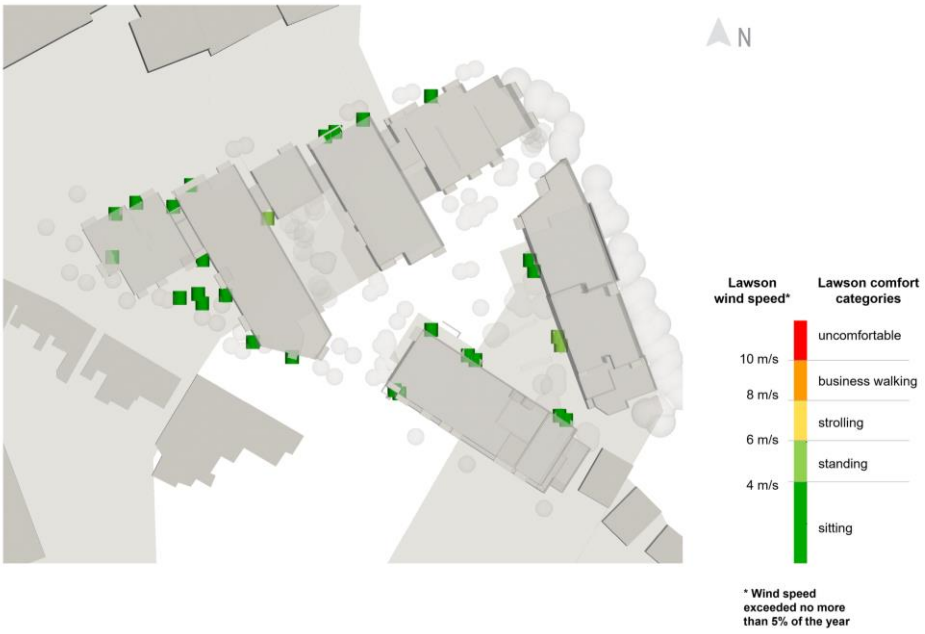


Figure 30: Lawson wind speeds at the entrances (cumulative surroundings with landscaping)

Figure 31: Lawson criteria at the entrances (cumulative surroundings with landscaping)

6.4 Public open spaces

The Stillorgan Public Library building has a marginal impact on the wind conditions at the public seating spaces, which are reasonable for the intended use.

Figure 32: Lawson wind speeds in key locations at the public seating spaces (cumulative surroundings with landscaping)

Figure 33: Lawson criteria in key locations at the public seating spaces (cumulative surroundings with landscaping)

7 Conclusions

The conclusions of the Blakes SHD Stillorgan wind microclimate study are as follows:

- Overall, the proposed development is expected to provide a suitable environment for pedestrians and occupants to carry out a wide variety of 'sitting', 'standing' and 'strolling' activities.
- Wind mitigation measures, have been adopted throughout the design to reduce the windiness across the site and to keep the wind conditions within acceptable limits. Mitigations include alterations to the building design and the landscaping plan.
- Most thoroughfares in and around the development with the proposed mature landscaping are expected to experience wind conditions that are suitable for their intended use.
- The wind conditions at the entrances of the proposed development meet the 'standing' limit for primary entrances.
- Most of the public seating spaces experience wind conditions within the 'sitting' to 'standing' range and are expected to be 'comfortable' for standing and short-term seating, like bench seating use. The wind conditions will improve as the landscaping matures.
- The introduction of the permitted Stillorgan Public Library development is expected to have a negligible impact on the wind conditions around the proposed development.

8 References

[1] Lawson, TV, 2001, 'Building Aerodynamics', Imperial College Press, London.