Chapter 11:

# Wind and Microclimate

# 11. WIND AND MICROCLIMATE

## 11.1. INTRODUCTION

There are two typical cases of acceleration of air as it moves through a built environment. First, when the wind impinges on the face of the building, it slows down and the pressure increases. This high pressure air will tend to move towards low pressure areas which exist at the base of the building and at the top of the building. This sudden acceleration of air produces downwash and upwash which could lead to uncomfortable conditions for the pedestrians near the foot of the building as well as occupants on the high level balconies and terraces.

Further, the effect can be compounded by the second effect which is the acceleration in the space between the buildings. When the air moves from an open environment and enters a built area, the area available for flow reduces. Consequently the air speed increases to compensate. This can also lead to gusts which are primarily experienced by pedestrians walking in between the buildings.

The analysis was carried out by IES (Harshad Joshi, BE (Mech.) MS (Mech. and Aerospace), CFD Project Leader).

## 11.2. STUDY METHODOLOGY

### 11.2.1. PEDESTRIAN COMFORT/SAFETY CRITERION

The assessment has been carried out in reference to the Lawson's Pedestrian Comfort and Safety Criterion. This 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 assesses whether the air movement will be comfortable for the pedestrian for different types of activities.
2. The second criteria assesses the feeling of safety or distress by the pedestrian at higher air speeds.

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 |

**Table 11.1: Lawson's Pedestrian Comfort Criteria**

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 |

**Table 11.2: Lawson's Pedestrian Safety Criteria**

### 11.2.2. SIMULATION PROCEDURE

The methodology for the simulations was as follows:

a. The annual mean wind speed was determined from the Sandyford-2016.fwt weather file.
b. 8 steady state Computational Fluid Dynamics (CFD) simulations were performed corresponding to the 8 directions – SW, W, NW, N, NE, E, SE and S respectively.
c. The local air speed at various designated locations around the site was recorded for each of the simulations.
d. This value was compared to the meteorological wind speed used and the magnification factor at that location for the corresponding wind direction was determined.
e. 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.
f. These recorded values were compared to the Lawson Pedestrian Comfort/Safety Criteria.

### 11.2.3. 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 11.1.

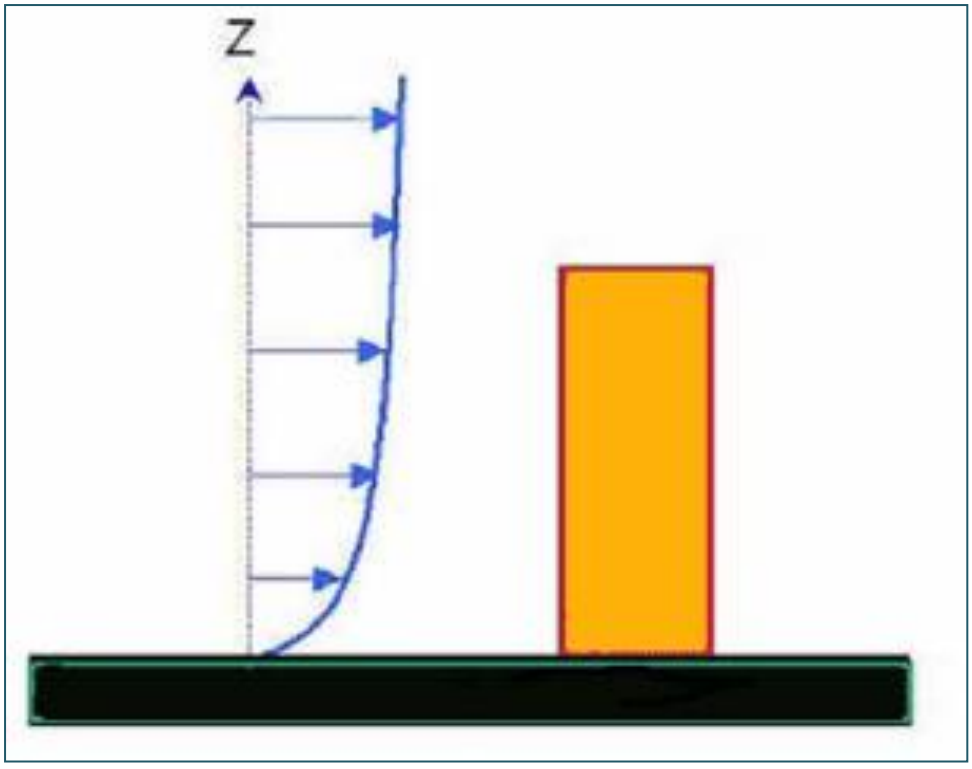



**Figure 11. 1: Typical wind boundary layer profile**

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 UH at height H above the ground is given by:

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

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 |
| **$\delta_{met}$** | = 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 below..

| **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 |

**Table 11.3: Parameters for terrain types**

For this project, we used the atmospheric boundary layer corresponding to the terrain category 1 i.e. large city centres type of site. The met data was taken on category 3 terrain at a height of 10m. Figure 11.2 below shows the shape of the wind boundary profile.

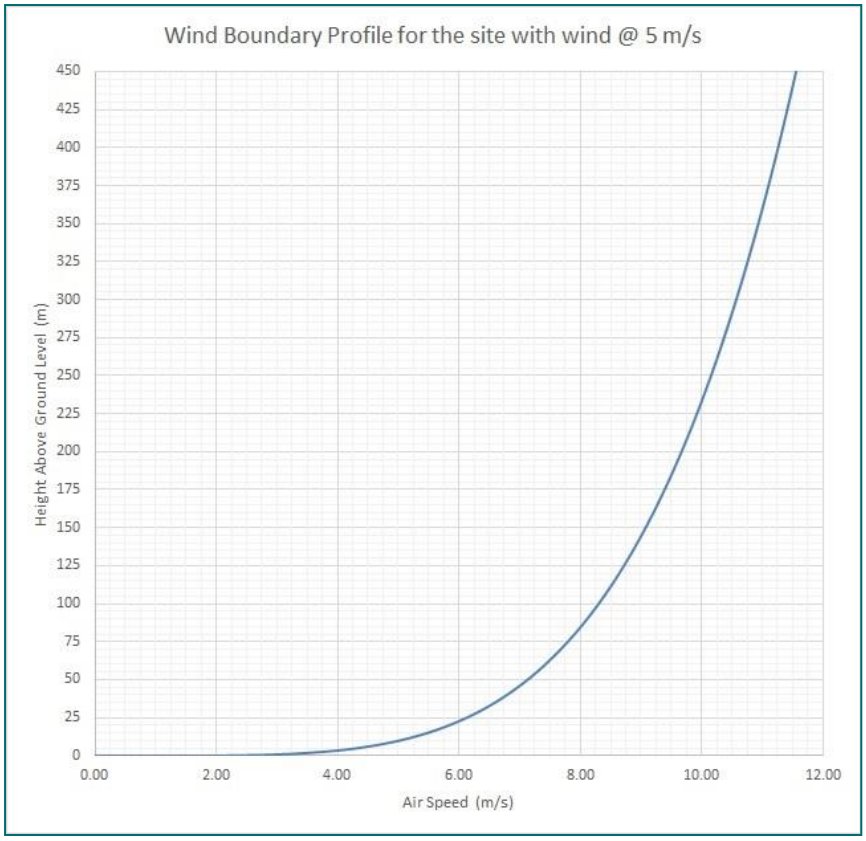



**Figure 11. 2: Wind Boundary Profile for wind @ 5m/s**

### 11.2.4 CFD MODEL

The CFD model was created based on the Revit Models, Landscape drawings and terrain models. Figures 11.3 to 11.8 show the geometry as modelled.


**Figure 11. 3: Plan view of the site**

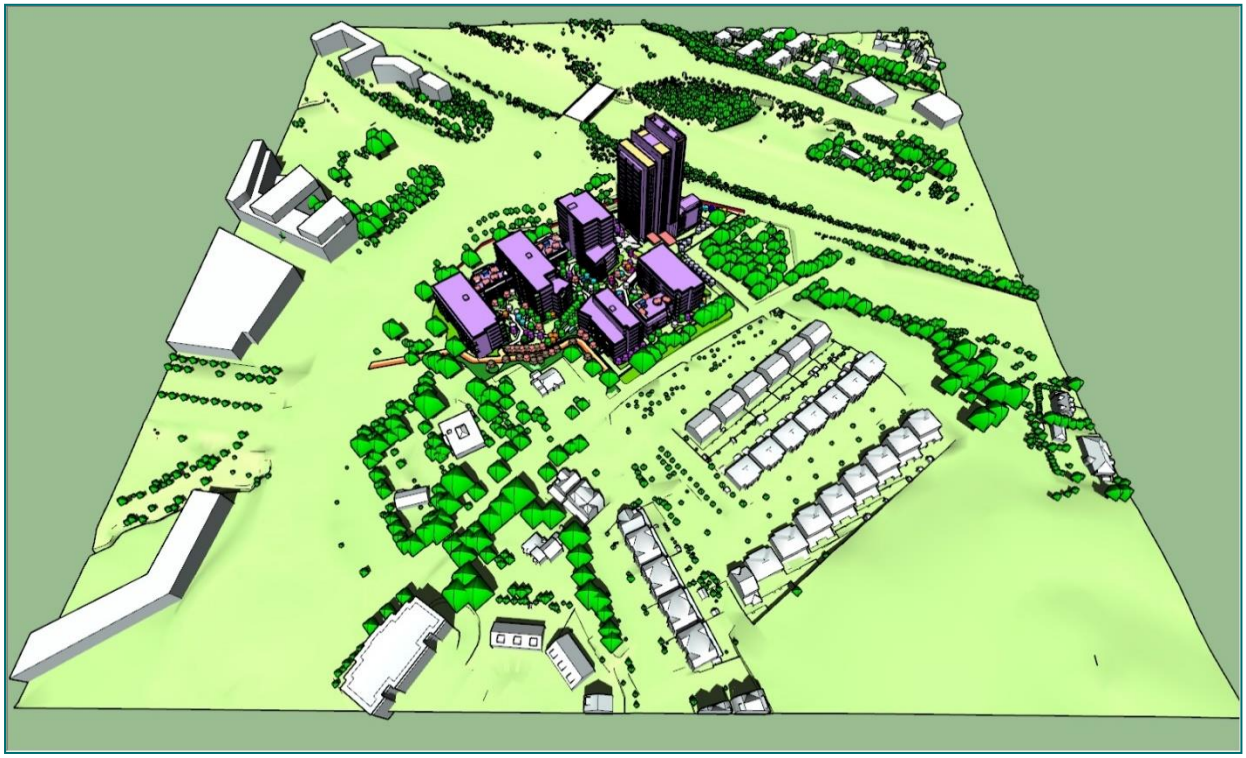


**Figure 11. 4: View of the site from the south**

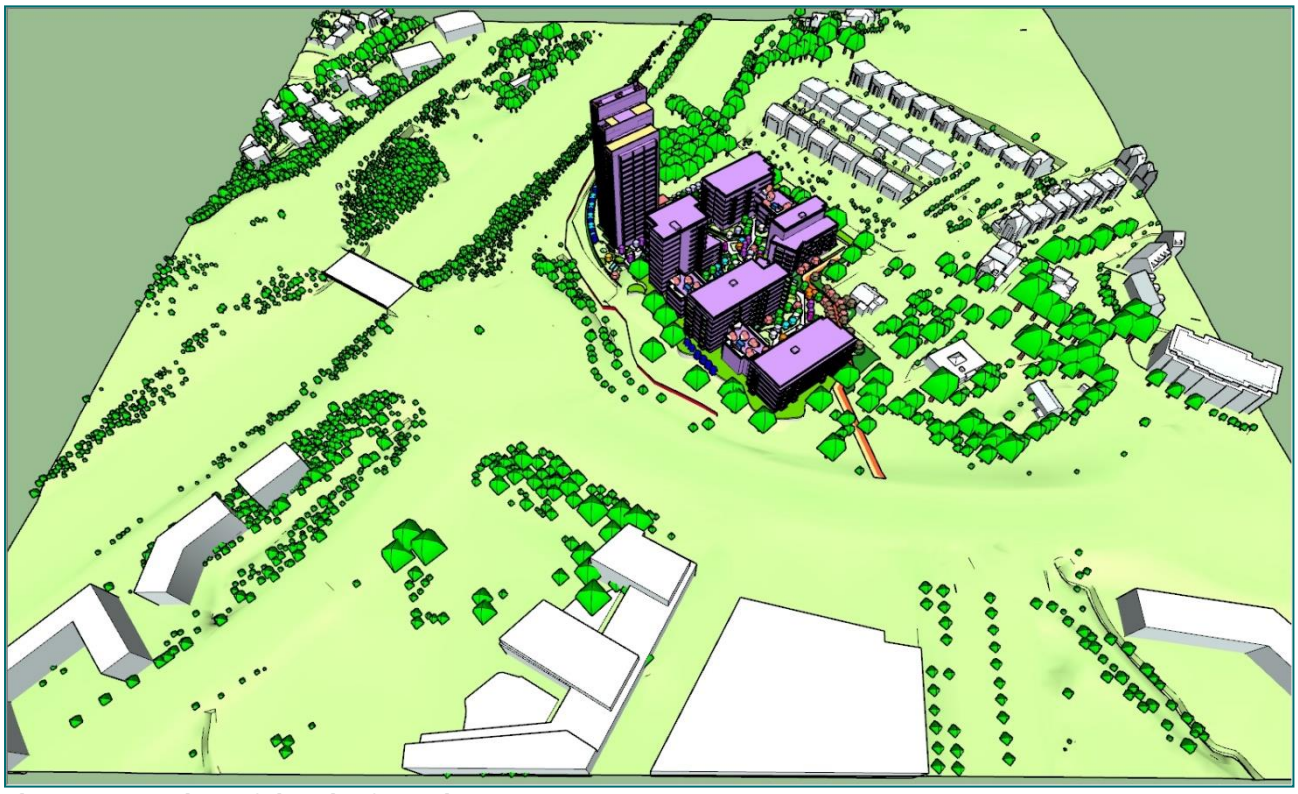


**Figure 11. 5: View of the site from the west**

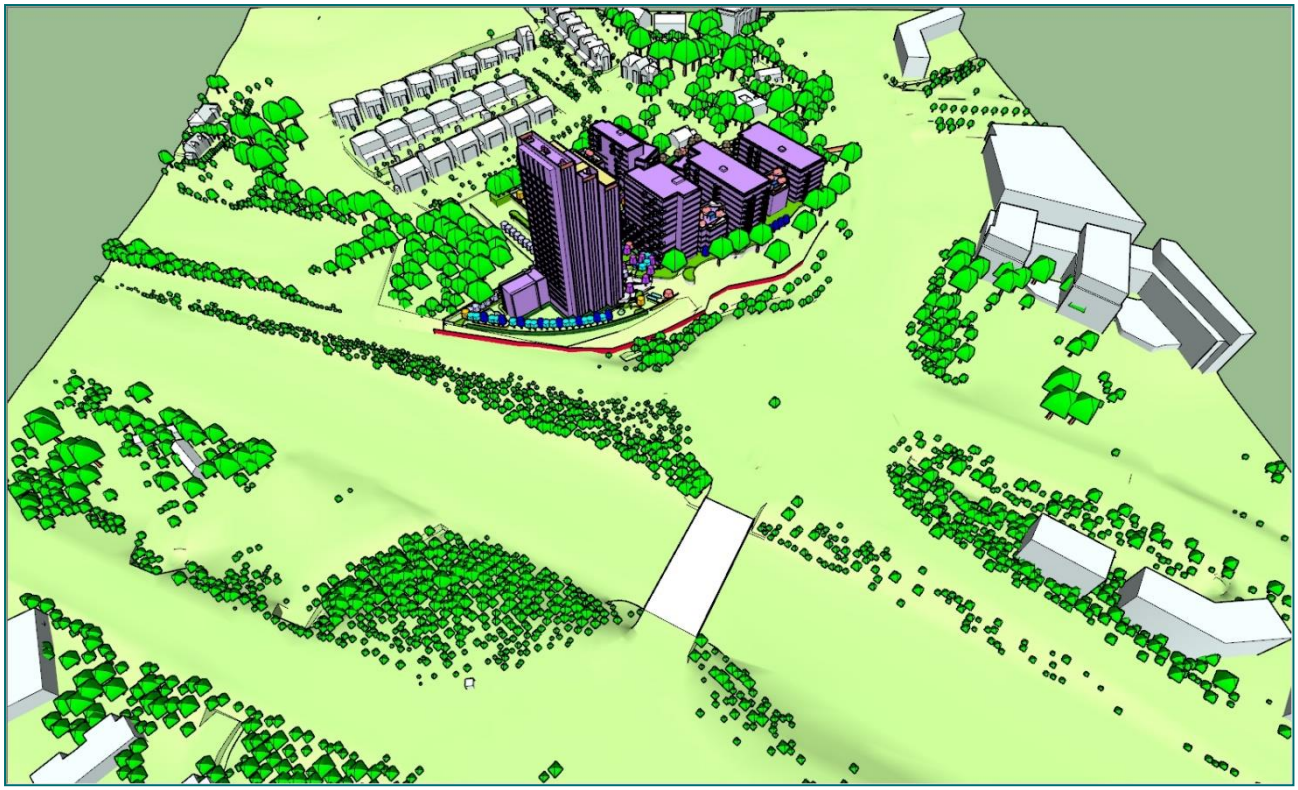


**Figure 11. 6: View of the site from the north**

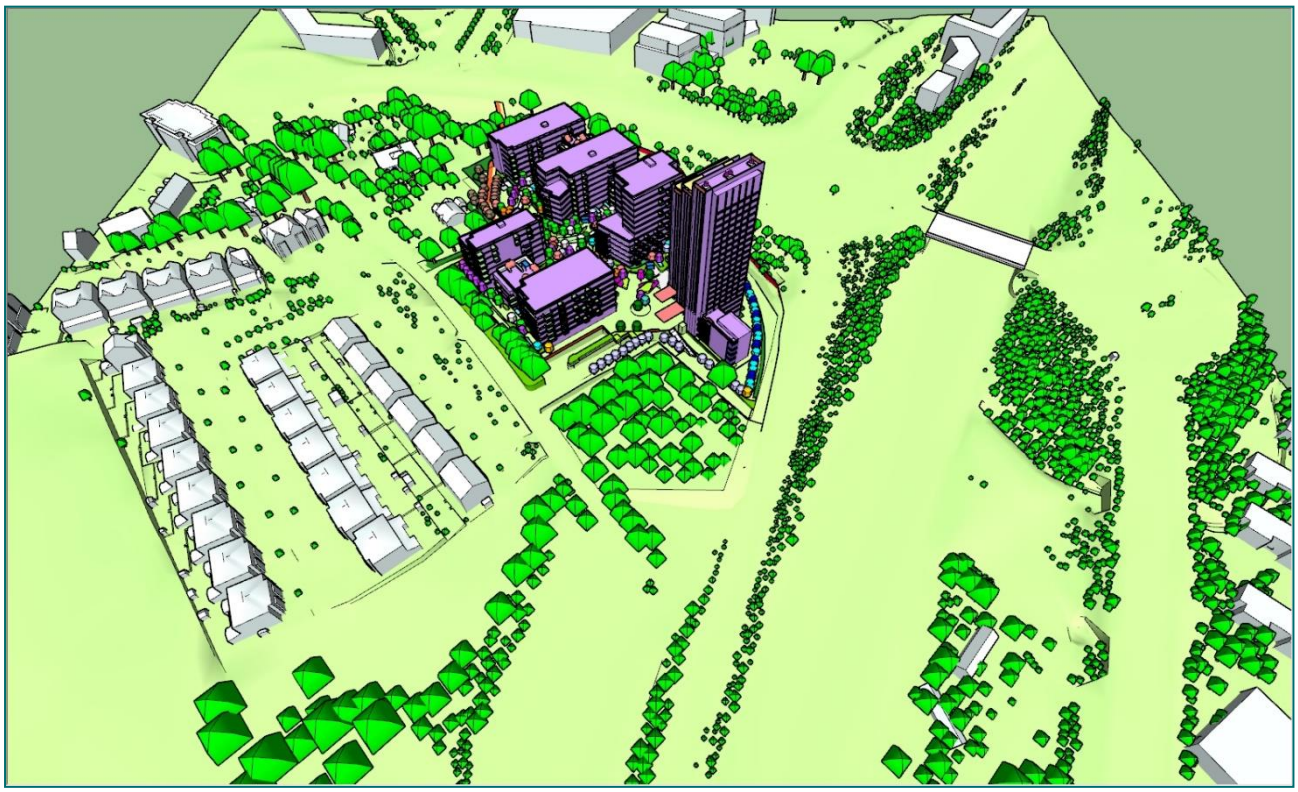


**Figure 11. 7: View of the site from the east**

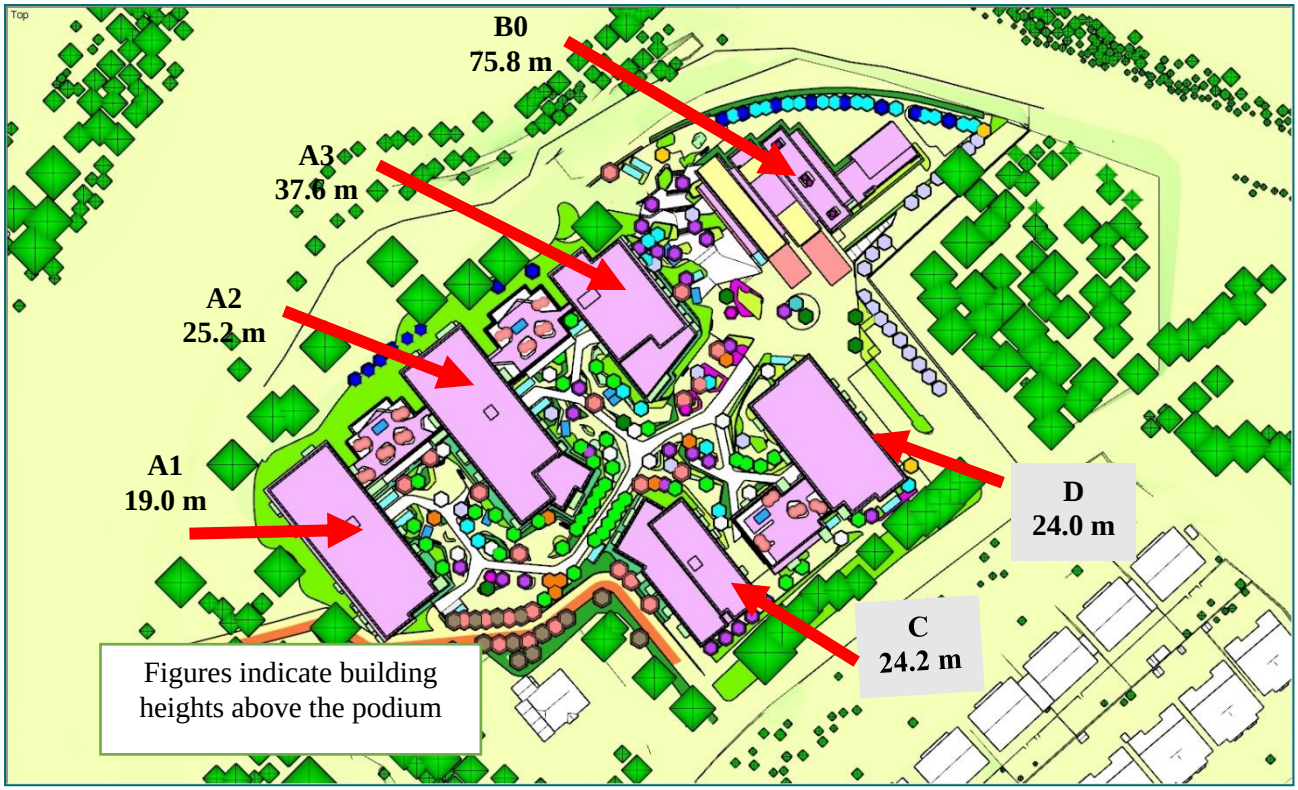



**Figure 11. 8: Closer plan view of Golf Lane plot**

The following table lists the various activities according to the amenity type will be focused mainly in the simulation.

| Amenity Area | Business Walking | Leisurely Walking | Standing | Sitting |
|---|---|---|---|---|
| Seating areas on ground | ✓ | ✓ | ✓ | ✓ |
| Balconies of all plots | | | ✓ | ✓ |
| Tenant amenities | ✓ | ✓ | ✓ | ✓ |
| Streets/Walkways | ✓ | ✓ | | |
| Public Realm | ✓ | ✓ | | |

**Table 11.4: Activities according to Amenity Type**

## 11.3. THE EXISTING RECEIVING ENVIRONMENT

The site of the proposed strategic housing development has an area of c. 2.56 hectares and is bound to the north by the M50 motorway, to the east by Golf Lane, to the west by Glenamuck Road, and to the south by several properties comprising residential dwellings set in large sites.

The site itself slopes from south to north,towards the M50 motorway, and accommodates stands of trees and areas of scrub and grassland. The site was previously occupied by the former residential properties of 'Tintagel', 'Auburn', 'Keelogues', 'Villa Nova', and 'Arda Lodge', which were demolished several years ago.

The lands are less than 500 metres from the Ballyogan Wood Luas Stop (to the west) and opposite The Park Carrickmines, which is a major mixed use area comprising office and commercial uses, retail and

retail warehousing uses and restaurant / café facilities. A new mixed use neighbourhood centre, commercial, residential, and leisure scheme has recently been subject to a grant of permission from An Bord Pleanála opposite the subject site at Quadrant 3 in The Park Carrickmines.

To the east / southeast of the subject site, on the opposite side of Golf Lane, is an area of existing residential development comprising semi-detached, two and three storey dwellings, with an area of existing apartment development located further to the south.

## 11.4. CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

The proposed development comprises a residential development of 482 no. units (all apartments) in 7no. blocks ranging from 4 to 22 storeys, along with ancillary residential amenities, and provision of a childcare facility, gym, and local shop. Two basement levels are proposed, providing car parking spaces (299 no.), bin stores, plant rooms, bicycle parking (1,000 no. spaces), and circulation areas. A further 240 no. bicycle parking spaces are provided at ground level. The proposed development includes landscaping, boundary treatments, public, private and communal open space (including roof terraces), two cycle / pedestrian crossings over the stream at the western side of the site, along with a new pedestrian and cycle crossing of Glenamuck Road South at the west of the site, cycle and pedestrian facilities, play facilities, and lighting. The proposed buildings include the provision of private open space in the form of balconies and winter gardens to all elevations of the proposed buildings. The development also includes vehicular, pedestrian, and cycle accesses, drop off areas, boundary treatments, services, and all associated ancillary and site development works.

## 11.5. POTENTIAL IMPACT OF THE PROPOSED DEVELOPMENT

### 11.5.1. CONSTRUCTION PHASE

The analysis in this chapter of the EIAR is, understandably, focussed on the completed form of the development, in this sense construction impacts themselves were not considered explicitly in the assessment.

The site is currently undeveloped and empty, in circumstances where a number of houses previously located on the site have been demolished. As the construction proceeds, and the height of the blocks rises, the wind conditions at the site will gradually evolve into the patterns as discussed in the following sections. The mitigation measures have already been included in the design, so any additional measures are not required for the construction phase.

### 11.5.2. OPERATIONAL PHASE

#### Sitting and Standing Comfort

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 that the local air speed at designated locations should not exceed 6m/s for more than 5% of the duration analysed.

#### Ground Amenity spaces

In the operational phase of the proposed development, the ground amenity spaces show good compliance for the sitting criteria. Figure 11. 9 and Figure 11. 10 show the results of sitting and standing comfort on the ground amenity spaces.


**Figure 11. 9: Sitting Criterion: View of the entire site**


**Figure 11. 10: Standing Criterion: View of the entire site**

It should be noted that some of the locations in orange and red band are above the threshold of the sitting comfort criterion of 4m/s for more than 5% of the year. However, when we observe the results of standing comfort criteria in Figure 11. 10, we see those locations are effectively compliant. We can infer that even when the air speed exceeds 4m/s, it is unlikely to exceed 6m/s. Thus the exceedance of sitting criteria can be termed marginal and not major.

### Resident's Amenities

The various terrace amenity spaces are marked in Figure 11. 11and Figure 11. 12 below.

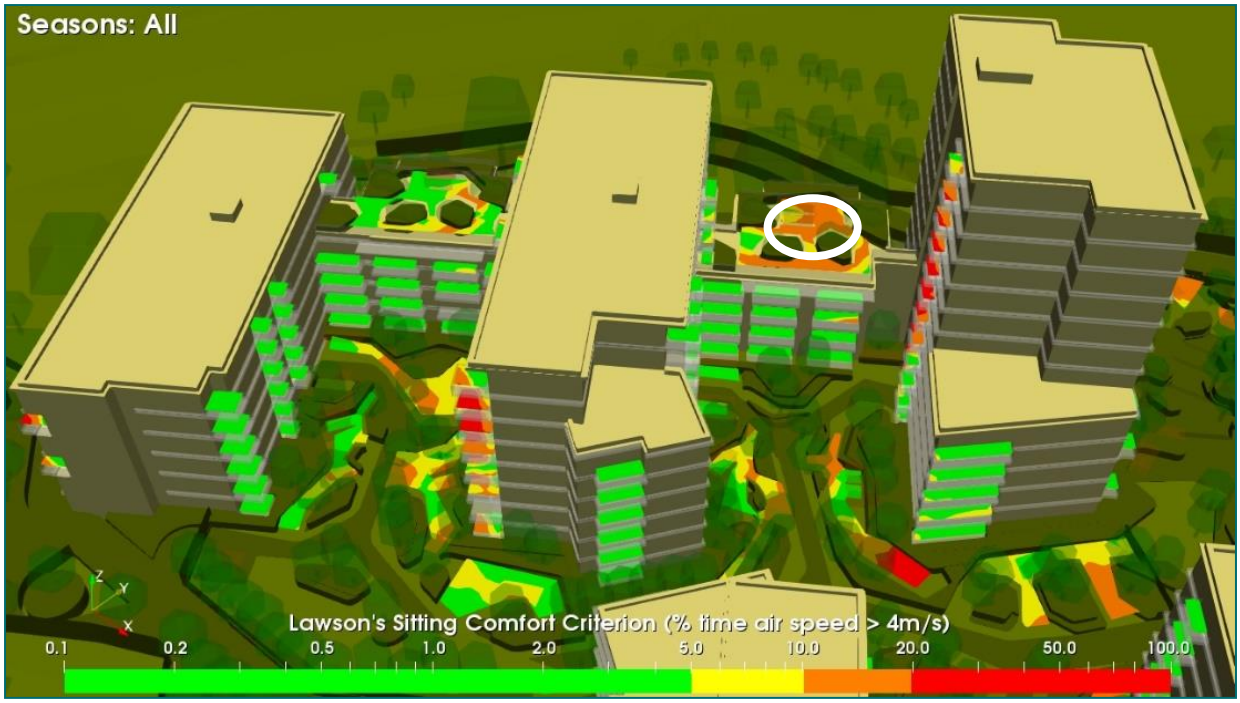



**Figure 11. 11: Sitting Criterion: View of the building blocks**


**Figure 11. 12: Standing Criterion: View of the building blocks**

The terrace amenity spaces between blocks A1 and A2 show good compliance to the sitting and standing comfort criteria, marked in yellow.

The terrace space between blocks A2 and A3 show limited compliance for sitting criteria but show good compliance to the standing criteria. The sitting criteria results are affected by downdraft from high rise block A3. As block A2 is much shorter, the space between A1 and A2 was not affected by a similar downdraft. Comparing Figure 11. 11 and Figure 11. 12, we note even if the air speed exceeded 4m/s, the air speed was also definitely under 6m/s.

Furthermore, the sitting location of this terraces shows compliance with sitting criterion as seen in Figure 11. 11 above. The rest of the space is expected to be used for standing breakout space by the occupants of blocks A2 and A3, where it does show good compliance.

Resident's amenity space on the roof of block between C and D is marked in Figure 11. 12 and Figure 11. 13 below.


**Figure 11. 13: Sitting Criterion: View of the building blocks**

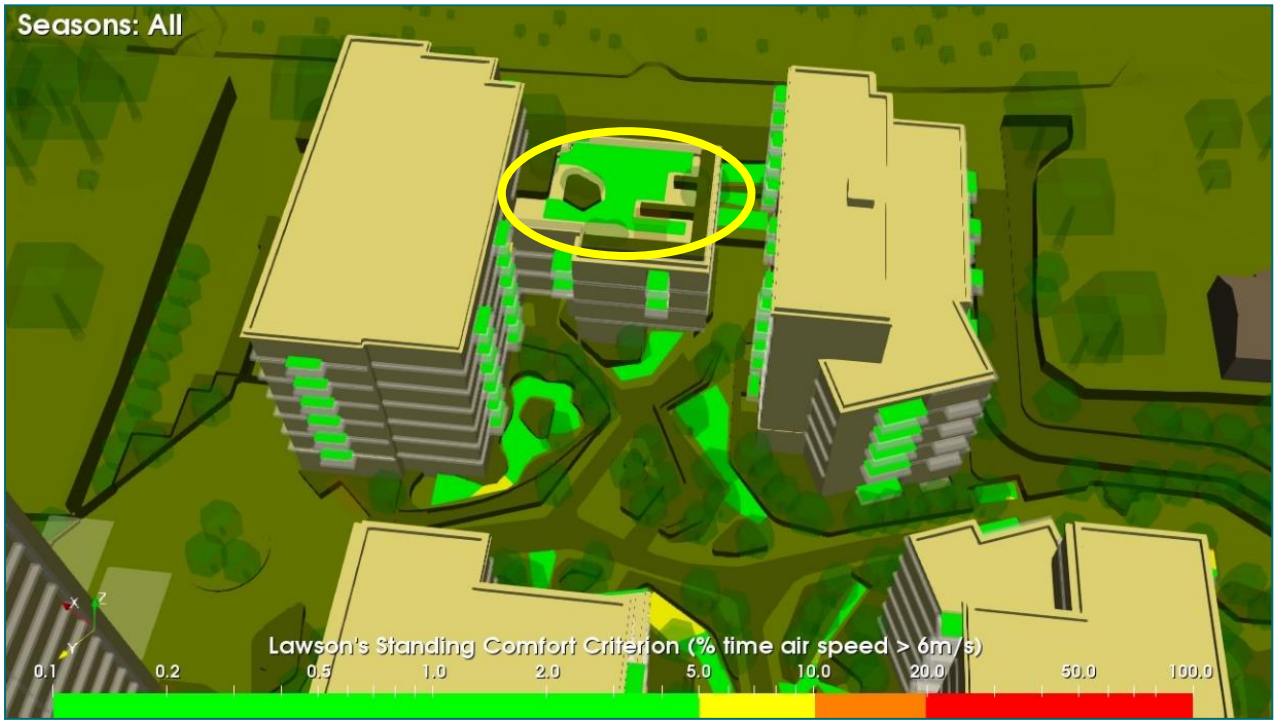



**Figure 11. 14: Standing Criterion: View of the building block**

The terrace amenity spaces between blocks C and D show excellent compliance to the sitting and standing comfort criteria, marked in yellow.

Terrace amenity space on the roof of block B is shown in Figure 11. 14and Figure 11. 15 below.


**Figure 11. 15: Sitting Criterion: View of the building blocks**

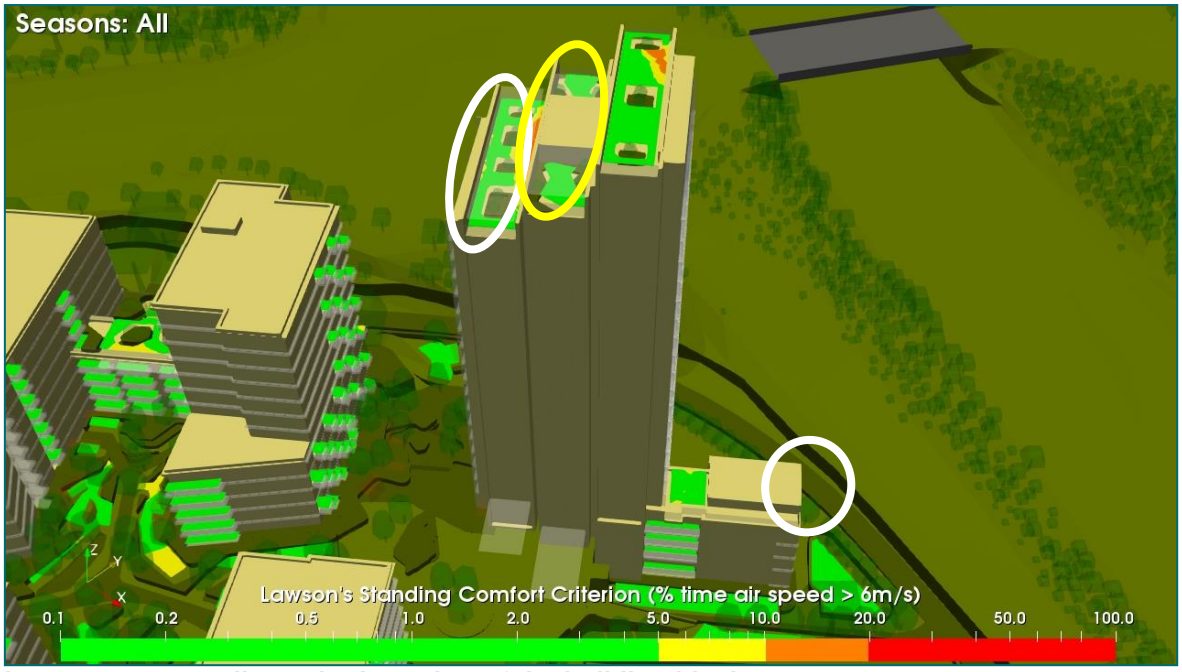



**Figure 11. 16: Standing Criterion: View of the building blocks**

The top-level spaces and the lower level space on residential Tower B marked in white ovals slightly exceeds the threshold of 4m/s for sitting comfort but is effectively compliant to the standing comfort criteria. Top level spaces are exposed to the high wind flow. The wind might get accelerated through the gap between canopy and the wind screen present on the edge.

This is excellent result considering these terraces are over 70m above the road level to the west.

The Top-middle level terraced space on the Tower B marked in yellow shows excellent compliance to the sitting and standing comfort criteria.

**Balconies**

Figure 11. 16 and Figure 11. 17show the south-west facing balconies of blocks A1 to A3.

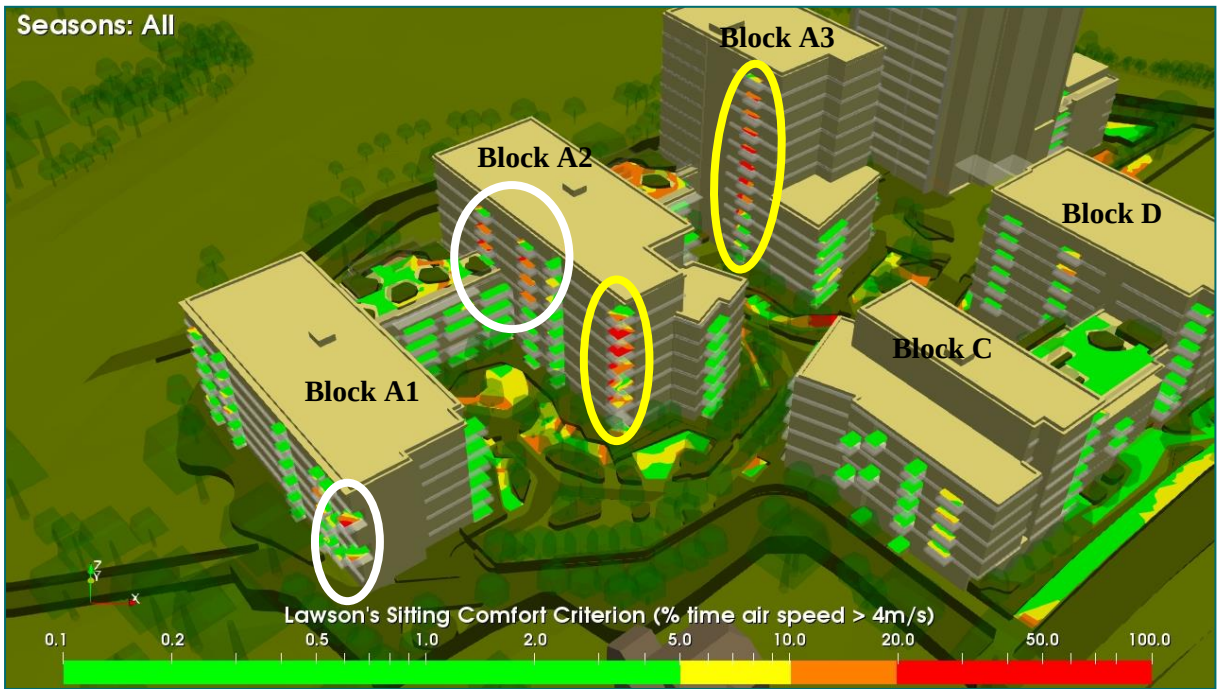



**Figure 11. 17: Sitting Criterion: View of the balconies**

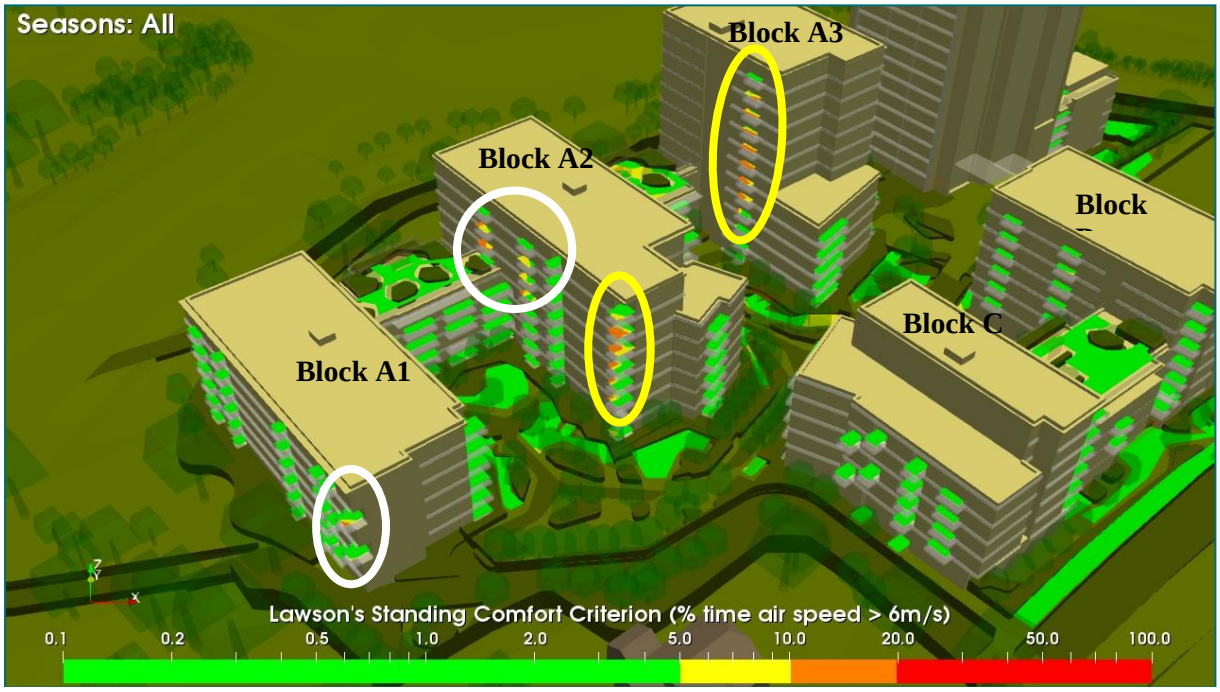



**Figure 11. 18: Standing Criterion: View of the balconies**

These are marginally above the threshold of 4m/s for sitting criteria but are under 6m/s which is a threshold for standing comfort. These balconies are effectively compliant to the standing comfort criteria. These are directly affected by the south-westerly and southerly wind. Mitigation measures are set out in this EIAR chapter to address these effects.

Figure 11. 16 and Figure 11. 17 show the north facing balconies of blocks A1 and A2.

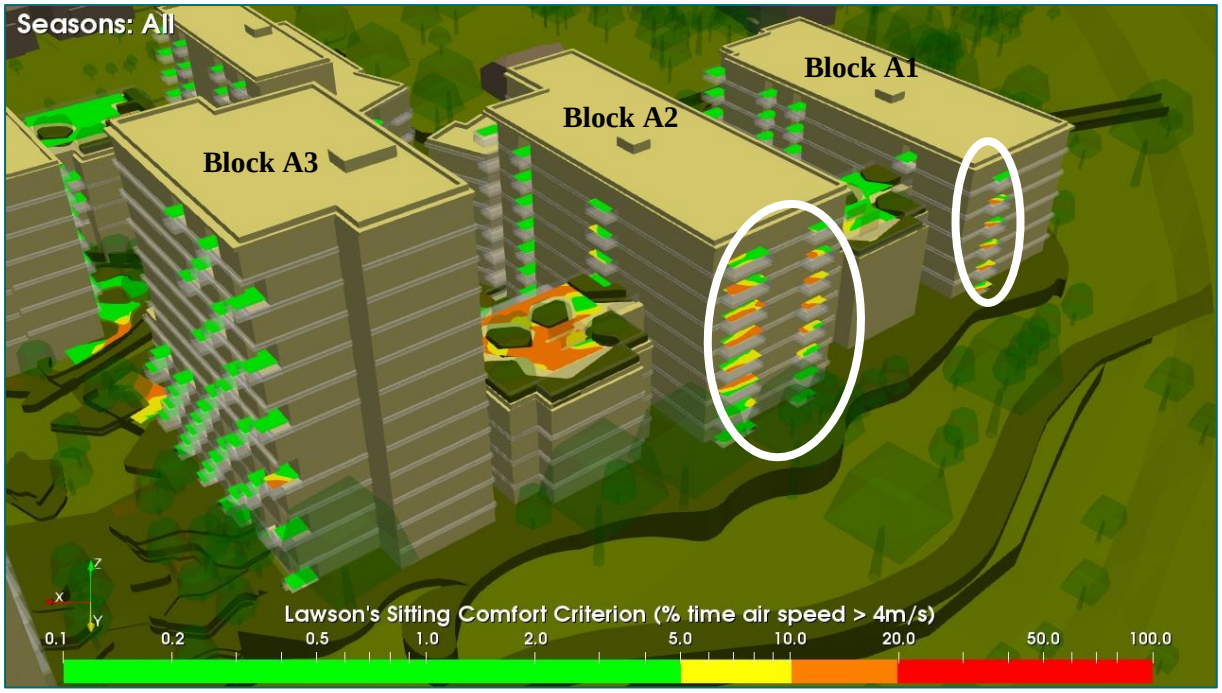



**Figure 11. 19: Sitting Criterion: View of the balconies**

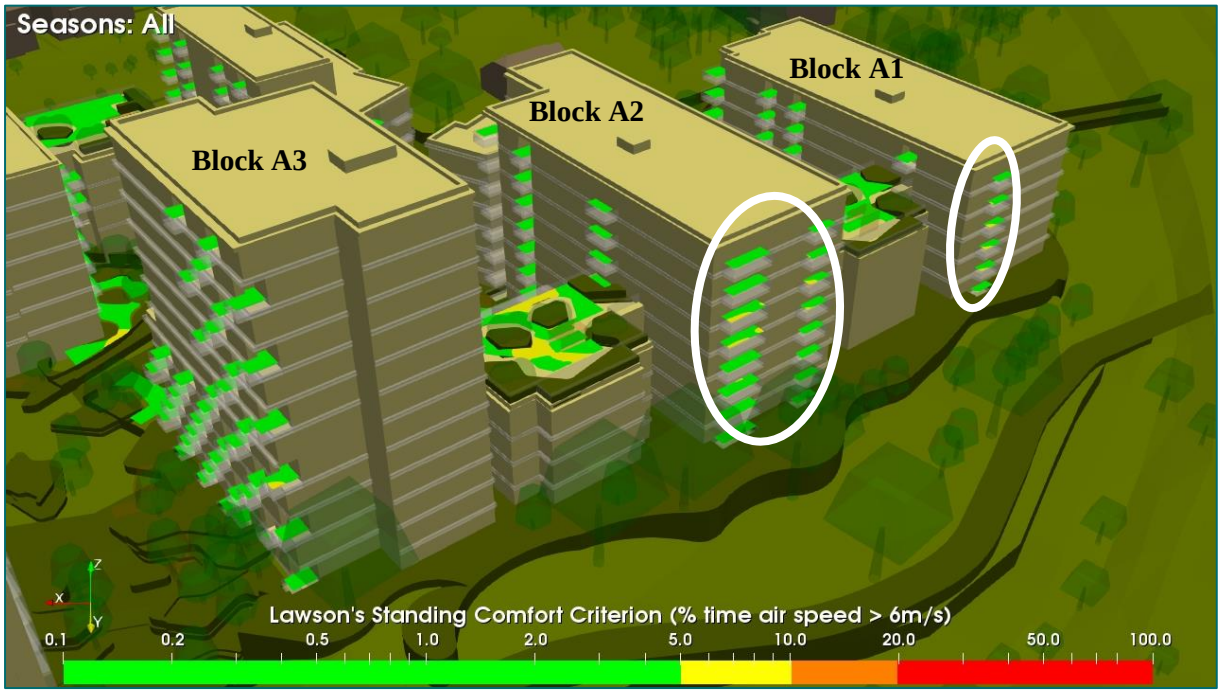



**Figure 11. 20: Standing Criterion: View of the balconies**

These are marginally above the threshold of 4m/s for sitting criteria but are under 6m/s which is a threshold for standing comfort. These balconies are effectively compliant to the standing comfort criteria. These balconies are affected by the prevailing westerly wind.

### Walking Comfort

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

Figure 11. 21 and Figure 11. 22 below shows the results of walking comfort criteria.


**Figure 11. 21: Leisure Walking Criterion: View of the model site**


**Figure 11. 22: Business Walking Criterion: View of the model site**

The site shows good compliance with the Lawson's Leisure and Business Walking Comfort Criteria.

**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 that the local air speed at designated locations should not exceed 15m/s for more than 0.01% of the duration analysed.

There is some concern for safety at the shared plaza at foot of tower B. as seen in Figure 11. 23 below.


**Figure 11. 23: Safety Criteria: All Season: View from above**

This has been observed due to likely acceleration of wind between the various landscape elements like plantings, trees and hedges for the south-westerly winds. This is only a potential impact of the design that was investigated. This impact has been dealt with in the mitigation section of this chapter. Essentially, this is a very a local effect on this spot. The mitigation measures implemented and noted further in the report will nullify this issue.

## 11.6. POTENTIAL CUMULATIVE IMPACTS

There are no long term cumulative impacts of the development from wind microclimate point of view. The other surrounding developments eg. the permitted retail development to the west of the site are sufficiently (>100m) away from this development to have any further impact.

## 11.7. DO NOTHING IMPACT

In absence of the development, the present wind pattern is likely to continue unobstructed.

## 11.8. MITIGATION MEASURES

Design related mitigation measures have been incorporated into the scheme design and are reflected in the application drawings / proposals submitted for approval. No additional construction or operational related mitigation measures are recommended.

For the affected apartments on Blocks A2 and A3, marked in yellow, additional secondary enclosed balconies / winter gardens have been added. These will provide additional breakout space for these apartments.

Figures 11.24 to 11.27 below show the updated layout of these apartments.

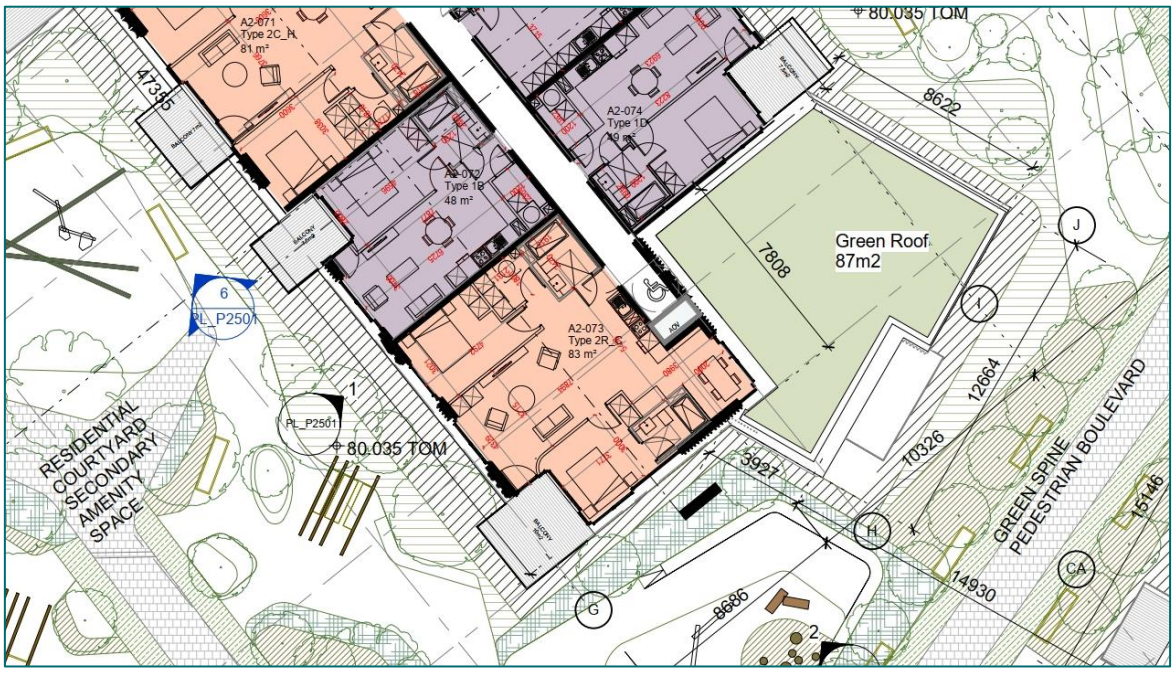



**Figure 11. 24: Block A2: Original Plan**

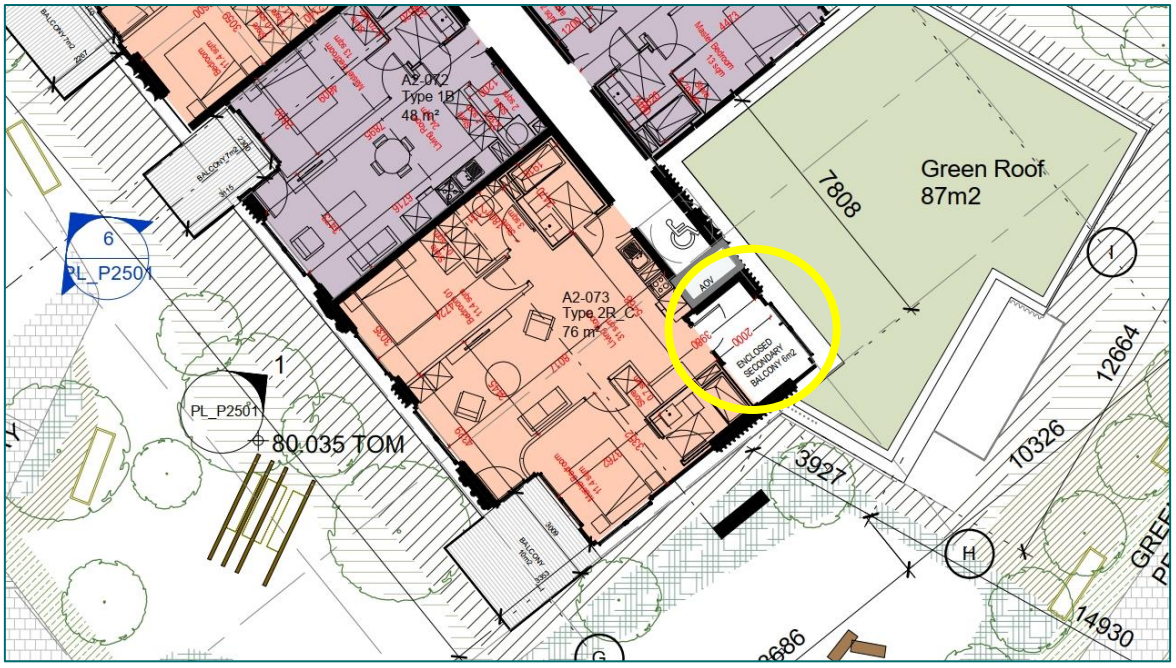



**Figure 11. 25: Block A2: Updated plan with secondary balcony**

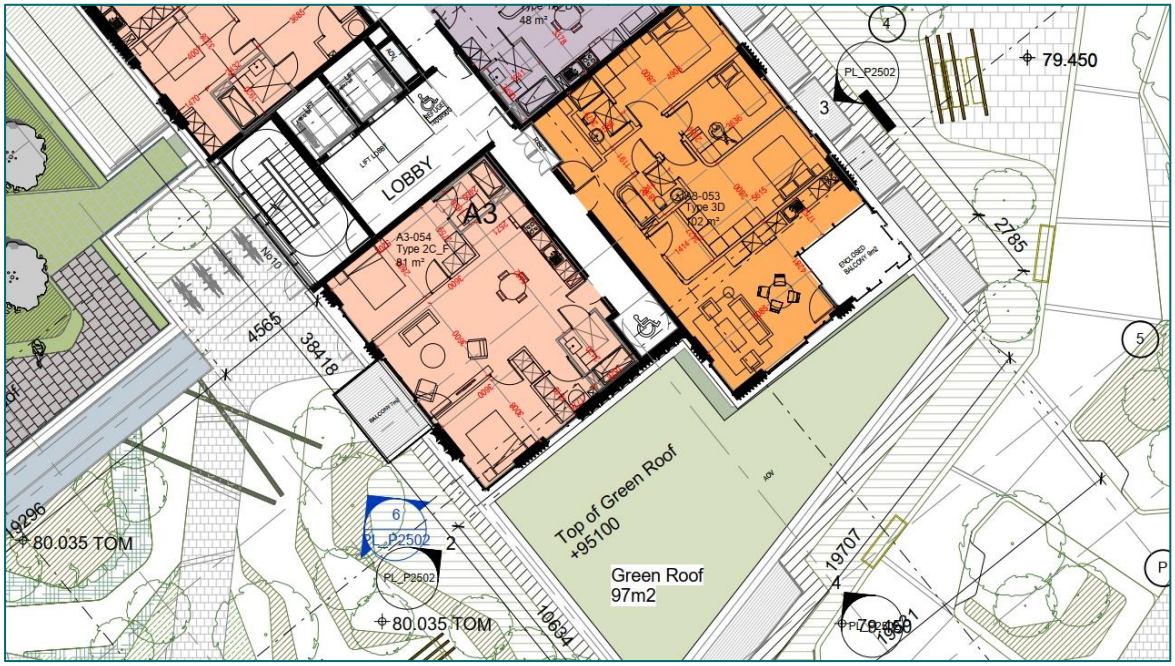



**Figure 11. 26: Block A3: Original Plan**

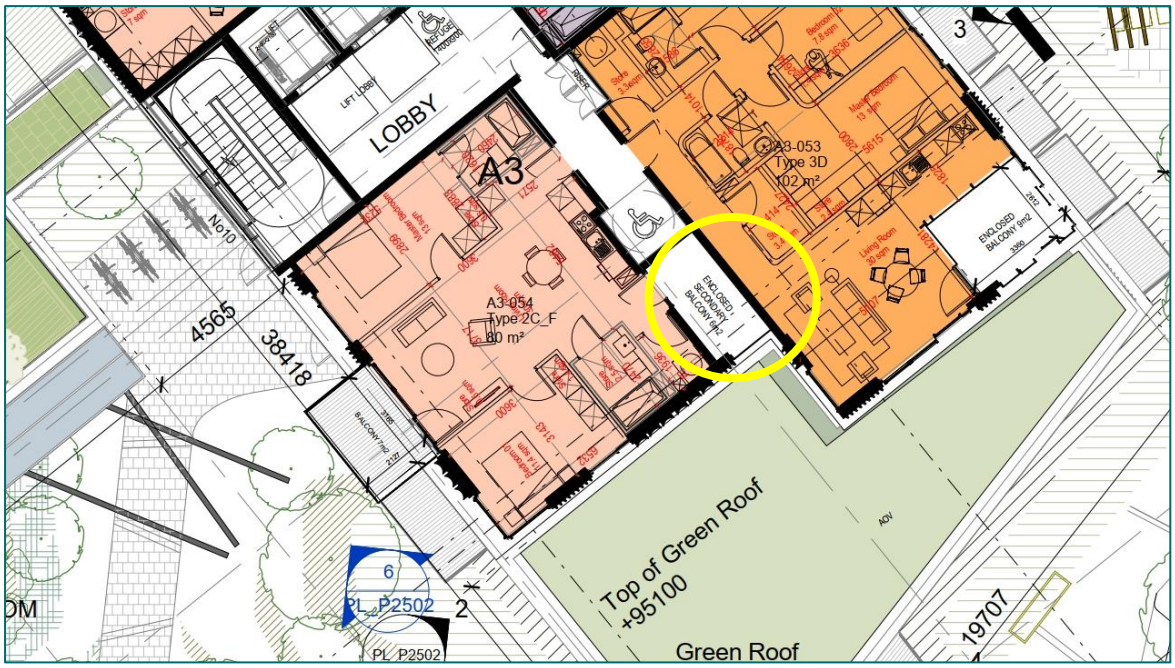



**Figure 11. 27: Block A3: Updated plan with secondary balcony**

### Safety Criterion

In the previous design iteration, the location had fewer landscape elements which did not produce the same acceleration levels. This is seen Figure 11. 28 below.


**Figure 11. 28: Safety results from previous design iteration**

Therefore, the landscape layout is being reverted to the previous iteration to restore the ability for the wind to slow down and counter the safety criterion observations. Figures below show the comparison between layout as simulated and final proposed layout to mitigate the effect of wind.

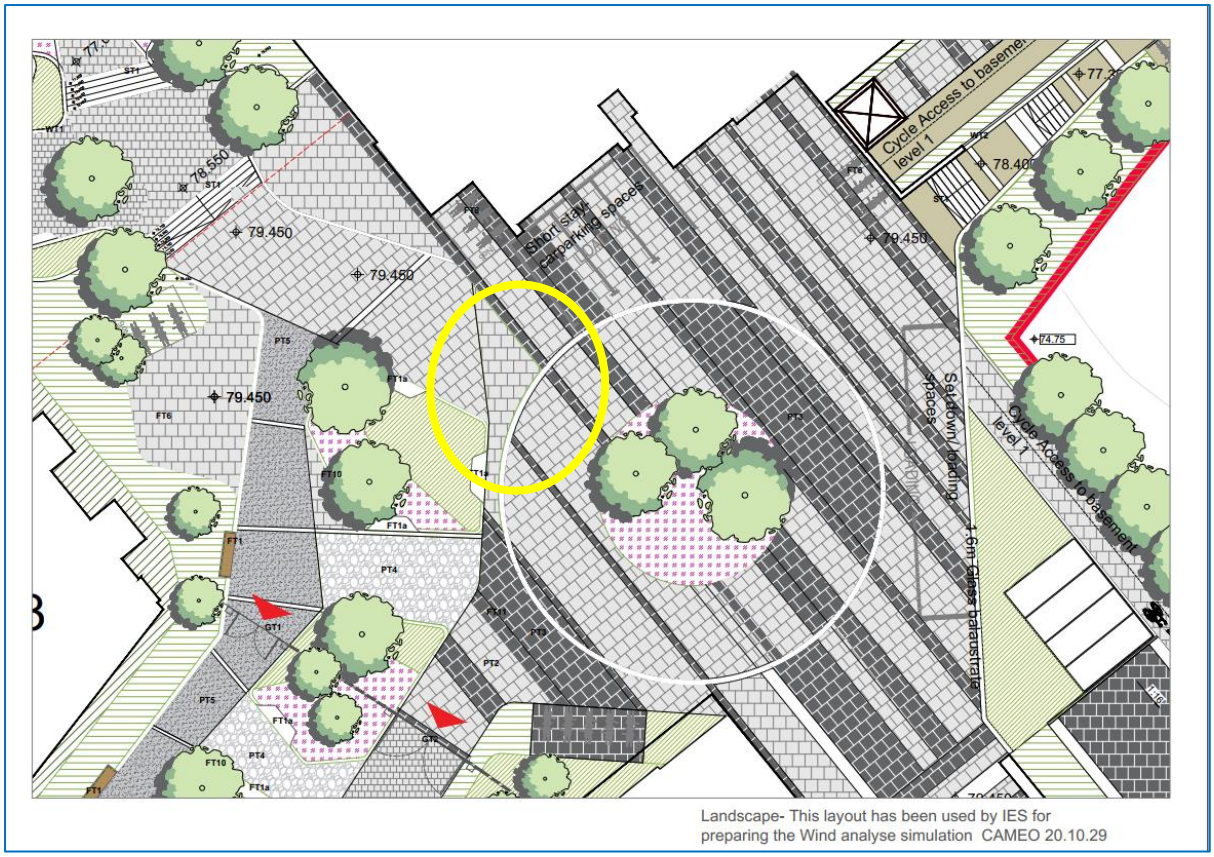
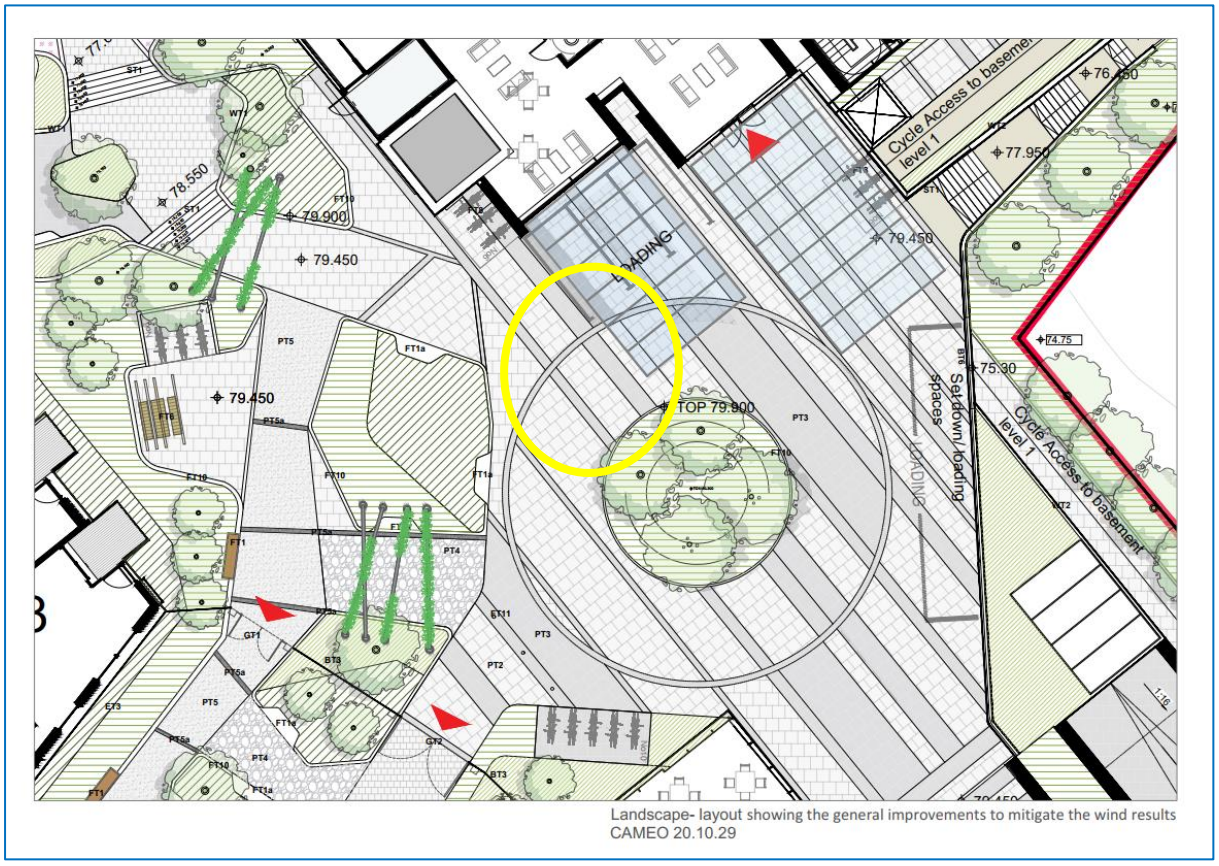



**Figure 11. 29: Landscape layout for current wind simulation**




**11.30: Landscape layout updated to mitigate wind results**

## 11.9. PREDICTED IMPACTS OF THE PROPOSED DEVELOPMENT

As the mitigation measures have been incorporated into the design of the development, the proposed development will not have any residual wind impacts.

## 11.10. MONITORING

No monitoring measures are proposed for the operational phase of the proposed development with respect to Wind impacts.

## 11.11. INTERACTIONS

This chapter is likely to have interactions with the Landscape and Visual chapter, as part of the mitigation approach for wind impact entailed the incorporation and adjustment of proposed landscape features and layout. The mitigation measures introduced have been prepared and coordinated in consultation with the landscaping consultants of this project (Cameo Landscape Architects).

## 11.12. DIFFICULTIES ENCOUNTERED IN COMPILING

No difficulties were encountered in creation of this report.

## 11.13. REFERENCES

T. V. Lawson (2001) Building Aerodynamics, Imperial College Press, London.
ASHRAE Fundamentals Handbook (2013)