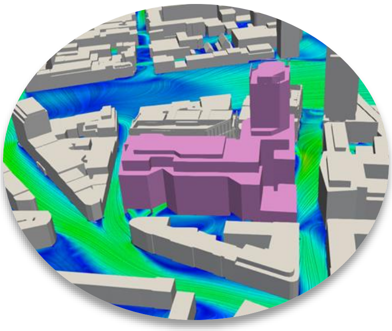
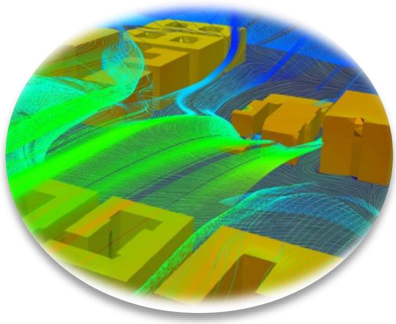
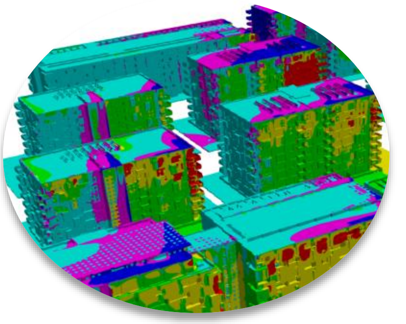

Impact of Wind on Microclimate Effects and Pedestrian Comfort

OMNI PLAZA SHD
Omni Park
Santry,
Dublin 9

Prepared by
B-FLUID Ltd.

Issued: 25 August 2022

B-Fluid
Buildings Fluid Dynamics

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B-Fluid
Buildings Fluid Dynamics

B-Fluid Ltd. | Buildings Fluid Dynamic Consultants

Ireland: 28 Baggot Street Lower, Dublin 2, D02 NX43
t: +353 (0)1 506 5671 m: +353 (0)85 713 6352

UK: Harwell Innovation Centre, 173 Curie Avenue, Didcot, OX11 0QG
t: +44 (0) 870 489 0207

Email: info@b-fluid.com
Website: www.b-fluid.com

1 INTRODUCTION

B-Fluid Limited has been commissioned by ’Serendale Limited’ to perform a Wind Microclimate Study for the Omni Plaza Strategic House Development at Omni Park, Santry, Dublin 9. This report is in response to ABP Pre Application consultation opinion no. 8 and no. 10 points that specifically required the following:

- ABP Request (no.8): Wind and Pedestrian Comfort Study
- ABP request (no.10): Impact assessment of Micro-climate effects

The site is located to the north-west corner of the Omni Park shopping centre and at Santry Hall Industrial Estate. The proposed development comprises a mixed-use residential and commercial development ranging in height from 4 to 12 storeys over basement. Providing 457 apartments in four blocks. Furthermore, a creche, a space for community facilities and two retail/café’/restaurant units activate a public plaza.

The following image shows the proposed development plan within the magenta line.

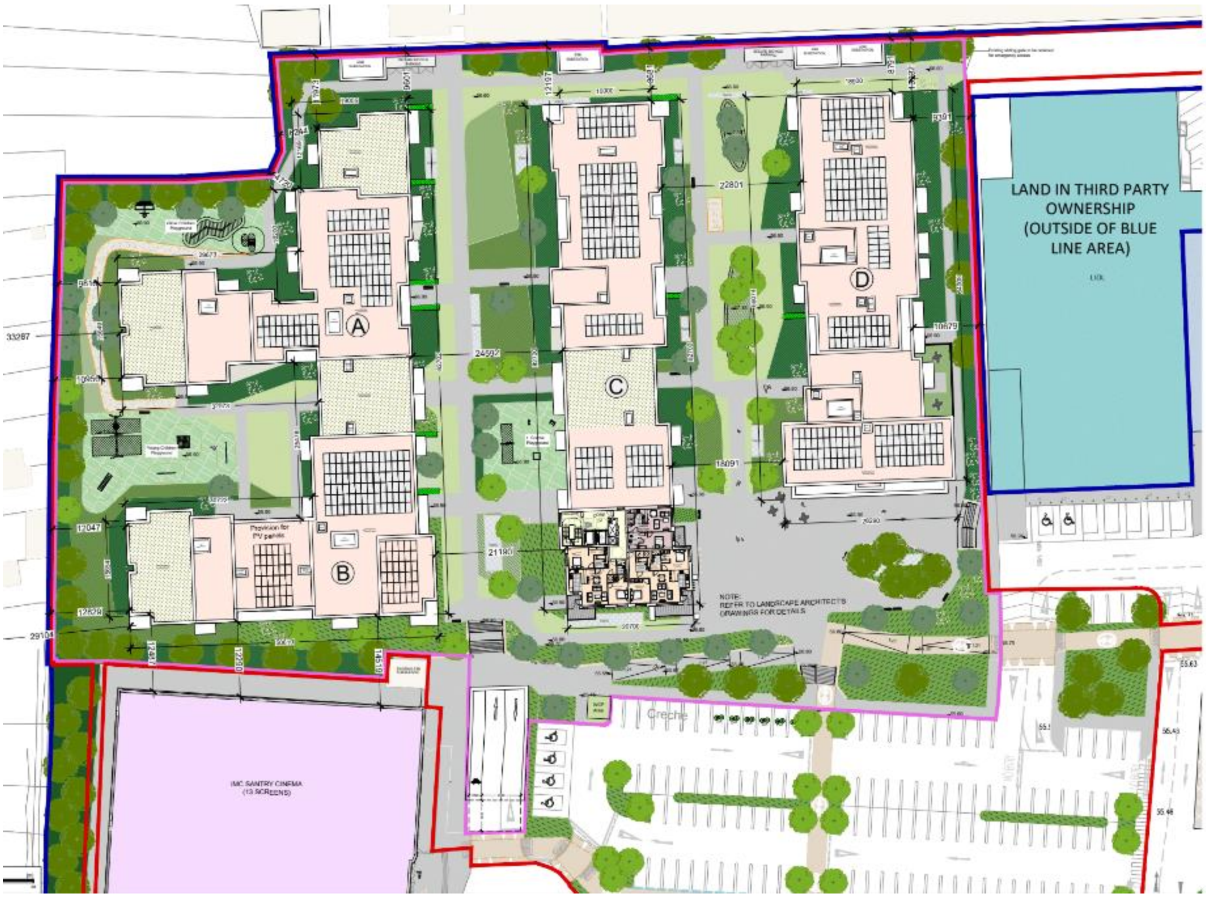

Figure 1 Proposed Development within the magenta line boundary

An impact assessment of microclimate effects on wind and pedestrian comfort study considers the possible wind patterns formed under both mean and peak wind conditions typically occurring on the site area, accounting for a scenario where the proposed development is inserted in the existing environment (potential impact) and, for a scenario where the proposed development is analysed together with the existing environment and any permitted development (not constructed yet) that can be influenced by the wind patterns generated by the proposed one (cumulative impact).The potential receptors include those areas, in the surrounding of the development, which can be exposed to potential risks generated by the elevated wind speed or building massing wind effects. Specifically:

- Amenity areas (pedestrian level), areas likely to be utilised for leisure purposes and as such should be comfortable surroundings.

- Pedestrian routes and seating areas – to determine if locations are comfortable for leisure activities.

- Entrance to the buildings – to determine if there is potential for pressure related issues for entrances or lobbies.

- Landscaped areas – where there are sheltered areas.

- Impact to existing or adjoining developments – where the proposed buildings will cause discomfort conditions through proximity related issues.

The acceptance criteria which define the acceptable wind velocities in relation to the perception of comfort level experienced while carrying out a specific pedestrian activity is known as the “Lawson Criteria for Pedestrian Comfort and Distress”. A wind microclimate study analyses the wind flow in an urban context (considering the wind conditions typically occurring on the site during a typical year) to develop the so called “Lawson Comfort and Distress Map”; the map identifies where a specific pedestrian activity can be carried out comfortably during most of the time.

The assessment can be performed by physical testing in wind tunnels or by performing “virtual wind tunnel testing” through numerical simulation using Computational Fluid Dynamics (CFD), as done for this project. The scope of the numerical study is to simulate the wind around the development to predict which wind speeds pedestrians will be exposed and what level of comfort pedestrians will experience when carrying out a specific activity (i.e. walking, strolling, sitting).

The following sections details the methodology, acceptance criteria, CFD wind simulations and the impact of the proposed development on the local wind microclimate against best practice guidelines for pedestrian comfort and safety.

1.2 Urban Wind Effects

Buildings and topography affect the speed and direction of wind flows. Wind speed increases with increasing height above the ground, assuming a parabolic profile.

Flow near the ground level encounters obstacles represented by terrain roughness/buildings that reduce the wind speed and introduce random vertical and horizontal velocity components. This turbulence causes vertical mixing between the air moving horizontally at one level, and the air at those levels immediately above and below it. For this reason, the wind velocity profile is given by a fluctuating velocity along a mean velocity value. The following graph shows the wind velocity profile, as described above.

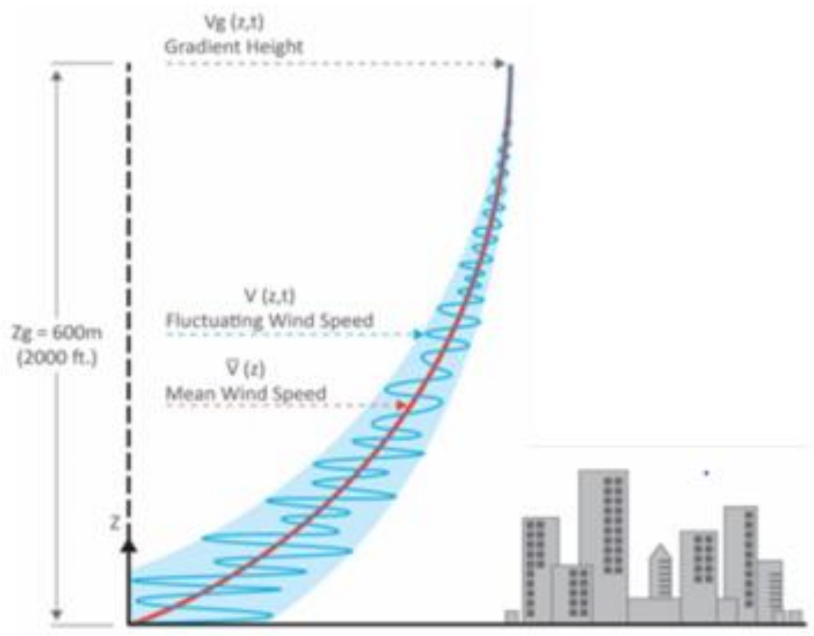

Figure 2 Wind parabolic velocity profile

In an urban context, wind speeds at pedestrian level are generally low compared with upper-level wind speeds, however, the wind can create adverse patterns when flowing in between buildings which can cause local wind accelerations or re-circulations. The wind patterns effect pedestrian safety and comfort. In general, the wind effects to be avoided/mitigated in an urban context include the following:

- **Funnelling Effects**: The wind can accelerate significantly when flowing through a narrow passage between building structures. The highest speeds are experienced at the point where the restriction of the area is the greatest.

- **Downwash Effects**: The air stream when striking a tall building can flow around it, over it and some of it can be deflected towards the ground. This downward component is called downwash effect and its intensity depends on the pressure difference driving the wind. The higher the building, the higher this pressure difference can be.

- **Corner Effects**: Wind can accelerate around the corners of the buildings. Pedestrians can experience higher wind speeds as well as more sudden changes in wind speeds. The reason for this is that there are narrow transition zones between the accelerated flows and the adjacent quiescent regions. This effect is linked to the downwash effect as the downward stream component subsequently flows around the corners towards the leeward side of the building.

- **Wake Effect**: Excessive turbulence can occur in the leeward side of the building. This can cause sudden changes in wind velocity and can raise dust or lead to accumulation of debris. This effect is also dependent on the height of the building.

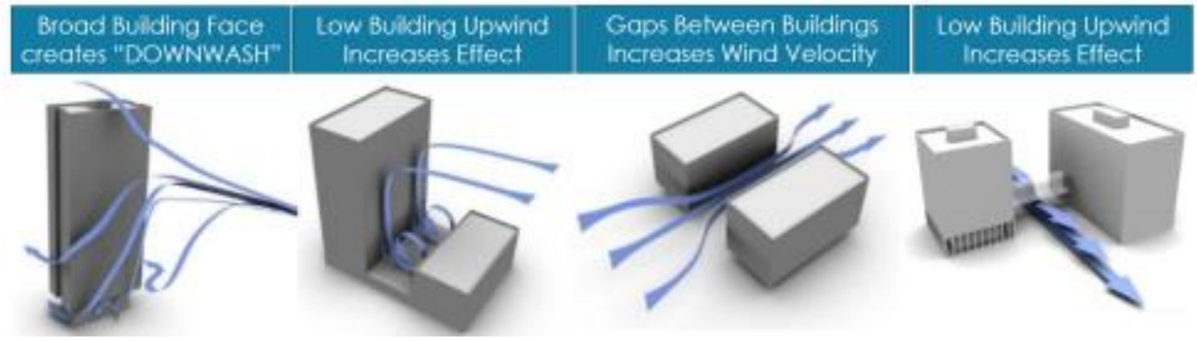

Figure 3 Typical urban wind effects

The anticipation of the likely wind conditions resulting from new developments are important considerations in the context of pedestrian comfort and the safe use of the public realm.

While it is not always practical to design out all the risks associated with the wind environment, it is possible to provide local mitigation to minimise risk or discomfort where required.

Figure 4 View of the 3D CFD model of the proposed development (coloured blocks) in the existing context

Figure 5 View of the 3D CFD model of the proposed development (coloured blocks) in the existing context (South View).

1.3 Guidance and Legislation for Wind Microclimate

The 'Urban Development and Building Heights, Guidelines for Planning Authorities (Government of Ireland, December 2020)' document, specific wind impact assessment of the microclimatic effects should be performed for 'buildings taller than prevailing building heights in urban areas'. The document is strongly supportive of increased building heights. In particular SPPR 1 notes that ' in accordance with Government policy to support increased building height in locations with good public transport accessibility, particular town/city cores, planning authorities shall explicitly identify through their statutory plans, areas where increased building height will be actively pursued for both redevelopment and infill development to secure the objective of the national Planning framework and regional spatial and Economic Strategies and shall not provide for blanket numerical limitation on building heights.

The recommended approach to wind microclimate studies is outlined in the "Wind Microclimate Guidelines for Developments in the City of London '(August 2019) and in the guidelines and recommendations contained in BRE Digest (DG) 520, "Wind Microclimate Around Buildings" (BRE, 2011). The Lawson Criteria of Comfort and Distress is used to benchmark the pedestrian wind microclimate.

The document also indicates how to use Computational fluid dynamics (CFD) to assess wind microclimate conditions and how to generate high quality outputs to provide a good understanding of the fundamental flow features around an urban context. Usually, the recommended approach to wind microclimate studies is based on the building height, as presented in the following table

Table.1 Recommended Approach to Wind Microclimate Studies based on Building Height, as prescribed by the Wind Microclimate Guidelines for Developments in the City of London (August 2019).

Building Height	Recommended Approach to Wind Microclimate Studies
Similar or lower than the average height of surrounding buildings **Up to 25m**	Wind studies are not required, unless sensitive pedestrian activities are intended (e.g. around hospitals, transport hubs, etc.) or the project is located on an exposed location
Up to double the average height of surrounding buildings **25m to 50m**	Computational (CFD) Simulations **OR** Wind Tunnel Testing
Up to 4 times the average height of surrounding buildings **50m to 100m**	Computational (CFD) Simulations **AND** Wind Tunnel Testing
High Rise **Above 100m**	**Early Stage Massing Optimization:** Wind Tunnel Testing OR Computational (CFD) Simulations **Detailed Design:** Wind Tunnel Testing **AND** Computational (CFD) Simulations to demonstrate the performance of the final building design

1.4 Quality Assurance and Competence

This Chapter is completed by Dr. Cristina Paduano, Dr. Chino Uzoka and Dr. Arman Safdari.

Dr. Cristina Paduano is a Chartered Engineer (CEng) and member of Engineers Ireland who specialises in computational fluid dynamics applications for urban environment and the construction industry with over 18 years' experience. She holds a PhD in Mechanical Engineering from Trinity College Dublin, with M.Eng and B.Eng in Aerospace Engineering.

Dr. Chino Uzoka is a CFD Specialist Engineer who specialises in computational fluid dynamics applications for the design of products related to buildings and the built environment. He holds a PhD in Mechanical Engineering and MSc in Engineering Management from the University of Huddersfield.

Dr. Arman Safdari is a CFD Modelling Engineer who specialises in computational fluid dynamics applications. He is an expert in airflow modelling, heat and mass transfer and multi-phase flow simulations. He holds a PhD in Mechanical Engineering from Pusan National University, a M.Sc. and B.Sc. in Mechanical Engineering.

Furthermore, the wind analysis of this chapter employs OpenFoam Software Code, which is based on a volume averaging method of discretization and uses the post-processing visualisation toolkit Paraview version 5.5.

OpenFoam is a CFD software code released and developed primarily by OpenCFD Ltd, since 2004. It has a large user base across most areas of engineering and science, from both commercial and academic organisations.

OpenFOAM CFD code has capabilities of utilizing a Reynolds Averaged Navier-Stokes (RANS) approach, Unsteady Reynolds Averaged Navier-Stokes (URANS) approach, Detached Eddy Simulation (DES) approach, Large Eddy Simulation (LES) approach or the Direct Numerical Simulation (DNS) approach, which are all used to solve anything from complex fluid flows involving chemical reactions, turbulence and heat transfer, to acoustics, solid mechanics and electromagnetics.

Quality assurance is based on rigorous testing. The process of code evaluation, verification and validation includes several hundred daily unit tests, a medium-sized test battery run on a weekly basis, and large industry-based test battery run prior to new version releases. Tests are designed to assess regression behaviour, memory usage, code performance and scalability.

The OpenFOAM solver algorithm directly solves the mass and momentum equations for the large eddies that comprise most of the fluid's energy. By solving the large eddies directly no error is introduced into the calculation.

To reduce computational time and associated costs the small eddies within the flow have been solved using the widely used and recognised Smagorinsky Sub-Grid Scale (SGS) model. The small eddies only comprise a small proportion of the fluids energy therefore the approximation errors introduced through the modelling of this component are minimal.

2 STUDY METHODOLOGY

The method for the study of wind microclimate combines the use of Computational Fluid Dynamics (CFD) to predict wind velocities and wind flow patterns, with the use of wind data from suitable meteorological station and the recommended comfort and safety standards (Lawson Criteria). The effect of the geometry, height and massing of the proposed development and existing surroundings including topography, ground roughness and landscaping of the site, on local wind speed and direction is considered as well as the pedestrian activity to be expected (sitting, standing, strolling and fast walking). The results of the assessment are presented in the form of contours of the Lawson criteria at pedestrian level. The assessment has comprised the following scenarios:

- **Baseline Existing Scenario**: this consists of the existing wind microclimate at the site.

- **Proposed Development in the Existing Scenario**: this consists of the assessment of the wind microclimate of the site with the proposed development surrounded by existing buildings.

- **Cumulative Scenario**: this consists of the assessment of the wind microclimate of the site with the proposed development surrounded by existing and permitted buildings. In accordance with the guideline cited in section 11.3, the wind microclimate study should consider the effect of the proposed development together with buildings (existing and/or permitted) that are within 400m from the centre of the site. Other taller buildings outside of this zone that could have an influence on wind conditions within the project site should be included for wind directions where they are upwind of the project site.

In particular, the following has been undertaken:

- Topography of the site with buildings (proposed and adjacent existing/permitted.

- Developments massing, depending on the scenario assessed “baseline, proposed or cumulative”) have been modelled using OpenFOAM Software.

- Suitable wind conditions have been determined based on historic wind data. Criteria and selected wind scenarios included means and peaks wind conditions that need to be assessed in relation to the Lawson Criteria.

- Computational Fluid Dynamics (CFD) has been used to simulate the local wind environment for the required scenarios (‘baseline, proposed, cumulative”).

- The impact of the proposed development massing on the local wind environment has been determined (showing the wind flows obtained at pedestrian level). Potential receptors (pedestrian areas) have been assessed through review of external amenity/public areas (generating the Lawson Comfort and Distress Map).

- Potential mitigation strategies for any building related discomfort conditions (where necessary) have been explored and their effect introduced in the CFD model produced.

Figure 6 Area of interest for the wind microclimate analysis

2.1 Assessment Criteria for Pedestrian Comfort and Distress

"Lawson Comfort and Distress Criteria" has been developed for wind microclimate studies as a means of assessing the long-term suitability of urban areas for walking or sitting, accounting for both microclimatic wind effects (i.e., site location and prevailing winds) and microclimatic air movement associated with wind forces influenced by the localised built environment forms and landscaping effects.

The Lawson scale assesses pedestrian wind comfort in absolute terms and defines the reaction of an average person to the wind.

For the distress (safety) criterion, only gust winds are considered. These are usually rare events but deserve special attention in city planning and building design due to their potential impact on pedestrian safety. Gusts cause most 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.

The following criteria are widely accepted by local authorities as well as the international building design and city planning community:

COMFORT CRITERIA: Relates to the activity of the individual.

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) which is exceeded for 5% of the time.

DISTRESS CRITERIA: Relates to the physical well-being of the individual.

Onset of distress:

- 'Frail Person or Cyclist': equivalent to an hourly mean speed of 15 m/s and a gust speed of 28 m/s (62 mph) to be exceeded less often than once a year (0.022% of the times). 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.
- 'General Public': A mean speed of 20 m/s and a gust speed of 37 m/s (83 mph) to be exceeded less often than once a year. Beyond this gust speed, aerodynamic forces approach body weight and it rapidly becomes impossible for anyone to remain standing. Where wind speeds exceed these values, pedestrian access should be discouraged (Ref. CFD simulation for pedestrian wind comfort and wind safety in urban areas - 2012).

Table 2 Comfort categories for wind in accordance with Lawson criteria

Pedestrian Comfort Category (Lawson Scale)	Mean and Gem wind speed not to be exceeded more than 5% of the time	Description
Long-Term Sitting	4m/s	Acceptable for frequent outdoor sitting use, i.e., restaurant /café
Standing	6m/s	Acceptable for occasional outdoor sitting use, i.e., public outdoor spaces
Walking/Strolling	8m/s	Acceptable for entrances/bus stops /covered walkaways
Business Walking	10m/s	Acceptable for external pavements, walkways
Unacceptable/Distress	>10m/s	Start of not comfortable/distress level for pedestrian access

Table 3 Safety categories (distress) for wind in accordance with Lawson criteria

Pedestrian Safety Category (Lawson Scale)	Mean and Gem wind speed not to be exceeded more than 0.0022% of the time	Description
Unsafe for public	>20m/s	Distress/safety concern for pedestrian
Unsafe for cyclists or frail person	>15m/s	Distress/safety concern for cyclist/frail person

These criteria for wind forces represent average wind tolerances. They are subjective and variable depending on thermal conditions, age, health, clothing, etc. which can all affect a person's perception of a local microclimate. Moreover, pedestrian activity alters between winter and summer months. The criteria assume that people will be suitably dressed for the time of year and individual activity. It is reasonable to assume, for instance, that areas designated for outdoor seating will not be used on the windiest days of the year. Weather data measured are used to calculate how often a given wind speed will occur each year over a specified area.

Pedestrian comfort and distress criteria are assessed at 1.5 m above ground level as required by the guideline cited in section 11.33. If the predicted wind conditions exceed the threshold, then conditions are unacceptable for the type of pedestrian activity and mitigation measures should be implemented into the design.

2.2 Significance Criteria

The significance of on-site measurement locations is defined by comparing the wind comfort/safety levels with the intended pedestrian activity at each location, using the table provided by the Lawson Comfort and Distress Criteria.

Table 4 Significance criteria for on-site receptors

Significance	Trigger	Mitigation required?
Major Adverse	Conditions are "unsafe"	Yes
Moderate Adverse	Conditions are "unsuitable" (in terms of comfort) for the intended pedestrian use.	Yes
Negligible	Conditions are "suitable" for the intended pedestrian use.	No
Moderate Beneficial	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	No

The significance of off-site measurement locations is defined by comparing the wind comfort/safety levels with the intended pedestrian activity at each location, prior and after the introduction of the proposed development.

Table 5 Significance criteria for off-site receptors

Significance	**Trigger**	**Mitigation required?**
Major Adverse	Conditions that were “safe” in the baseline scenario became “unsafe” as a result of the Proposed Development. *OR* Conditions that were “suitable” in terms of comfort in the baseline scenario became “unsuitable” because of the Proposed Development. *OR* Conditions that were “unsafe” in the baseline scenario are made worse because of the Proposed Development.	Yes
Moderate Adverse	Conditions that were “suitable” in terms of comfort in the baseline scenario are made windier (by at least one comfort category) as a result of the Proposed Development but remain “suitable” for the intended pedestrian activity.	No
Negligible	Conditions remain the same as in the baseline scenario.	No
Major Beneficial	Conditions that were “unsafe” in the baseline scenario became “safe” because of the Proposed Development.	No
Moderate Beneficial Potential Receptors	Conditions that were “unsuitable” in terms of comfort in the baseline scenario became “suitable” because of the Proposed Development. *OR* Conditions that were “unsafe” in the baseline scenario are made better as a result of the Proposed Development (but not so as to make them “safe”.	No

3 CFD MODELLING METHOD

The wind microclimate study is conducted through Computational Fluid Dynamics (CFD). This is a numerical technique to simulate fluid flow, heat and mass transfer, chemical reaction and combustion, multiphase flow, and other phenomena related to fluid flows. Wind flow is described by Navier-Stokes equations which are solved within the CFD analysis using a finite volume algorithm based on the volumetric mesh/grid in which the geometry is divided.

CFD modelling includes three main stages: pre-processing, simulation, and post-processing as described in the schematic that follows.

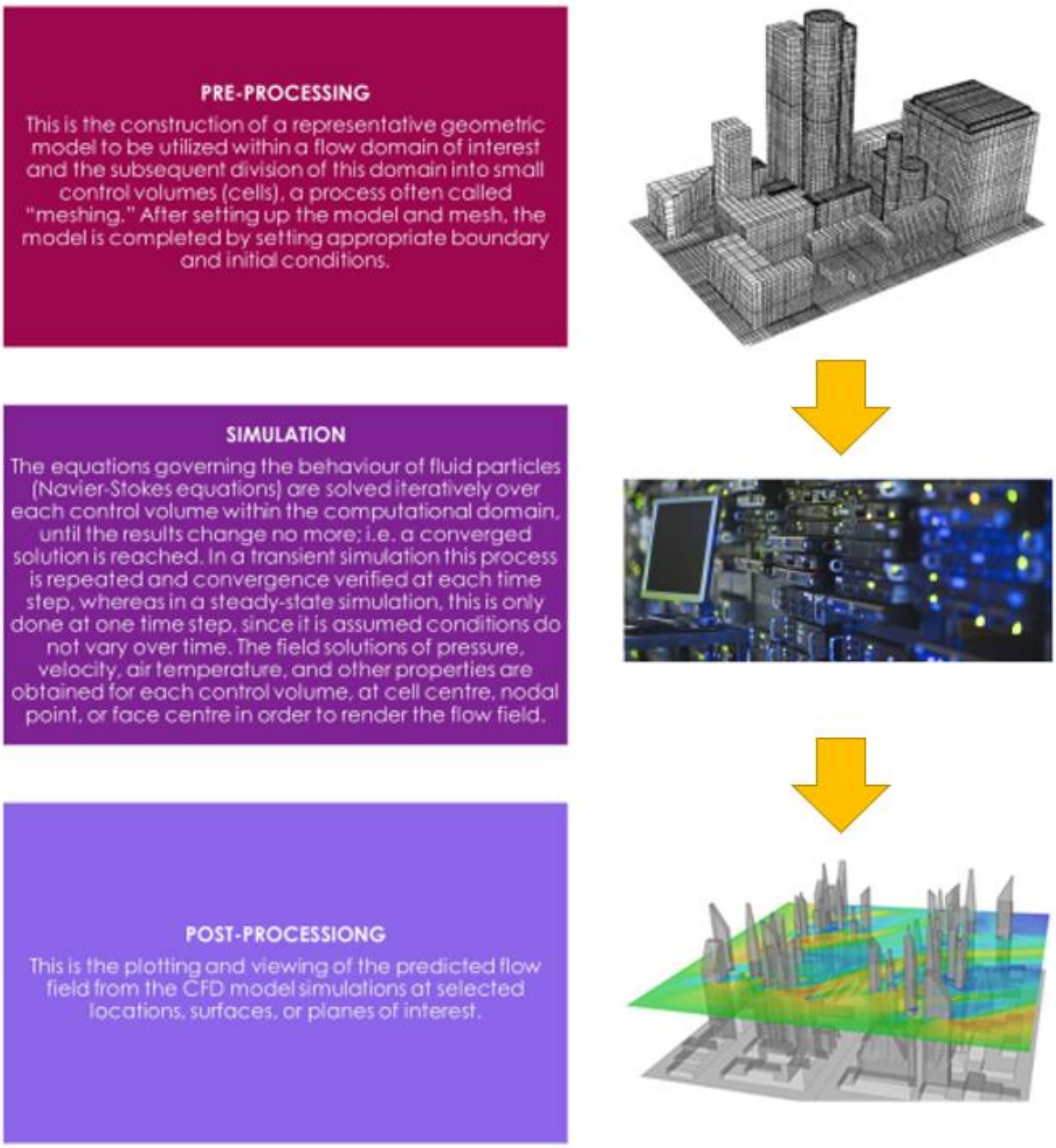

Figure 7 CFD Modelling procedure phases-schematic

3.2.1 CFD Model Details of the Wind Microclimate Study

This subsection describes all features included in the geometrical and physical representation of the proposed development CFD model. Any object which may have significant impact on wind movement and circulation are represented within the model.

To be accurate, the structural layout of the building being modelled should include only the obstacles, blockages, openings and closures which can impact the wind around the building. It is important to remember that a CFD simulation approximates reality, so providing more details of the geometry within the model will not necessarily increase the understanding of the bulk flows in the real environment.

3.2.2 Modelled Geometry and Computational Mesh

In accordance with the guideline cited in section 11.3, when a wind study is carried out using CFD modelling the modelled area must include a detailed three-dimensional representation of the proposed development and the numerical calculation should take place using a model mesh with maximum cell sizes near critical locations (e.g. entrances, corners, etc.) in the order of 0.3m or smaller. Sufficient mesh cells should be also used between buildings with a minimum of 10 cells across a street canyon. However, the cell size of buildings away from the target can be larger to allow for wind modelling efficiency. (Computational Fluid Dynamics for Urban Physics -2015).

To represent reality and consider the actual wind impacting on the site, the modelled area for the wind modelling study comprises a wider urban area, this to include the recommended dimensions (400m radius from the site centre) as outlined in section 2

Table.6 Computational Modelling details

CFD Model Details	Modelled CFD Environment Dimensions		
	Width	Length	Height
CFD Mesh Domain	1600m approx.	1600m approx	160m approx

3.2.3 Boundary Conditions for The CFD Model

A rectangular computational domain was used for the analysis. The wind directions were altered without changing the computational mesh. For each simulation scenario, an initial wind velocity was set according to the statistical weather data collected in order to consider the worst-case scenario. Building surfaces within the model are specified as ‘no slip’ boundary conditions. This condition ensures that flow moving parallel to a surface is brought to rest at the point where it meets the surface. Air flow inlet boundaries possess the ‘Inlet’ wind profile velocity patch boundary condition with its appropriate inflow turbulence intensity and dissipation rates. Air exits the domain at the ‘pressure outlet’ boundary condition. (Ref. Best Practice Guidelines for the CFD Simulation of Flows -2007).

Due to aerodynamic drag, there is a wind gradient in the wind flow just a few hundred meters above the Earth’s surface – “the surface layer of the planetary boundary layer”.

Wind speed increases with increasing height above the ground, starting from zero, due to the no-slip condition. In particular, the wind velocity profile used for the analysis is parabolic. Flow near the surface encounters obstacles that reduce the wind speed and introduce random vertical and horizontal velocity components. This turbulence causes vertical mixing between the air moving horizontally at one level, and the air at those levels immediately above and below it. For this reason, the velocity profile is given by a fluctuating velocity along a mean velocity value which are both numerically simulated by mean of inlet velocity profile and turbulence intensity values assigned to the model.

The equation used for the wind velocity profile within the model, as described above is shown below.

$$v_2 = v_1 \cdot \frac{ln\frac{h_2}{z_0}}{ln\frac{h_1}{z_0}}$$

where:

- v_1 = wind speed measured at the reference height h_1
- h_1 = reference height to measure v_1
- h_2 = height of the wind speed v_2 calculated for the wind profile
- z_0 = 0.4 [m] roughness length selected

3.2.4 Computational Mesh

The level of accuracy of the CFD results are determined by the level of refinement of the computational mesh. Details of parameters used to calculate the computational mesh are presented in Table 7, and Figure 8 shows the mesh utilised in the simulations.

The grid follows the principles of the ‘Finite Volume Method’, which implies that the solution of the model equations is calculated at discrete points (nodes) on a three-dimensional grid, which includes all the flow volume of interest. The mathematical solution for the flow is calculated at the centre of each of these cells and then an interpolation function is used by the software to provide the results in the entire domain.

Table 7 Parameter to Calculate Computational Mesh

Parameters To Calculate Computational Mesh	
Air Density ρ	$1.2 kg/m^3$
Ambient Temperature (T)	$288K$ ($approx. 15C^{\circ}$) isothermal analysis
Gravity Acceleration (g)	$9.8 m/s^2$
dx	0.3 m at the building 1m in the surroundings 2m elsewhere
Mesh cells size	0.1 m (ratio 1:1)
Total mesh size	Approx. cells number = 10 millions

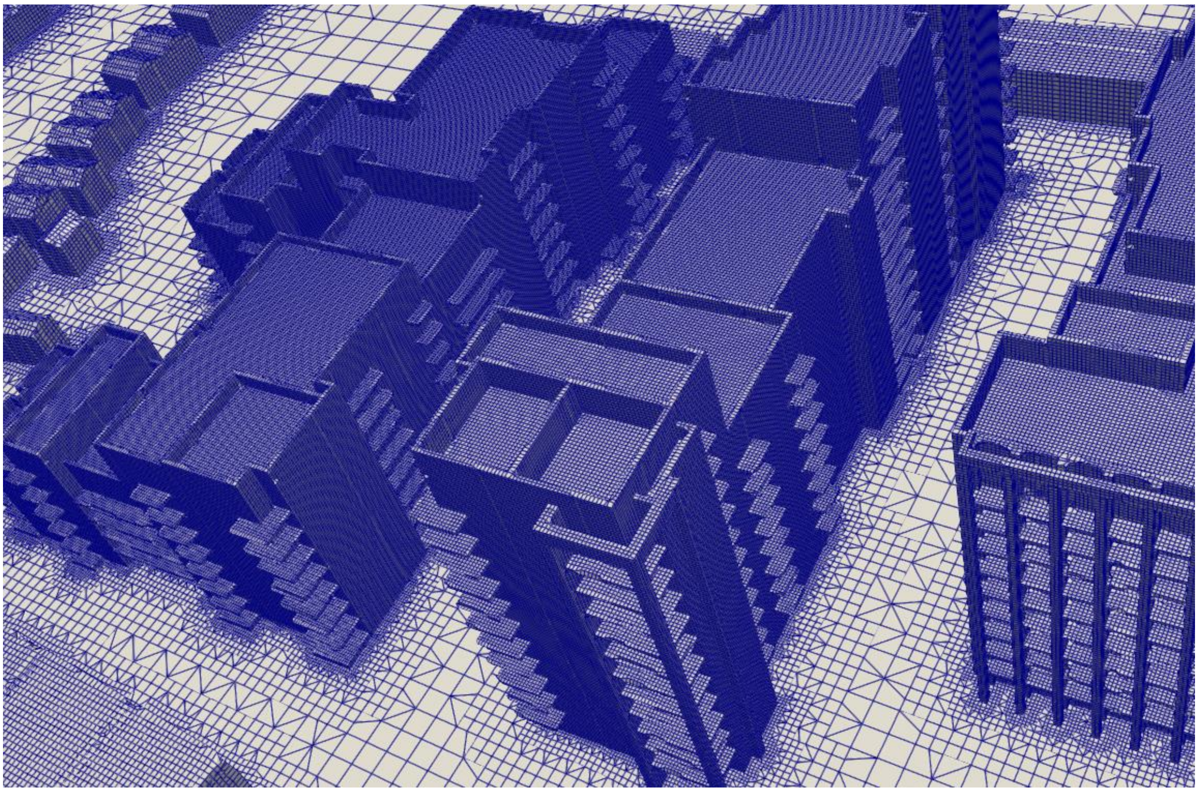

Figure 8 Computational mesh used for the CFD wind modelling and simulation

4 THE EXISTING AND RECEIVING ENVIRONMENT (BASELINE SITUATION)

The baseline environment consists of the area to be developed as shown in Figure 9 and its surroundings. The wind microclimate of the baseline environment is defined by the wind patterns that develop on the existing site under the local wind conditions shown in section11.2.

Figure 9 Existing environment around the proposed site (highlighted in red).

The existing context is analysed, and Lawson criteria is applied considering that pedestrian activities (walking, strolling) are taking place on the existing area.

4.2.1 Local Wind Climate

A statistical analysis of 30 years historical wind data has been carried out to characterise the existing wind climate in terms of wind speeds, frequency, and directions.

The existing wind conditions are obtained using the annual average of meteorology data collected at Dublin Airport Weather Station. The figure that follows shows on the map the position of the subject site and the position of Dublin Airport.

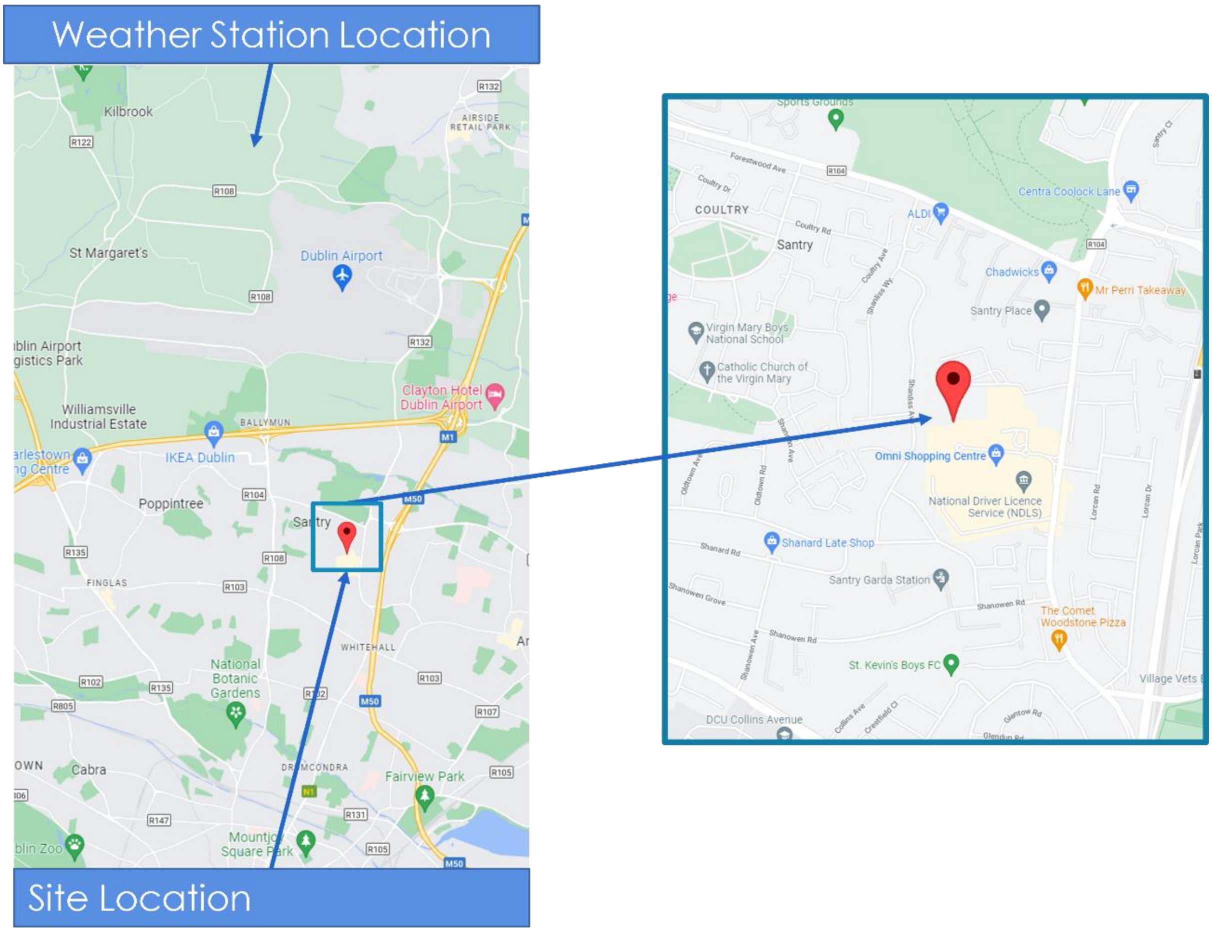

Figure 10 Site location and weather station location at Dublin airport

Regarding the transferability of the available wind data from the Dublin Airport Weather Wind station to the site location, the following considerations have been made:

- **Terrain**: The meteorological station is located on the flat open terrain of the airport, whereas the development site is in an urban area with dense built-in structure with buildings of more than 10-20 m height in average and with some buildings even taller.

- **Mean Wind Speeds**: Due to the different terrain environment, the ground-near wind speeds (at pedestrian level) will be lower at the proposed site compared to the meteorological station at the airport.

- **Wind Directions**: The landscape around the development site can principally be characterised as flat terrain. Isolated small elevations in the near area of the development should have no influence on the wind speed and wind directions. With respect to the general wind climate, no significant influence is expected.

Based on the above considerations, it can be concluded that the data from the meteorological station at Dublin Airport are applicable for the assessment of the wind climate at the development site.

Two different data sets are analysed as follows:

- The meteorological data associated with the maximum daily wind speeds recorded over a 30-years period between 1990 and 2020 and,

- The mean hourly wind speeds recorded over a 10-years period between 1990 and 2020. The data is recorded at a weather station at the airport, which is located 10m above ground or 71mOD.

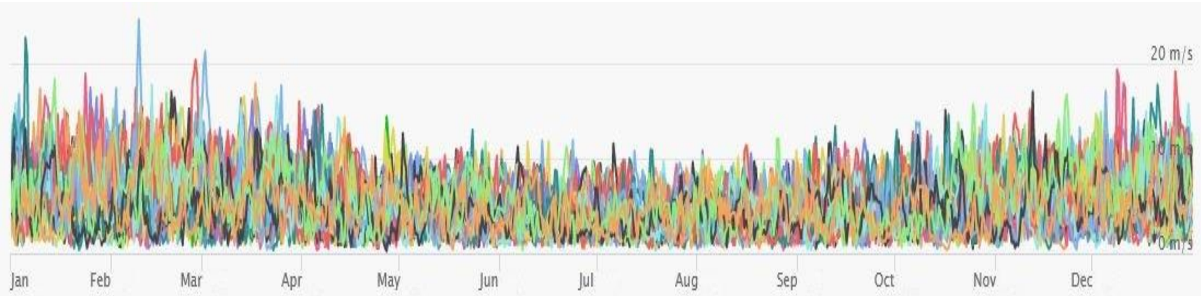

Figure 11 Local Wind Conditions - Wind Speed (Mean Values per Months)- historic data 1990-2020- (Data Source www.meteoblue.com)

Furthermore, a Weibull distribution was fitted to the wind data for each wind direction simulated through the adoption of an appropriate dispersion parameter, c, and a shape parameter, k. In house-based 'Python script' applies the factors to the simulation input wind conditions directly. The local data from Dublin Airport was transposed to the development site using the ESDU (Engineering Sciences Data Unit) methodology.

4.2.2 Local Wind for the Assessment of Pedestrian Comfort and Distress

The predominant wind directions on the baseline environment identifies from which direction the wind is blowing on the site for most of the time during a typical year.

In accordance with Lawson Criteria, if the proposed site is exposed to a wind from a specific direction for more than 5% of the times, then the microclimate analysis should consider the impact of this wind (accounting for its direction and most frequent speed) on the local microclimate.

A statistical analysis was carried out based one 2 historical wind data sources:

- Meteoblue (over 40 years historical data – since 1979) – Dublin Airport

- Openweather (over 40 years historical data – since 1979) – Dublin Airport and Site location

To understand and correctly validate the weather conditions at the site, a comparison was carried out between the historical data provided by both sources (Meteoblue and Openweather) at the weather station (Dublin Airport).

Data analysis and data visualization were obtained with an in-house program which is coded based on Python language. The speed and frequency of wind per each direction were considered, and, seasonal changes were analysed in order to indicate the prevailing wind directions (as shown in the following Figures).

Furthermore, statistical analysis of the number of hours and magnitudes of wind for 36 angles (10° increments) is performed to produce the Lawson plots. Each of the 36 wind directions were interpolated to calculate the probability that a velocity threshold will be exceeded.

Figure 12 presents the wind speed diagram for Dublin, the diagram shows how often (how many days per month) the wind blows with a specific speed.

Figure 13 shows the wind rose for Dublin and details how often (how many hours per year in this case) the wind blows from a specific direction. This data highlights that the predominant wind directions for the site are West-South-West, West, and South-West.

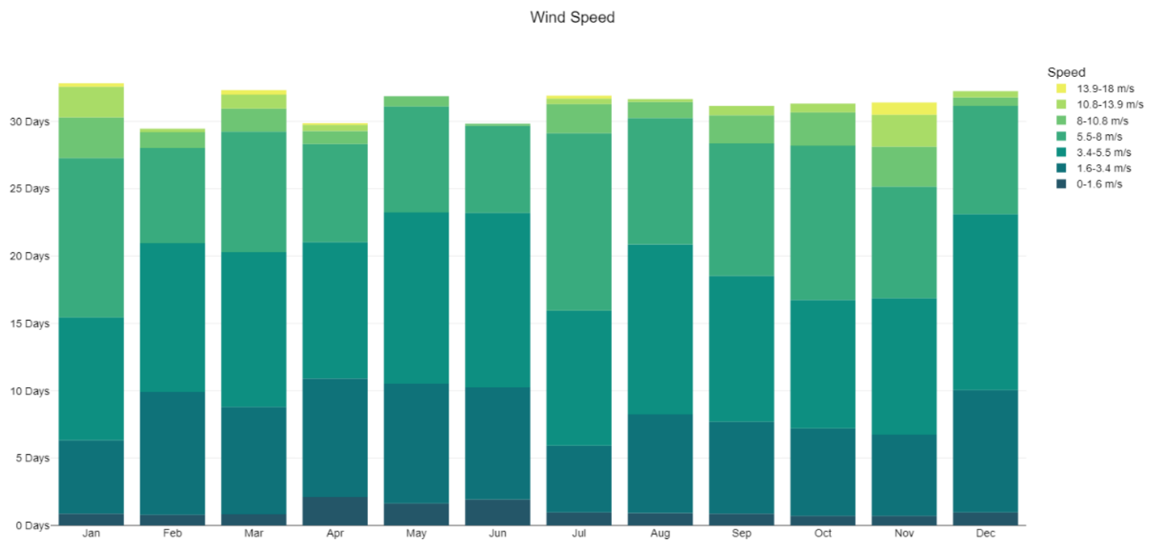

Figure 12 Annual Wind speed diagram -Dublin (Data Source www.Meteoblue.com)

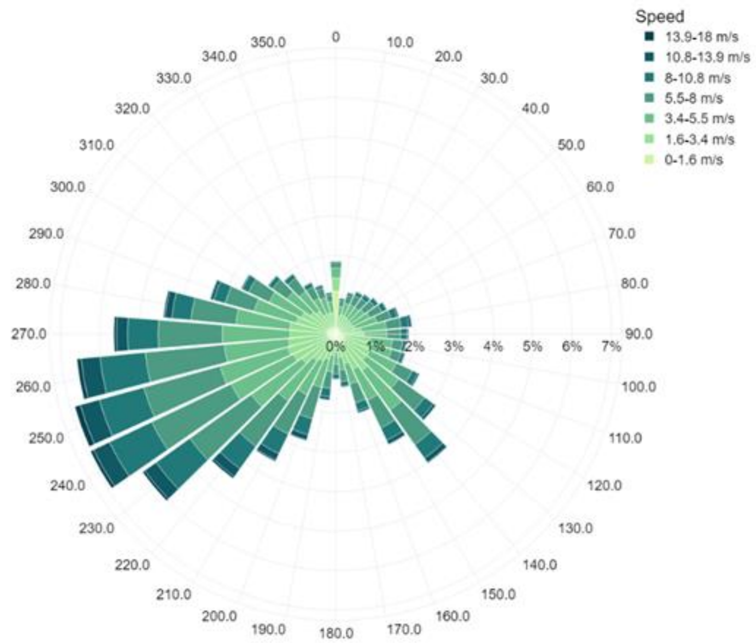

Figure 13 Wind rose for Dublin, speeds, frequency and directions (Data Source www.Meteoblue.com)

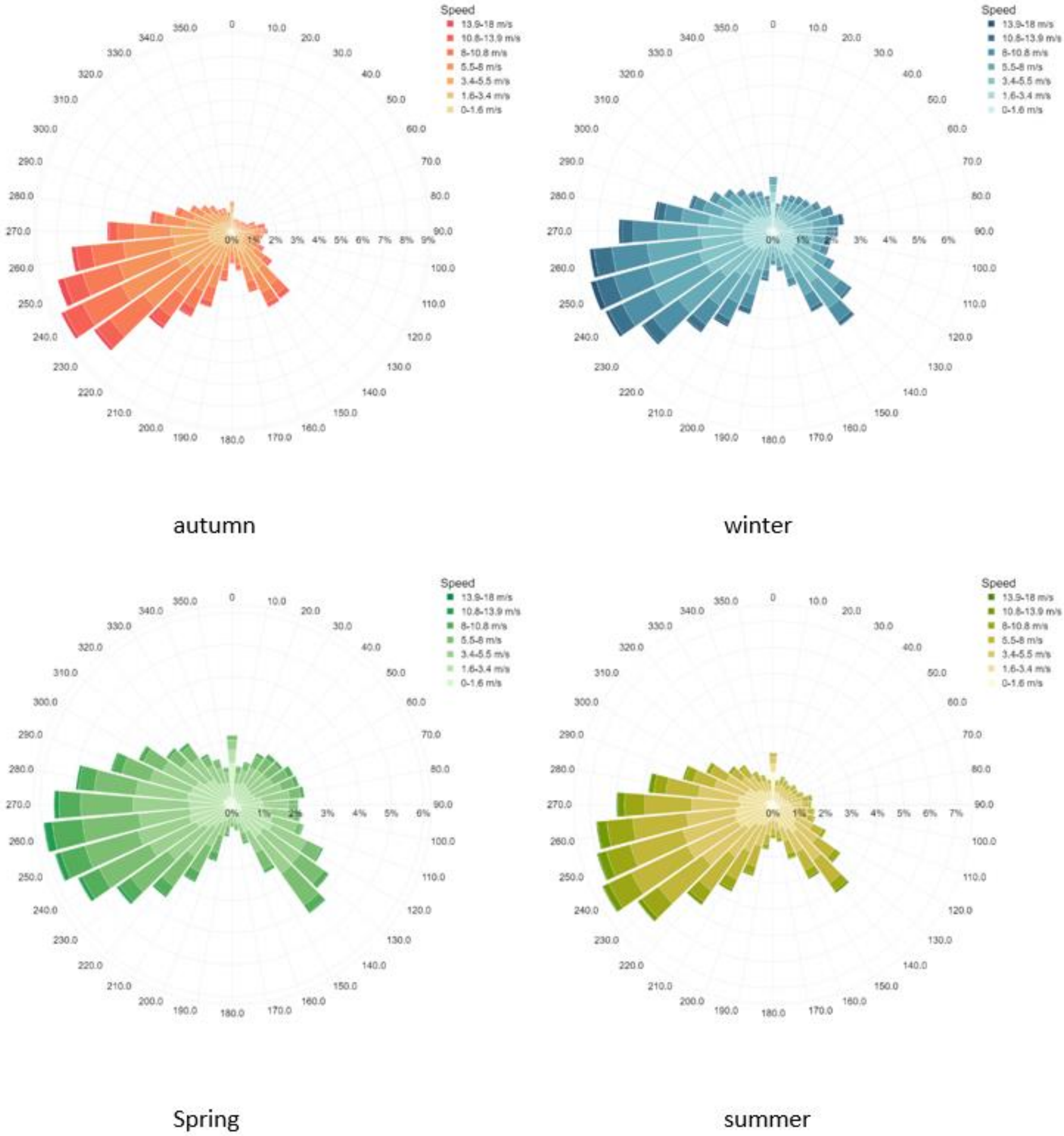

Figure 14 Wind speeds and wind directions at different seasons in Ireland (Data Source www.Meteoblue.com)

The table that follows reports all the wind directions and their correspondent velocity, displayed in order of frequency of occurrence with those most frequent on the top.

As it can be noted, the wind at the site is mostly blowing (higher frequency of occurrence) from the South-West (225deg) direction with a wind velocity of approximately 5m/s. A similar wind speed is blowing also from the South-South-West direction (213deg), however the frequency of occurrence of this wind is less than 5% (only 3.288% of the times, as indicated in the table) therefore, this wind is not relevant for the scope of performing the pedestrian comfort and distress analysis as per Lawson Criteria. For assessing the wind microclimate for the proposed development, the study has considered the site exposed to all the wind directions which exceed the 5% of frequency, as required for the Lawson Criteria and some additional high-speed winds, which are occurring less often (below 5% of the times) but that can cause distress conditions because of their speed.

Table.8 Summary of the wind speeds at the site with the indicated magnitude, directions, and frequency of occurrence

BASELINE WIND SPEEDS, DIRECTIONS AND FREQUENCY OF OCCURENCE		
Velocity (m/s)	**Direction (deg11)**	**Frequency (%)**
5.601	225	11.233 (> 5%)
4.626	135	6.849 (> 5%)
5.847	236.25	6.792 (> 5%)
6.049	258.75	6.747 (> 5%)
6.034	247.5	6.689 (> 5%)
5.888	270	5.662 (> 5%)
4.994	315	4.338
5.503	281.25	3.904
4.974	292.5	3.436
5.357	213.75	3.288
4.736	123.75	3.105
4.406	146.25	2.751
5.101	303.75	2.648
5.246	112.5	2.500
4.121	157.5	2.386
4.581	101.25	2.340
4.169	45	2.180
3.558	90	2.135

Note: Table cells highlighted in grey indicate the top 8 higher frequency which exceed the 5% frequency and are fundamental for the wind microclimate analysis.

4.2.3 Baseline Scenario

The wind microclimate of the baseline scenario is defined by the wind patterns that develop on the site and it's surroundings (existing buildings and topography) under the local wind conditions relevant for the assessment of the Pedestrian Comfort and Distress. In this scenario, the assessment has considered the impact of wind on the existing area. Results of wind microclimate at pedestrian level (1.5m height - flow speeds) are collected throughout the modelled site. These flow velocities identify if locally, wind speeds at pedestrian-level are accelerated or decelerated in relation to the undisturbed reference wind speed due to the presence of the existing baseline environment.

The impact of these speeds are then combined with their specific frequency of occurrence and presented in the maps that show the area of comfort and distress in accordance with Lawson Criteria, these maps are produced at pedestrian level on the ground and identify the suitability of each area to its prescribed level of usage and activity.

Figure 15 Baseline scenario- CFD Model for wind analysis

4.2.4 Wind speeds at pedestrian level

Results of wind speeds and their circulations at pedestrian level of 1.5m above the development ground are presented in the following images with a colorbar ranging from 0 m/s to 8m/s, in order to assess wind flows at ground floor level of Omni Plaza Strategic House Development.

Wind flow speeds are shown to be within tenable conditions. Higher velocity and recirculation effects are found in the existing site.

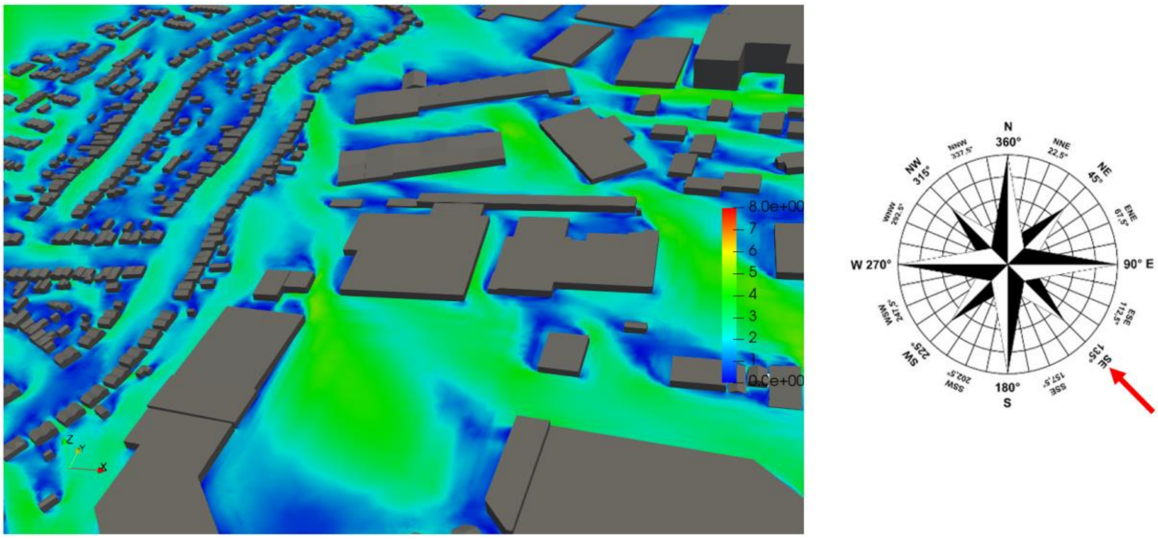

Figure 16 Wind at pedestrian level – Baseline Scenario - direction SE

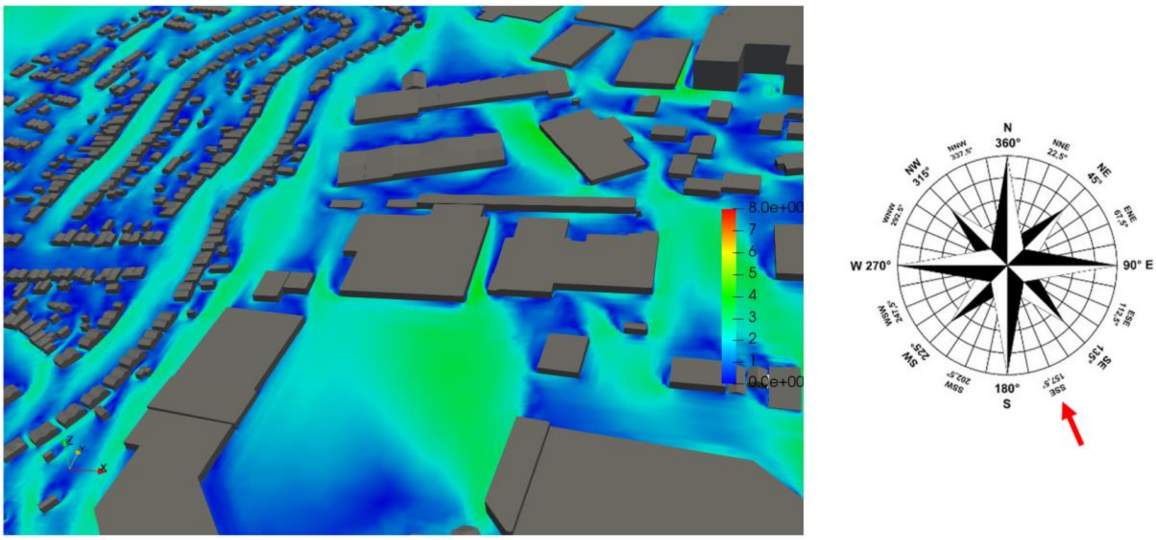

Figure 17 Wind at pedestrian level – Baseline Scenario - direction SSE

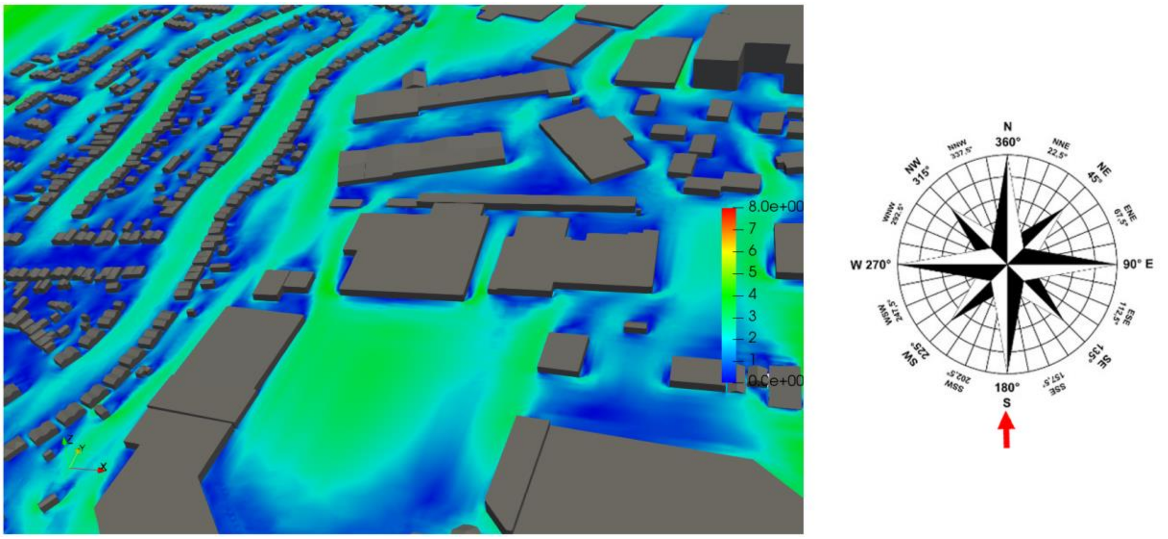

Figure 18 Wind at pedestrian level – Baseline Scenario - direction S

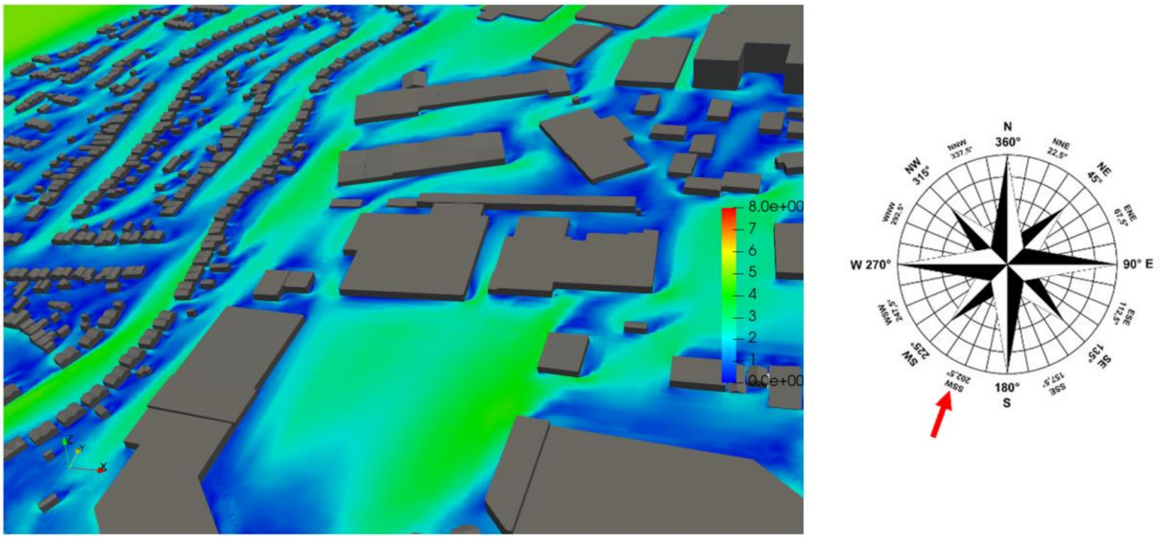

Figure 19 Wind at pedestrian level – Baseline Scenario - direction SSW

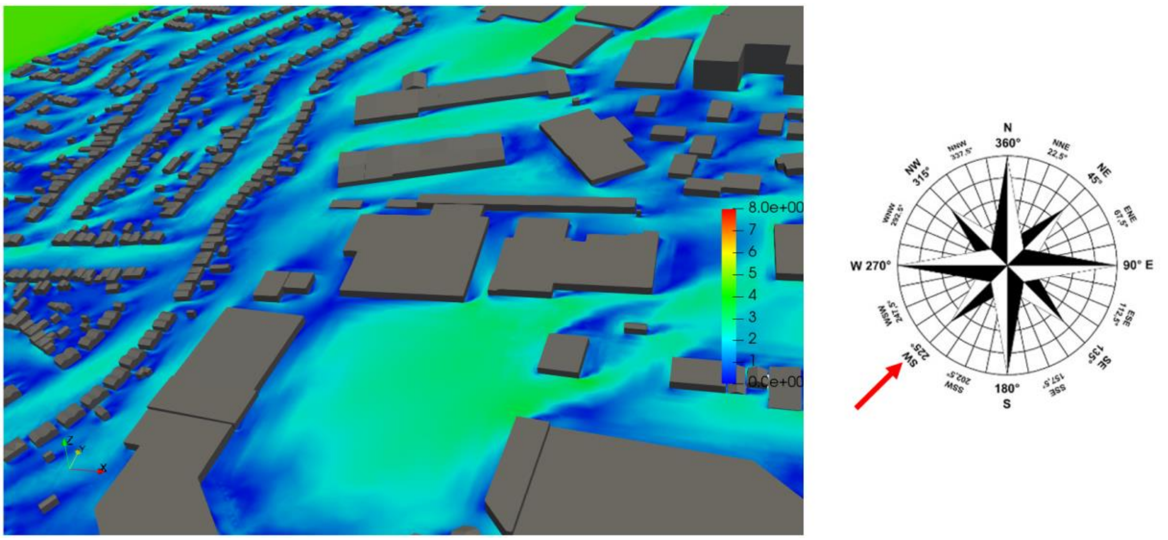

Figure 20 Wind at pedestrian level – Baseline Scenario - direction SW

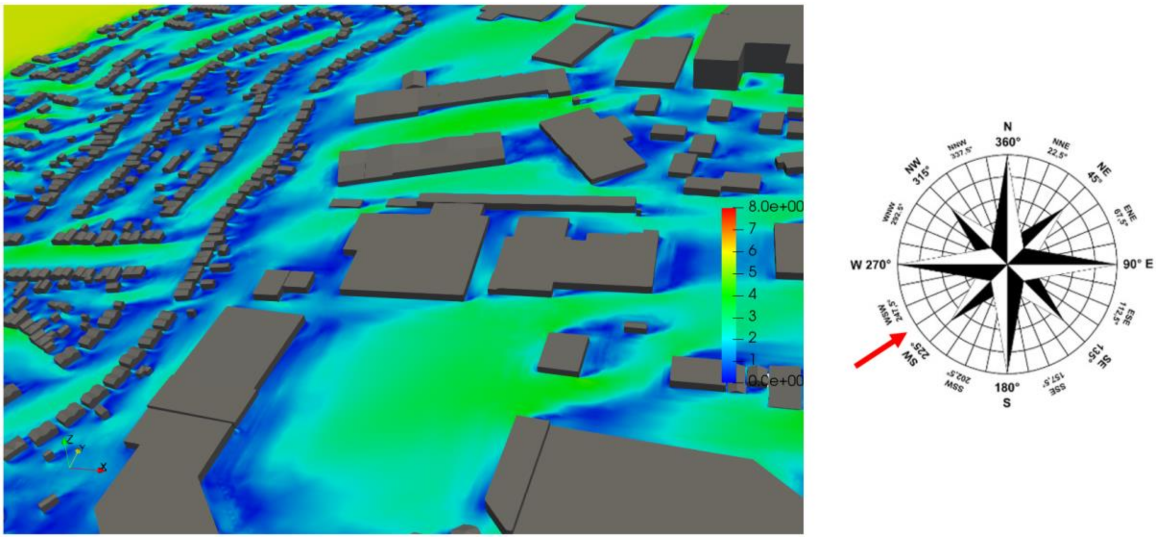

Figure 21 Wind at pedestrian level – Baseline Scenario - direction SWW

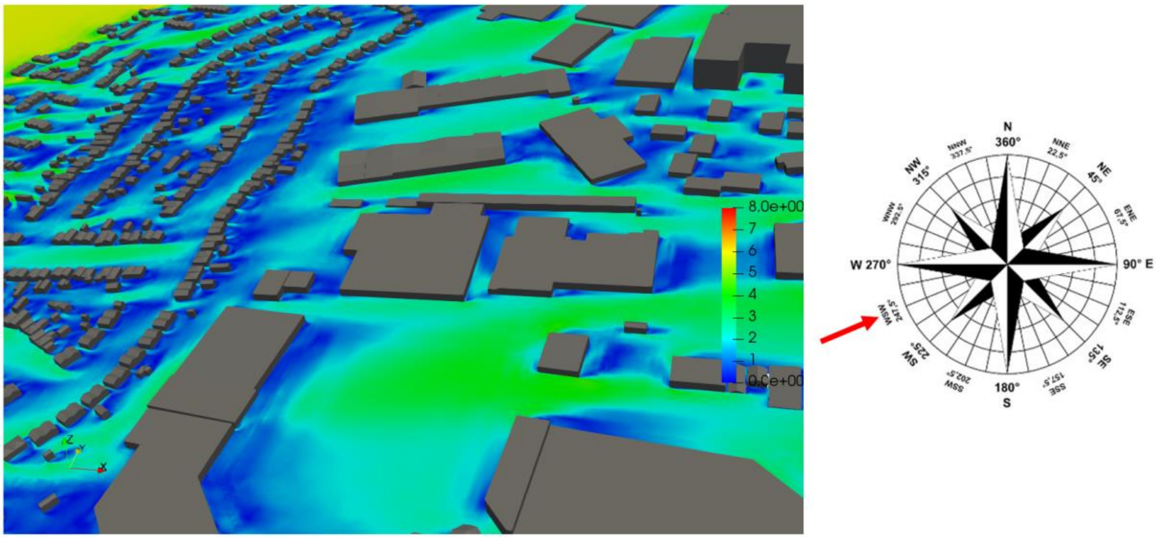

Figure 22 Wind at pedestrian level – Baseline Scenario - direction WSW

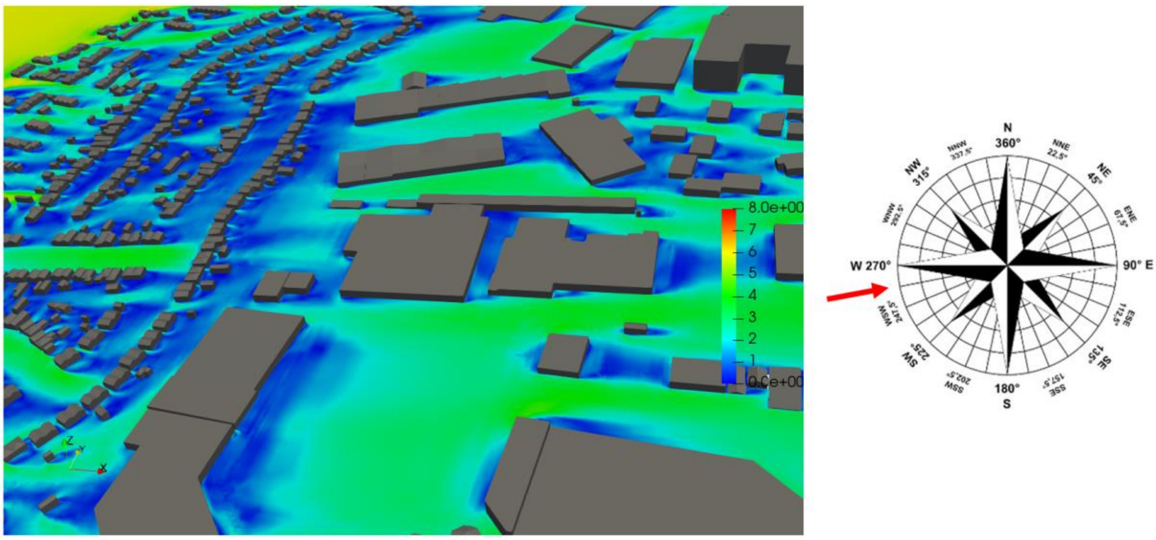

Figure 23 Wind at pedestrian level – Baseline Scenario - direction WSWW

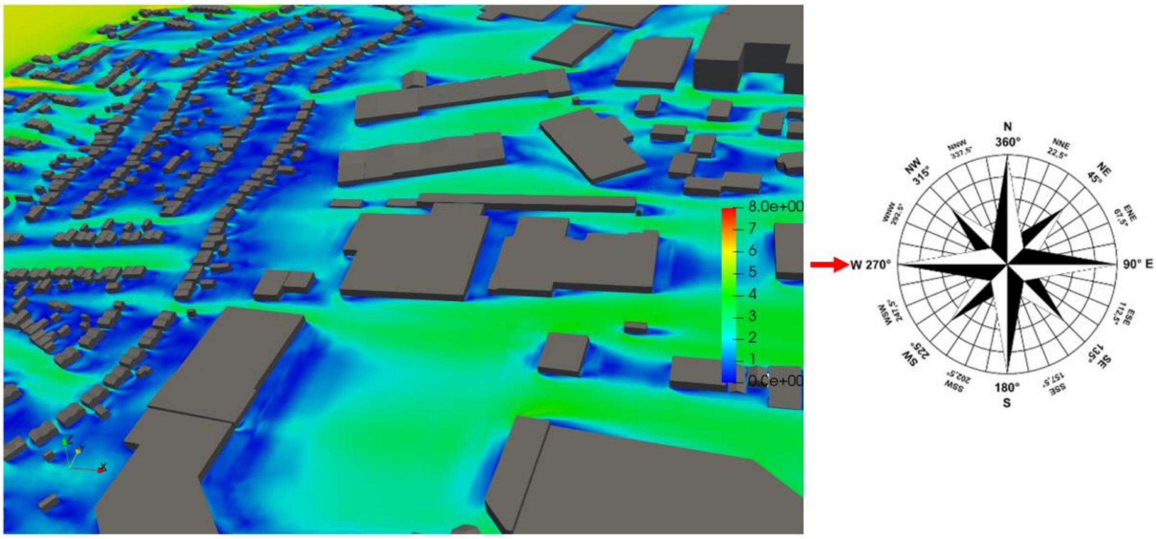

Figure 24 Wind at pedestrian level – Baseline Scenario - direction W

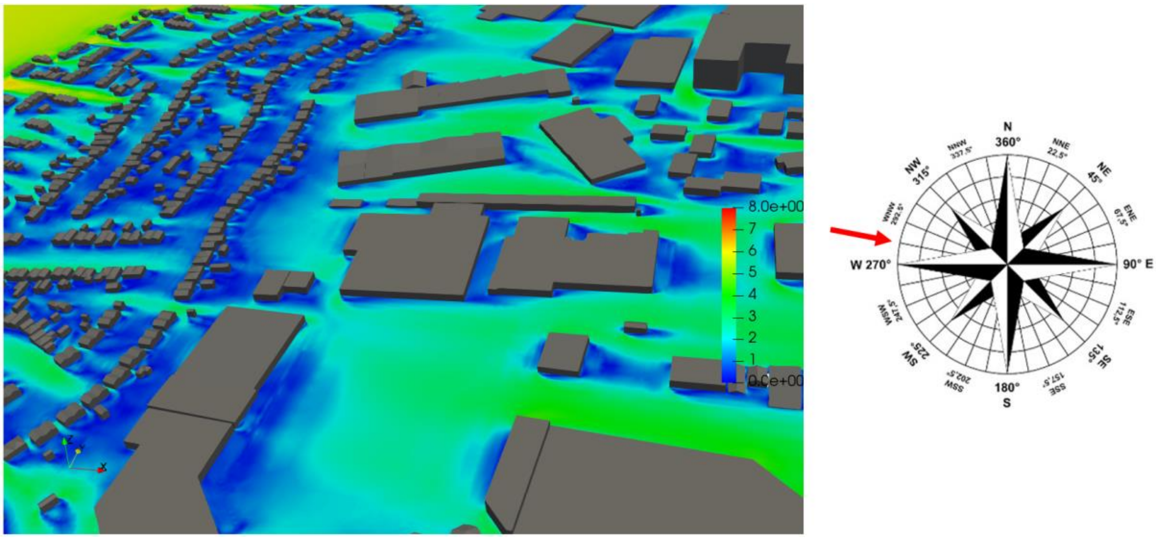

Figure 25 Wind at pedestrian level – Baseline Scenario - direction WWNW

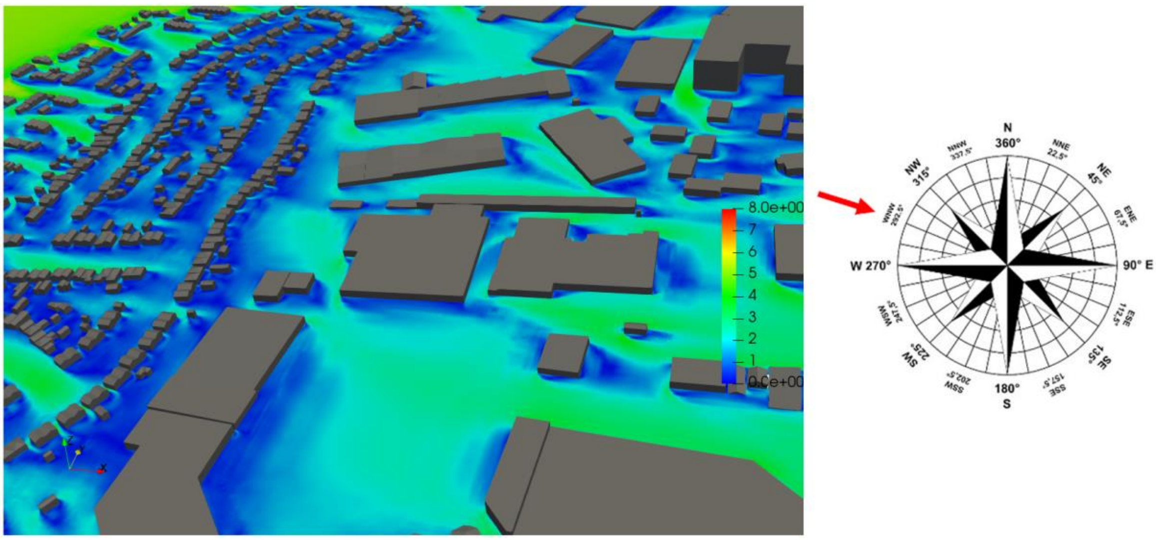

Figure 26 Wind at pedestrian level – Baseline Scenario - direction NW

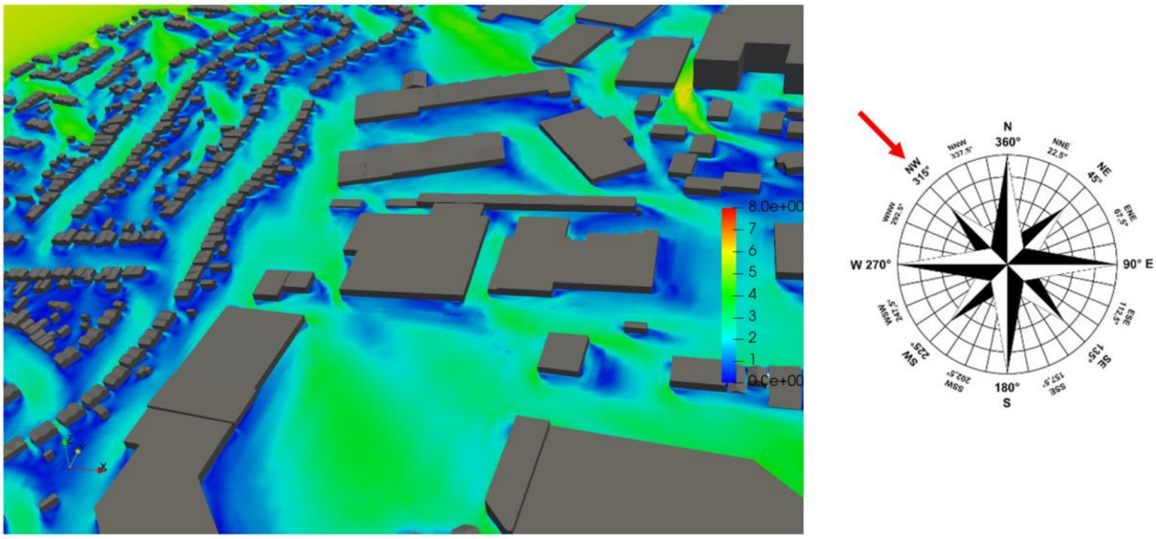

Figure 27 Wind at pedestrian level – Baseline Scenario - direction NW

4.2.5 Baseline Wind Microclimate

The wind flow results obtained simulating the different direction and wind speeds, are combined with wind frequencies of occurrence to obtain comfort ratings at pedestrian level in all areas included within the model. The comparison of comfort ratings with intended pedestrian activities is shown in the Lawson Comfort and Distress Map that follows. The comfort/distress conditions are presented using a colour coded diagram below formulated in accordance with the Lawson Criteria.

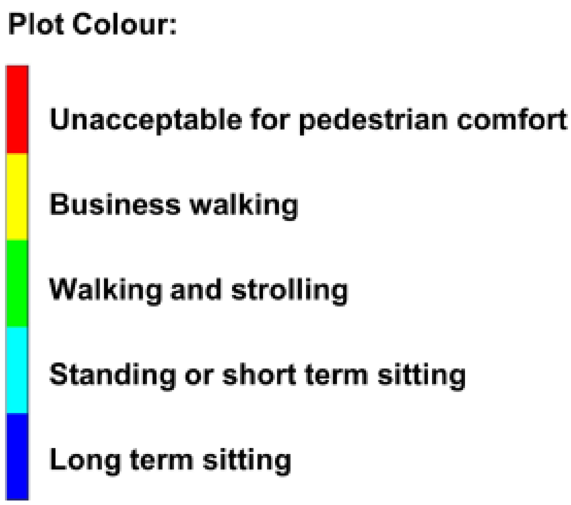

Figure 28 Lawson criteria scale

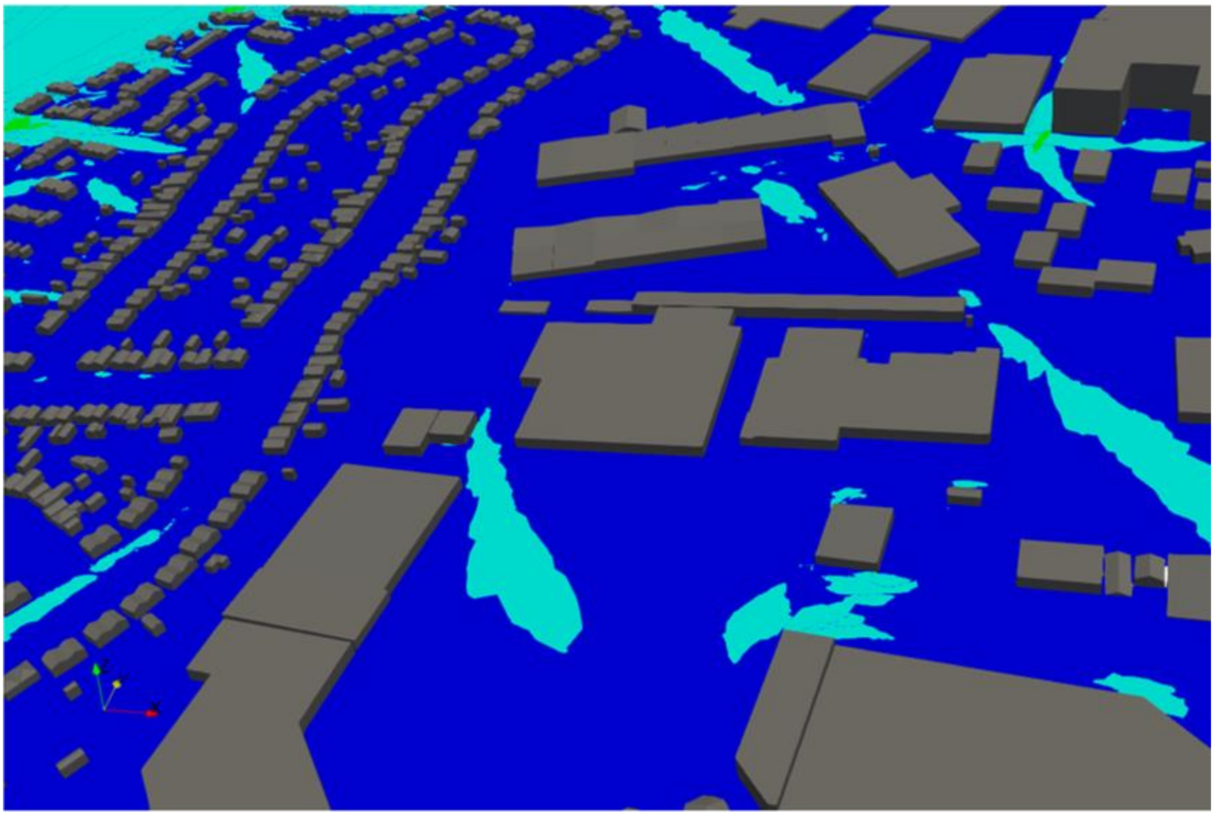

Figure 29 Wind comfort-distress map (Lawson Map) - Baseline scenario

From the simulation results the following observations are pointed out:

- The assessment of the baseline scenario has shown that no area is unsafe within the analysed study area and no conditions of distress are created in the existing environment under the local wind climate.
- The area where the proposed site is going to be constructed, is now occupied by an existing structure, the adjacent area at ground level is usable for walking and short-term sitting, the roads in the surrounding of the proposed development are usable for their intended scope (walking).
- Now there is no designated area, on the site of the proposed development, for public long-term sitting, however the site presents comfortable conditions for this activity.

5 CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

The proposed development comprises the demolition of the existing industrial / warehouse buildings northwest of Omni Park Shopping Centre, Santry, Dublin 9 and the construction of 457 no. apartments across 4 no. blocks, ranging in height from 4-12 storeys (over basement). The proposal includes 2 no. retail/café/restaurant units, 1 no. community building, 1 no. childcare facility, 1no. residential amenity space and 5 no. ESB substations.

The development also provides for a basement carpark of 213 no. spaces and 7 no. motorcycle spaces with 7 no. creche drop-off parking spaces and 6 no. carshare parking spaces located in newly reconfigured surface carpark. The proposal provides for 768 no. bicycle parking spaces.

The proposal includes the provision of a new public open space plaza, with consequential revisions to existing commercial car parking areas, to integrate the proposals with the wider District Centre.

The proposal includes the provision of pedestrian and cycle connections and improvements through Omni Park Shopping Centre, including a plaza and cycle/pedestrian link substantially in the form permitted as part of the Omni Living Strategic Housing Development (Ref. ABP-307011-20).

Access to the proposed 213 no. basement car parking spaces is via the existing Omni Park Shopping Centre. A secondary servicing and emergency access is via the existing service road to the rear of existing retail premises at Omni Park Shopping Centre and accessed from the Swords Road.

The development provides for all associated and ancillary site development, demolition and clearance works, hoarding during construction, revisions to car parking within the Omni Park Shopping Centre, soft and hard landscaping, public realm works, public lighting and signage, ancillary spaces, plant including photovoltaic panels, water infrastructure, utilities and services.

Figure 30 View of proposed development within the existing context

Figure 31 View of proposed development within the existing context

5.2.1 Sensitive Receptors

Potential receptors for the wind assessment are all pedestrian circulation routes, building entrances and leisure open areas within the site and in neighbouring adjacent areas. The pedestrian level is considered at 1.5m above ground.

In addition to the roads and entrances, some sensitive receptors such as courtyard and play area for this assessment are discussed below. These areas are designed for public use activities such as for long term sittings and are designated for the use of children which are considered 'frail person' in accordance to Lawson wind microclimate criteria, therefore the wind flows acceptable in these area are more critical and have a more restrictive criteria to be considered comfortable/safe.

The image that follows shows designated public communal and play spaces as designated within the proposed development.

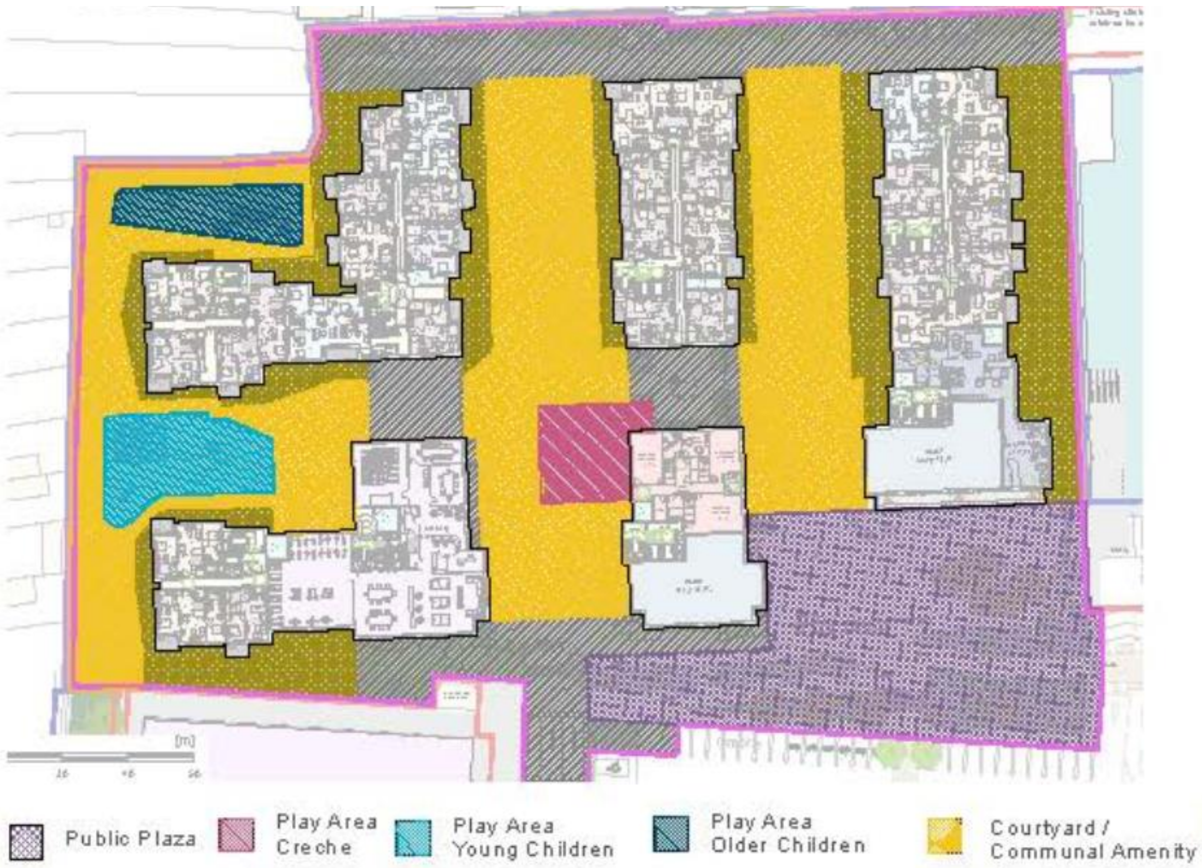

Figure 32 Amenities and Public area of the proposed development

The image below shows the main pedestrian activity area at ground level (green color) which is considered a sensitive potential receptor for the wind microclimate.

Figure 33 Sensitive receptors at ground level (in green color)

As stated in the previous section, if the predicted wind conditions exceed the threshold on the sensitive receptors, the conditions would be considered unacceptable for the type of pedestrian activity and mitigation measures should be accounted for.

In particular, it is possible to summarise the different flow features that are likely to be present for the proposed development due to the height of the blocks and the spacing between them:

Downdraft/Downdwash effect: When the leeward face of a low building faces the windward face of a tall building, it causes an increase in the downward flow of wind on the windward face of the tall building. This results in accelerated winds at pedestrian level in the space between the two buildings and around the windward corners of the tall building.

Funneling effect Wind speed is accelerated when wind is funnelled between two buildings. The intensity of the acceleration is influenced by the building heights, size of the facades, building separation distance and building orientation.

The use of landscaping is beneficial to mitigate these effects in particular as shown in the landscaping design image that follows. The landscape at the base of the blocks at ground level reduces the wind speeds at grade from the incoming wind flow, and wind conditions on the ground can improve.

A number of iterations of this study have been carried out as the design developed, including adjusting and adding mitigation measures in the form of landscape. Through CFD Modelling, the landscape trees are simulated as comprising effects of porous zones within the urban environments. The proposed landscape is implemented in the wind simulations that have been carried out, to accurately assess the actual wind speed and pattern at a pedestrian level.

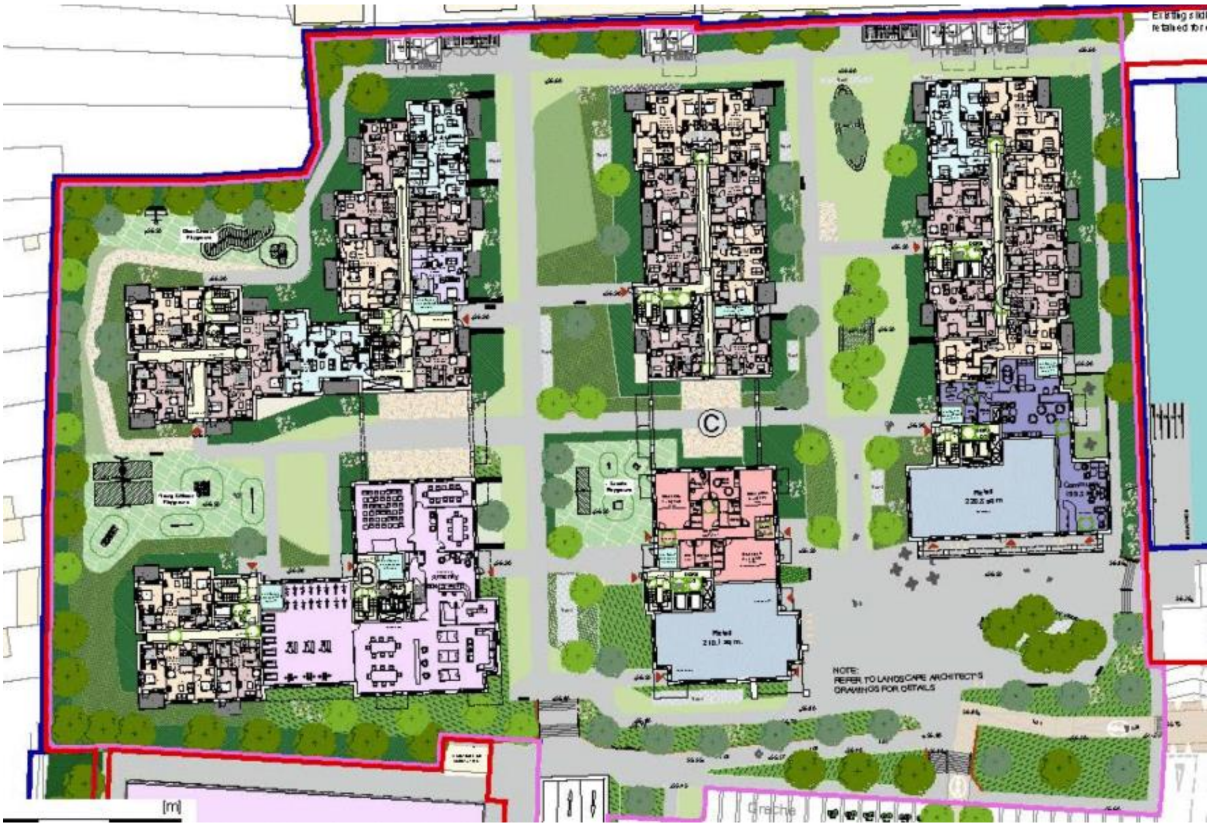

Figure 34 Proposed landscape

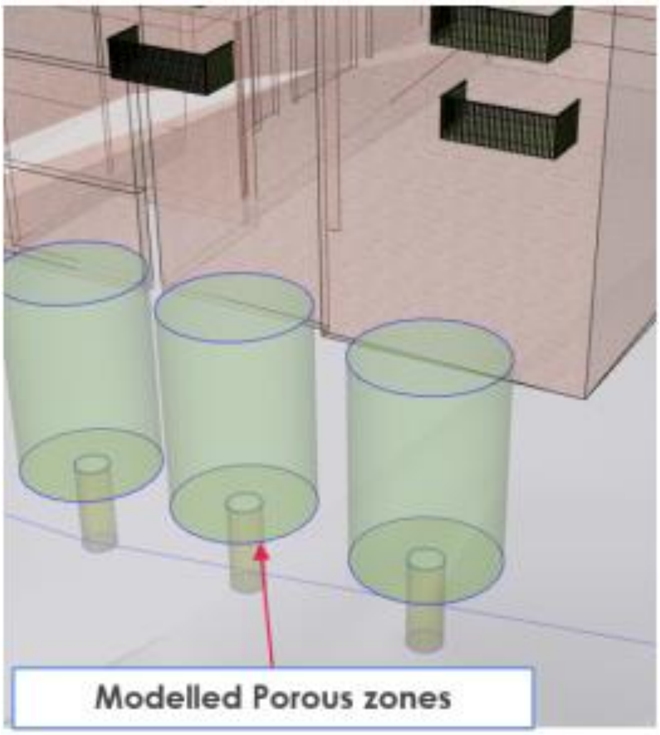

Figure 35 CFD modelling of the tree for mitigation of wind impacts

6 POTENTIAL IMPACT OF THE PROPOSED DEVELOPMENT

This section assesses the potential impact of the proposed development on the already existing environment, and the suitability of the proposed development to create and maintain a suitable and comfortable environment for different pedestrian activities.

6.2.1 Construction Phase

As the finalization of the development proceeds, the wind setting at the site would progressively conform to those of the completed development. Because windier conditions are acceptable within a construction area (not accessible to the public), and the proposed development would not be the reason for critical wind conditions on-Site (and are slightly calmer when the development is in site), the impacts evaluated on-Site are considered to be insignificant. Thus, the predicted impacts during construction phase are identified as not significant or negligible.

In summary, as construction of the Omni Plaza Strategic House Development gets underway, the wind conditions at the site would gradually adjust to those of the completed development. During the construction phase, predicted impacts are classified as negligible.

6.2.2 Operational Phase

This section shows CFD results of wind microclimate assessment carried out considering the "Operational Phase" of Omni Plaza Strategic House Development. In this case, the assessment has considered the impact of wind on the existing area including the proposed Omni Plaza Strategic House Development. Wind simulations have been carried out on all the various directions for which the development could show critical areas in terms of pedestrian comfort and safety.

Results of wind microclimate at pedestrian level (1.5m height - flow speeds) are collected throughout the modelled site and shown in particular for the areas which are considered as potential receptors. These flow velocities identify if locally, wind speeds at pedestrian-level are accelerated or decelerated in relation to the undisturbed reference wind speed due to the presence of the existing baseline environment. The impact of these speeds are then combined with their specific frequency of occurrence and presented in the maps that show the area of comfort and distress in accordance with Lawson Criteria. These maps are produced at pedestrian level on the ground and identify the suitability of each area to its prescribed level of usage and activity

6.2.3 Wind speeds at pedestrian level

Results of wind speeds and their circulations at pedestrian level of 1.5m above the development ground are presented in the following images with a colorbar ranging from 0 m/s to 8m/s, to assess wind flows at ground floor level of Omni Plaza Strategic House Development.

Wind flow speeds are shown to be within an acceptable range. Higher velocity and recirculation effects are found in the existing site.

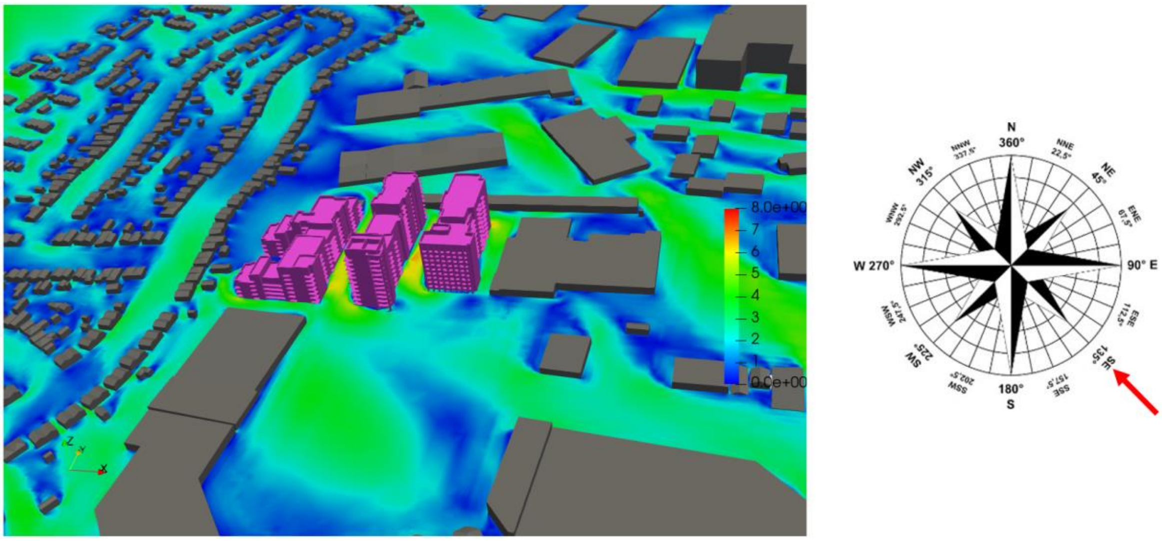

Figure 36 Wind at pedestrian level – Proposed Scenario - direction SE

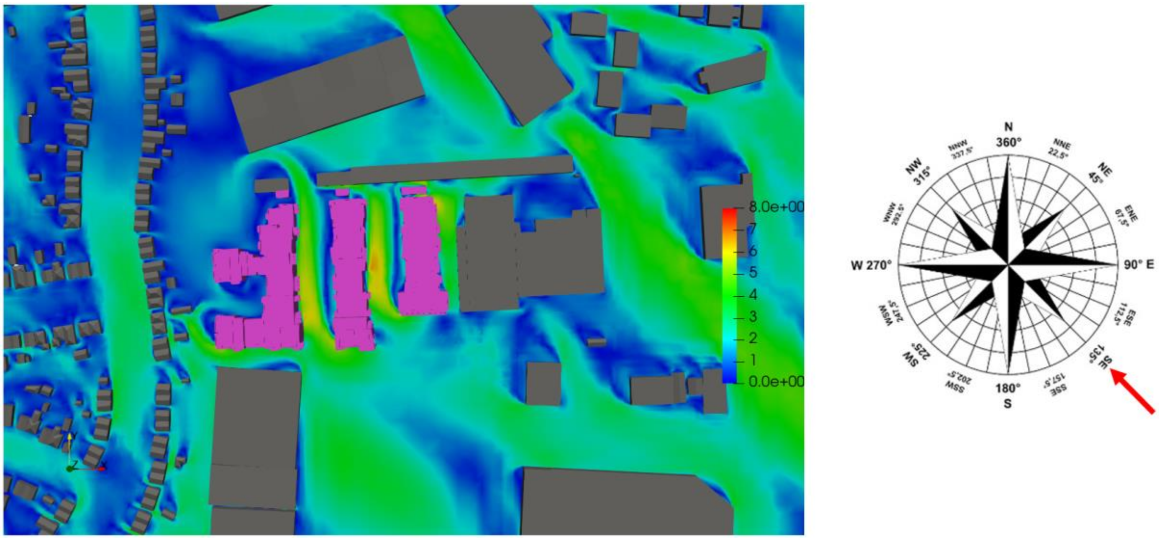

Figure 37 Wind at pedestrian level – Proposed Scenario – Plan view - direction SE

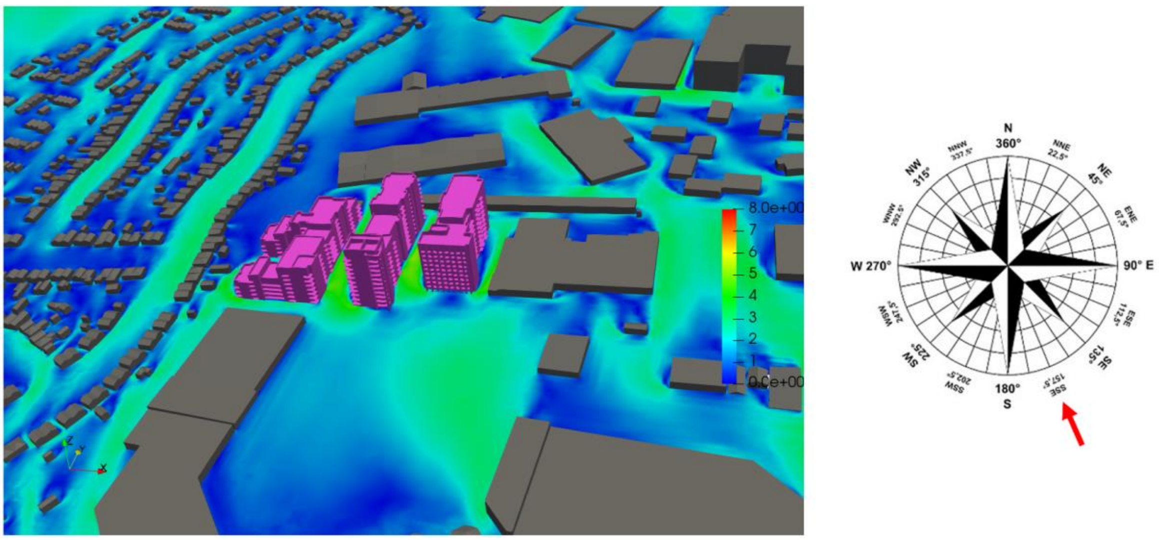

Figure 38 Wind at pedestrian level – Proposed Scenario - direction SSE

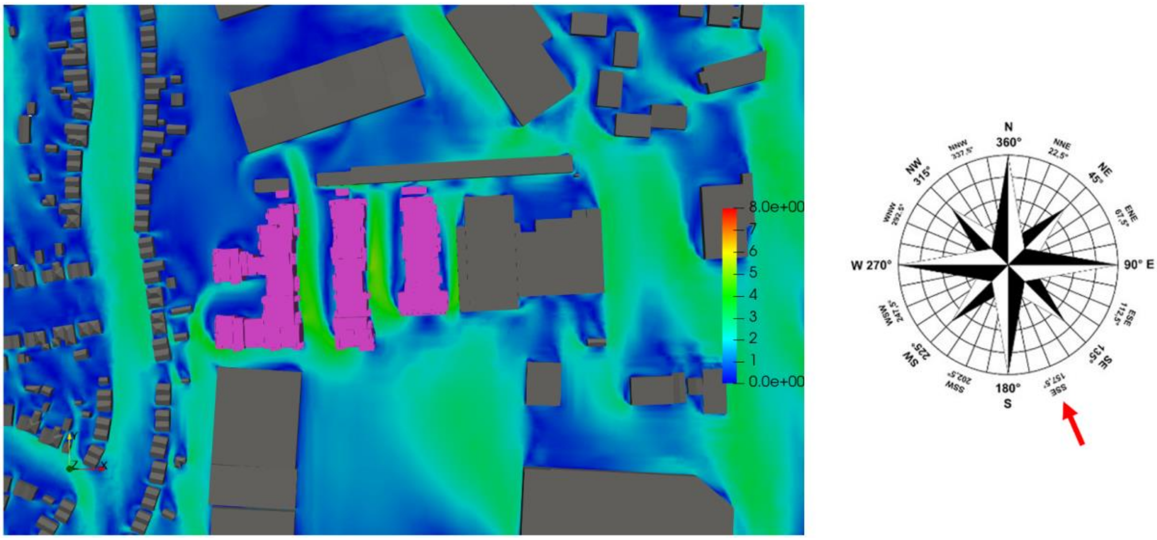

Figure 39 Wind at pedestrian level – Proposed Scenario – Plan view - direction SSE

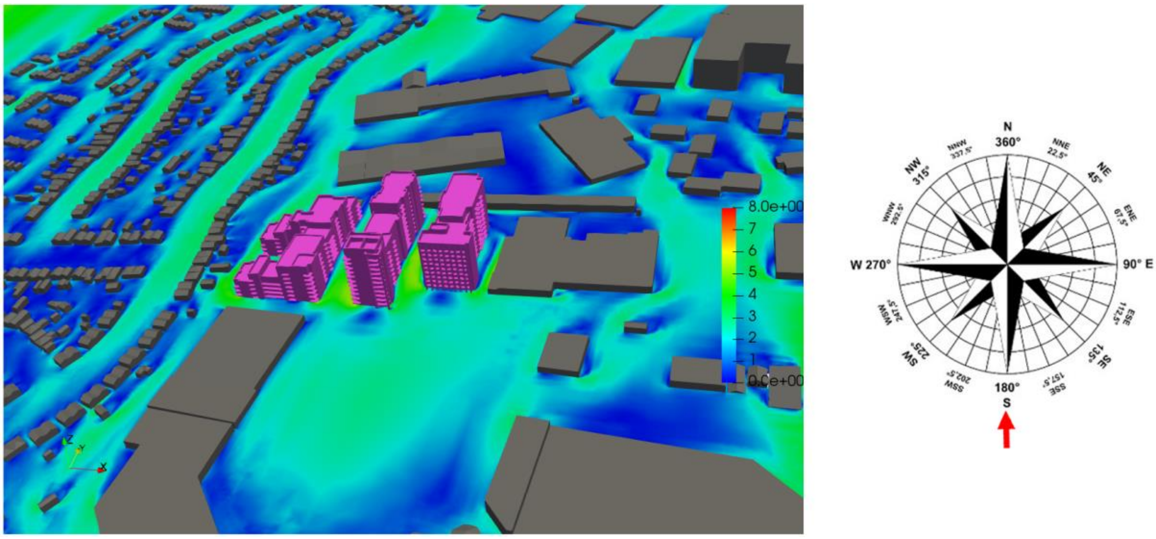

Figure 40 Wind at pedestrian level – Proposed Scenario - direction S

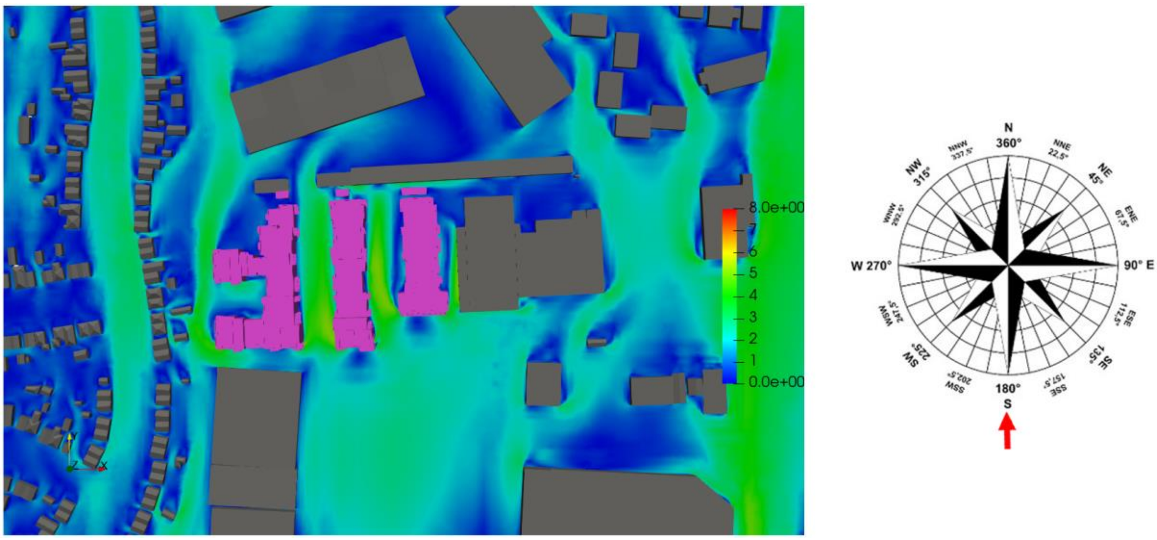

Figure 41 Wind at pedestrian level – Proposed Scenario – Plan view - direction S

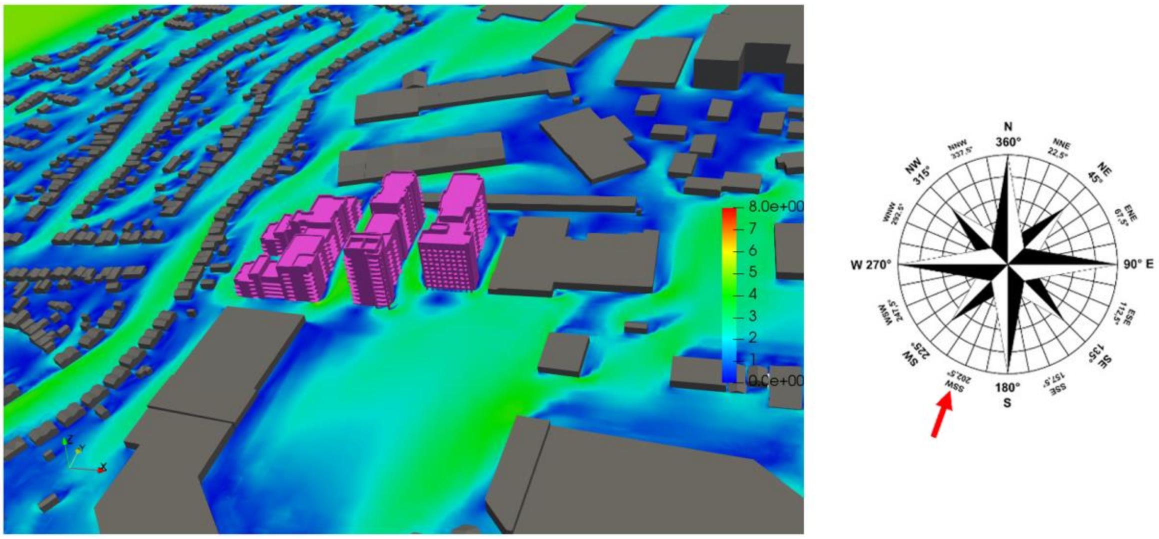

Figure 42 Wind at pedestrian level – Proposed Scenario - direction SSW

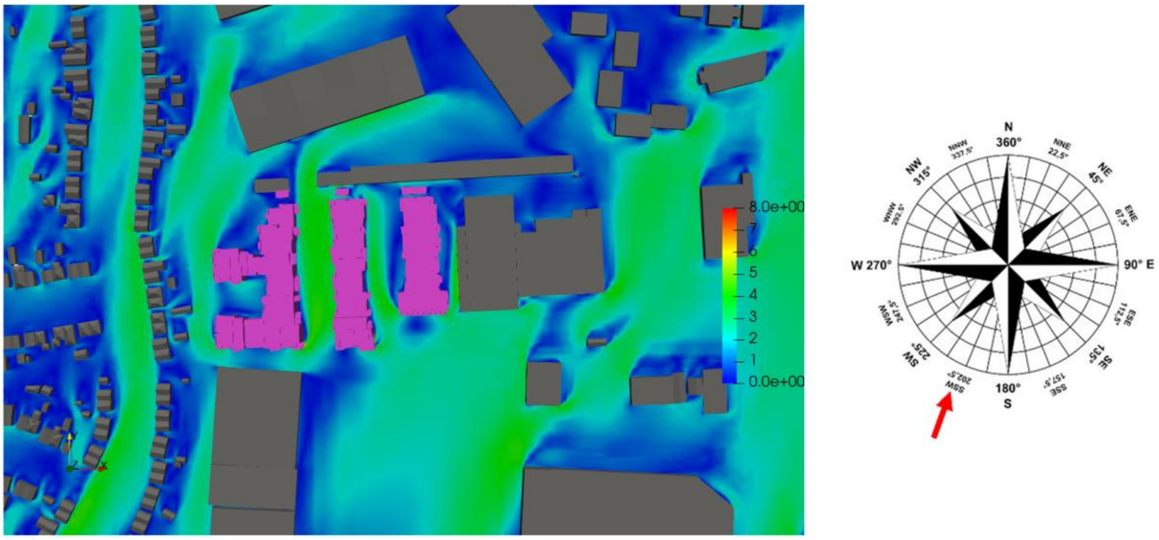

Figure 43 Wind at pedestrian level – Proposed Scenario – Plan view - direction SSW

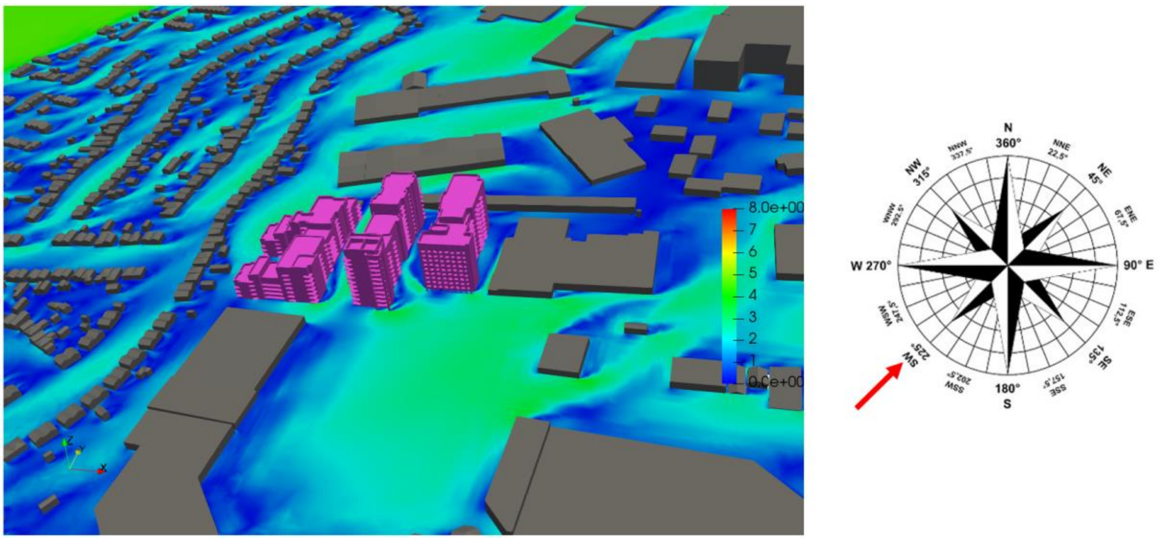

Figure 44 Wind at pedestrian level – Proposed Scenario - direction SW

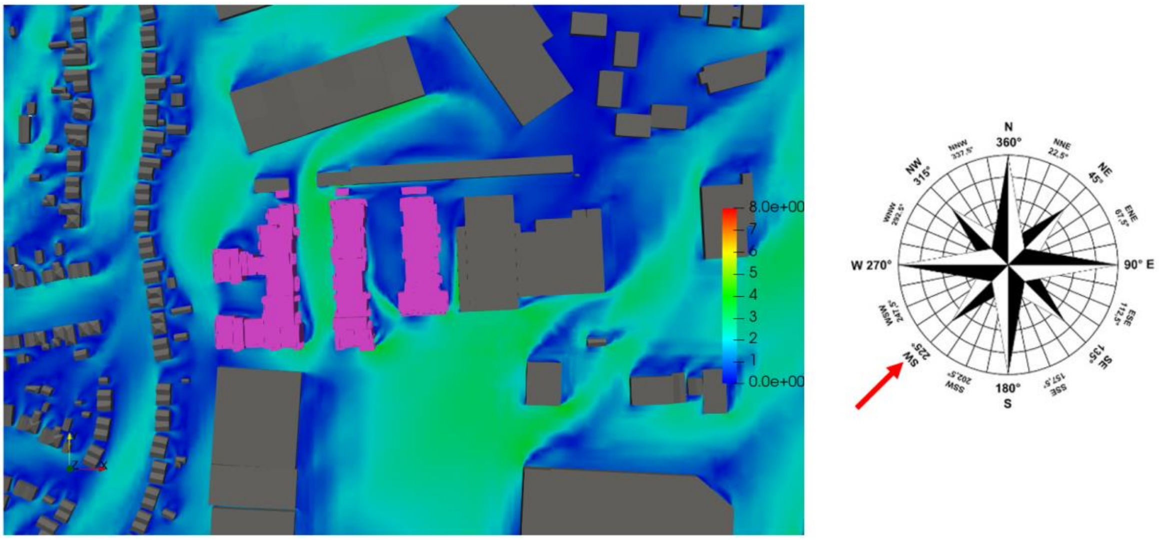

Figure 45 Wind at pedestrian level – Proposed Scenario - Plan view - direction SW

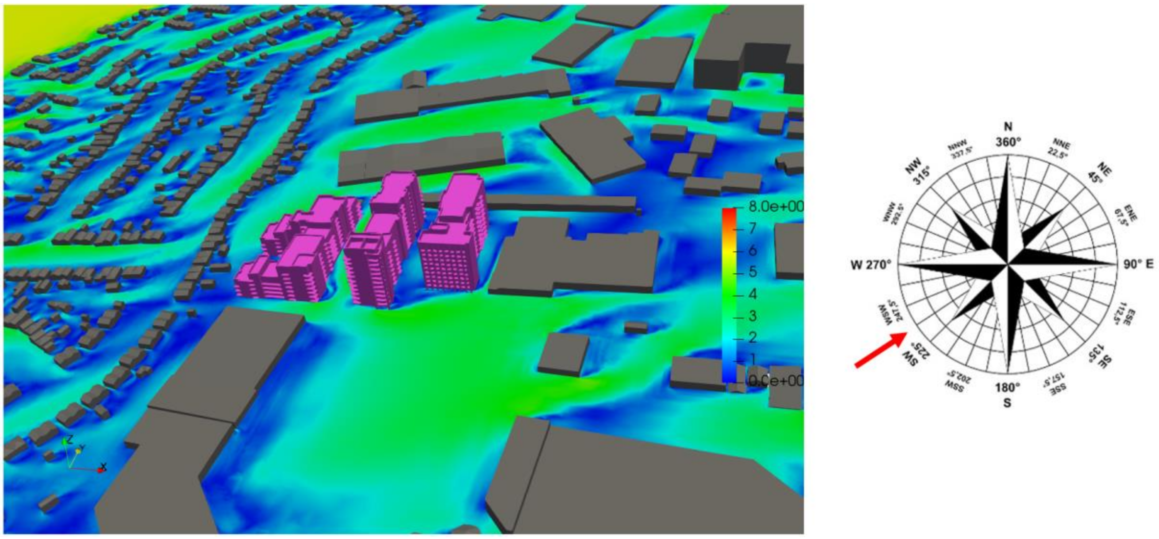

Figure 46 Wind at pedestrian level – Proposed Scenario - direction SW

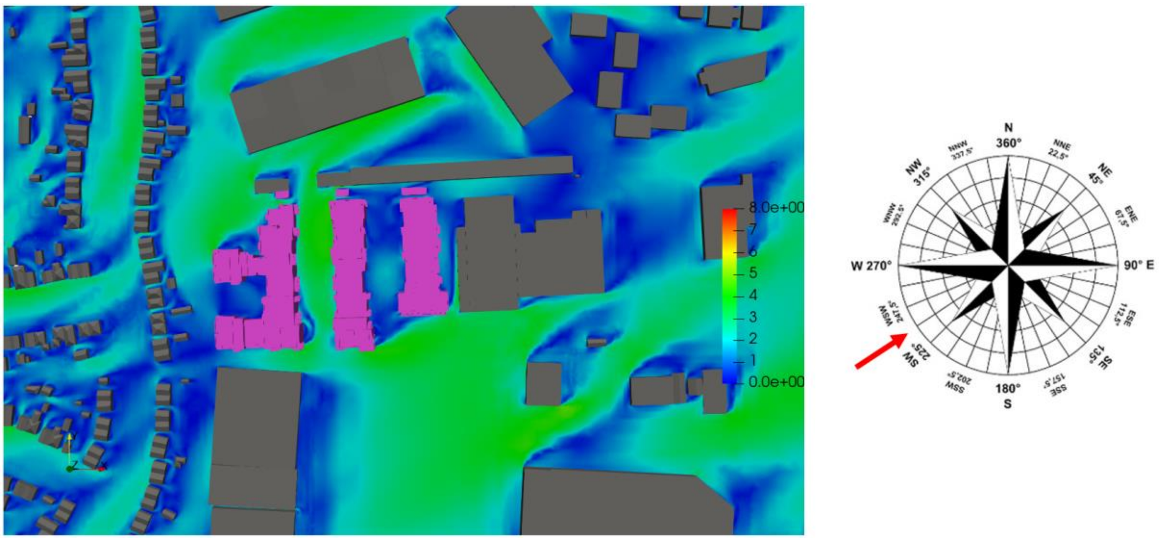

Figure 47 Wind at pedestrian level – Proposed Scenario – Plan view - direction SW

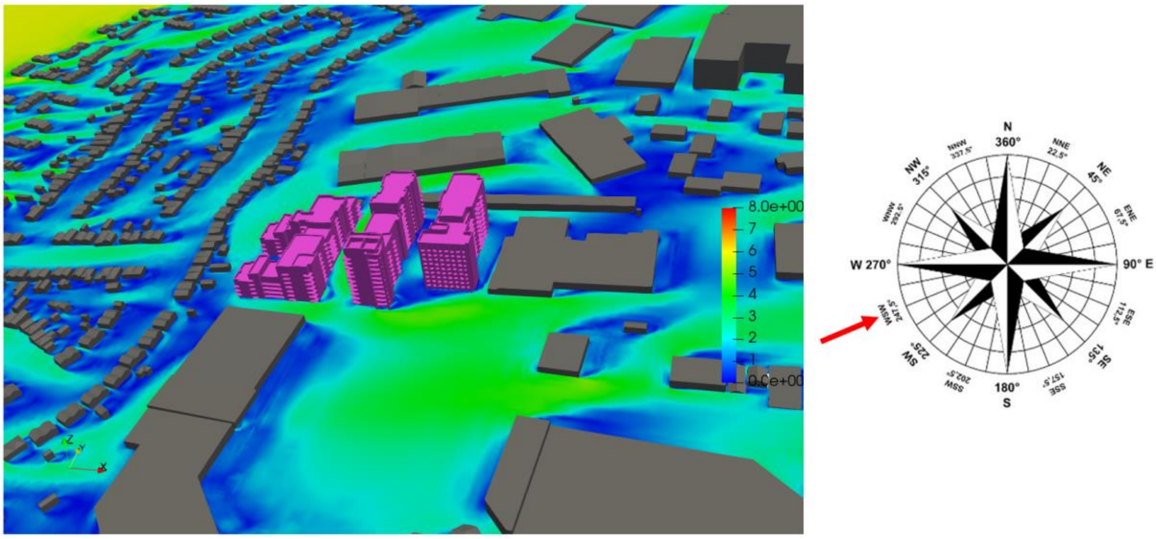

Figure 48 Wind at pedestrian level – Proposed Scenario - direction WSW

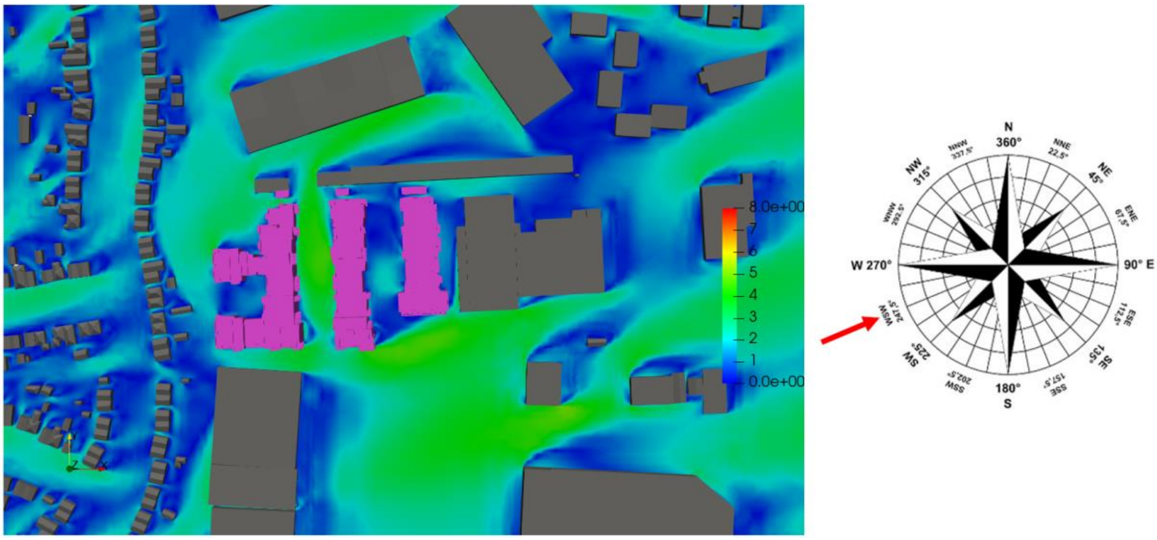

Figure 49 Wind at pedestrian level – Proposed Scenario - Plan view - direction WSW

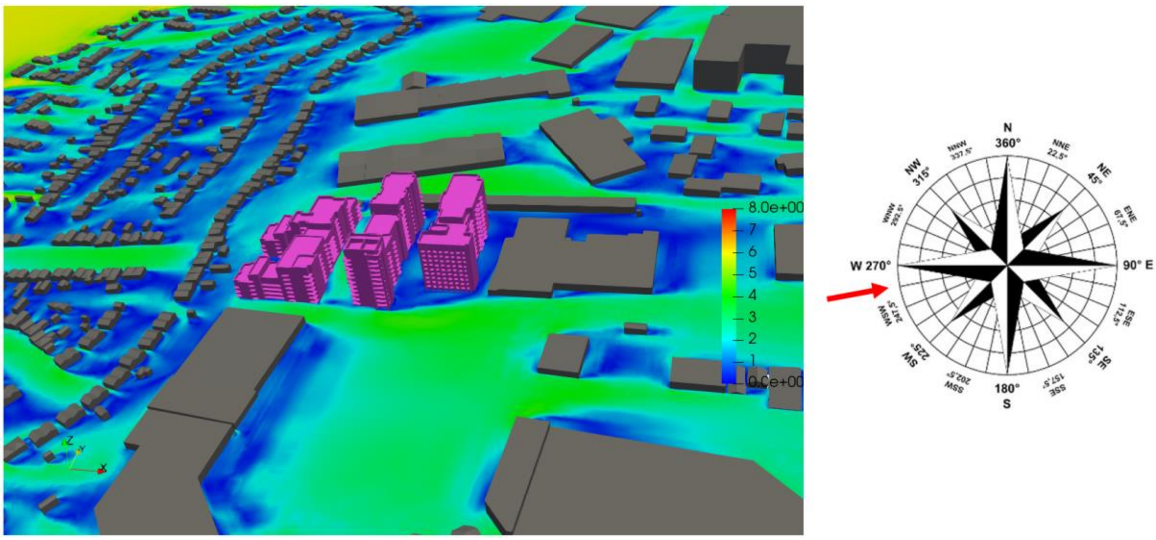

Figure 50 Wind at pedestrian level – Proposed Scenario - direction WSWW

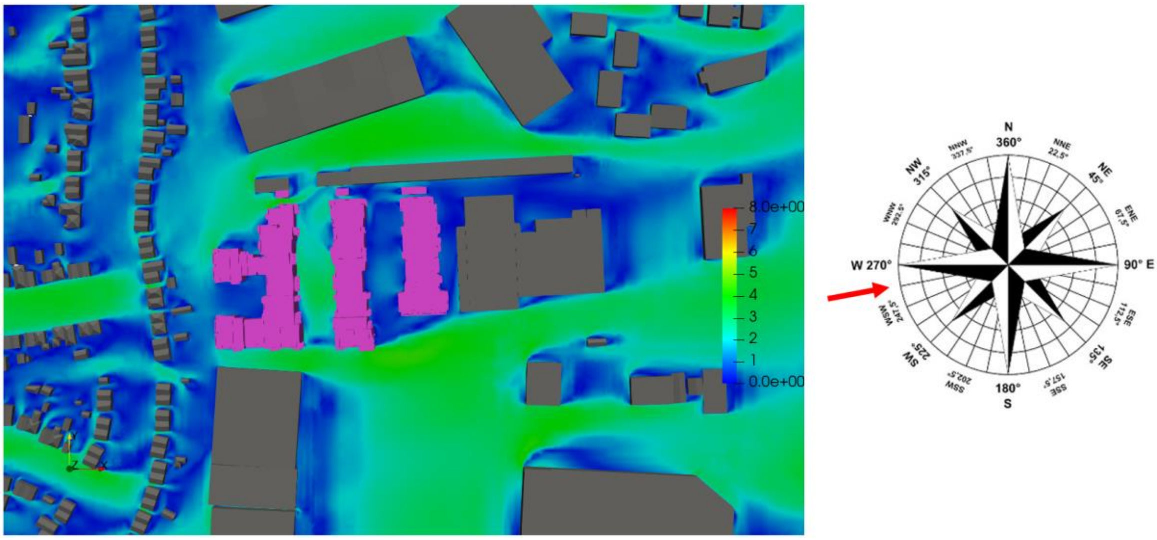

Figure 51 Wind at pedestrian level – Proposed Scenario - Plan view - direction WSWW

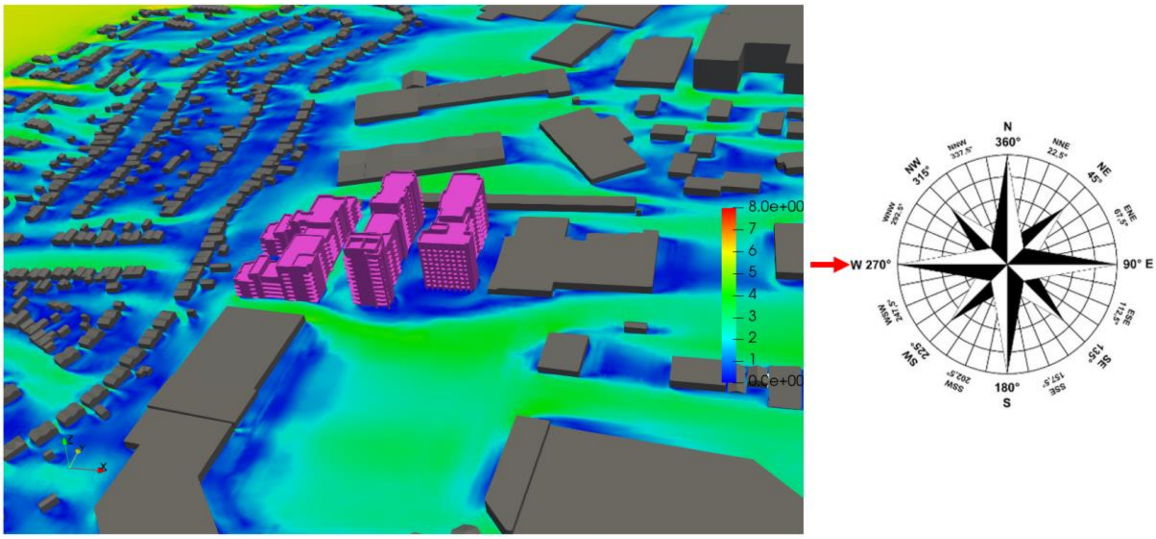

Figure 52 Wind at pedestrian level – Proposed Scenario - direction W

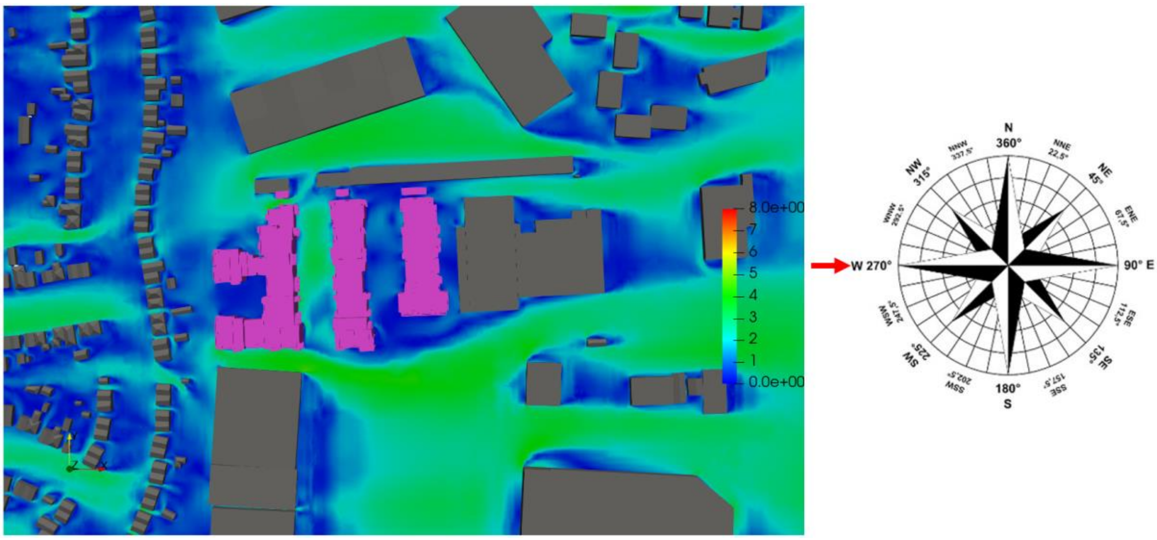

Figure 53 Wind at pedestrian level – Proposed Scenario - Plan view - direction WSWW

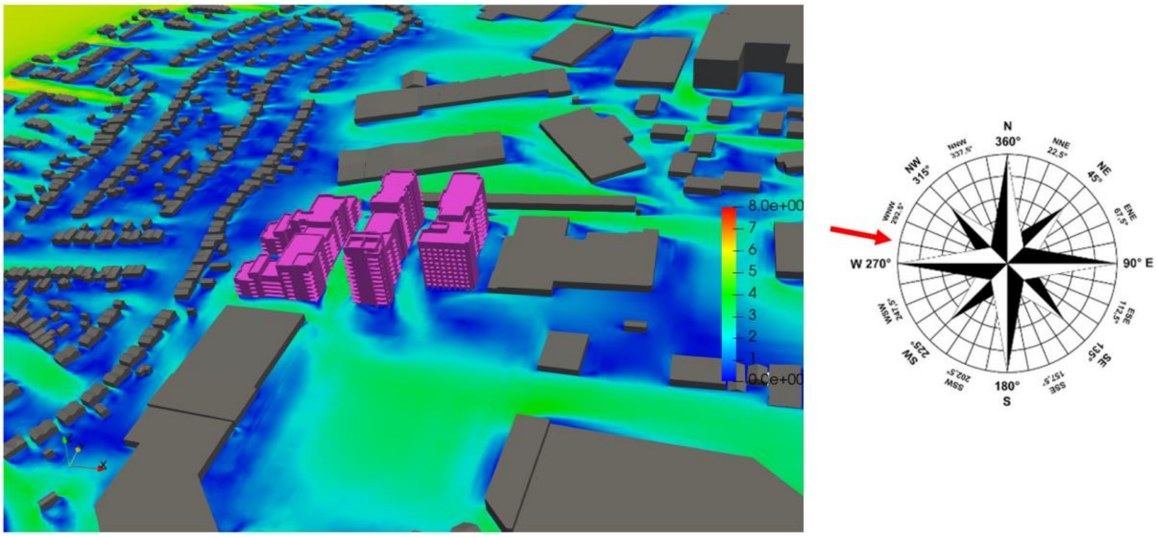

Figure 54 Wind at pedestrian level – Proposed Scenario - direction WWNW

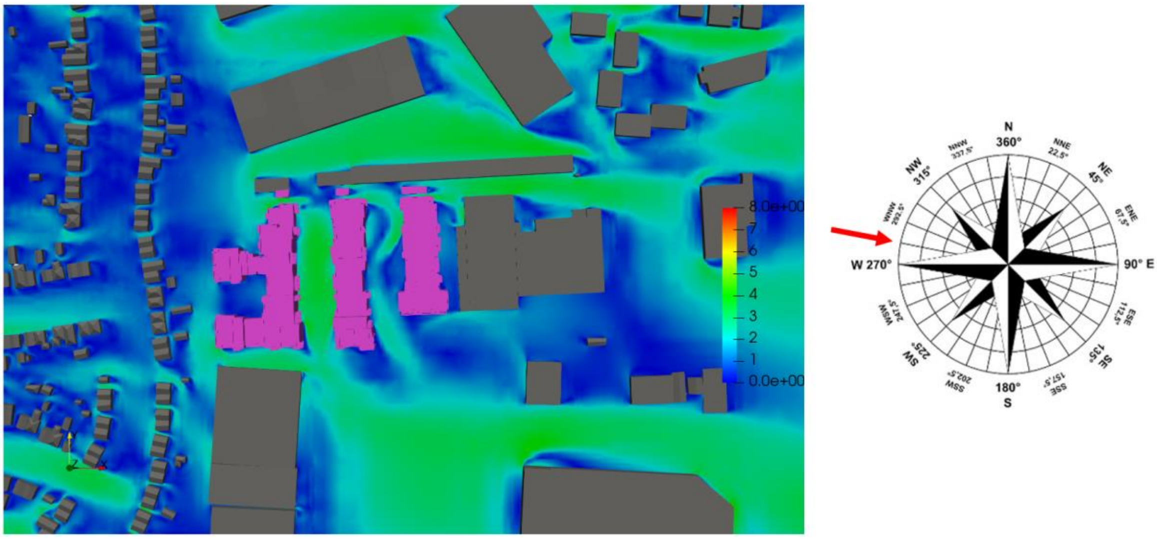

Figure 55 Wind at pedestrian level – Proposed Scenario - Plan view - direction WWNW

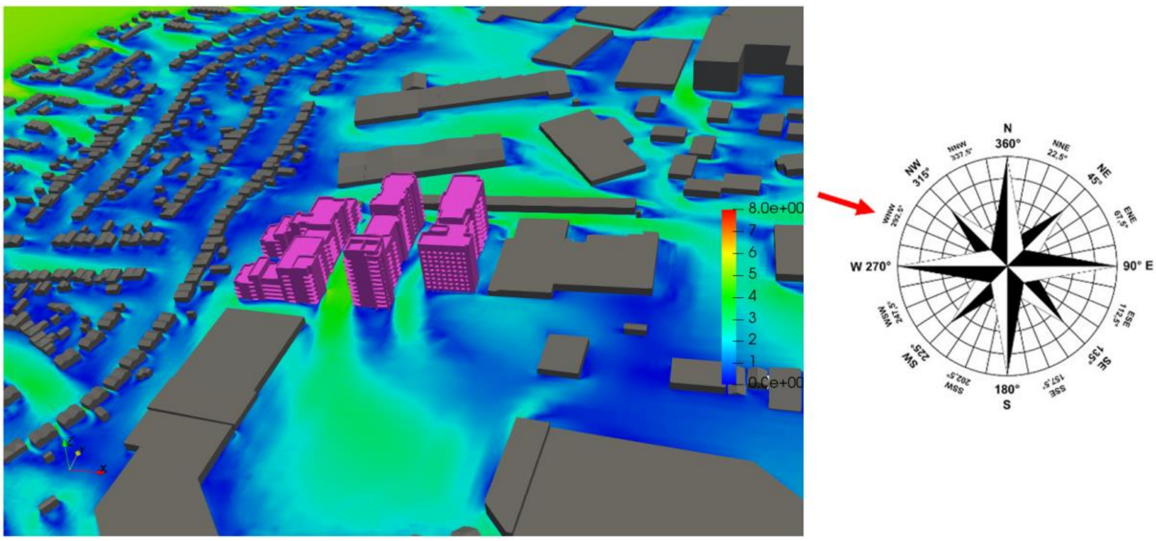

Figure 56 Wind at pedestrian level – Proposed Scenario - direction WNW

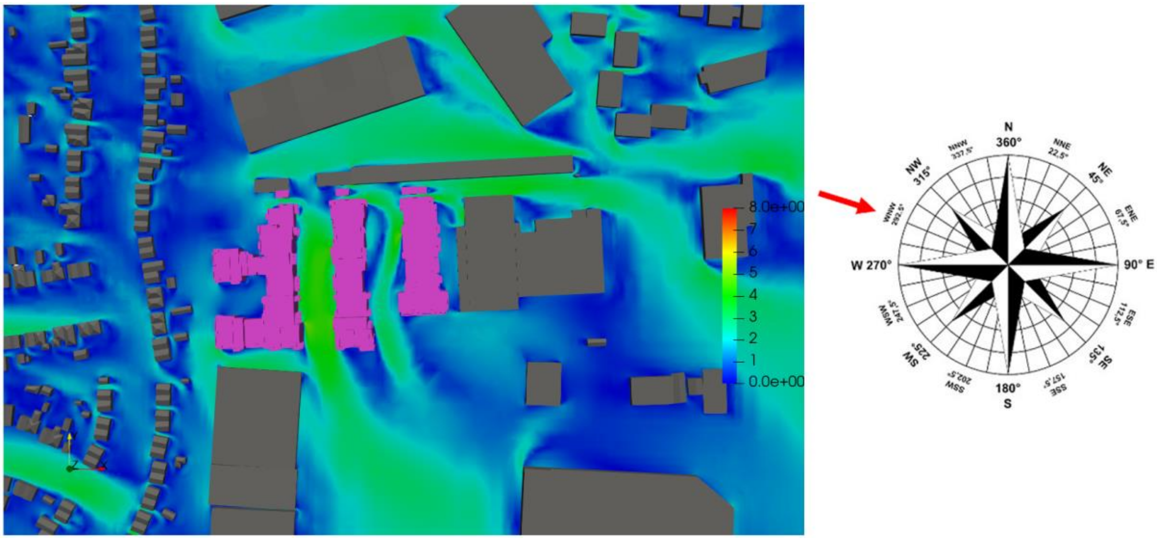

Figure 57 Wind at pedestrian level – Proposed Scenario – Plan view - direction WNW

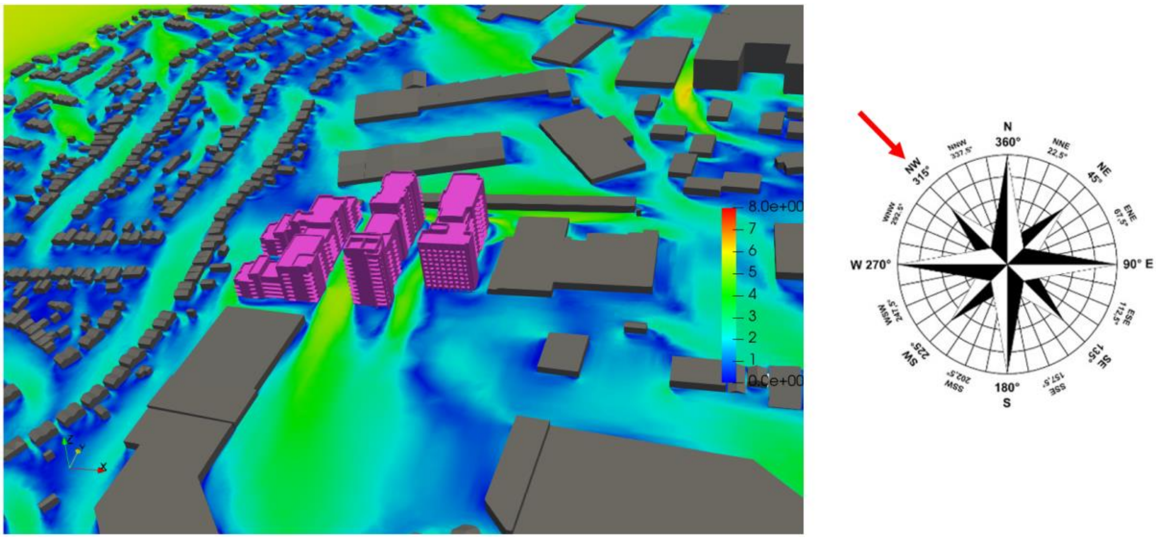

Figure 58 Wind at pedestrian level – Proposed Scenario - direction NW

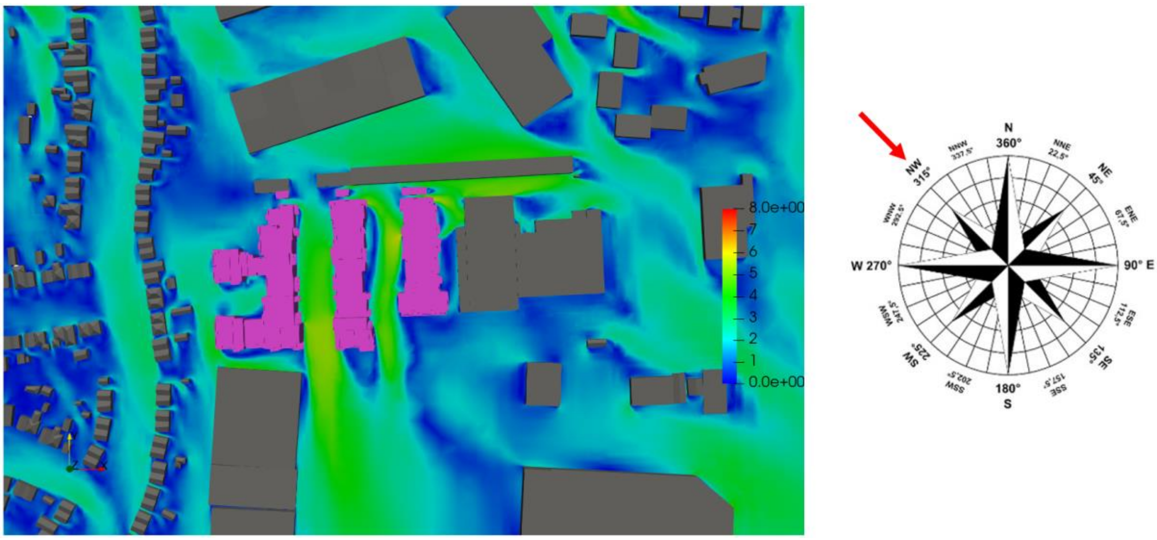

Figure 59 Wind at pedestrian level – Proposed Scenario – Plan view - direction NW

6.2.4 Wind speeds on sensitive receptors (Balconies-vertical plane)

Results of velocity across the balconies in the vertical plane are presented in the following images.
Some local accelerations can be found on the top level balconies when the wind is blowing from west-south-west direction. However, these velocities are below the threshold values defined by the acceptance criteria and therefore are not critical for safety. Furthermore, balconies are likely to be used as amenity space mostly during spring/summer season when the wind is calmer.

The images also report the wind velocity conditions across block C which is the tallest proposed block in this development. As anticipated in section 1.2 the air stream across this tall building can be, in part deflected towards the ground causing a downwash/downdraft effect. As it can be seen from the wind simulation results, the downwash effect is not critical, and the design of the ground level receiving the effect from above acts as a mitigation measure to this effect, furthermore the area below is for pedestrian walking or traffic circulation and there is no any sitting or play area located directly in the air stream from above.

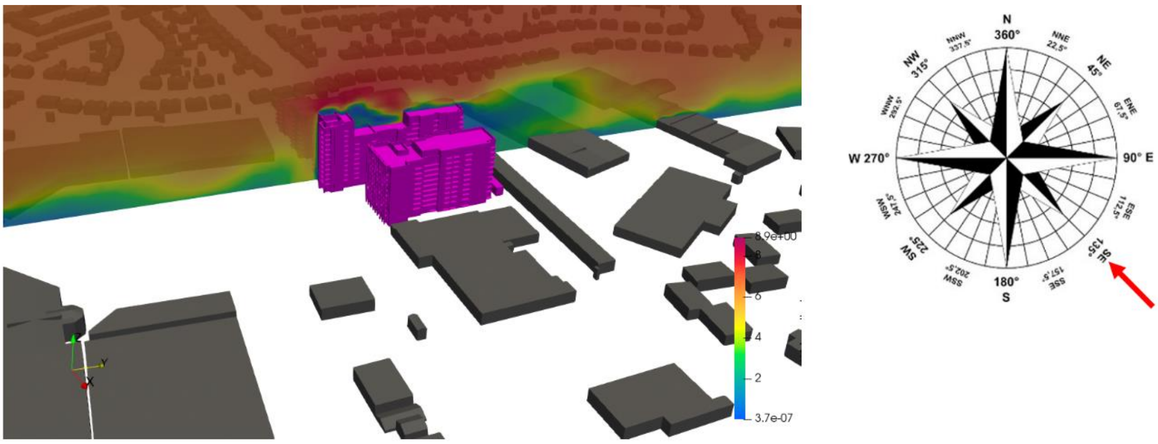

Figure 60 Wind across development – Proposed Scenario - direction SE

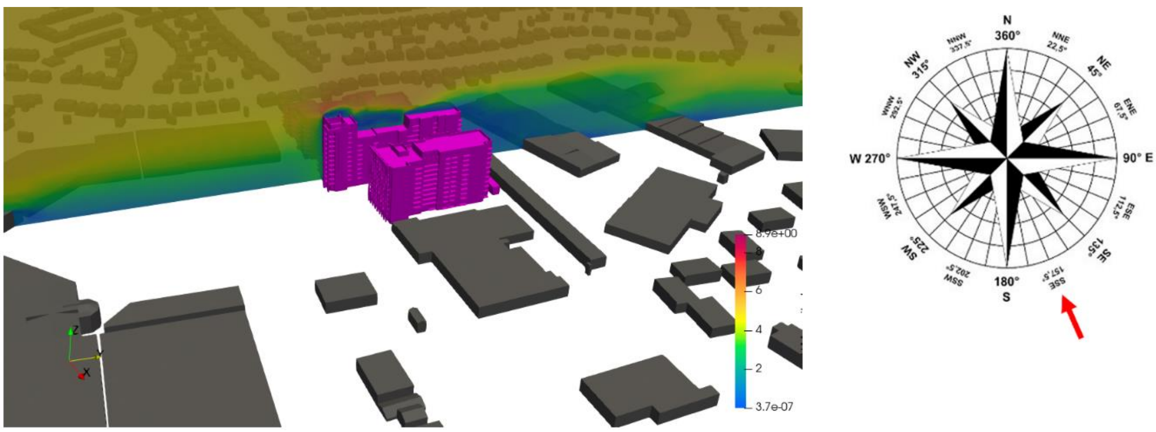

Figure 61 Wind across development – Proposed Scenario - direction SSE

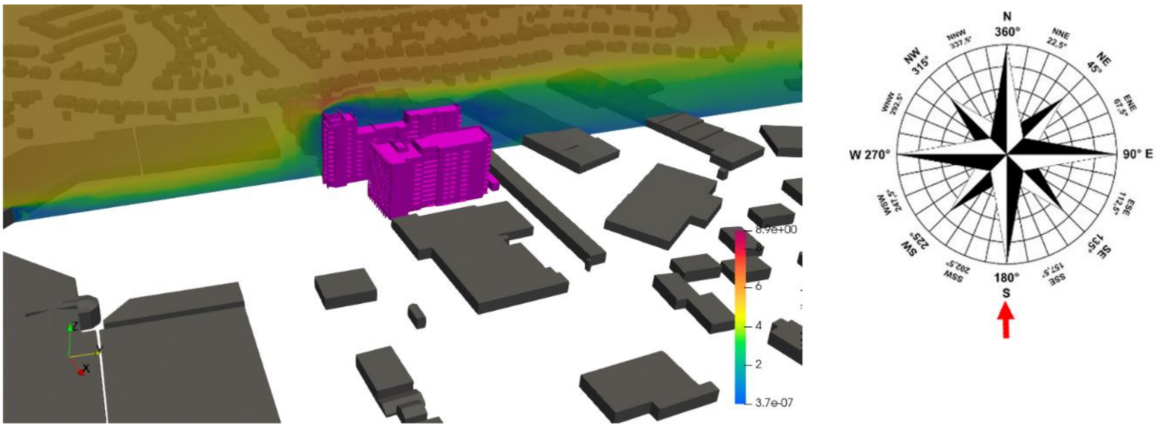

Figure 62 Wind across development – Proposed Scenario - direction S

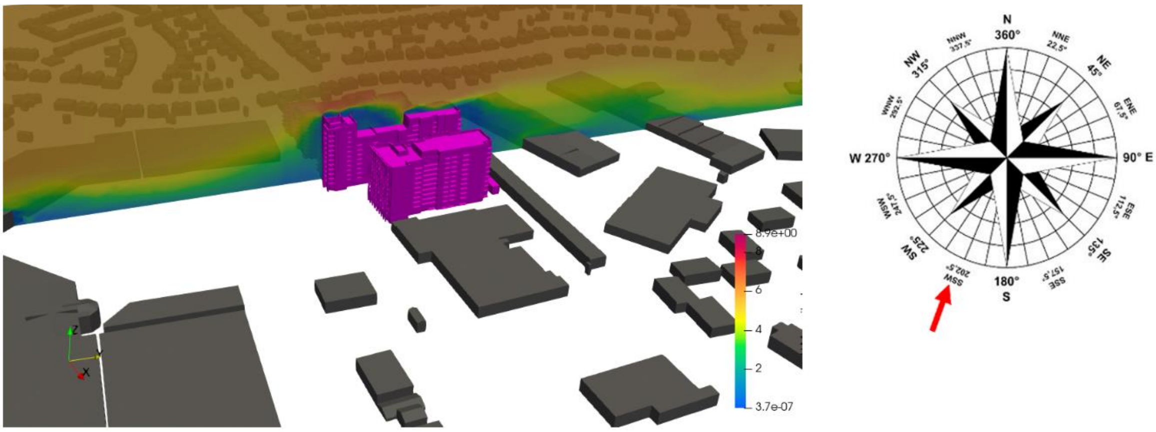

Figure 63 Wind across development – Proposed Scenario - direction SSW

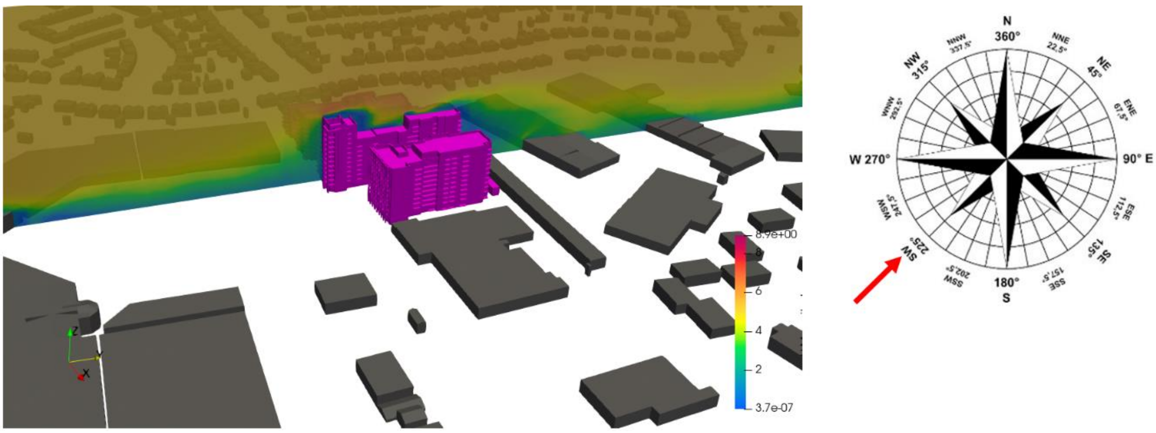

Figure 64 Wind across development – Proposed Scenario - direction SW

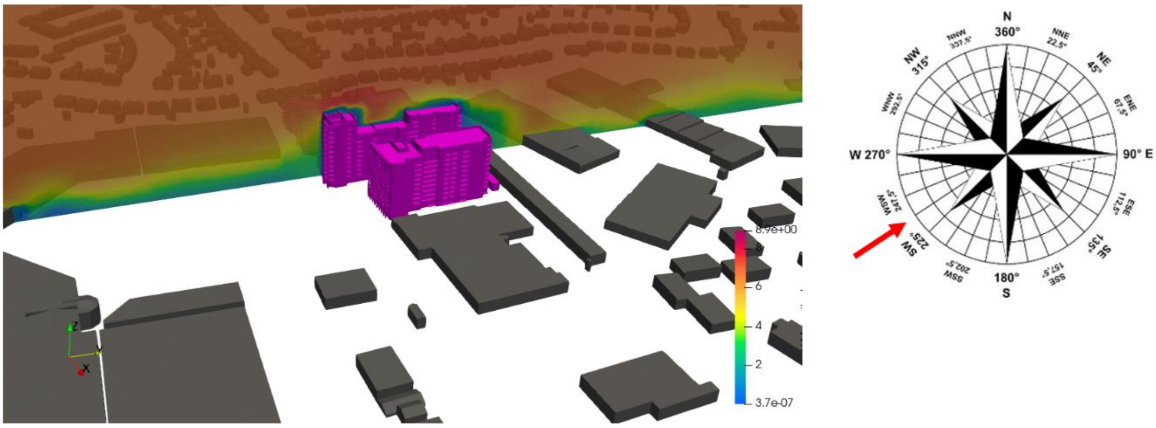

Figure 65 Wind across development – Proposed Scenario - direction SWWSW

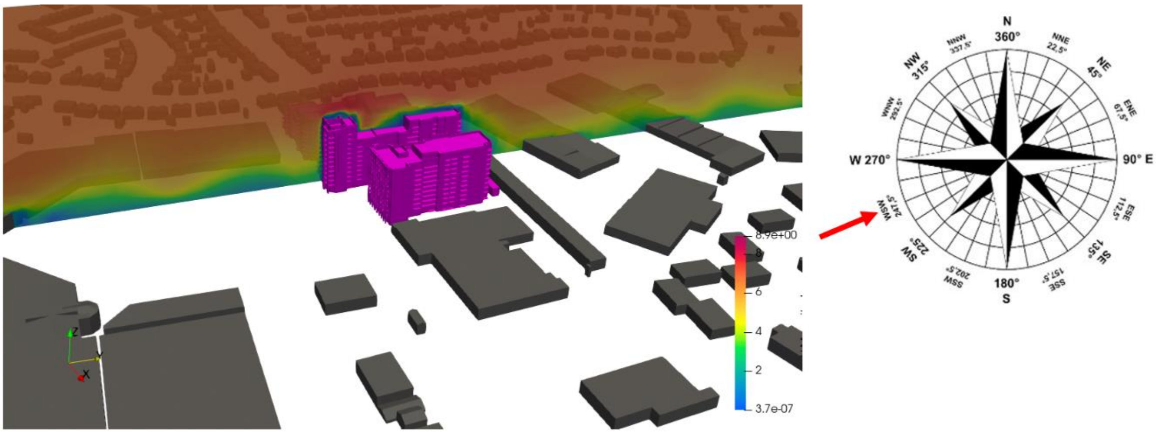

Figure 66 Wind across development – Proposed Scenario - direction WSW

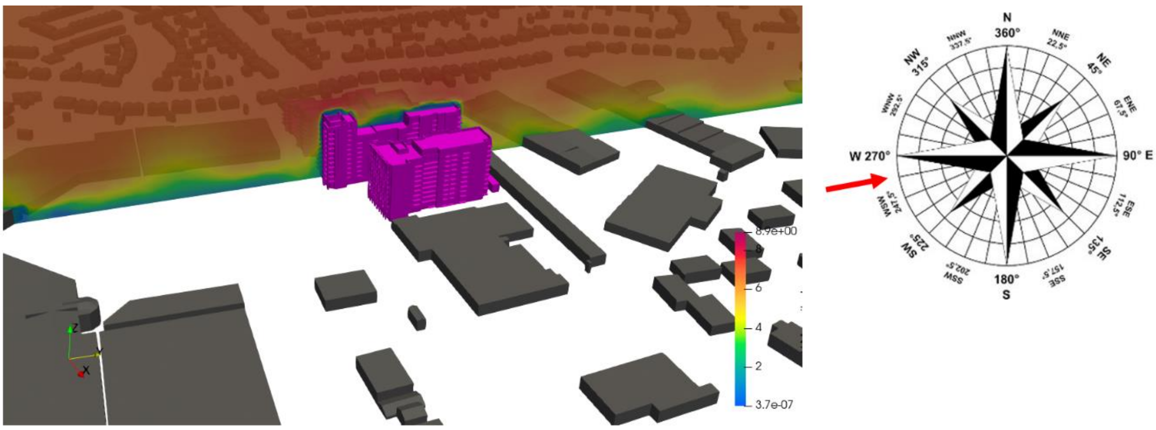

Figure 67 Wind across development – Proposed Scenario - direction WSWW

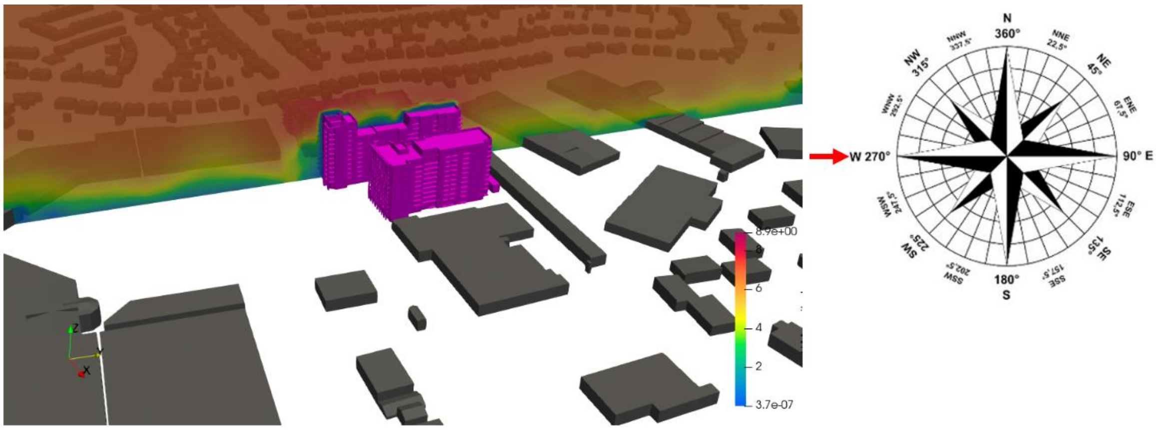

Figure 68 Wind across development – Proposed Scenario - direction W

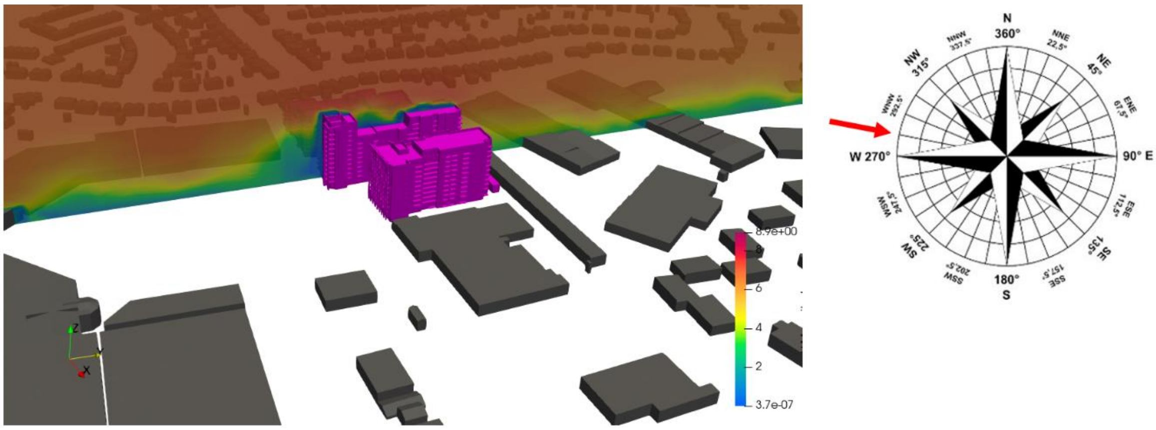

Figure 69 Wind across development – Proposed Scenario - direction WWNW

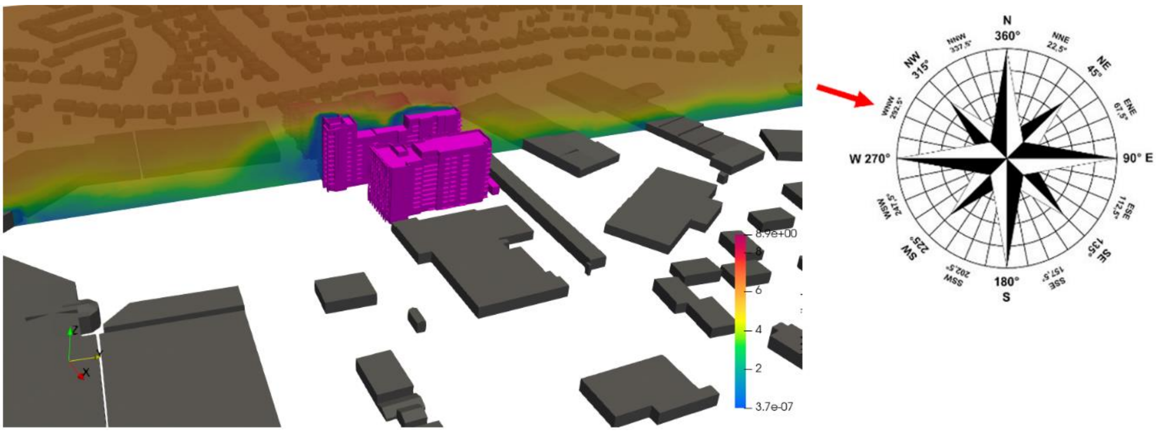

Figure 70 Wind across development – Proposed Scenario - direction WNW

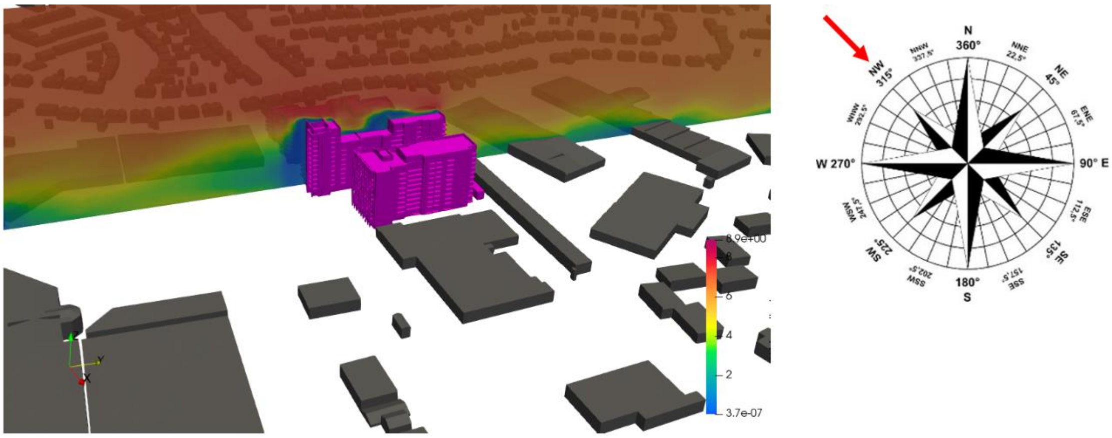

Figure 71 Wind across development – Proposed Scenario - direction NW

6.2.5 Proposed Scenario Wind Microclimate

The wind flow results obtained simulating the different direction and wind speeds, are combined with wind frequencies of occurrence to obtain comfort ratings at pedestrian level in all areas included within the model. The comparison of comfort ratings with intended pedestrian activities is shown in the Lawson Comfort and Distress Map that follows. The comfort/distress conditions are presented using a colour coded diagram below formulated in accordance with the Lawson Criteria.

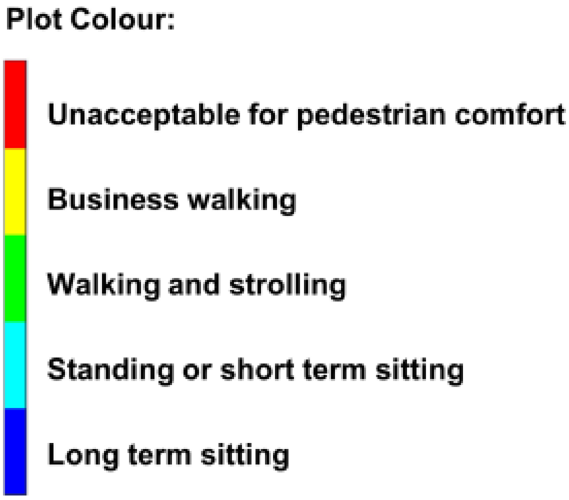

Figure 72 Lawson criteria scale

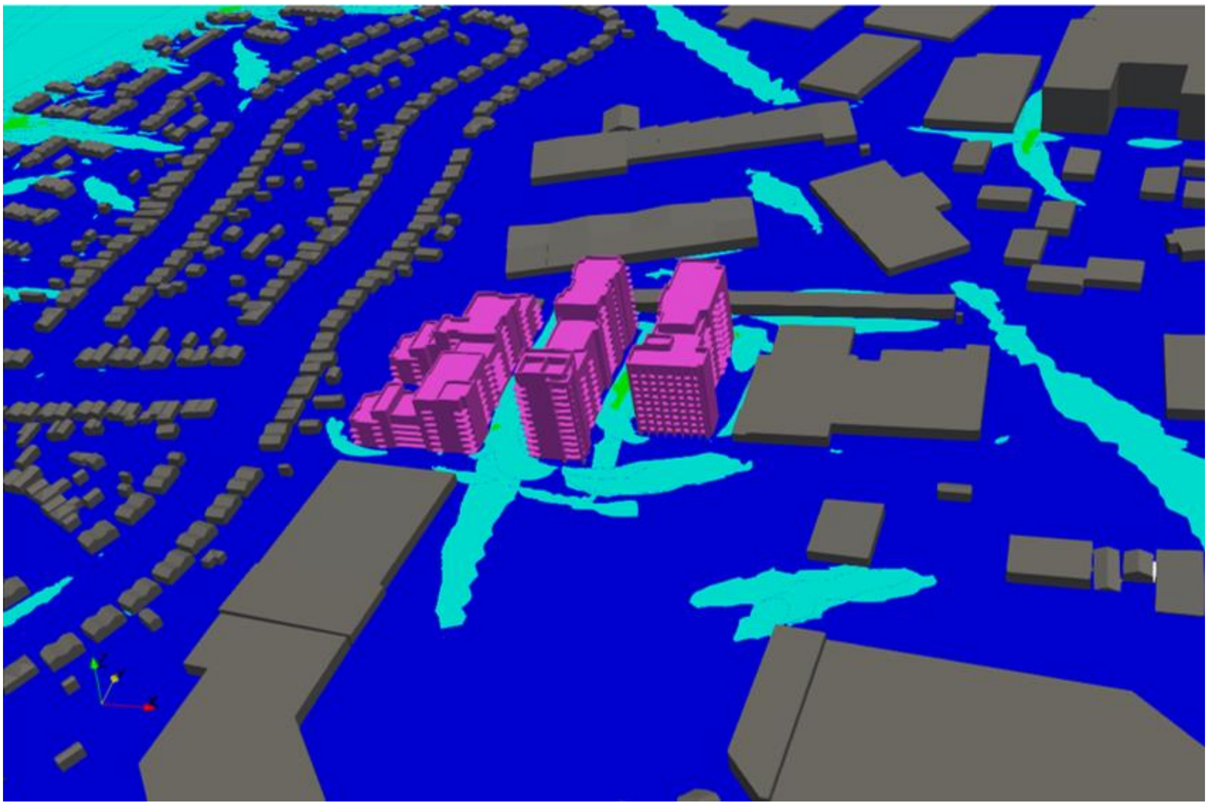

Figure 73 Wind comfort-distress map (Lawson Map) - Proposed scenario

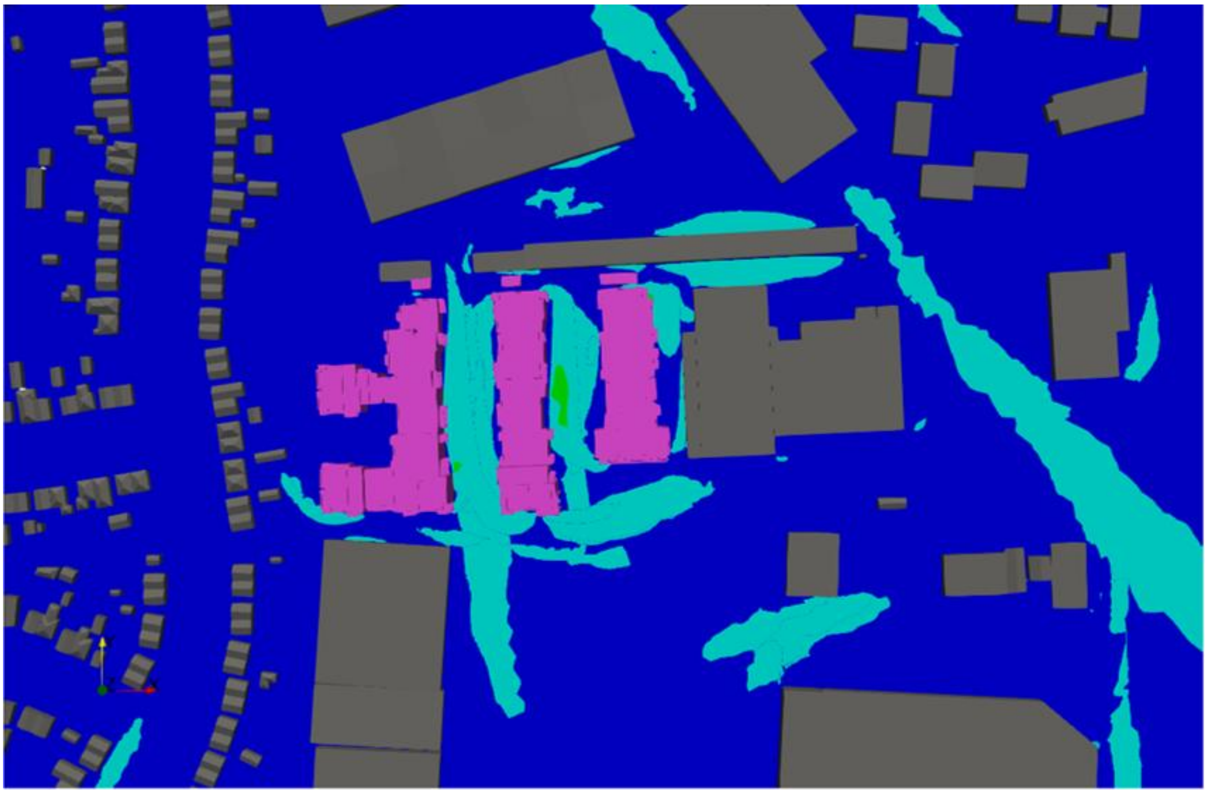

Figure 74 Wind comfort-distress map (Lawson Map) - Proposed scenario- top view

This section presented the “Wind Microclimate” study performed for Omni Plaza Strategic House Development. This study has been carried out to identify the possible wind patterns around the area proposed, under mean and peaks wind conditions typically occurring in Dublin.

The wind profile of the baseline environment has been built using the annual average meteorology data collected at Dublin Airport Weather Station. The prevailing wind directions for the site are identified as West, South-East and West-South-West, with magnitude of approximately 6m/s. A CFD numerical model was built, where the typical wind conditions were applied on the area around the development, both considering the baseline scenario and the impact of the proposed development in a cumulative assessment.

The results of the wind speeds and patterns formed under the different simulated wind conditions were combined with the frequency of occurrence of the same and an overall wind map was produced (Lawson map) which has shown the suitability of each area to a specific pedestrian activity.

The following conclusions can be made from observing the results of the wind microclimate analysis and comparing the results, under the same wind conditions for the baseline scenario with the proposed development scenario in a cumulative assessment:

- The proposed development does not impact or give rise to negative or critical wind speed profiles at the nearby adjacent roads, or nearby buildings. Moreover, in terms of distress, no critical conditions were found for “Frail persons or cyclists” and for members of the” General Public” in the surroundings of the development.

- The development is designed to be a high-quality environment for the scope of use intended of each area/building (i.e., comfortable, and pleasant for potential pedestrians).

- The assessment of the proposed scenario has shown that no area is unsafe, and no conditions of distress are created by the proposed development.

The table at the end of this summary indicates the impact and significance of the proposed development on the on-site receptors (pedestrian areas, roads, entrances) and on the off-site receptors (roads/ pedestrian areas off-site on the north, south, west and east directions).

The results of the baseline scenario are compared against those of the proposed scenario. As a result of the proposed development construction, the wind on the surrounding urban context is also mitigated when compared with the baseline situation. The proposed development therefore has a beneficial effect on the surrounding wind microclimate and can create comfortable pedestrian areas and public spaces. Furthermore, the proposed scenario assessment demonstrates that wind microclimate conditions are also improving (calmer areas on off-site receptors) when the proposed development is analysed in conjunction with the existing developments within an area of 400m radius from the centre of the site.

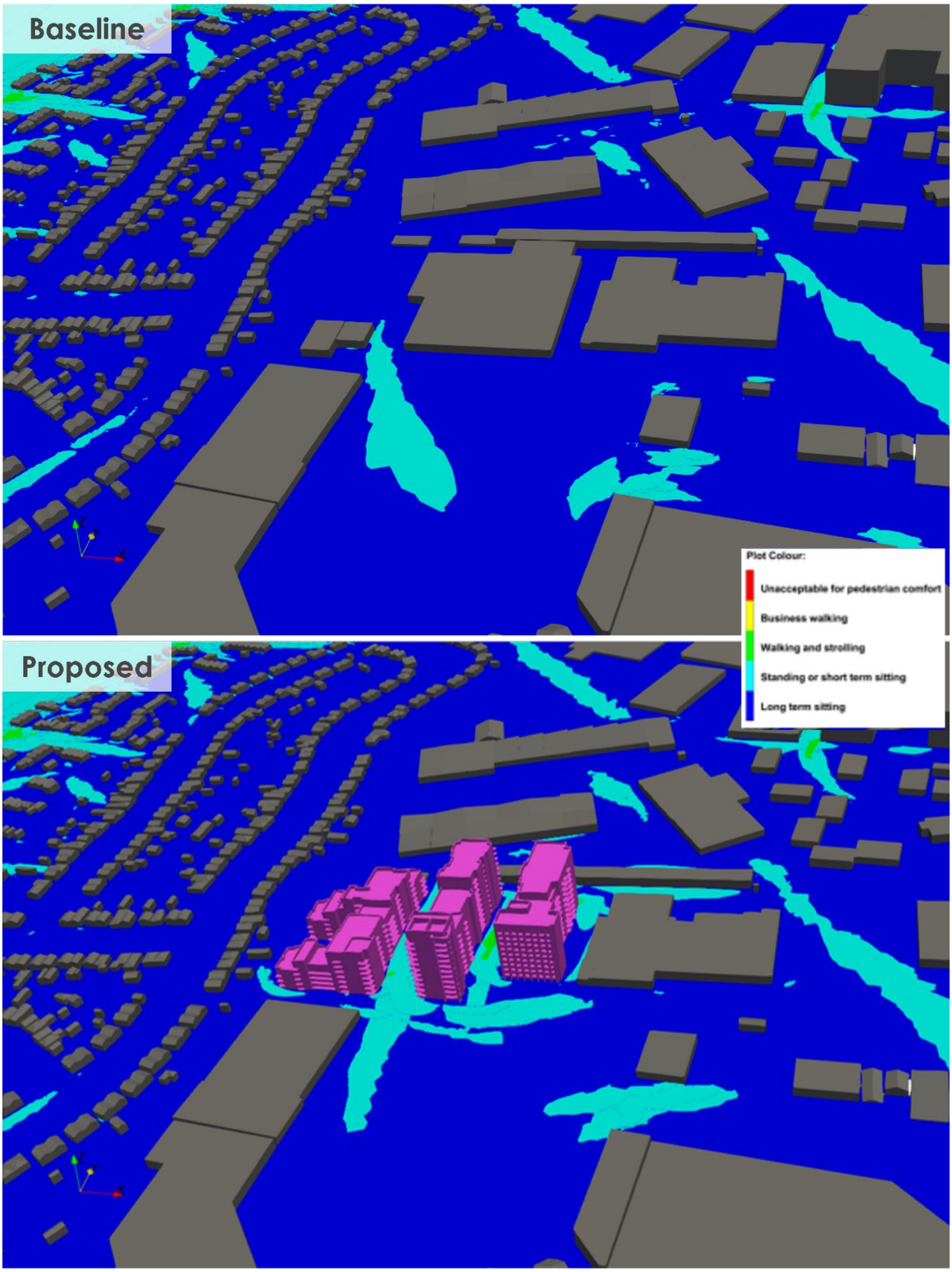

Figure 75 Wind comfort/distress map – Baseline versus Proposed scenario

Table.9 Significance impact of the proposed development versus baseline conditions

Potential Receptors *(on-site)*	**Baseline Conditions**	**Proposed Development Conditions**	**Impact Significance**
Roads	Conditions are "suitable" for the intended pedestrian use.	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	*Negligible*
Entrances	Not applicable	Conditions are "suitable" for the intended pedestrian use.	*Negligible*
Pedestrian circulation areas	On the location designated for this use conditions are "suitable" for the intended pedestrian use.	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	*Negligible*
Balconies	Not applicable	Conditions are "suitable" for the intended use. (short/long-term sitting especially in relation to the balconies and considering the wind roses of the spring/summer seasons).	*Negligible*
Ground Amenity areas	Not applicable	Conditions are "suitable" for the intended use. (short/long-term sitting considering the wind roses of the spring/summer season).	*Negligible*
Potential Receptors *(off-site)*	**Baseline Conditions**	**Proposed Development Conditions**	**Impact Significance**
Off-Site Area-North	Conditions are suitable for the pedestrian activity intended.	Conditions become calmer than required for the intended pedestrian use (by at least one comfort category).	*Negligible*
Off-Site Area-South	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	Conditions remain the same as in the baseline scenario.	*Negligible*
Off-Site Area-East	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	Conditions remain the same as in the baseline scenario.	*Negligible*
Off-Site Area-West	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	Conditions remain the same as in the baseline scenario.	*Negligible*

7 Potential Cumulative Impacts

This section assesses the impact of the proposed development on the existing environment and also considers projects that have been:

- *granted planning permission but that are not built yet*

In accordance with the guideline cited in section 11.2, the wind microclimate study should consider the effect of the proposed development together with buildings (existing and/or permitted) that are within 400m from the centre of the site. Other taller buildings outside of this zone that could have an influence on wind conditions within the project site should be included for wind directions where they are upwind of the project site. Having seen the proposed site and proposed development, at the time of this planning application submission, the permitted developments which are included in a cumulative assessment are as detailed in the list below and shown in the Figure 76

- OMNI Living (Permitted scheme not built yet)
- Unit 126 Bank (Permitted scheme not built yet)
- Santry Place (Permitted and partially constructed scheme)
- Swiss Cottage (Constructed scheme).

Figure 76 Cumulative Scenario

7.2.1 Wind speeds at pedestrian level

Results of wind speeds and their circulations at pedestrian level of 1.5m above the development ground are presented in the following images to assess wind flows at ground floor level of Omni Plaza Strategic House Development.

Wind flow speeds are shown to be within an acceptable range. Higher velocity and recirculation effects are found in the existing site.

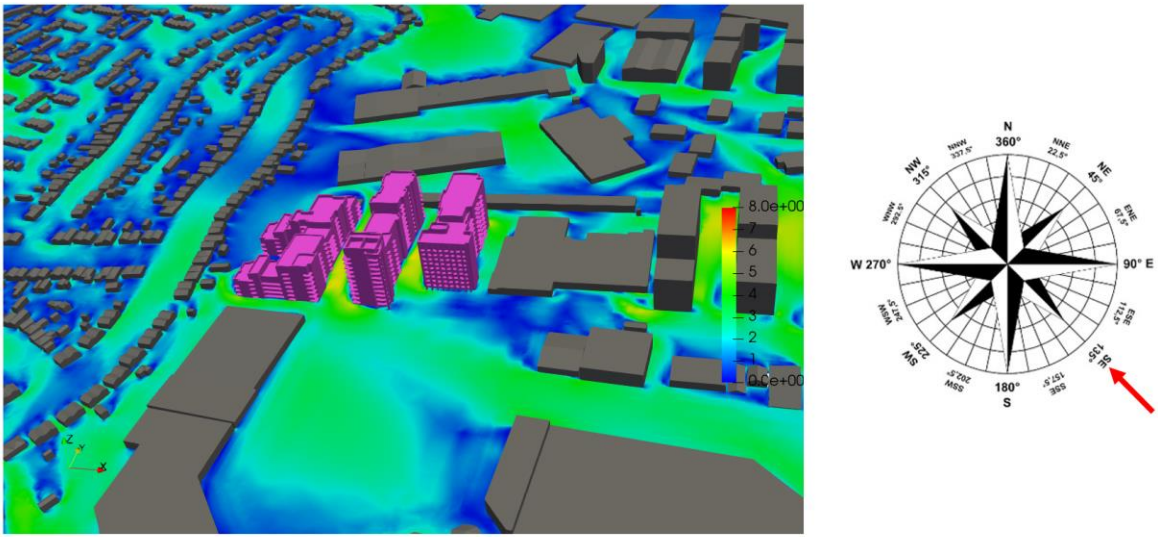

Figure 77 Wind at pedestrian level – Cumulative Scenario - direction SE

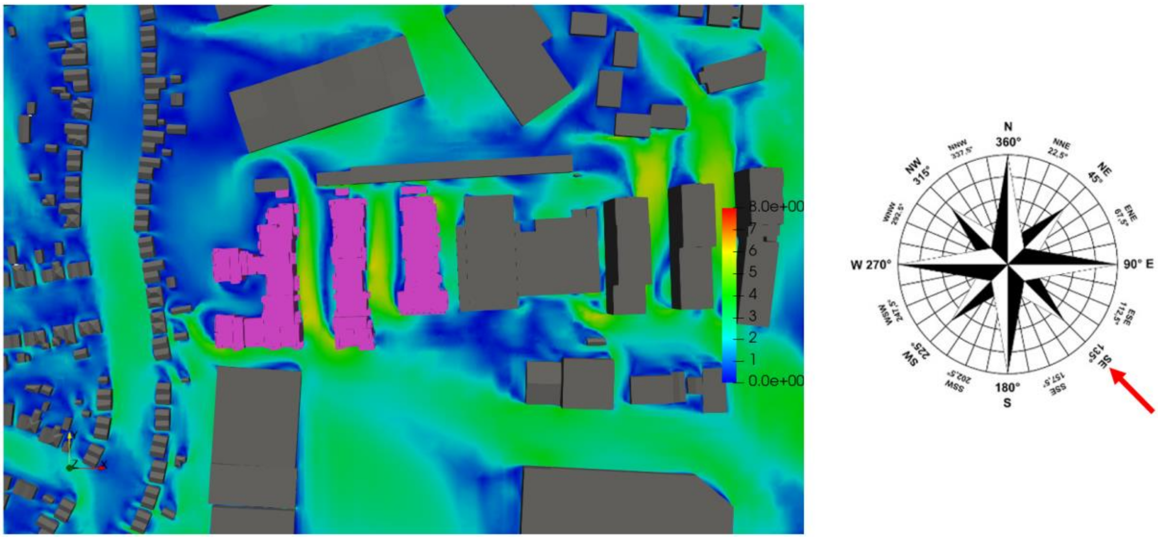

Figure 78 Wind at pedestrian level – Cumulative Scenario – Plan view - direction SE

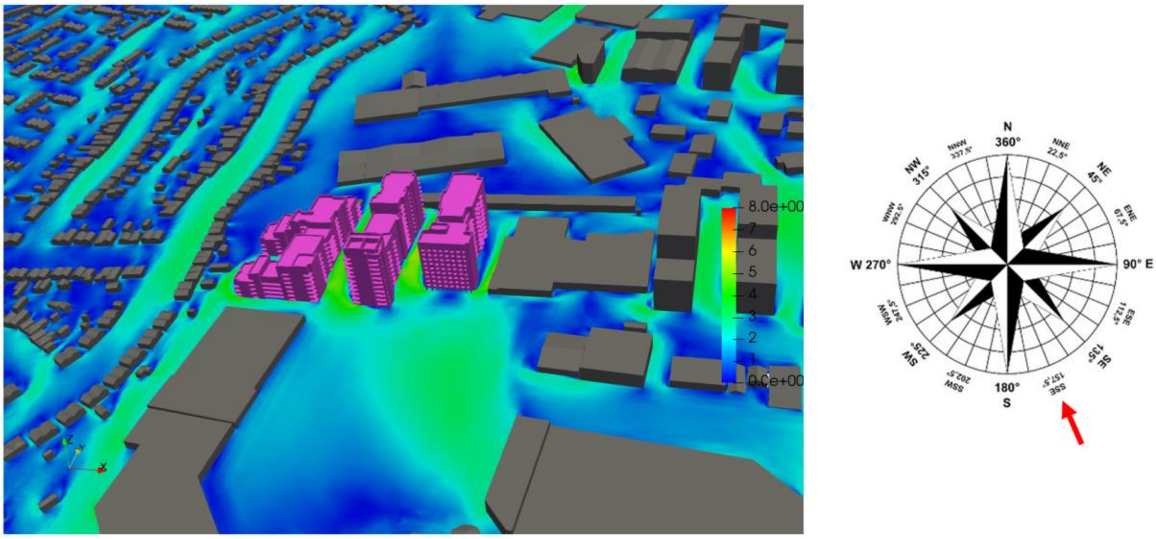

Figure 79 Wind at pedestrian level – Cumulative Scenario - direction SSE

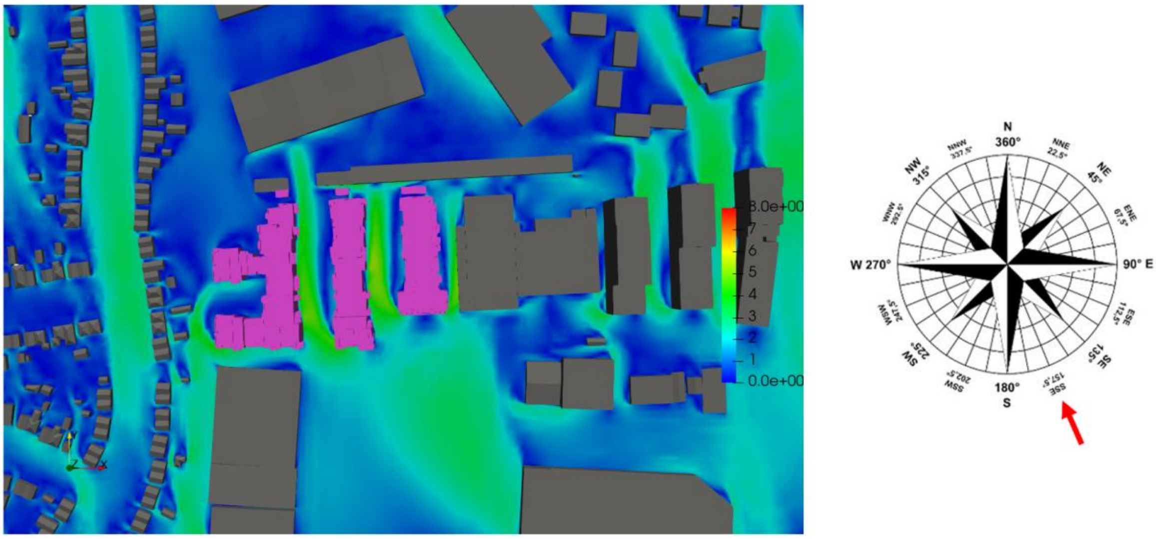

Figure 80 Wind at pedestrian level – Cumulative Scenario – Plan view - direction SSE

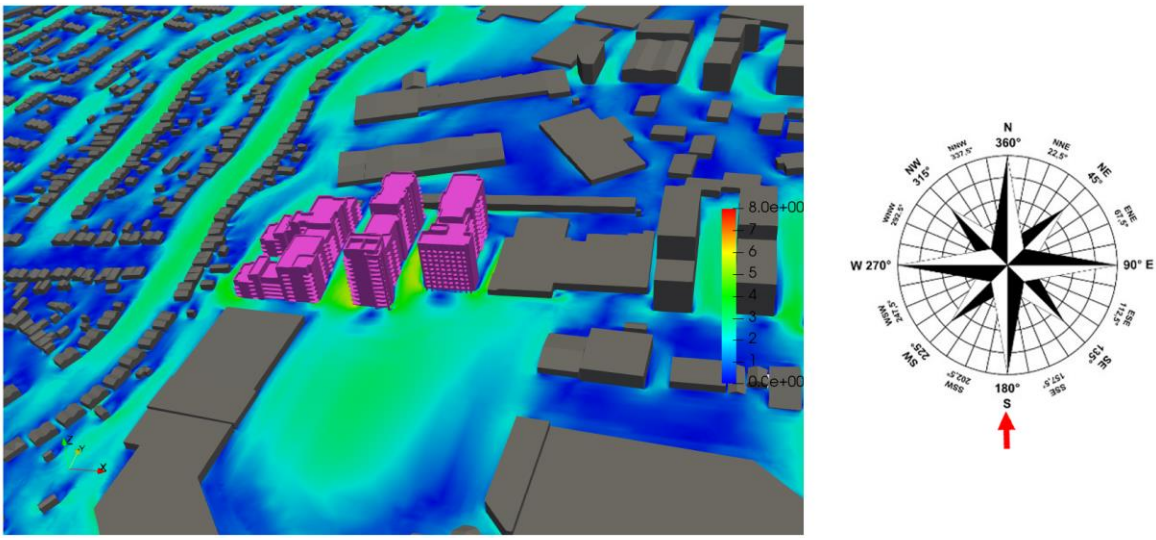

Figure 81 Wind at pedestrian level – Cumulative Scenario - direction S

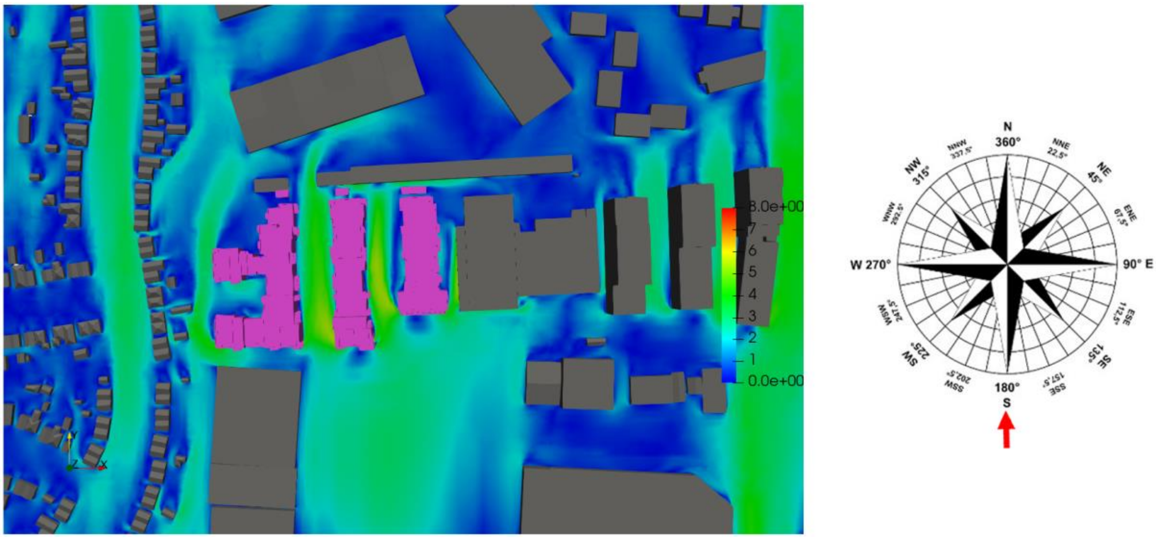

Figure 82 Wind at pedestrian level – Cumulative Scenario – Plan view - direction S

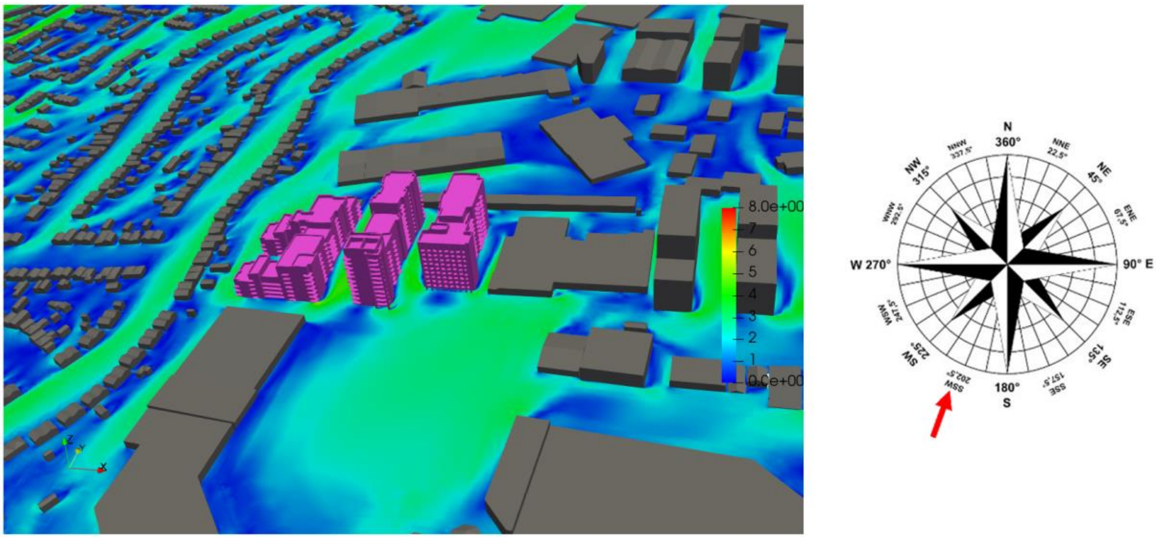

Figure 83 Wind at pedestrian level – Cumulative Scenario - direction SSW

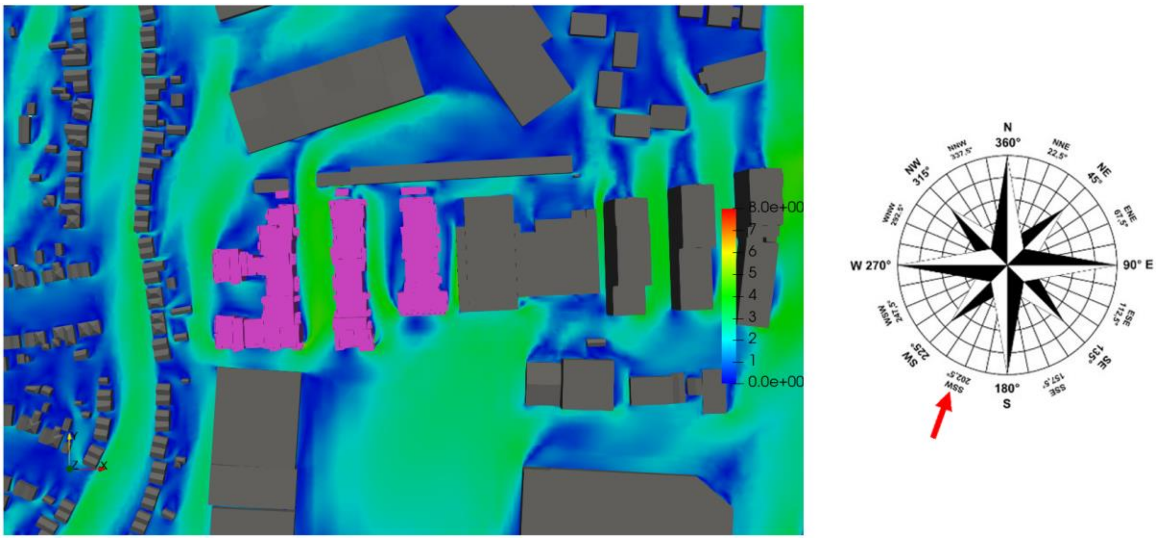

Figure 84 Wind at pedestrian level – Cumulative Scenario – Plan view - direction SSW

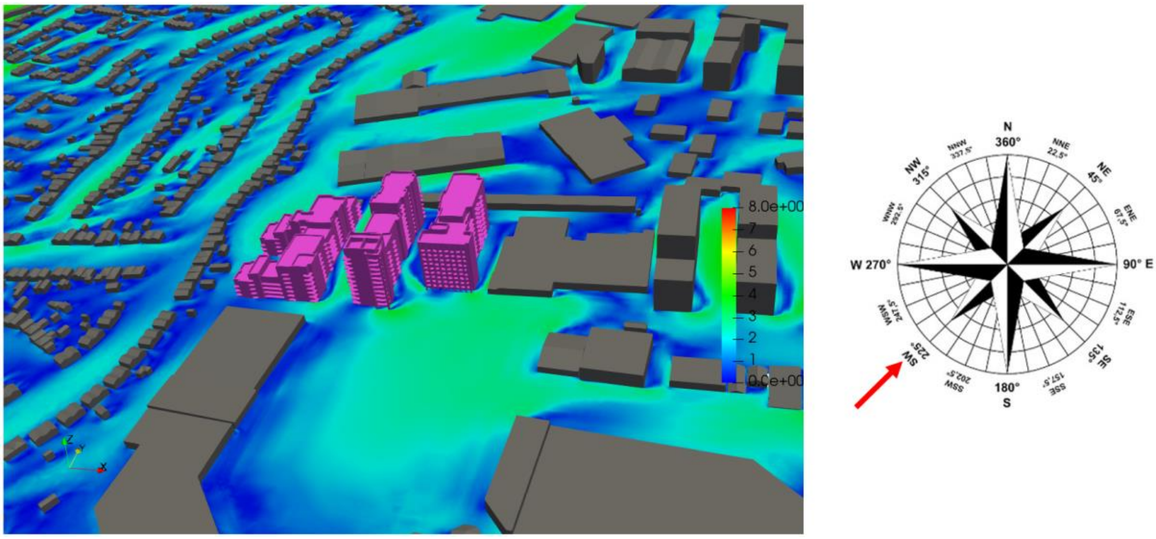

Figure 85 Wind at pedestrian level – Cumulative Scenario - direction SW

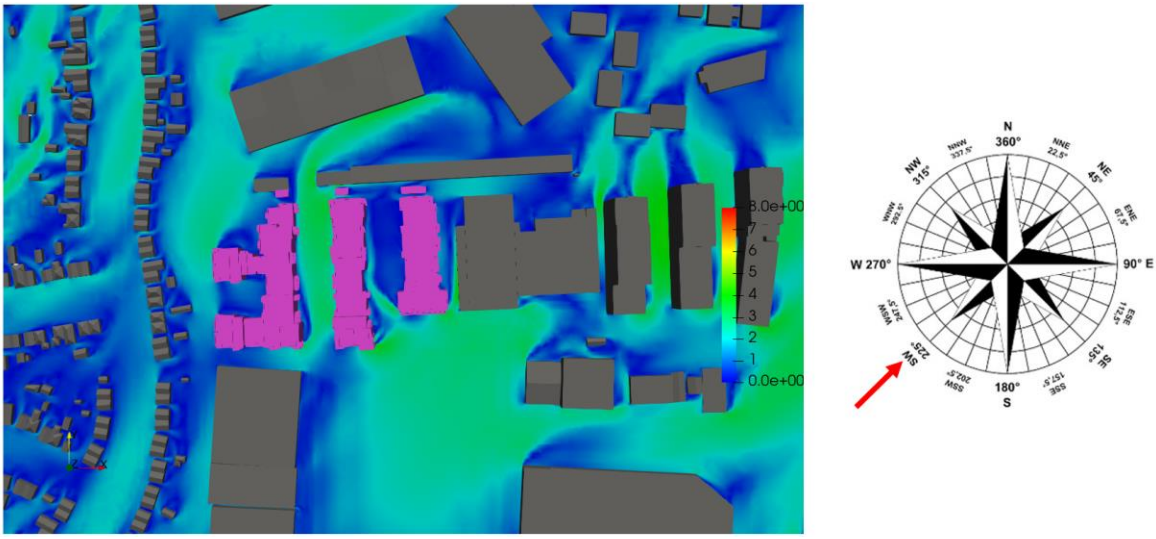

Figure 86 Wind at pedestrian level – Cumulative Scenario - Plan view - direction SW

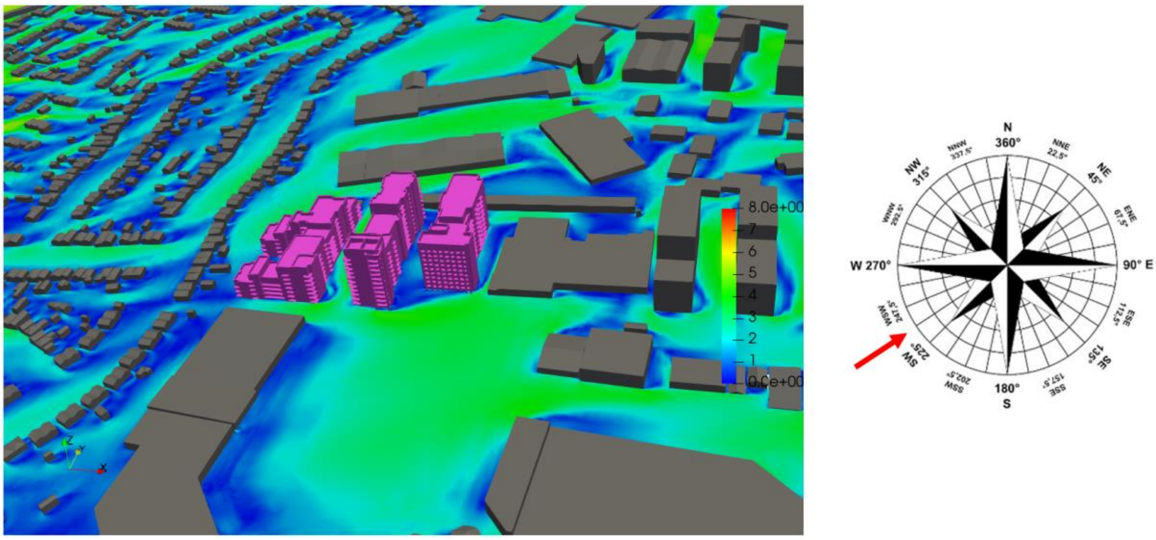

Figure 87 Wind at pedestrian level – Cumulative Scenario - direction SW

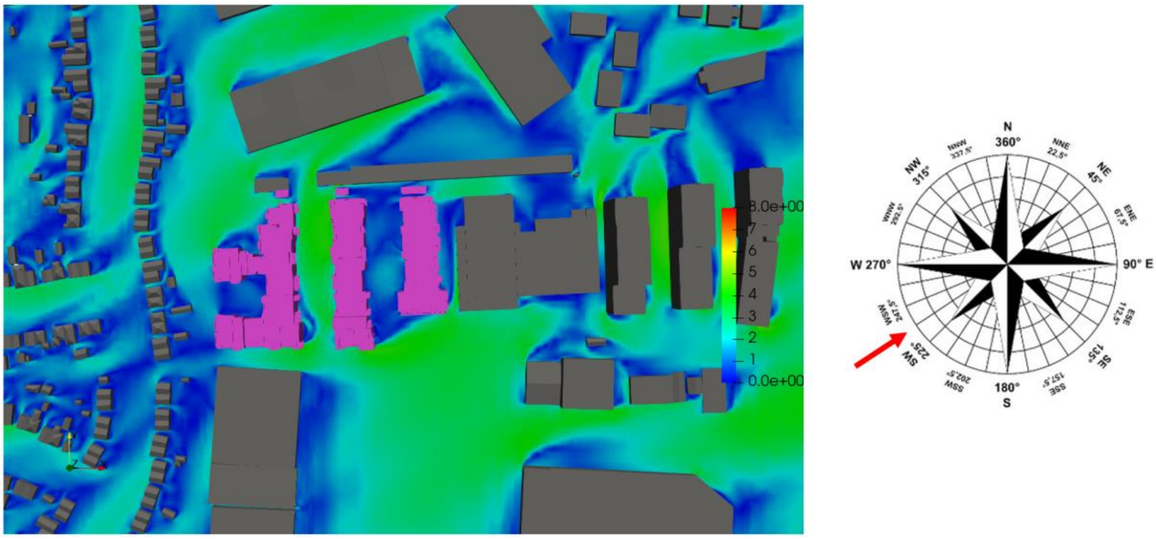

Figure 88 Wind at pedestrian level – Cumulative Scenario – Plan view - direction SW

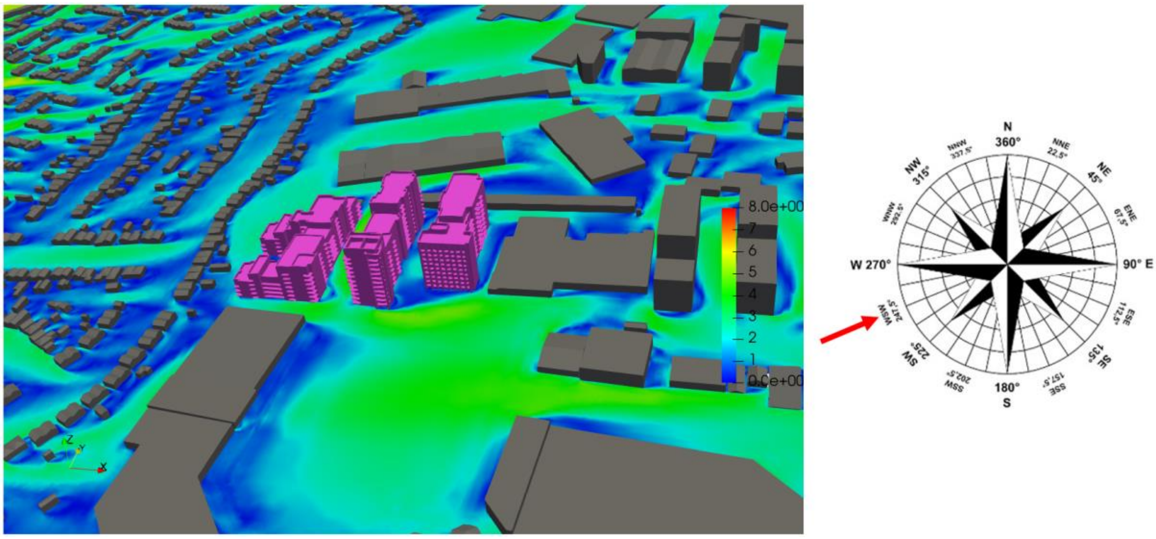

Figure 89 Wind at pedestrian level – Cumulative Scenario - direction WSW

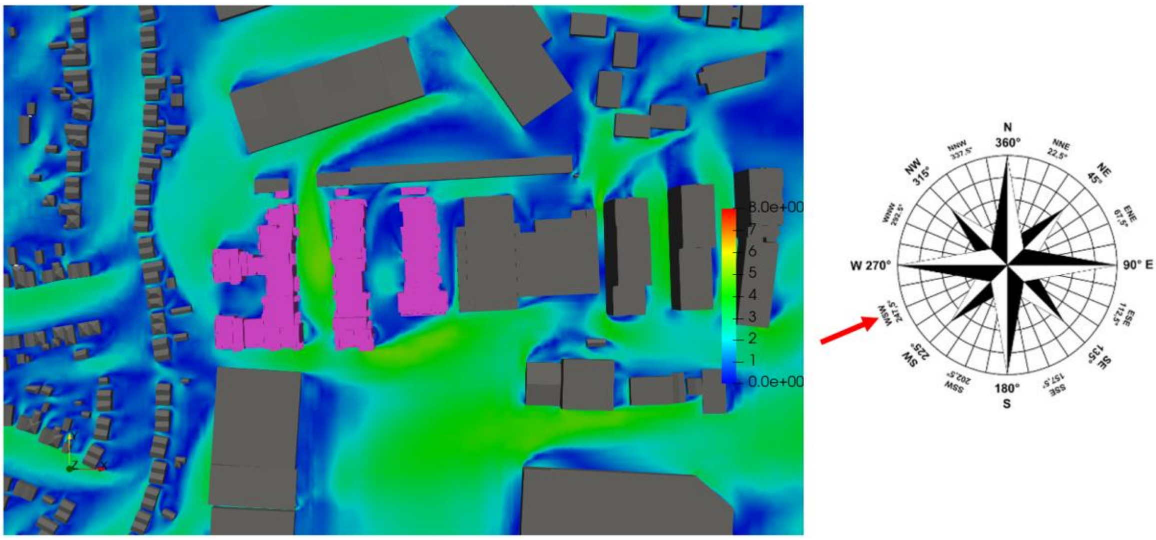

Figure 90 Wind at pedestrian level – Cumulative Scenario - Plan view - direction WSW

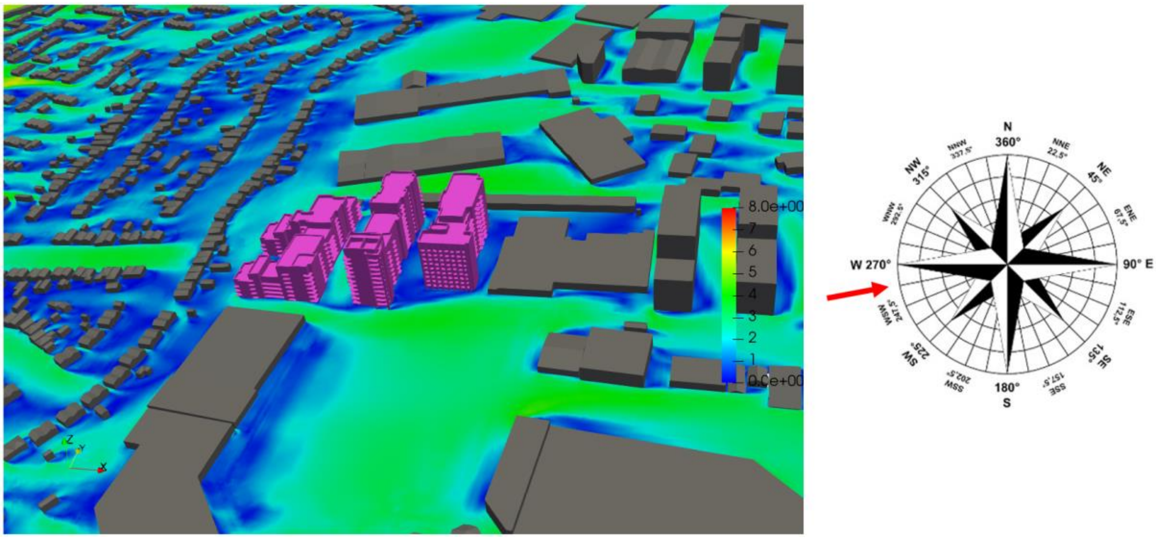

Figure 91 Wind at pedestrian level – Cumulative Scenario - direction WSWW

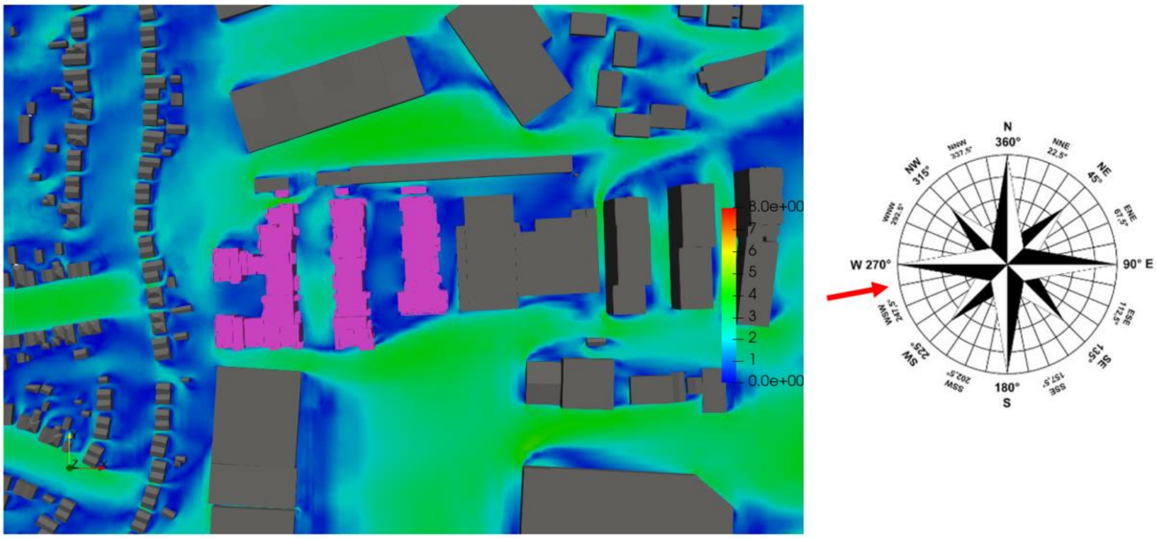

Figure 92 Wind at pedestrian level – Cumulative Scenario - Plan view - direction WSWW

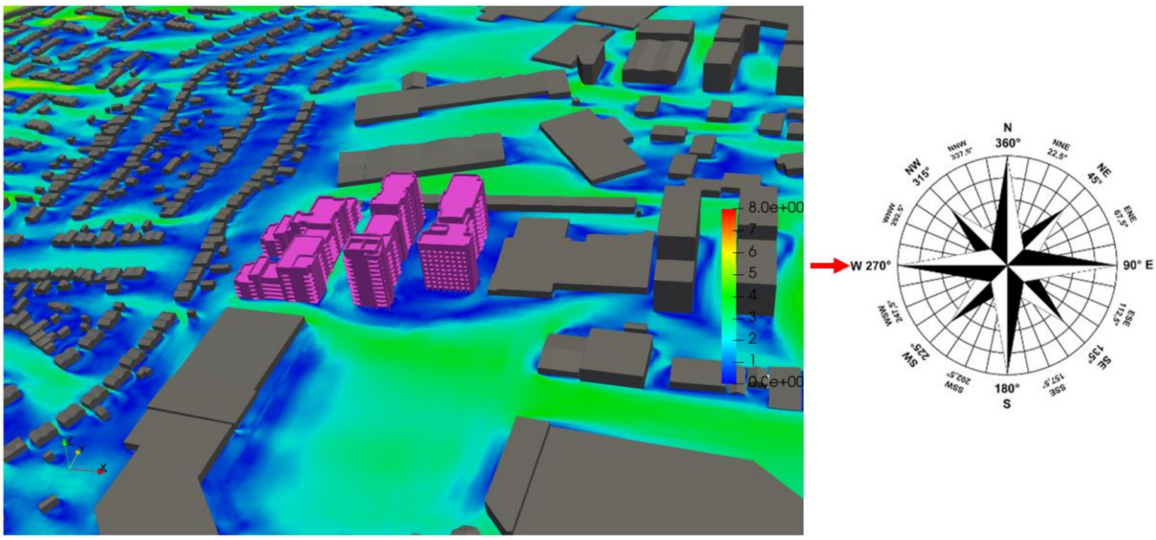

Figure 93 Wind at pedestrian level – Cumulative Scenario - direction W

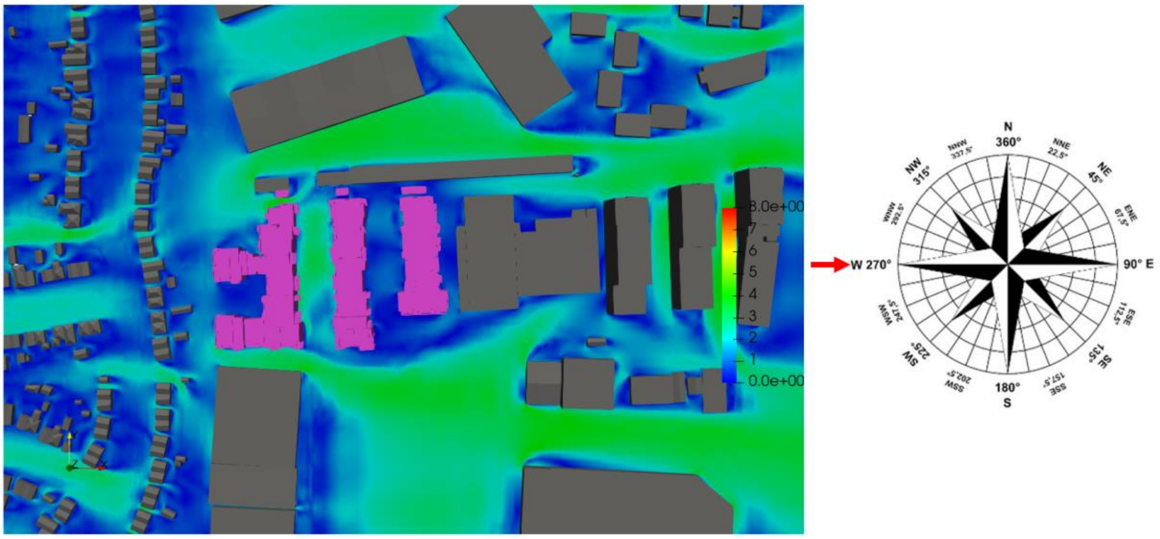

Figure 94 Wind at pedestrian level – Cumulative Scenario - Plan view - direction WSWW

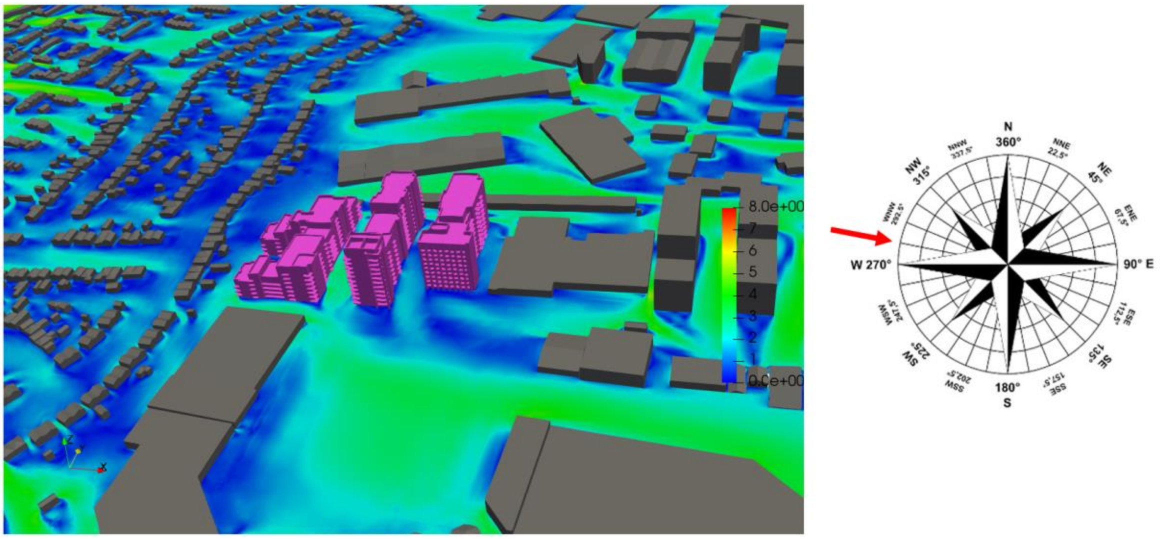

Figure 95 Wind at pedestrian level – Cumulative Scenario - direction WWNW

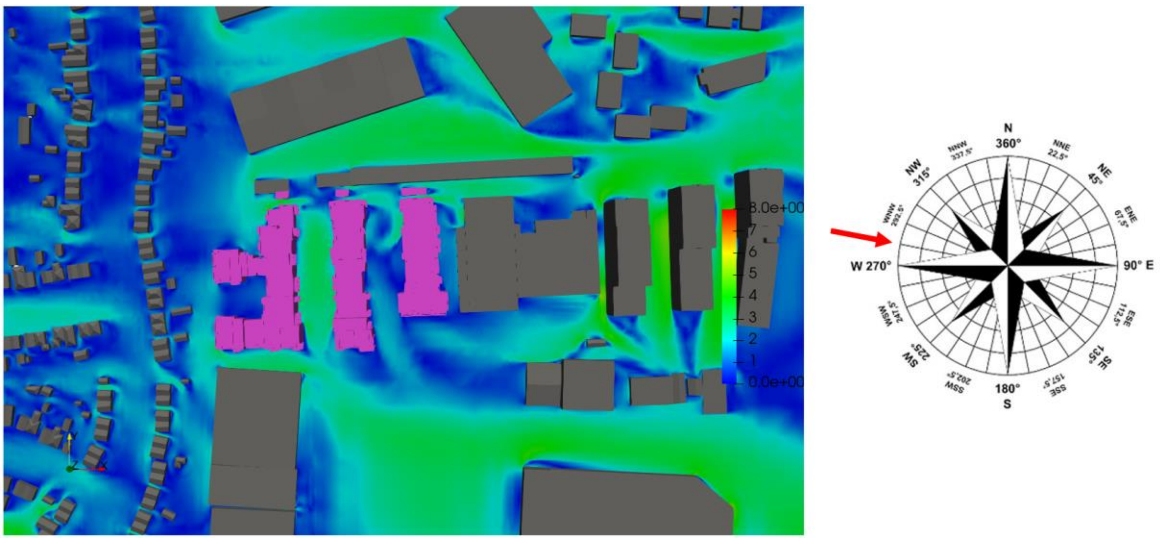

Figure 96 Wind at pedestrian level – Cumulative Scenario - Plan view - direction WWNW

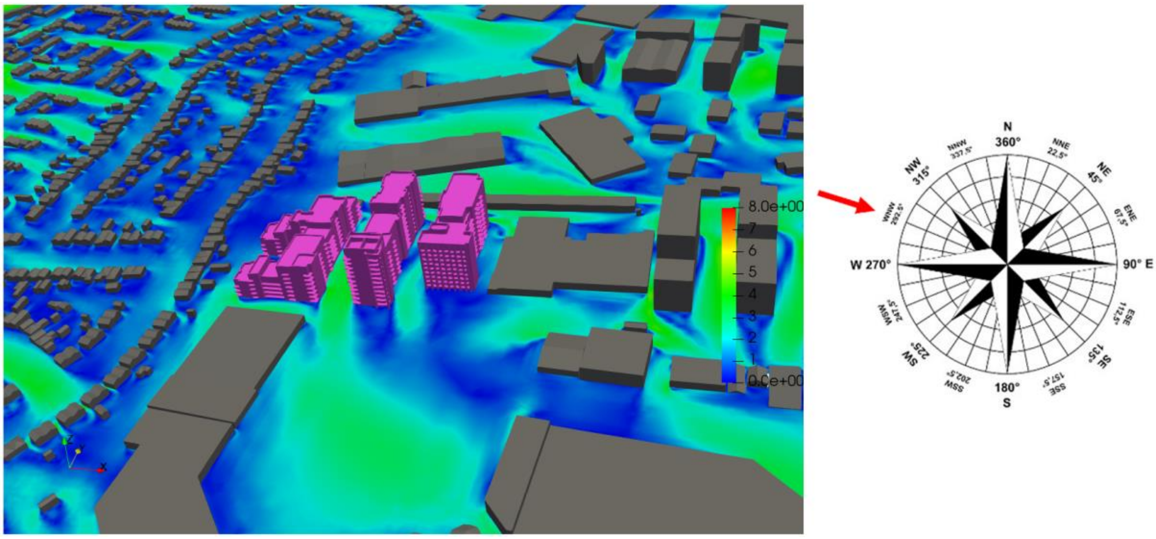

Figure 97 Wind at pedestrian level – Cumulative Scenario - direction WNW

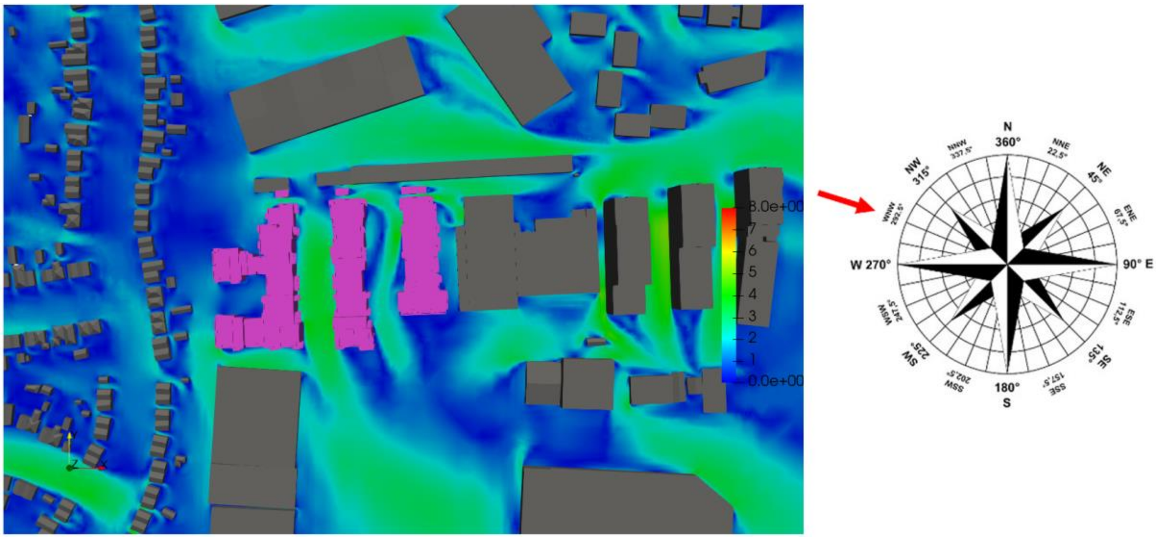

Figure 98 Wind at pedestrian level – Cumulative Scenario – Plan view - direction WNW

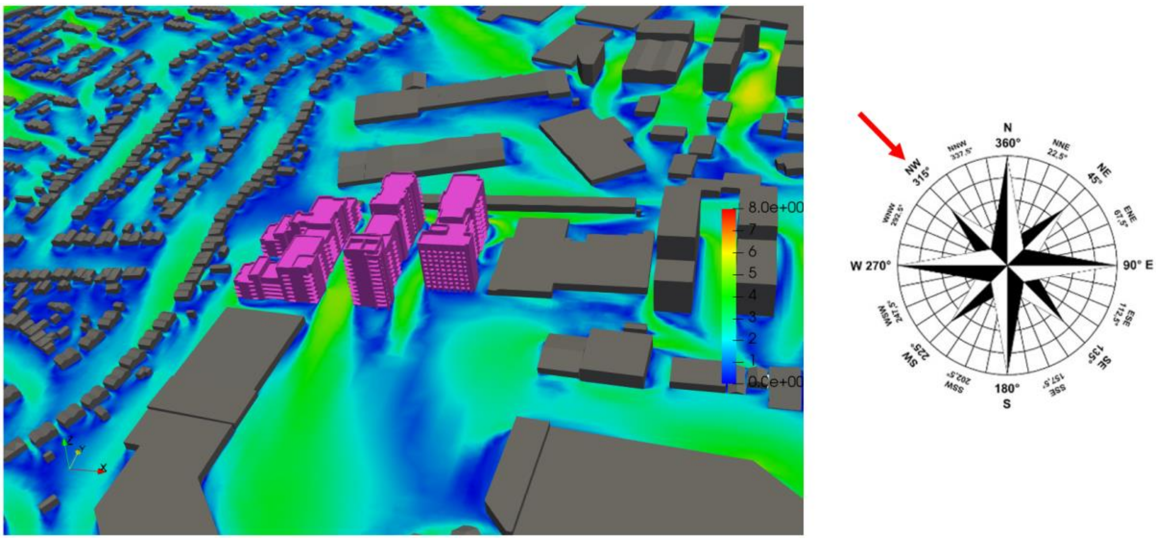

Figure 99 Wind at pedestrian level – Cumulative Scenario - direction NW

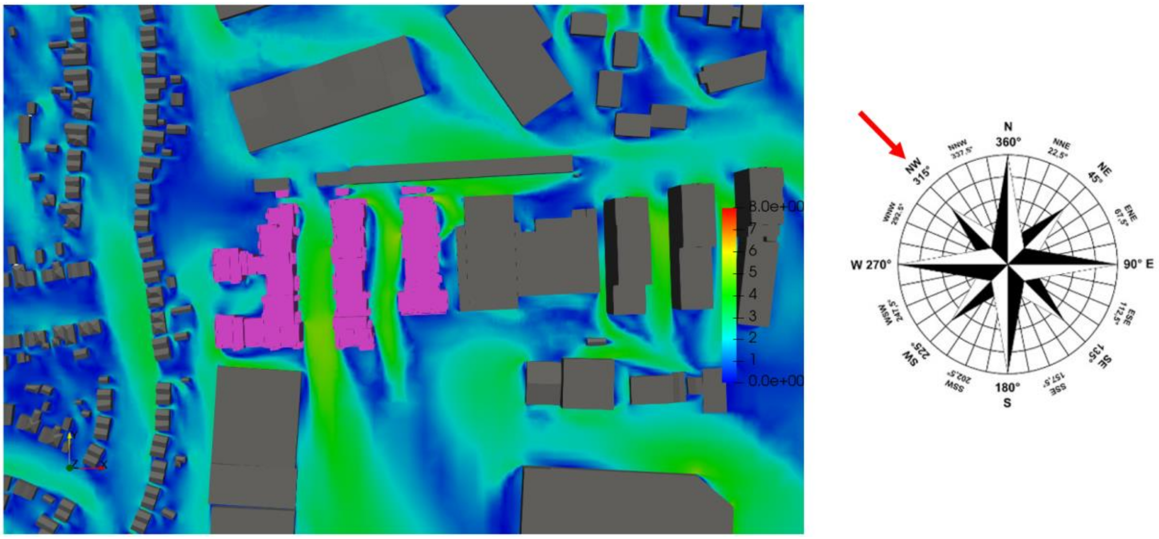

Figure 100 Wind at pedestrian level – Cumulative Scenario – Plan view - direction NW

7.2.2 Wind speeds on sensitive receptors (Balconies-vertical plane)

Results of velocity across the balconies in the vertical plane are presented in the following images.

Some local accelerations can be found on the top level balconies when the wind is blowing from west-south-west direction. However, these velocities are below the threshold values defined by the acceptance criteria and therefore are not critical for safety. Furthermore, balconies are likely to be used as amenity space mostly during spring/summer season when the wind is calmer.

The images also report the wind velocity conditions across the block which is the tallest proposed block in this development. As anticipated in section 11.2 the air stream across the tallest building can be, in part deflected towards the ground causing a downwash/downdraft effect. As it can be seen from the wind simulation results, the downwash effect is not critical, and the design of the ground level receiving the effect from above acts as a mitigation measure to this effect, furthermore the road below is for pedestrian walking or traffic circulation and there is no sitting or play area directly into the air stream from above.

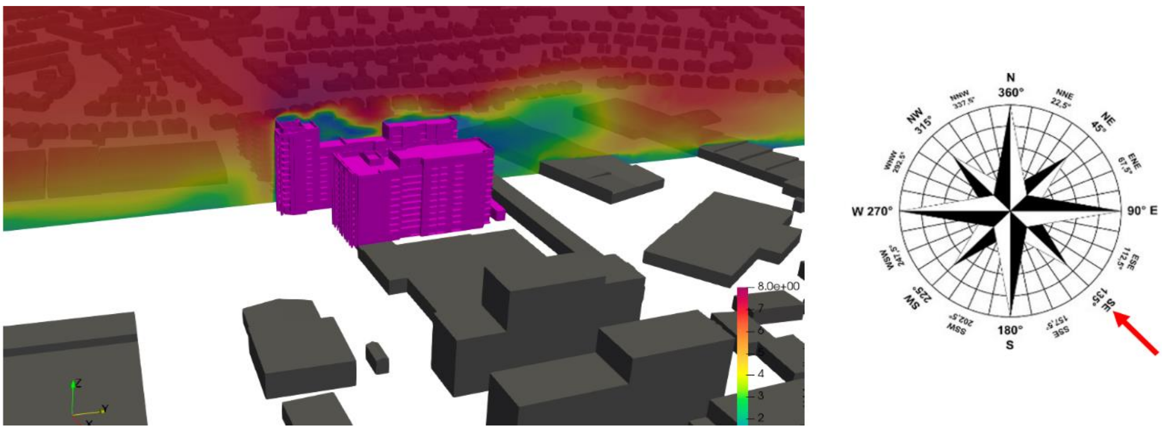

Figure 101 Wind across development – Cumulative Scenario - direction SE

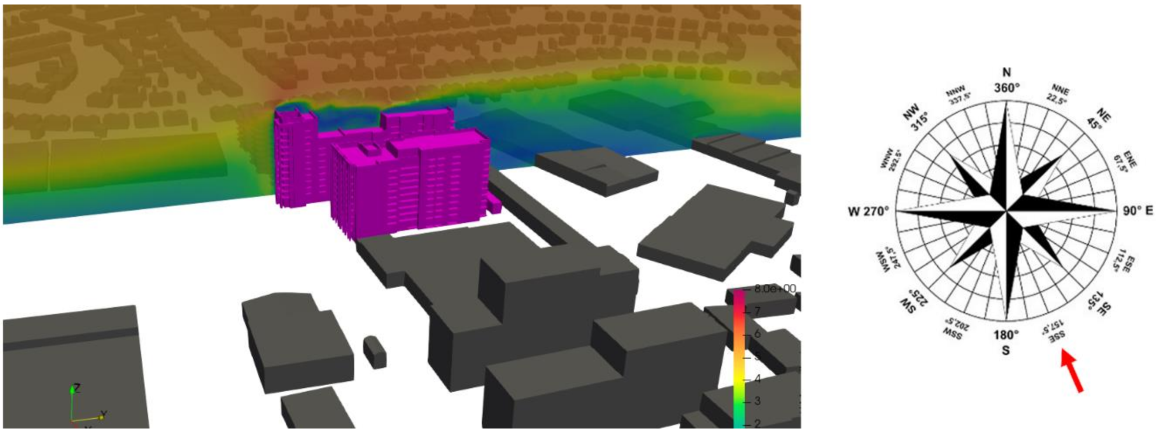

Figure 102 Wind across development – Cumulative Scenario - direction SSE

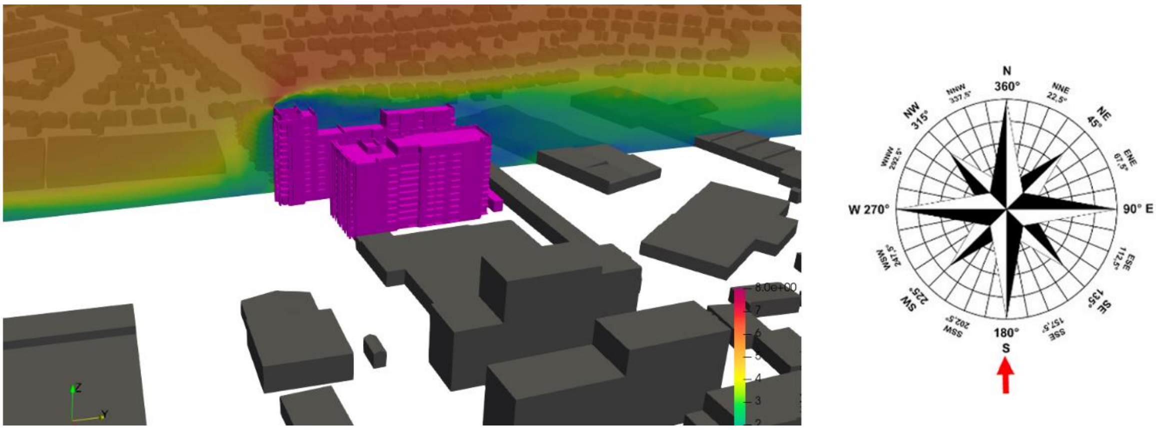

Figure 103 Wind across development – Cumulative Scenario - direction S

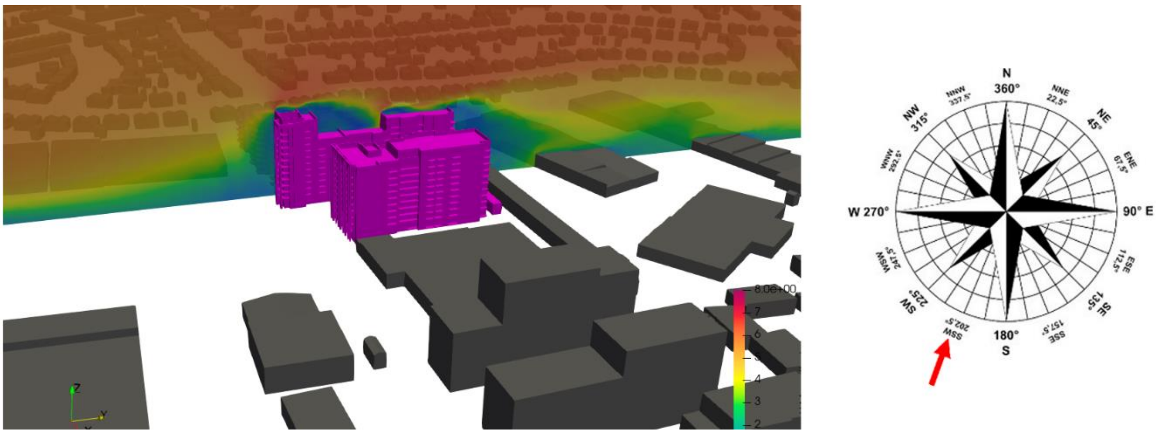

Figure 104 Wind across development – Cumulative Scenario - direction SSW

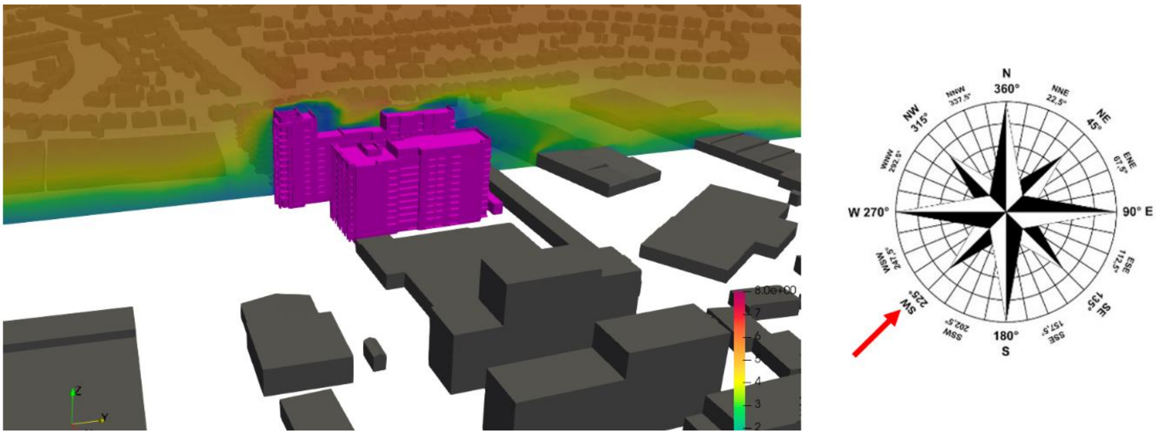

Figure 105 Wind across development – Cumulative Scenario - direction SW

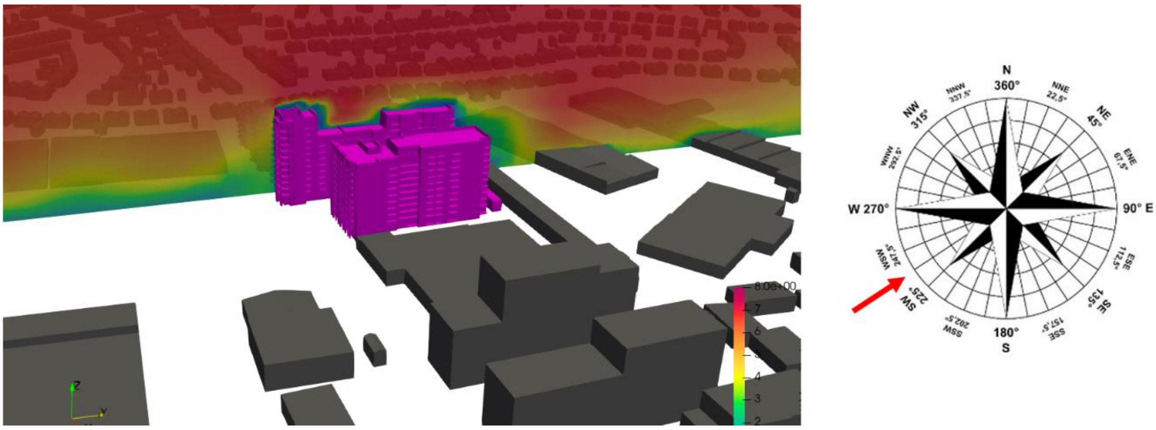

Figure 106 Wind across development – Cumulative Scenario - direction SWWSW

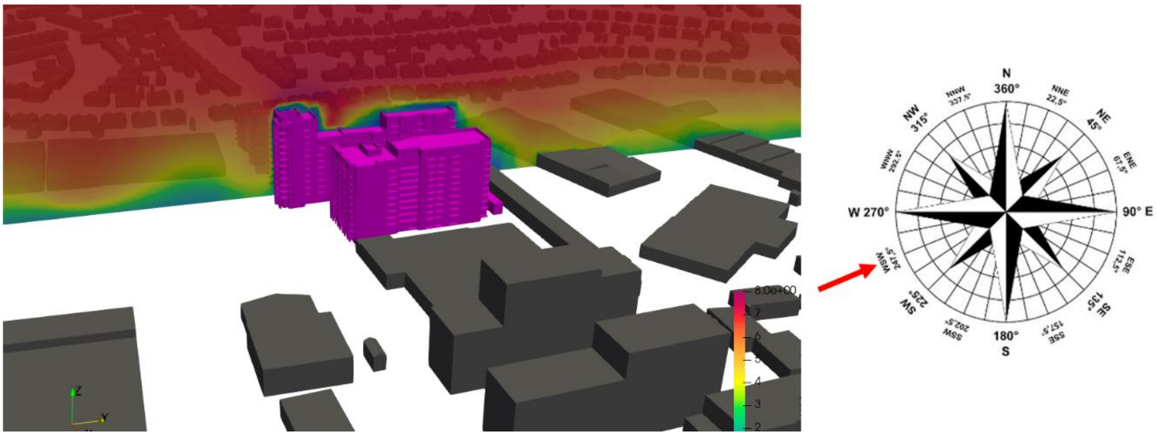

Figure 107 Wind across development – Cumulative Scenario - direction WSW

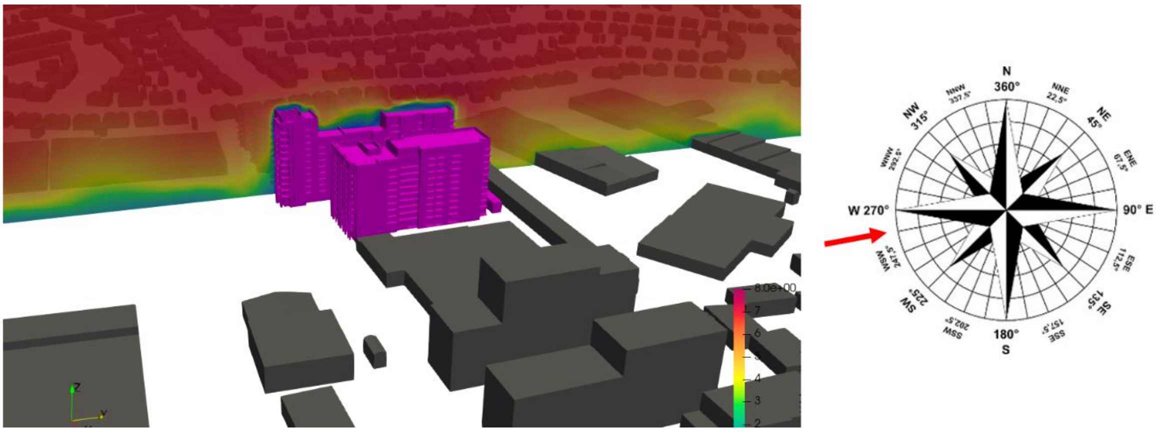

Figure 108 Wind across development – Cumulative Scenario - direction WSWW

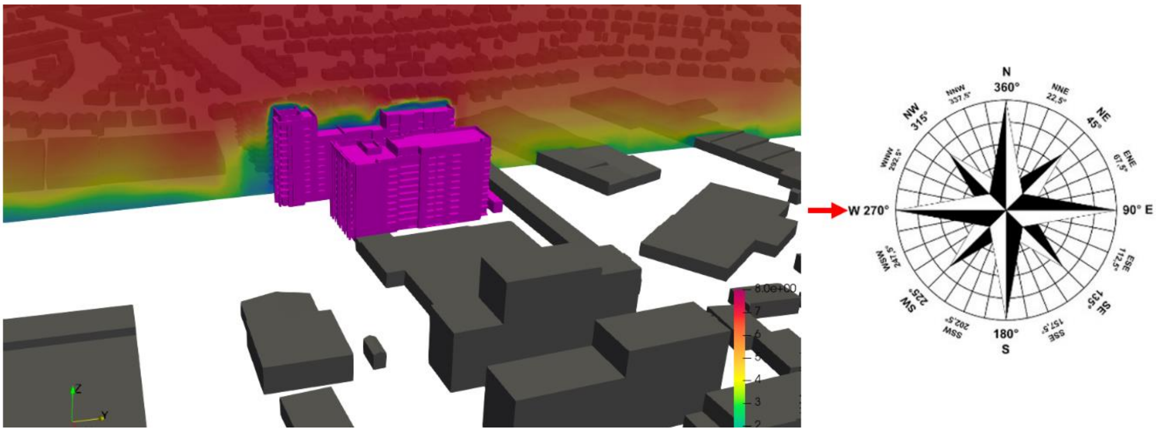

Figure 109 Wind across development – Cumulative Scenario - direction W

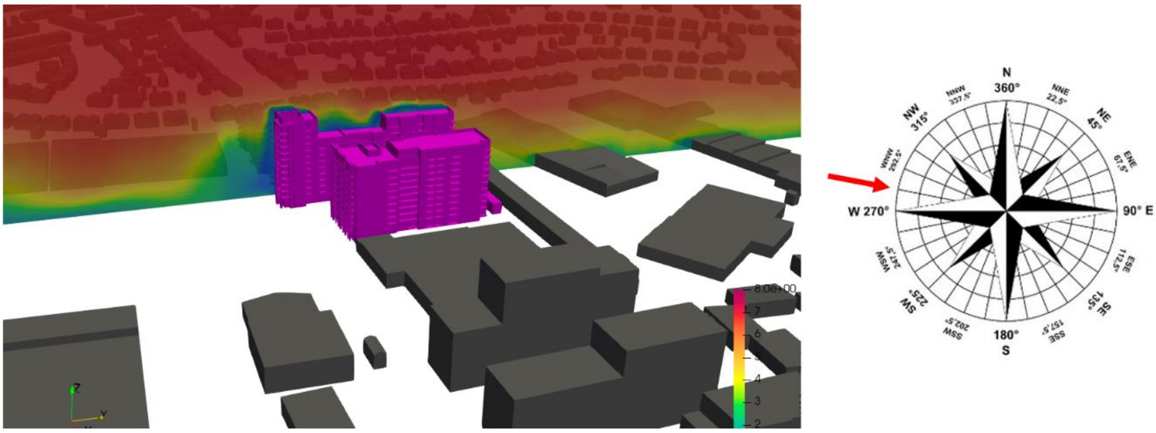

Figure 110 Wind across development – Cumulative Scenario - direction WWNW

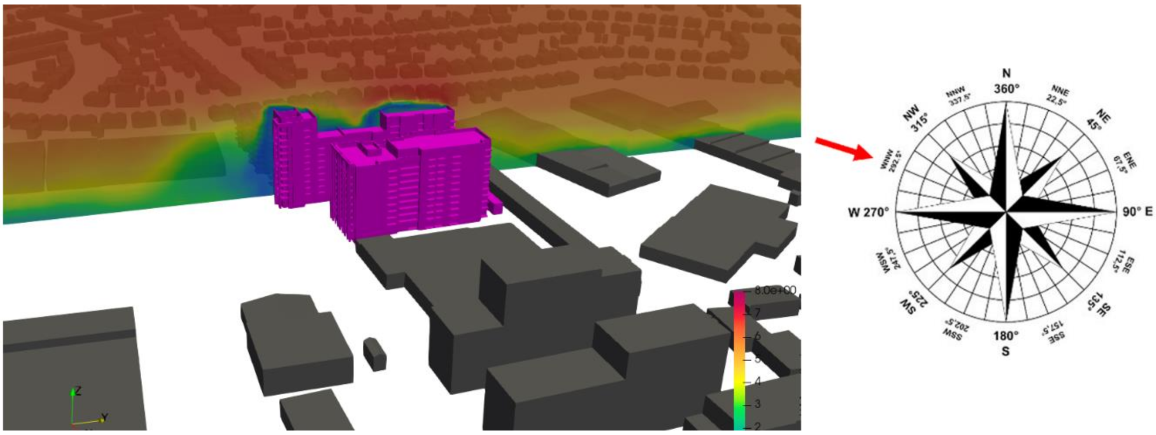

Figure 111 Wind across development – Cumulative Scenario - direction WNW

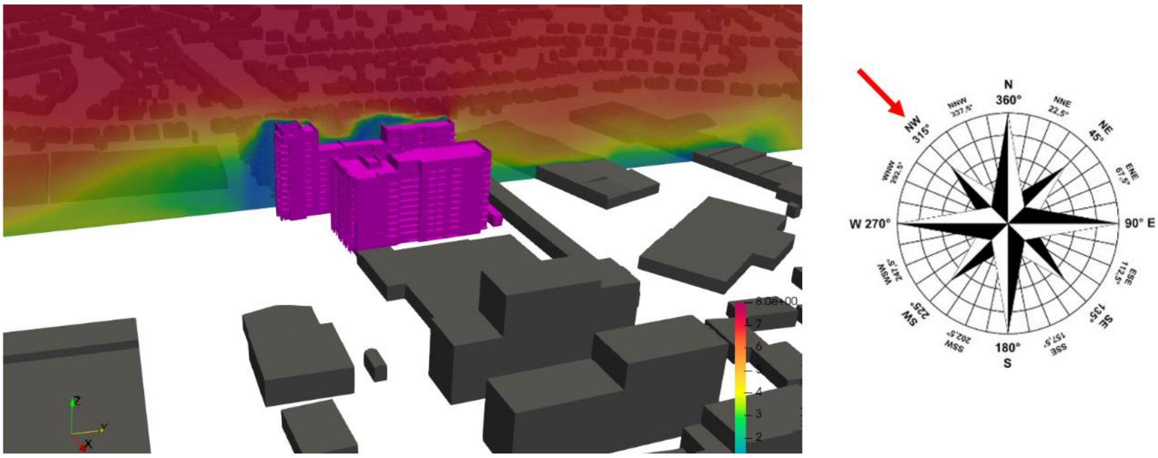

Figure 112 Wind across development – Cumulative Scenario - direction NW

7.2.3 Cumulative Scenario Wind Microclimate

The wind flow results simulating the different direction and wind speeds, are combined with wind frequencies of occurrence to obtain comfort ratings at pedestrian level in all areas included within the model. The comparison of comfort ratings with intended pedestrian activities is shown in the Lawson Comfort and Distress Map that follows. The comfort/distress conditions are presented using a colour coded diagram below formulated in accordance with the Lawson Criteria.

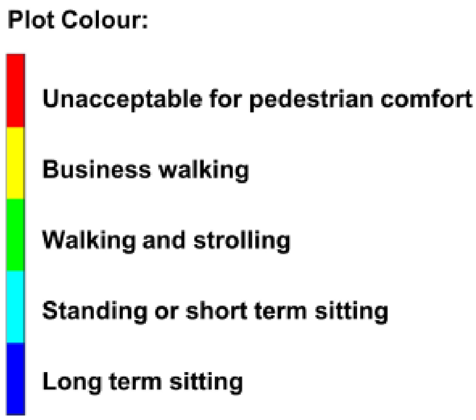

Figure 114 Lawson criteria scale

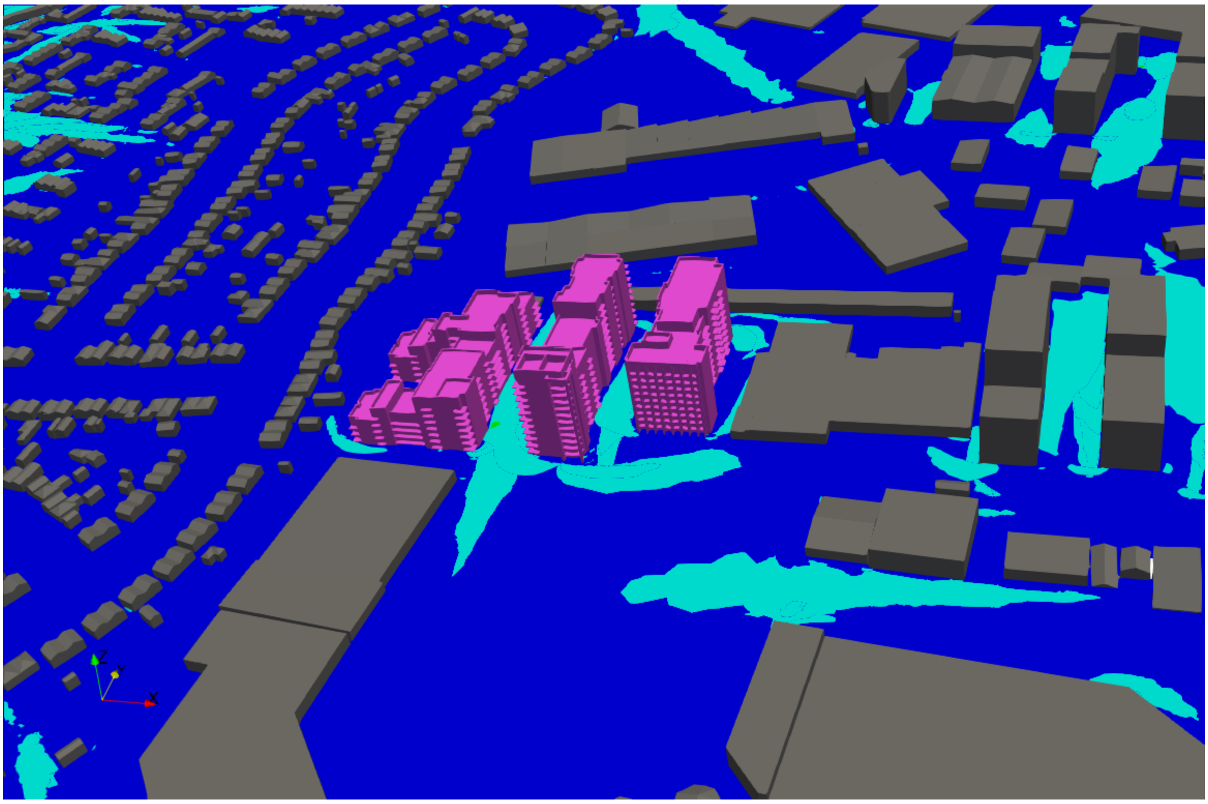

Figure 113 Wind comfort-distress map (Lawson Map) - Cumulative scenario

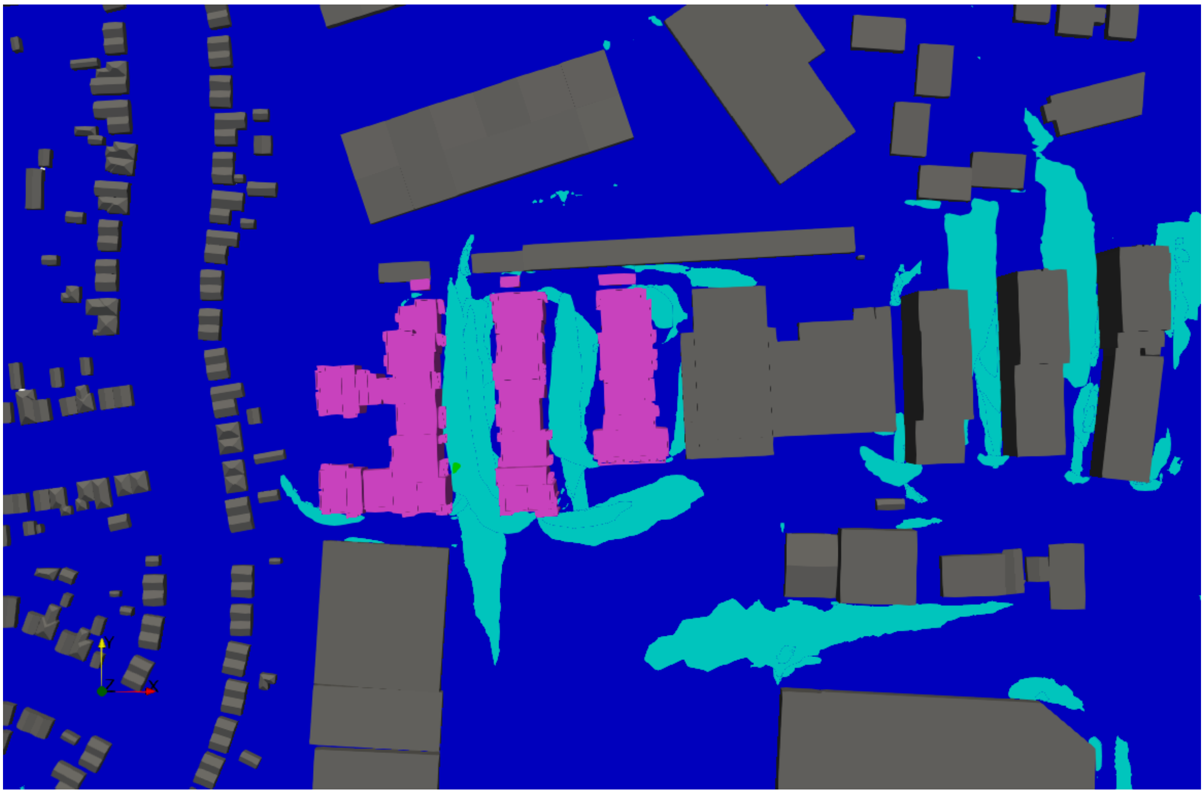

Figure 114 Wind comfort-distress map (Lawson Map) - Cumulative scenario- top view

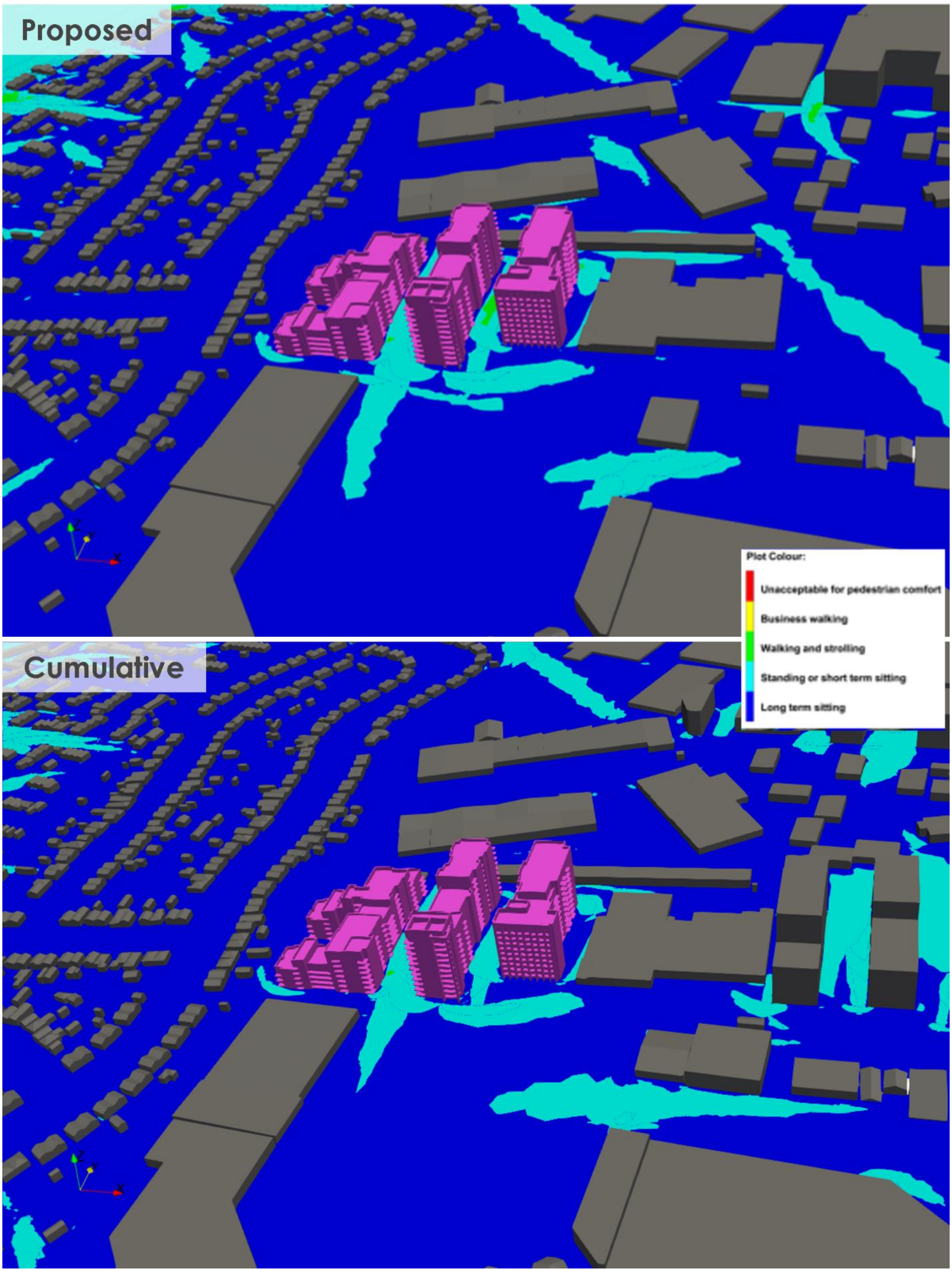

Figure 115 Wind comfort/distress map – Proposed versus Cumulative scenario

This section presented the analysis of the wind impact on the microclimate for prediction of pedestrian comfort/distress for Omni Plaza Strategic House Development. The study has identified the possible wind patterns around the area proposed, under mean and peak wind conditions typically occurring in Dublin.

As done previously for the Baseline and Proposed scenarios, the same wind profile was adopted to simulate wind conditions for the Cumulative scenario. A CFD numerical model was built, to analyse the impact of the proposed development in a cumulative assessment.

The results of the wind speeds and patterns formed under the different simulated wind conditions were combined with its frequency of occurrence and an overall wind map was produced (Lawson map) which has shown the suitability of each area to a specific pedestrian activity.

The following conclusions can be made from observing the results of the wind microclimate analysis and comparing the results, under the same wind conditions for the proposed scenario in a cumulative assessment:

- The proposed development does not impact or give rise to negative or critical wind speed profiles at the nearby adjacent roads, or nearby buildings when the permitted development has been constructed. Moreover, in terms of distress, no critical conditions were found for "Frail persons or cyclists" and for members of the" General Public" in the surroundings of the development.

- The proposed development is designed to be a high-quality environment for the scope of use intended for each area/building (i.e., comfortable, and pleasant for potential pedestrians). Specifically, the area between Block C and D of the Proposed Scenario which is to be used for '*walking and strolling'* is seen to become more comfortable (of one Lawson Category) when the Cumulative scenario is analysed.

- The assessment of the Cumulative Scenario, similarly to that already displayed with the Proposed Scenario has shown that no area is unsafe, and no conditions of distress are created by the proposed development.

The table at the end of this summary indicates the impact and significance of the proposed development in a Cumulative Scenario on the on-site receptors (pedestrian areas, roads, entrances) and on the off-site receptors (roads/ pedestrian areas off-site on the north, south, west and east directions).

The wind comfort distress map showing the baseline, proposed and cumulative scenarios are illustrated below. As a result of the proposed development construction in conjunction with the permitted development considered in the Cumulative Scenario, the wind on the surrounding urban context is also mitigated when compared with the baseline situation and the proposed scenario in the existing context. The proposed development therefore has a beneficial effect on the surrounding wind microclimate and can create comfortable pedestrian areas and public spaces.

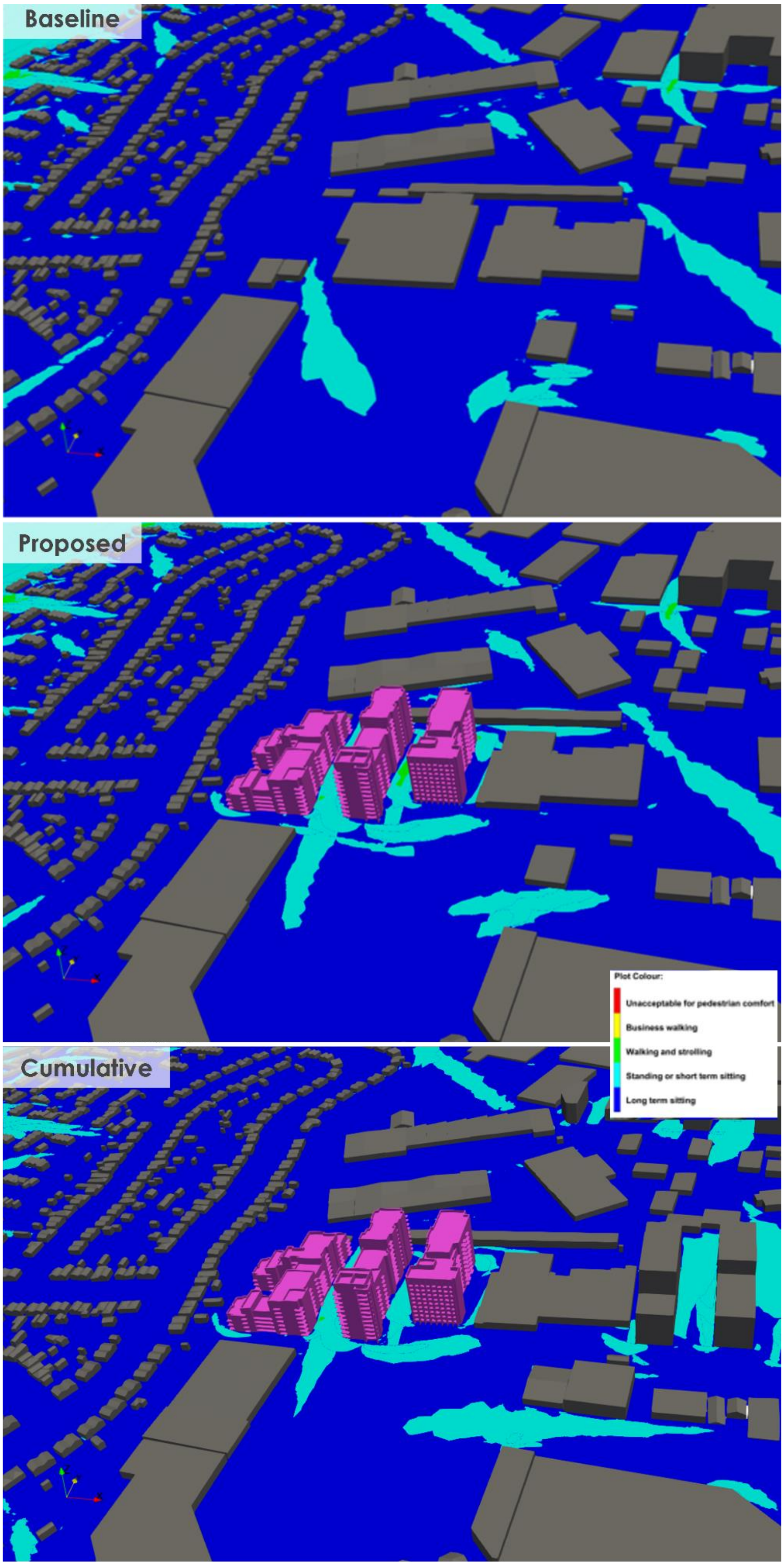

Figure 116 Wind comfort/distress map - Baseline versus Proposed versus Cumulative scenario.

Table 10 Significance impact of the proposed development versus cumulative conditions

Potential Receptors *(on-site)*	**Proposed Development Conditions**	**Cumulative Development Conditions**	**Impact Significance**
Roads	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category in relation to the baseline).	Conditions remain the same as in the proposed scenario	*Negligible*
Entrances	Conditions are "suitable" for the intended pedestrian use.	Conditions remain the same as in the proposed scenario	*Negligible*
Pedestrian circulation areas	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category in relation to the baseline).	Conditions remain the same as in the proposed scenario	*Negligible*
Balconies	Conditions are "suitable" for the intended use. (short/long-term sitting especially in relation to the balconies and considering the wind roses of the spring/summer seasons).	Conditions remain the same as in the proposed scenario	*Negligible*
Ground Amenity areas	Conditions are "suitable" for the intended use. (short/long-term sitting considering the wind roses of the spring/summer season).	Conditions remain the same as in the proposed scenario	*Negligible*
Potential Receptors *(off-site)*	**Proposed Development Conditions**	**Cumulative Development Conditions**	**Impact Significance**
Off-Site Area-North	Conditions become calmer than required for the intended pedestrian use (by at least one comfort category in relation to the baseline).	Conditions remain the same as in the proposed scenario	*Negligible*
Off-Site Area-South	Conditions remain the same as in the baseline scenario.	Conditions remain the same as in the proposed scenario.	*Negligible*
Off-Site Area-East	Conditions remain the same as in the baseline scenario.	Conditions remain the same as in the proposed scenario.	*Negligible*
Off-Site Area-West	Conditions remain the same as in the baseline scenario.	Conditions remain the same as in the proposed	*Negligible*

8 AVOIDANCE, REMEDIAL & MITIGATION MEASURES

8.2.1 Construction Phase

The wind conditions at the site would gradually adjust to those of the completed development during the construction phase.

8.2.2 Operational Phase

The landscaping proposed for the development has been considered within the wind analysis and its effect has been beneficial in reducing the wind speed around the development and creating calmer wind conditions in areas such as the parks and landscaped areas where pedestrians can be comfortable for long-term sitting. Landscaping is simulated as porous zones within the CFD model.

8.2.3 "Do Nothing" Impact

In the case where the development is not constructed, the wind conditions on the site will be in line with those obtained with the Baseline scenario wind microclimate.

8.2.4 Residual Impacts

Wind cannot be eliminated or totally mitigated as it depends on weather conditions which could vary. The data of the historical wind conditions collected and reported in the previous sections, show that the wind speeds likely to occur on the site are below critical values and that pleasant and comfortable microclimate can be maintained for most of the time and under the most frequent wind scenarios. Gusts and storms can still occur however, and they can create unpleasant and sometimes unsafe conditions. The pedestrian activities concerning the Lawson Comfort and Distress Criteria are not in general carried out during those weather conditions.

Having considered the above, no further changes to the development design and further increasing of the landscaping is suggested, as safety and pedestrian comfort is maintained in accordance with Lawson Comfort and Distress Criteria.

8.2.5 Monitoring

8.2.5.1 Construction Phase

There is no requirement to monitor wind impact during construction phase for pedestrian comfort and distress as the designated amenity areas will not be in use during this phase of the project and pedestrians are not accessing construction sites.

8.2.5.2 Operational Phase

The development has been designed to conform to acceptable Lawson Criteria for Comfort and Distress in accordance with the Wind Beaufort Scale and considering the historical wind conditions of the site, there is no further element to monitor for this scope as far as the landscaping is maintained in place as designed.

8.2.6 Difficulties Encountered When Compiling

No difficulties were encountered in compiling this chapter.

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