

OCSC

O'CONNOR · SUTTON · CRONIN

MULTIDISCIPLINARY CONSULTING ENGINEERS

L395: ROYAL LIVER PHASE 2

PEDESTRIAN WIND COMFORT STUDY

For

LAND DEVELOPMENT AUTHORITY

24 September 2026

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OCSC Job No: L395	Project Code	Originator	Zone Volume	Level	File Type	Role Type	Number	Status / Suitability Code	Revision
	L395	OCSC	XX	XX	RP	YS	0003	S4	P03

Rev.	Status	Authors	Checked	Authorised	Issue Date
P01	For Comment	AN	PMcV	PMcV	14/09/2026
P02	For Comment	AN	PMcV	PMcV	23/09/2026
P03	For Submission	AN	PMcV	PMcV	24/09/2026

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1 EXECUTIVE SUMMARY

This report outlines the predicted climatic wind conditions experienced within and surrounding the proposed residential development Royal Liver Phase 2.

A conscious effort was made by the design team during the design stages to mitigate the risk of localised increased wind speed conditions due to the proposed development. The introduction of mitigation measures such as the courtyard locations as well as the strategic location of extensive landscaping, all assist in reducing the potential development of local increased wind speed and the negative impact on local climatic conditions.

Based on the CFD modelling results, the proposed development is expected to provide a generally comfortable wind environment for occupants and pedestrians.

Certain areas around the development, particularly within the street-level areas, have been identified as potentially uncomfortable for long- and short-duration sitting. However, these areas are limited in extent, and the identified concerns have been largely addressed through the incorporation of landscaping, which will help to mitigate excessive wind speeds and improve local wind conditions.

The assessment indicates that these areas are expected to remain suitable for leisurely walking. The exceedance of the specified comfort criteria in some locations is largely influenced by the prevailing climatic conditions in Dublin, which can result in relatively higher background wind speeds.

Overall, the proposed development will be a high-quality, comfortable environment for occupants throughout the year.

2 INTRODUCTION

The intention of this report is to outline the predicted climatic wind conditions experienced within and surrounding the proposed residential development Royal Liver Phase 2.

The proposed method for compliance validation is via the industry best practice standard for pedestrian comfort (Lawson Criteria). The Lawson Criteria sets acceptable levels of wind speed and velocity for various human activities.

Given the specific location of the building and recorded metrological data available for the area, and standard interpolation calculation procedures, it is possible to predict the expected wind speeds and their annual occurrence.

3 PROPOSED DEVELOPMENT

The The development will consist of amendments to a previously permitted mixed-use development (DCC Reg. Ref.: 4238/19; ABP Ref. PL29S.307804, as amended by DCC Ref.: 4436/23 and DCC Reg. Ref.: 5050/26). The proposed amendments relate solely to the permitted Blocks B1, B2, C1, C2, D1 & D2 (identified as Phase 2). No amendments are proposed to any other permitted blocks.

1. The proposed alterations result in an overall increase of 2 no. units increasing the total overall units from 1196 to 1198. The proposed amended residential development of Block B1, B2, C1, C2, D1 & D2 will consist of a total of 635 no. residential apartments (an increase from 633 no. as permitted), which includes 38 No. Studios, 269 No. 1-Bed, 288 No. 2-Bed- 4-Person and 40 No. 3-Bed- 5-Person, units as follows:

    - Alteration of Block B1 from a permitted 11-12-storey building providing for 90 no. apartment units to a 10-storey building providing for 107 no. apartments.
    - Alteration of Block B2 from a permitted 10 storey building providing for 90 no. apartment units to a 10-storey building providing for 89 no. apartments.
    - Alteration of Block C1 from a permitted 10-storey building providing for 171 no. apartment units to a 10-storey building providing for 144 no. apartments.
    - Alteration of Block C2 from a permitted 10-storey building providing for 89 no. apartment units to a 10-storey building providing for 98 no. apartments.
    - Alteration of Block D1 from a permitted 9-storey building providing for 87 no. apartment units to a 9-storey building providing for 123 no. apartments.
    - Alteration of Block D2 from a permitted 8-storey building providing for 106 no. apartment units to an 8-storey building providing for 74 no. apartments.

2. The reconfiguration of internal layouts of each of the blocks has resulted in the minor shift in the block footprints. The permitted podium between Block B2 and Block C1 is removed with additional public realm and connection to the south proposed. The block amendments result in amendments to permitted communal amenity space with the removal of roof terraces on Blocks C1, C2 and D1 and amendment to roof terraces on Block B1 and B2.

3. Façade modifications are proposed to respond to the revised internal layouts including minor relocation of windows, balconies etc. and a revised approach to the Naas Rd frontage.

4. Alteration of the permitted uses and facade at ground floor level and removal of permitted BTR tenant amenity spaces located in Blocks B1, B2, C1 & C2 to provide for a ground floor level that includes:

- Blocks B1-B2: 1 no. retail/café/restaurant unit, 1 no. café unit, 1 no. community unit, a creche (relocated from Block D1) and associated cycle parking, plant areas and entrances.

- Block C1-C2-D1-D2: 1 no. retail unit, 2 no. retail/cafe/restaurant units, own door residential units, undercroft parking and associated cycle parking, plant areas and entrances.

5. Alterations to the permitted undercroft and basement parking areas under Blocks B1, B2, C1, C2, D1 & D2 to include for alterations to permitted layouts of car parking, cycle parking, plant, waste stores and substation locations.

6. Amendment of Condition 3 (a) of the parent permission (DCC Reg. Ref.: 4238/19; ABP Ref. PL29S.307804) relating to the Build to Rent (BTR) covenant, and its removal as it relates to Blocks B1, B2, C1, C2 & D1.



Figure 1: Proposed Development Site Plan

4 PEDESTRIAN COMFORT COMPLIANCE

The Lawson criteria gives guidance to quantify the effect of wind velocity on pedestrian comfort and safety. The Lawson recommended guidance indicates that for the comfort and safety assessment of the wind environment, it is not only the velocity of wind that is considered but also the frequency of occurrence of these velocities. The frequency of occurrences is used here as an indicator of the likely duration of certain wind speeds. The Lawson criteria indicates that the threshold mean hourly wind speed for each pedestrian activity should not be exceeded for more than 5% of the time to maintain pedestrian comfort.

Pedestrian activity	Threshold mean hourly wind speed not to be exceeded for more than 5% of the time [m/s]
Business Walking	10
Leisurely Walking	8
Standing or Short Term Sitting	6
Long Term Sitting	4

Table 1. Lawson Criteria for Pedetrian Comfort

There are 2 No. additional classes to quantify the safety conditions for typical or sensitive (e.g. frail or a cyclist) pedestrians which are summarised in Table 2.

Pedestrian activity	Threshold mean hourly wind speed not to be exceeded for more than 0.023% of the time [m/s]
Typical Pedestrian	20
Sensitive Pedestrian	15

Table 2. Lawson Criteria for Saftey Assessment

5 ASSESSMENT METHODOLOGY

The methodology adopted for the study combines the use of Computational Fluid Dynamics (CFD) to predict air flow patterns and wind velocities around the proposed development, the use of wind data from the nearest suitable meteorological station and the recommended comfort and safety standards (The Lawson Criteria).

The study considered the following factors:

- The effect of the geometry, height and massing of the proposed development and existing surroundings on local wind speed and direction;
- The wind speed as a function of the local environment such as topography, ground roughness and nearby obstacles (buildings, bridges, etc.);
- The effects of site location (open field, inner city, etc.);
- Orientation of the buildings relative to the prevailing wind direction; and
- The pedestrian activity to be expected (long term sitting, standing or short term sitting, leisure and business walking).

The wind analysis focuses on the potential variation of the wind velocities from the reference wind data due to the proposed development.

EXTENT OF CFD STUDY AREA

The extent of the built area that is represented in the computational domain is dependent on the influence of the features on the region of interest which includes the site and its nearby surroundings. The analytical CFD model analyses the proposed development. It also includes existing buildings surrounding the development with the extent of the buildings included in the study area illustrated in Figure 2.

The analytical CFD model is assessed against the full Lawson Criteria to identify the pedestrian comfort and safety conditions surrounding the development.

- The analytical CFD model has been constructed based on the information provided below:
- 3D AutoCAD model and plans received from HJL;
- Topographical survey drawings of surrounding buildings;
- Available aerial photographic data via Google Maps;
- Meteorological wind data for Dublin Airport.



Figure 2. Extent of CFD Area View 1

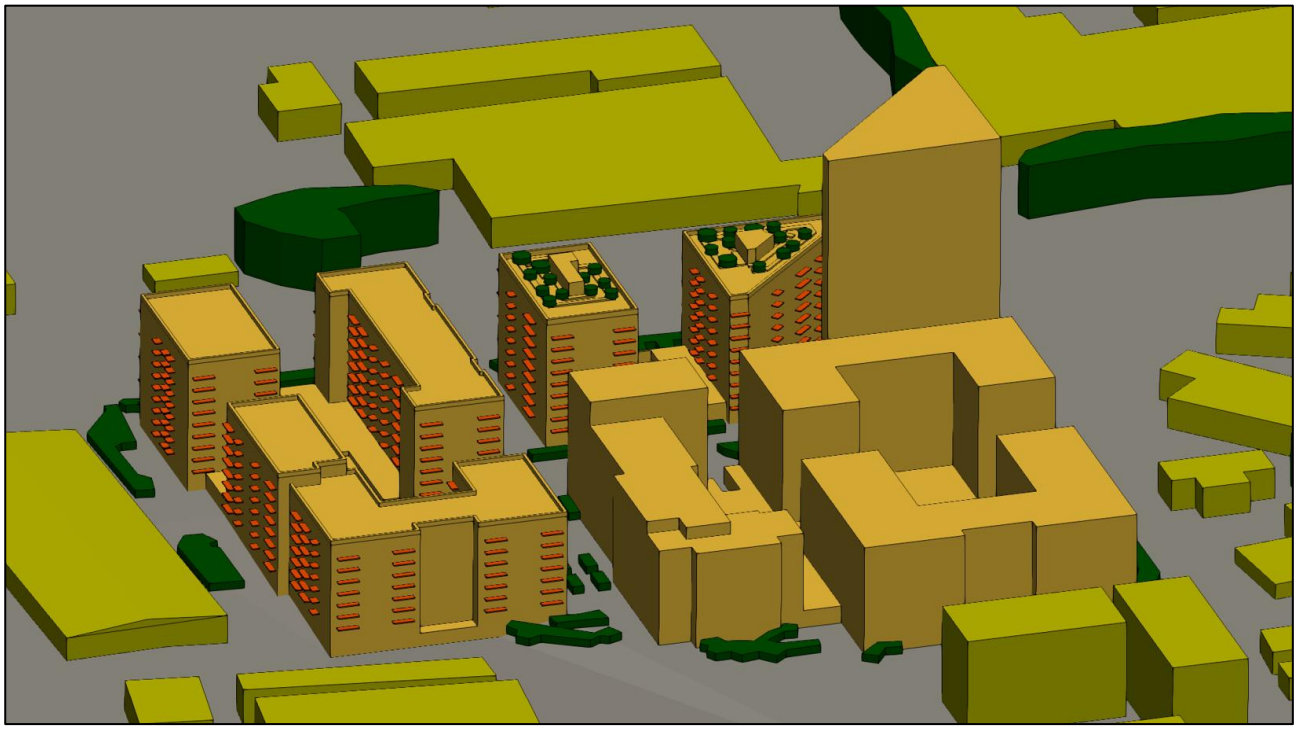


Figure 3. Extent of CFD Area View 2

WIND CLIMATE

The wind climate analysis is based on the wind data obtained from the Dublin Airport weather station which incorporates hourly wind data over a 80-year period (1946 until 2026). Figure 4 illustrates the percentage of hours per wind direction over a period of 80 years for 12 no. wind directions.

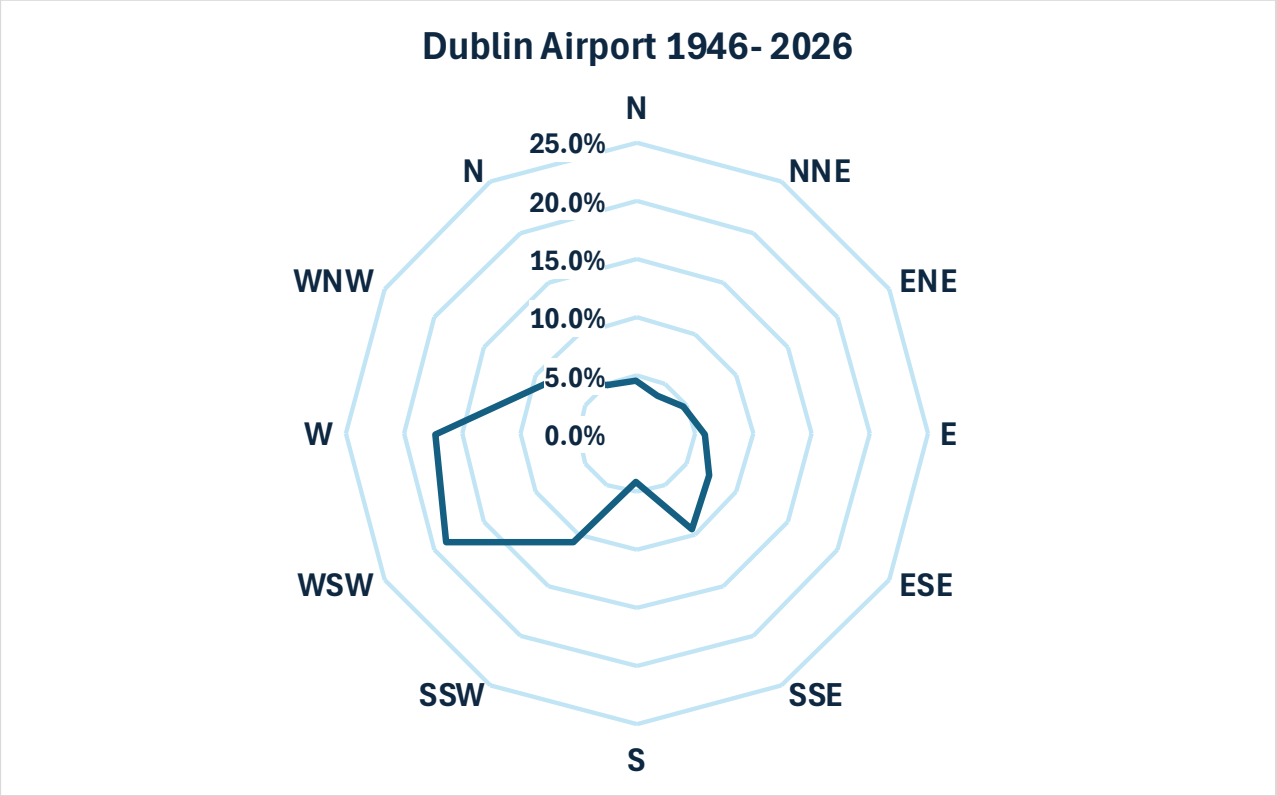


Figure 4. Percentage of Hours per Wind Direction over 80 years

The hourly wind data is the basis for the wind climate analysis. The number of hours that wind occurs from a given wind direction and velocity influences the local wind climate. The CFD simulation is used to calculate the wind-factor (local wind velocity relative to reference wind velocity). The wind-factor is a measure to calculate the number of hours that a given threshold wind velocity is exceeded based on statistical wind data. The yearly average frequency of a wind velocity occurrence per wind direction is outlined in Table 3.

Wind Velocity	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	N
	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs
0-1	14707	2356	1937	3127	3925	3678	2208	2478	2733	3224	3142	2555
1-2	7249	8150	8307	13204	16233	16411	8121	13722	20196	20399	15014	9440
2-3	5269	7372	10738	12380	16061	19680	7211	20872	36422	36039	21667	11037
3-4	3090	4758	6890	7050	8541	15002	5864	19287	33377	29794	12984	6851
4-5	1321	2308	3210	3803	3785	7443	3504	11964	22121	17971	5988	2881
5-6	516	939	1225	1737	1535	3112	1546	5377	11196	8805	2107	923
6-7	190	362	380	679	647	1182	512	2068	4950	3862	824	349
7-8	23	21	63	145	140	231	64	427	1056	868	149	52
8-9	5	11	4	24	37	33	7	77	287	275	38	8
9-10	1	2	0	4	1	4	1	7	68	62	12	0
10-11	0	0	0	0	1	0	1	6	28	18	2	0
11-12	0	0	0	0	0	0	0	0	4	8	0	0
12-13	0	0	0	0	0	0	0	0	0	0	0	0

Table 3. Frequency of Wind Velocity Occurrence per Wind Direction

WIND PROFILE

A cylindrical computational domain was created to simulate the effect of the atmospheric boundary layer surrounding the region of interest. The height of the computational domain is 6 times the height of the highest building in the domain.

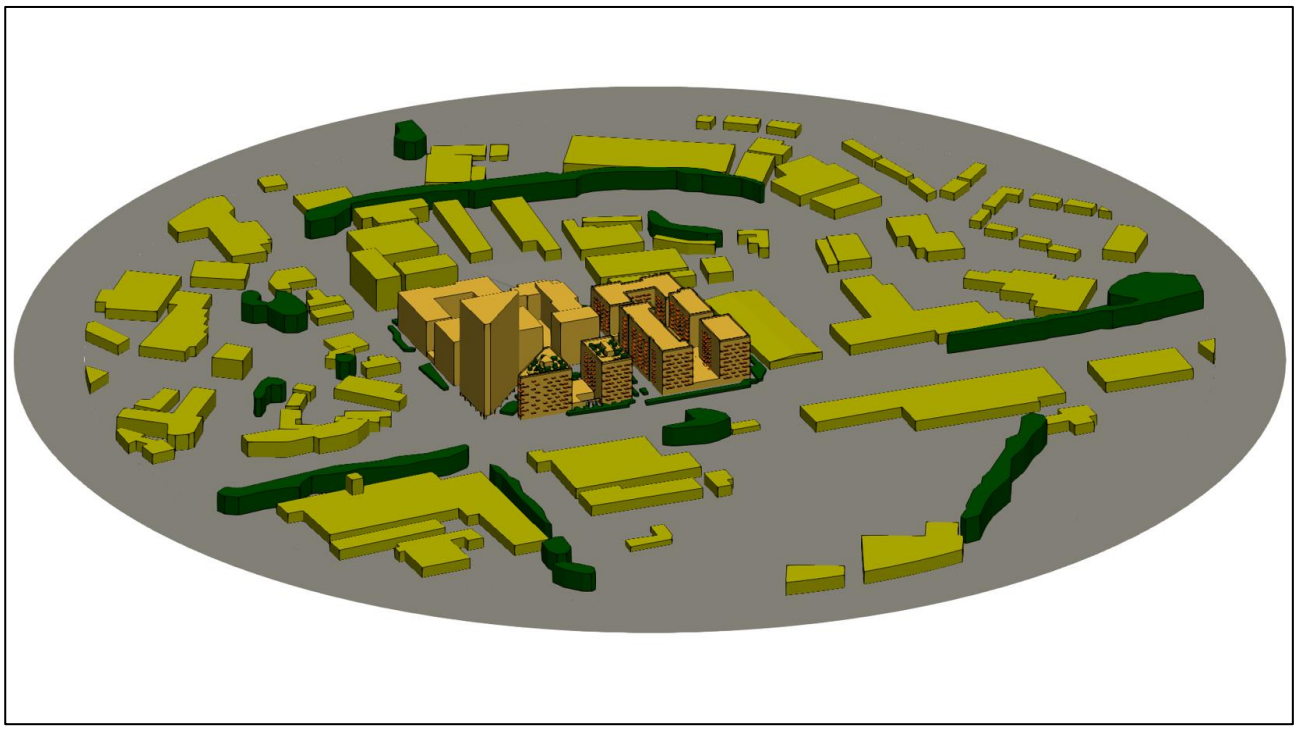


Figure 5. Computational Domain Surrounding the Region of Interest

An atmospheric boundary layer wind profile (v_{wind}) is applied to the boundaries of the computational model. To incorporate the effect of small height differences and small objects at street level, which are not explicitly included in the model, a roughness has been applied to the ground surface of the detailed CFD model. For the wind profile a roughness length (z_0) of 1.6 m has been estimated.

Based on the reference velocity, reference height, and roughness length, a wind profile can be defined. The wind profile v_{wind} is defined as follows.

$$U(z) = U_{ref}\left(\frac{z}{z_{ref}}\right)^{\alpha}$$

Where:

U(z)	Wind velocity	[m/s]
Uref	Reference velocity	[m/s]

z	Height above the ground	[m]
zref	Roughness length	[m]
α	power coefficient	[m]

WIND FACTOR

The CFD simulations are used to calculate the wind factor. The wind factor is a factor which indicates if the wind speed is locally increased (wind factor > 1.0) or decreased (wind factor < 1.0) due to buildings (or other geometry), relative to the applied reference wind speed at 10m height. The wind factor is independent of the magnitude of the reference wind speed at 10m height, making the obtained wind factor valid for all wind speeds in a specific wind direction range. Hence, one simulation can be applied per wind direction covering all wind speeds in this direction.

To explain the wind factor in more detail, the wind factor results for the 0-degree wind direction (i.e. North) are illustrated in Figure 6. The wind factor arrows that are coloured green, cyan or dark blue indicate that the local wind speed has been reduced (wind factor < 1.0), while wind factor arrows which are coloured light green/yellow indicate the local wind speed has increased (wind factor > 1.0). Using the wind factors, the quantity of hours that a wind speed is exceeded can be calculated (per wind direction) which is then used to assess compliance against the Lawson Criteria.

The wind factor results for all 12 no. wind directions are included in Appendix A.

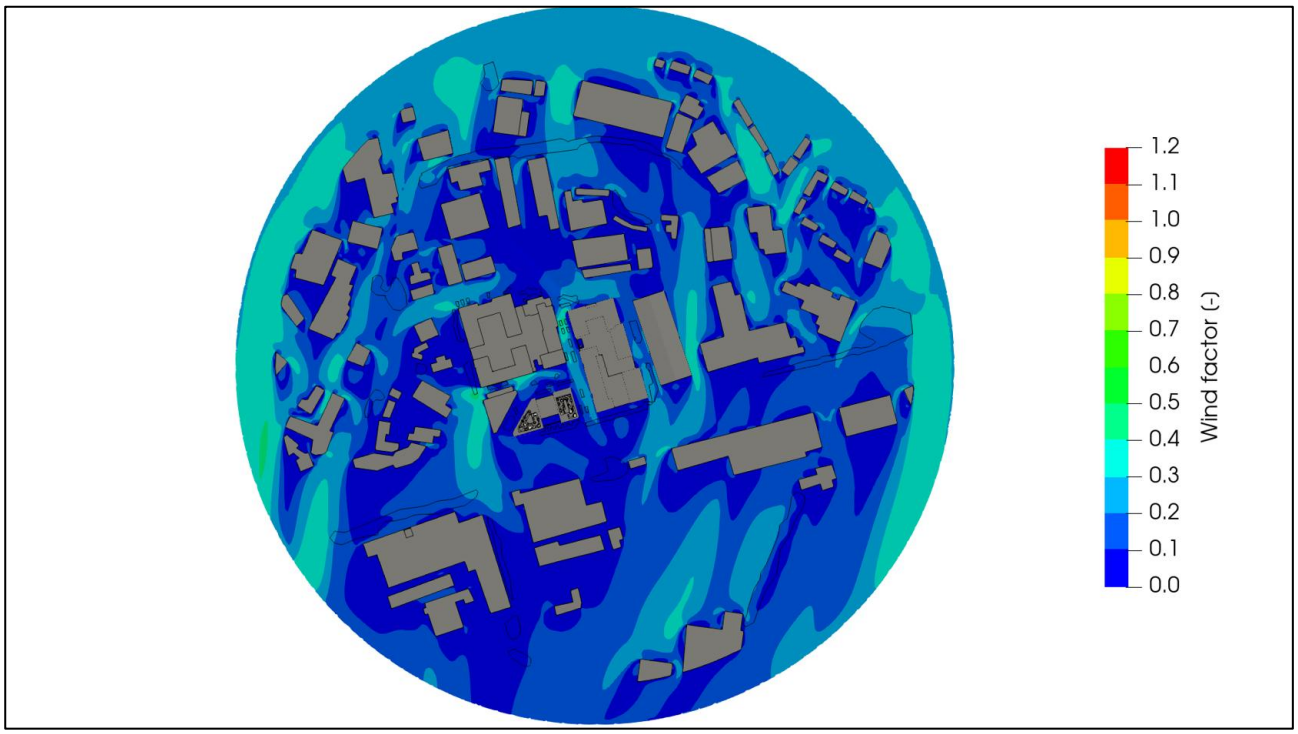


Figure 6. Wind Factor - 0 Degree (N) Wind Orientation

CFD MODELLING

The CFD simulation has been performed using the software package Helyx, which is based on OpenFOAM. This software package can be used for a large range of applications and has been extensively validated.

A full 3D CFD model of the proposed development and surrounding buildings was created and split into a large number of control volumes or cells. The standard equations for fluid motion and energy transport are applied to each cell. The equations are then solved using numerical techniques. The CFD settings used for the analysis are summarised in Table 4.

CFD settings	Description
Grid type	Snappy hex mesh (hexahedra and split hexahedra)
Cell size	Dynamic, ranging from 0.06 up to 1.8 m at the building surfaces and growing to 3.6 m in the volume
Number of cells	57.7 million elements
Simulation type	Steady state
Convergence	<1e-4
Simulation time	1500 s
Fluid	Air fixed properties
Turbulence model	Realizable k-ε model
Walls	Smooth, no slip
Wind volume	Profile for velocity and turbulence
Roughness	Volumetric sources for momentum and turbulence
Vegetation	Volumetric loss coefficient

Table 4. Summary of CFD Model Settings

6 ASSUMPTIONS AND LIMITATIONS

Computational Fluid Dynamic (CFD) is a widely recognised method for modelling airflow problems and as computer power develops, it increasingly improves its applicability. However, there are some limitations with CFD in relation to the modelling of wind environments. The method uses mean hourly wind values and presents a limitation to capture gusts.

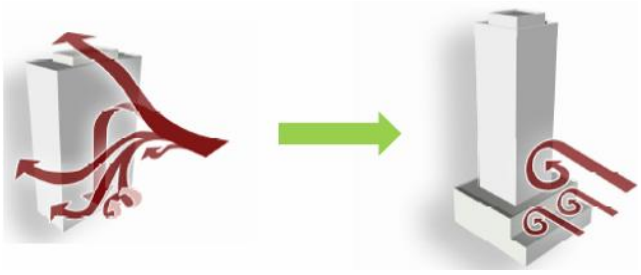
The Lawson criteria for pedestrian comfort focus on the effect of wind and do not factor in other environmental variables such as air temperature, solar radiation and relative humidity. However, overlaying all these factors would be a complex process and Lawson's simplified method presents the best available methodology for anticipating wind effects in the built environment.

The buildings were modelled as blocks, i.e. with smooth surfaces and sharp corners, which is generally sufficient detail to represent buildings in airflow modelling. This assumption is industry accepted as further detail to the model such as the window reveals and façade texture would add an impractical and unnecessary complexity to the model without adding greater quality results. Landscaping features such as pergolas and trellis structures were not modelled within the simulation as they would provide an extra level of complexity to an otherwise large CFD model. Furthermore, a very limited number of trees and hedges were modelled locally to prove their impact on mitigating wind speeds. Incorporating all balconies, trees and hedges would be impractical on a model this size.

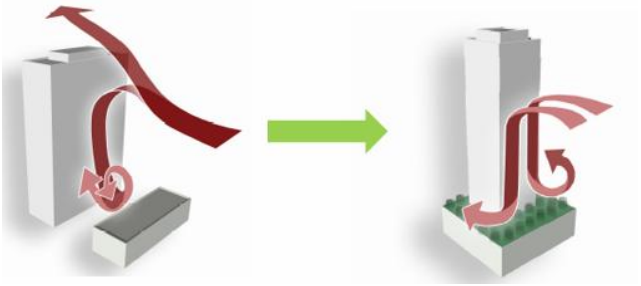
7 WIND MITIGATION MEASURES

The following are common strategies to mitigate excessive wind speeds associated with building developments[1].

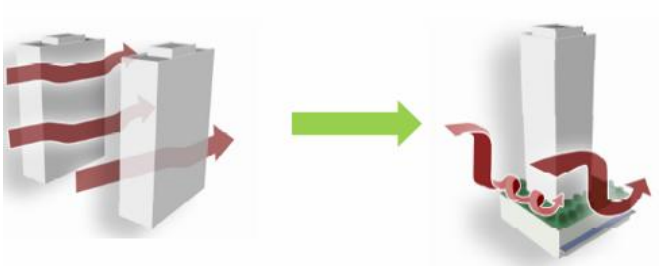
- When wind hits the windward face of a building, the building deflects the wind downwards (downwashing), causing accelerated wind speeds at pedestrian level and around the corners of the building. By introducing a base building or podium, the downward wind flow can be deflected, resulting in a reduction of wind speed at pedestrian level.



- When the leeward face of a low building faces the windward face of a tall building, it causes an increase in the downward wind flow. By landscaping the base building roof, wind speeds can be further reduced.



- Wind speed is accelerated when wind is funneled between two buildings. A horizontal canopy on the windward face of a base building can improve pedestrian comfort conditions.



[1] *Pedestrian Wind Comfort and Safety Studies,* (City of Mississauga, 2014).

The following specific mitigation measures have been incorporated into the proposed design to prevent excessive wind speeds.

COURTYARD LOCATION

The large central courtyards within the development at ground level have been strategically located as they are all sheltered from the predominant south-west wind direction resulting in a comfortable environment for pedestrians using the space.



Figure 7. Wind Mitigation Measure - Courtyard Location

LANDSCAPING

The landscaping has been strategically designed to mitigate increased wind speeds and to provide shelter for pedestrians at street level and in the central courtyards. The landscaping design incorporates trees as wind breakers and sheltered seating pockets to act as wind mitigation measures.

The proposed landscaping design is illustrated in Figure 8 to 10. Trees are to be planted close to primary entrance ways and along the streetscape, mitigating excessive wind speeds and providing shelter for pedestrians at street level. The use of trees and low-level shrubs all assist in the localised reduction of wind speed.

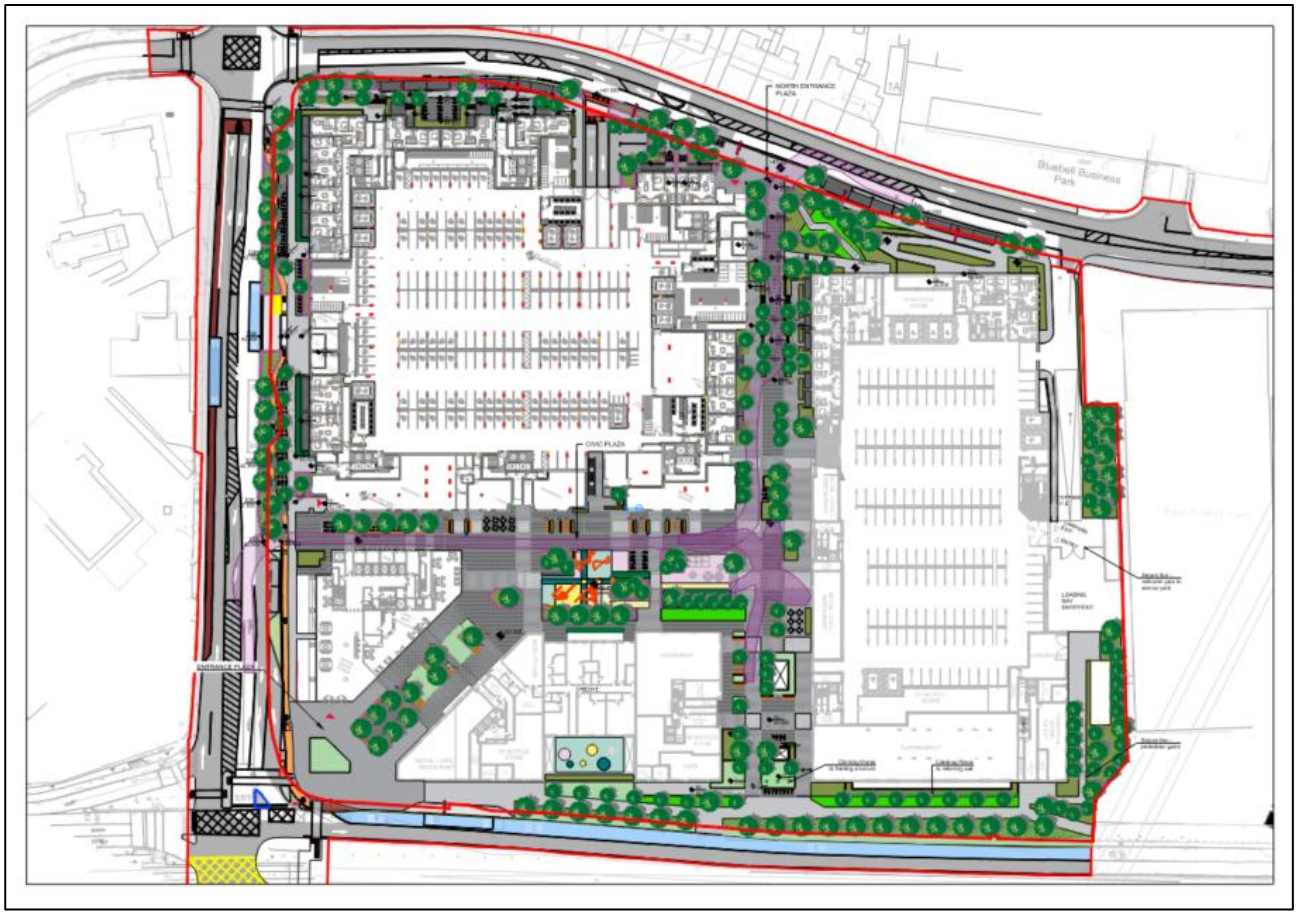


Figure 8. Wind Mitigation Measure - Landscaping Design (Master Plan)



Figure 9. Wind Mitigation Measure - Landscaping Design (First/Podium Floor)



Figure 10. Wind Mitigation Measure - Landscaping Design (Roof)

8 PEDESTRIAN COMFORT RESULTS

Ground/Street Level

The number of hours for all wind directions are summed to calculate the total number of hours that a given pedestrian activity class exceeds the 5% yearly threshold with the results presented in Figure 11.

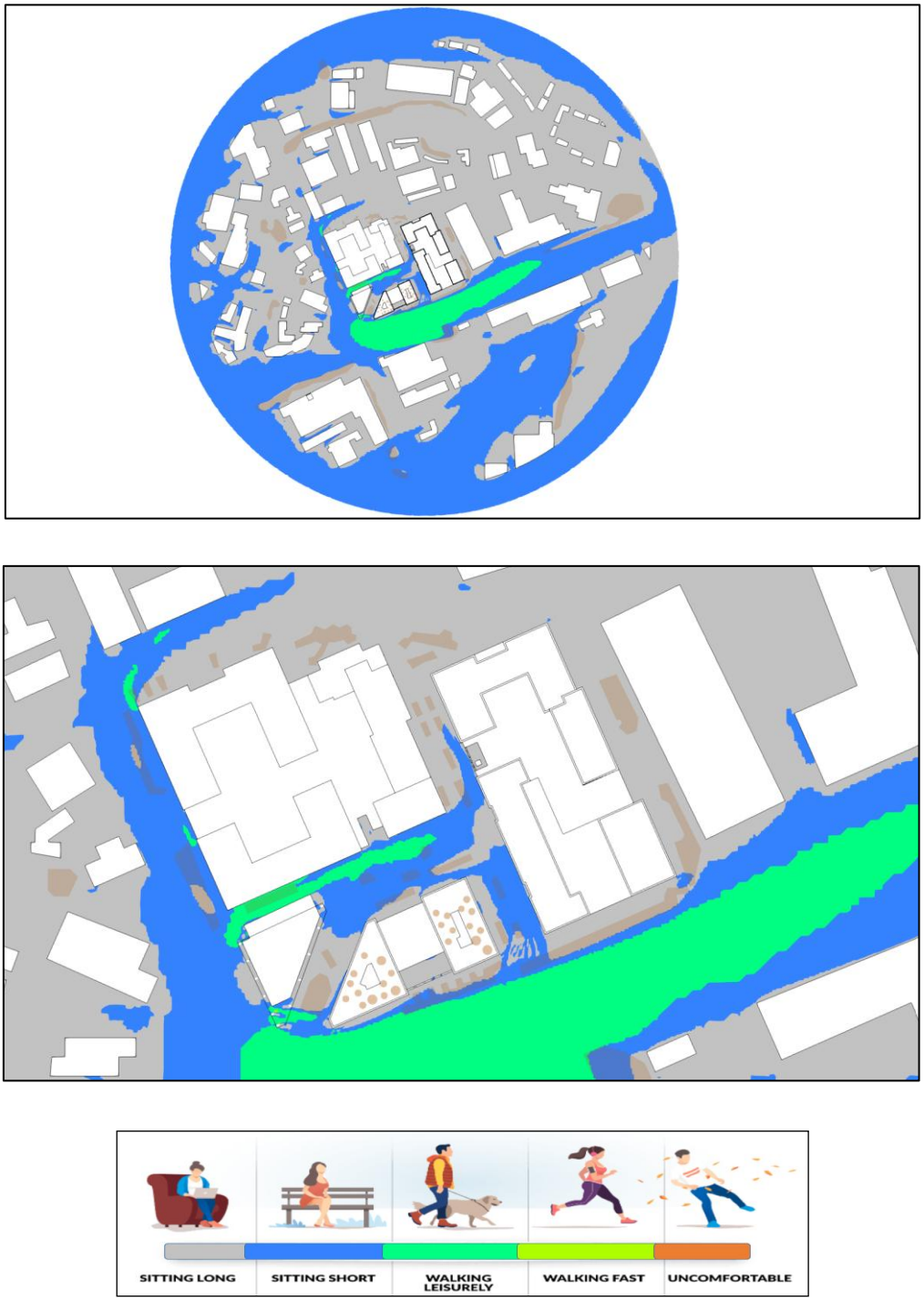


Figure 11. Pedestrian Wind Comfort Results at Ground/Street Level

The results of the simulations show that no comfort classes are exceeded for the majority of areas within the proposed developed, with no areas deemed uncomfortable. In certain localised areas, the long and short term sitting comfort class is marginally exceeded.

The pedestrian wind comfort results at ground/street level (1.5m above ground level) are included in this section and are summarised as follows:

- As illustrated in Figure 11, areas at street level are suitable for long sitting highlighted in grey.
- The majority of the remaining areas that do not comply with the "Long Sitting" class but suitable for "Short Sitting" (areas highlighted in blue).
- The area highlighted in green represent good enough for leisurely walk but not for sitting.
- The pedestrian comfort at ground/street level is satisfactory throughout the development with the layout of the buildings and the proposed trees having a significant positive effect in terms of mitigating excessive wind speeds.

Following on from the above summary, it should also be noted that a pedestrian activity class is only a statistical assessment of the local wind climate. When a region does not meet a certain criterion (e.g. sitting), this does not mean that one can never do this activity in this region. It only means that for more than 5% of the time per year the wind speed for this activity is exceeded. The remaining time of the year this activity is possible.

Finally, the wind speed threshold for a certain pedestrian class is only meant to provide guidance on where to locate certain areas where a certain type of activity is expected to be performed. In practice, the experience of the outdoor climate depends on more than just wind speed. Other factors such as clothing, air temperature, solar irradiation, age and relative humidity must also be considered.

Shared Amenity Spaces on Podium Level

Shared amenity spaces are located at the podium level and have been evaluated against established pedestrian wind comfort criteria. The assessment indicates that all podium-level amenity areas meet the comfort thresholds for both sitting and walking activities, as shown in Figure 12.

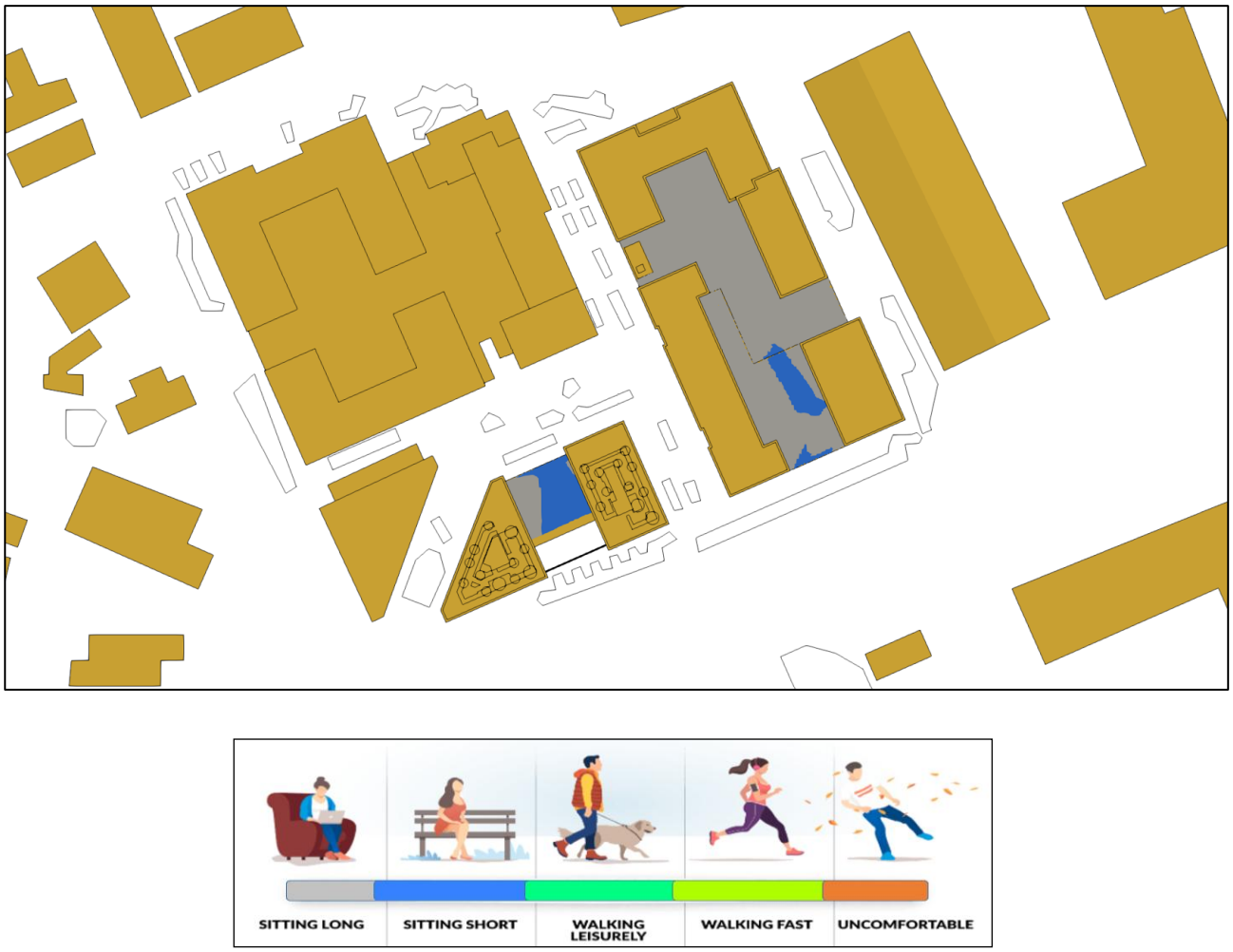


Figure 12. Pedestrian Wind Comfort Results at Podium Level

Shared Amenity Spaces at terrace Level

As amenity terraces are not considered common pedestrian areas, they have not been assessed against the typical comfort classes for pedestrian comfort. However, they have been assessed based on the safety criteria with the most stringent condition being considered, i.e. "sensitive". Based on the sensitive class, all amenity spaces are currently considered safe as illustrated in Figure 13.



Figure 13. Pedestrian Wind Comfort Results Frail Pedestrian – Shared Terraces within Block B1 & B2

Private Balconies Safety

As private balconies are not considered common pedestrian areas, they have not been assessed against the typical comfort classes for pedestrian comfort. However, they have been assessed based on the safety criteria with the most stringent condition being considered, i.e. "sensitive" (refer to Table 2).

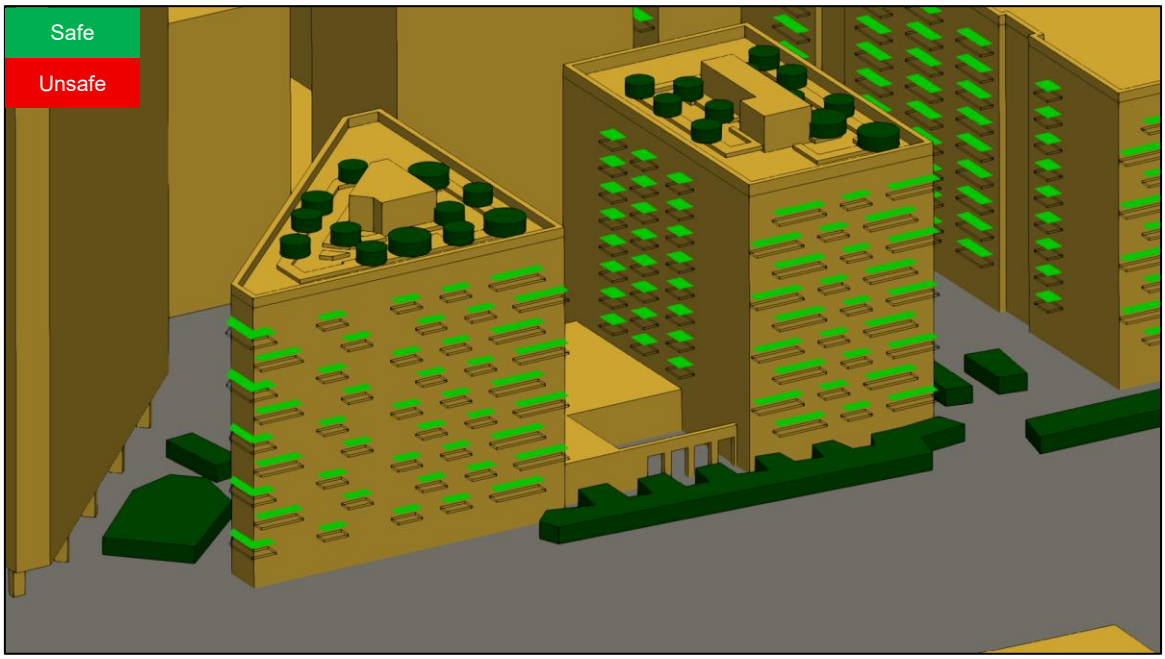


Figure 14. Pedestrian Wind Comfort Results Frail Pedestrian - Private Balconies within Block B1 & B2 (South & West)

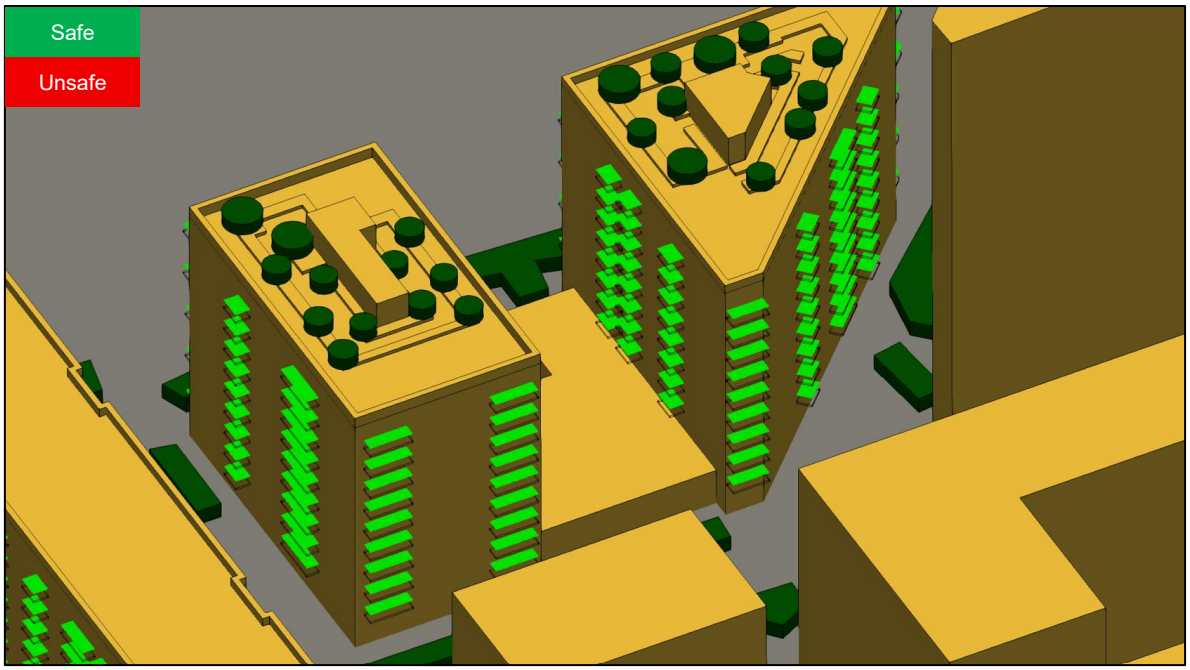


Figure 15. Pedestrian Wind Comfort Results Frail Pedestrian - Private Balconies within Block B1 & B2 (North & East)

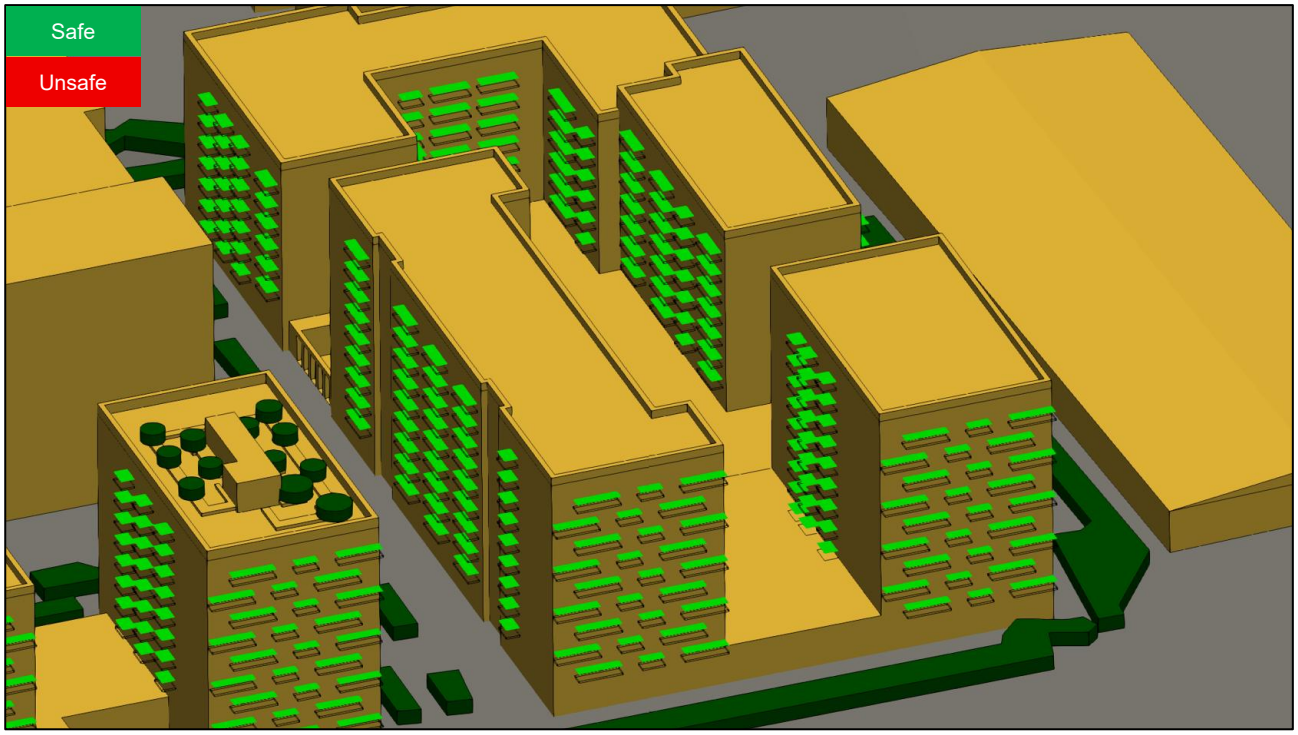


Figure 16. Pedestrian Wind Comfort Results Frail Pedestrian - Private Balconies within Block C1, C2, D1 & D2 (South & West)

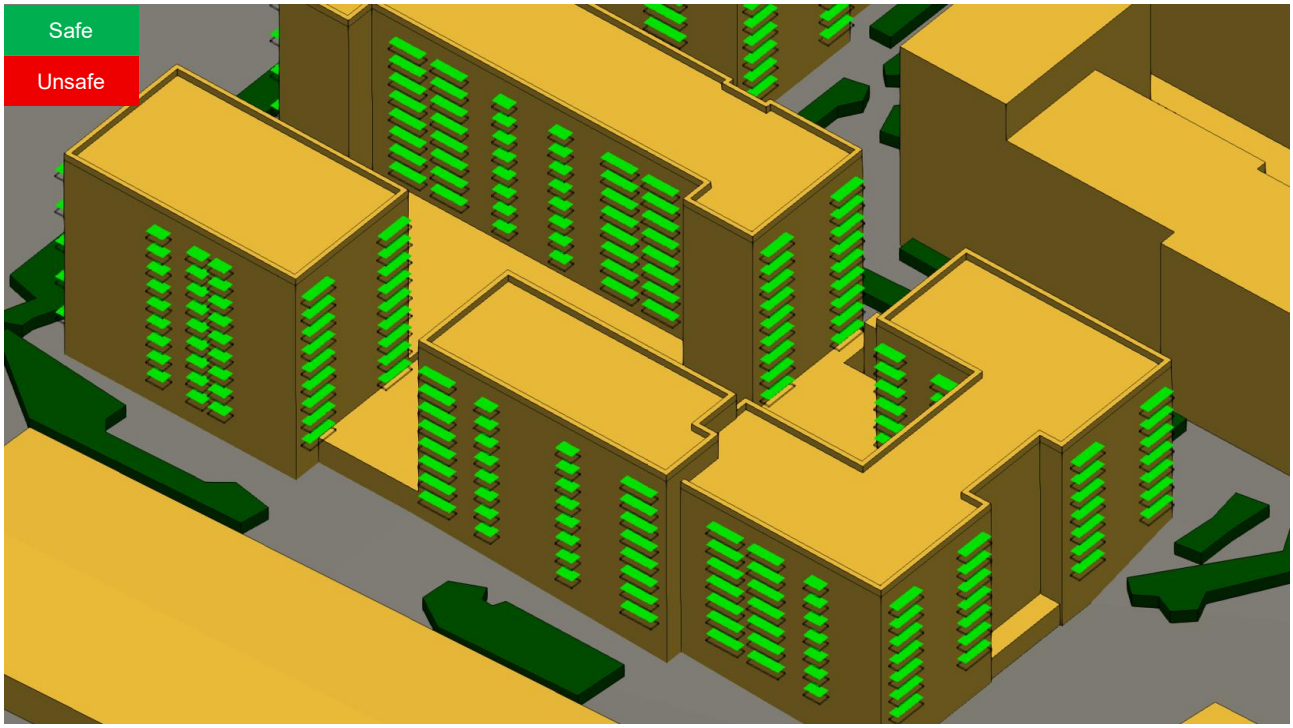


Figure 17. Pedestrian Wind Comfort Results Frail Pedestrian - Private Balconies within Block C1, C2, D1 & D2 (North & East)

To further understand the wind comfort conditions on the private balconies, an assessment has also been undertaken against the Lawson wind comfort criteria. As noted above, compliance with the Lawson comfort criteria is not mandatory for private balconies, which are generally assessed primarily against the relevant safety criteria.

Nevertheless, the Lawson comfort assessment has been undertaken to provide a better understanding of the expected wind comfort conditions for occupants and to further support the robustness of the proposed design.

The left-hand image illustrates the balconies assessed under the current design. The right-hand image illustrates the same balconies with solid screening introduced along the balcony fronts at the orientations identified as potentially experiencing higher wind speeds. The screening has been considered as a mitigation measure to improve the local wind environment and enhance occupant comfort on the affected balconies.

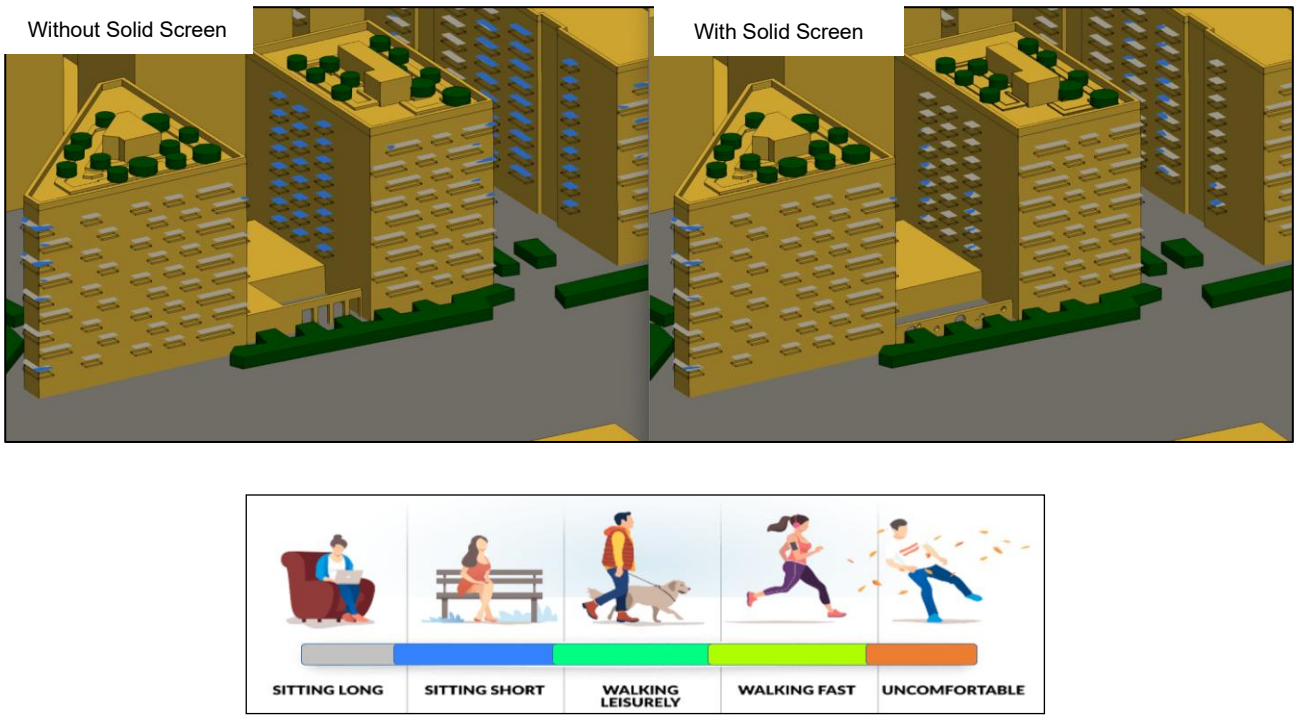


Figure 18. Pedestrian Wind Comfort Results - Private Balconies with & without Solid Screen within Block B1 & B2 (South & West)

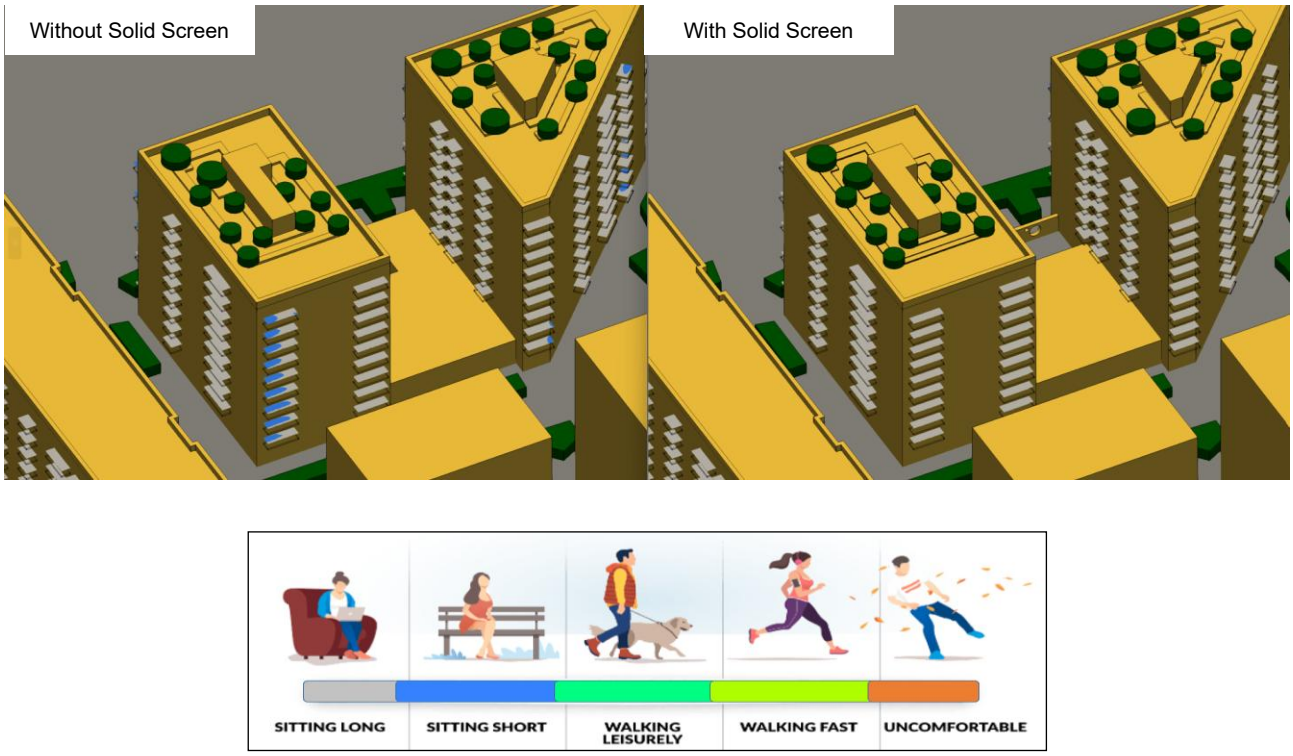


Figure 19. Pedestrian Wind Comfort Results - Private Balconies with & without Solid Screen within Block B1 & B2 (North & East)

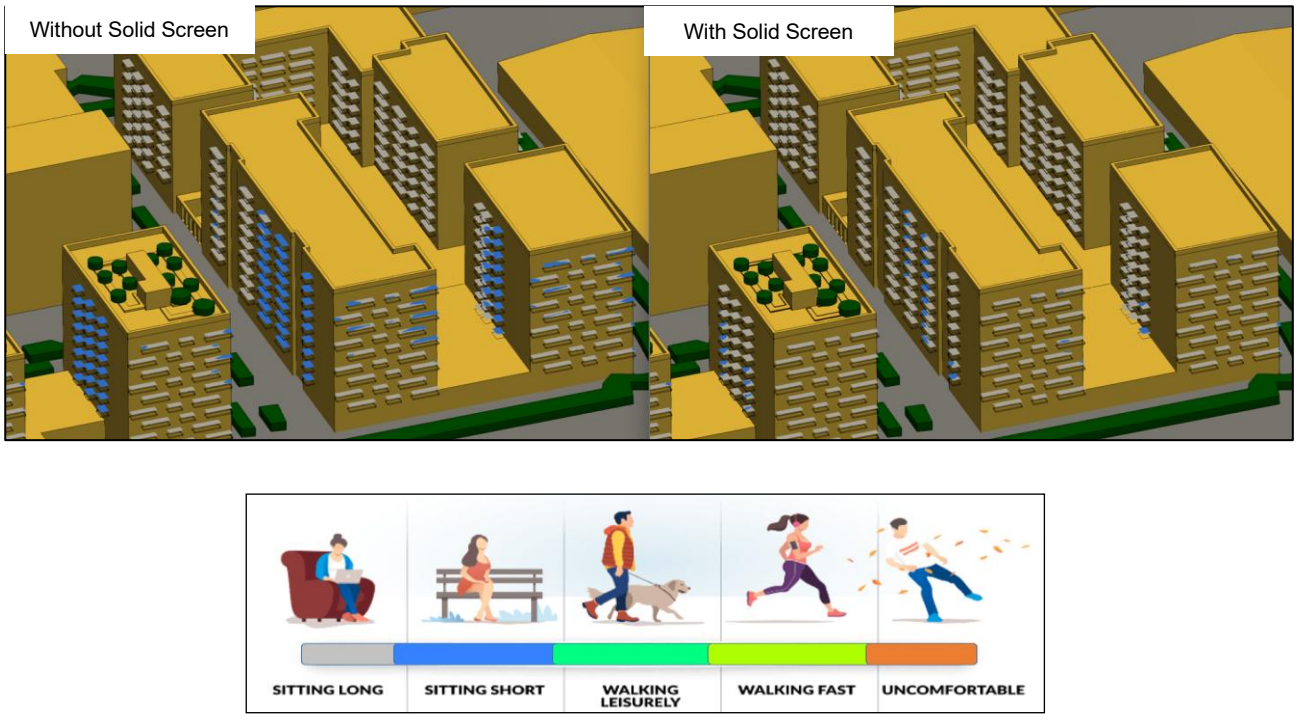


Figure 20. Pedestrian Wind Comfort Results - Private Balconies with & without Solid Screenwithin Block C1, C2, D1 & D2 (South & West)

9 CONCLUSION

This report outlines the predicted climatic wind conditions experienced within and surrounding the proposed development located on Royal Live Pahse 2.

As part of this assessment, the industry accepted standard of the Lawson Criteria was utilised. The Lawson Criteria gives guidance to quantify the effect of wind velocity on pedestrian comfort and safety. The wind climate analysis is based on the wind data obtained from the Dublin Airport weather station which incorporates hourly wind data over a 80-year period (1946 until 2019).

A conscious effort was made by the design team during the design stages to mitigate the risk of localised increased wind speed conditions due to the proposed development. The introduction of mitigation measures such as the courtyard locations, strategic location of extensive landscaping, and solid screen infront of balconies assist in reducing the potential development of local increased wind speed and the negative impact on local climatic conditions.

Based on the CFD modelling results, the proposed development is expected to provide a generally comfortable wind environment for occupants and pedestrians.

Certain areas around the development, particularly within the street-level areas, have been identified as potentially uncomfortable for long- and short-duration sitting. However, these areas are limited in extent, and the identified concerns have been largely addressed through the incorporation of landscaping, which will help to mitigate excessive wind speeds and improve local wind conditions.

The assessment indicates that these areas are expected to remain suitable for leisurely walking. The exceedance of the specified comfort criteria in some locations is largely influenced by the prevailing climatic conditions in Dublin, which can result in relatively higher background wind speeds.

Overall, the proposed development will be a high-quality, comfortable environment for occupants throughout the year.

10 VERIFICATION

This report was compiled and verified by:

Ashish Nautiyal
Senior Sustainability Engineer
O'Connor Sutton Cronin & Associates

Appendix A CFD SIMULATION RESULTS

The CFD wind factor results included in this section are for all 12 No. wind directions as referenced within the body of the report. The wind directions referenced in the wind rose below correspond to the wind directions referenced in the CFD results.

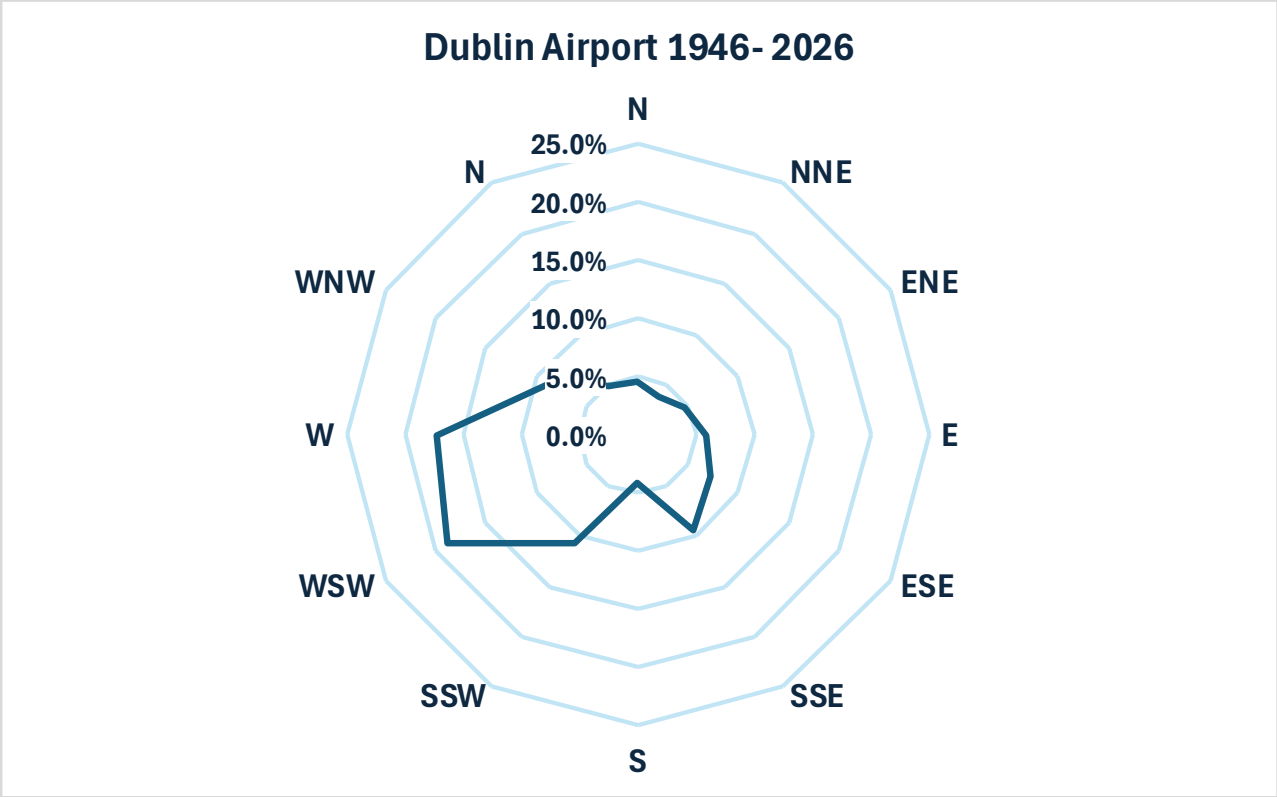


Figure 21. Dublin Airport Wind Rose Data (1946 – 2026)

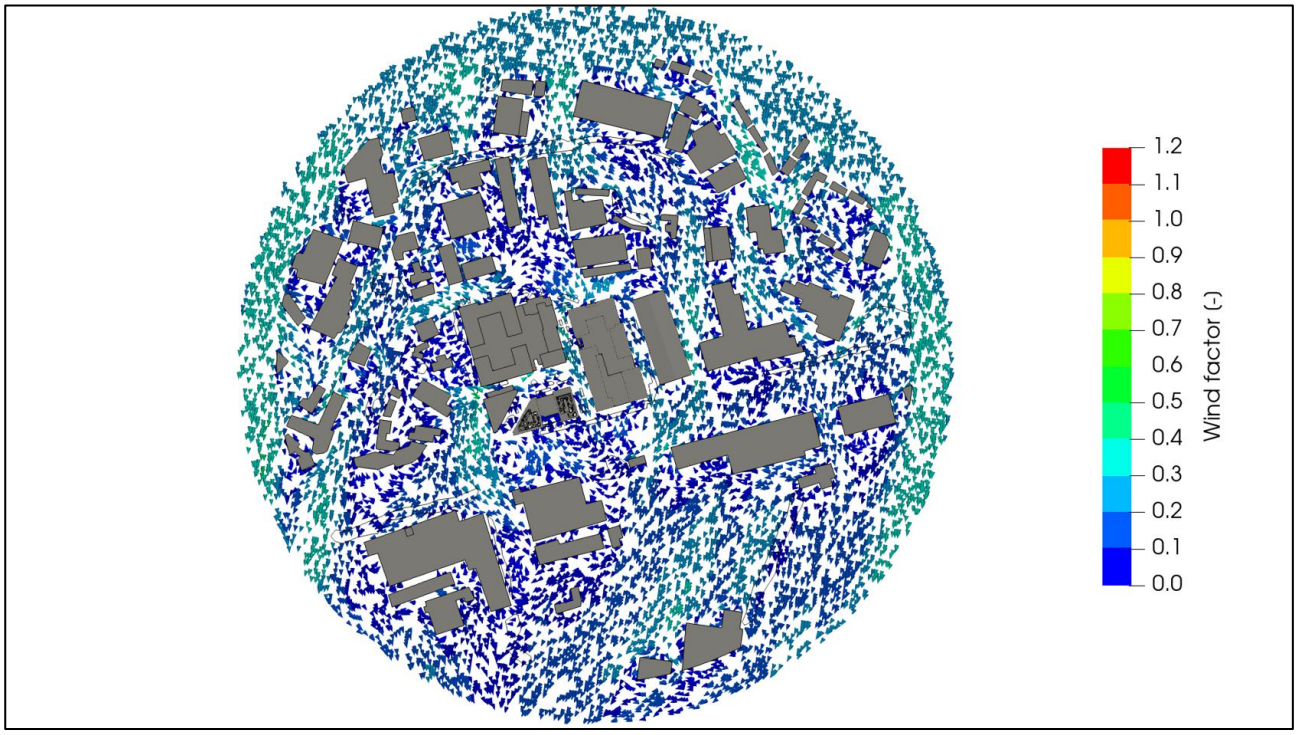


Figure 22. Wind Factor – 0 Degree (N) Wind Direction (Vector View)

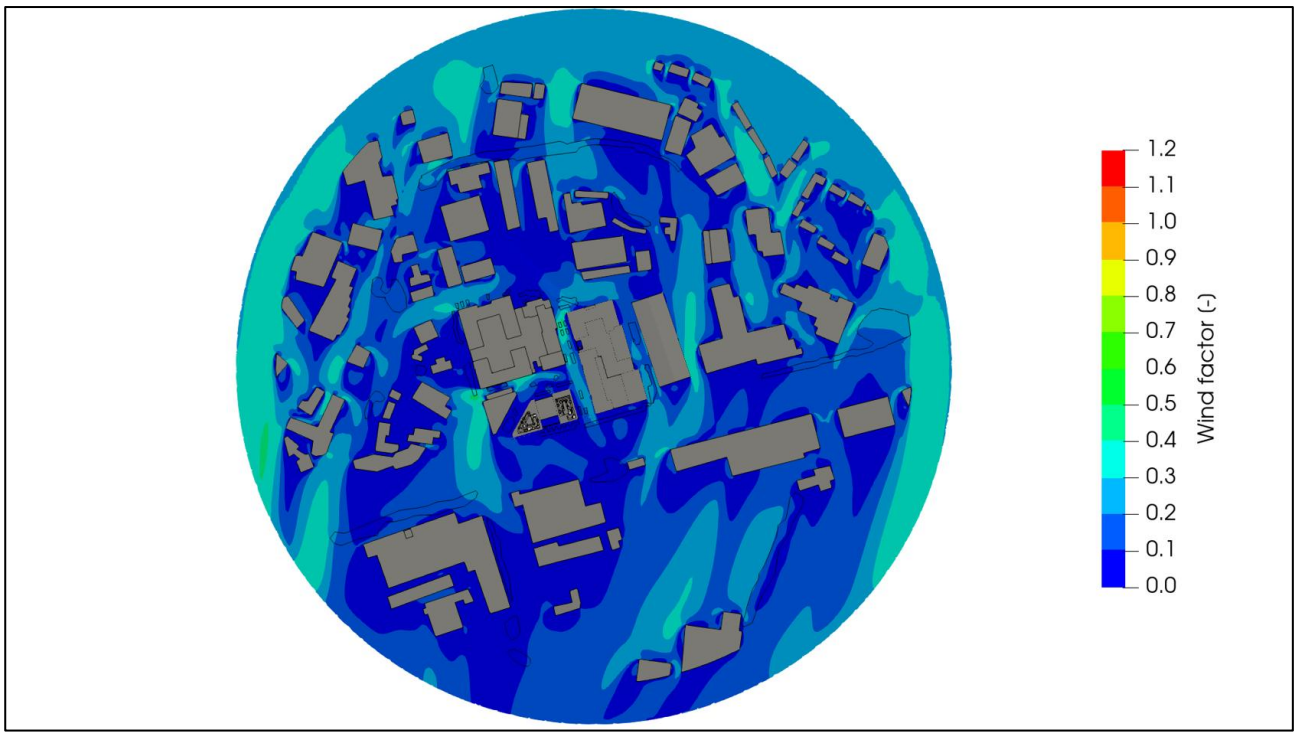


Figure 23. Wind Factor – 0 Degree (N) Wind Direction (Contour View)

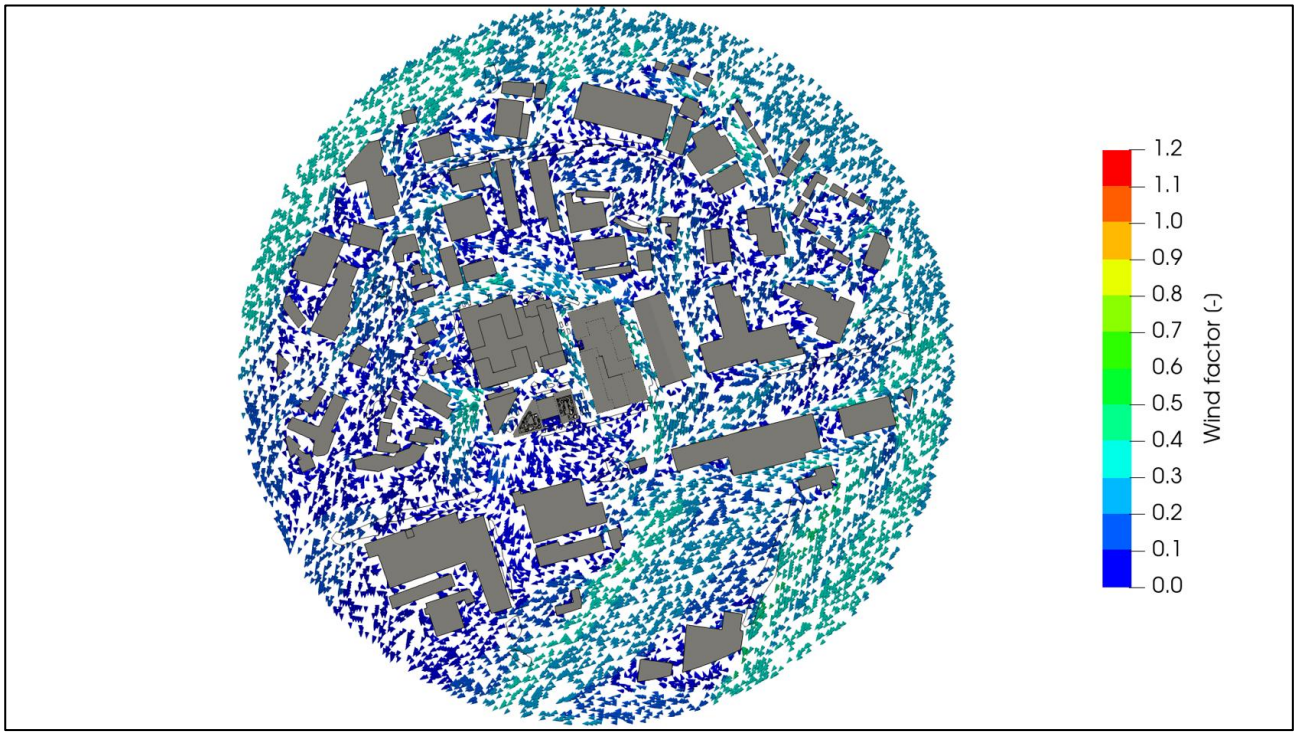


Figure 24. Wind Factor – 30 Degree (NNE) Wind Direction (Vector View)

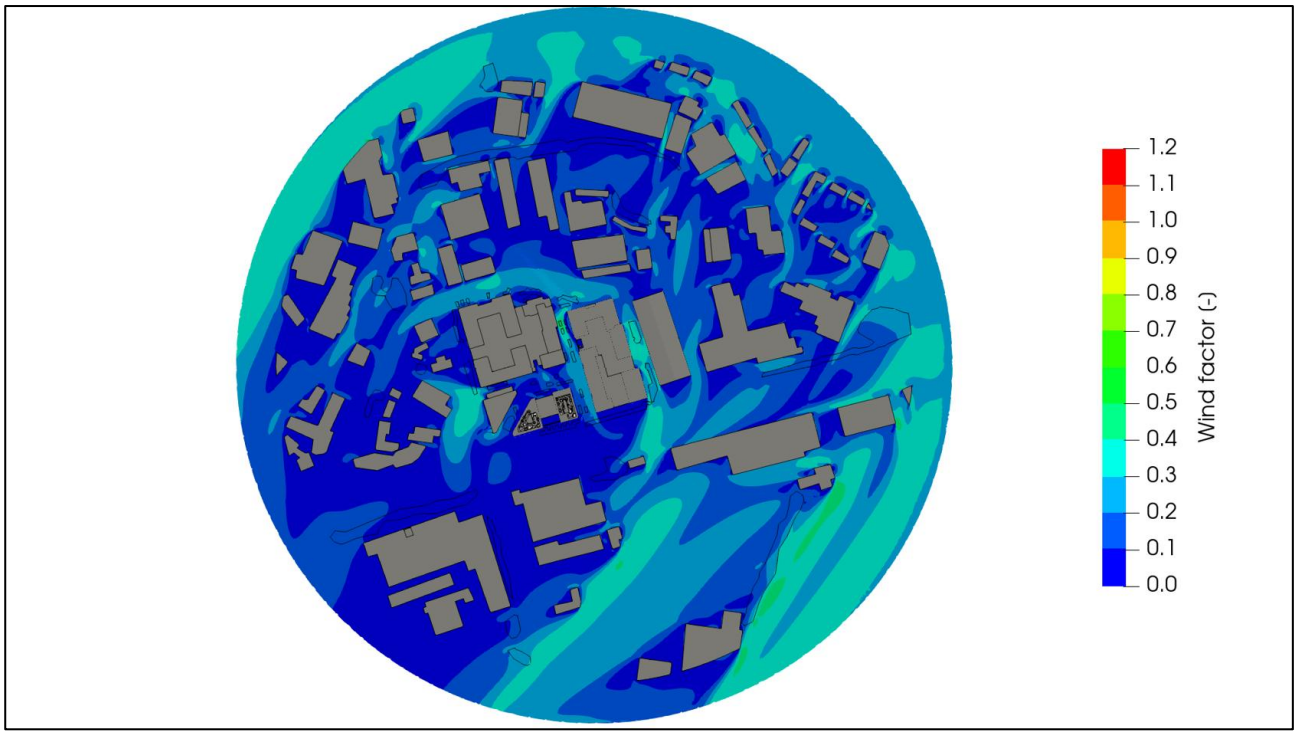


Figure 25. Wind Factor – 30 Degree (NNE) Wind Direction (Contour View)

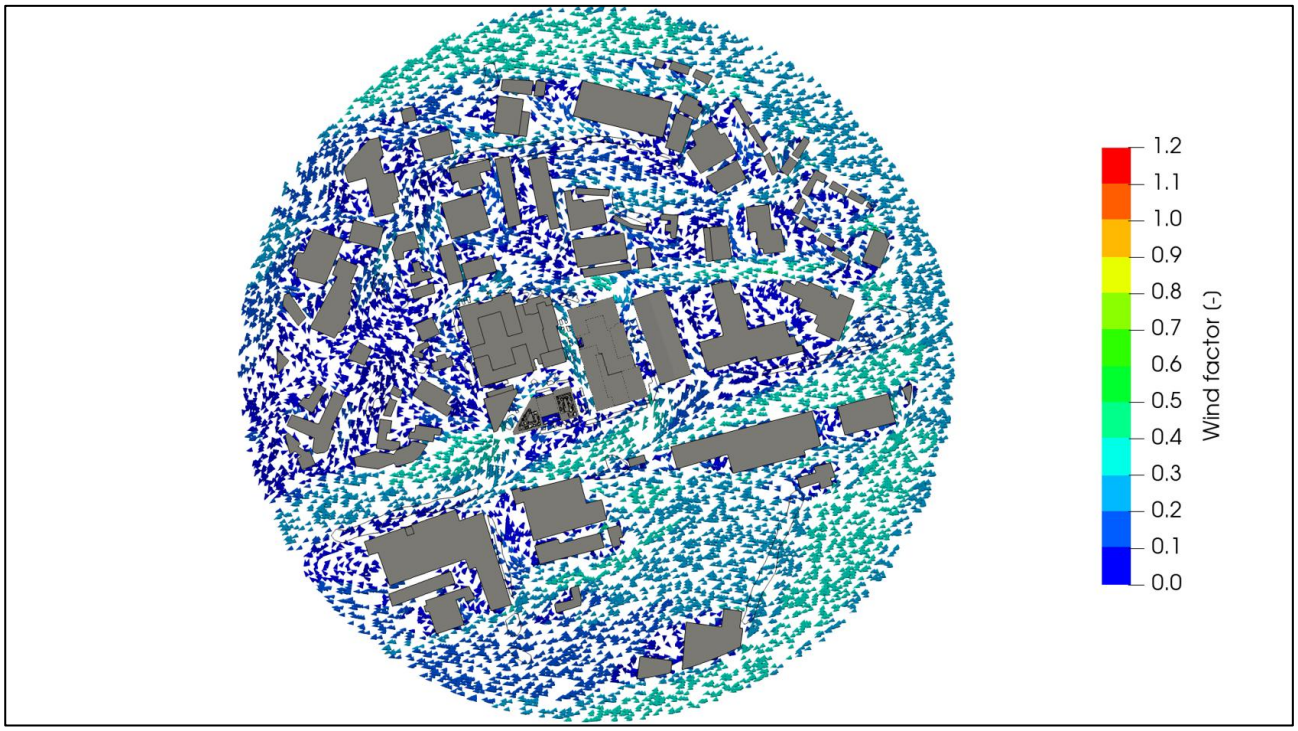


Figure 26.Wind Factor – 60 Degree (ENE) Wind Direction (Vector View)

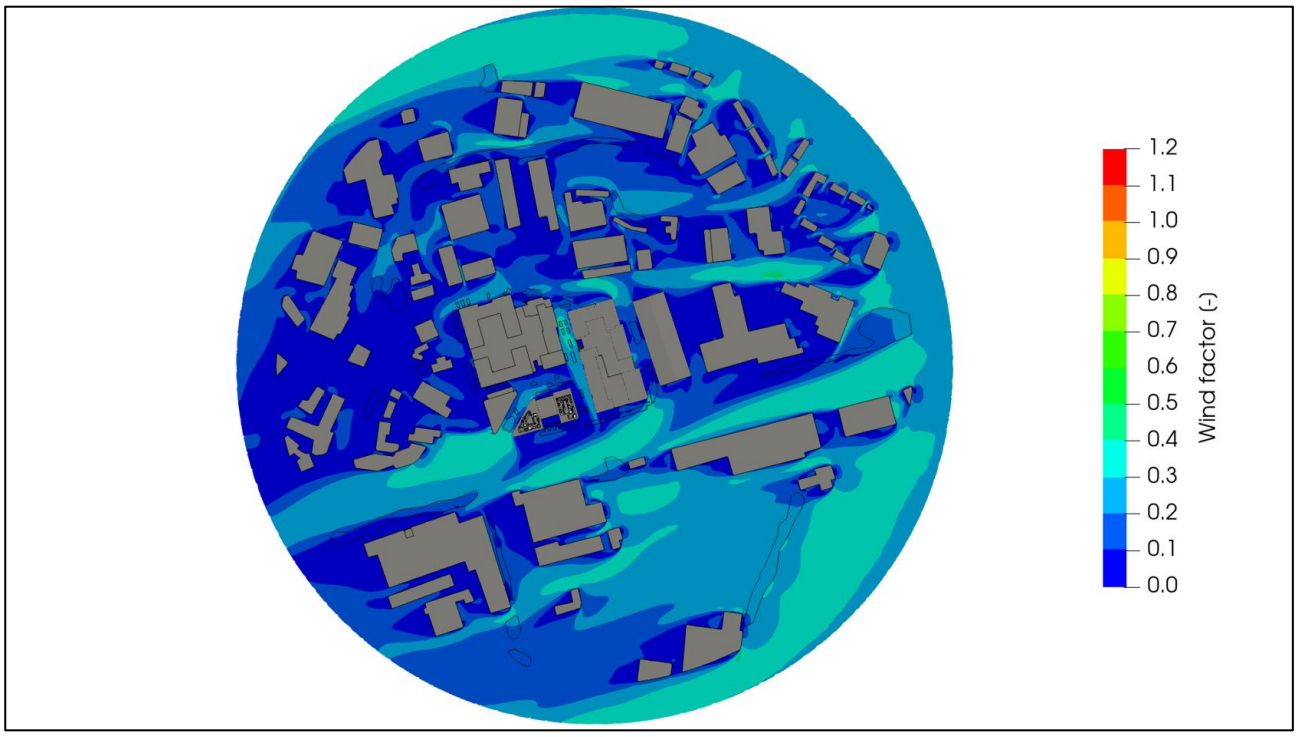


Figure 27.Wind Factor – 60 Degree (ENE) Wind Direction (Contour View)

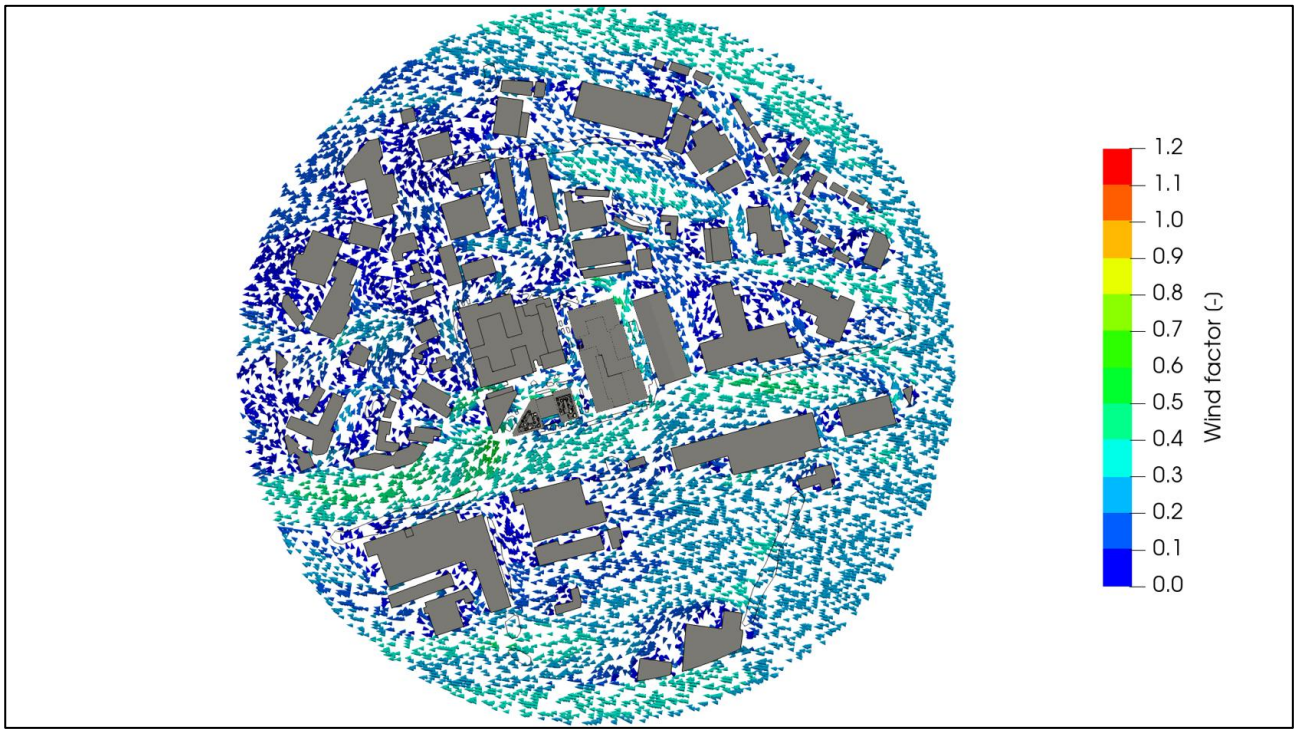


Figure 28. Wind Factor – 90 Degree (E) Wind Direction (Vector View)

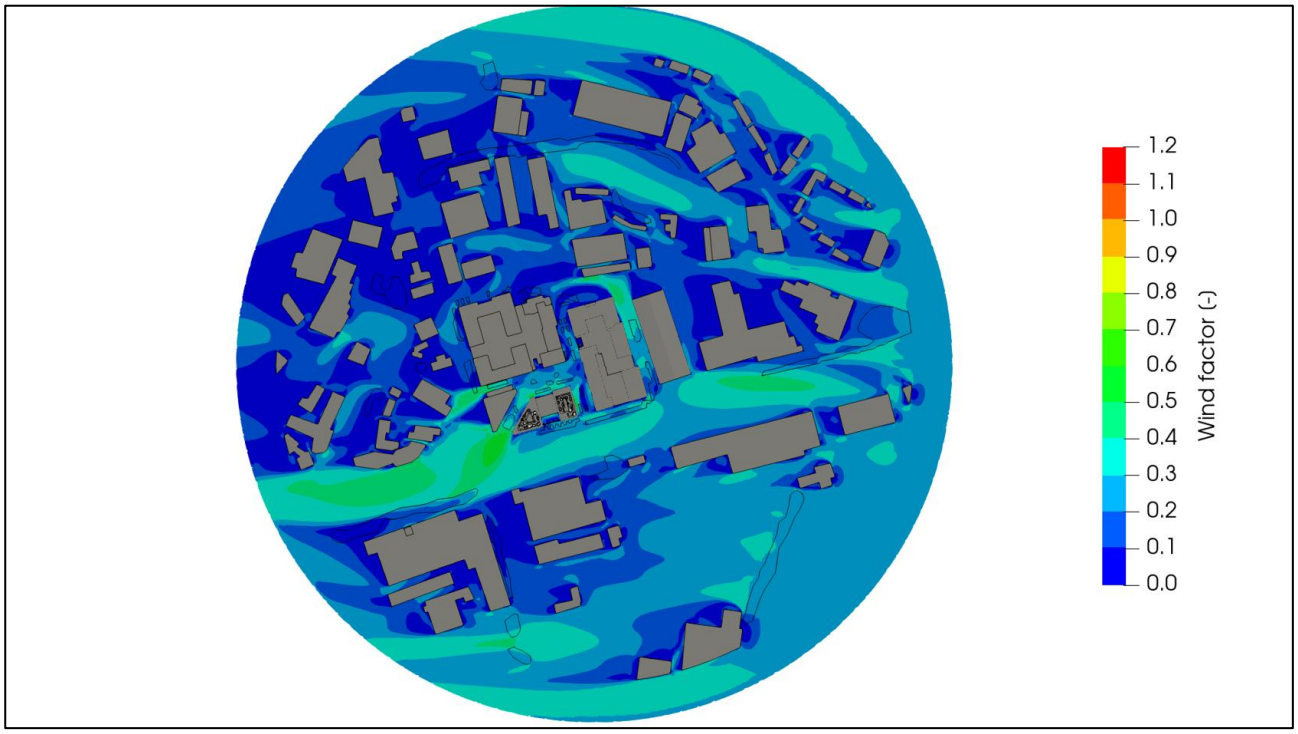


Figure 29. Wind Factor – 90 Degree (E) Wind Direction (Contour View)

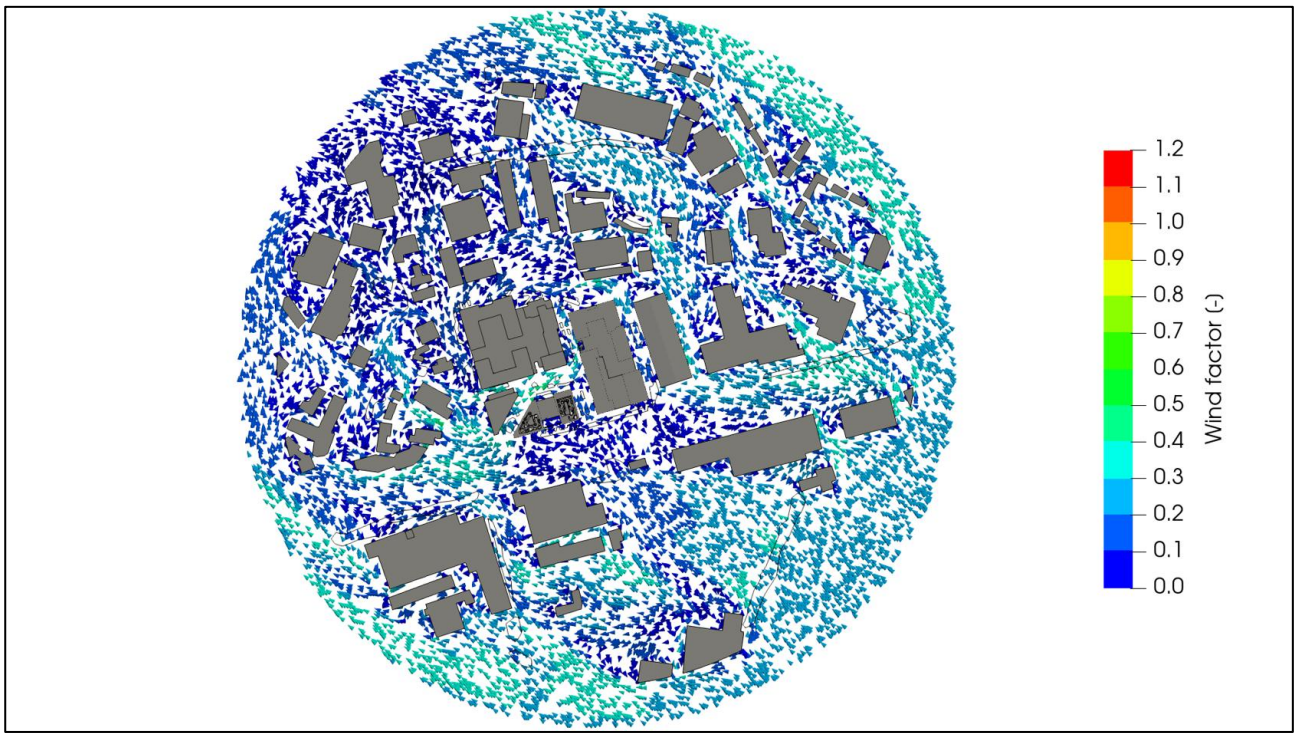


Figure 30. Wind Factor –120 Degree (ESE) Wind Direction (Vector View)

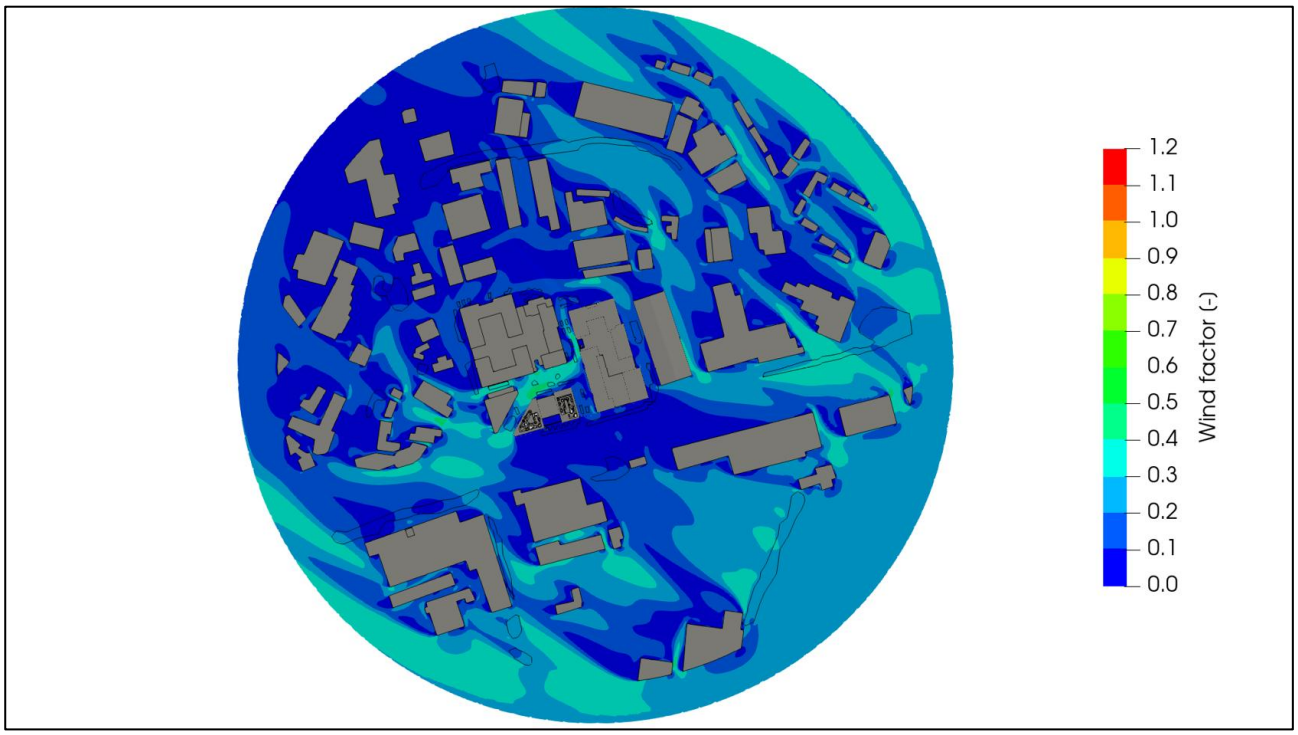


Figure 31. Wind Factor –120 Degree (ESE) Wind Direction (Contour View)

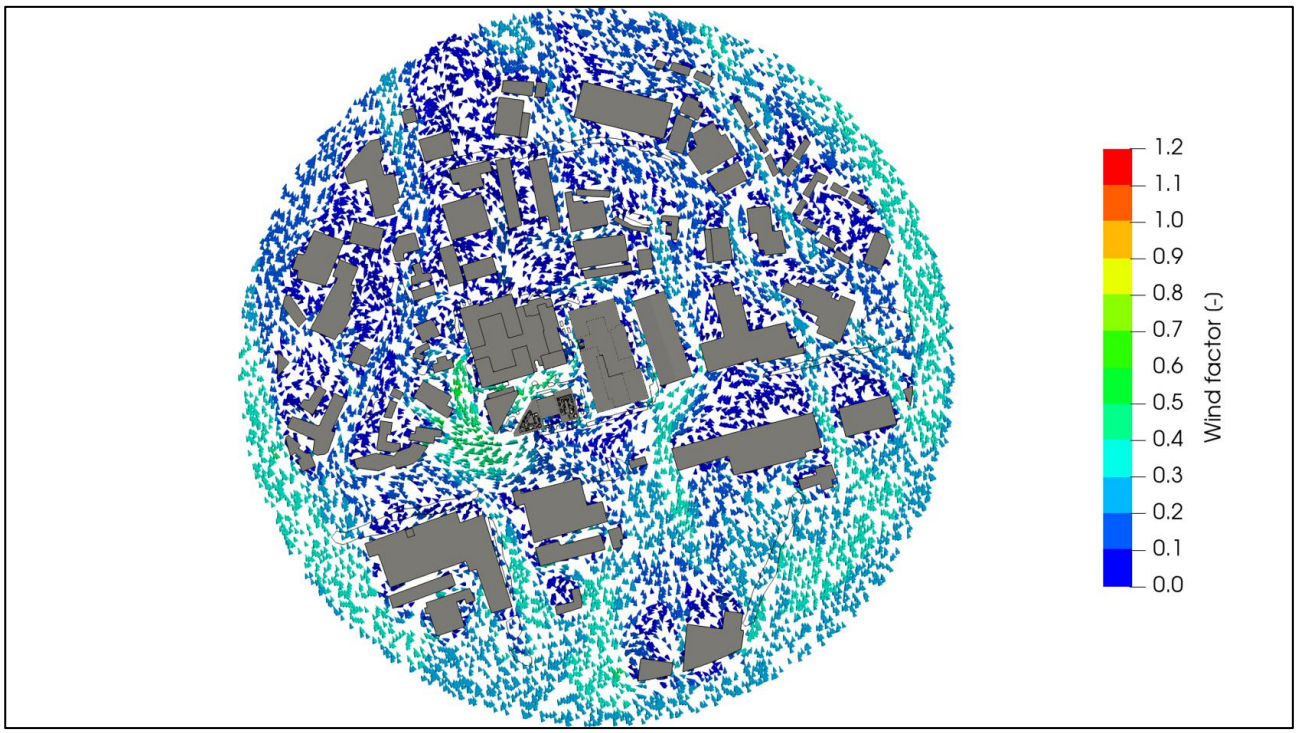


Figure 32. Wind Factor – 150 Degree (SSE) Wind Direction (Vector View)

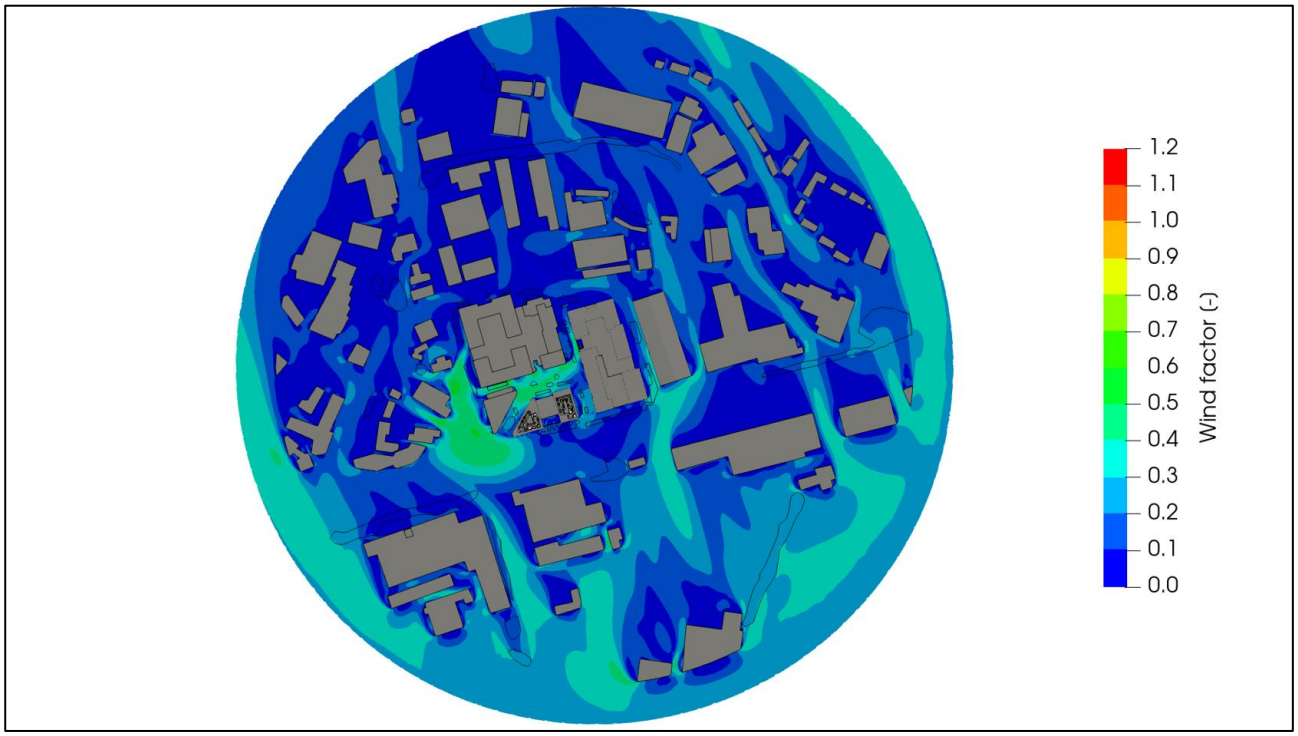


Figure 33. Wind Factor – 150 Degree (SSE) Wind Direction (Contour View)

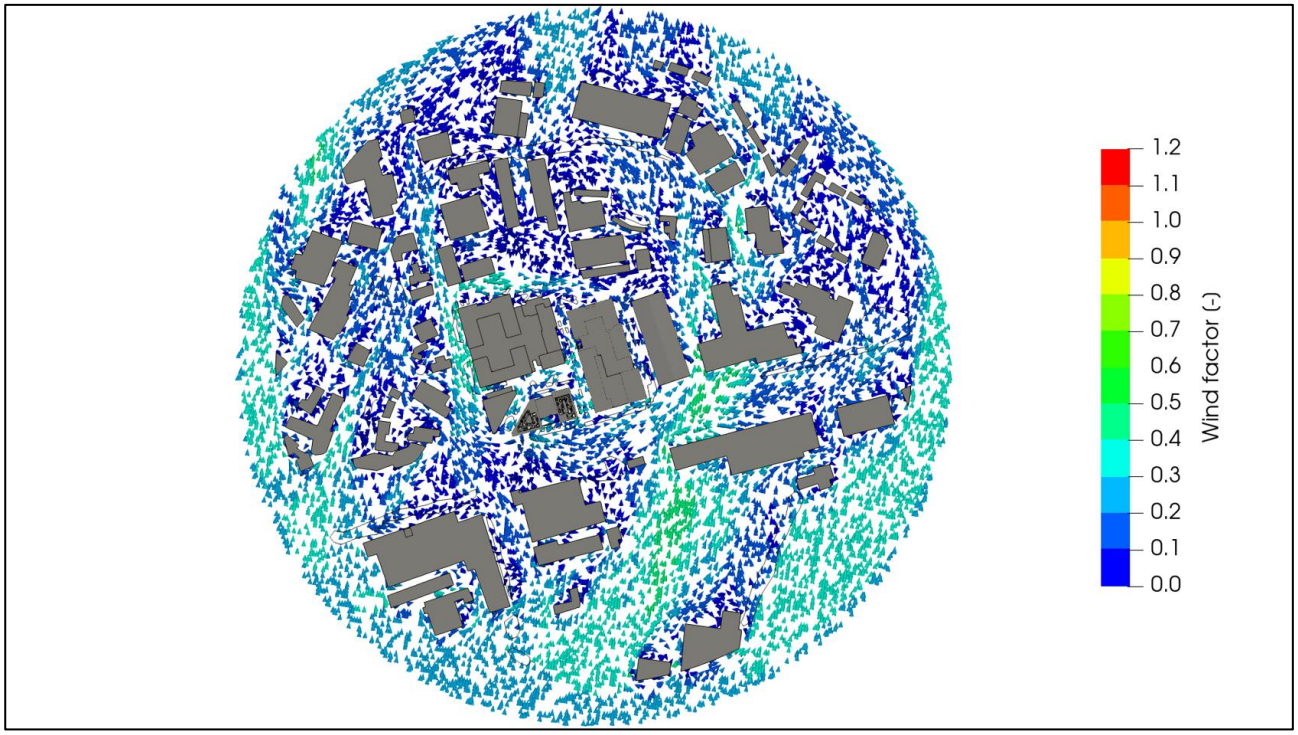


Figure 34. Wind Factor – 180 Degree (S) Wind Direction (Vector View)

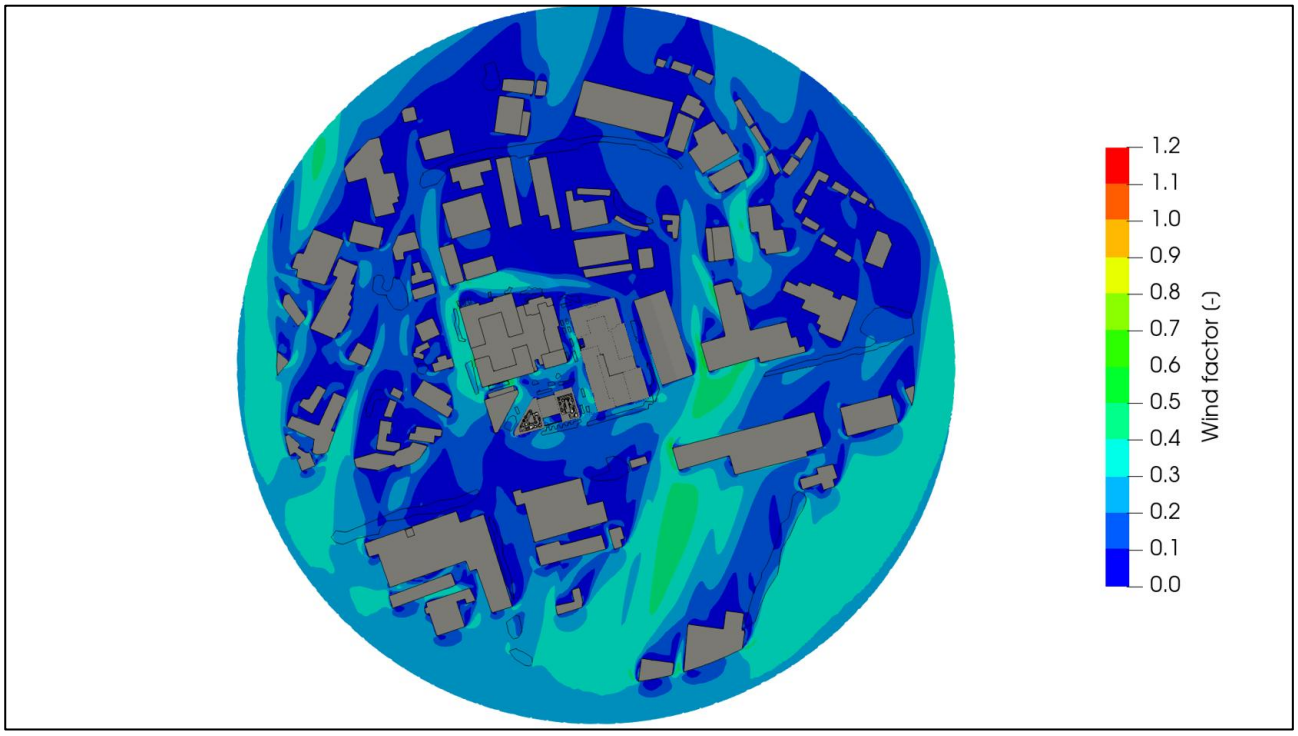


Figure 35. Wind Factor – 180 Degree (S) Wind Direction (Contour View)

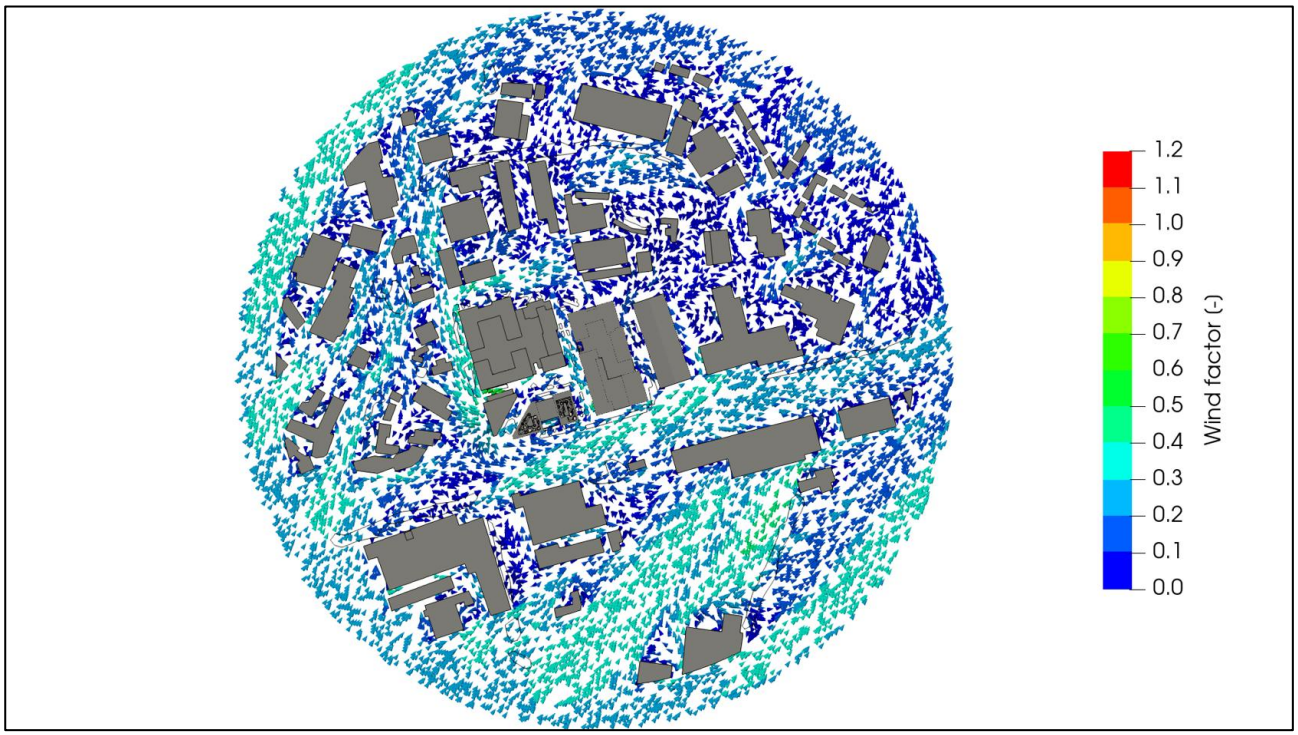


Figure 36. Wind Factor – 210 Degree (SSW) Wind Direction (Vector View)

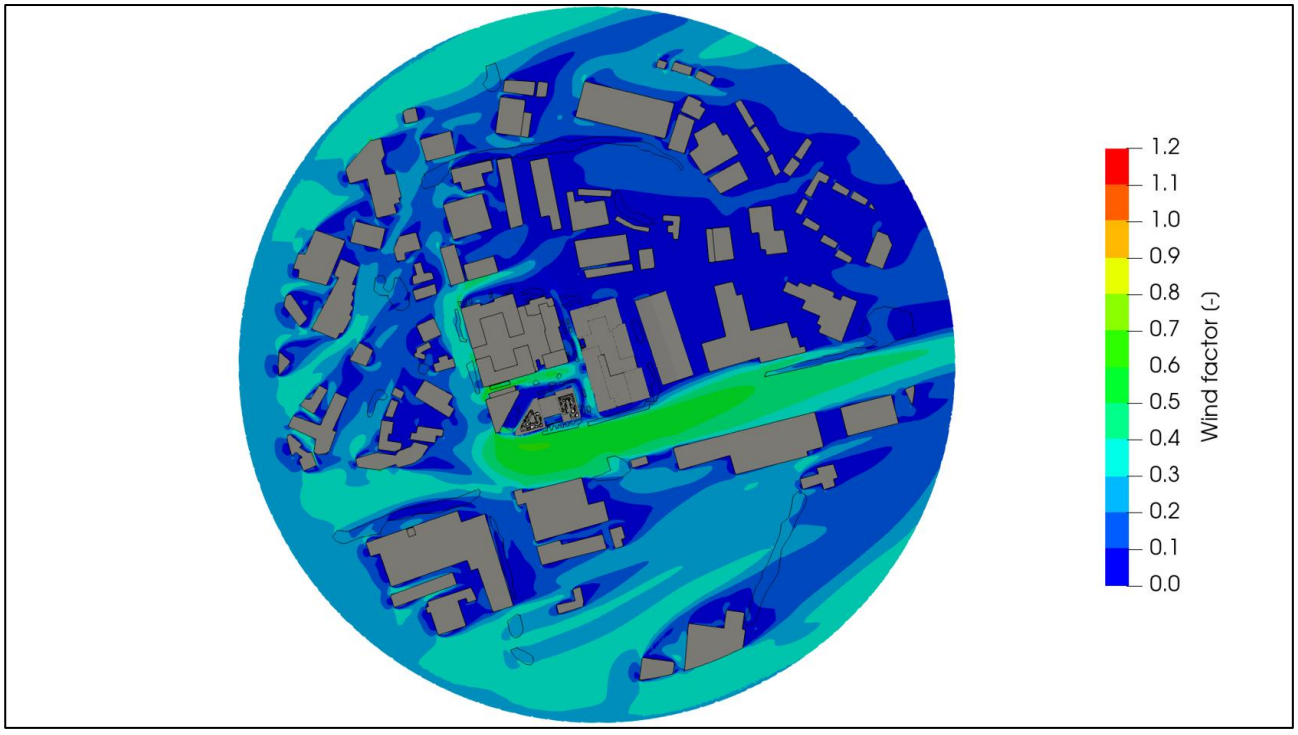


Figure 37. Wind Factor – 210 Degree (SSW) Wind Direction (Contour View)

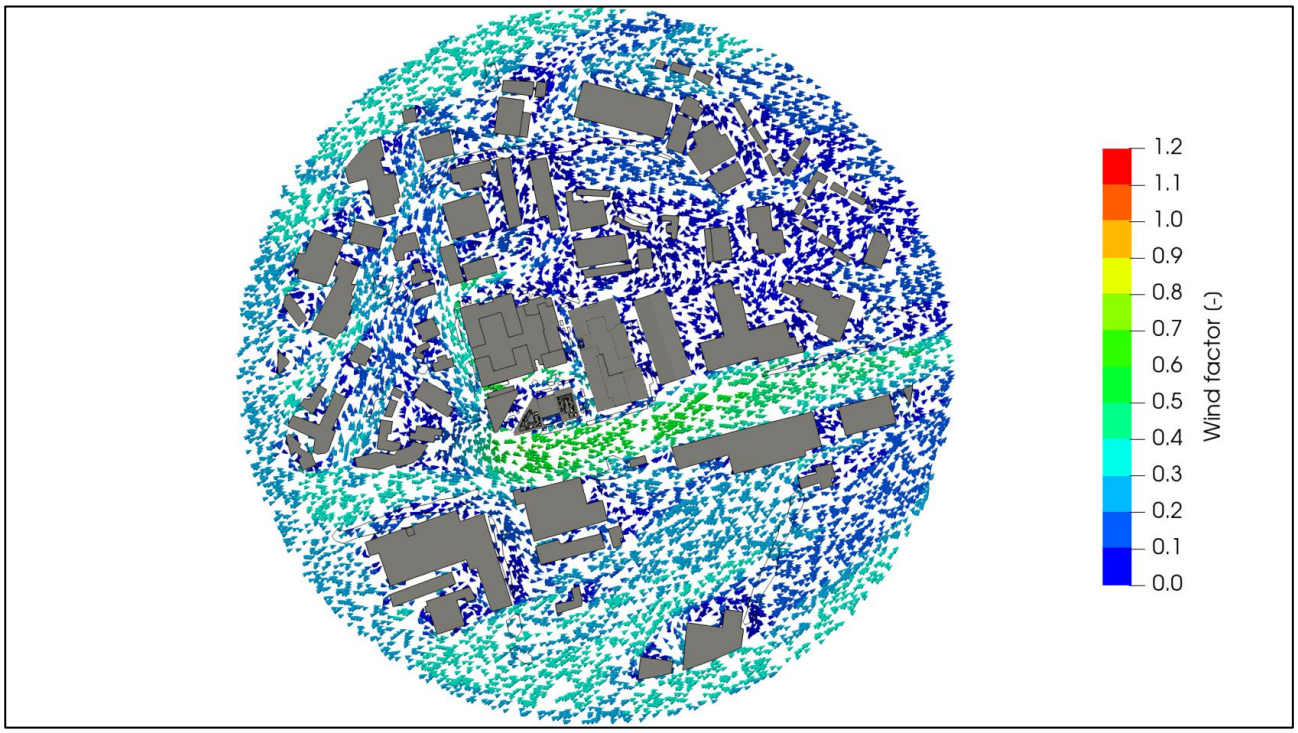


Figure 38. Wind Factor – 240 Degree (WSW) Wind Direction (Vector View)

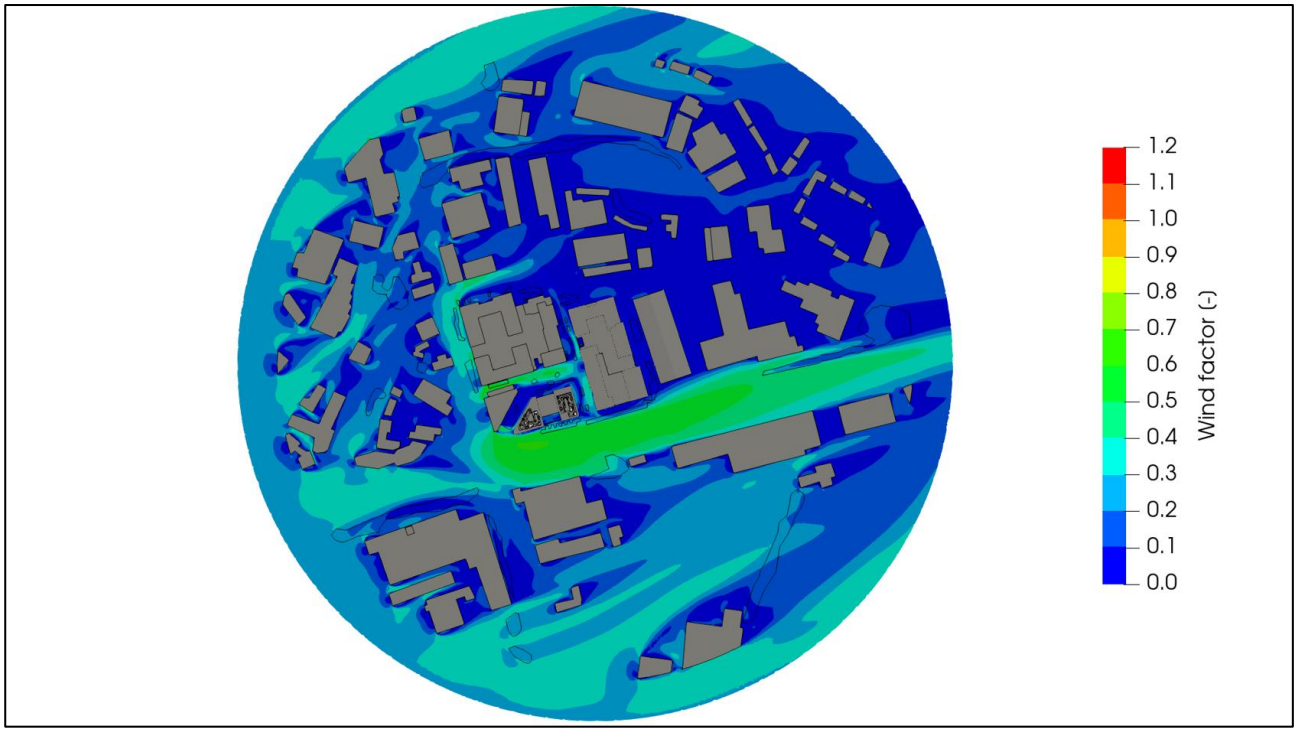


Figure 39. Wind Factor – 240 Degree (WSW) Wind Direction (Contour View)

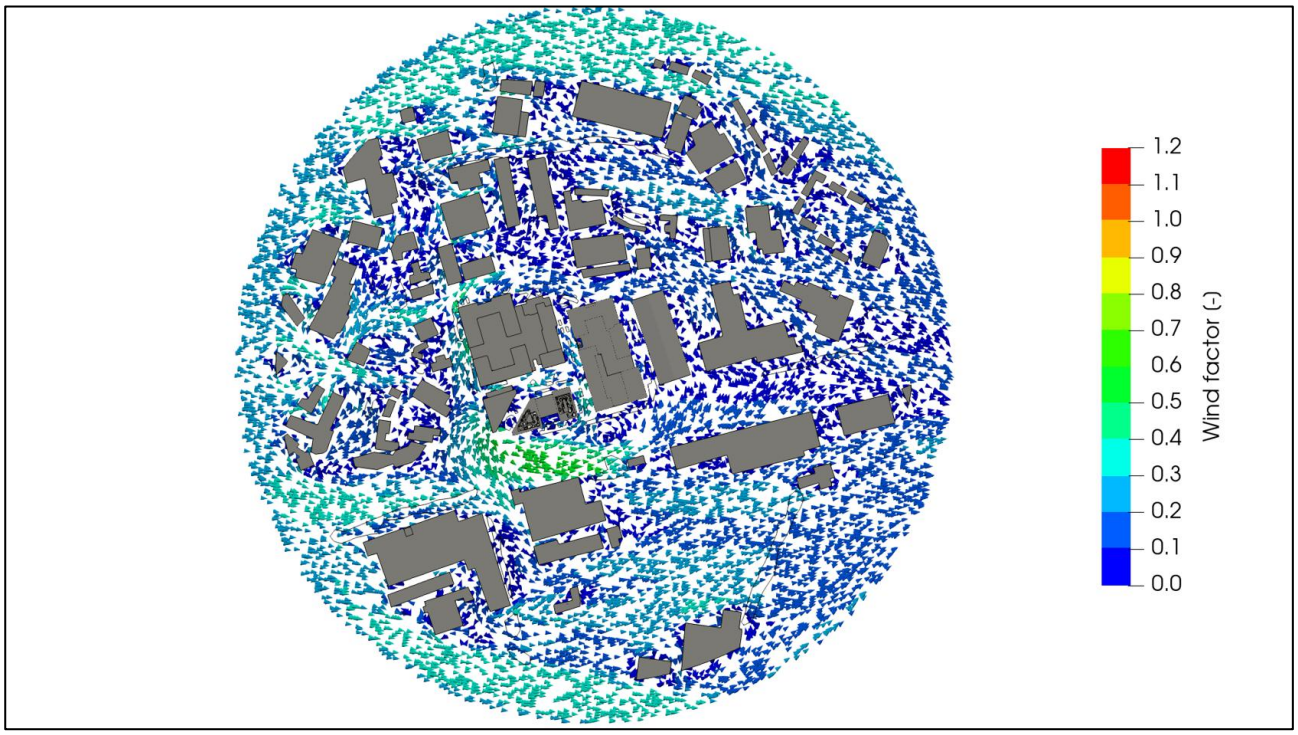


Figure 40. Wind Factor – 270 Degree (W) Wind Direction (Vector View)

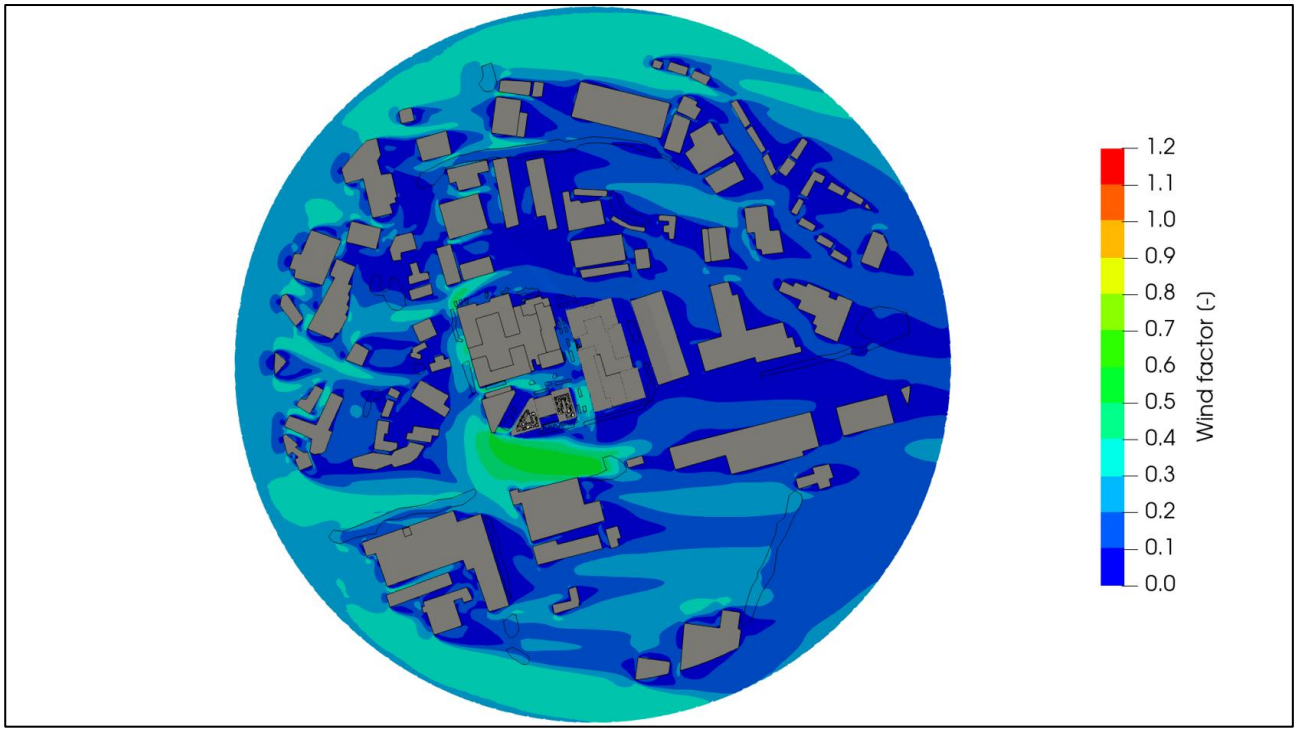


Figure 41. Wind Factor – 270 Degree (W) Wind Direction (Contour View)

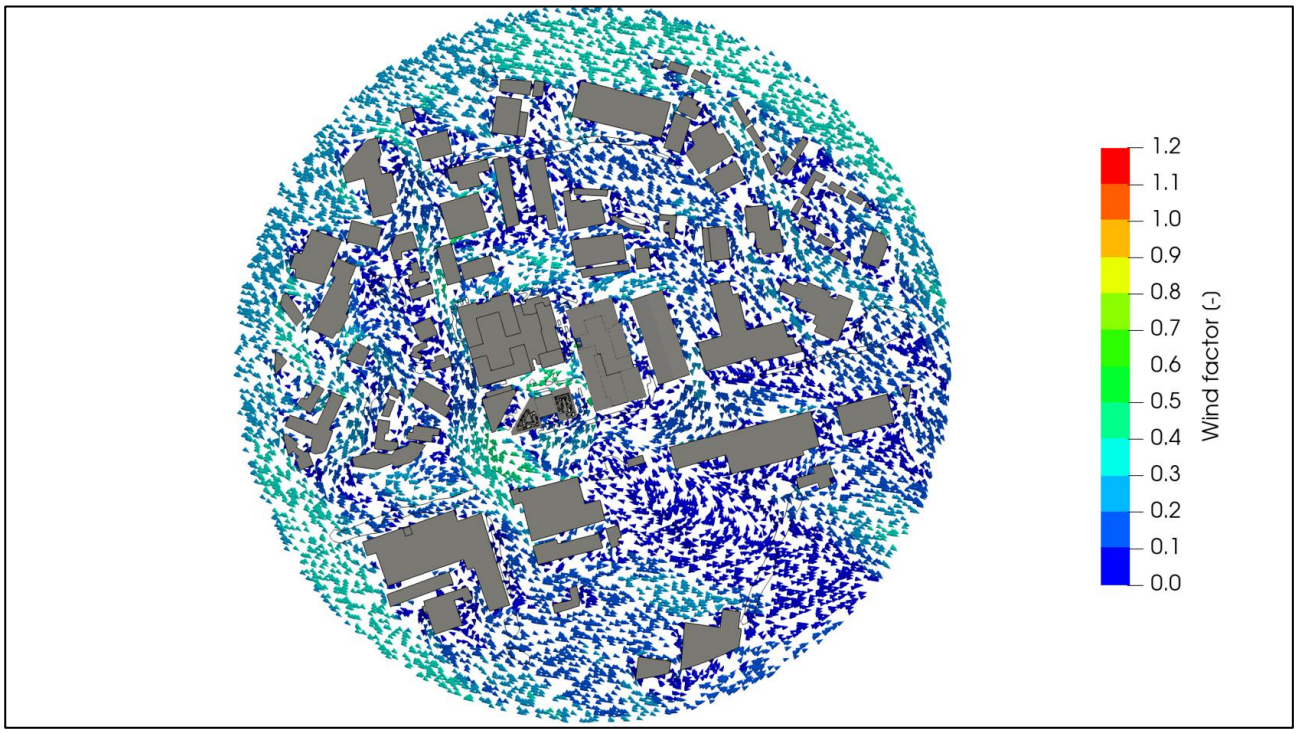


Figure 42. Wind Factor – 300 Degree (WNW) Wind Direction (Vector View)

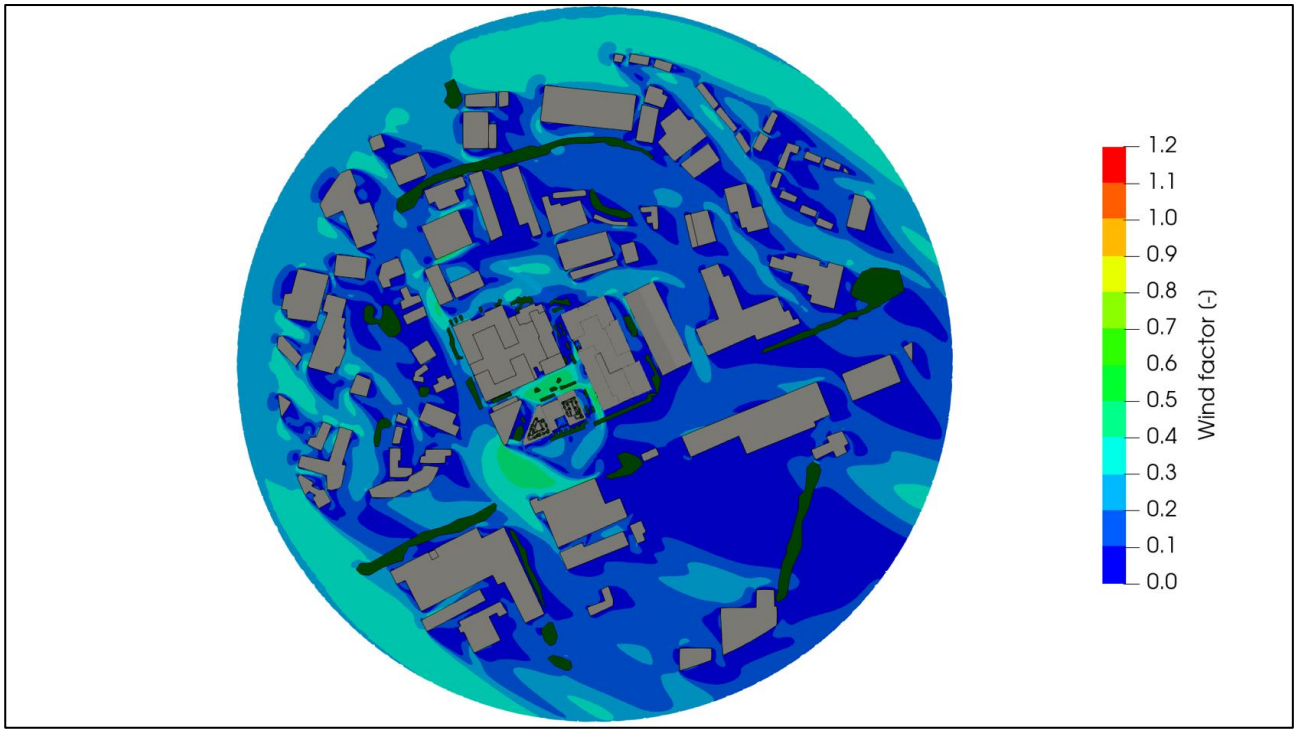


Figure 43. Wind Factor – 300 Degree (WNW) Wind Direction (Contour View)

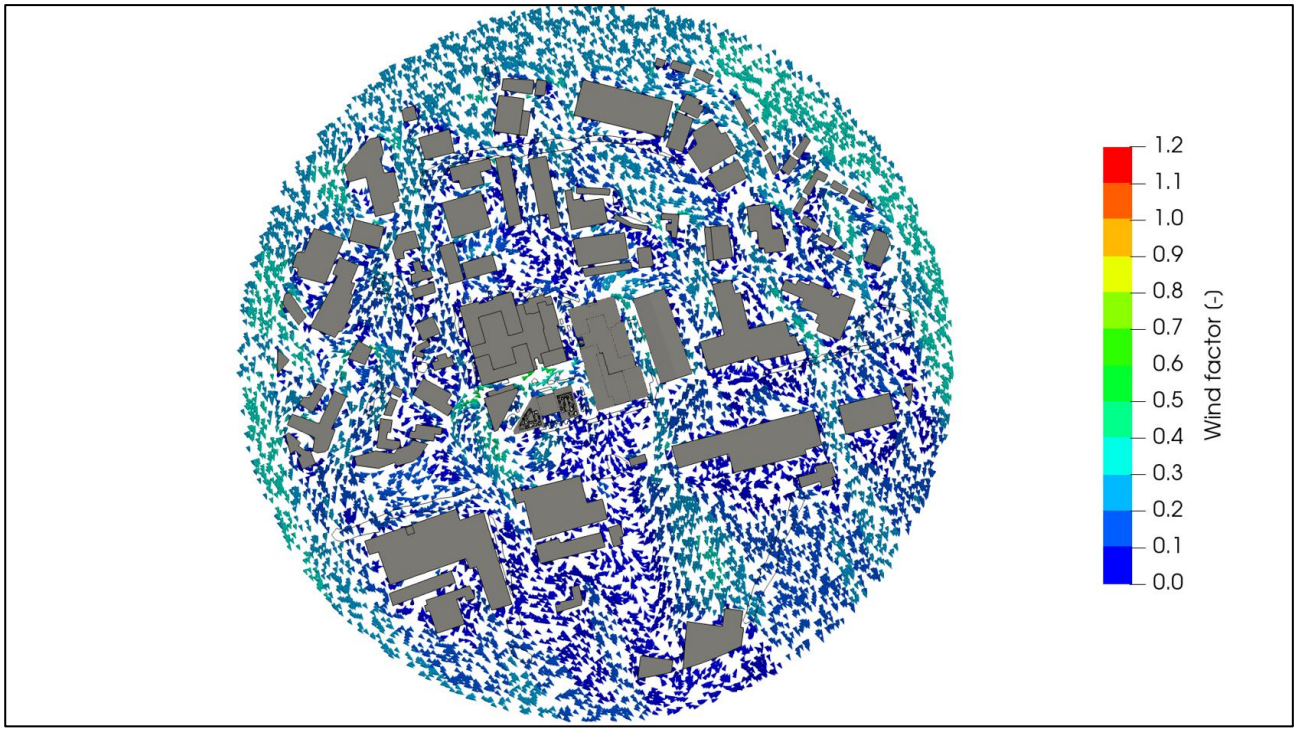


Figure 44. Wind Factor – 330 Degree (NNW) Wind Direction (Vector View)

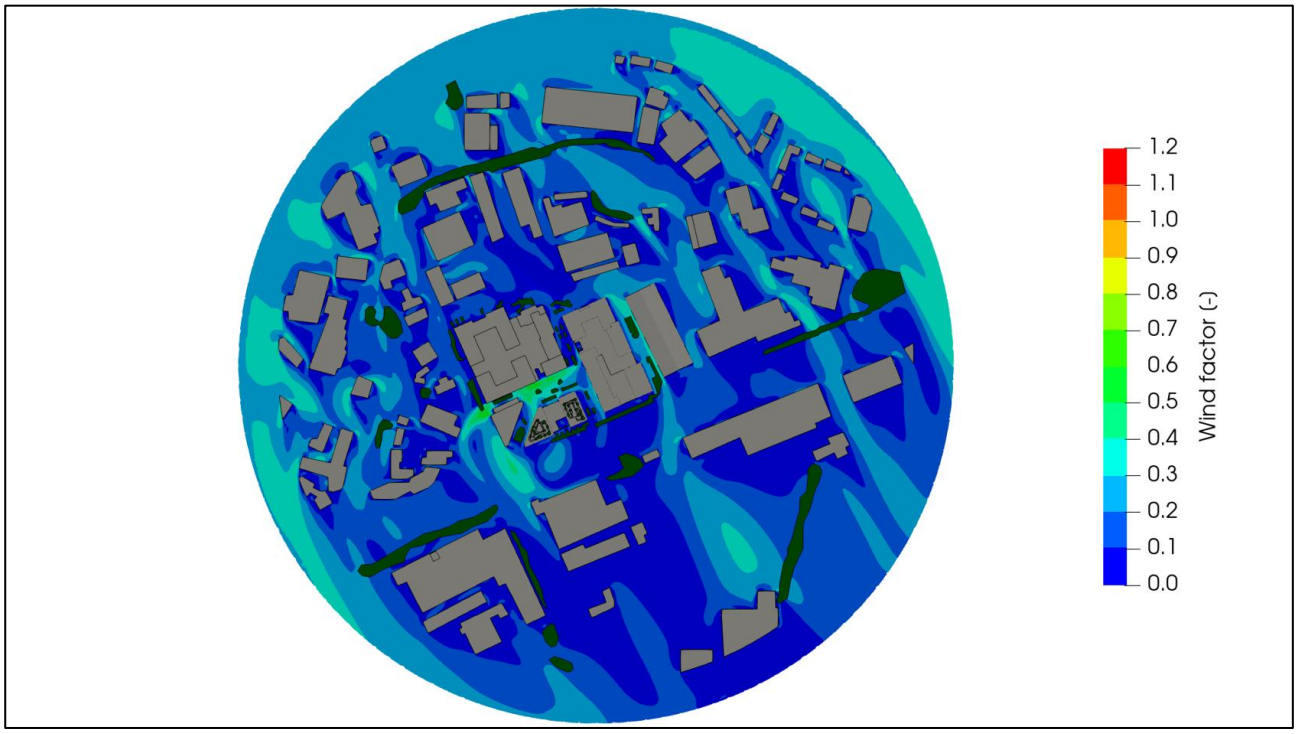


Figure 45. Wind Factor – 330 Degree (NNW) Wind Direction (Contour View)

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