9 WIND MICROCLIMATE

Introduction

9.1. This chapter of the ES assesses the potential impacts and associated likely effects of the proposed development on the local wind microclimate within and around the application site. In particular, it considers the likely effects of wind upon pedestrian comfort and safety and summarises the findings of Computational Fluid Dynamics (CFD) assessments.

9.2. The chapter describes the methods used to assess the potential impacts; the baseline conditions currently existing at the application site and the study area; as well as the potential impacts and likely effects on wind microclimate during construction and at the completed development stage, taking into consideration embedded mitigation measures. Where appropriate, additional mitigation measures required to prevent, reduce, or offset the likely effects are identified and the chapter concludes with a summary of the likely residual effects.

9.3. This chapter is accompanied by the following technical appendices in ES Volume 3A:

- Appendix 9.1: Wind Microclimate Results.

Methodology

9.4. There is no published guidance for wind microclimate assessment in EIA. Accordingly, the assessment has been informed by the following legislation, policies and published guidance:

- NPPF[1];
- PPG[2]; and
- Reading Borough Local Plan 2019[3].

9.5. In addition, professional judgment has been applied.

Consultation

9.6. No consultations have been undertaken in addition to the formal EIA scoping process. At the time of undertaking this assessment, the EIA Scoping Opinion remains outstanding.

Assessment Scope

9.7. The assessment has been based on a series of development parameters, as described in Chapter 2: EIA Process and Methodology; Chapter 4: Proposed Development Description; and Chapter 5: Demolition and Construction Environmental Management. Due to the flexibility being sought in respect of land use classes and associated development scenarios, the wind microclimate assessments have been undertaken for the worst-case massing proposals represented by parameter plan 105 (mixed-use scheme).

Technical Scope

9.8. The wind microclimate assessments quantify the expected wind microclimate in pedestrian areas at ground level and at roof top level. The measured wind speed statistics have been benchmarked against the Lawson Comfort Criteria[4] to determine the suitability of the proposed development for different pedestrian activities. Strong winds have also been considered.

9.9. Existing pedestrian receptor locations around the proposed development have been assessed for wind conditions against both their intended use and against the baseline wind conditions. New pedestrian receptor locations introduced by the proposed development have been assessed against their intended use.

9.10. For both existing and new receptor locations, where changes to conditions have been measured, the significance of effect for each location has been defined.

Spatial Scope

9.11. The study area includes existing and cumulative surrounding buildings and terrain covering a 300 m radius from the application site boundary. The extent of the virtual wind tunnel was 1,800 m long by 1,100 m wide by 350 m tall and was rotated with wind direction.

Temporal Scope

9.12. The assessment has considered the following three configurations:

- Existing baseline;
- Existing baseline + proposed development; and
- Existing baseline + proposed development + cumulative schemes.

Baseline Characterisation Method

Desk Study

Meteorological Data

9.13. Seasonal wind data for the Reading area was sourced from the nearest weather station, London Heathrow Airport. The wind data for London Heathrow was collected for each of the four seasons and was averaged over a 20-year period, starting from the year 2001. The data for the four seasons are averaged by season with Spring covering March-May, Summer June-August, Autumn September-November, and Winter December-February. The seasonal averaging of weather data is used to allow consideration of worst-case conditions as well as expected seasonal usage of specified amenity spaces. The weather station data was then adapted with site specific roughness factors to assess the local wind conditions surrounding the site.

Field Study

9.14. A field study was not required to inform the assessments.

Assessment Method

Methodology

Demolition and Construction

9.15. Typically, for a wind microclimate assessment, the likely effects during demolition and construction would be assessed using the professional judgement of an experienced wind engineer. The assessment is based on the background wind climate at the application site and on an understanding of the effects of wind in the built environment. This approach is taken on the basis that the on-site

[1] Secretary of State for Ministry of Housing, Communities and Local Government, 2019. National Planning Policy Framework.
[2] https://www.gov.uk/government/collections/planning-practice-guidance
[3] Reading Borough Council, 2019. Reading Borough Local Plan. RBC.
[4] Lawson TV (2001). Building Aerodynamics. Imperial College Press

activity during this time (i.e., construction activity) is less sensitive to wind conditions than when the proposed development is completed and occupied (which would include entrance and amenity spaces, for example).

9.16. A qualitative assessment of the wind microclimate during demolition and construction has therefore been undertaken and has been based on professional judgement (informed by an assessment of the background wind microclimate in the area, the results of the tested configurations for the baseline and completed development scenarios, and the wind specialist's experience of assessing wind in the built environment).

Completed Development

9.17. To predict the local wind environment associated with the completed development and to determine the resulting pedestrian comfort within and immediately surrounding the application site (the study area), simulations using SimScale Computational Fluid Dynamics Software (CFD) have been performed.

9.18. The mathematical solver employed by SimScale uses the Lattice Boltzmann Method (LBM). The LBM solver is very well suited to wind microclimate assessments allowing for the accurate resolution of complex geometries in an efficient computational time frame.

9.19. CFD simulation is a well-established means of assessing the pedestrian wind microclimate. It has been used to assess conditions within, and immediately surrounding, the proposed development. CFD enables the turbulent wind conditions at the application site to be quantified and classified in accordance with the widely accepted Lawson Comfort Criteria, as described below.

9.20. Three 3D computer geometry models were constructed representing the following three configurations:

- Configuration 1: Existing baseline;
- Configuration 2: Existing baseline + proposed development; and
- Configuration 3: Existing baseline + proposed development + cumulative schemes.

9.21. The proposed development is expected to alter the pedestrian use of spaces and so a direct comparison of the existing wind conditions with those on the developed site may not be suitable. For example, it may be considered a negligible change where conditions suitable for walking in the existing climate remain suitable for walking following the completed development. However, mitigation would be required should the use of the space have changed to a building entrance and standing conditions would be more appropriate. The new pedestrian activities for a developed site should therefore be considered.

9.22. For each of the configurations, the model also included ground topography such that local wind effects are accurately represented. Minor geometrical details (such as street furniture, foliage, rooftop plants, etc.) were not included in the CFD models. This simplified model geometry provides a worst-case scenario.

9.23. In total, 16 wind directions were used to assess the wind microclimate in terms of pedestrian comfort. Strong winds, defined as wind speeds in excess of 15 m/s for more than two hours annually (0.022%) have also been included in these assessments and are discussed with the results.

9.24. The methodology used to quantify the pedestrian level wind environment for the above configurations comprised the following:

- Step 1: The geometry of the study area, proposed development, and cumulative schemes were assembled in three different 3D computer models representing the three configurations.
- Step 2: The meteorological data for the application site was used and appropriate wind exposure classifications for each direction were applied.
- Step 3: The wind speed, direction and frequency at pedestrian level were modelled for all wind directions.
- Step 4: The wind speed results were compared with respect to the Lawson LDDC Comfort criteria with incorporated Gust Equivalent Mean (GEM). A GEM is defined as the highest sustained gust over a 3-second period having a 1:50 probability of being exceeded per year. A statistical summary of all wind directions was produced as a single plot for the application site and study area.
- Step 5: Strong winds were analysed using London LDDC criteria for assessing unsafe conditions. This scale is a modification to the Lawson LDDC Comfort scale, developed for the City of London, and incorporates locations where winds greater than 15 m/s (0.022% annually) may be expected.

9.25. The prevailing wind direction for the application site is south-westerly (SW) to south-south-westerly (SSW) for the summer, autumn, and winter seasons. Additionally, during spring, a strong north-easterly (NE) to east-north-easterly (ENE) wind results in a smaller secondary peak in the wind rose, as shown in Figure 9.1.

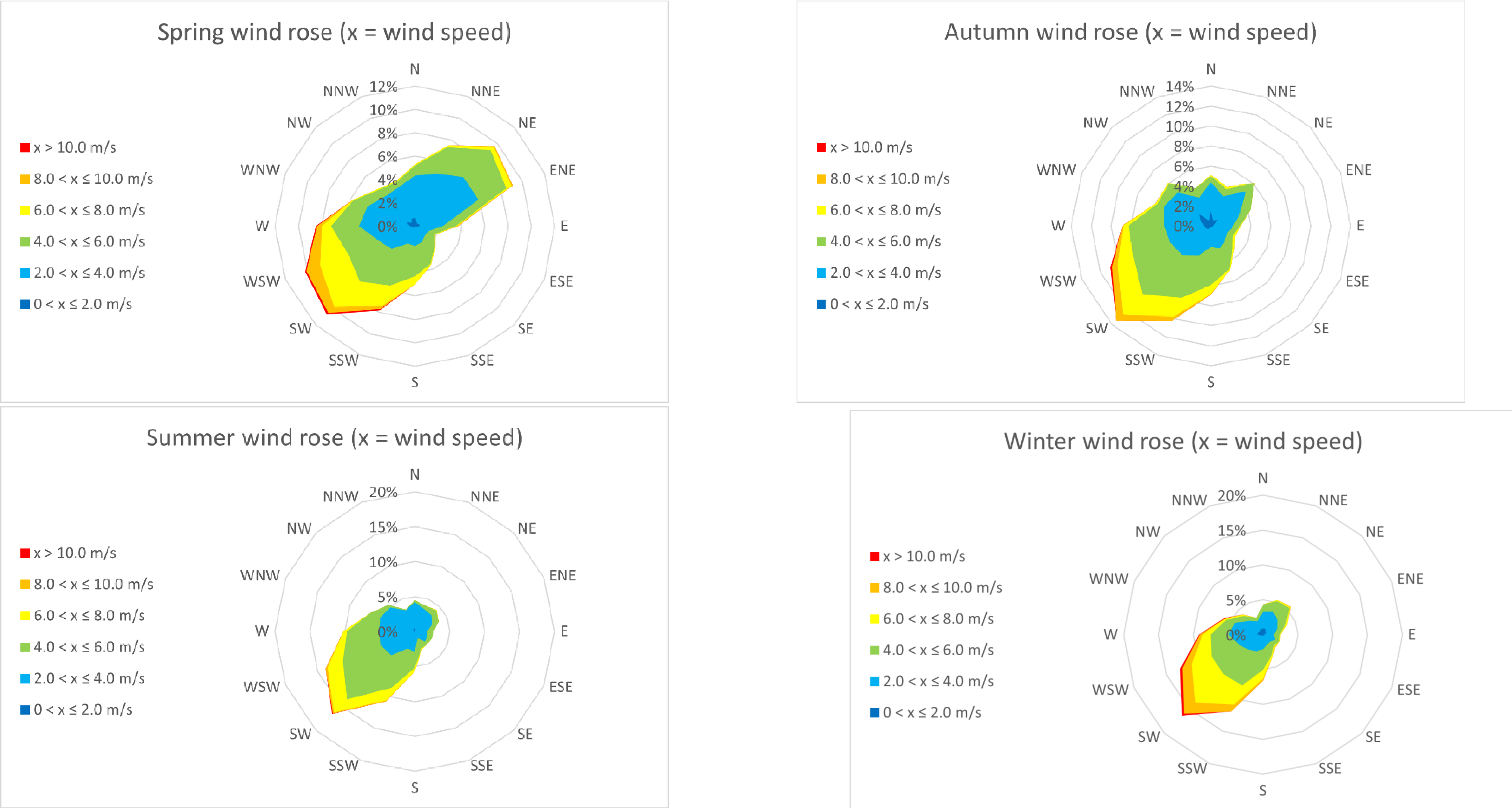


Figure 9.1: Seasonal Average Wind Roses for London Heathrow, UK[5].

9.26. The region around the application site was assessed for ground roughness using BREVe software with the resulting wind exposures applied to the wind data within SimScale using wind engineering standard EN 1991-1-4. The surrounding terrain was classified as either Suburban (III) or Urban (IV) as appropriate.

9.27. The wind profile for Reading is dominated by south-south-westerly and south-westerly winds for all seasons, 191° to 236° on the cardinal coordinate system, which is common for much of the south of

[5] Compiled from Meteostat wind data for London Heathrow

England. The wind levels are generally higher during the winter months than the summer months. In general, the wind roses are largely similar for all seasons, though the spring season features a prominent north-easterly wind. Sixteen (16) equally-distributed wind directions were resolved for these assessments.

9.28. As the winds are typically strongest during the winter, the winter-averaged wind conditions were used as a worst-case for wind microclimate assessments. All the presented Lawson plots account for 16 wind directions. Seasonal wind data were collected from Meteostat for each individual season from the nearest weather station (London Heathrow Airport) and were then averaged over a 20-year period, starting from the year 2001. Wind data were imported into SimScale before site-specific roughness factors were applied to represent the local wind conditions for the site.

9.29. Winter winds are considered strongest and therefore represent a worst-case scenario. In general summer wind conditions can be considered to be one classification below that of winter conditions, for example an area of "Business Walking" in winter season is expected to be suitable for "Pedestrian Walking" in summer. Additionally, amenity space is expected to be used differently in winter and summer seasons. An area of seating for example, does not require wind conditions to be suitable for "Pedestrian Sitting" as it is not expected there will be any requirement for using the space as such in the winter season. The results presented here are for the winter season, though both winter and summer seasons are presented in Appendix 9.1: Wind Microclimate Results.

9.30. The CFD simulations were run across the three development configurations, each for 16 unique wind directions using the wind data defined for the application site and direction. The simulation provides transient flow results including gusts. These results were then averaged at a 1.5 m height above ground level (and roof top level) for velocity. A statistical surface solution, representing a single result which combines all wind directions was derived automatically in SimScale; the Gust Equivalent Mean (GEM) Lawson LDDC Comfort and London LDDC Criteria were applied to these results to produce the wind maps.

9.31. The results of the assessment criteria are displayed on coloured "heat" maps. The colour plots allow easy identification of wind microclimate conditions across the application site and proposed development.

9.32. Traditional wind tunnel wind microclimate assessments rely upon many sensors positioned across the model to measure wind speed at these discrete sensor positions. The effects at these individual points are then reported on. CFD simulation is not limited by individual sensor points. Rather, the results are contour mapped allowing results to be observed at any point in the test area. However, a "measurement location" approach is often expected and can be helpful to describe usage suitability at specified locations. As such, a series of measurement locations (1-50) have been defined across and around the proposed development to assist with analysis and discussion as shown in Figure 9.2. These measurement locations are considered to give an accurate representation of the wind conditions across the application site and proposed development to reflect key receptor locations. It should be noted that certain probe positions at the edge of buildings are dual purpose, these are used for; for representing building entrances where target conditions should be suitable for pedestrian standing, and thoroughfares/pavements past the building where target conditions should be suitable for pedestrian walking. These can be seen in Figure 9.3 where two target conditions pass through a single measurement location. Further details, including images of the models used, are provided in Technical Appendix 9.1.

Figure 9.2: Wind Assessment Measurement Locations

Lawson Comfort Criteria

9.33. The Lawson Comfort Criteria has been established and industry recognised for over 30 years as a way to assess wind conditions and measurements. The Lawson Comfort Criteria seek to define the reaction of an average pedestrian to the wind, as described below. If the measured wind conditions exceed the threshold wind speed for more than a specified percentage of the time, then they are unacceptable for the stated pedestrian activity and the expectation is that there may be complaints of nuisance or people would not use the area for its intended purpose.

9.34. There are multiple variants of the Lawson Comfort Criteria; two of these are presented in this chapter. The Lawson LDDC (London Docklands Development Corporation) Comfort Criteria, setting out six pedestrian activities reflecting the fact that less active pursuits require more benign wind conditions. The six categories presented in Table 9.2 are: outdoor dining, pedestrian sitting, pedestrian standing, pedestrian walking, business walking and uncomfortable, in ascending order of activity level. In other words, the wind conditions in an area for pedestrian sitting need to be 'calmer' than a location that people merely walk past. Pedestrian walking can be considered a more "leisurely" walking pace, for example a park amenity space where the user would like to spend time. The business walking classification can be considered a faster walking pace, for example along a main road where the user may not want to dwell for long. The coloured key in Table 9.2 corresponds to the presentation of CFD test results described later in this chapter.

9.35. Note that these categories, as presented in the results, include the Gust Equivalent Mean (GEM). Gust assessments for RANS (Reynolds Averaged Navier-Stokes) mean results are often made by the professional judgement of a wind engineer based on experience with similar developments. SimScale, however, incorporates a Gust Equivalent Mean feature to account for the averaged nature of RANS results. This is defined as the highest sustained gust over a 3-seconds period having a 1:50 probability of being exceeded per year. This formulation of the results is presented in figures following the classifications outlined in Table 9.2.

Table 9.2: Receptor Sensitivity Criteria: Lawson LDDC Comfort with Gust Equivalent Mean (GEM)

Key	Comfort Category	Threshold	Time Percentage	Description
A	Outdoor Dinning	2 m/s	< 5%	Light breezes desired for outdoor restaurants
B	Pedestrian Sitting	4 m/s	< 5%	Light breezes seating areas where one can read a paper or comfortably sit for long periods
C	Pedestrian Standing	6 m/s	< 5%	Gentle breezes acceptable for main building entrances, pick up / drop-off points and bus stops
D	Pedestrian Walking	8 m/s	< 5%	Moderate breezes that would be appropriate for pedestrian walking along a city / town centre street, plaza or park
E	Business Walking	10 m/s	< 5%	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
U	Uncomfortable	10 m/s	> 5%	Winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended

Target Conditions

9.36. For a mixed-use urban area, within which the proposed development site is located, the desired wind microclimate would have areas acceptable for outdoor dining, pedestrian sitting, pedestrian standing, pedestrian walking and business walking use. A description of the required comfort categories for the intended use in accordance with Table 9.2 is given in Table 9.3.

Table 9.3: Target Wind Conditions for Intended Uses

Intended Use	Target Wind Condition Summer	Target Wind condition Winter
Building Entrances	Pedestrian Standing	Pedestrian Standing
Public Amenity Areas	Pedestrian Sitting / Pedestrian Standing	N/A (Seasonal Use)
Balconies and Roof Terraces	Pedestrian Sitting / Pedestrian Standing	N/A (Seasonal Use and Weather Dependent)
Thoroughfares	Pedestrian Walking	Pedestrian Walking
Pedestrian Crossings	Business Walking	Business Walking
Bus Stops	Pedestrian Standing	Pedestrian Standing

9.37. For public amenity spaces, the target wind condition is pedestrian sitting during the summer months. However, as use is expected to be seasonal for these spaces, there is no specific target for the winter months. If the amenity area is large with many different locations for pedestrians to gather, then a mixture of pedestrian sitting, and pedestrian standing will be acceptable. However, seating areas will require the pedestrian sitting classification. Balconies and roof terraces are considered to have weather-dependant use at the property owner's discretion; therefore, they do not have a specific winter target.

9.38. Given the outline nature of the application, the intended uses for the proposed development have not been defined. However, Figure 9.3 describes typical criteria that have been assumed to enable assessment at this stage. Pedestrian standing classification would be expected around buildings where entrances could be delivered; pedestrian walking classification would be expected in thoroughfares; pedestrian sitting for amenity spaces and pedestrian sitting and pedestrian standing for roof terraces.

	A	2 m/s	< 5%	Outdoor Dining
	B	4 m/s	< 5%	Pedestrian Sitting
	C	6 m/s	< 5%	Pedestrian Standing
	D	8 m/s	< 5%	Pedestrian Walking
	E	10 m/s	< 5%	Business Walking
	U	10 m/s	> 5%	Uncomfortable

Figure 9.3: Proposed Development Assumed Intended Pedestrian Use. The percentage values represent the allowable time at the given windspeed threshold.

Strong Winds

9.39. Beyond the above presented Lawson LDDC Comfort Criteria (with GEM), strong winds exceeding 15 m/s for more than 2 hours of the year (0.022%) are generally considered to present a safety hazard to vulnerable pedestrians. This is captured in the London LDDC scale. This scale includes a particularly strict time percentage threshold for wind speeds exceeding 15 m/s, highlighting areas that may require mitigation even if “Uncomfortable” exceedances (>10 m/s, 5% according to the Lawson LDDC Comfort (GEM) scale) are not noted. Mitigation should be used to reduce the frequency of, or even eliminate, any strong winds. The London LDDC scale is given in Table 9.4. The only category of interest from this scale is “Unsafe”. All other assessments for lower windspeed classifications use the Lawson LDDC Comfort (with GEM) scale.

Table 9.4: London LDDC Criteria for Strong Wind Conditions

Key		Wind Speed	% Time	Description
	A	2.5 m/s	< 5%	Frequent Sitting
	B	4.0 m/s	< 5%	Occasional Sitting
	C	6.0 m/s	< 5%	Standing
	D	8.0 m/s	< 5%	Walking
	E	8.0 m/s	> 5%	Uncomfortable
	S	15.0 m/s	> 0.022%	Unsafe

Significance Criteria

9.40. The significance criteria used in the assessment are based upon the relationship between the desired pedestrian use of a particular area of the proposed development, using the categories defined by the Lawson LDDC Comfort Criteria (with GEM), and the predicted wind conditions at that location. This allows for the assessment to take into account any change in pedestrian activity that might arise as a result of the proposed development.

9.41. A seven-point scale has been used within this assessment to assess the significance of effects, as shown in Table 9.5.

Table 9.5: Significance Criteria

Modelled Wind Microclimate Criteria	Scale of Effect
Wind Conditions are three categories calmer than desired	Major Beneficial
Wind Conditions are two categories calmer than desired	Moderate Beneficial
Wind Conditions are one category calmer than desired	Minor Beneficial
Wind Conditions are similar to those desired	Negligible
Wind Conditions are one category windier than desired	Minor Adverse
Wind Conditions are two categories windier than desired	Moderate Adverse
Wind Conditions are three categories windier than desired	Major Adverse

9.42. The adopted scale for the significance criteria is a logical comparison of the measured wind environment with the desired wind environment. An adverse effect implies that a location has a wind environment that is unsuitable for its intended use and mitigation should therefore be considered.

9.43. The minor, moderate and major categories indicate the scale of the difference between the desired microclimate and the actual microclimate. As an example, if the desired wind conditions at a particular location are required to be suitable for pedestrian standing, but the predicted wind conditions are suitable for pedestrian walking, the difference between the desired and predicted wind condition is one category windier than desired. In this case, the significance of the effect would be identified as minor adverse. Any adverse effect would be material to the planning decision process because it implies that a location, or area, has a wind microclimate that is unsuitable for the desired use of that area.

9.44. Wind effects due to development are usually ‘felt’ within the application site boundary or the immediate surrounding streets and are due to the building massing and orientation. Consequently, all reported effects are considered to be direct, local and long-term/irreversible unless there is a change in the massing or climate.

Assumptions and Limitations

9.45. Computational simulations have limitations to the scale and detail that can be represented in the computer model geometry. Building geometry is simplified such that footprint, height and only major features are represented. Similarly, smaller details such as trees, fencing, and street furniture were not included, in the geometry model. With fewer obstructions to the air flow, this provides a "worst-case" wind scenario.

9.46. Care is needed when interpreting computationally derived wind data as the simulation methods have limitations. However, the SimScale LBM solver has been extensively validated against other simulation solvers and against wind tunnel and real-world measurements.

9.47. Measured data are very accurate but rely upon nearby weather stations for that to be the case. For example, Heathrow airport data are very complete but are 36 km from the application site which leads to regional calibration. Wind data derived from London Heathrow have been adopted here, where seasonal wind data were collected from Meteostat for each individual season from London Heathrow Airport. This wind speed data were then averaged for each of the four seasons over a 20-year period, starting from the year 2001. The seasonal wind data were processed using a wind rose generator script to re-write the data in a form which SimScale was then able to use to perform the seasonal simulations. Site-specific roughness factors were then applied to the wind data specific for the proposed development site.

9.48. It is the authors' opinion that the assumptions followed here represent a robust and thorough method of assessment.

Baseline Conditions

Existing Baseline

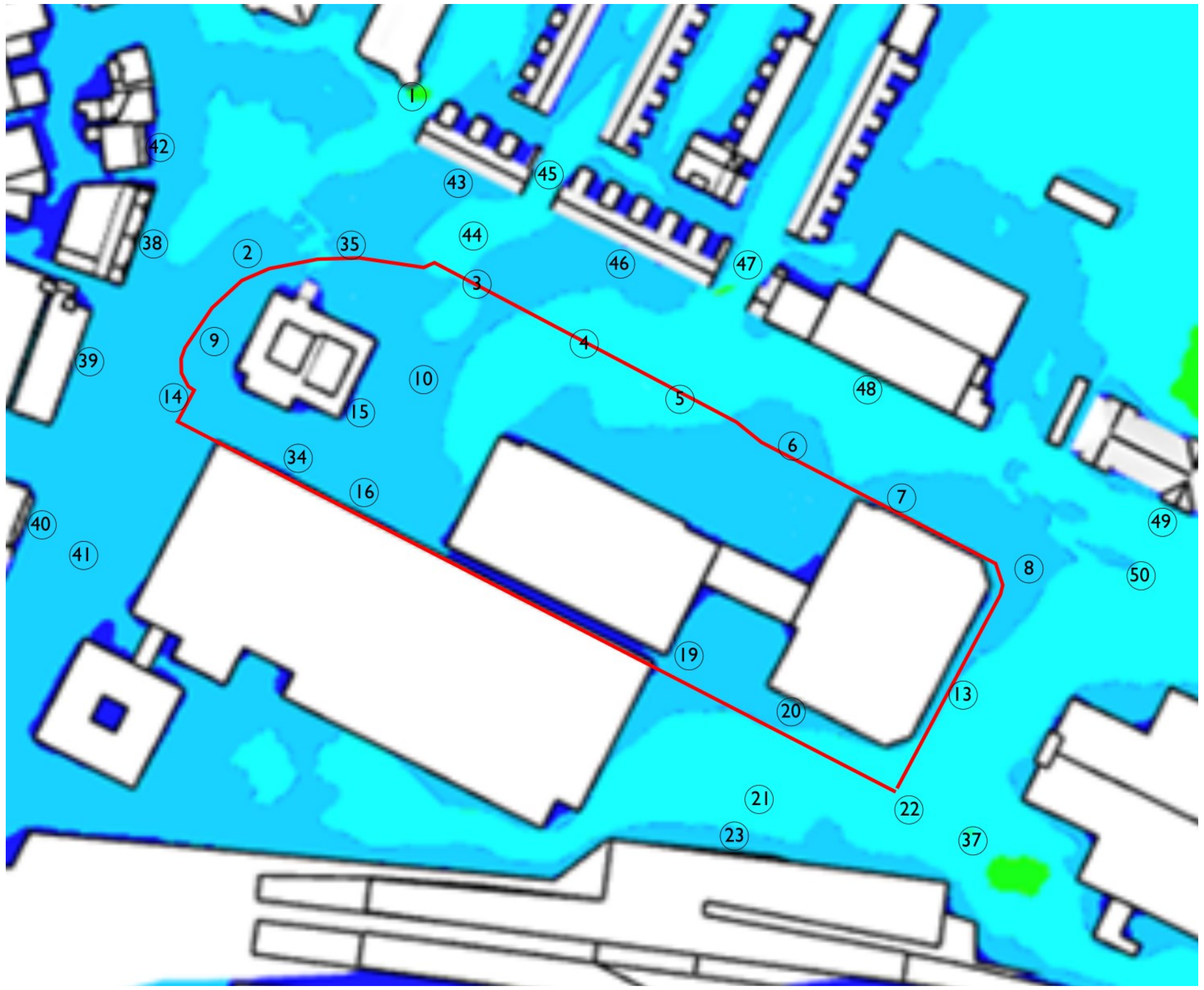
Configuration 1: Existing Baseline

9.49. The existing application site is characterised by two buildings. The smaller of the two buildings is single storey with a pitched roof, the larger building is formed of two interconnected structures approximately two storeys in height with a shallow pitched roof. The surrounding area is characterised by low rise residential and commercial development, typically of one to two storeys with pitched roofs. The existing on-site buildings are commercial and much of the outdoor space is allocated for car parking with some thoroughfares for access and areas around building entrances.

9.50. Wind conditions on the site are currently largely suitable for pedestrian sitting or pedestrian standing as shown in Figure 9.4. There are smaller areas suitable for outdoor dining and pedestrian walking. Detailed assessment of induvial sensitive receptors is provided in the next section.

Strong Winds

9.51. There are no instances of winds exceeding 15 m/s for more than 0.022% of the time in this configuration within or close to the application site.



9.52.

	A	2 m/s	< 5%	Outdoor Dining
	B	4 m/s	< 5%	Pedestrian Sitting
	C	6 m/s	< 5%	Pedestrian Standing
	D	8 m/s	< 5%	Pedestrian Walking
	E	10 m/s	< 5%	Business Walking
	U	10 m/s	> 5%	Uncomfortable

Figure 9.4: Configuration 1: Existing Baseline Pedestrian Comfort (Lawson LDDC Comfort with GEM) Winter season, representing the worst-case conditions.

Sensitive Receptors

Existing Sensitive Receptors

9.52. The existing sensitive receptors that could be affected by the proposed development are:

- pedestrians using thoroughfares around the application site; represented by measurement locations 1, 2, 9 and 14 on Caversham Road, 35, 3-7 on Vastern Road, and 8 and 13 on Troopers Port Way.

Pedestrians using De Montfort Road, measurement location 45 and Lynmouth Road, measurement location 47, are also considered.

- pedestrians using the bus stop at measurement location 37;
- pedestrians using outdoor amenity spaces at the railway station entrance and drop off area at measurement location 21; and
- residents of entrances across from the surrounding buildings at measurement locations 38, 39, 40, 42, 43, 46, 48 and 49.
- Pedestrians using the crossings at measurement locations 41, 44, and 50.

New Sensitive Receptors

9.53. The new sensitive receptors resulting from the proposed development would be the pedestrians and occupants of newly introduced on-site buildings including workers and residents entering and exiting the proposed development; using the thoroughfares, public, communal and private ground level and elevated amenity areas in and around the proposed development.

9.54. The measurement locations presented in Figure 9.2 cover both existing receptors and new receptor locations.

Assessment of Effects

Demolition and Construction Effects

9.55. The proposed development would comprise the demolition of all existing buildings. Demolition and construction works would be undertaken on a phased basis, as described in ES Chapter 5: Demolition and Construction Environmental Management.

9.56. Based upon professional judgement, the demolition and construction works are not anticipated to give rise to any significant change to the existing (relatively calm) wind microclimate both on and off-site.

9.57. The likely effect is therefore judged to be temporary **Negligible** and wind conditions both on and off-site would remain acceptable for their intended pedestrian uses. As construction of the proposed development proceeds, the wind conditions of the application site and its surrounds would gradually adjust to those described below for the completed development.

Completed Development Effects

Configuration 2: Existing Baseline + Proposed Development

9.58. The proposed development would deliver new buildings ranging in height from 93 m to 113 m. At ground level, public areas and amenity spaces, as well as four new thoroughfares would be delivered. New thoroughfares created by the proposed development plots are labelled as 1, 2, 3, and 4 in Figure 9.5.

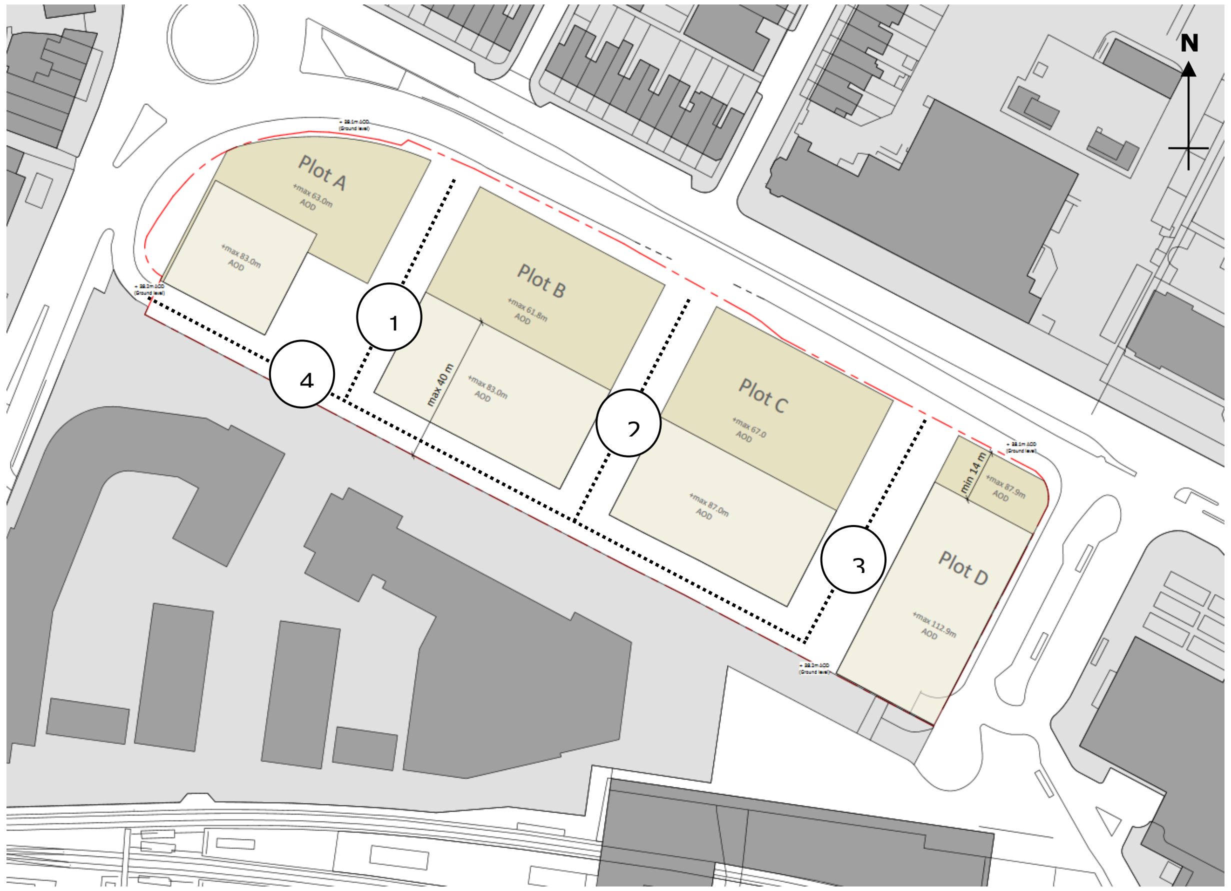
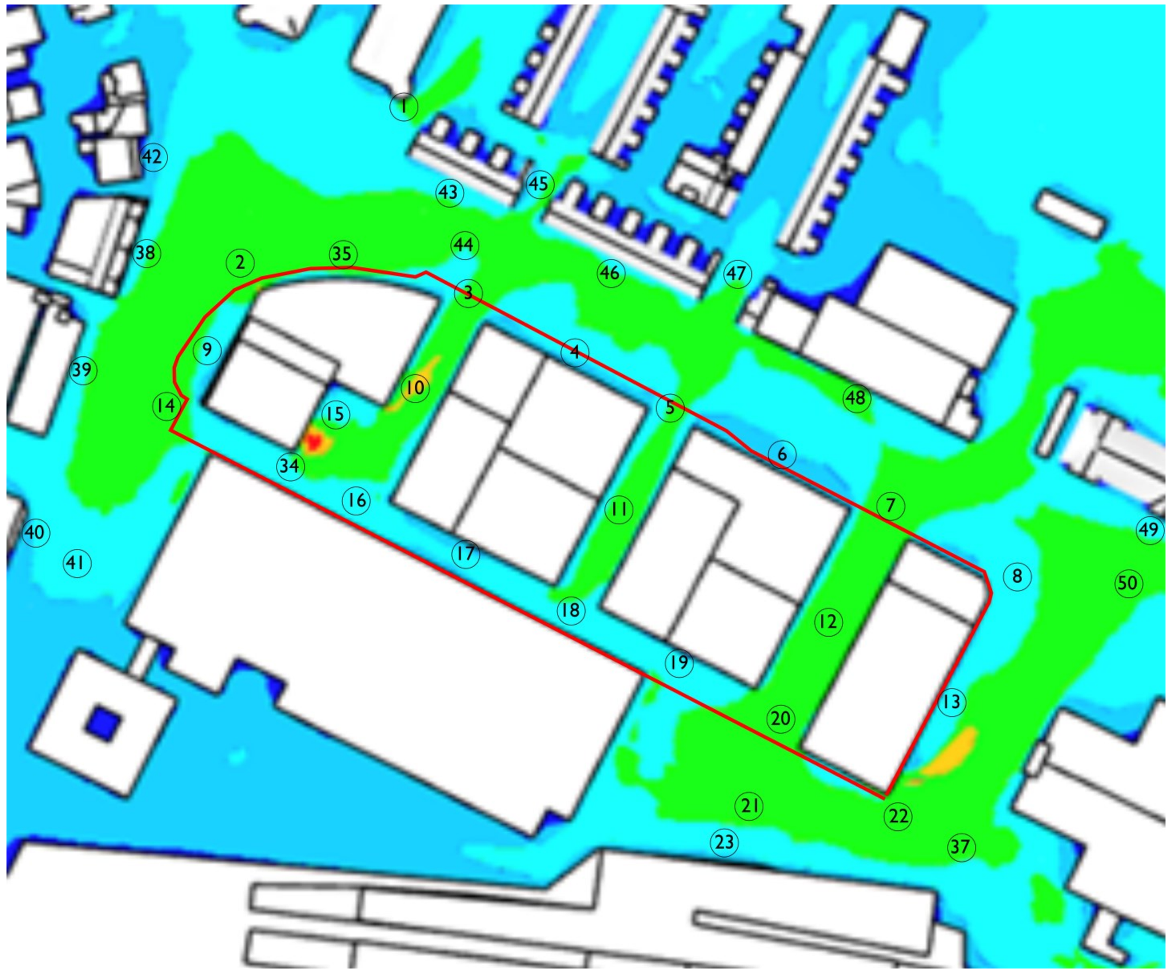


Figure 9.5: Configuration 2 - Proposed Development Thoroughfares

Pedestrian Comfort

9.59. For Configuration 2, the modelled wind comfort conditions for the ground level is shown in Figure 9.6.



	A	2 m/s	< 5%	Outdoor Dining
	B	4 m/s	< 5%	Pedestrian Sitting
	C	6 m/s	< 5%	Pedestrian Standing
	D	8 m/s	< 5%	Pedestrian Walking
	E	10 m/s	< 5%	Business Walking
	U	10 m/s	> 5%	Uncomfortable

Figure 9.6: Configuration 2 – Ground Level Pedestrian Comfort (Lawson LDDC Comfort with GEM) Winter season, representing the worst-case conditions.

9.60. At ground level, wind conditions would range from being suitable for pedestrian sitting to pedestrian walking during the summer months, and pedestrian standing to pedestrian walking with small regions of uncomfortable classification for the winter.

9.61. Specific receptor locations are discussed in more detail below.

Existing Off-Site Thoroughfares

9.62. Thoroughfares should typically be expected to have target conditions suitable for pedestrian walking during the winter.

9.63. Measurement locations 3, 4, 6, 7 and 35 on the pavement of Vastern Road target pedestrian walking conditions. These locations would achieve the target wind conditions or better. Locations 3 and 5 achieve conditions suitable for pedestrian walking, matching the target the target. Whereas measurement locations 4 and 5 achieve levels suitable for standing. Therefore, the effects would be **Minor Beneficial** to **Negligible**.

9.64. The pavement on Troopers Port Way measurement locations 13 and 22 would achieve wind conditions for pedestrian standing/pedestrian walking and therefore the effect would be **Minor Beneficial** to **Negligible.**

9.65. Measurement locations 2, 9 and 14 along Caversham Road would achieve winds conditions of pedestrian standing/pedestrian walking. However, there is a region between these locations where conditions are suitable for Business Walking, therefore the effect would be **Minor Beneficial** to **Minor Adverse.**

9.66. At Brighams Mead, measurement location 1, the wind conditions would be suitable for pedestrian walking and therefore the effect would be **Negligible.**

9.67. At De Montfort Road, measurement location 45, the wind conditions would be suitable for pedestrian walking and therefore the effect would be **Negligible**.

9.68. At Lynmouth Road, measurement location 47, the wind conditions would be suitable for pedestrian walking and the effect would be **Negligible**.

Proposed Development Thoroughfares

9.69. Measurement location 10 is on Thoroughfare 1. The wind conditions would range from being suitable for pedestrian walking to business walking. Accordingly, the effect would range from **Negligible to Minor Adverse**.

9.70. Measurement location 11 is on Thoroughfare 2. The wind conditions would be suitable for pedestrian walking. Accordingly, the effect would be **Negligible.**

9.71. Measurement location 12 is on Thoroughfare 3. The wind conditions would be suitable for pedestrian walking. Accordingly, the effect would be **Negligible.**

9.72. Measurement locations 34, 16, 17, 18, 19 and 20 are along Thoroughfare 4, the wind conditions at these locations would range from being suitable for pedestrian standing to pedestrian walking. Accordingly, the effect would range from **Minor Beneficial** (16, 17, 18, 19) to **Negligible** (20, 34). Note, measurement location 34 is close to a region of uncomfortable wind, this would lead to an effect of **Moderate Adverse**.

Pedestrian Crossings

9.73. The target conditions for pedestrian crossings is typically pedestrian walking.

9.74. The pedestrian crossing at measurement location 41 on Caversham road has pedestrian standing wind conditions, a **Minor Beneficial** effect.

9.75. There are two pedestrian crossings on Vastern Road, the first, Measurement Location 44 and 50, both have wind conditions suitable for pedestrian walking and a **Negligible** effect.

Existing Off-Site Entrances

9.76. Entrances should typically provide shelter for pedestrians leaving a building and should have wind conditions suitable for pedestrian standing.

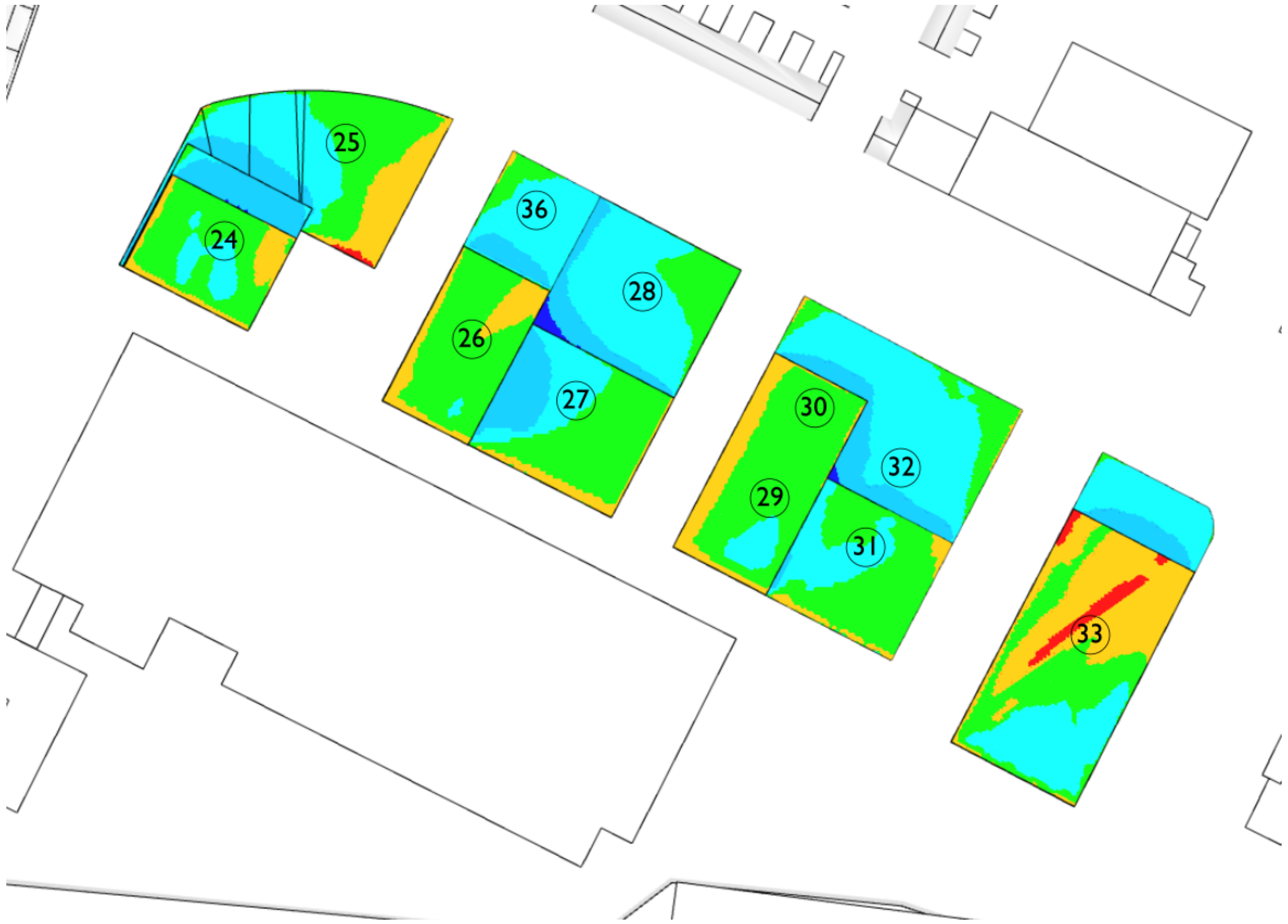
9.77. There are three entrances on Caversham road, measurement location 38 and 39 show conditions suitable for pedestrian standing close to the building. Accordingly, the effect would be **Negligible**. Measurement location 40 would have wind conditions suitable for pedestrian sitting close to the building, though it is close to a transition to pedestrian standing so the effects are likely to be **Minor Beneficial** to **Negligible**. Measurement location 42 would have wind conditions suitable for pedestrian sitting, a **Minor Beneficial** effect.

9.78. On Vastern Road, the entrances at measurement locations 43, 46, 48 and 49 are all on the transition of pedestrian standing to pedestrian walking and so the effects are **Negligible** to **Minor Adverse**.

9.79. The entrance to the railway station at measurement location 23 experiences would experience wind conditions suitable for pedestrian standing, which represents a **Negligible** effect.

Proposed Development Entrances

9.80. Entrance locations for the proposed development have not yet been defined. Modelled wind conditions at measurement locations 4, 6, 9, 13, 15, and 19 would be most suitable for entrances as they would achieve pedestrian standing wind conditions which would be suitable for this use. Accordingly, the effect at these locations would be **Negligible** to **Minor Beneficial**.



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	B	4 m/s	< 5%	Pedestrian Sitting
	C	6 m/s	< 5%	Pedestrian Standing
	D	8 m/s	< 5%	Pedestrian Walking
	E	10 m/s	< 5%	Business Walking
	U	10 m/s	> 5%	Uncomfortable

Figure 9.7: Configuration 2 – Roof Level Pedestrian Comfort (Lawson LDDC Comfort with GEM) Winter season, representing the worst-case conditions.

9.81. In the event that entrances are located along Thoroughfares 1, 2 and 3, or to the north of Building A and south of Building D, wind conditions would range from being suitable for pedestrian standing/pedestrian walking (measurement locations 16 and 35) to pedestrian walking (measurement location 22). Accordingly, the effect would range from **Negligible** to **Minor Adverse**.

Off-site Bus Stops

9.82. The target wind conditions for a bus top should be pedestrian standing.

9.83. The bus stop at measurement location 37 at the railway station would experience conditions suitable for pedestrian walking, which is a change from the baseline and once category higher than the target. Accordingly, the effect would be **Minor Adverse**.

Off-Site Amenity Area

9.84. Target wind conditions for amenity spaces vary according to the intended use but would be expected to range from pedestrian sitting to pedestrian standing.

9.85. The wind conditions at the sitting and pick-up area outside the railway station at measurement location 21 would experience conditions suitable for pedestrian walking, which is a change from the baseline and is two categories higher than the target range. Accordingly, the effect would be **Moderate Adverse.**

Proposed Development Ground Floor Amenity

9.86. The ground floor amenity areas and intended uses for the proposed development are not defined at this stage. Therefore, amenity space could come forward anywhere within the application site that is not covered by the footprints of Plots A-D. The wind conditions for this area would range from being suitable for pedestrian standing (measurement location 15) to being pedestrian walking (measurement location 12). When compared against the assumed target condition range of pedestrian sitting to pedestrian standing, the effect would range from **Negligible** (measurement location 12) to **Minor Adverse** (measurement location 15). However, measurement location 15 is close to a region of uncomfortable conditions in a region where the target conditions are pedestrian sitting, the is represents a **Major Adverse** effect. The impact for measurement location 15 drops in the summer season to business walking but still results in a **Major Adverse** effect. It is assumed that at the detailed design stage, the landscape strategy would design the amenity spaces such that the intended use accounts for the reported wind conditions and that mitigation measures, such as porous screening, would be employed in order to reduce wind conditions to the target levels.

Proposed Development Roof Top Amenity

9.87. Wind conditions at the roof top level are shown in Figure 9.7. For winter season, summer season results are available in Appendix 9.1: Wind Microclimate Results. As is typically expected the summer classification is typically one category lower than the winter season.

9.88. The wind conditions would range from being suitable for pedestrian sitting use to pedestrian walking during the summer season, and from mostly pedestrian walking to uncomfortable during the winter. When compared against the assumed target condition range of pedestrian sitting to pedestrian standing, the effect would range from **Minor Beneficial** to **Major Adverse**.

9.89. Note that parapets or other structural features at elevated levels were not included in the provided computer models, making this a worst-case scenario.

Strong Winds

9.90. The London LDDC criteria are used for identifying locations where windspeeds greater than 15 m/s for 0.022% of the time may be expected (Figure 9.8, red areas). Note that because of the strict time percentage threshold for these winds, some areas may be identified as "Unsafe" according to this scale, whereas they may be merely "Uncomfortable", or suitable for "Business Walking" according to the Lawson LDDC Comfort (with GEM) scale. In such cases, mitigation is required.

S 15.0 m/s > 0.022% Unsafe

Figure 9.8: Configuration 2 – Ground Level Strong Winds (London LDDC) Winter season, representing the worst-case conditions.

9.91. Unsafe, strong winds feature at ground level within the proposed development and at roof level. The regions are relatively small occurring close to measurement locations 10, 13 and 15.

9.92. At roof level, strong winds would also occur during winter. On Building A there is a small point close to measurement location 24 on the upper roof, on lower roof close to measurement location 25 there is strong winds at the east and south east corner. Buildings B and C have regions on strong winds along the southern edge of the roof. Building D is most effected around measurement location 33.

9.93. Mitigation is required to reduce the occurrence of 15 m/s or greater winds at these locations. (Note: that models do not include parapets or fencing at the building roof tops).

9.94. All instances of strong winds are considered to be Major Adverse.

9.95.

S 15.0 m/s > 0.022% Unsafe

Figure 9.9: Configuration 2 – Roof Level Strong Winds (London LDDC) Winter season, representing the worst-case conditions.

Assessment of Residual Effects

Additional Mitigation

Demolition and Construction

9.96. No additional mitigation measures are required during the demolition and construction stage over and above those described in ES Chapter 5: Demolition and Construction Environment Management.

Completed Development

9.97. CFD testing of Configuration 2 highlights several locations which would experience conditions that would be windier than acceptable for the assumed intended uses according to the Lawson LDDC Comfort Criteria (with GEM) and, therefore, would require mitigation.

9.98. In addition, strong winds according to the London LDDC criteria (> 15 m/s, 0.022% of the time) were recorded at or close to 8 measurement locations throughout the proposed development. These locations would require measures to reduce the time winds exceed 15 m/s to less than 0.022% of the time.

9.99. Given the outline nature of the proposal, the following mitigation measures would be explored and incorporated during the detailed design stage:

- Building form, scale and massing: Mitigation could be achieved by means of the articulation of the building scale, footprint and mass of the developments.
- Elevational treatment: Fins, canopies, balustrades, arcades, screens can be used on buildings to slow and redirect wind flow preventing vertical flow down the building reaching pedestrian areas at ground level. Options would consider the potential for low-level ground winds being "trapped" under canopies preventing the air from escaping.
- Recessed building entrances: Entrances can be recessed into buildings or built with screening nearby to provide an area of shelter for building users entering and exiting the buildings. Pedestrians are particularly sensitive when leaving a controlled environment so a sheltered region will allow time to acclimatise.
- Screening: Screening in the form of sculptures which may be particularly useful to provide pedestrian shelter at sensitive areas such as entrances and seating areas. Porous screens allow some wind to penetrate but reduce the energy the wind contains, while solid screens can deflect the wind.
- Landscaping: Landscaping can be a valuable tool to provide shelter. Raised and lowered terrain features can provide shelter and reduce exposure to the wind and break up air flow.
- Planting: Planting should be relatively dense for maximum impact otherwise benefits will be relatively local. Semi-mature planting will provide some shelter from an early stage as the plants gain maturity. Whilst deciduous plants offer maximum shelter in summer months, this is greatly reduced to be negligible during windier winter months when the plant has shed its leaves. Trees and planting can provide not only fluctuations in airflow but also decrease wind speed. Greater mitigation can be expected from larger, well-established trees.
- Pergola Structures: Pergolas provide similar mitigation to planting and porous screening combining their effects. Pergolas can disrupt and slow airflow providing shelter.

9.100. Wind tunnel testing would be secured by means of an appropriately worded planning condition and undertaken at the detailed design stage to refine and demonstrate the effectiveness of these measures. The results of this assessment would be used to inform the design of the public realm to ensure that proposed uses achieve the required wind conditions.

9.101. Based on professional judgement and experience, the above listed measures could successfully mitigate the significant adverse and unsafe effects identified within this assessment.

Enhancement Measures

9.102. No enhancement measures are applicable for this assessment.

Demolition and Construction Residual Effects

9.103. The residual effects would remain temporary **Negligible**.

Completed Development Residual Effects

9.104. The results presented here are based upon an assessment according to summer conditions for public outdoor amenity spaced, and winter (worst-case) conditions for all other locations. The intention is to inform mitigation and detailed design decisions.

9.105. The mitigation measures identified above would be developed at the detailed design stage and assessed by means of wind tunnel testing to be secured by means of an appropriately worded planning condition. However, at this outline stage, the effects during the winter remain as follows:

- Uncomfortable conditions between measurement locations 15 and 34.
- Business Walking conditions at measurement locations; 10.
- Pedestrian Walking conditions at measurement locations; 1, 2, 3, 5, 7, 11, 12, 14, 20, 21, 22, 35, 37, 38, 44, 46, 48, and 50.
- Pedestrian Standing conditions at measurement locations; 4, 8, 9, 13, 15, 16, 17, 18, 19, 23, 34, 39, 40, 41, 43, 45, 47 and 49.
- Pedestrian Sitting conditions at measurement locations; 6 and 42.
- Outdoor dining conditions at measurement location; No specific location number (close to 42 and 45).

Summary of Residual Effects

Table 9.10: Summary of Residual Wind Effects

Receptor	Residual Effect	Additional Mitigation	Nature of Residual Effect*					
			Scale of Effect **	**+ -**	**D I**	**P T**	**R IR**	**St Mt Lt**
Demolition and Construction								
Pedestrians on-site and on off-site thoroughfares	Wind conditions suitable for pedestrian walking	None	Negligible	N/A	D	T	R	St
Completed Development								
Pedestrians on Vastern Road	Wind conditions suitable for pedestrian standing/pedestrian walking	Mitigation would be required and would be explored at the detailed design stage. This would include: articulation of the building form, scale and massing; screening; landscaping; and planting.	Minor Beneficial to Moderate Beneficial	N/A -	D	P	R	LT
Pedestrians on Caversham Road	Wind Conditions suitable for pedestrian standing		Moderate Beneficial	N/A -	D	P	R	LT
Pedestrians on Trooper Ports Way	Wind Conditions suitable for pedestrian standing/pedestrian walking		Negligible to Minor Beneficial	N/A -	D	P	R	LT
Pedestrians on-site Thoroughfares 1 to 4	Wind Conditions suitable for pedestrian sitting to Uncomfortable		Negligible to Moderate Adverse	N/A -	D	P	R	LT
Pedestrians and building occupants using off-site building entrances	Wind Conditions range from suitable for pedestrian standing		Moderate Beneficial to Minor Adverse	+/-	D	P	R	LT
Pedestrians and building occupants using on-site building entrances	Wind Conditions suitable for pedestrian standing		Minor Beneficial to Major Adverse	+/-	D	P	R	LT
Pedestrians using bus stop	Wind Conditions suitable for pedestrian standing		Minor Adverse	-	D	P	R	LT
Pedestrians using crossings	Wind Conditions range from suitable for pedestrian standing to pedestrian walking		Minor Beneficial to Major Beneficial	+	D	P	R	LT
Pedestrians using station entrance	Wind Conditions suitable for pedestrian walking		Moderate Adverse	-	D	P	R	LT
Pedestrians and occupants of buildings using on-site proposed	Wind Conditions range from suitable for outdoor dining to uncomfortable		Minor Beneficial to Major Adverse	-	D	P	R	LT

Table 9.10: Summary of Residual Wind Effects

development amenity areas								
Pedestrians and occupants of Brighams Mead Development	Wind Conditions suitable for pedestrian standing/pedestrian walking		Minor Adverse	-	D	P	R	LT
Notes: * - = Adverse/ + = Beneficial/ +/- Neutral; D = Direct/ I = Indirect; P = Permanent/ T = Temporary; R=Reversible/ IR= Irreversible; St-Short term/ Mt –Medium term/ Lt –Long term. **Negligible/Minor/Moderate/Major								

9.106. Based on the above, all effects reported as Moderate Adverse, or as a range from Minor to Moderate Adverse, and strong wind incidents are considered to be significant effects.

Cumulative Effects

9.107. The following cumulative schemes are within close proximity to the application site and have the potential to lead to inter-project cumulative effects:

- Thames Quarter;
- Station Hill;
- 29 Station Road;
- 80 Caversham Road; and
- Vastern Road.

Demolition and Construction

9.108. The cumulative scheme sites are currently occupied by low-rise buildings ranging from 1 to 5 storeys in height.

9.109. Based upon professional judgement, the demolition of the existing low-rise structures of the application site, together with construction works at cumulative schemes in close proximity to the application site are not anticipated to give rise to any significant change to the existing (relatively calm) wind microclimate both on and off-site. The likely effect is therefore judged to be **Negligible** and wind conditions both on and off-site would remain acceptable for their intended pedestrian uses.

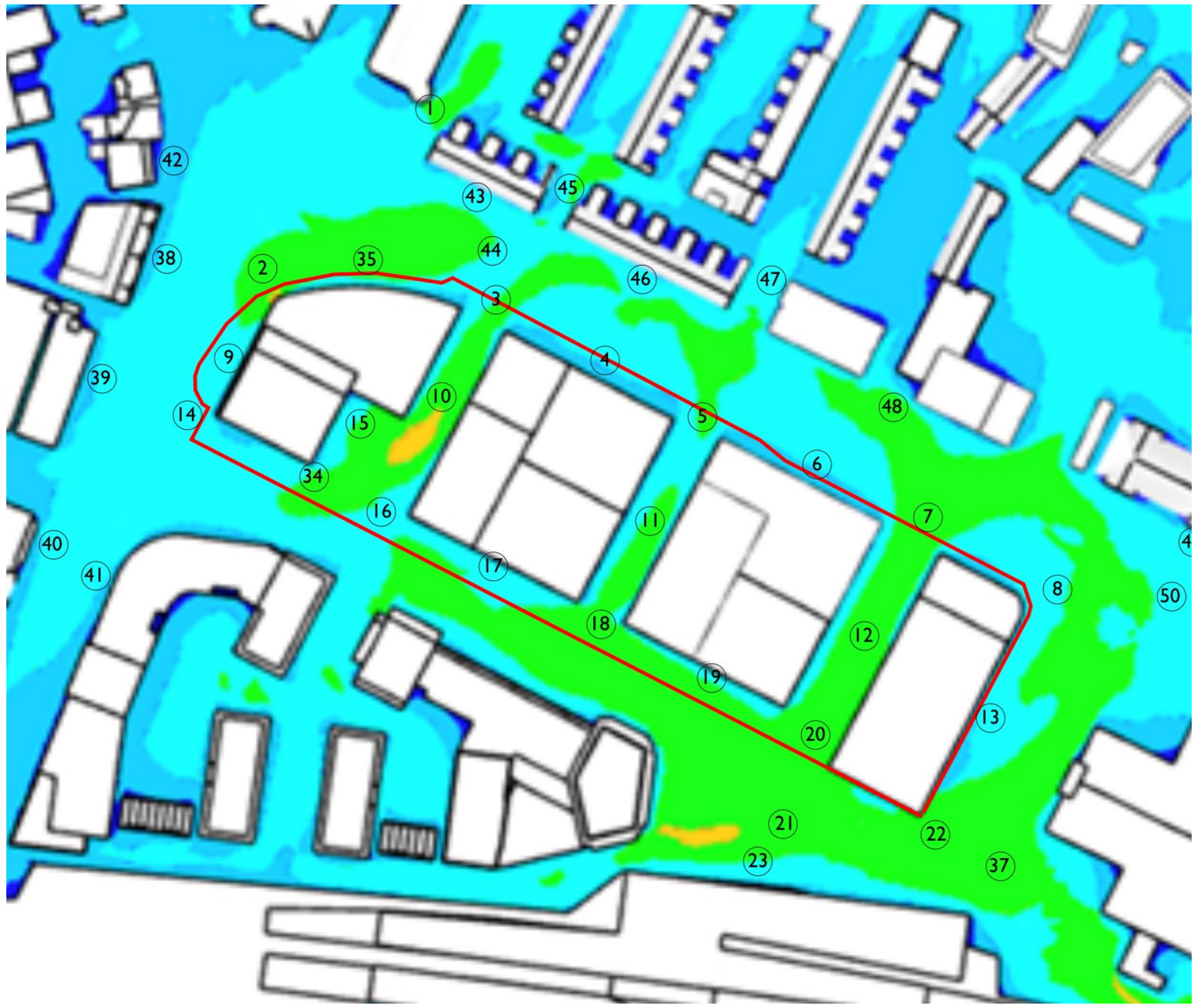
9.110. As construction of the proposed development and the above-mentioned cumulative schemes proceeds, the wind conditions of the application site and its surrounds would gradually adjust to those described below for the completed development.

Completed Development

Configuration 3: Existing Baseline + Proposed Development + Cumulative Schemes

Pedestrian Comfort

9.111. The combined pedestrian comfort effects resulting from the cumulative development of neighbouring sites are considered in this section. The Lawson LDDC Comfort Criteria (with GEM) plots for the development + cumulative schemes are shown in Figure 9.10 for ground level, and Figure 9.11 for roof top level.



	A	2 m/s	< 5%	Outdoor Dining
	B	4 m/s	< 5%	Pedestrian Sitting
	C	6 m/s	< 5%	Pedestrian Standing
	D	8 m/s	< 5%	Pedestrian Walking
	E	10 m/s	< 5%	Business Walking
	U	10 m/s	> 5%	Uncomfortable

9.112.

Figure 9.10: Configuration 3 - Ground Level Pedestrian Comfort (Lawson LDDC Comfort with GEM) Top: Winter season, representing the worst-case conditions.

Existing Off-Site Thoroughfares

9.108. Following the introduction of the cumulative schemes, all off-site thoroughfare locations with the exceptions of measurement locations 15 and 21, would achieve the target conditions or calmer and therefore the effects would be **Negligible**. Measurement locations 15 and 21 would experience pedestrian walking conditions, which is three categories windier than the target conditions and therefore the effect would be **Major Adverse**.

Proposed Development Thoroughfares

9.109. Following the introduction of the cumulative schemes, thoroughfares two, three and four within the application site would achieve the target conditions therefore the effects would be **Negligible.**

9.110. Thoroughfare one has a region of suitable for Business Walking and so the the effect would be **Minor Adverse.**

Pedestrian Crossings

9.111. Following introduction of the cumulative schemes, the wind conditions and effects on the pedestrian crossings would achieve the target conditions or calmer and therefore the effects are **Negligible** to **Minor Beneficial**.

Existing Off-Site Entrances

9.112. Off-site entrances would achieve a mixture of the required conditions or calmer conditions. Accordingly, the effects are **Minor Beneficial** to **Negligible**.

Proposed Development Entrances

9.113. Entrances locations for the proposed development have not yet been defined. Measurement locations 4, 6, 9 and 15 would remain the most suitable points for entrances with pedestrian standing wind conditions which are suitable for this use**.** The cumulative effects here would be **Negligible**.

9.114. Wind conditions at measurement locations 9 and 19 remain unchanged from pedestrian standing and pedestrian walking, a **Negligible** effect when compared to target conditions.

9.115. Around measurement location 11, conditions improve from walking use to standing use, a **Negligible** effect when compared to target conditions making this location suitable for an entrance.

Off-site Bus Stops

9.116. The bus stop at measurement location 37 at the railway station would be suitable for pedestrian walking use, a **Minor Adverse** effect when compared to target conditions.

Off-Site Amenity Areas

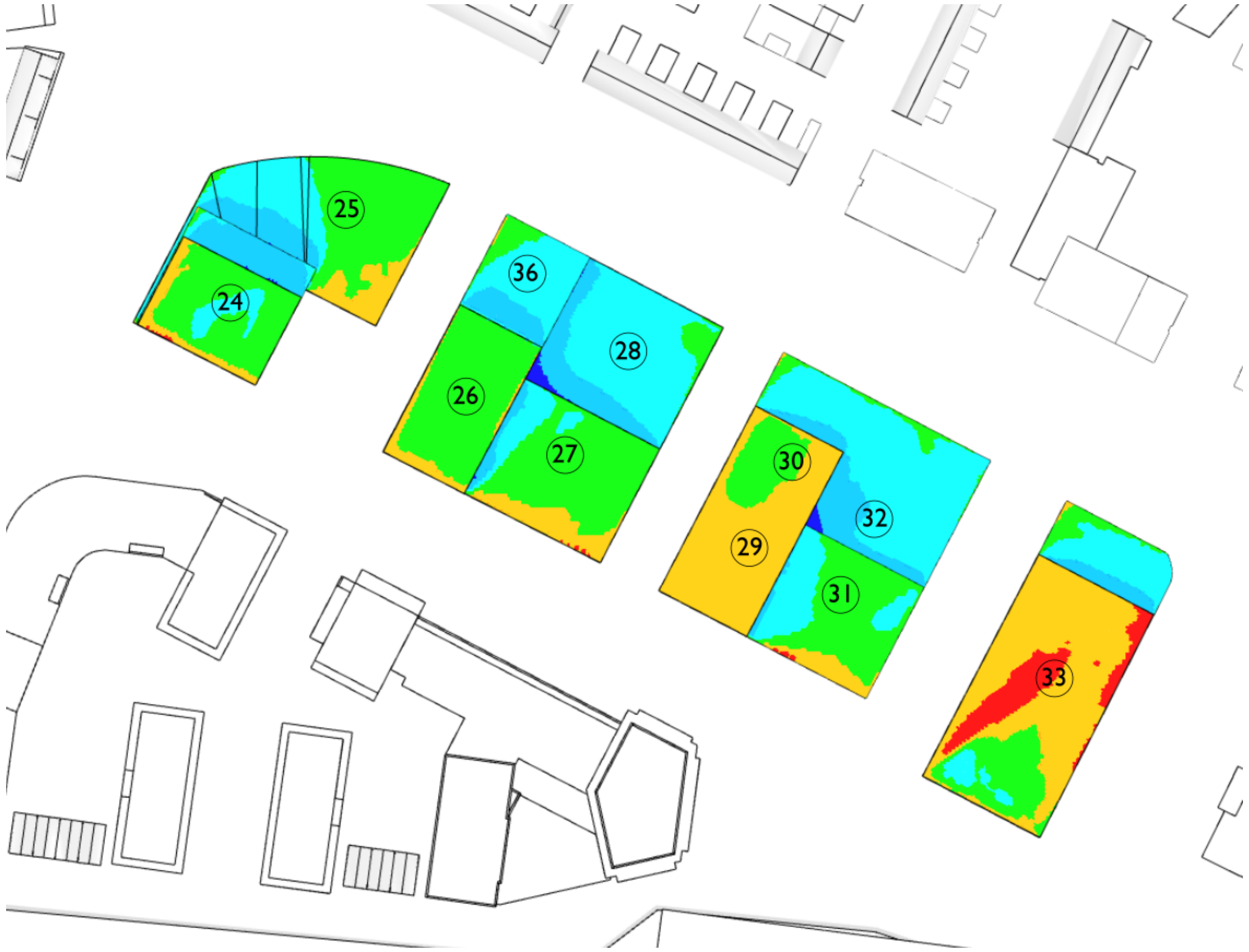
9.117. The wind conditions at the sitting and pick-up area outside the railway station at measurement location 21 would be suitable for pedestrian walking use representing a **Moderate Adverse** effect when compared to target pedestrian sitting conditions.

Proposed Development Ground Floor Amenity

9.118. The wind conditions around development Buildings A to B would remain varied. Wind conditions at the ground level would range from being suitable for pedestrian standing to pedestrian walking, with a localised area suitable for business walking on thorough fare one, during the winter season, whilst being suitable for pedestrian sitting to pedestrian walking during the summer. The cumulative effects when compared to target conditions therefore range from **Minor Beneficial** to **Minor Adverse.**

Proposed Development Roof tops

9.119. Wind conditions at the roof top level would range from being suitable for pedestrian sitting to being uncomfortable during the winter season, whilst being suitable for pedestrian sitting to business walking during the summer. When compared against the assumed target condition range of pedestrian sitting to pedestrian standing, the cumulative effect would range from **Minor Beneficial** to **Major Adverse**.



	A	2 m/s	< 5%	Outdoor Dining
	B	4 m/s	< 5%	Pedestrian Sitting
	C	6 m/s	< 5%	Pedestrian Standing
	D	8 m/s	< 5%	Pedestrian Walking
	E	10 m/s	< 5%	Business Walking
	U	10 m/s	> 5%	Uncomfortable

9.120.

Figure 9.11: Configuration 3 - Roof Level Pedestrian Comfort (Lawson LDDC Comfort with GEM) Winter season, representing the worst-case conditions.

Strong Winds

9.119. The London LDDC criteria are used for identifying locations where windspeeds greater than 15 m/s for 0.022% of the time may be expected (Figure 9.12 ground level and Figure 9.13 roof level). Note that because of the strict time percentage threshold for these winds, some areas may be identified as "Unsafe" according to this scale, whereas they may be merely "Uncomfortable", or suitable for "Business Walking" according to the Lawson LDDC Comfort (with GEM) scale. In such cases, mitigation is required.

	S	**15.0 m/s**	**> 0.022%**	**Unsafe**

Figure 9.12: Configuration 3 - Ground Level Strong Winds (London LDDC) Winter season, representing the worst-case conditions.

9.120. The impact of strong winds would be reduced by the cumulative schemes, although some small areas of unsafe wind conditions would remain around measurement locations 10 at ground level and measurement locations 24, 26, 27, 29, 31 and 33 at roof level.

9.121. Unsafe regions near measurement locations 15 and 13, improve from being unsafe to safe following the cumulative schemes.

9.122. The unsafe wind conditions on the roof tops remain similar to the configuration 2 conditions. Though measurement location 25 goes from being unsafe to safe.

Figure 9.13: Configuration 3 - Roof Level Strong Winds (London LDDC) Winter season, representing the worst-case conditions.

Summary

Background

9.123. A wind microclimate assessment of the proposed development was undertaken by means of Computational Fluid Dynamics (CFD) simulation using SimScale of the following three configurations:

- Existing baseline;
- Existing baseline + proposed development; and
- Existing baseline + proposed development + cumulative schemes.

9.124. Consideration was given to the comfort impacts and effects on current and future pedestrians and building occupants (workers and residents) when using thoroughfares, building entrances and amenity spaces at ground floor and at roof levels. These were assessed according to the Lawson LDDC Comfort Criteria (with Gust Equivalent Mean - GEM). In addition, consideration was given to safe wind conditions, as defined according to the London LDDC Criteria – specifically locations where windspeeds of 15 m/s are expected to be exceeded more than 0.022% of the time. Wind maps according to both scales are automatically generated by SimScale and are presented in this chapter.

9.125. Due to the outline nature of the proposed development, the worst-case massing proposals together with assumed pedestrian uses were considered. For thoroughfares, pedestrian walking or walking conditions would be required; for building entrances, pedestrian standing conditions would be required; for amenity spaces pedestrian sitting and outdoor dining conditions would be required or a combination of pedestrian standing and pedestrian sitting conditions.

9.126. Wind speed data for London Heathrow was obtained from Meteostat, who are one of the largest vendors of open weather and climate data. Their data was used to model the wind velocity profile at and around the application site for 16 different wind directions based on seasonal average conditions. The wind data was compiled for each of the seasons and was then averaged over a 20-year period, starting from the year 2001. Obtaining the wind data in this way allows for the seasonal simulations to be undertaken, as well as allowing for the potential for future simulations using annual wind data from Heathrow Airport to be undertaken.

9.127. In arriving at these results some key assumptions were made. Minor features and landscaping were not included in the model geometry making a more "open" environment. This represents a worst-case scenario. In addition, seasonally averaged wind conditions were used in determining suitability for the intended usages of sensitive receptors. These conditions provide a worst-case result which is suitable for preliminary assessment and inform potential mitigation measures to be considered during the detailed design stage. Wind tunnel testing should be used when confirming the detailed design and mitigation options.

Baseline

9.128. The prevailing wind for the site is south-westerly year-round with a secondary peak from a north-easterly wind in spring time.

9.129. Existing baseline conditions range from being suitable for pedestrian sitting and pedestrian walking use. There are no instances of strong winds where wind speeds are expected to exceed 15 m/s for more than 2 hours per year at the existing site.

Demolition and Construction

9.130. Wind conditions during the demolition and construction period were assessed using professional judgement and were based on the results for the existing baseline conditions at the application site and surrounding study area.

9.131. Wind conditions during the demolition and construction period are expected to gradually adjust from those in the existing baseline to those described for the proposed development.

Completed Development

9.132. The modelling results indicate that with the proposed development would result in increased wind velocities and therefore winder conditions around much of the completed development in comparison to the existing Baseline levels according to the Lawson LDDC Comfort Criteria (with GEM). Assessment against the London LDDC criteria for identifying safety exceedances (15 m/s, 0.022%) would require mitigation to ensure a safe environment for pedestrians.

Pedestrian Comfort

9.133. The wind conditions for the completed development would range from areas which would be suitable for pedestrian sitting use to being uncomfortable.

Thoroughfares

9.134. Vastern Road and Caversham Road would remain suitable for pedestrian walking throughout the year. Close to the roundabout and across junctions, the wind conditions is also suitable for pedestrian walking use. Three of the proposed on-site thoroughfares and Caversham Road would all have locations of pedestrian walking winds. These effects are **Negligible** and would therefore not require mitigation at the detailed design stage.

Entrances

9.135. Entrances have not been defined though there are suitable locations around the completed development where wind conditions would be suitable for pedestrian standing use. Caution is needed in the detailed design stage and reference should be made to the comfort levels within thoroughfares.

Ground Level Amenity Space

9.136. The small area enclosed by Building A would be suitable for pedestrian sitting use, close to the building, but features a region of both uncomfortable and strong wind which should be addressed through mitigation. The drop off and sitting area outside the station would be two categories above expected pedestrian sitting use. The effect is **Moderate Adverse** and would therefore require mitigation at the detailed design stage.

Roof Tops

9.137. The roof level spaces would be exposed to high winds and would be uncomfortable, mostly for Building D, with small regions of uncomfortable winds in comparison with Buildings A, B, and C. These effects are all adverse and significant and would therefore require mitigation at the detailed design stage.

Strong Winds

9.138. There would be instances of small regions of strong winds where 15 m/s for 2 hours of the year would be exceeded. These include close to measurement locations 10 and 15 (near Building A) and 13 (close to Building D). The occurrence of these winds would pose a safety risk to more vulnerable road users and pedestrians and therefore represents significant adverse effects which would require mitigation at the detailed design stage.

Cumulative Schemes

9.139. An overall improvement in wind conditions Lawson criteria would occur with the introduction of cumulative schemes, because of the shelter achieved from these schemes. However, despite improvement, unsafe conditions would remain and would require mitigation to ensure the comfort and safety of those using the spaces.

Pedestrian Comfort

9.140. Pedestrian comfort remains mostly comparable following the Cumulative schemes with areas suitable for sitting.

Thoroughfares

9.141. Pedestrian comfort remains comparable following the Cumulative schemes with areas previously classed as uncomfortable (i.e., thoroughfare 1) are now suitable for business walking.

Pedestrian Crossings

9.142. Crossings on Vastern Road remain largely unchanged with pedestrian walking and pedestrian standing wind categories. A **Minor Beneficial** and **Moderate Beneficial** effect. The crossing on Caversham road becomes suitable for pedestrian standing as well as pedestrian walking conditions, a **Negligible** to **Minor Beneficial** effect.

Entrances

9.143. Following the cumulative schemes, entrances on Thoroughfare 2 become viable with wind conditions reducing 2 categories, a **Moderate Beneficial** effect. Entrances on the south walls of Plot B and C become less suitable by one category representing a **Minor Adverse** effect. Entrances at 39 and 42 remain unchanged suitable for pedestrian sitting, a **Negligible** effect. The entrances to the north of Vastern Road, 43, 46, and 49 (48 becomes a thoroughfare) broadly improve wind conditions. Much of the area which was measured as pedestrian walking becomes suitable for pedestrian standing with the entrance effects ranging from **Negligible** to **Minor Beneficial.**

Ground Level Amenity Space

9.144. The courtyard in Building A remains unchanged, a **Negligible** effect. The drop-off and sitting area at the train station remains mostly suitable for pedestrian walking but an area previously suitable for walking also drops one category to pedestrian walking representing a **Minor Beneficial** effect.

Roof Tops

9.145. The roof tops exhibit broadly similar wind conditions following the cumulative schemes. In general a **Negligible** impact.

Strong Winds

9.146. Small regions of strong winds still exist around the proposed development following Cumulative developments, though some have diminshed. The area where strong winds, 15 m/s for over 2 hours of year remains at measurement location 10, close to Building A.

Mitigation

9.147. Wind mitigation around the proposed development would be required to remove the areas of unsafe wind and ensure that all receptor locations are suitable for their intended use.

9.148. These mitigation measures could comprise in order of effectiveness; changes to building shape and massing, canopies and building facades, porous screening, foliage, and planting of mature trees (5m) and hedges (1m), landscaping.

9.149. and would be subject to further CFD assessment or wind tunnel testing at the detailed design stage. The CFD assessment or wind tunnel testing would be secured by means of an appropriately worded planning condition.