10 Wind

10.1 INTRODUCTION

10.1.1 This chapter assesses the impact of the Proposed Development on the local wind environment. In particular the assessment considers the potential effects of the proposed and existing surrounding buildings and other structures on the wind environment at pedestrian level, anticipating the likely wind conditions in the context of safety and comfort for pedestrians.

10.1.2 Wind environment is defined as the wind flow experienced by people and the subsequent influence it has on their activities. It is concerned primarily with wind characteristics at pedestrian level. Other potential wind effects including wind loads, structural response and natural ventilation are not directly related to wind environment at pedestrian level therefore do not fall within the scope of this chapter.

10.1.3 Given the strategic nature of the planning application at this stage, the assessment has been based on the single most frequent, fastest wind speed and direction.

10.1.4 The impact of the Proposed Development on the local microclimate has been assessed against best practice criteria for pedestrian comfort and safety. These two aspects are associated with pedestrian use of public open spaces and it is important to ensure that the design follows UK good practice design guidelines developed to minimise associated negative impacts.

10.1.5 This chapter (and its associated figures and appendices) is not intended to be read as a stand alone assessment and reference should be made to the Front End of this ES (**Chapters 1 – 5**), as well as **Chapter 15 - Cumulative Effects**.

10.2 LEGISLATION, POLICY AND GUIDANCE

Legislative Framework

10.2.1 There is no specific national legislation for the assessment of the impact on the local wind environment on pedestrian comfort and safety.

Planning Policy

10.2.2 Planning policy at the national, regional, county and local level is discussed in **Chapter 5 – Planning Policy Context** and corresponding **Appendix 5.1**. However, none of the documents within Appendix 5.1 refer to planning policies with respect to wind environments and/or pedestrian comfort.

Guidance

10.2.3 The widely accepted wind environment criteria for pedestrian comfort and safety developed by TV Lawson (Ref. 10.1) from Bristol University have been used in this chapter. This method is comparable with international guidance.

10.2.4 The Best Practice Guideline for the Computational Fluid Dynamics (CFD) Simulation of Flows in the Urban Environment (Ref. 10.2) has also been used as a technical reference for the study; see full reference in section 10.7.

10.3 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

Scope of the Assessment

10.3.1 A formal Environmental Scoping Letter was issued to WMBC (October 2009) (**Appendix 2.2**). This document identified the impacts that the development will potentially have on the wind environment during the site preparation, earthworks and construction and operational stages of the development.

10.3.2 The following lists the relevant potential impacts highlighted within the Environmental Scoping Letter (particularly in Appendix A of the letter) which are relevant to the operational phase:

Operational Phase

- Change in wind environment from baseline conditions (providing wind shelter and wind acceleration) experienced by future users.

10.3.3 The only deviation since the submission of the Environmental Scoping Letter is that the Change in wind environment from baseline conditions during the Site Preparation, Earthworks and Construction Phase has not been considered as the modelling used within the assessment (see below) is based upon the completed development (as operational).

10.3.4 Wind effects including wind loads, structural response and natural ventilation are not directly related to wind environment at pedestrian level and therefore do not fall within the scope of this chapter.

Extent of the Study Area

10.3.5 The wind model is a three dimensional flow domain covering a lateral distance of 1.8km (East-West) and 1km wide (North-South) to cover the area of the Site and adjacent surroundings, in line with recommended best practice guidance for computer based wind modelling.

Method of Baseline Data Collation

10.3.6 The Baseline data was collected via 3D model information provided by the architect's team and by a site visit conducted by the team. Supporting and reference information was also obtained through aerial photographs and navigation through the Site via IGIS satellite mapping system.

Assessment Methodology and Modelling

10.3.7 The effects on the Proposed Development on wind have been informed by the massing of the illustrative masterplan, which has been considered as 'a likely case scenario'. The reason for this is that in terms of massing, assessing a minimum and maximum scenario is likely to result in effects that are worst case, to an extent that the effects presented are not considered likely.

10.3.8 The assessment focuses on the comparison between the wind environment at the existing Site and the predicted wind conditions with the Proposed Development in place. By quantifying the wind velocities for different wind conditions for the 'with' and 'without development' scenarios, an assessment of the deviation from the baseline has been undertaken. The impact assessment include wind scenarios to test pedestrian safety and pedestrian comfort (i.e. future users), in line with the adopted guidance and recommended criteria.

10.3.9 The wind studies at this stage have focused on the prevailing wind conditions (west north-west). There are other relevant wind conditions which may be tested later as and when the design for each of the quarters (illustrated in **Appendix 4.1**) develops. These other wind conditions may include infrequent wind conditions and winds from various other directions. However by selecting the most frequent wind speed and direction (west north-west) the assessment presented within this chapter is representative of the average worst case wind conditions at the Site.

10.3.10 The method adopted for the modelling combines the use of CFD to predict air flow patterns and wind velocities around the Proposed Development, the use of wind data from the nearest suitable meteorological station (Liverpool Airport Weather Station) and recommended comfort and safety standards (the Lawson Criteria). This took into account 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 as topography, ground roughness and nearby obstacles (buildings, bridges, etc.);
- The effects of terrain type 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 (sitting, standing, strolling and fast walking). It should be noted that effects on pedestrian comfort and safety are only considered externally to the building. No assessment was made of the potential effects, direct or indirect, of the wind environment inside buildings as microclimate studies are only intended to address external conditions.

10.3.11 The wind analysis focused on the potential variation of the wind velocities and direction from the reference wind data arising as a result of the Proposed Development. The assessment of the effects was conducted based on a comparison of the CFD modelling results of the 'Baseline Condition' and 'Proposed' scenarios.

10.3.12 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.

10.3.13 Assumptions on the heights of the existing buildings currently located around the Site were made based on photographic information collected during the site visit and aerial photographs and navigation through the Site via IGIS satellite mapping system.

10.3.14 The model excludes both soft and hard landscaping (trees, street furniture, etc.), which is commonly accepted in the industry when assessing proposals at this stage the planning process.

Meteorological Data

10.3.15 Hourly wind data from Liverpool Weather Centre over the period 2000 - 2004 was used to assess the local wind conditions surrounding the Site. This was chosen as the most suitable and reliable set of data for this assessment, as this is the closest meteorological station to the Site. These measurements represent the wind speed in the free stream, i.e. away from any obstruction, and a roughness factor has been introduced to represent the flow conditions near the ground. The summary of this data is illustrated in **Figure 10.1** and within **Table 10.1**.

10.3.16 For this region, the prevailing wind direction is west north west blowing at a dominant 14.6% of the time. The next most frequent direction is the south direction at 11.9% of the time however the wind speeds are much reduced from this direction as compared to the west north-west direction.

10.3.17 The winds are strong winds, exceeding the 10m/s speed only in the west and west north-west directions at 1.4%,1.1% of the time respectively. The presence of buildings could either aggravate it or improve it depending on the characteristics of the new blocks.

Table 10.1: Frequency of Wind Speed by Direction (Liverpool Airport Weather Centre)

Wind Direction		Percentage Frequency for Stated Range of Wind Speed (%)			
	Bearing	0-4m/s	4-10m/s	above 10m/s	TOTAL
North	350-10	2.5	1.9	0.0	4.5
North northeast	20-40	2.2	0.8	0.0	3.0
East northeast	50-70	3.3	1.8	0.0	5.1
East	80-100	2.9	2.3	0.0	5.3
East southeast	110-130	4.4	3.0	0.0	7.5
South southeast	140-160	6.2	5.1	0.1	11.5
South	170-190	5.6	6.2	0.2	11.9
South southwest	200-220	3.2	4.3	0.2	7.6
West southwest	230-250	3.1	5.2	0.5	8.8
West	260-280	3.3	5.5	1.4	10.2
West northwest	290-310	4.0	9.5	1.1	14.6

North northwest	320-340	3.5	4.2	0.2	7.9
	TOTAL	46.3	49.8	3.9	100.0

Significance Criteria

Determining Magnitude of Change and Sensitivity of Receptors

10.3.18 In order to determine the magnitude of the change and the sensitivity of receptors, the Lawson Criteria for wind environment has been applied. The Lawson criteria provide guidance to quantify the effect of wind velocity on pedestrian comfort and safety. The criteria state the maximum velocity at which pedestrians can be exposed, according to type of pedestrian activity and still feel comfortable and safe (**Tables 10.2** and **10.3**).

10.3.19 The Lawson guidance also indicates that for the comfort and safety assessment of wind effects 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 and rate of certain wind speeds. The Lawson criteria indicates that the threshold mean hourly wind speed for each pedestrian activity (**Table 10.2**) should not be exceeded for more than 5% of the time to maintain pedestrian comfort. Regarding pedestrian safety, the guide gives upper limit wind speeds of 15m/s and 20m/s for typical and sensitive pedestrians respectively that should not be exceeded for more than once a year (**Table 10.3**).

Table 10.2: Lawson's Comfort Assessment Criteria

Category	Pedestrian Activity	Threshold mean hourly wind speed not to be exceeded for more than 5% of the time
C1	Business walking	10 m/s
C2	Leisurely walking	8 m/s
C3	Standing	6 m/s
C4	Sitting	4 m/s

Table 10.3: Lawson's Safety Assessment Criteria

Category	Pedestrian Type	Threshold mean hourly wind speed not to be exceeded once per annum *
S1	Typical pedestrian	20 m/s
S2	Sensitive pedestrian	15 m/s

10.3.20 The S2 category for safety is defined so that wind speed at pedestrian level should not be greater than 15m/s more than once a year. The guidance defines sensitive pedestrians as those likely to experience distress if wind speeds are over 15m/s, i.e. elderly people, cyclists and children.

Mitigation Frequency Thresholds

10.3.21 The Lawson Criteria state that if the critical wind speed for each activity is exceeded for more than 20% of the time then mitigation may be required. If the percentage lies between 10% and 20% some discomfort may be experienced but mitigation is not required. The guidance suggests that a frequency value of 5% gives a reasonable allowance for extreme and relatively infrequent winds that are tolerable within each category.

Suitability for Planned Use

10.3.22 The suitability of pedestrian level wind environment for various activities was assessed for each of the Quarters of the Proposed Development. The activities considered, and their relation to the comfort criteria described above, are summarised in **Table 10.4** below.

Table 10.4: Suitability Criteria

Category	Suitability
C1/C2 6 – 10 m/s	For passage through and around the Proposed Development
C2/C3 4 – 6 m/s	For access to and from buildings and leisurely strolling through the Proposed Development
C3/C4 0 – 4 m/s	For general outdoor recreation, such as seating, standing and strolling.

10.3.23 The assessment of potential impacts as a result of the Proposed Development has taken into account the operational phase. The significance level attributed to each impact takes into consideration the comparison between the recommended wind velocities according to the Lawson Criteria, and the resulting wind conditions. For example, the results might indicate that the areas designated for sitting are in fact better suited for walking or brisk walking.

10.3.24 **Table 10.5** presents the magnitude of change/effect (i.e. the deviation from the baseline conditions) at the pedestrian level and whether the change falls within the Lawson Criteria. The aim has been to keep a balance between the frequency of extreme / rare wind conditions, what is acceptable for the sensitive receptors (compliance with the Lawson Criteria) and the change from the baseline conditions.

10.3.25 **Table 10.5** shows how the significance of the impacts relates to the Lawson Criteria. The table focuses on the impact resulting from deviation from the criteria and qualifies the level of impact according to whether a receptor falls within or outside of the Lawson Criteria. In determining whether the impact is minor major or negligible a professional judgment has been used supported by the results of the wind assessment.

Table 10.5: Significance Levels

Adverse Change from the Baseline	Significance of Impact			
	Safety		Comfort	
	Outside Lawson's	Within Lawson's	Outside Lawson's	Within Lawson's
High	Major	Negligible	Moderate	Minor
Medium	Major	Negligible	Moderate	Minor
Low	Moderate	Negligible	Minor	Negligible
Negligible	Moderate	Negligible	Negligible	Negligible

10.4 BASELINE CONDITIONS

10.4.1 A CFD model of the Site was constructed to establish the baseline conditions of the current wind environment within and around the Site.

10.4.2 The computer model of the baseline scenario was based on the architectural 3D model provided by the architect's team and by a site visit conducted by the team. Supporting and reference information i.e. dimensions for existing buildings and surrounding buildings on the Site was also obtained through aerial photographs and navigation through the Site via IGIS satellite mapping system. A view of the baseline wind model is provided in **Figure 10.2**.

10.4.3 The results of the baseline scenario modelling are presented in the form of wind velocity contours at 1.5m above the ground level. This reference height is industry standard to assess pedestrian comfort and safety, as this is the average height of a pedestrian including adults and children.

10.4.4 As outlined above, the following wind speed and direction for the baseline scenario modelling has been selected to represent 'typical' wind conditions occurring for more than 5% of the time in line with the Lawson Criteria for Pedestrian Comfort:

- Wind Condition: West northwest wind direction (290°) at 9 m/s.

10.4.5 The result of the baseline scenario modelling are illustrated in **Appendix 10.1** and further discussed below.

10.4.6 In summary, the results of the baseline scenario modelling showed localised regions of wind acceleration around some of the industrial buildings on the south of the Site off Corporation Road adjacent to the Site with velocities ranging from 8-10m/s in these areas. Other areas showing localised increase of wind velocities are on the central buildings of the committed Northbank East development with wind velocities increasing to 8-9m/s in these areas. These are maximum velocities which fall within the pedestrian comfort criteria assuming uses for walking and business walk (**Table 10.3**). Other than the regions identified, the wind environment on the Site and surroundings is suitable for all pedestrian activities (**Table 10.3**) and falls within the recommended comfort criteria outlined in **Table 10.4**.

10.5 ASSESSMENT OF IMPACTS, MITIGATION AND RESIDUAL EFFECTS

Operational Phase

Change in wind environment from baseline conditions (providing wind shelter and wind acceleration) experienced by future users

10.5.1 New building forms and layouts will have an effect on the local wind environment. The wind environment resulting from the Proposed Development will be influenced by the position and orientation of the new buildings in relation to prevailing winds and neighbouring streets and open spaces.

10.5.2 As outlined above, in order to assess the impact of the Proposed Development, the baseline wind CFD model was modified to introduce the Proposed Development on the Site, and the model was re-run under the same wind conditions as those used for the baseline scenario modelling. An illustration of the view of the Proposed Development wind model is illustrated in **Figure 10.3**.

10.5.3 The result of the modelling is presented in the form of velocity contours in **Appendix 10.1**. The images are shown separately for the baseline scenario and 'with development' scenario.

10.5.4 The results of the 'with development' scenario under the west north-west prevailing wind direction modelled shows areas of acceleration of wind around the western corners of the building blocks of the Northbank West and Victoria Studios Quarters. This is likely to be a localised area of discomfort although the stream of increased velocity in this area is channelled through into the water area of the Dock, reducing the effect within pedestrian areas.

10.5.5 The results of the 'with development' scenario under the west north-west prevailing wind direction modelled shows areas of higher pressure towards the western end of the Site. There is slight wind acceleration around the buildings to the south-east of the Site. However it is also noticeable that with the exception of these areas, the remainder of the Site appears to result in more stable wind conditions and greater areas of low velocities than within the baseline scenario. There are reductions in velocities on the corners of the buildings and open areas to the south side of the Site with velocities ranging from 8-10m/s in these areas identified in the baseline scenario and also in the open areas within the committed Northbank East development.

10.5.6 The results of the modelling also indicate that the wind acceleration identified does not deviate significantly from the prevailing incoming wind velocity suggesting that the wind environment is likely to remain within the safety and comfort limits set out in the Lawson's criteria.

10.5.7 The sensitivity of future users of the Proposed Development to increase in wind velocities and acceleration is high and the magnitude of change (based on **Table 10.5**) is low. Therefore, there is likely to be a direct, permanent, long term effect on future users of the Proposed Development of **minor** significance prior to the implementation of mitigation measures. The significance is considered **positive** in most areas and **negative** is some localised areas.

Mitigation

10.5.8 Based on the results of the wind studies and taking into consideration the required pedestrian comfort thresholds outlined in the Lawson criteria, the wind environment of the Proposed Development is likely to fall within the recommended standards. However the modelling has identified areas of the Proposed Development where the wind velocities fall outside the criteria therefore some form of mitigation would be required in these areas. The areas requiring mitigation are mainly the areas to the west of the Site i.e. Northbank West and Victoria Studios, often the areas in close proximity to corners of the buildings where wind speeds have a tendency to increase.

10.5.9 The best options available are likely to be a combination of strategic planting and landscaping to add further density and obstruction to airflow in the pedestrian areas of the Site. Trees and shrubs can play a significant role in absorbing winds and reduce the effects locally. As and when the buildings blocks are further designed, and additional detail is available, there will be an opportunity to soften down the effect of wind currently illustrated on the corners through the incorporation of smoothed or rounded angles rather than sharp corners. This is more effective in deflecting the airflow and reducing the wind velocities.

Residual Effects

10.5.10 The sensitivity of future users of the Proposed Development to increase in wind velocities and acceleration is high and the magnitude of change (based on **Table 10.5**) remains low. Therefore, there is likely to be a direct, permanent, long term effect on future users of the Proposed Development of **minor positive** significance following the implementation of mitigation measures.

Monitoring and Follow Up

10.5.11 This chapter has focused on a prevailing wind condition. However the need for further modelling of other wind conditions will be screened and undertaken as the design of the building blocks develops.

Limitations and Assumptions

10.5.12 The buildings have been 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 standard for these type of studies since further detail such as the window reveals and façade texture would add an impractical and unnecessary complexity to the model without adding greater quality to the results.

10.5.13 The model excludes both soft and hard landscaping at this stage (trees, street furniture, etc.), which is commonly accepted in the industry when assessing proposals at the planning stage. These are recommended to be included during the subsequent design development stages of the sites.

10.5.14 The assessment has been based on the most frequent wind speed and direction (west north-west) at this stage. Further wind conditions will be tested during subsequent design development stages.

10.5.15 The wind model covers a lateral distance of 1.8km (East-West) and 1km wide (North-South) to cover the area of the Site and adjacent surroundings, in line with recommended best practice guidance for computer based wind modelling. It is unlikely that significant impacts to the wind environment will occur in areas beyond the extent of the model.

10.5.16 The modelling was carried out based on third party data.

Cumulative Impacts

10.5.17 The consented Northbank East development has been included in the modelling associated with the above assessment. The results indicate that for incoming winds from the west north-west, the Proposed Development will help reduce wind speeds before reaching the Northbank East development, resulting in a

positive impact. This is likely to be the case for south and south east wind directions although these will have be tested at a later stage as the design of the building blocks develops.

10.6 SUMMARY

10.6.1 This chapter assesses the effect of the Proposed Development on the local wind environment. In particular it considers the potential effects of the buildings and other structures on the wind environment at pedestrian level. The without and with development scenarios have been modelled using specialist software.

10.6.2 The 'without development' scenario showed localised regions of wind acceleration around some of the industrial buildings to the south of the Site and Corporation Road with velocities ranging from 8-10m/s in these areas. Other areas showed a localised increase of wind velocities around the committed Northbank East development. These are maximum velocities which fall within the pedestrian comfort criteria for leisure and business walk.

10.6.3 The 'with development' scenario shows areas of higher pressure towards the west end of the Site. There is slight wind acceleration around the buildings to the south-east of the Site. However, the remainder of the Site benefits from more stable wind conditions and greater areas of low velocities than those shown on the 'without development' scenario. There are reductions in velocities on the corners of the buildings and open areas to the south side of the Site identified in the baseline scenario and around the committed Northbank East development.

10.6.4 The modelling has identified some localised areas of the Proposed Development where the wind velocities tend to fall outside the criteria. Therefore some form of mitigation would be required in these areas. The best option to be considered includes strategic planting and landscaping which will add further density and obstruction to airflow in the pedestrian areas of the Site.

Table 10.6: Summary of Effects Table for Wind

Description of Likely Significant Effects	Significance of Impacts					Summary of Mitigation / Enhancement Measures	Significance of Residual Effects					Relevant Policy	Relevant Legislation
	(Major, Moderate, Minor, Negligible)	Positive / Negative	(P/T)	(D/I)	ST/MT/LT)		(Major, Moderate, Minor, Negligible)	Positive / Negative	(P/T)	(D/I)	ST/MT/LT)		
Site Preparation, Earthworks and Construction													
Change in wind environment from baseline conditions (providing wind shelter and wind acceleration) experienced by future users.	Minor	Positive in most areas, negative in localised areas	P	D	L/T	▪ Planting and landscaping ▪ Smoother building corners ▪ Further iterations and testing of	Minor	Positive	P	D	L/T	N/A	N/A

Key to table:

P/T = Permanent or Temporary, D/I = Direct or Indirect, ST/MT/LT = Short Term, Medium Term or Long Term

N/A = Not Applicable

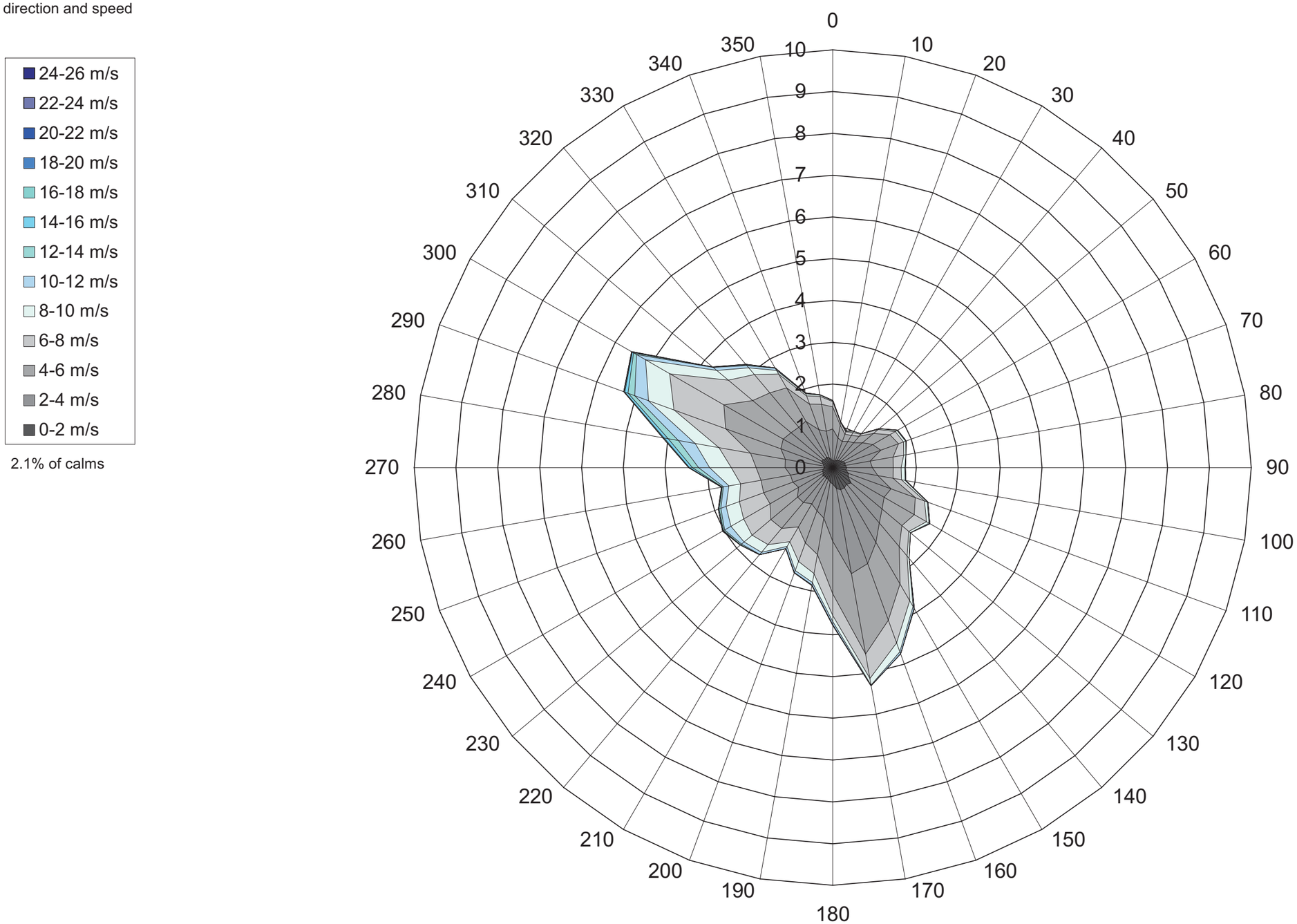
10.7 REFERENCES

Ref. 10.1 T.V. Lawson (2001) Building Aerodynamics, Imperial College Press.

Ref. 10.2 Best Practice Guideline for the CFD Simulation of Flows in the Urban Environment. Edited by Jorg Franke, Antti Hellsten, Henke Schlunzen, Bertrand Carissimo, May 2007, University of Hamburg.

Wind Rose

Frequency of wind direction and speed



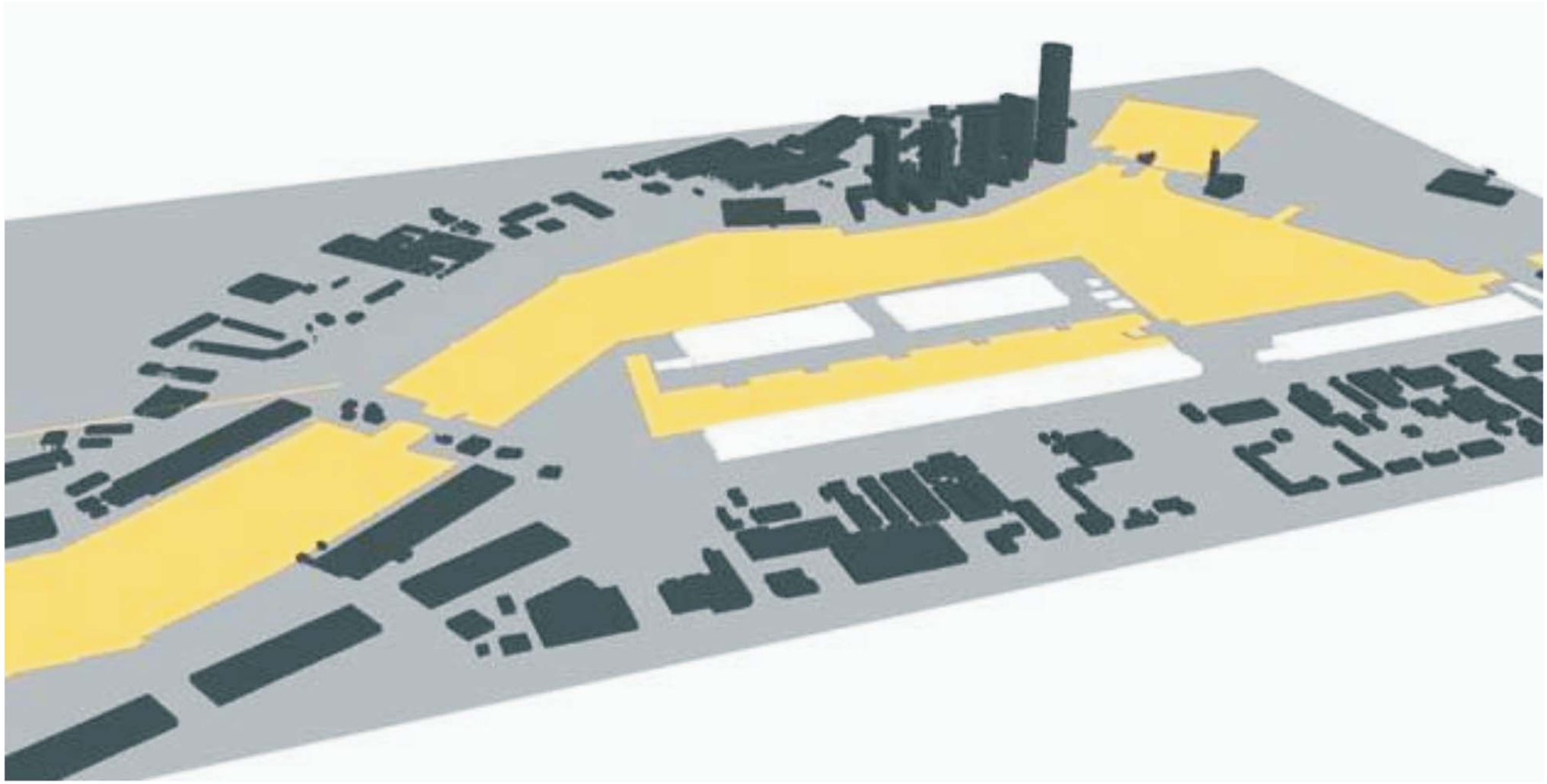
2.1% of calms

PROJECT: East Float, Wirral Waters
PROJECT No: 12261552-001
CLIENT: Peel Land and Property (Ports) Limited

DRAWN: GH
CHECKED: AR
APPROVED: AR
REVISION: A
DATE: December 2009

View of Baseline Wind Model

Figure 10.2



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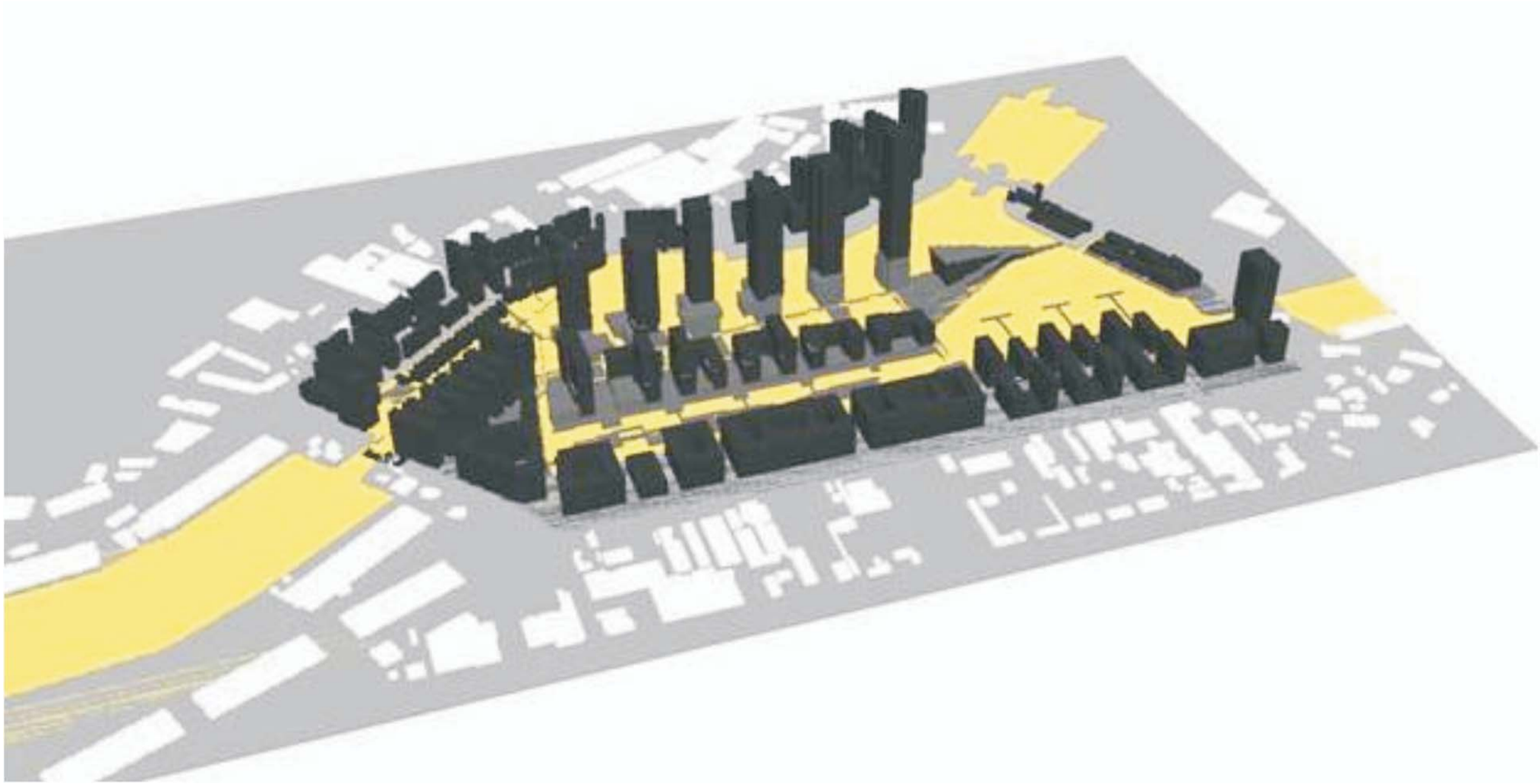
DATE: December 2009

View of Proposed Development Wind Model

Figure 10.3



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