BUROHAPPOLD ENGINEERING

Bevington Bush Desktop Wind Engineering

Wind Engineering Report

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author	**Bernardo Vazquez**
Date	**17/02/2016**
approved	**David Kingstone**
signature	
date	**17/02/2016**

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Executive Summary

This report has been prepared to consider wind effects and microclimate on and around the Bevington Bush development and the existing baseline condition. It considers the effect of topography, building shape and climate on wind conditions around the site.''

At the request of the Liverpool City Council a desktop wind assessment has been carried as the means to comply with the planning city council request.

The widely accepted methodology developed by TV Lawson from Bristol University has been defined in this report and can be used in any further quantitative study.

This study is intended to assist with the detailed assessment and design proposals for the site in order to mitigate any undesirable conditions on site. The likely effects caused by the new development on surrounding areas and within the site are highlighted and described. The following conclusions have been made:

- The baseline condition, and the new development scenarios have been studied
- The main wind effects created by the introduction of the proposed development is to create areas of shelter over the existing open space. There is also expected to be wind acceleration within the courtyard for westerly and southwesterly winds.
- The building that form proposed development are not tall, however Block B has 15 stories and its taller than the surrounding developments. Block A and C have 7 and 9 storeys respectively.
- Most entrances to buildings are likely to be suitable for the activity. However the entrance located to the southeast elevation is likely to be subject to wind acceleration under westerly and south-easterly winds. Conditions may not be suitable for an entrance.
- The landscape strategy shows areas of planting within the courtyard and surrounding the perimeter of blocks A, B and C, that is likely to help reduce the effect of wind acceleration however due to façade downwash from Block B, sitting may require of additional perimeter protection.
- Local wind acceleration is likely to occur towards the south east edge of the development, under westerly and south-easterly winds, conditions are likely to be suitable for fast walking only.
- The impacts caused by façade downwash have been classified as negligible for business walking activities (tolerable), however sitting and standing within the courtyards are likely to require of further perimeter protection.

Due to the height of the buildings (more than 10 storeys) that form the proposed development and the nature of the residual effects once landscape is put in place, as informed through the desk based assessment, it's considered further quantitative assessment (Computational Fluid Dynamics (CFD)/Wind Tunnel) should be carried out. This could be secured through an appropriate planning condition.

1 Introduction

This report provides an overview of the external wind conditions as they relate to pedestrian comfort and safety. The study covers the entire proposed development, the wind flow around the buildings and their surroundings.

1.1 International policy and guidance

There is no specific international legislation or policy guidance for the assessment of the impact that a new development has on the comfort and safety of the local wind microclimate. However local planning guidance in a number of cities including London, Leeds and Bristol recommends that where new developments are significantly taller than neighbouring areas, the effect of the development on local microclimate should be assessed.

1.2 National Planning Policy

There are no national codes of practice or legislative policies relating to the assessment of environmental wind flows in the built environment. The impact of environmental wind on pedestrian spaces and the subsequent suitability of these spaces for planned usage are described by Lawson Comfort Criteria (LCC) (Lawson 2001), which are recognised by Local Planning Authorities (LPAs) as a suitable benchmark for wind assessments. LCC is applied in the wind assessment of the Application Site.

There is no specific national or regional legislation or policy guidance for the assessment of the local wind microclimate impact that a new development has on the comfort and safety of users.

1.3 Local Planning Policy

A number of local authorities provide planning guidance for tall buildings. Note Liverpool City Council have requested that a wind microclimate assessment be performed.

2 Wind Impact Analysis

2.1 Assessment methodology

To identify any changes in the microclimate, the development, its immediate surrounding environment and building structures need to be studied. The elements of this type of study that will affect the wind environment are:

- Local wind climate
- Surrounding areas and local terrain topography
- Building form, shape, height, location and orientation
- Site uses and activities
- Landscape (trees, fences, hedges).

Wind engineering uses skills in meteorology, aerodynamics, comfort assessment and urban design. Professional judgement has been applied to this desk-based assessment. Consideration is given to the characteristics of the local area and a wind frequency analysis of the site is carried out. From this analysis, appropriate wind directions are selected and analysed. The results of this baseline assessment can be used to assist the overall design process.

The assessment is made through qualitative evaluation of the above elements. Reference is made to known urban wind phenomena including façade downwash for tall buildings, funnelling between buildings, wake effects, skimming flow and courtyard effects.

2.2 Assessment of significance

Microclimate comfort strongly depends on an individual's activity and so has been defined separately for each activity in terms of an average (mean) wind speed exceeded for a certain percentage of the year.

The pedestrian comfort criteria (Lawson 2001[i]) have been developed around the Beaufort scale, extending its applicability to environments in and around buildings. The criteria are listed in **Table 2—1**.

Table 2—1 Lawson Comfort Criteria

Lawson Comfort Criteria Classification	Use of Space	Maximum acceptable combination of wind speed and occurrence		
		Beaufort Scale	**(m/s)**	**allowable occurrence**
Distress	General public	B6	13.85	0.01%
10	Road & Car parks	B5	10.95	6%
9	Pedestrian Business walking	B5	10.95	2%
8	Pedestrian Walk through	B4	8.25	4%
6,7	Entrances/ Standing	B4	8.25	2%

5	Sitting	B3	5.6	6%

Sensitive receptors in respect of wind and microclimate are the occupants and users of the site. Their sensitivity and the magnitude of any impact will determine the effect and its significance.

2.3 Impact magnitude

The criteria used to assess the magnitude of the wind impacts are as follows:

Table 2—2 Impact Magnitude

Impact magnitude	Impact
Major	Failure of distress criteria or change of at least 2 categories in the above comfort table.
Moderate	Change of at least one category in the above comfort table.
Minor	Very localised change of wind conditions by one category only.
Negligible	No change in wind conditions

Impacts are also expressed as:

- **Adverse** – detrimental or negative impacts to an environmental resource or receptor compared with the baseline condition;
- **Beneficial** – advantageous or positive impact to an environmental resource or receptor compared with the baseline condition.
- **Neutral/Negligible** -represent the cases of minimal or no impact on wind conditions that is likely to be experienced

2.4 Impact significance

The significance of an impact is a product of the magnitude of the impact and the sensitivity of the resource or receptor. A matrix table has been provided to illustrate this relationship. In addition, any area where the Lawson distress criterion is exceeded is judged to be a profound impact.

Table 2—3 Assessment Matrix

Receptor sensitivity	Magnitude of change			
	Receptor sensitivity	**Receptor sensitivity**	**Receptor sensitivity**	**Receptor sensitivity**
Very High	Slight	Moderate	Significant	Profound
High	Slight	Moderate	Significant	Significant

Moderate	Imperceptible	Slight	Moderate	Moderate
Low	Imperceptible	Imperceptible	Slight	Slight

3 Baseline conditions

3.1 Current baseline

3.1.1 Wind Conditions

The prevailing wind across Liverpool is from the west and south-west, with contribution from the south-east. The most appropriate climatological data available was provided from Crosby, 2 miles north of the site.

Wind speeds are generally highest in the winter and spring with the seasonal pattern shows very similar range of directions for winter, spring and autumn. Summer has southerly and westerly prevailing winds.

The predicted site wind rose is shown in **Figure 3—1**. This shows the direction the wind is blowing from, with long bars representing frequent winds and wider bars representing stronger winds.

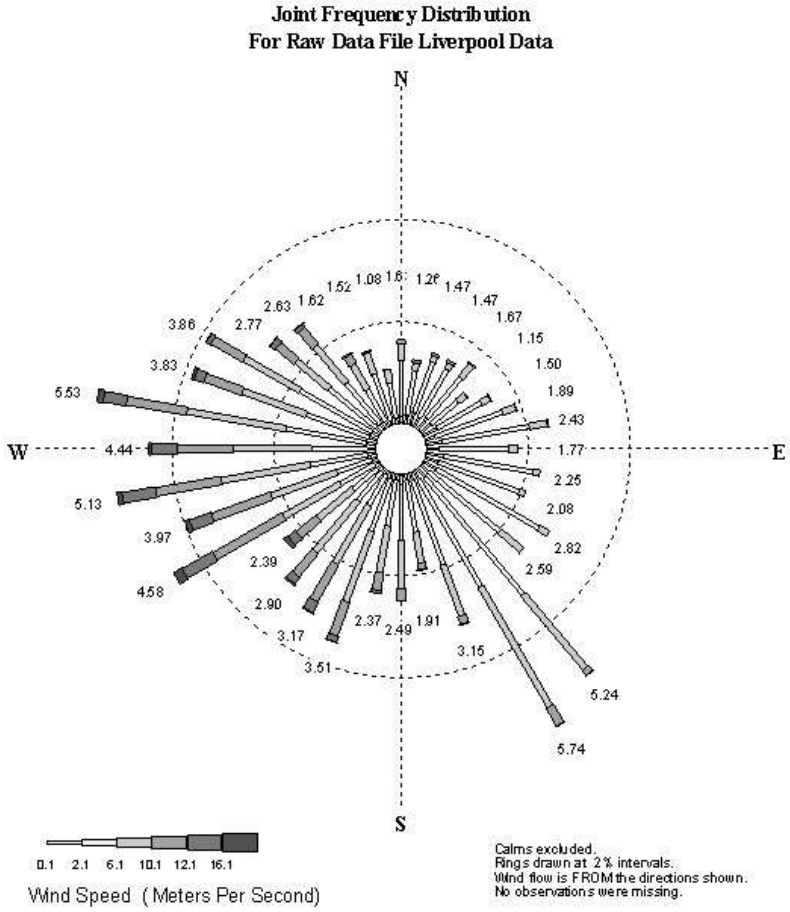

Figure 3—1 Annual wind rose for the site at the height of the building.

3.1.2 Site exposure

In the baseline condition, the site is occupied by a two story warehouse. The site is bounded by Gardner's Row, Edgar Street and Bevington Bush cul-de-sac. The site is likely to be sheltered from the prevailing winds by the buildings to the west of the site (within 3 and 4 stories). The site is open to winds from the east and northeast and southeast, this may results in possible exposure to strong winds from these directions, however due to the low high of the buildings the wind effects on site and around the perimeter of the site are likely to be low.

There are walking activities within and around the site, not sitting areas have been identified.

There is a two story building to the south, that is likely to offer some protection from southerly winds.

The site is surrounded by matures trees species.

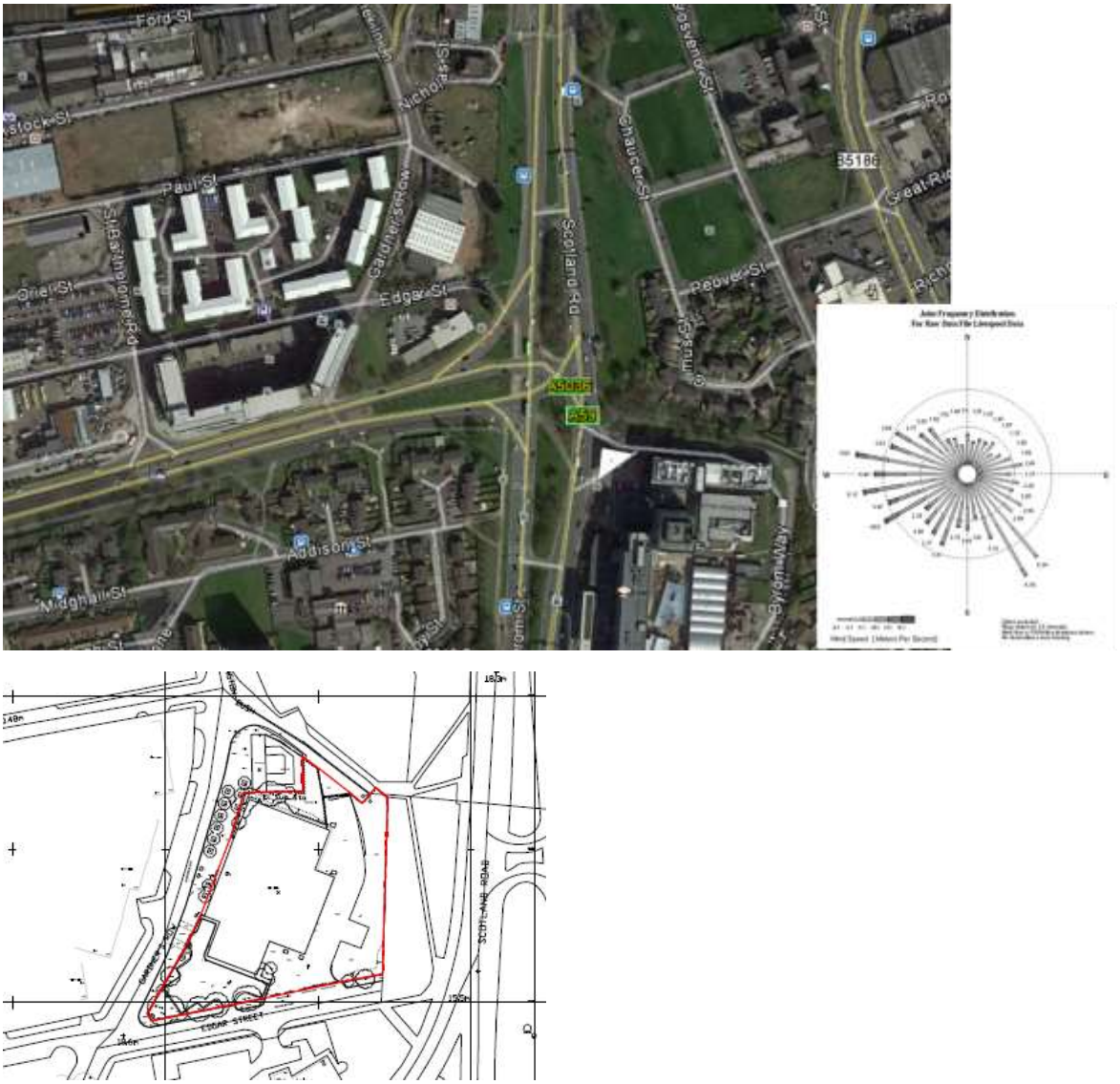

Figure 3—2 Site view from above (Site wind rose overlaid), Proposed development location show by red line.

3.2 Future baseline

Although climate change is currently expected to have significant impacts on a national level, wind conditions are not likely to change sufficiently to require specific analysis. No clear pattern of increasing strength or frequency of strong winds has thus far been identified. As such it is normal practice to assume that historical wind conditions give a good indication of the likely range of future conditions.

The general pattern of increased development in the city is likely to lead to a general increase in shelter and modest reduction in wind speeds in the area.

This means that the future baseline is the same as the current condition unless development takes place on site.

4 Assessment of impacts

4.1 Development proposals and incorporated mitigation measures

The massing proposal is shown below.

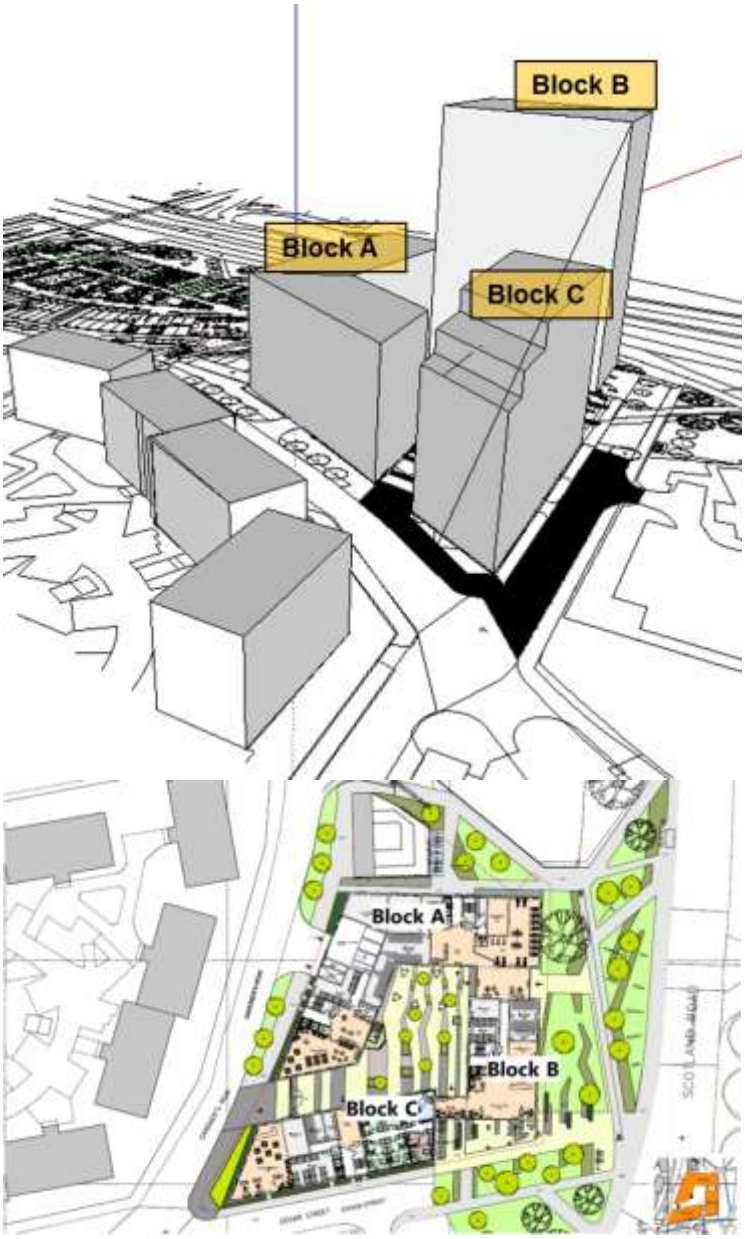

Figure 4—1 Building massing.

The initial massing in **Figure 4—1** shows the proposed development formed by three blocks A, B , and C split into 3 different buildings. Block A and C are 7 and 9 storeys respectively or lower and Block B has 15 stories. There is a courtyard in the middle of the massing.

4.2 Construction

There are no significant construction impacts, therefore no mitigation is required, however, standard construction mitigation measures will be implemented including standard site hoardings to shelter neighbouring areas.

4.3 Operation

The assessment above takes into account the effect of building massing in sheltering public spaces from strong winds. It does not consider the effect of landscaping and street furniture, which can be expected to further improve pedestrian conditions.

4.3.1 Westerly winds

Winds from the west are prevailing in Liverpool and will approach the site skimming over the development to the west of the propose site. Light façade downwash will be experience by blocks A and C west orientations. Wind acceleration is also likely to be felt at the Block C terraces, some façade downwash is likely to occur but winds are likely to skimmed over. This is likely to be minor adverse to negligible for walking activities along Gardner's Row. Some degree of funnelling is expected between Blocks A and C entrance to the courtyard, the effect of this wind acceleration is likely to negligible for general circulation areas in the perimeter of the building.

Block B however it is likely to create façade downwash as the main façade is orientated perpendicular to the prevailing winds see **Figure 4—2**. This is likely to cause wind acceleration within the courtyard, additional local perimeter protection is likely to be require and/or the location of a porous canopy or additional landscape trees directly below the façade downwash area. The façade downwash is also likely to affect the entrance to the building located to the southeast orientation. We cannot quantify with this study the degree of wind acceleration that will be experience at this location, it is likely to be moderate adverse for entrances and minor adverse for fast walking.

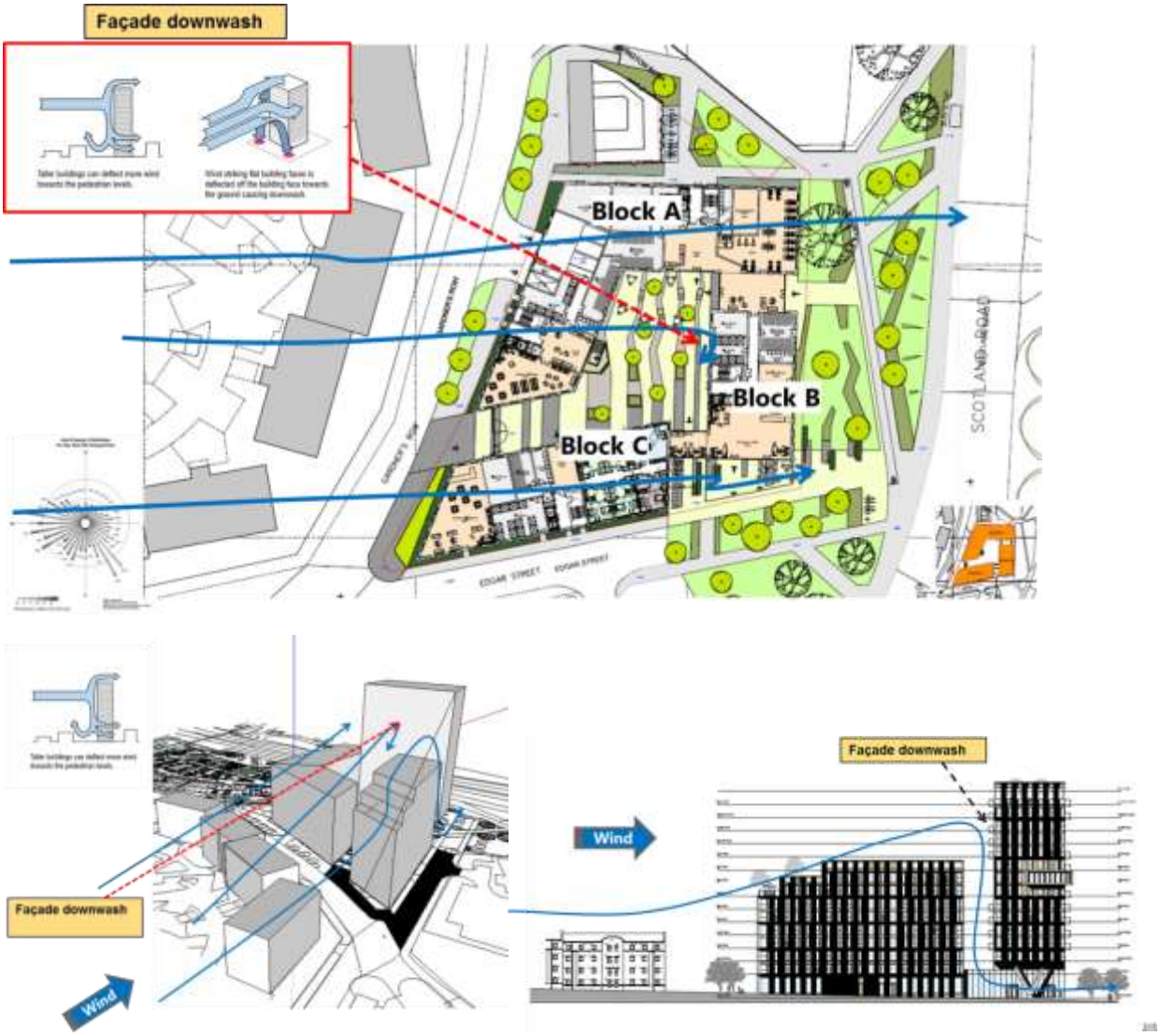

Figure 4—2 Westerly winds

4.3.2 South-westerly winds

Wind acceleration is also likely to be felt at the Block C western edge from this wind direction, this is likely to be minor adverse to negligible for walking activities. Some degree of funnelling is expected between Blocks A and C and the effect of this wind acceleration is likely to negligible to minor adverse for general circulation areas see **Figure 4—3** below.

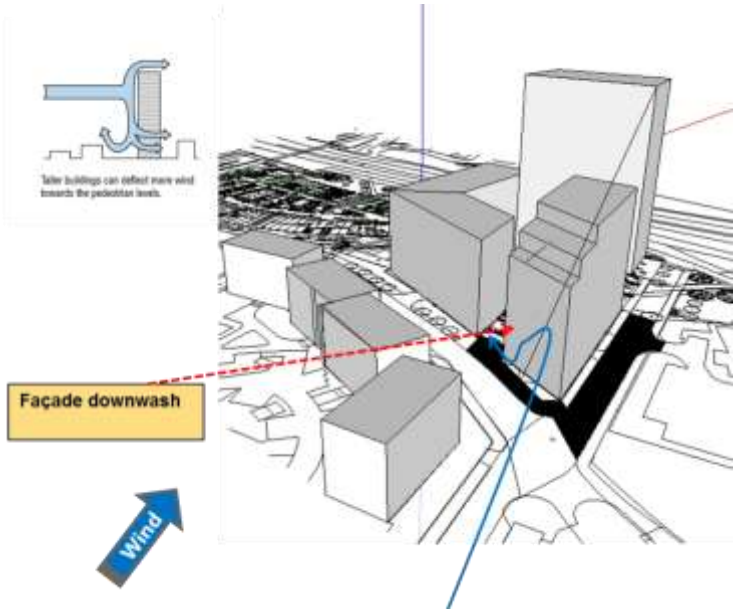

Figure 4—3 South-westerly winds

4.3.3 South-easterly winds

Some degree of façade downwash will be experience at the southeast of Block B during Winter and Summer. It is likely to affect the entrance, the effect is likely to be minor adverse to negligible for entrances See **Figure 4—4** below.

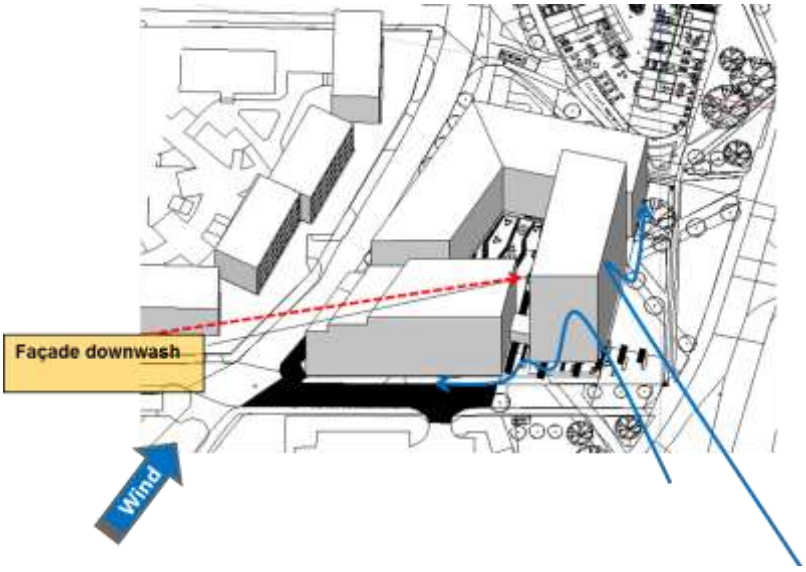

Figure 4—4 Main south-easterly winds effects

Northerly winds

Although the Blocks A and C are around 9 storeys it is not expected that large wind effects, there may be however some corner acceleration at the northwest corner of Block A. The impact on the wind comfort environment is likely to be negligible to minor adverse.

The proposed development brings into place new pedestrian activities like seating in public spaces for example, only leisure and business walking along major access routes. Conditions are expected to be suitable for this range of activities provided normal allowances are made, e.g. sheltering for seating areas, bus stops, etc.

The location of the courtyard is expected create exposure and a degree of wind acceleration. Within the site itself, conditions are expected to become more comfortable being suitable for pedestrian walking / strolling for much of the year. However the southeast of block B its likely to be exposed to wind acceleration.

The strongest local peak conditions will be stronger than those currently experienced on site. The expected operational impacts are summarised in Table 5 -1 below.

4.4 Supplementary mitigation measures

The assessment shows that without considering landscaping and street furniture, conditions in most areas can be expected to be suitable for the intended activities with the exception of the courtyard and the southeast corner for sitting/standing and entrances within these zones. Landscaping and street furniture are likely to further improve conditions relative to those shown in this report. The introduction of mitigation measures could help to reduce these impacts to minor adverse to negligible.

The landscape strategy is shown below. The landscape show that the perimeter areas have been provided with soft low and high landscape elements that are likely to help reduce wind acceleration at these locations and make the area suitable for diverse activities, like hedges at the west of block C and along Edgar Street. Tree and hedges have been also been provided within the courtyard. Additional landscape may be required as follows to reduce the effect of downwash:

- Set back of 1 to 2 meters of the entrance doors located at the southeast elevation of Block B
- Provide rotating doors at the southeast elevation of Block B.
- Trees or low hedge/bush provided close to the west façade of block B immediately below the area affected by façade downwash (See below Figure 4-7 area in green in right hand figure)
- A porous canopy at the west elevation will have a similar mitigate effects seen in Figure 4-7.
- A canopy at the southeast elevation may also be required (see figure 4-7).

Some low hedges have been provided to at the southeast orientation, however it is not possible to say at this stage if it will be sufficient to reduce façade downwash affecting the southeast entrance to the building. A canopy at this location may be required.

The northern perimeter has been provided with low and high landscape elements that are likely to help create a pleasant environment around the norther perimeter of the site.

Trees have been located to the south and west perimeters of Block A and C that are likely to be of benefit in reducing wind corner acceleration.

Figure 4—5 Current landscaping design

Figure 4—6 Location of additional mitigation measures.

5 Conclusions

This report provides an overview of the external wind conditions as they relate to pedestrian comfort and safety. The study covers the entire proposed development and it surroundings, to assess the impact of the wind flow around them.

Wind microclimate analysis was carried out for this stage of design, to determine the main impacts and allowing key recommendations to be incorporated in the landscape strategy. Within the site itself, large areas are expected to become comfortable with conditions suitable for pedestrian walking / strolling for much of the year, with the exception of the courtyard and the southeast corner of Block B where the entrance to the building is located. The strongest local peak conditions may be similar to those currently experienced across a larger area of the site.

Due to the height of the buildings (more than 10 storeys) that form the proposed development and the nature of the residual effects once landscape is put in place, as informed through the desk based assessment, it's considered further quantitative assessment (Computational Fluid Dynamics (CFD)/Wind Tunnel) should be carried out. This could be secured through an appropriate planning condition.

6 Significant residual impacts

Table 6—1 Summary of significant impacts

Receptor/Resource	Significant Impact	Mitigation	Residual effect
Pedestrians to neighbouring areas along surrounding streets	Negligible	None required	Negligible
Pedestrians/sitting areas within the courtyard	Moderate to minor adverse	Has been provided with low and high soft landscape. May require landscape elements to be located immediately below the areas affected by façade downwash and/or a porous canopy on the western elevation of Block B	Negligible (subject to further mitigation and modelling)
Entrances	Negligible. With the exception of the southeast entrance to block B where a moderate to minor adverse effect is expected	None required for most entrances. However, southeast entrance will require a setback, and/or a canopy to the west and around the southeast perimeter of block B and/or the addition substantial evergreen landscape	Negligible (subject to further mitigation and modelling)
Pedestrians walking along Garner's Row	Negligible to Minor Adverse	Has been provided with low and high soft landscape	Negligible

7 References

1) Lawson (2001) Building Aerodynamics, Imperial College Press.
2) The Designer's Guide to Wind Loading of Building Structures, Part 1 (1985), N.J. Cook.

Bernardo Vazquez
Buro Happold Limited
2 Brewery Place
Brewery Wharf
Leeds
LS10 1NE
UK

T: +44 (0)113 204 2200
F: +44 (0)870 787 4144
Email: Bernardo.Vazquez@burohappold.com

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