15 Wind and Microclimate

15.1 Introduction

BuroHappold was commissioned by the applicant to carry out a wind microclimate review and assessment as part of the planning application for the proposed Beorma Phase 2 and 3 development.

Around and within the project, pedestrians will require safe and comfortable use of entrances, sitting and general external spaces. In addition, recreational and amenity areas where people can stroll, stand or sit, need to be sheltered from high wind speed. Since high air velocities at pedestrian level are uncomfortable and can cause significant wind chill factors, it is desirable to keep the air velocity around the development to a minimum.

The principal purpose of this element of the EIA is therefore to assess whether or not the new structures and their configuration will give rise strong wind eddying effects and vortices that could be problematic for pedestrians on and around the site.

This section thus considers the impact of the 2015 proposed development on the wind microclimate of the site and surrounding area. Factors considered include methodology and criteria used to assess the wind environment around the existing site and the likely impact of the proposed development on the pedestrian wind environment.

It should be noted, however, that a Wind Tunnel assessment (WTA) was undertaken by RWDI Anemos consulting engineering in 2008 to predict and analyse the wind environment at the site and support the production of appropriate mitigation. The information is contained within the RWDI report R07-625-C PLW[Final] issue 30th of June 2008 and corresponding wind microclimate chapter 15 of the 2009 planning application[1] ES. The modelling undertaken was based on the fully developed scheme comprising development of all three phases as presently proposed, although the presently proposed Phases 2 and 3 differ to some degree from proposed development of those areas on the original scheme (not radically, however).

The information regarding the 2015 proposed development was provided by Broadway Malyan Architects. For ease of comparison between the 2009 and 2015 developments, the buildings for the two schemes are referred to for the 2008 consented scheme as buildings A, B and C that correspond to Phase 2, 3 and 1 buildings for the 2015 proposal respectively. In order to better appreciate the differences between the schemes (from a microclimate and

1 Environmental Statement Beorma Quarter, Salhia Investments Limited, ENVIRON UK Limited, January 2009

wind modelling perspective), the physical differences between the modelled 2008 scheme and proposed 2015 scheme illustrated below.

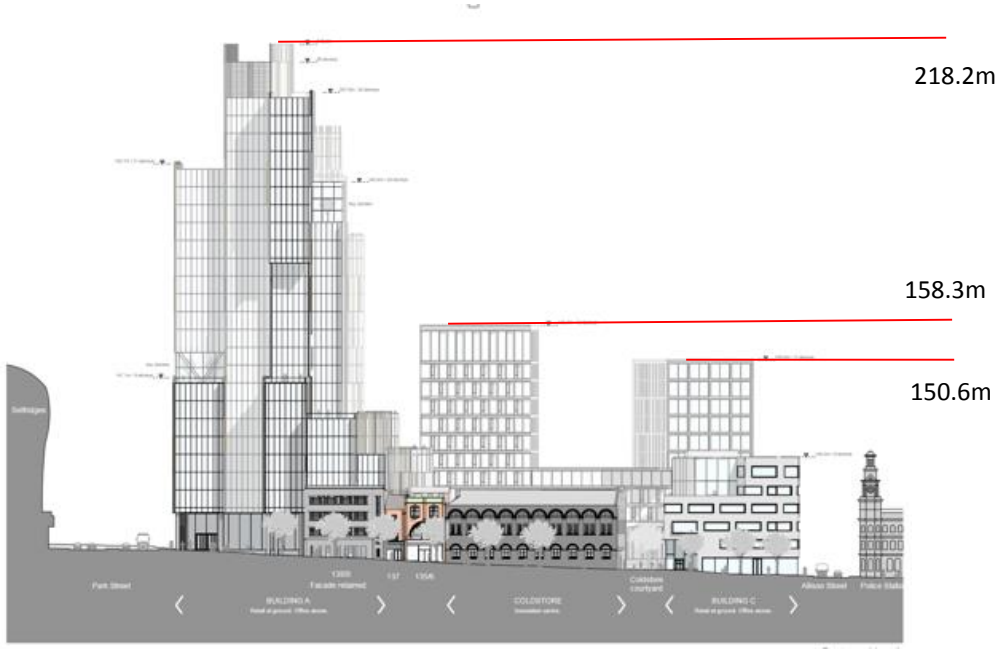

Figure 15.1a: *2009 Digbeth High Street Elevation (with tower heights)*

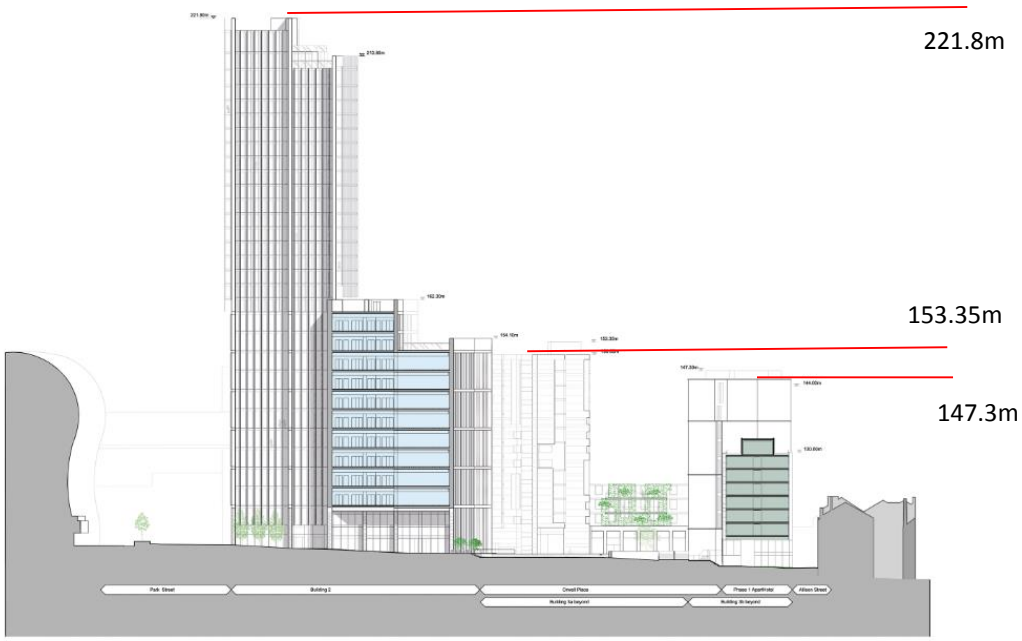

Figure 15.1b: *2015 Scheme Digbeth High Street Elevation (with tower heights)*

Figure 15.2a: *2009 Scheme Well Lane Elevation*

Figure 15.2b: *2015 Scheme Well Lane Elevation*

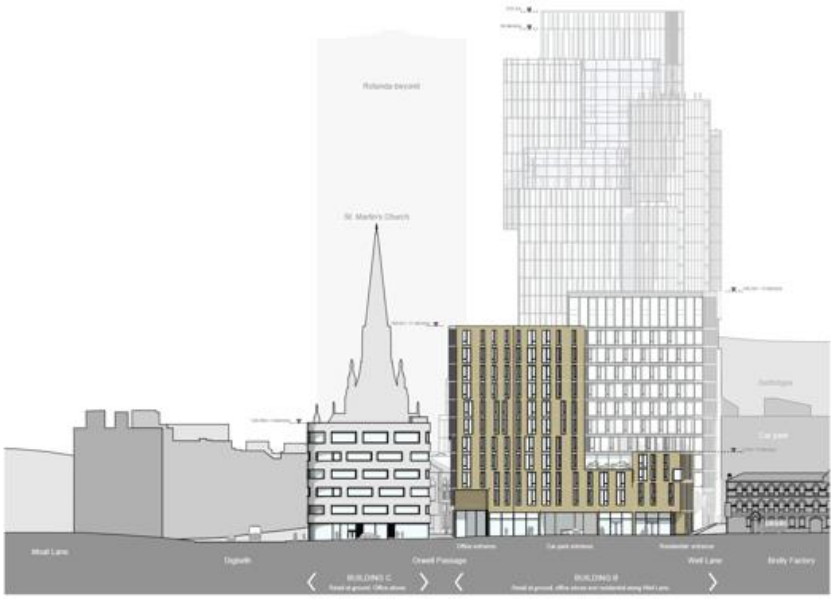

Figure 15.3a: *2009 Scheme – Allison Street Elevation*

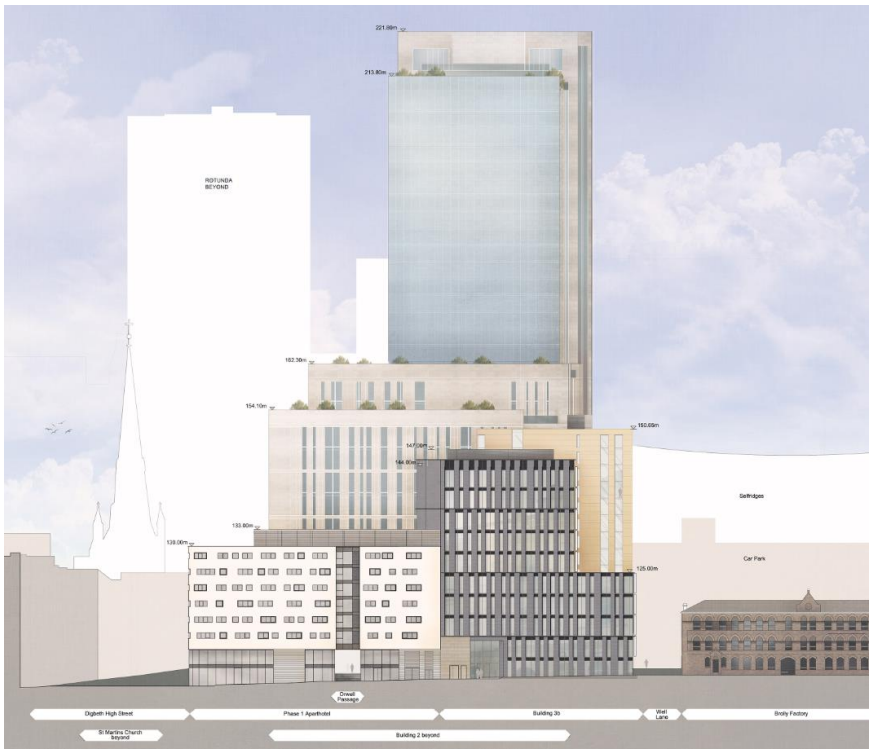

Figure 15.3b: *2015 Scheme – Allison Street Elevation*

As can be seen from the comparative elevations above the mass and form of the two schemes are broadly similar with there being a marginal increase in height of the main tower (by 3.6m) and a reduction in height of the second and third towers (again by a few metres). The main physical change is the slimming of the main tower and increase in mass of the lower storeys of Building 2 (compared to Building A on the original scheme).

In terms of the overall orientation of the building mass, it remains the same is likely to maintain minimal facade downwash.

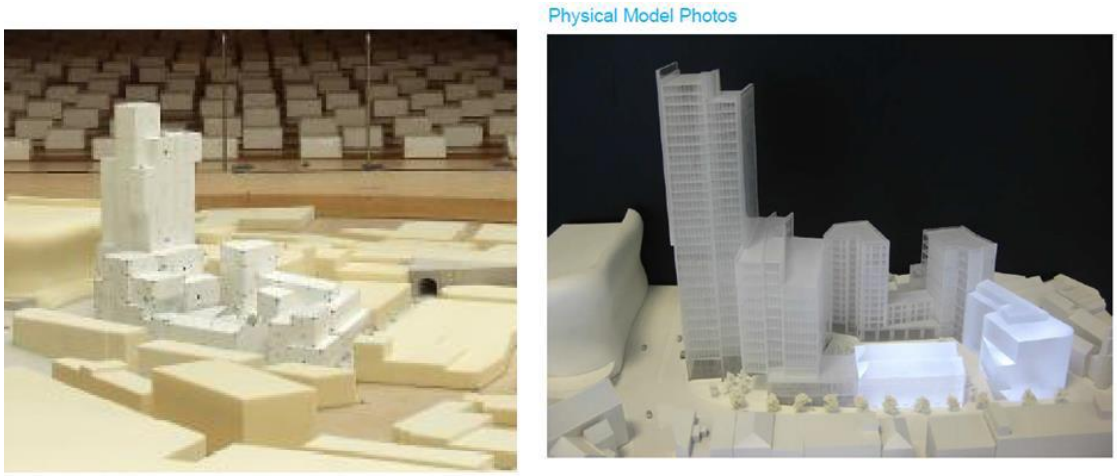

Figure 15.4: *Latest 2008 (left) and 2014 (right) proposal view from South.*

Given that at lower pedestrian levels there is fundamentally no significant difference between the general orientation and mass of the building blocks between the schemes, it has been concluded that the modelling data for the 2009 scheme can be applied to the revised scheme that is the subject of this 2015 application. As such the 2015 scheme has not yet been wind tunnel tested directly but shall be considered during detailed design.

15.2 Legislation and Policy Context

The legislative context is contained within the National, Regional and Local Planning Policy and Guidance which is described below.

15.2.1 National 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), 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.

15.2.2 Regional Policy

There is no specific 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.

15.2.3 Local Policy

A number of local authorities provide planning guidance for tall buildings, recommending that a wind microclimate assessment be performed. The definition of tall buildings in these documents varies, but typically includes any buildings which are significantly higher than their neighbours. Defined as 15 storeys-plus in *High Places*, (2) a 2003 council policy document, tall buildings in Birmingham run west to east through the city's central ridge, which includes its highest point. Within this document the assessment of microclimate is highlighted as part of the consideration of tall building the following;

"Other important considerations include: relationships with neighbouring buildings; overshadowing; impact on micro-climate; key views; sustainability and airport requirements."

15.3 Assessment Methodology and Significance Criteria

Around and within the development, pedestrians will require safe and comfortable access to the building and circulation areas. In addition, recreational and amenity areas where people can stroll, stand or sit, need to be sheltered from high wind speeds. Since high air velocities at pedestrian level are uncomfortable and can cause significant wind chill factors, it is desirable to keep the air velocity around the development to a minimum.

Utilising the frozen design information of the 2008 proposed development RWDI produced a scale model of 1:300 of the baseline and 2008 proposed development and their surroundings (*Figure 15.5*).

There was no soft landscaping, such as trees, included in the wind tunnel tests in order to obtain a conservative, *i.e.* relatively windy, set of results. Planting and landscaping measures are a useful means of mitigation as outlined in *Appendix 15* (RWDI-Anemos Report R07-625C PLW).

2High Places, a planning policy framework for tall buildings Birmingham City Council

Figure 15.5: *Wind tunnel test model (RWDI 2008[3]).*

Wind tunnel testing is the most well-established and robust means of assessing the pedestrian wind environment. The wind tunnel tests enable the pedestrian level wind microclimate at the Site to be quantified and classified in accordance with the widely accepted Lawson Comfort Criteria (Comfort Criteria). The wind tunnel tests deliver a detailed assessment of the mean and gust wind conditions around the existing Site and the proposed development for all wind directions in terms of pedestrian comfort and safety ratings.

The methodology for quantifying the pedestrian level wind environment is outlined below:

- **Step 1:** Measure the building-induced wind speeds at pedestrian level in the wind tunnel;
- **Step 2:** Adjust standard meteorological data to account for conditions at the Site;
- **Step 3:** Combine these to obtain the expected frequency and magnitude of wind speeds at pedestrian level; and

3 Birmingham Beorma Quarter Digbeth Development: Pedestrian Level Wind Microclimate Wind tunnel test results, Ingleby Limited. 30th June 2008 Project Reference R07-625-C PLW[Final]

- **Step 4**: Compare the results with the Lawson Comfort Criteria to 'grade' conditions around the Site.

The following scenarios were tested by RWDI:

- Baseline of the existing site without the proposed development; and
- Existing site with the 2008 proposed development.

Assessment Criteria

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

The pedestrian comfort and safety criteria have been developed around the Beaufort scale (Lawson Comfort Criteria), extending its applicability to environments in and around buildings.

RWDI's definition of the comfort categories of the Lawson Comfort Criteria has been described in the following sections.

Comfort Criteria

The criteria are set for six (*Table 15.1*) pedestrian activities and reflect the fact that less active pursuits require more benign wind conditions. The six categories are sitting, entering/leaving a building, standing, walking, business walking, and roadway/car-park and these are assigned letters F to A respectively. For each of these categories a threshold is defined, beyond which conditions are unacceptable for the stated activity. If the conditions are below the threshold then conditions are described as tolerable (or in lay terms suitable) for the stated activity. It is expected that tolerable conditions will not affect the amenity of a location, whereas unacceptable wind conditions will lead to pedestrians not using the site for its intended purpose and complaints of wind nuisance. An unacceptable result implies that remedial actions should be taken to mitigate wind conditions or that the proposed pedestrian activity at that location should be redefined.

Table 15.1: *Pedestrian Comfort Criteria (from RWD 2008 report)*

Wind speed & exceedence	4% B6	2% B6	6% B5	2% B5	4% B4	2% B4	6% B3	1% B3	6% B2	4% B2	50% B1	25% B1
Numbered Criterion	12	11	10	9	8	7	6	5	4	3	2	1

Description	Letter	Threshold
Roads and Car Parks	A	6% > B5
Business Walking	B	2% >B5
Pedestrian Walk-through	C	4% >B4
Pedestrian Standing	D	6% >B3
Entrance Doors	E	6% >B3
Sitting	F	1% >B3

Pedestrian Safety Criteria

The Lawson Comfort Criteria also specifies a lower limit safety criterion when winds exceed Beaufort Force 6. Notification of exceedence greater than one hour in the year is required. Exceedence of this safety criterion may indicate a need for remedial measures or careful assessment of the expected use of that location, *e.g.* it is reasonable to expect vulnerable pedestrians to be present at the location on the windiest day of the year.

The study additionally considered the potential requirement, if any, for further mitigation schemes at each location. Any potential areas that require further mitigation in order to create a wind environment sufficiently safe and comfortable for planned uses have been highlighted in the results. Other areas for which further wind mitigation schemes may be beneficial, for example to provide more amenable conditions for leisurely strolling, extend the suitability of seating areas into spring and autumn, or allow general leisure uses in areas mainly planned for access purposes, have also been indicated in the results.

Significance and Impact Criteria

The significance criteria defined below have been developed to help interpret the RWDI impact assessments.

Significant impacts that are considered to be of major significance for the purposes of this assessment are effects which impact on the safety of the receptors *i.e.* breaches the distress criteria described in *Table 15.2* and criteria used to assess the magnitude of the wind impacts are presented in *Table 15.3*. These types of impacts will require detailed and careful mitigation.

Moderate and minor impacts are not considered to cause significant effects, however, in order to reduce the impacts further and improve the comfort of receptors mitigation measures to reduce the effects from moderate to minor will be specified as appropriate.

Table 15.2: *Significance criteria*

Severity of Impact	Description
Major	Any impact that affects safety (or distress)
Moderate	Any impact affecting pedestrian comfort where conditions change from suitable for existing activities to unsuitable for the proposed activities be considered moderate and vice versa for positive impacts.
Minor	Conditions that are marginal with respect to the criteria or criteria are met during key seasons only.

Table 15.3: *Criteria determining magnitude of an impact*

Magnitude of Impact	Description
Adverse	detrimental or negative impacts to an environmental resource or receptor compared with the baseline condition
Beneficial	advantageous or positive impacts 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

This wind study includes a direct comparison between the baseline and the proposed development and describes the quantitative assessment of the likely wind environment. Qualitative judgements have been made in order to identify areas of potential concern. This analysis includes an assessment of the relative forms, layouts and massing of the existing site and the proposed development, as well as site landscaping and topography.

Impacts of the likely wind conditions for the 2015 proposed development are judged based on BuroHappold's extensive experience of wind assessments, full-scale testing, CFD and wind tunnel modelling of similar developments.

Further to the quantitative assessment of the two configurations, cumulative effects due to the proposed development and other future developments near the project site have been evaluated qualitatively.

Meteorological Data

The meteorological data for Elmdon (Birmingham Airport) indicate that the prevailing winds occurred from south-westerly directions throughout the year but with secondary prevailing winds from the north-east particularly during late spring and summer. *Figure 15.6* shows the seasonal wind roses for Elmdon.

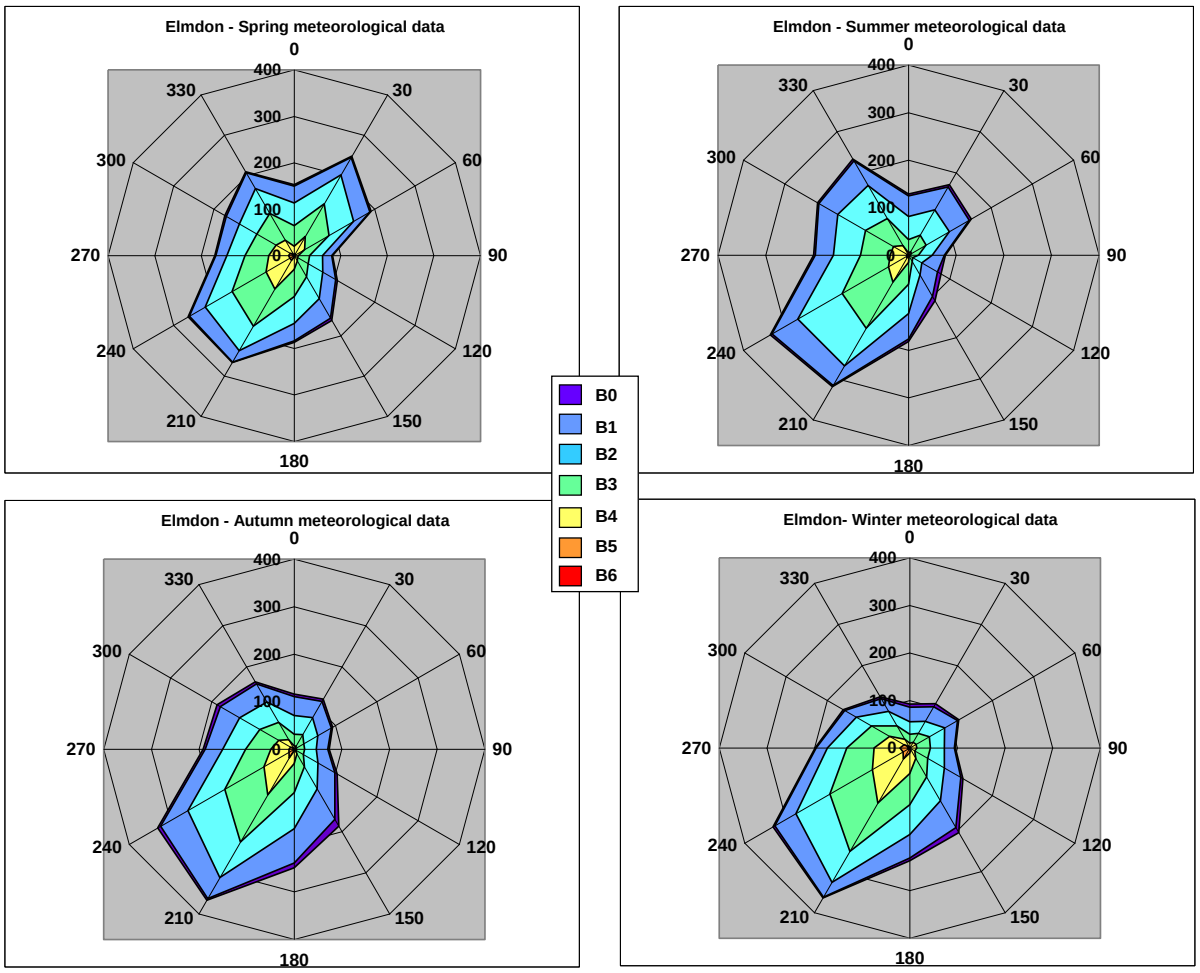

Figure 15.6: *Seasonal wind roses for Elmdon (in Beaufort Force).*

The adjustment of the meteorological data from open countryside terrain to the site was conducted using the BREVe2 software package which is capable of modelling the boundary

layer and changes to the flow characteristics caused by changes in the surface roughness. The results of this analysis are shown in *Table 15.4.*

Table 15.4: *BREVe2 Mean Factors for the Site*

Height (m)	Direction (degrees °)											
	0	30	60	90	120	150	180	210	240	270	300	330
10	0.57	0.58	0.60	0.58	0.57	0.58	0.58	0.57	0.58	0.59	0.58	0.58
150	1.29	1.31	1.35	1.29	1.29	1.29	1.30	1.29	1.31	1.33	1.32	1.31

This analysis indicated that the exposure of the site is relatively homogeneous in all directions and typical for an urban location.

Assumptions and Limitations

A qualitative assessment of the likely wind environment has been performed for the 2015 proposed development, based on the design and parameters, and judgements based on the experience of the wind engineer in similar projects were made in order to identify areas of potential concern. A wind tunnel assessment was carried out to support the 2009 planning application that did not include testing mitigation measures and is thus considered to be a conservative scenario.

15.4 Baseline Conditions

The baseline condition was assessed during the 2008 wind tunnel test and has not been reviewed further. In summary the conditions for the baseline were suitable for entrance/standing even during the windiest season. Only two locations show conditions appropriate for leisure walking.

Baseline conditions identified in the 2008 RWDI report are described below.

15.4.1 Existing Wind Conditions at the Site

The existing low-rise buildings are partially sheltered by the surrounding buildings. *Figure 15.7* and *Figure 15.8* summarise the measured results for the existing site for the worst-case season (winter) and summer, respectively.

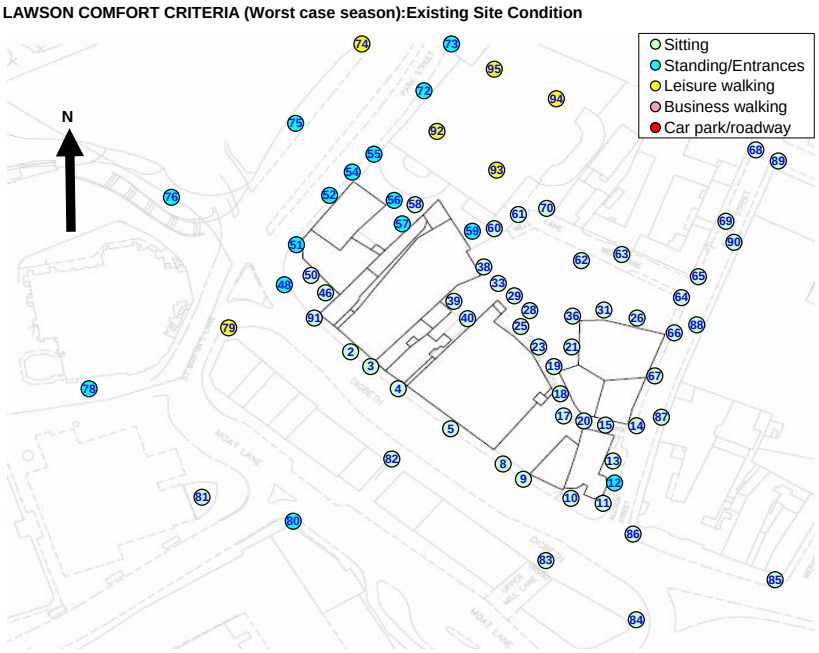

Figure 15.7: *Lawson Comfort Criteria for Existing Site Condition – Worst Case*

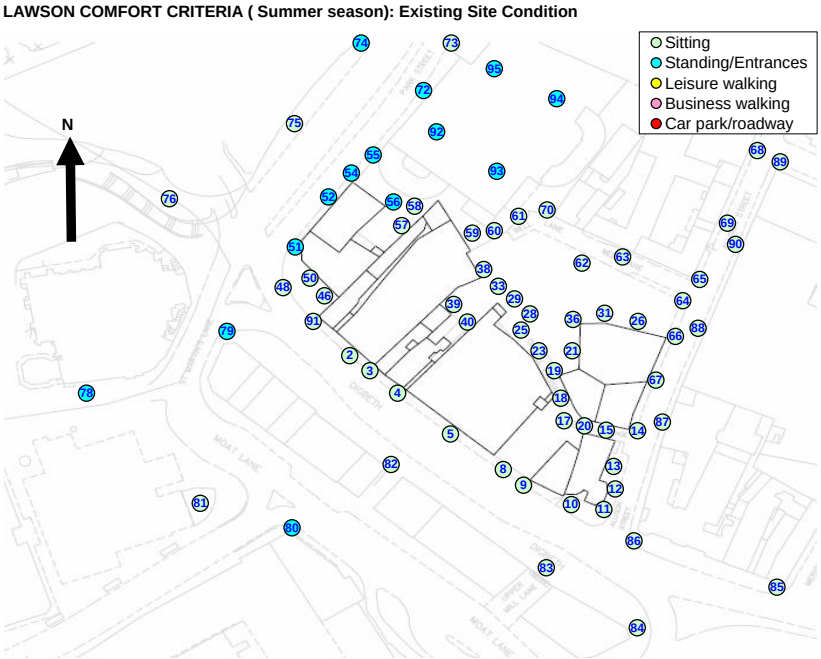

Figure 15.8: *Lawson Comfort Criteria for Existing Site Condition – Summer Season*

With regards to pedestrian comfort, the existing site wind conditions at ground level are suitable for standing or better during the windiest season. Hence, all the entrances to the existing buildings are expected to be suitable for pedestrians entering or leaving the buildings. All the thoroughfares around the existing building are suitable for leisure walking or better. In the summer season, within the existing site, winds are generally lighter and suitable for standing or better.

For the existing site, the wind conditions at all the measured locations are safe for pedestrian use and unlikely to generate nuisance. Conditions in the immediate surrounds of the Site are generally suitable for standing/entrance or better during the windiest season (winter). There are two exceptions to that, to the north and west of the Site (Locations 74 and 79), suitable for leisure walking during the winter season. In the summer season wind conditions in the surrounds of the site are generally suitable for standing or sitting.

The wind microclimate on the roof-top car park to the north of the site is suitable for leisure walking during the windiest season (locations 92 to 95). This implies that the wind conditions are suitable for the intended pedestrian usage of this area, involving access to and from vehicles.

15.5 Assessment of Project Impacts

15.5.1 Construction

It is possible that during construction of the new development there will be temporary localised wind acceleration across the Site. Since the effects are short-term and local, and the normal sheltering from standard site hoardings is expected to be sufficient, ***negligible impacts*** are expected.

During construction, localised wind acceleration is likely to result in a gradual transition to the new conditions. Impacts from this will be negated at ground level through the provision of hoardings (causing negligible impacts).

No public will be allowed on the site during the construction phase and site health and safety risk assessments should take account of potentially strong wind conditions and hazards therein on construction sites.

15.5.2 Operation

This section discusses the impact of the new development on the site. Comparisons are made with the baseline and qualitative conclusions are drawn based on the latest design proposal. The following chapter deals with mitigation proposals to further improve conditions on site.

The 2009 and latest 2015 design proposal can be seen in *Figure 15.9*. This latest option has not yet been wind tunnel tested and shall be considered during detailed design. However we make reference throughout this section to the wind tunnel assessment of the 2008 proposed development, to draw qualitative conclusions on the latest design proposal.

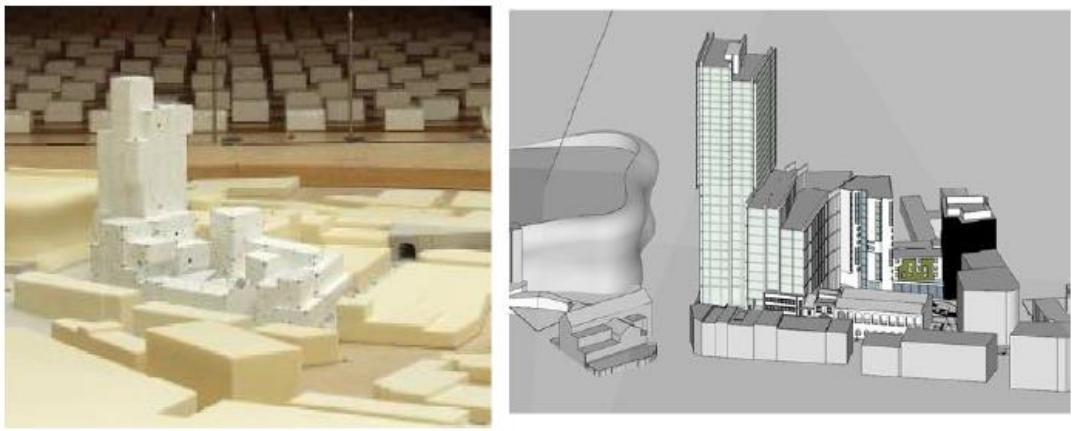

Figure 15.9: *2008 (left) and latest 2014 (right) proposal view from South*

The summary of the findings of the 2008 study for the operational phase of the proposed development was as follows:

- Wind conditions at all the measured locations were shown to be safe except four points at ground level (55,56,94,92) and five terrace (96,97,98,99,100) and need to be mitigated. With regards to pedestrian comfort, wind conditions within the site were suitable for standing/entrance or better (see Figure 15.10, Figure 15.1 below). Wind conditions in the immediate surround of the site were suitable for leisure walking or better during the windiest season (winter). This was considered in keeping with the intended pedestrian use of these locations;
- The study was tested without landscape and represents a conservative scenario;
- The impact for most locations at ground level was shown to be negligible to minor beneficial;
- Five entrances were found to have an adverse impact and mitigation was recommended in the form of local shelters; and
- Terraces were found to have an adverse impact and local mitigation was recommended.

The principal change from the 2008 proposals is that Building A plan area has increased in size and the height has increased from 96m to 108m. The lower section of building A has also increased in height by around 5 floors from level 6 to level 11.

It is likely that the overall effect for the two proposed schemes (2009 and 2015) are going to be very similar. The peak conditions are likely to be present at the same locations identified during the 2008 WTA as follows:

- Wind conditions at Saint Martin's place and Saint Martin's passage (cantilever) are likely to be worse and will require further quantitative assessments during detailed design;
- Wind conditions around the former location of the JFK Memorial are likely to be worse and will require further quantitative assessments during detailed design;
- Building B and C have creased in height but the impact on the wind climate is likely to be similar to the 2008 proposed development;
- With regards to comfort, due to the relatively strong wind conditions most areas are likely to feel windy during the worst season. However during summer most of the site is likely to be suitable for planned activities; and
- Terraces are at a higher level on the 2015 proposal which is likely to reduce the wind speeds as the facade downwash is likely to be less.

When the two above scenarios are compared with the baseline, it can be observed that the overall windiness of the site has increased for some locations, but this is marginal when compared with the baseline. For some areas of the site the pedestrian activity has also changed, therefore in these areas the increase in wind speed may be counteracted by the change in expected activity. The increase in windiness is mainly due to the massing of the building that has evolved through the planning process.

The presence of the development is expected to produce localised regions of increased wind speeds within the site. Because the development represents a change in the intended usage of the site, activities need to be closely link to the comfort criteria for evaluation of impacts. Appropriate mitigation measures can serve to reduce the severity of these impacts and associated effects to protect key receptors (*i.e.* pedestrian routes, access points, amenity areas and outdoor seating areas *etc.*) till the final effects are considered to be not significant.

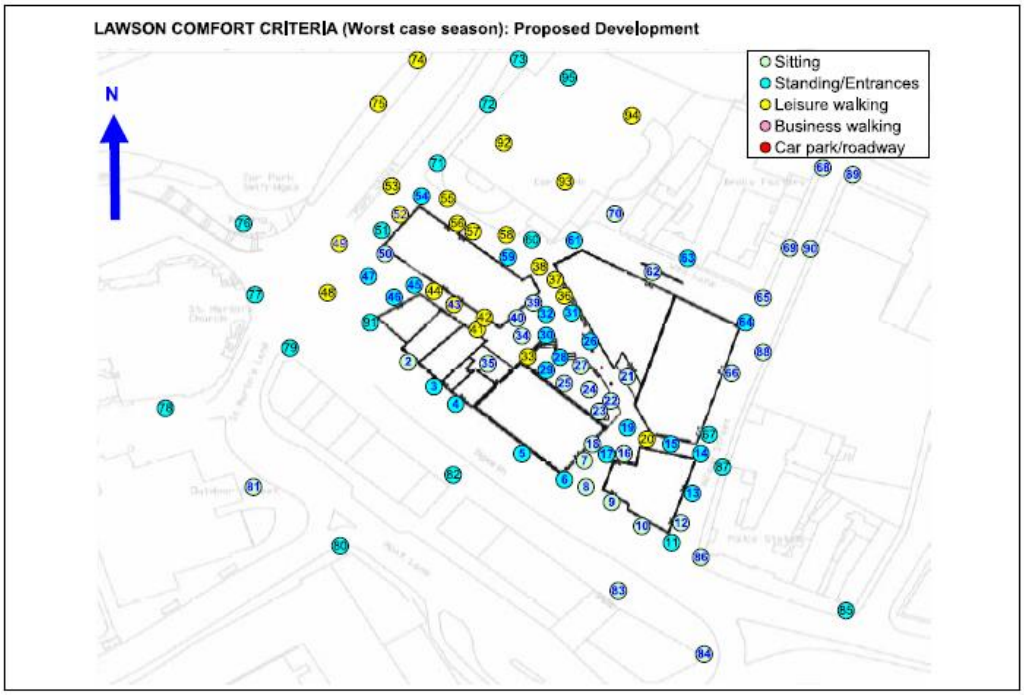

Figure 15.10: *Worst season wind tunnel results for the proposed development*

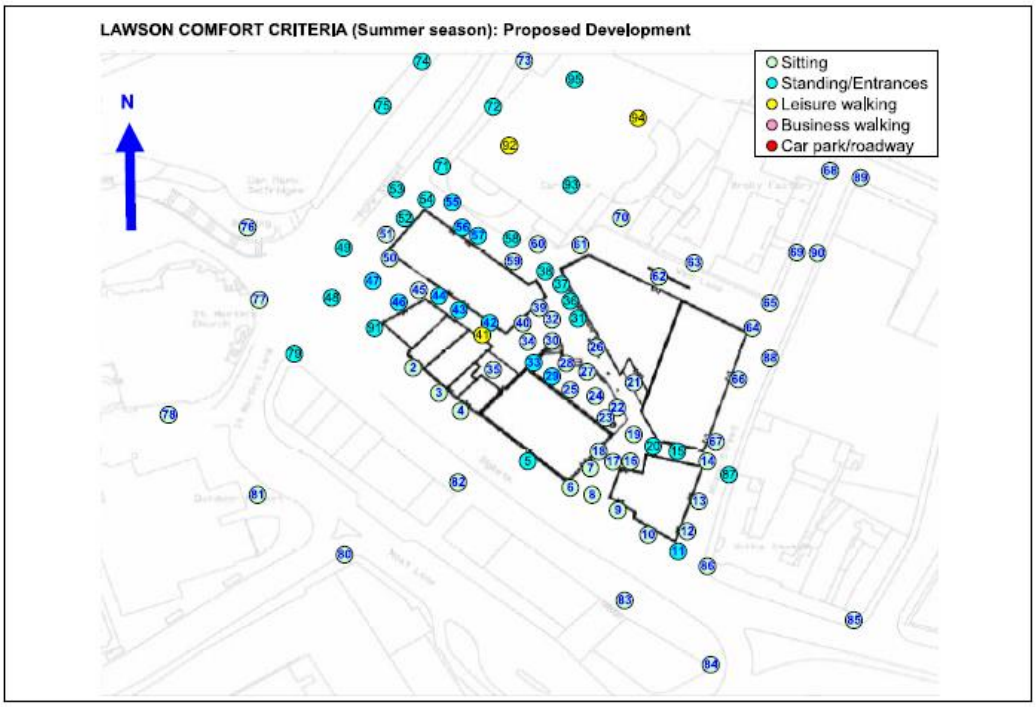

Figure 15.11: *Summer wind tunnel results for the proposed development*

15.6 Assessment of Cumulative Impacts

No future developments are known to exist or be planned in the immediate proximity that are likely to modify the local wind conditions and cumulative impacts are not anticipated.

15.7 Impact Mitigation and Residual Effects

15.7.1 Construction

There are ***no significant construction impacts*** predicted therefore no other mitigation is required apart from standard construction mitigation measures that are implemented including standard site hoardings to shelter neighbouring areas.

15.7.2 Operation

Areas surrounding the proposed development could potentially experience increased wind speeds. The application of supplementary mitigation methods is particularly important in these areas, as it is possible that these areas could produce conditions that are likely to exceed the distress criterion at pedestrian level for high wind speeds. Therefore Local mitigation is proposed to reduce windiness to appropriate levels for the activities in the perimeter of the building and surroundings. Also the recessing or screening entrances on these areas of the site would generate a buffer zone directly in front of these. These measures are recommended to be further developed and wind tunnel tested.

With appropriate supplementary mitigation, it is considered that the areas surrounding and within the development will have no significant residual wind effects; this is likely to be ***negligible.***

15.8 Summary

The wind tunnel tests were carried out to assess the wind environment surrounding the 2009 proposed development. The assessment indicates that conditions at the perimeter of the building and surrounding areas are likely to feel windier and in some locations minor adverse is expected for the planned activities. The increase in windiness is mainly due to the shape and height of the proposed building that has evolved through the planning process.

Local mitigation was proposed to reduce windiness to appropriate levels for the activities in the perimeter of the building and surroundings. Also the recessing or screening entrances on the these areas of the site would generate a buffer zone directly in front of these, these mitigation was not tested.

The 2009 and 2015 proposed developments were assessed by means of a qualitative assessment and the findings of the study suggest that the wind effects overall are likely to be very similar. It is likely the 2015 proposed development will experience slightly windier conditions, and the peak conditions are likely to be experienced at the same locations as highlighted by the 2008 WTA.

Based upon the appraisal of wind and microclimate impacts discussed above, the residual impacts associated with the **Construction Phase** are deemed to be of **LOW** significance and short-term and temporary in nature. The residual impacts associated with the **Operational Phase** are deemed to be of **LOW** significance and long-term or permanent in nature.