10.0 EFFECT ON THE ENVIRONMENT: Wind.

10.1 Introduction.

10.1.1 This chapter has been prepared by Malone O'Regan and RWDI Anemos and identifies the possible wind effects generated as a result of the proposed development which could potentially affect both existing and future sensitive receptors. This chapter of the EIS also identifies mitigation measures required to minimise wind effects.

10.2 Assessment Methodology.

10.2.1 A desk-top study has been carried out by RWDI Anemos (contained in Appendix 10.1) who have extensive experience and expertise in the way in which wind interacts with the built environment. In this regard, they have reviewed the current meteorological conditions using data from Dublin Airport and applied this to the existing built environment to describe the wind microclimate and suitable uses. The layout, proposed building heights and massing for Zones 1 and 2, which are closest to existing receptors and which represent areas of greatest building density, were reviewed to determine the main flow interactions affecting the development and how these might then affect pedestrian comfort. The Lawson Comfort Criteria, a generally accepted measure of assessment, are used to quantify the wind conditions.

10.2.2 A worst case scenario in terms of potential building heights was assessed for the purposes of this chapter. Accordingly, the heights stated or illustrated in this chapter and associated appendix may be slightly higher than those listed in the planning scheme documentation or elsewhere in this document.

10.2.3 The proposed buildings along the southern shoreline are low rise and therefore not included in the study.

10.2.4 Pigeon House Dock was excluded from this study as the wind conditions, proposed heights, and especially suggested mitigation measures, were considered equally applicable to this area as to Zones 1 and 2 where the desk top study was undertaken.

10.2.5 No wind tunnel testing has been carried out as initial assessments indicated that this was not required.

10.2.6 BS6399 Part 2: 1997 is the code of practice used for the assessment of wind effects on buildings in the UK. This standard concentrates on wind loading issues and is therefore not within the scope of this assessment.

10.2.7 Evaluative Criteria for Reviewing the Effects of Wind.

Pedestrian Comfort Criteria.

10.2.7.1 The Lawson Comfort criteria are regularly used to describe wind conditions at a site in terms of annoyance or reaction. Lawson[1] devised a twelve-point scale to represent equal increments of annoyance or reaction to the wind and these were then used to set threshold values for particular pedestrian activities. The criteria account for the fact that the wind conditions perceived as tolerable by pedestrians depend on the activity they are engaged in. For example, wind conditions in an area designated for sitting need to be more benign than a location that people merely walk past. In total six pedestrian activities are described in Table 10.2.7.1 in ascending order of activity: sitting, entrances, standing, leisure walking, business walking and roadways/car parks. Table 10.2.7.2 summarises the Beaufort Land Scale and quantifies the wind speeds associated with each Beaufort Range.

Table 10.2.7.1 Lawson Comfort Criteria

DESCRIPTION	LETTER	THRESHOLD
Roads and Car Parks	A	6% > B5
Business Walking	B	2% > B5
Leisure Walking	C	4% > B4
Pedestrian Standing	D	6% > B3
Entrance Doors	E	6% > B3
Sitting	F	1% > B3

[1] T.V. Lawson, 'Building Aerodynamics', Imperial College Press, © 2001

Table 10.2.7.2 The Beaufort Land Scale

BEAUFORT FORCE	HOURLY-AVERAGE WIND SPEED (m/s)	DESCRIPTION OF WIND	NOTICEABLE WIND EFFECT
0	< 0.45	Calm	Smoke rises vertically
1	0.45 - 1.55	Light Air	Direction shown by smoke drift but not by vanes
2	1.55 - 3.35	Gentle Breeze	Wind felt on face; leaves rustle; wind vane moves
3	3.35 - 5.60	Light Breeze	Leaves & twigs in motion; wind extends a flag
4	5.60 - 8.25	Moderate Breeze	Raises dust and loose paper; small branches move
5	8.25 – 10.95	Fresh Breeze	Small trees, in leaf, sway
6	10.95 - 14.10	Strong Breeze	Large branches begin to move; telephone wires whistle
7	14.10 - 17.20	Near Gale	Whole trees in motion
8	17.20 - 20.80	Gale	Twigs break off; personal progress impeded
9	20.80 - 24.35	Strong Gale	Slight structural damage; chimney pots removed
10	24.35 - 28.40	Storm	Trees uprooted; considerable structural damage
11	28.40 - 32.40	Violent Storm	Damage is widespread; unusual in the U.K.
12	> 32.40	Hurricane	Countryside is devastated; only occurs in tropical countries

Pedestrian Safety.

10.2.7.2 The Lawson Criteria also specify a lower limit safety criterion when winds exceed Beaufort Force 6. If this safety criterion is exceeded then there may be a need for mitigation measures or a careful assessment of the expected use of that location, e.g. is it reasonable to expect vulnerable pedestrians (i.e. elderly & children) to be present at the location on the windiest day of the year? Experience has shown that occurrences of business walking and roadway wind conditions are associated with wind speeds in excess of the Beaufort 6 safety criterion and therefore pedestrian safety as well as comfort should be considered if such conditions occur.

10.3 The Receiving Environment.

10.3.1 It is often the case that a new development dramatically alters the pedestrian activity on site and consequently a comparison of the original wind conditions with those on the developed site can be meaningless. For example wind conditions currently suitable for pedestrian (leisure) walking and which remain suitable for pedestrian walking after development leads to the conclusion that there is negligible impact due to the development. However, if following new development the location of interest is outside

a main entrance then the impact is adverse and will require remedial action. This is an important consideration when defining and applying baseline conditions.

10.3.2 The Current Wind Conditions on Site.

10.3.2.1 Analysis of the meteorological data for the existing open site (Zones 1 and 2) indicates that the existing conditions at ground level on site are likely to be tolerable for leisure walking use. The implication of this result is that, after development, if the site has a number of locations where the conditions are tolerable for (say) business walking, then these are likely to be perceived to be 'windy' relative to general conditions in the area.

10.3.2.2 It is noted that most urban sites, whether in central Dublin or central London tend to have an 'open site' classification that is suitable for standing/entrance use because of the shelter provided by the building in all directions. The Poolbeg site is therefore a relatively windy site.

10.3.3 The Current Wind Conditions around the Site (on neighbouring properties).

10.3.3.1 It is desirable, as part of a good neighbour policy, to minimise adverse changes to the wind conditions on neighbouring buildings due to a development. Generally, development (in terms of building additions or removals) may lead to increased wind speeds on adjacent properties for some wind directions but increased shelter for other directions.

10.3.3.2 As the existing location (Zones 1 and 2) is mostly open, it is not expected to provide shelter to neighbouring properties.

10.3.4 The Desired Pedestrian Activity around the Site.

10.3.4.1 The proposed scheme in Zone 1 and 2 is for mixed use. Therefore, conditions suitable for leisure walking during the worst-case season on pedestrian thoroughfares, with standing/entrance conditions at main entrances and in retail areas, and sitting at outdoor seating and amenity areas during the summer are applicable.

10.3.5 Comparison of the Wind Conditions with the Desired Conditions.

10.3.5.1 In the assessment of the proposed development, comparison is made between the wind conditions expected on the developed site and the desired wind conditions. This is generally the most useful baseline for comparison because it indicates whether the wind conditions are suitable for the intended pedestrian activity at a location.

10.4 Relevant Characteristics of the Draft Planning Scheme.

10.4.1 The tallest buildings within the scheme (assessed as a worst case scenario) range between 42m to 60m in height and are concentrated around the Urban Square at the centre of Zone 1 and on the east corner and along the south elevation of the IGB Development and Fabrizia Site. The rest of the buildings within Zone 1 are of variable height but would generally be considered to be low-rise units (in terms of wind assessment). Zone 2 consists of a row of low-rise buildings along South Bank Road. At ground level, the open areas around the buildings are expected to be used as thoroughfares; however there are a number of courtyards and public realm spaces in-between and even within the individual building plots. A 3D image of the development as assessed is presented in Appendix 10.1, Figure 3 to illustrate the variation in height of the buildings within the proposed scheme.

10.5 Likely Impact of the Draft Planning Scheme.

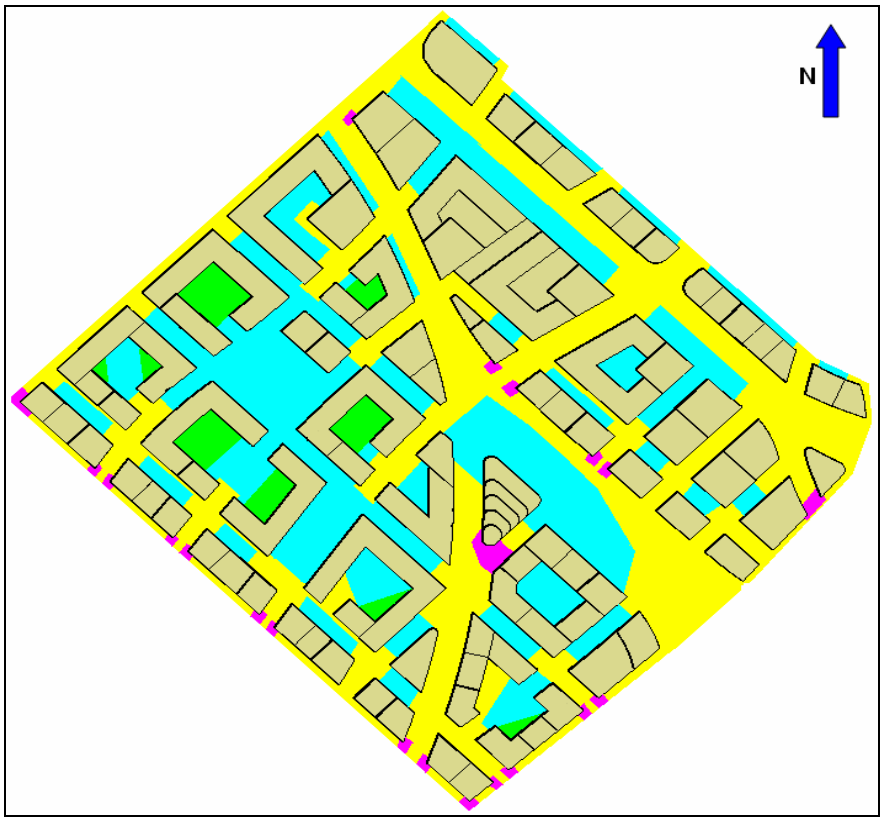
10.5.1 Wind Conditions Around the Proposed Development

10.5.1.1 The overall assessment for the site is presented in Figure 10.5.1.1. The shaded areas show the expected pedestrian usage, during the windiest season, for which the wind conditions are suitable as defined by the Lawson Comfort Criteria (Table 10.2.7.1). During the summer it is expected that the wind conditions to be one category less windy than predicted in Figure 10.5.1.1. For example, this means that the yellow areas in 10.5.1.1 would become blue and suitable for standing/entrance use. In the assessment it has been assumed that there is no landscaping or planting around the development in order to obtain a set of conservative, i.e. relatively windy, results.

10.5.2 Windiest Areas on Site

10.5.2.1 The windiest conditions are expected around the buildings corners exposed to the prevailing south-westerly and/or south-easterly winds, primarily along the south-western and south-eastern perimeter of the Proposed Development. These corners (highlighted in pink in Figure 10.5.1.1) are expected to experience business walking conditions during the worst-case season (winter). During the summer, the wind is generally calmer and these corners are expected to be tolerable for leisure walking.

Figure 10.5.1.1 Expected Worst Case Lawson Comfort Criteria – Indicative Proposed Development (No mitigation).



Note: colour denotes suitability according to Lawson Criteria

yellow = leisure walking, pink = business walking; turquoise = standing/entrances; green = sitting

10.5.3 Overall Assessment

10.5.3.1 In general, the wind microclimate of the proposed scheme is expected to be relatively calm and suitable for a range of uses from sitting to leisure walking, but suitable for business walking at the most exposed building corners. The wind conditions at most areas within and around the development are considered to be in keeping with the desired pedestrian use of these areas.

10.5.3.2 There are a number of building corners (pink areas in Figure 10.5.1.1) where the expected conditions are suitable for business walking during the worst case season (winter). Local residents will be acclimatised to the general windiness in Dublin, which increases their tolerance of windy conditions, and so might justify a business walking classification in some areas during the windiest season. However, the business walking classification is associated with occasional strong winds during the windiest season and these conditions are one category windier than we would generally recommend for a thoroughfare. For this reason, the corner zones, highlighted pink in Figure 10.5.1.1, would benefit from mitigation to address the potential for strong winds during the winter. Suitable mitigation is described below.

10.5.3.3 Any entrances located in areas where the expected conditions are suitable for leisure/business walking (yellow/pink areas in Figure 10.5.1.1) are windier than desired, and mitigation is required. Suitable mitigation is described below.

10.5.3.4 Any areas intended for amenity/outdoor seating (i.e. within the Urban Square and Cascade) where the expected summertime wind conditions are windier than sitting require mitigation, and suitable mitigation is described below.

10.5.3.5 During the summer season the wind microclimate is generally calmer, and conditions are expected to improve. The overall conditions on site are expected to be suitable for a range of activities from sitting (in the more sheltered areas) to leisure walking.

10.5.4 Existing Residential Receptors

10.5.4.1 The proposed development of Zones 1 and 2 is expected to provide partial shelter to neighbouring properties to the northwest and northeast of the site, and to the River Liffey to the north.

10.5.4.2 The development may increase windiness along the northern boundary of Sean Moore Park where the prevailing south westerly winds blow. The on-coming winds are likely to be brought down by the new development and directed through the Park in contrast to what is expected to currently happen with the relatively open nature of the IGB site, where the winds would blow over the park before continuing on over the existing site. However playing conditions are unlikely to be affected because tolerance to wind is higher when involved in rigorous activity. Mitigation in terms of landscaping described in Section 10.6.2.1 below can reduce the wind environment to acceptable levels along the northern boundary of the Park if for example seating were proposed along the northern boundary of the Park. Accordingly there will be no issue with wind shear at Sean Moore Park which has been raised as a concern by local residents.

Construction Phase

10.5.4.3 There is likely to be no wind impact. See operational phase comments above.

'Do Nothing' Scenario'.

10.5.4.4 It is likely that existing residents would experience wind conditions currently experienced in and around the peninsula.

10.6 Mitigation.

10.6.1 Construction Phase

10.6.1.1 There is no mitigation necessary for the construction phase.

10.6.2 Operational Phase

10.6.2.1 In the assessment above, it has been assumed that there is no landscaping or planting around the development. However, planting and other landscape enhancements will increase the shelter within the development compared to the expected wind conditions

described above, particularly when trees and plants are established and in full leaf. This is especially true during the late spring and summer seasons, when the trees are in full leaf, and pedestrian activity requires calmer wind conditions. However, wind conditions within and around the site are expected to be generally suitable for a range of activities from business walking to sitting, and most locations have a wind microclimate which is in-keeping with the intended pedestrian use of the area.

10.6.2.2 According to RWDI Anemos, business walking conditions will be associated with exceedence of the Beaufort Force 6 distress criterion which implies strong winds during the windiest (winter) season on occasion. The business walking classification is intended to represent zones where pedestrians are unlikely to linger and the areas identified as suitable for business walking are at building corners on pedestrian thoroughfares where this classification may therefore be acceptable. Local residents will be acclimatised to the general windiness in Dublin, which increases their tolerance to windy conditions, however, the corner zones would benefit from mitigation to address the potential for strong winds during the winter. Suitable landscape planting and/or screening at street level would displace strong winds above head level, sheltering pedestrians and achieving the desired leisure walking conditions throughout the year.

10.6.2.3 Should entrances be situated in areas where conditions are expected to be windier than standing/entrance conditions, mitigation in the form of recessing or screening is recommended. Recessing or vertical screening these entrances would create a sheltered buffer zone, allowing pedestrians entering/leaving the building to gradually pass from the “controlled” internal environment to the windier open space. Alternatively, relocating the entrances to a more sheltered location (marked by the green or blue shading in Figure 10.5.1.1) is expected to achieve the desired standing/entrance conditions. If there are entrances in areas where the wind microclimate is classified as suitable for business walking then this two-category difference in the desired and actual wind conditions is unlikely to be adequately addressed by the simple recess/screen options described above and relocating the entrance is the preferred course of action.

10.6.2.4 No further mitigation is considered necessary in order to achieve the desired wind microclimate within Zones 1 and 2. It should be noted however, that the desk-based

wind microclimate assessment provided for the Draft Planning Scheme of Zones 1 and 2 in Poolbeg, Dublin is intended to provide general guidance on the likely wind microclimate throughout the Masterplan. Wind tunnel testing is recommended upon the detail design of individual developments within Areas 1 and 2 as part of the S25 application process, for relatively tall buildings (i.e. 15 storeys or taller) to ensure that the comfort and safety criterion is complied with.

10.6.2.5 Appendix A of Appendix 10.1 contains general comments with regard to wind in the built environment.

10.7 References.

T.V. Lawson, 'Building Aerodynamics', Imperial College Press, © 2001

10.8 Appendices.

Appendix 10.1 - Dublin Docklands Development Authority, Draft Planning Scheme, Poolbeg Dublin, Wind Microclimate Desk Study, RWDI Anemos Consulting Engineers, October 2008.

Appendix 10.1.

Wind Microclimate Desk Study

RWDI Anemos Consulting Engineers

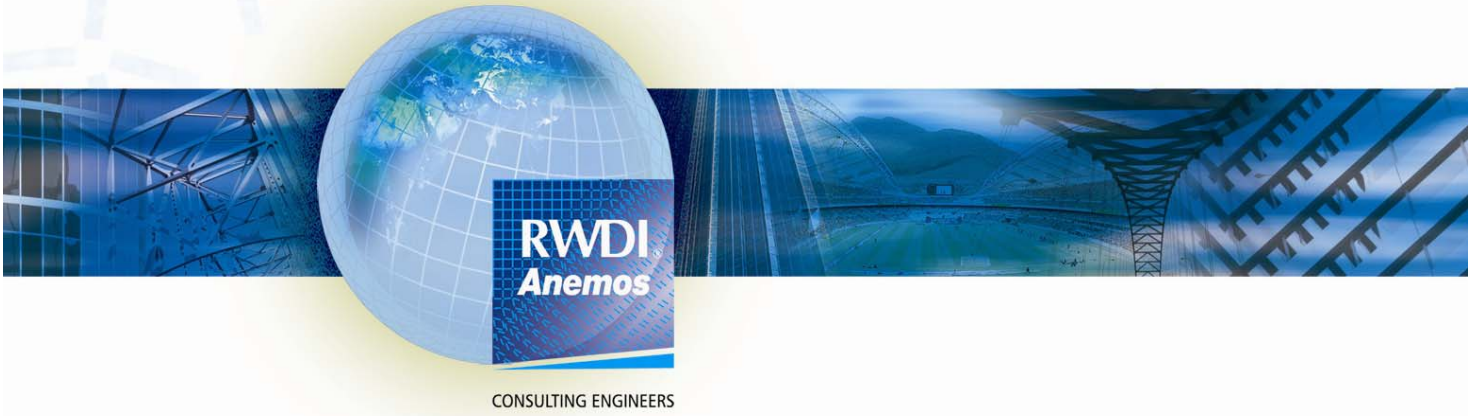
October 2008.

Dublin Development Authority, Proposed Draft Planning Scheme: Poolbeg, Dublin
Wind Microclimate Desk Study

Malone O'Regan

31st October 2008

Project Reference R09-3023F-DS (Final)



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OBJECTIVE

The objective of this study was to review contextual and architectural drawings of the proposed development as part of the Dublin Docklands Development Authority, Proposed Draft Planning Scheme in Poolbeg, Dublin and to make a desk-based assessment of the expected environmental wind conditions at pedestrian level. The assessment is based on our extensive experience of similar urban developments and our expert knowledge of the flow of wind around buildings.

VERSION HISTORY

INDEX	*DATE*	*PAGES*	*AUTHOR*
A	*18th September 2008*	*All*	*E. Palombi*
B	*19th September 2008*	*All*	*E. Palombi*
C	*24th September 2008*	*All*	*E. Palombi*
D	*25th September 2008*	*1, 2, 3 and 6*	*E. Palombi*
E	*22nd October 2008*	*11*	*S. Carmichael*
F	*31st October 2008*	*1,9*	*E. Palombi*

CHECKED BY:

W. Pearce

CONTENTS

TABLES

FIGURES

1. SUMMARY

This is an assessment of the likely wind conditions around the proposed development as part of the Dublin Docklands Development Authority, Proposed Draft Planning Scheme in Poolbeg, Dublin. It outlines the overall methodology and the use of the Lawson Comfort Criteria to describe the wind conditions expected on site. The assessment is based upon RWDI Anemos' experiences with other similar schemes and our expert knowledge of the interaction of wind with the built environment.

It is our understanding that the wind assessment provided on the proposed draft Planning Scheme will be used as an aid for developers in understanding the expected wind microclimate and therefore should be considered when in the process of detail design of an individual development within the Masterplan.

In the present study, the Lawson Comfort Criteria are used in the assessment of the pedestrian level wind conditions within and around the development. In addition, the site description is used mainly to identify building massing and features that are pertinent to the wind microclimate on site. The discussion describes meteorological conditions and the expected main flow interactions around the site.

2. SITE DESCRIPTION

2.1 Site location and context

The Site examined in this report comprises two of the development areas within the draft Poolbeg Planning Scheme Area - Areas 1 and 2. Area 1 includes the IGB Development and Fabrizia Site and Area 2 covers a small strip of proposed buildings to the north of South Bank Road. Area 1, the larger of the two developments, is bounded by Sean Moore Road to the northwest, Sean Moore Park to the southwest, Area 3 the Southern Shore Development & the beaches of Sandymount Strand to the southeast and Southbank road to the northeast with Area 2 just beyond.

The surrounds comprise generally low-rise industrial and residential buildings with the River Liffey located north of Areas 1 and 2 and the south port. Dublin city centre is approximately 3km NW of these Areas. Area 1 was, until recently, occupied by industrial buildings, which have now been demolished. Area 2 is on the edge of an area used by Dublin Port for container storage. Figure 1 shows an aerial view of the existing Areas 1 and 2 which still shows the IGB buildings present.

2.2 Proposed Development

Figure 2 shows an illustrative site plan of the Proposed Development as assessed (i.e.as a worst case scenario). The tallest buildings as assessed range between 42m to 60m in height and are concentrated around the Urban Square at the centre of Area 1 and on the east corner and along the south elevation of the IGB Development and Fabrizia Site. The rest of the buildings within Area 1 are of variable height but are considered to be low-rise units. Area 2 consists of a row of low-rise buildings along South Bank Road. At ground level, the open areas around the buildings are expected to be used as thoroughfares;

however there are a number of courtyards and public realm spaces in-between and even within the individual building plots. A 3D image of the development is presented in Figure 3 to illustrate the variation in height of the buildings within the Proposed Development as assessed.

3. METHODOLOGY

3.1 Meteorological Data

Knowledge of the prevailing wind direction allows us to focus attention on the likely impact of these winds on the site except where the building massing/layout indicates that winds from other directions are likely to be important. This means that, taking account of other design constraints, it is desirable that the site is arranged so that the maximum acceleration of the wind due to the building massing occurs for the lightest and most infrequent wind speeds and directions. In this way pedestrian comfort is optimised.

3.1.1 General meteorological data

Joint frequency tables of wind speed, divided into ranges of the Beaufort Scale and direction for 30° sectors around the compass, were obtained for Dublin. The frequency tables are fitted by standard Weibull curves. In this way the data are smoothed and converted into a format more suitable for analysis.

The graphical presentation of the results (see Figure 4) in this report is for seasonal data defined as spring (March, April, and May), summer (June, July and August), autumn (September, October, November) and winter (December, January, February). Data for the Dublin Airport were used in this investigation.

The Dublin Airport meteorological data indicate a peak from the south-westerly direction which would be expected to be prevalent throughout the year, and a secondary southeast peak which is strongest during the spring and summer seasons.

3.1.2 Surface roughness around the site

Another consideration is the ground roughness in each wind direction because wide, open spaces permit the wind to blow down to ground level generating conditions similar to that of open countryside even within a built-up area. In the present study, assessment of the ground roughness for the development site was based on calculations undertaken using the BREVe2 software package which contains an internal database of surface roughness for UK.

Table 1 presents the ‘mean factors’ for the site where the mean factor represents the ratio of wind speed on site at the stated reference height as a fraction of the wind speed in open, flat countryside at a height of 10m.

For Areas 1 and 2 of the Dublin Docklands Development Authority, Proposed Draft Planning Scheme in Poolbeg, Dublin, the mean factors at 10m vary between 0.78 and 1.17, with the highest exposure to the northeast, east and southeast. The magnitude of the mean factors is representative of the mainly low-rise residential surrounds to the

southwest through to the north and the exposure of the site to winds over the adjacent water.

3.2 Lawson Comfort Criteria

3.2.1 Pedestrian Comfort Criteria

The assessment of the wind conditions requires a 'standard' against which the measurements can be compared. The Lawson Criteria have been established for some thirty years and have been widely used on building developments across the United Kingdom. RWDI Anemos routinely use criteria developed by Lawson[2]. Lawson devised a twelve-point scale (not shown here) to represent equal increments of annoyance or reaction to the wind and these were then used to set threshold values for particular pedestrian activities. The criteria account for the fact that the wind conditions perceived as tolerable by pedestrians depend on the activity they are engaged in. For example, wind conditions in an area designated for sitting need to be more benign than a location that people merely walk past. In total six pedestrian activities are described in Table 2 in ascending order of activity: sitting, standing, entrances, leisure walking, business walking and roadways/car parks. Table 3 summarises the Beaufort Land Scale and quantifies the wind speeds associated with each Beaufort Range of wind speeds.

The Criteria set out six pedestrian activities which reflect the fact that less active pursuits require more benign wind conditions. For each of these categories an upper threshold was defined, beyond which conditions were described as unacceptable for the stated activity. If conditions were below the threshold then they were described as tolerable (or suitable). 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 Proposed Development for its intended purpose and complaints of wind nuisance. An unacceptable result implies that remedial action should be taken to mitigate wind conditions or that the proposed pedestrian activity at that location should be redefined.

3.2.2 Pedestrian Safety

The Lawson Criteria also specify a lower limit safety criterion when winds exceed Beaufort Force 6. If this safety criterion is exceeded then there may be a need for mitigation measures or a careful assessment of the expected use of that location, e.g. is it reasonable to expect vulnerable pedestrians (i.e. elderly & children) to be present at the location on the windiest day of the year? Experience has shown that occurrences of business walking and roadway wind conditions are associated with wind speeds in excess of the Beaufort 6 safety criterion and therefore pedestrian safety as well as comfort should be considered if such conditions occur.

4. BASELINE CONDITIONS

It is often the case that a new development dramatically alters the pedestrian activity on site and consequently a comparison of the original wind conditions with those on the

[2] T.V. Lawson, 'Building Aerodynamics', Imperial College Press, © 2001

developed site can be meaningless. For example wind conditions currently suitable for pedestrian (leisure) walking and which remain suitable for pedestrian walking after development leads to the conclusion that there is negligible impact due to the development. However, if on the new development the location of interest is outside a main entrance then the impact is adverse and will require remedial action. This is an important consideration when defining and applying baseline conditions.

4.1 The current wind conditions on site

Analysis of the meteorological data for the existing open site indicates that the existing conditions at ground level on site are likely to be tolerable for leisure walking use. The implication of this result is that, after development, if the site has a number of locations where the conditions are tolerable for (say) business walking, then these are likely to be perceived to be 'windy' relative to general conditions in the area.

It is noted that most urban sites, whether in central Dublin or central London tend to have an 'open site' classification that is suitable for standing/entrance use because of the shelter provided by the building in all directions. The Poolbeg site is therefore a relatively windy site.

4.2 The current wind conditions around the site (on neighbouring properties)

It is desirable, as part of a good neighbour policy, to minimise adverse changes to the wind conditions on neighbouring buildings due to a development. Generally, development (in terms of building additions or removals) may lead to increased wind speeds on adjacent properties for some wind directions but increased shelter for other directions.

As the existing site is mostly open with; it is not expected to provide shelter to neighbouring properties.

4.3 The Desired Pedestrian Activity around the Site

The Proposed Development is for mixed use. Therefore, we would generally look for conditions suitable for leisure walking during the worst-case season on pedestrian thoroughfares, with standing/entrance conditions at main entrances and in retail areas, and sitting at outdoor seating and amenity areas during the summer.

4.4 Comparison of the wind conditions with the desired conditions

In the assessment of the proposed development, comparison is made between the wind conditions expected on the developed site and the desired wind conditions. This is generally the most useful baseline for comparison because it indicates whether the wind conditions are suitable for the intended pedestrian activity at a location.

5. WIND CONDITIONS AROUND THE PROPOSED DEVELOPMENT

The overall assessment for the site is presented in Figure 5. The shaded areas show the expected pedestrian usage, during the windiest season, for which the wind conditions are suitable as defined by the Lawson Comfort Criteria (Table 2). During the summer we would expect the wind conditions to be one category less windy than predicted in Figure 5. For example, this means that the yellow areas in Figure 5 would become blue and suitable for standing/entrance use.

In the assessment it has been assumed that there is no landscaping or planting around the development in order to obtain a set of conservative, i.e. relatively windy, results.

5.1 Windiest Areas on the Site

The windiest conditions are expected around the buildings corners exposed to the prevailing south-westerly and/or south-easterly winds, primarily along the south-western and south-eastern perimeter of the Proposed Development. These corners (highlighted in pink in Figure 5) are expected to experience business walking conditions during the worst-case season (winter). During the summer, the wind is generally calmer and these corners are expected to be tolerable for leisure walking.

5.2 Overall Assessment

In general, the wind microclimate at the Proposed Developed is expected to be relatively calm and suitable for a range of uses from sitting to leisure walking, but suitable for business walking at the most exposed building corners. The wind conditions at most areas within and around the development are considered to be in keeping with the desired pedestrian use of these areas.

There are a number of building corners (pink areas in Figure 5) where the expected conditions are suitable for business walking during the worst case season (winter). Local residents will be acclimatised to the general windiness in Dublin, which increases their tolerance of windy conditions, and so might justify a business walking classification in some areas during the windiest season. However, the business walking classification is associated with occasional strong winds during the windiest season and these conditions are one category windier than we would generally recommend for a thoroughfare. For this reason, the corner zones, highlighted pink in Figure 4, would benefit from mitigation to address the potential for strong winds during the winter. Suitable mitigation is described in Section 7.

Any entrances located in areas where the expected conditions are suitable for leisure/business walking (yellow/pink areas in Figure 5) are windier than desired, and mitigation is required. Suitable mitigation is described in the Section 7.

Any areas intended for amenity/outdoor seating (i.e. within the Urban Square and Cascade) where the expected summertime wind conditions are windier than sitting require mitigation, and suitable mitigation is described in the Section 7.

During the summer season the wind microclimate is generally calmer, and conditions are expected to improve. The overall conditions on site are expected to be suitable for a range of activities from sitting (in the more sheltered areas) to leisure walking.

5.3 Surrounds

The Proposed Development is expected to provide partial shelter to neighbouring properties to the northwest and northeast of the site, and to the River Liffey to the north.

6. CUMULATIVE IMPACT

We are not aware of any planned or consented developments in the immediate neighbourhood of this site that would affect the microclimate of the Proposed Development.

7. MITIGATION MEASURES

In the assessment above, it has been assumed that there is no landscaping or planting around the development. However, planting and other landscape enhancements will increase the shelter within the development compared to the expected wind conditions described above, particularly when trees and plants are established and in full leaf. This is especially true during the late spring and summer seasons, when the trees are in full leaf, and pedestrian activity requires calmer wind conditions. However, wind conditions within and around the site are expected to be generally suitable for a range of activities from business walking to sitting, and most locations have a wind microclimate which is in-keeping with the intended pedestrian use of the area.

In our experience business walking conditions will be associated with exceedence of the Beaufort Force 6 distress criterion which implies strong winds during the windiest (winter) season on occasion. The business walking classification is intended to represent zones where pedestrians are unlikely to linger and the areas identified as suitable for business walking are at building corners on pedestrian thoroughfares where this classification may therefore be acceptable. Local residents will be acclimatised to the general windiness in Dublin, which increases their tolerance to windy conditions, however, the corner zones would benefit from mitigation to address the potential for strong winds during the winter. Suitable landscape planting and/or screening at street level would displace strong winds above head level, sheltering pedestrians and achieving the desired leisure walking conditions throughout the year.

Should entrances be situated in areas where conditions are expected to be windier than standing/entrance conditions, mitigation in the form of recessing or screening is recommended. Recessing or vertical screening these entrances would create a sheltered buffer zone, allowing pedestrians entering/leaving the building to gradually pass from the “controlled” internal environment to the windier open space. Alternatively, relocating the entrances to a more sheltered location (marked by the green or blue shading in Figure 5) is expected to achieve the desired standing/entrance conditions. If there are entrances in areas where the wind microclimate is classified as suitable for business walking then this two-category difference in the desired and actual wind conditions is unlikely to be

adequately addressed by the simple recess/screen options described above and relocating the entrance is the preferred course of action.

No further mitigation is considered necessary in order to achieve the desired wind microclimate within the Proposed Development.

8. CONCLUDING REMARKS

In conclusion:

1. The meteorological data for the site indicate prevailing winds from the south westerly quadrant throughout the year, and secondary winds from the south easterly direction particularly during the spring and summer months.
2. For the existing site, the wind microclimate is expected to be safe and suitable for leisure walking or better during the windiest season. The wind microclimate is expected to be suitable for standing/entrance use or better during the summer season.
3. In the presence of the proposed building, the wind conditions within the site are expected to be suitable for a range of activities business walking to sitting during the windiest season. The wind microclimate is expected to be suitable for leisure walking or better during the summer season.
4. Business walking wind speeds are associated with occasional strong winds during the windiest season which exceed Beaufort Force 6. The acclimatisation of local residents may justify business walking as an acceptable result on thoroughfares near building corners, however, the corner zones would benefit from mitigation intended to achieve a leisure walking classification for these areas.
5. All the remaining thoroughfares within the site are expected to be suitable for the intended pedestrian use, and no further mitigation measures are required.
6. In general most locations on site are classified with a wind microclimate that is suitable for its intended pedestrian usage. However, any entrances located in areas where the expected conditions are windier than standing/entrance require mitigation. Suitable mitigation in the form of effective use of planting or landscaping within public outdoor seating spaces, particularly within the Urban Square and Cascade, are also recommended.
7. The desk-based wind microclimate assessment provided for the proposed draft Planning Scheme of Areas 1 and 2 in Poolbeg, Dublin is intended to provide general guidance on the likely wind microclimate throughout the Masterplan. Wind tunnel testing is recommended upon the detail design of individual developments within Areas 1 and 2, for relatively tall buildings (i.e. 15 storeys or taller) to ensure that the comfort and safety criterion is complied with.

	Direction											
	0	30	60	90	120	150	180	210	240	270	300	330
Mean factor at 2m	0.75	0.82	0.90	0.87	0.87	0.83	0.79	0.69	0.42	0.44	0.61	0.44
Mean factor at 10m	0.98	1.07	1.18	1.13	1.14	1.09	1.03	0.95	0.78	0.82	0.94	0.82

Table 1: Mean Factors at 2m and 10m above Ground at the Site

DESCRIPTION	LETTER	THRESHOLD
Roads and Car Parks	A	6% > B5
Business Walking	B	2% > B5
Leisure Walking	C	4% > B4
Pedestrian Standing	D	6% > B3
Entrance Doors	E	6% > B3
Sitting	F	1% > B3

Table 2: Lawson Comfort Criteria

BEAUFORT FORCE	HOURLY-AVERAGE WIND SPEED (m/s)	DESCRIPTION OF WIND	NOTICEABLE WIND EFFECT
0	< 0.45	Calm	Smoke rises vertically
1	0.45 - 1.55	Light Air	Direction shown by smoke drift but not by vanes
2	1.55 - 3.35	Gentle Breeze	Wind felt on face; leaves rustle; wind vane moves
3	3.35 - 5.60	Light Breeze	Leaves & twigs in motion; wind extends a flag
4	5.60 - 8.25	Moderate Breeze	Raises dust and loose paper; small branches move
5	8.25 – 10.95	Fresh Breeze	Small trees, in leaf, sway
6	10.95 - 14.10	Strong Breeze	Large branches begin to move; telephone wires whistle
7	14.10 - 17.20	Near Gale	Whole trees in motion
8	17.20 - 20.80	Gale	Twigs break off; personal progress impeded
9	20.80 - 24.35	Strong Gale	Slight structural damage; chimney pots removed
10	24.35 - 28.40	Storm	Trees uprooted; considerable structural damage
11	28.40 - 32.40	Violent Storm	Damage is widespread; unusual in the U.K.
12	> 32.40	Hurricane	Countryside is devastated; only occurs in tropical countries

Table 3: The Beaufort Land Scale

Figure 1: Aerial Site Photograph (Existing Site)

Figure 2: Illustrative Ground Level Plan of the Proposed Development (assessed as a worst case scenario)

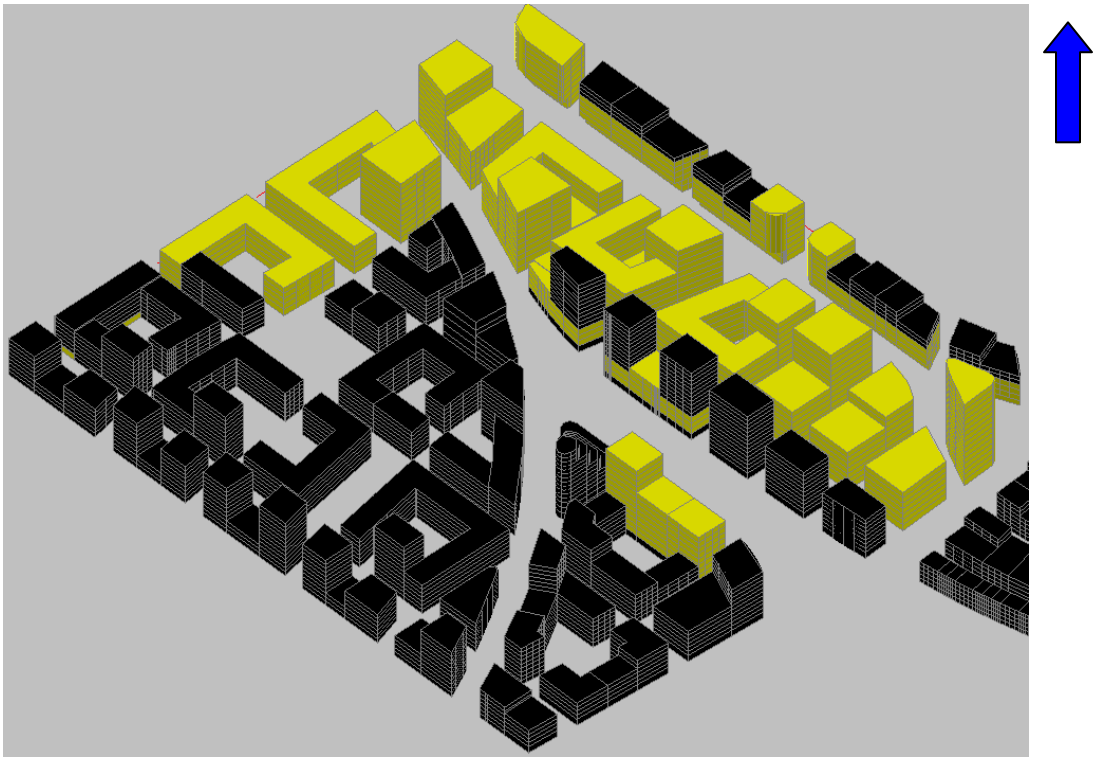

Figure 3: 3D Image of the Proposed Development (assessed as a worst case scenario)

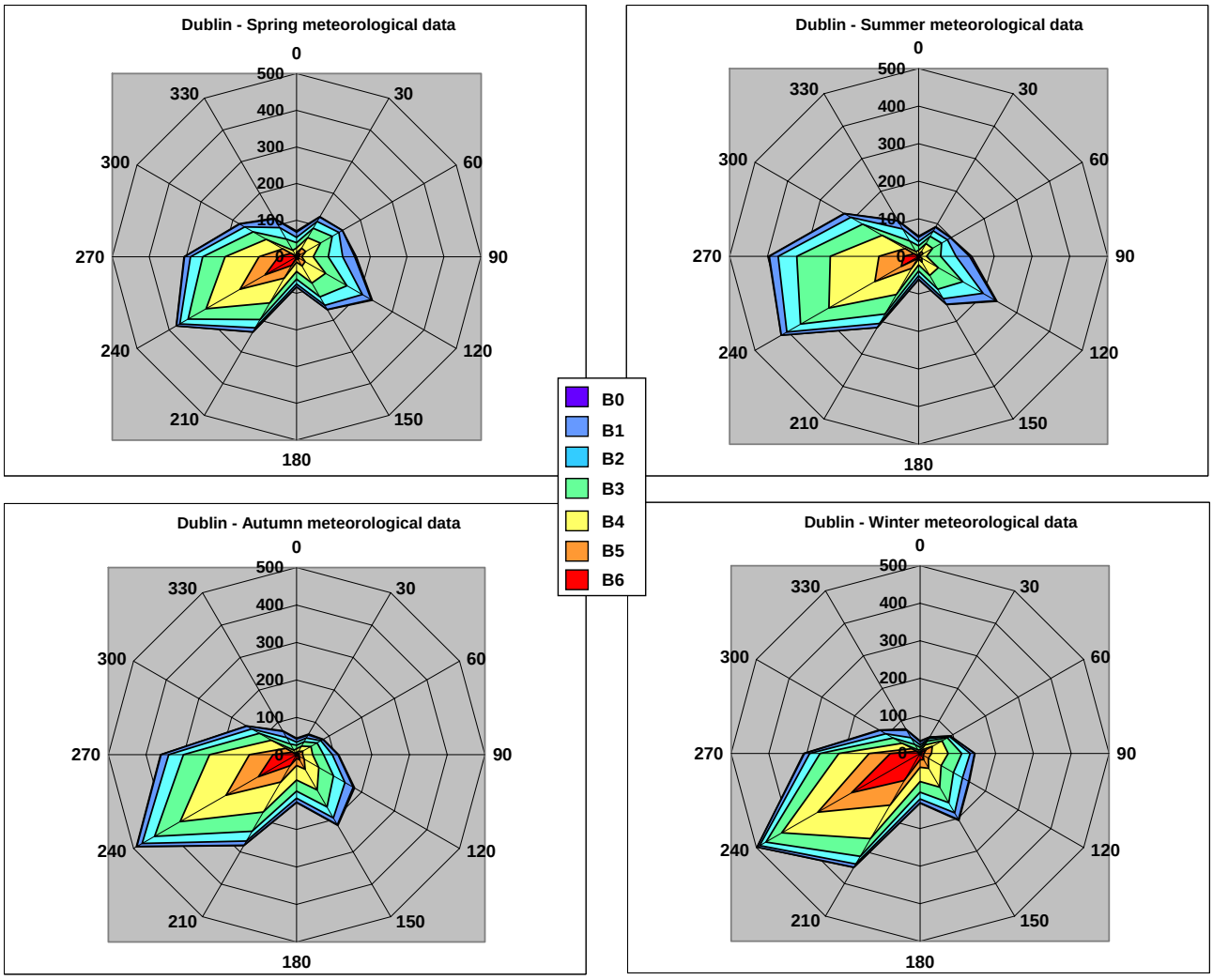

Figure 4: Seasonal Wind Roses for Dublin Airport Meteorological Station (in Beaufort Force)

(Beaufort Force and hours of wind stated range is exceeded)

Figure 5: Expected Worst Case Lawson Comfort Criteria – Proposed Development (Height of each building is indicated in metres)

APPENDIX A: GENERAL COMMENTS ON WIND IN THE BUILT ENVIRONMENT

Urban airflow

As the wind approaches a built-up area it is displaced upwards to roof level and tends to blow across the roof tops with gusts down to street level that are a function of the relative heights-to-width of the street canyon. When the height-to width ratio of the street canyon is greater than 0.7 the skimming flow regime dominates and the wind blows across the top of the street with little penetration down to ground level, whereas a height-to-width ratio less than 0.4 produces conditions similar to the isolated building scenario[3]. However, when there is an increase in building height across the street this can reinforce the rotating, or vortex, air movements within the street. Relatively open spaces, even inside a city, can be windy as the wind blows down from roof level into the open space.

Calm areas are generally desirable for pedestrian comfort. However, very slow air movement can result in poor ventilation of pollutants and in these areas it is desirable that pollutant sources are limited.

Seasonal variability

Pedestrian activity differs during the summer and winter months when other climatic conditions, for example air temperature, have a marked impact. The Lawson Criteria assume that pedestrians will be suitably dressed for the season and when making a worst-case assessment it is reasonable to assume that pedestrians will not be sitting at a street-side café on the windiest days of the year.

Entrances

Pedestrians are particularly sensitive to wind conditions at entrances because of the potentially marked change between the controlled environment inside the building and external conditions. For this reason it is important that conditions immediately adjacent to an entrance are relatively benign or that there is a sheltered ‘buffer’ zone, which allows pedestrians time to acclimatise. For recessed entrances the recess creates a buffer zone but is also prone to accumulating wind-blown debris because of the trapped vortex, or rotational, flows that can occur in the recess. Entrances are also used throughout the year so that even during the windiest days of the year the entrance should be relatively sheltered.

Entrances on different building façades are also susceptible to pressure-driven through flows when opened simultaneously. The windward façade is generally positively pressurised whereas the side and/or downwind façades are at a lower pressure. If the entrances are into a central atrium then the different external surface pressures can be directly connected when doors are opened simultaneously. This can lead to nuisance draughts and in extreme cases difficulty in opening doors or whistling as the pressure difference forces the doors slightly ajar. Revolving doors eliminate the problem because

[3] T. R. Oke, ‘Boundary Layer Climates’, Routledge, © 1987

the pressure seal across the building envelope is maintained. The extent of any potential nuisance is in part related to the footfall through the entrances because this will affect the probability of doors being opened simultaneously. Lobby doors are another means of limiting the impact of nuisance draughts but again the likelihood of both sets of lobby doors being opened simultaneously should be considered when selecting and sizing this option.

Landscaping

Landscaping is a very useful means of softening the streetscape and creating naturalised shelter within and around the site. There are generally two ways in which landscaping works; relatively dense lines of planting act like a solid screen deflecting the wind, whereas more open planting removes energy from the wind as it flows through the screen. In both cases shelter is created but for the case of the more solid screen winds can remain relatively strong at the extreme ends of the screen. If we consider the case of street canyons in UK towns and cities, the tree canopy minimises the penetration of vertical gusts down to pedestrian level and horizontal winds are displaced upwards by the canopy.

Another consideration is the seasonal variation of the species. Deciduous varieties create a denser screen during the summer months but during the winter months offer limited protection due to the bare branches. Evergreen varieties offer more consistent shelter throughout the year. When considering seasonal variability, account should be taken of the more transient pedestrian activity during the winter months where other climatic factors, e.g. air temperature, impact upon the way in which pedestrians will use a site. Finally, the maturity of the planting is significant; semi-mature species offer reasonable protection from an early stage in the life of the development, whereas immature planting will take time to establish.

Balconies

If there are buildings with recessed balconies then it is generally the case that these will be sheltered unless they are particularly long balconies when the wind can blow along and into the balcony. Partition walls/screens between the balconies of adjoining properties are usually sufficient to eliminate this potential wind nuisance.

Protruding balconies are potentially more susceptible to wind nuisance because the main flow along the surface of the building can blow directly across the balcony. This condition is exacerbated if the protruding balcony skirts around a corner of the building where the strong corner winds will blow across the balcony. There is usually a requirement to screen the ends of the protruding balconies in order to displace the wind away from the balcony.

Colonnades

In this discussion a colonnade is defined as a covered walkway where the cover is generally provided by overhanging upper storeys of the building. In other words the building footprint at ground level is set-back. Colonnades create shelter from the direct

effects of downdraught but are exposed to horizontal winds which can be channelled along the colonnade. If the colonnade connects windward and leeward elevations of the building then a pressure-driven flow is generated through the colonnade. If the building façade at ground level is curved then this can also be expected to accelerate the winds through the colonnade.

Colonnades do not necessarily provide shelter from the wind. Consequently, it may be necessary to increase resistance to air movement along the colonnade, and/or to prevent penetration of wind into the colonnade, by suitable screening.

Covered open spaces

Developments which are covered but open, either along the sides of the roof or at low level, will have internal environmental conditions that are variable and dependent upon the prevailing weather conditions. The canopy, typically a lightweight glazed canopy or fabric roof, may increase shelter from the rain and thereby improve the utility of the covered space; however, when the external air temperature is low and there is a breeze along the street it will generally be the case that pedestrians will need to be suitably dressed.

The challenge with these covered but open spaces is that the perception of shelter due to the canopy roof creates an expectation of shelter from both rain and wind. Put another way, if the wind conditions on a ‘normal’ street are identical to those in a covered street the pedestrian perception will be that the conditions beneath the canopy are less benign.

To design against this it is necessary that the wind conditions along a covered street are relatively benign. It is also important that the retail tenants on the street, particularly those operating food kiosks or cafes with ‘external’ seating, appreciate the variability of the weather conditions or are suitably catered for in terms of demountable screens and (say) patio heaters to enhance conditions locally.