FINAL REPORT

THE BEEHIVE REDEVELOPMENT

CAMBRIDGE, UK

PEDESTRIAN LEVEL WIND DESK-BASED ASSESSMENT
RWDI #2405918 – REV A
30TH AUGUST 2024

SUBMITTED TO	SUBMITTED BY
Gardiner & Theobald LLP	RWDI

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VERSION HISTORY

RWDI Project #2405918	The Beehive Redevelopment Cambridge, UK	
Report	Releases	Dated
Reports	Rev A Final	2nd August 2024 30th August 2024
Project Team	JM KJ SH	

EXECUTIVE SUMARY

This is a desk-based assessment of the likely wind conditions associated with the proposed Beehive Redevelopment in Cambridge, UK. The report outlines the overall methodology and describes the expected on-Site wind conditions. The assessment is based upon analysis of meteorological conditions for Cambridge, adjusted to the Site, a review of the scheme drawings in the context of the surrounding area and in combination with RWDI's experience in wind flow in the urban environment.

When the Proposed Development is introduced, the majority of spaces would be suitable for their intended usage and only isolated areas would require mitigation. Due to the height of the scheme in relation to the immediate surrounding space, stronger, higher-level winds would interact with the proposed massing, drawn down to lower levels and would accelerate around building corners and in between close proximity buildings. Furthermore, the majority of elevated amenity terraces would be exposed from a number of wind directions. The proposed landscaping scheme, with trees at least 5m in height, will provide some benefit in diffusing wind flow across the Site.

There would be several areas with unsuitable wind conditions for the intended uses. Furthermore, there would be elevated terraces that would likely have strong wind exceedances which could pose a safety concern to occupants. Mitigation measures have been suggested which would be expected to further reduce the windiness across the Site.

1 INTRODUCTION

RWDI was appointed by Gardiner & Theobald LLP to conduct a desk-based assessment of the proposed Beehive Redevelopment (hereafter referred to as the 'Proposed Development'), in Cambridge, UK. This report presents the background, objectives and results from RWDI's assessment. A summary of the overall recommendations from the study are presented in Section 7, "Conclusions".

2 SITE DESCRIPTION

2.1 Site and Surroundings

The Proposed Development is located in Cambridge. The Site is bounded by Coldhams Lane to the north, Railways to the east and low-rise residential buildings to the south and west. The OS Landranger reference grid for the Site is TL466585.

The Site is currently occupied by low-rise commercial buildings and associated car parking. The surrounding area is comprised of primarily low-rise buildings. This type of terrain would result in wind speeds approaching the Site having a higher mean wind speeds and lower turbulence (i.e. less 'gusty'), compared to a Site located in a more dense environment, such as London. An aerial view of the approximate Site location is highlighted in yellow with its surroundings in Error! Reference source not found..

Figure 1: Aerial view of the existing Site (approximate extent of the Site highlighted in yellow)

2.2 The Proposed Development

The demolition and redevelopment of the Beehive Centre, including in Outline Application form for the demolition and redevelopment for a new local centre (E (a-f), F1(b-f), F2(b,d)), open space and employment (office and laboratory) floorspace (E(g)(i)(ii) to the ground floor and employment floorspace (office and laboratory) (E(g)(i)(ii) to the upper floors; along with supporting infrastructure, including pedestrian and cycle routes, vehicular access, car and cycle parking, servicing areas, landscaping and utilities.

The current scheme masterplan and building heights is shown in Figure 2.

Figure 2: Image of the Proposed Development (View from above)

3 METHODOLOGY AND ASSESSMENT CRITERIA

The wind conditions at the Proposed Development have been qualitatively assessed based on the meteorological data for the area, a terrain assessment, and RWDI's extensive experience of wind flow in the urban environment.

Knowledge of the prevailing wind direction focuses attention on the likely impact of these winds on the Site except where the proposed building massing/layout indicates that winds from other directions are likely to be important.

3.1 General Meteorological Data

Approximately 25 years' worth of meteorological data were obtained from the meteorological station at RAF Mildenhall airbase which was used in this report and is presented in Figure 3. The radial axis indicates the directional distribution of winds. The seasons are defined as spring (March, April and May), summer (June, July and August), autumn (September, October and November) and winter (December, January and February).

The meteorological data indicates that the prevailing wind direction throughout the year is from the south-west and a secondary peak from north-easterly winds during the spring.

Figure 3: Seasonal wind roses for RAF Mildenhall (Radial axis indicates the percentage time for which the stated wind speed is exceeded)

3.2 Terrain Roughness

Another consideration is the terrain roughness in each wind direction because wide, open spaces permit the wind to flow smoothly at ground level generating conditions similar to those of open countryside even within a built-up area. An assessment of the terrain roughness for the Site was conducted using the methodology implemented in ESDU 01008[1]. The assessment of terrain roughness identified a mean factor at both 2m and 10m above ground for each of the 36 wind directions approaching the Site which describes the characteristics of the approaching wind. A higher mean factor indicates that mean winds speeds will be closer to the free stream velocity and less turbulent, and a lower mean factor indicates the opposite. Mean factors for the Site are presented in Table 1.

Table 1: ESDU mean factors at 2m and 10m above ground level

Wind Direction	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°
Mean Factor at 2m	0.40	0.40	0.40	0.41	0.41	0.41	0.41	0.41	0.77	0.77	0.77	0.77
Mean Factor at 10m	0.75	0.74	0.74	0.76	0.76	0.76	0.76	0.76	1.00	1.00	1.00	1.00
Wind Direction	**120°**	**130°**	**140°**	**150°**	**160°**	**170°**	**180°**	**190°**	**200°**	**210°**	**220°**	**230°**
Mean Factor at 2m	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.36	0.35	0.41	0.41
Mean Factor at 10m	0.75	0.75	0.75	0.74	0.74	0.74	0.74	0.74	0.72	0.70	0.76	0.76
Wind Direction	**240°**	**250°**	**260°**	**270°**	**280°**	**290°**	**300°**	**310°**	**320°**	**330°**	**340°**	**350°**
Mean Factor at 2m	0.41	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Mean Factor at 10m	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74	0.74	0.75	0.75	0.75

[1] ESDU International, Computer program for wind speeds and turbulence properties; flat or hilly sites in terrain with roughness changes, ESDU 01008, 2001.

3.3 Comfort Criteria

The assessment of the wind conditions requires a standard against which the measurements can be compared. This report uses the Lawson Comfort Criteria[2], which have been established for over thirty years. The Criteria, which seek to define the reaction of an average pedestrian to the wind, are described in Table 1. If the measured wind conditions exceed the threshold wind speed for more than 5% of the time, then they are unacceptable for the stated pedestrian activity and the expectation is that there may be complaints of nuisance or people will not use the area for its intended purpose.

The Criteria sets out four pedestrian activities and reflect the fact that less active pursuits require more benign wind conditions. The four categories are sitting, standing, strolling and walking, in ascending order of activity level, with a fifth category for conditions that are uncomfortable for all uses. In other words, the wind conditions in an area for sitting need to be calmer than a location that people merely walk past.

The distinction between strolling and walking is that in the strolling scenario pedestrians are more likely to take on a leisurely pace, with the intention of taking time to move through the area, whereas in the walking scenario pedestrians are intending to move through the area quickly and are therefore expected to be more tolerant of stronger winds.

The Criteria are derived for open air conditions and assume that pedestrians will be suitably dressed for the season. Thermal comfort is discussed with reference to acceptable wind environments but not evaluated as part of the assessment.

The coloured key in Table 1 corresponds to the presentation of results described in the results section of this report.

Table 2: Lawson Comfort Criteria

Key	Comfort Category	Threshold	Description
	Sitting	0-4 m/s	Light breezes desired for outdoor restaurants and seating areas where one can read a paper or comfortably sit for long periods
	Standing	4-6 m/s	Gentle breezes acceptable for main building entrances, pick-up/drop-off points and bus stops
	Strolling	6-8 m/s	Moderate breezes that would be appropriate for window shopping and strolling along a city/town centre street, plaza or park
	Walking	8-10 m/s	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
	Uncomfortable	>10 m/s	Winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended

[2] Lawson T.V. (April 2001), Building Aerodynamics, Imperial College Press

3.4 Desired Pedestrian Activity around the Development

For the Proposed Development, the target conditions are:

1. Strolling during the windiest season on pedestrian thoroughfares;
2. Standing conditions at main entrances throughout the year;
3. Standing use conditions at private amenity spaces such as balconies or larger amenity areas where seating is not intended; and
4. Sitting conditions at outdoor seating during the summer season when these areas are more likely to be frequently used by pedestrians.

The walking and uncomfortable classifications are usually avoided because of their association with occasional strong winds, unless they are on a minor pedestrian route or a route where pedestrian access could be controlled in the event of strong winds. Walking use wind conditions are also acceptable at crossings as pedestrians do not linger, however wind conditions must be safe.

Achieving a sitting classification in the summer usually means that the same location would be acceptable for standing in the windiest season because winds are stronger at this time of year. This is considered an acceptable occurrence for the majority of external amenity spaces because other factors such as air temperature and precipitation influence people's perceptions about the 'need' to use seating in the middle of winter.

Standing use wind conditions are the target conditions for main entrances, however strolling use wind conditions are considered acceptable at secondary entrances and fire exits.

It should be noted that a mixture of sitting and standing uses is acceptable for large terrace spaces, provided that any desired seating areas are situated in areas having sitting wind conditions. In addition, standing use conditions are also considered tolerable at private amenity areas (such as balconies) where the occupant has control over the use of the space.

3.5 Strong Winds

Lawson also specified a lower limit strong wind threshold when winds exceed 15m/s for more than 2.2 hours of the year. Exceedance of this threshold may indicate a need for remedial measures or a careful assessment of the expected use of that location, e.g. is it reasonable to expect elderly or very young pedestrians to be present at the location on the windiest day of the year?

Wind speeds that exceed 20m/s for more than 2.2 hours of the year represent a safety issue for all members of the population, which would require mitigation to provide an appropriate wind environment.

In the UK, strong winds are associated with areas which would be classified as acceptable for walking or as uncomfortable. In a mixed-use urban development scheme, walking and uncomfortable conditions would not usually form part of the 'target' wind environment and would usually require mitigation due to pedestrian comfort considerations. This mitigation would also reduce the frequency of, or even eliminate, any strong winds.

3.6 Typical Wind – Building Interactions

Potential wind conditions generated by a new development would be created by typical flow behaviour, common at most suburban/urban developments. Common wind effects which may occur at the Site are discussed below.

Down-washing of the wind occurs when a building is taller than its surrounding buildings. The taller scheme forces high level winds to ground level where they create locally high wind speeds in the pedestrian realm.

Corner acceleration around building corners may occur due to the difference in pressure on the upwind and downwind façades (low pressure zones on the leeward side and zones of higher pressure on the windward side of the building). This effect is particularly pronounced around sharp corners which create localised windy areas in the vicinity of the corner where the flow is accelerated around the building.

Channelling between buildings in close proximity to each other, particularly where the area between is aligned with the prevailing wind direction, “squeezes” the wind through a smaller area resulting in wind acceleration.

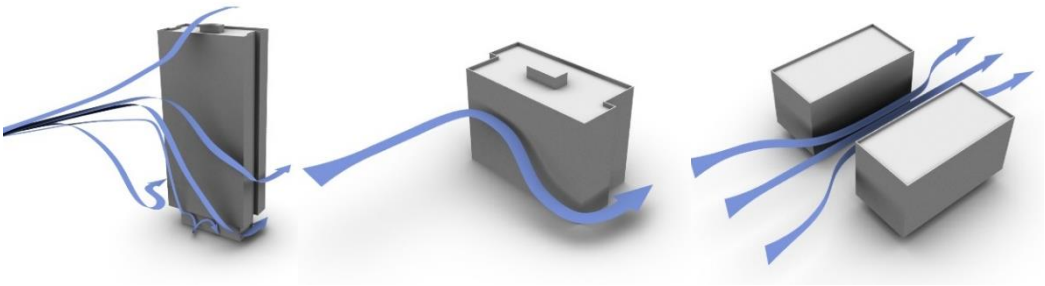


Figure 4: Visual representation of down-washing (left), corner acceleration (centre) and channelling (right).

4 EXISTING SITE WITH EXISTING SURROUNDING BUILDINGS

Often a new development will alter the pedestrian activity (i.e. intended use) on-site. Assessment in terms of the desired pedestrian activity on, or around, a site takes into consideration any change of use, and this is where the comfort criteria are particularly helpful.

4.1 Pedestrian Comfort

Based on the terrain roughness analysis discussed in section 3.2, the baseline conditions at 2m above ground level at an idealised "empty" Site would be acceptable for standing use during the windiest season, with strolling use wind conditions 10m above ground level. During the summer season, wind conditions are generally calmer, which is due to the lower wind speeds and frequency associated with this period of the year, with localised sitting and standing use wind conditions strolling use wind conditions at 2m and 10m above ground level, respectively.

The existing Site is currently occupied by low-rise commercial buildings and associated car parking. During the windiest season, standing use wind conditions are expected across the majority of the nearby surrounding ground level area. During the summer season, calmer sitting use wind conditions are expected.

4.2 Strong Winds

Strong winds with the potential to be a safety concern for cyclists and more vulnerable pedestrians are anticipated to occur in areas with walking or uncomfortable wind conditions during the windiest season.

As no conditions windier than suitable for strolling use are likely to occur, strong winds with the potential to be a safety concern are not expected to occur at the existing Site.

5 PROPOSED DEVELOPMENT WITH EXISTING SURROUNDING BUILDINGS

The expected wind conditions of the Proposed Development at ground level for the windiest season and summer season can be seen in Figures 5 and 6 respectively. During the summer season, wind conditions at elevated levels are shown in Figure 7. Figures can be found in the "Figures" section of this report.

5.1 Pedestrian Comfort

The Proposed Development would be taller than the surrounding buildings and the existing Site. As such, stronger, higher-level winds would interact with the proposed massing, drawn down to lower levels and would accelerate around building corners and in between close proximity buildings. Furthermore, the majority of elevated amenity terraces would be exposed from a number of wind directions. It should be noted that the 'channel' that runs through the centre of the Site, would align with the prevailing south-westerly winds. The proposed landscaping scheme, with trees at least 5m in height, will provide some benefit in diffusing wind flow across the Site.

The Site would primarily have a mixture of standing and strolling use wind conditions during the windiest season, with the windiest of areas in the tight 'channels' in the central areas of the Site. During the summer season, wind conditions would generally be one category calmer.

Thoroughfares (Figure 5)

Wind conditions at pedestrian thoroughfares would be a mixture of standing and strolling use during the windiest season, suitable for the intended use.

Entrances (Figure 5)

Entrances would mostly have standing use wind conditions during the windiest season, suitable for the intended use.

However, there would be a number of entrances with strolling use wind conditions, which would be one category windier than required. These entrances would be situated at:

- The northern and north-western elevations of Block 4;
- The northern, southern and north-western elevations of Block 5;
- The northern, western and north-western elevations of Block 6;
- The south-eastern and southern elevations of Block 7;
- The southern and western elevations of Block 9; and
- The southern and south-western elevations of Block 10.

Therefore, wind mitigation measures would be required to improve conditions, which can be found in Section 6 “Mitigation Measures”.

Strolling use conditions expected at bin stores, entrance/emergency exits, cycle storage and other infrequently used entrances would be acceptable for the intended use.

Ground Level Amenity (Figure 6)

Ground level amenity would mostly have a mixture of sitting and standing use wind conditions during the summer season, with localised strolling use wind conditions between Blocks 6 and 7, Blocks 5 and 9, and Blocks 4,5 and 10. Standing use wind conditions would be suitable for more active use amenity (i.e. plays paces). All fixed seating areas would require sitting use wind conditions. Therefore, wind mitigation measures would be required to improve conditions, which can be found in Section 6 “Mitigation Measures”.

Rooftop Level Amenity (Figure 7)

Rooftop level amenity would mostly have a mixture of sitting and standing use wind conditions during the summer season, with localised strolling use wind conditions on Blocks 7 and 8. All fixed seating areas would require sitting use wind conditions. Standing use wind conditions would be acceptable in areas where occupants are not expected to sit. Strolling use wind conditions would be windier than desired. Therefore, wind mitigation measures would be required to improve conditions, which can be found in Section 6 “Mitigation Measures”.

5.2 Strong Winds

Strong winds with the potential to be a safety concern for vulnerable occupants are anticipated to occur in areas with walking or uncomfortable wind conditions during the windiest season (equivalently strolling or walking use during the summer season).

Therefore, strong winds with the potential to be a safety concern for occupants are anticipated to occur at the rooftop terraces of Blocks 7 and 8. Therefore, wind mitigation measures would be required to improve conditions, which can be found in Section 6 “Mitigation Measures”.

6 MITIGATION MEASURES

With the Proposed Development in situ, wind conditions across the Site would be expected to be suitable for the intended uses. However, there would be several isolated areas with unsuitable wind conditions for the intended uses. Furthermore, there would be areas that would likely have strong wind exceedances which could pose a safety concern to occupants.

The proposed landscaping scheme, with trees at least 5m in height, will provide some benefit in diffusing wind flow across the Site. However, mitigation measures have been suggested which would be expected to further reduce the windiness across the Site, with examples of similar measures shown in Figures 8-10.

6.1 Entrances

For entrances with unsuitable wind conditions suggested mitigation measures include:

- Recessing entrances into the façade by at least 1.5m;
- Full height screening (at least 50% solid) either side of entrances:
- Planters with planting (2m tall) surrounding seating areas; or
- Deciduous/evergreen trees (at least 3m tall.

Figure 8: Example mitigation measures for entrances

6.2 Ground Level Amenity

For ground level amenity with unsuitable wind conditions suggested mitigation measures include:

- Solid or ~50% porous, screening surrounding seating areas (1.5m tall);
- Planters with planting (1.5m tall) surrounding seating areas; or
- Deciduous/evergreen trees (at least 3m tall.

Figure 9: Example mitigation measures for ground level amenity

6.3 Rooftop Level Amenity

For rooftop level amenity with unsuitable wind conditions suggested mitigation measures include:

- Solid or ~50% porous, balustrade (at least 1.5m tall);
- Solid or ~50% porous, screening surrounding seating areas (1.5m tall);
- Planters with planting (1.5m tall) surrounding seating areas; or
- Deciduous/evergreen trees (at least 3m tall).

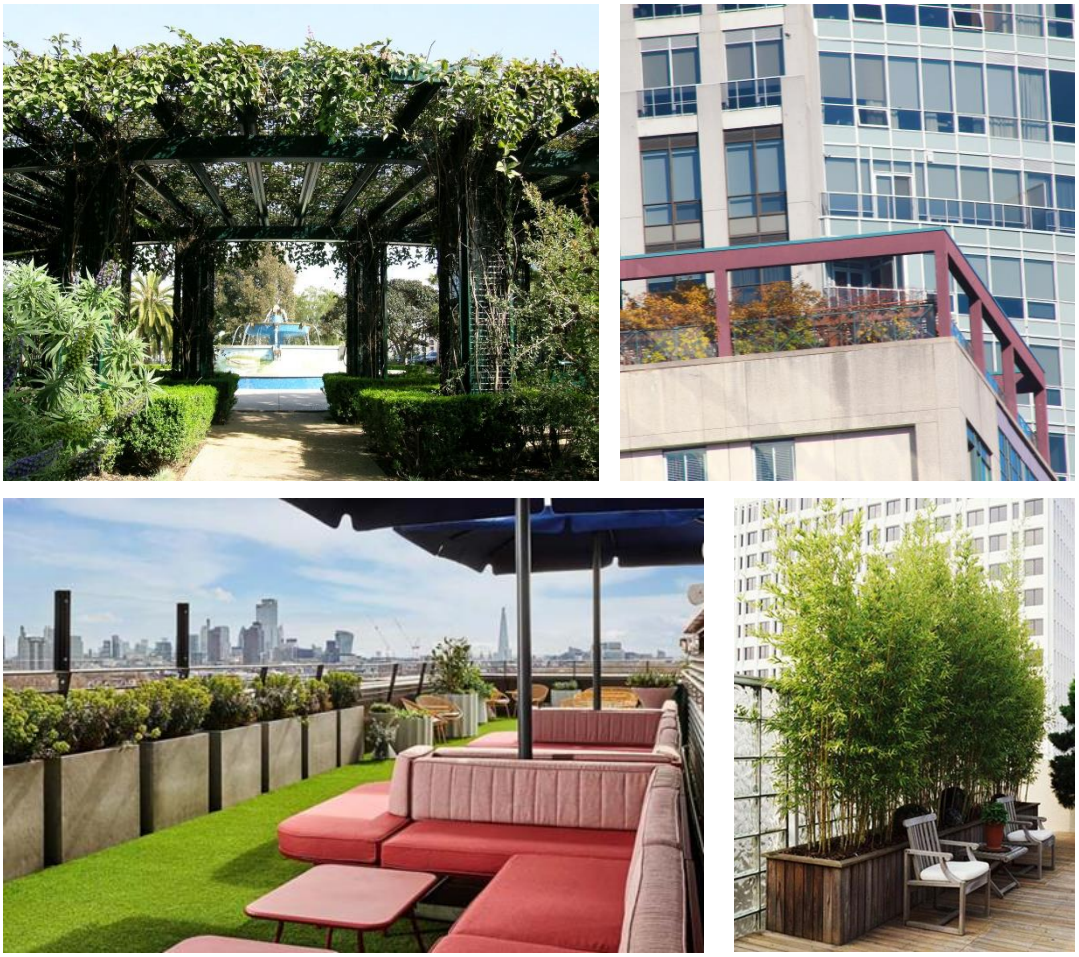


Figure 10: Example mitigation measures for rooftop level amenity

7 CONCLUSIONS

In conclusion:

1. In the baseline scenario, standing use wind conditions are expected across the majority of the nearby surrounding ground level area during the windiest season. During the summer season, calmer sitting use wind conditions are expected.

2. When the Proposed Development is introduced, the majority of spaces would be suitable for their intended usage. However, there would be several areas with unsuitable wind conditions for the intended uses. Furthermore, there would be areas that would likely have strong wind exceedances which could pose a safety concern to occupants.

3. Mitigation measures have been suggested which would be expected to further reduce the windiness across the Site.

STATEMENT OF LIMITATIONS

This report entitled Pedestrian Level Wind Microclimate Assessment dated 2nd August 2024, was prepared by RWDI for Gardiner & Theobald LLP ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the development described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final design stage to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilise the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.

ASSUMPTIONS AND LIMITATIONS

The findings included in this report are based on the following information ("Project Data") disclosed to RWDI:

- "“PO-LDA-ZZ-00-DR-A-030007 (P2) - Masterplan 16 Ground Floor.dwg”-received 7th July 2024;
- “PO-LDA-01-ZZ-DR-A-030000 (P2) - Block 01 - Floor Plans.dwg”-received 7th July 2024;
- “PO-LDA-04-04-DR-A-030103 (P1) - Block 04 - Fourth Floor Plan.dwg”-received 7th July 2024;
- “PO-LDA-06-03-DR-A-030004 (P1) - Block 06 - Third Floor Plan.dwg”-received 7th July 2024;
- “PO-LDA-07-03-DR-A-030103 (P1) - Block 07 - Third Floor Plan.dwg”-received 7th July 2024;
- “PO-LDA-08-03-DR-A-030103 (P1) - Block 08 - Third Floor Plan.dwg”-received 7th July 2024; and
- “PO-LDA-09-03-DR-A-030103 (P1) - Block 09 - Third Floor Plan.dwg”-received 7th July 2024.

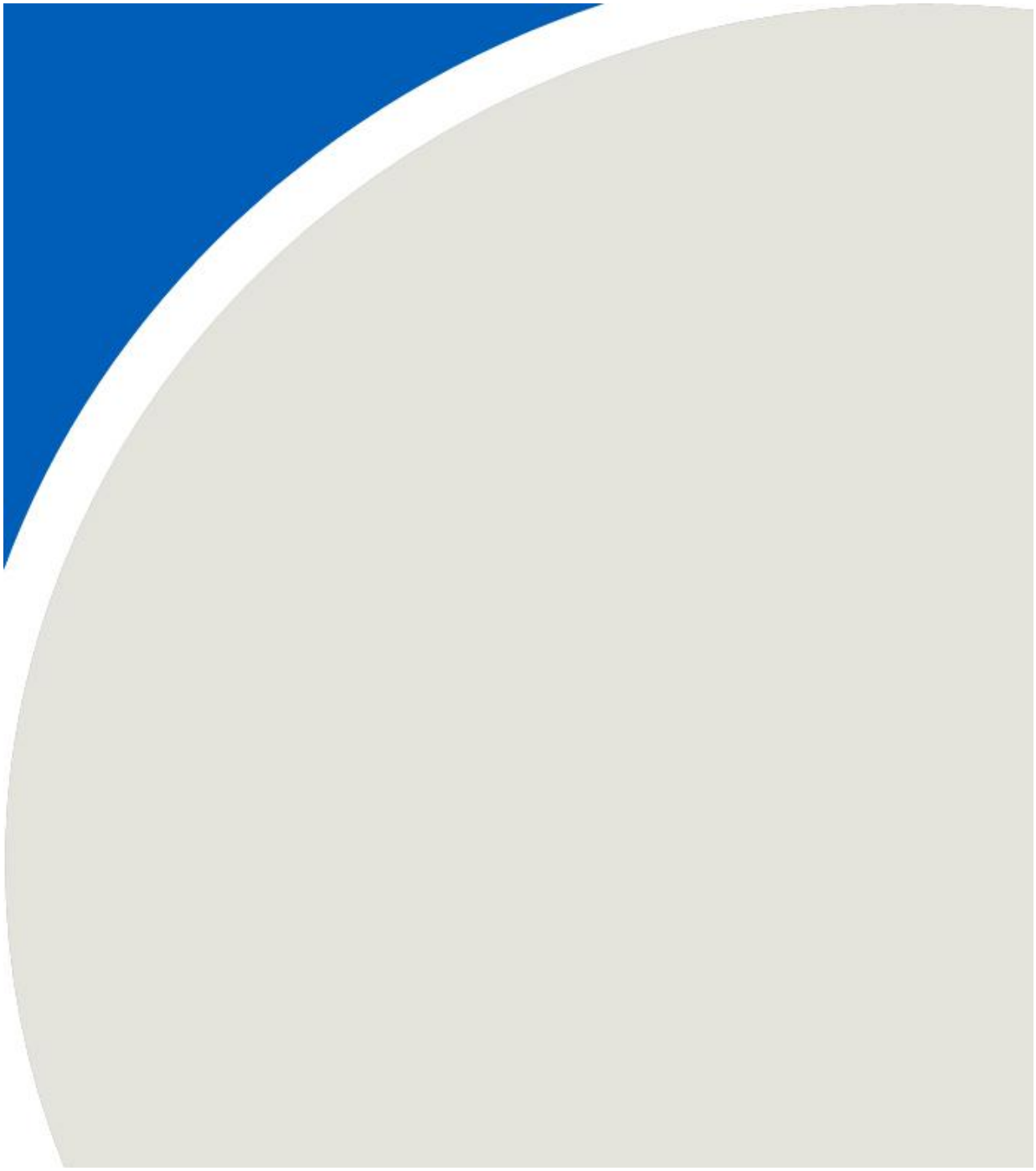
The recommendations and conclusions are based on the following assumptions:

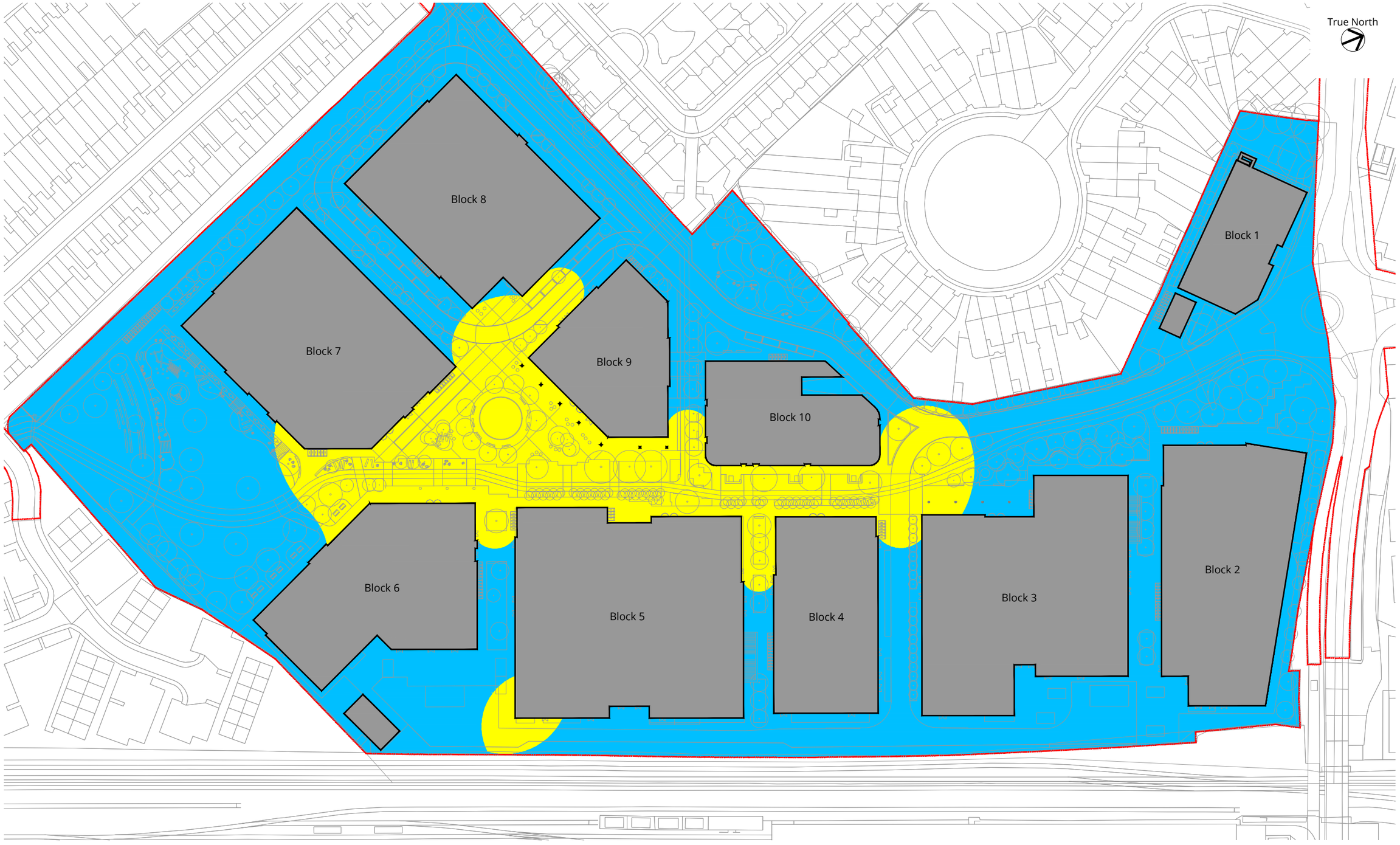
- The Project Data is accurate and complete;
- The Proposed Development, when built, does not deviate substantially from the information listed above. “Substantially” in this case means any change to the exterior form of the buildings that would change the wind flow around it, in a way that would impact pedestrian comfort or safety.
- Sensitive areas of the Site (such as amenity spaces) are expected to be used in line with the temporal specifications set out in the report body.

Any change in the Project Data or Project Specific Conditions not reflected in this report can impact and/or alter the recommendations and conclusions in this report. Therefore, it is incumbent for the Client and/or any other third party relying on the recommendations and conclusions in this report to contact RWDI in the event of any change in the Project Data and Project Specific Conditions in order to determine whether any such change(s) may impact the assumptions upon which the recommendations and conclusions were made.

Finally, the recommendations and conclusions in this report are partially based on historical data and can be affected by a number of external factors, including but not limited to Project design, quality of materials and construction, site conditions, meteorological events, and climate change. As such, the conclusions and recommendations contained in this report do not list every possible outcome.

FIGURES





LDDC COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

Pedestrian Wind Usage Conditions - Ground Floor

Configuration 2: Proposed Development with Existing Surrounding Buildings

Windiest Season

2303688 The Beehive Redevelopment - Cambridge, UK

Figure: 5

LDDC COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

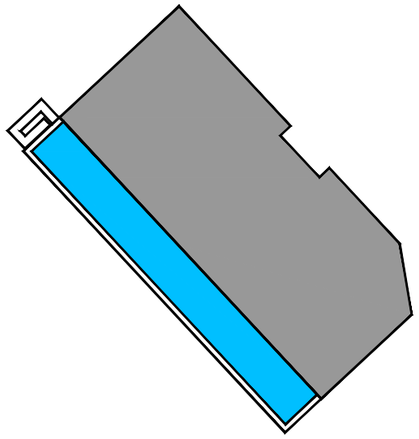
Pedestrian Wind Usage Conditions - Ground Floor

Configuration 2: Proposed Development with Existing Surrounding Buildings

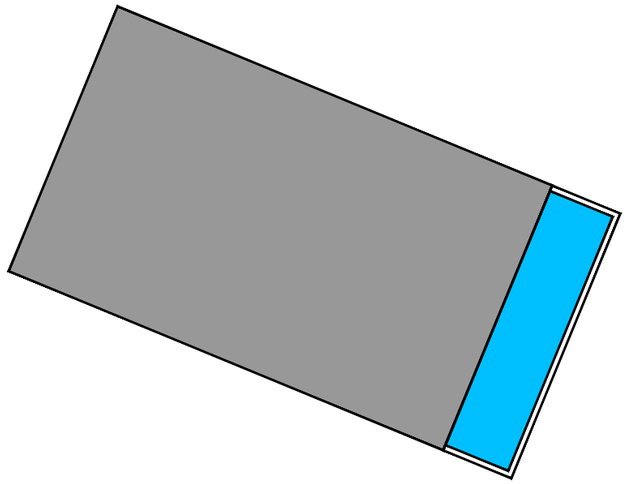
Summer Season

2303688 The Beehive Redevelopment - Cambridge, UK

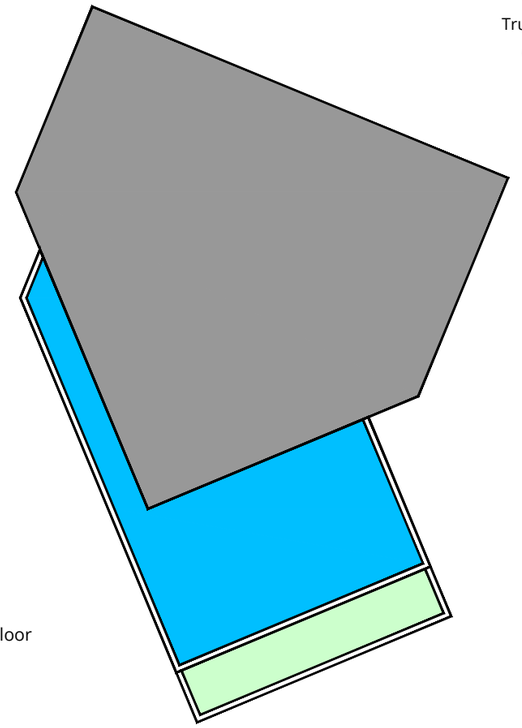
Figure: 6



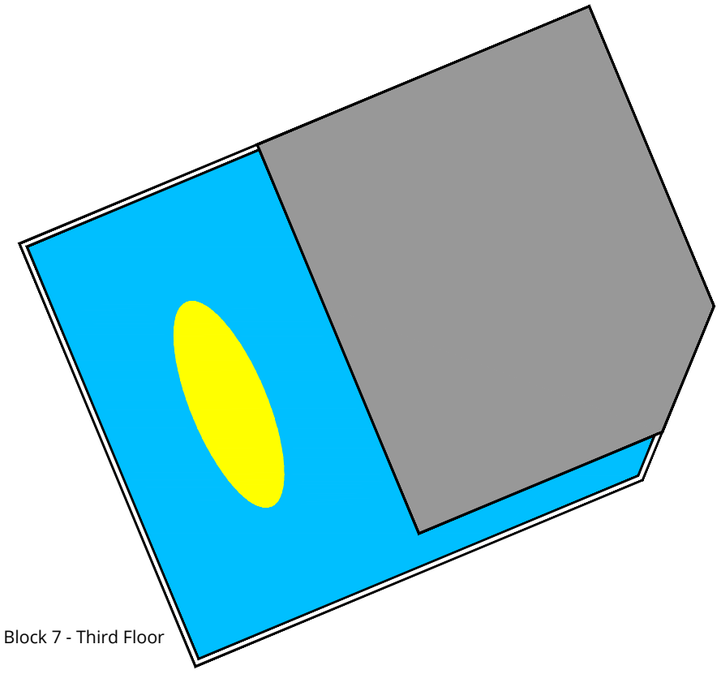
Block 1 - First Floor



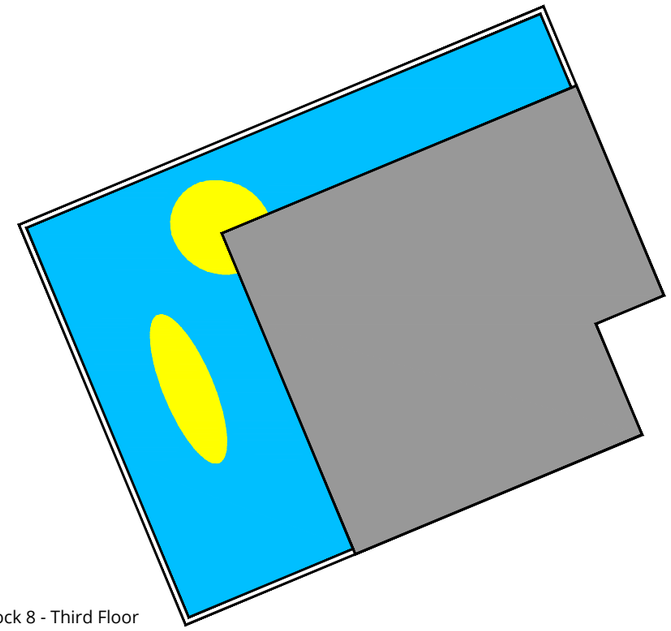
Block 4 - Fourth Floor



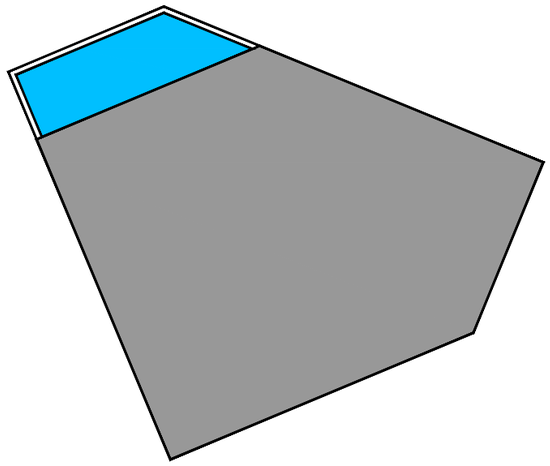
Block 6 - Third Floor



Block 7 - Third Floor



Block 8 - Third Floor



Block 9 - Third Floor

LDDC COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

Pedestrian Wind Usage Conditions - Elevated Levels

Configuration 2: Proposed Development with Existing Surrounding Buildings

Summer Season

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Figure: 7