FINAL REPORT

STAG BREWERY

LONDON, UK

PEDESTRIAN LEVEL WIND MICROCLIMATE ASSESSMENT

RWDI #1901953
23 JANUARY 2020

SUBMITTED TO

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VERSION HISTORY

RWDI Project #1901953	Stag Brewery London, UK	
Report	**Releases**	**Dated**
Reports	Rev B Rev C	05 November 2019 23 January 2020
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1 EXECUTIVE SUMMARY

The objective of this study was to determine the ground, terrace and balcony level wind environment within and around the Proposed Development in London, UK.

This report presents a description of the methodology used and the results of four configurations tested in the wind tunnel, namely:

- Configuration 1: The Development with Existing Surrounding Buildings; and
- Configuration 2: The Development with Existing Surrounding Buildings and Proposed Landscaping

The Proposed Development comprise the detailed design element to the east (Buildings 01 through 12) including the school and the outline element to the west (Buildings 13 through 21).

The meteorological data for the Site indicates strong prevailing winds from the south-west quadrant throughout the year with secondary winds from the north-east direction which are more prevalent during the spring months.

Without proposed landscaping (Configuration 1) the wind conditions throughout the Proposed Development would generally be suitable for the intended use, with wind conditions which would range from suitable for sitting use to strolling use during the windiest season. The exceptions to this would be the outdoor seating to the west of Building 07 (probe locations 169 and 170) and the seating area near the north-west corner of Building 06 (probe location 201). These locations would be one category windier than required without landscaping in situ.

The inclusion of landscaping (Configuration 2) would mitigate the windier conditions at the noted seating areas in Configuration 1. All other locations in and around the Proposed Development (as for Configuration 1) would also be suitable for the intended use.

It should be noted that several rooftop terraces on outline Buildings 15 to 19 have wind conditions suitable for standing use during the summer season. This would be suitable for general amenity use but would be windier than required for sitting use. Therefore, these areas may require wind mitigation measures which would be developed at the RMA stage of the buildings when the intended uses are confirmed.

No strong wind exceeding the safety threshold of 15m/s have occurred around the Proposed Development in either configuration.

2 INTRODUCTION

RWDI was retained to conduct a pedestrian level wind microclimate (PLW) assessment for the Proposed Development in London, UK (referred to hereafter as the "Proposed Development"). This report presents the background, objectives, methodology, results and discussion from RWDI's assessment. A summary of the overall recommendations from the investigation are presented in Section 6 "Conclusions".

Wind tunnel tests were conducted on a 1:300 scale model of the Proposed Development. The investigation quantifies the wind conditions within and around the Site through comparison of the measured wind velocity and frequency of occurrence with the Lawson Comfort Criteria. Meteorological data for London, UK has been combined, analysed and adjusted to the Site conditions by modelling the effect of upstream terrain roughness on the wind velocities approaching the Site.

Measurements were taken at up to 356 locations for 36 wind directions, in 10° increments. The measurements covered ground level locations along the building façades and at corners, near main entrances, on pedestrian routes within and around the Site, private balconies and terraces within the Site. The analyses were conducted on seasonal basis, however, the report focuses primarily on the windiest season (i.e. winter) and the summer season results, when pedestrian activity generally requires calmer conditions.

The following list represent the number of modelled configurations tested in the wind tunnel in ascending order:

- Configuration 1: The Development with Existing Surrounding Buildings; and
- Configuration 2 The Development with Existing Surrounding Buildings and Proposed Landscaping

The Development model was constructed based on the following information:

- "18125-SQP-ZZ-ZZ-M3-A-0001_rkl - 3D View - EXPORT FOR CONSULTANTS.dwg" – received August 27th, 2019
- "18125_G100_P_00_001_A.pdf" - received August 27th, 2019
- "18125_G100_P_02_001_-.dwg" - received August 27th, 2019"P10736-00-003-GIL-0101-00 GIL mark up.pdf" – received August 13th, 2019

2.1 Site Description and Surroundings

The Site is located in London UK, approximately 240m to the north of Mortlake Railway Station. The site is bounded by Bulls Alley to the east, Mortlake High Street to the south, Ship Lane to the west and River Thames to the north. The outline Site is located to the west of the detailed element Site and is bounded by Williams Lane to the west. The Ordnance Survey Landranger grid reference is TQ204760.

The surrounding buildings are generally low to medium rise. This area topology represents a high-intensity suburban terrain, which results in a relatively turbulent environment with a lower mean wind velocity in comparison to an open terrain (such as by the coast) where the mean wind velocities are higher with lower turbulence levels. A satellite view of the approximate location of the Site is highlighted in yellow with its surroundings in Figure 1.

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

2.2 The Proposed Development

The Proposed Development comprise the detailed design element to the east (Building 01 through 12) including the school and the outline element to the west (Buildings 13 through 21). There are amenity spaces at ground level which include outdoor seating and general amenity, as well as terraces and balconies at higher levels. A thorough proposed landscaping scheme has also been included which includes trees and planters throughout the entirety of the Site. Figure 2 shows the wind tunnel model of the Proposed Development from the south.

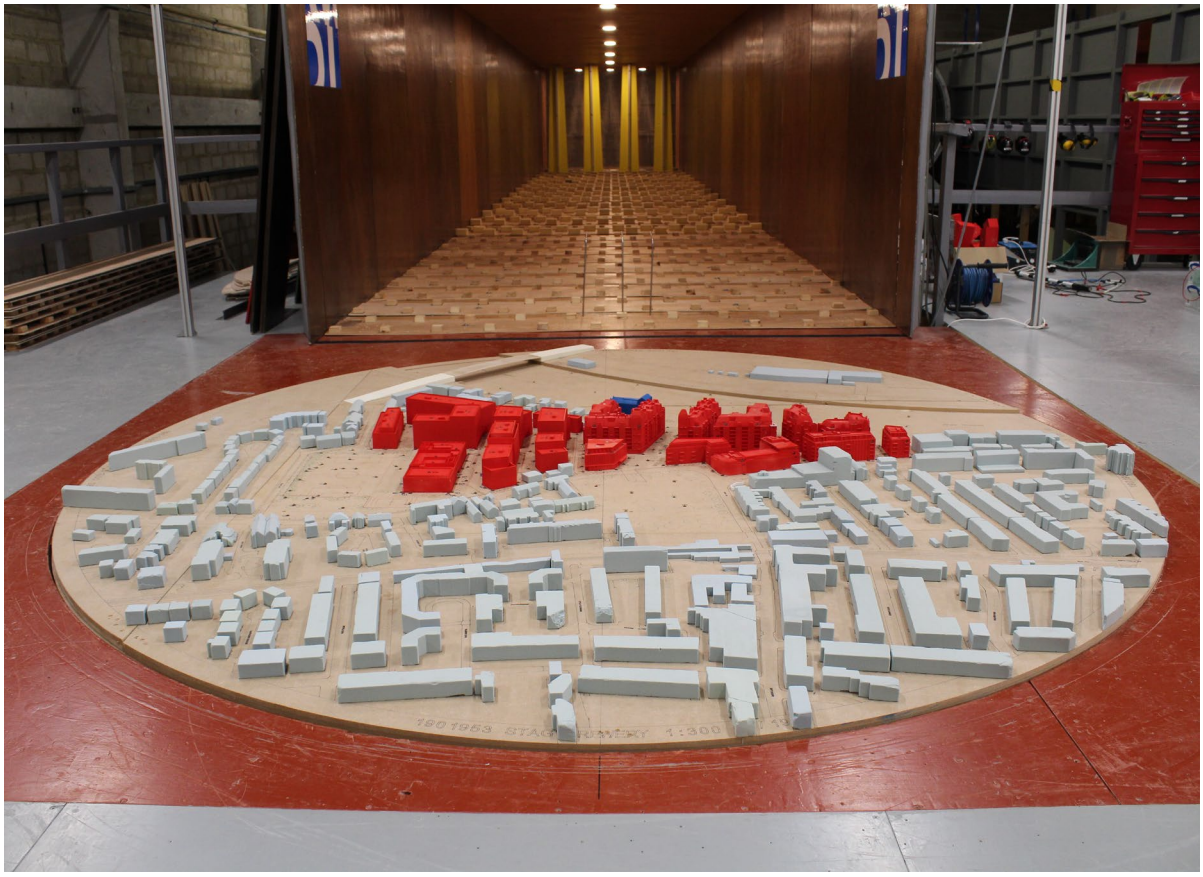


Figure 2: South View of the Stag Brewery Project with Existing Surrounding Buildings (Configuration 1) in wind tunnel

3 METHODOLOGY AND ASSESSMENT CRITERIA

Wind tunnel testing is a well-established and robust technique to assess the pedestrian wind microclimate of the Proposed Development. It provides the means to quantify the wind conditions at the Site and for the measurements to be classified in accordance with the Lawson Comfort Criteria (outlined in Section 3.5). Wind tunnel investigations were conducted using a 1:300 scale model of the Proposed Development with existing and cumulative surrounding buildings and terrain covering a radius of 260m centred on the Site.

The basic methodology for quantifying the PLW environment is outlined below:

1. Measure the wind speeds at pedestrian level in the wind tunnel relative to a reference wind speed;
2. Adjust standard meteorological data to account for conditions at the Site;
3. Combine these to obtain the expected frequency and magnitude of wind velocities at pedestrian level; and
4. Compare the results with the Lawson Comfort Criteria to 'grade' conditions around the Site.

3.1 Simulation of Atmospheric Winds

Wind flow is considered turbulent with varying levels of turbulence that depend on the location of the Site. In addition, atmospheric boundary layers arise from the fluid viscosity causing the mean wind velocity to increase with height as a result of the layers shearing effect. This effect is modelled in the wind tunnel upstream of the test section using spires and floor roughness elements to reproduce a naturally-grown boundary layer that is representative of urban or open country conditions, as appropriate. The detailed contoured proximity model around the Site is used to further refine the flow dynamics and create conditions similar to those expected at full scale (as shown in Figure 2).

3.2 Measurement Technique

Wind speed measurements in the wind tunnel were made using Irwin probes (Irwin, 1981). For pedestrian comfort studies, both the mean wind speed and the peak wind speed are measured at specified locations at the Site and surrounding area to represent sensitive receptors, such as entrances, amenity areas and thoroughfares, at a scaled height of 1.5m above ground level. The typical equivalent full-scale time period for measuring the mean wind speed is around 90 minutes, whereas the peak wind speed is taken as the wind speed exceeded for 1% of the time.

Wind speed at each location was measured for 36 wind directions in 10° increments, with 0° representing wind blowing from the north and 90° wind blowing from the east.

3.3 Scaling

The length scale of the model was 1:300 and the velocity scale was approximately 1:2 for strong winds. Consequently, the time scale for the tests was 1:150, or in other words 1 second in the wind tunnel is equivalent to 150 seconds at full scale.

3.4 Meteorological Data

Meteorological data reveal the prevailing wind direction throughout the year to focus the attention on the possible influence of these winds on the Site with the exception to the building massing and layout that may indicate that winds from other directions may be equally important.

The meteorological data for this report was derived from the meteorological stations at two major airports (Heathrow and City) and has been revised to standard conditions of 10m above open flat level country terrain. The data is then adjusted to the Site conditions using the methodology implemented in the BREVe3.2 software package. Low to medium rise inner city environments increase the turbulence within the atmospheric boundary layer which reduces the mean wind speed, requiring terrain roughness factors to be specified and applied to the meteorological data to account for the variations in terrain surrounding the Site.

Approximately thirty years' worth of data were obtained from the combined London airports and was categorised by season as demonstrated in Figure 15 as wind roses. The radial axis indicates the cumulative number of hours that the wind velocity exceeds the particular Beaufort Force in a full circle per season. 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 data indicates that the prevailing wind direction throughout the year is from south-west, which is typical for many areas of southern England. In addition, there is a secondary peak from the north-east that becomes dominant during the spring season.

3.5 Pedestrian Comfort

The assessment of the wind conditions requires a standard against which the measurements can be compared. This report uses the Lawson Comfort Criteria (Lawson, 2001) that have been established for over thirty years and have been widely used on building developments across the United Kingdom. The comfort criteria seek to define the reaction of an average pedestrian to the wind as described in Table 1. If the measured wind conditions exceed the threshold wind velocity for more than 5% of the time, then they are deemed unacceptable for the intended pedestrian activity. 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 categories are sitting, standing, strolling and walking, in ascending order of activity level, with a fifth category for conditions that are uncomfortable for all pedestrian 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 wind tunnel test results described in the results section of this report.

Table 1: 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 strolling along a city/town 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

3.6 Strong Winds

The criteria also specify a strong wind threshold when winds exceed 15m/s for more than 0.025% of the time. Exceedance of this threshold indicates a need for remedial measures and careful assessment of the expected use of that location.

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

4 RESULTS

4.1 Details of Analysis

To account for the difference in height and terrain roughness between meteorological conditions at the airports and the Site, it is necessary to apply adjustment factors to the wind tunnel velocity ratios. Adjustment factors (mean factors) were computed for wind directions from 0° through to 360°. The reference height in the wind tunnel was at the equivalent full-scale height of 120 metres. Table 2 presents the mean factors for the Site.

4.1.1 Table 2: BREVe3 mean factors at 120m above ground level

Wind Direction	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
Mean Factor at 120 m	1.39	1.41	1.42	1.43	1.38	1.40	1.45	1.44	1.40	1.38	1.39	1.36

4.2 Desired Pedestrian Activity around the Proposed Development

For the Proposed Development, the target conditions are:

1. Strolling during the windiest season on pedestrian thoroughfares;
2. Standing/entrance conditions at main entrances, drop off areas or taxi ranks, and bus stops throughout the year (although it should be noted that back of house entrances and fire escapes, which are used less frequently, would tolerate windier conditions suitable for strolling use);
3. Standing use conditions during the summer season at private balcony/terrace spaces where there is no designated seating; and
4. Sitting conditions at outdoor seating and amenity areas during the summer season when these areas are more likely to be frequently used by pedestrians. Larger amenity spaces would tolerate a mixture of sitting and standing use wind conditions during the summer season, should all seating areas be suitable for sitting use.

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.

Achieving a sitting classification in the summer usually means that the same receptor 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.

It should be noted that a mixture of sitting and standing uses is acceptable for a 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.

4.3 Performance against the Lawson Comfort Criteria

The results of the assessment for each configuration against Lawson Comfort Criteria are described below and presented graphically in Figures 3 to 10.

4.3.1 Configuration 1 – The Development with Existing Surrounding Buildings

The wind microclimate results for Configuration 1 are shown in the following figures:

- Figure 3: Windiest Season (Ground Level)
- Figure 4: Windiest Season (Balcony/Roof Level)
- Figure 5: Summer Season (Ground Level)
- Figure 6: Summer Season (Balcony/Roof Level)

4.3.2 Configuration 2 - The Development with Existing Surrounding Buildings and Proposed Landscaping

The wind microclimate results for Configuration 2 are shown in the following figures:

- Figure 7: Windiest Season (Ground Level)
- Figure 8: Windiest Season (Balcony/Roof Level)
- Figure 9: Summer Season (Ground Level)
- Figure 10: Summer Season (Balcony/Roof Level)

4.4 Occurrence of Strong Winds

Strong winds exceeding 15m/s and 20m/s for more than 0.025% (2.2 hours) are a safety concern and would be reported.

There would be no occurrences of strong winds exceeding 15m/s for more than 2.2 hours per year in both configurations.

5 MITIGATION MEASURES

This section discusses the mitigation measures that are recommended by RWDI to mitigate the comfort exceedances in a seating area located at probe location 159 (north east corner of Building 02). As part of the mitigation strategy this seating area will be moved further to the south where wind conditions are suitable for sitting use.

It should be noted that balcony/terrace location 282 would have suitable wind conditions only with a solid balustrade 1.4m in height. Without this balustrade or with a railing balustrade, unsafe wind conditions would occur and therefore the balustrade at this location form part of the embedded mitigation inherent in the Development.

6 CONCLUSIONS

The meteorological data for the application site indicated prevailing winds from the south-west quadrant throughout the year with secondary winds from the north-easterly direction, particularly during spring.

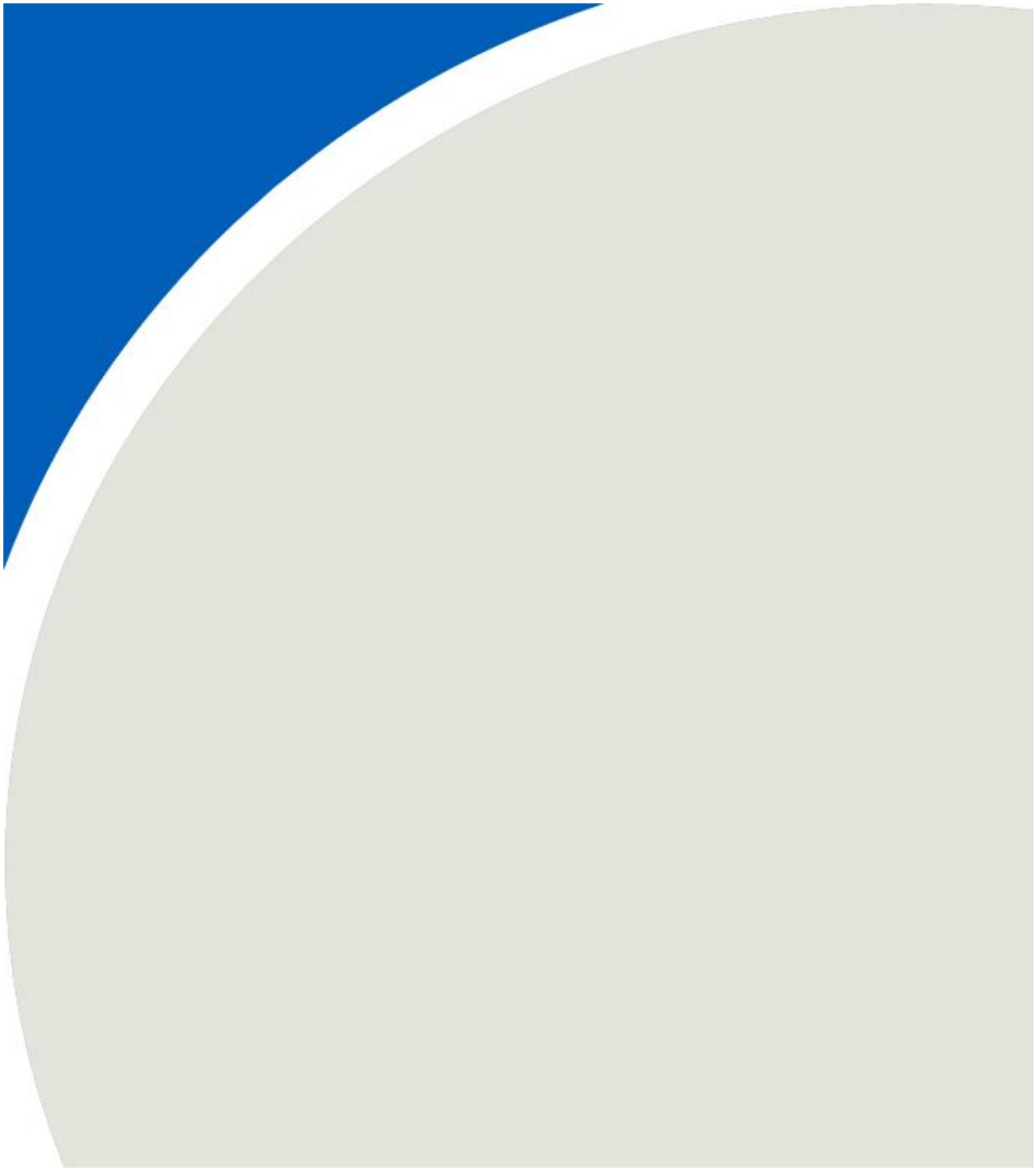
Without landscaping in situ, wind conditions would be as expected for an urban development and would generally be suitable for the intended use. All thoroughfares, private balconies, terraces and the majority of amenity seating areas were suitable for the intended use, with the exception of outdoor seating to the west of Building 07 and near the north-west corner of Building 06. These locations had wind conditions one category windier than suitable for the intended use.

With the inclusion of the proposed landscaping all locations (including outdoor seating to the west of Building 07 and near the north-west corner of Building 06) at the Proposed Development would be suitable for the intended use.

No strong winds exceeding the safety threshold of 15m/s would occur with or without landscaping in situ.

No further wind mitigation would be required in addition to the embedded landscaping and balcony design.

FIGURES



LEGEND:

LDDC COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:

- Ground Level
- Podium Level
- Balcony/Roof Level

BLOCK 20
BLOCK 19
BLOCK 18
BLOCK 21
BLOCK 16
BLOCK 17
BLOCK 15
BLOCK 13
BLOCK 14
BLOCK 01
BLOCK 02
BLOCK 03
BLOCK 04
BLOCK 07
BLOCK 08
BLOCK 11
BLOCK 12
BLOCK 06
BLOCK 10
BLOCK 05
BLOCK 09
WILLIAMS LANE
LOWER RICHMOND ROAD
MORTLAKE HIGH STREET
VINEYARD PATH
SHEEN LANE
ALDER ROAD

0 40 80m

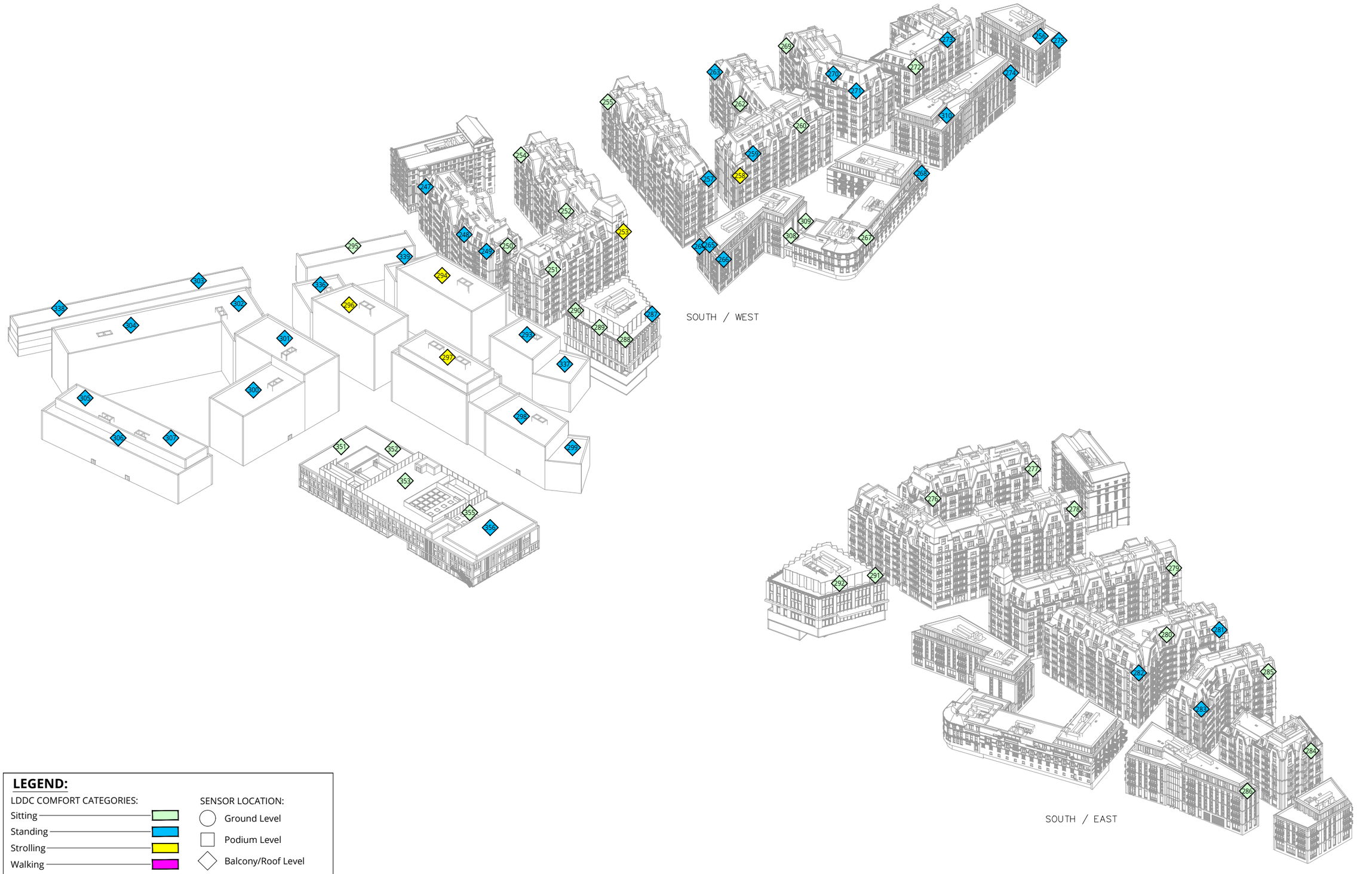
Pedestrian Wind Comfort Conditions - Ground Floor
Configuration 1: Proposed Development with the Existing Surrounding Buildings
Windiest Season

Stag Brewery- Revised Scheme - London, UK

True North

Project #1901953

Drawn by:	EN	Figure:	3
Approx. Scale @A3:	1:2000		
Date Revised:	Oct. 28, 2019		



LEGEND:

LDDC COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:

- Ground Level
- Podium Level
- Balcony/Roof Level

0 30 60m

Pedestrian Wind Comfort Conditions - Isometric Views
Configuration 1: Proposed Development with the Existing Surrounding Buildings
Windiest Season

Stag Brewery- Revised Scheme - London, UK

Project #1901953

Drawn by:	EN	Figure:	4
Approx. Scale @A3:	1:1500		
Date Revised:	Oct. 28, 2019		

LEGEND:

LDDC COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:

- Ground Level
- Podium Level
- Balcony/Roof Level

BLOCK 20
BLOCK 19
BLOCK 21
BLOCK 18
BLOCK 16
BLOCK 17
BLOCK 15
BLOCK 13
BLOCK 14
BLOCK 01
BLOCK 02
BLOCK 03
BLOCK 04
BLOCK 07
BLOCK 08
BLOCK 11
BLOCK 12
BLOCK 09
BLOCK 06
BLOCK 10
BLOCK 05
WILLIAMS LANE
LOWER RICHMOND ROAD
MORTLAKE HIGH STREET
VINEYARD PATH
SHEEN LANE
ALDER ROAD

0 40 80m

Pedestrian Wind Comfort Conditions - Ground Floor
Configuration 1: Proposed Development with the Existing Surrounding Buildings
Summer Season

Stag Brewery- Revised Scheme - London, UK

True North

Project #1901953

Drawn by:	EN	Figure:	5
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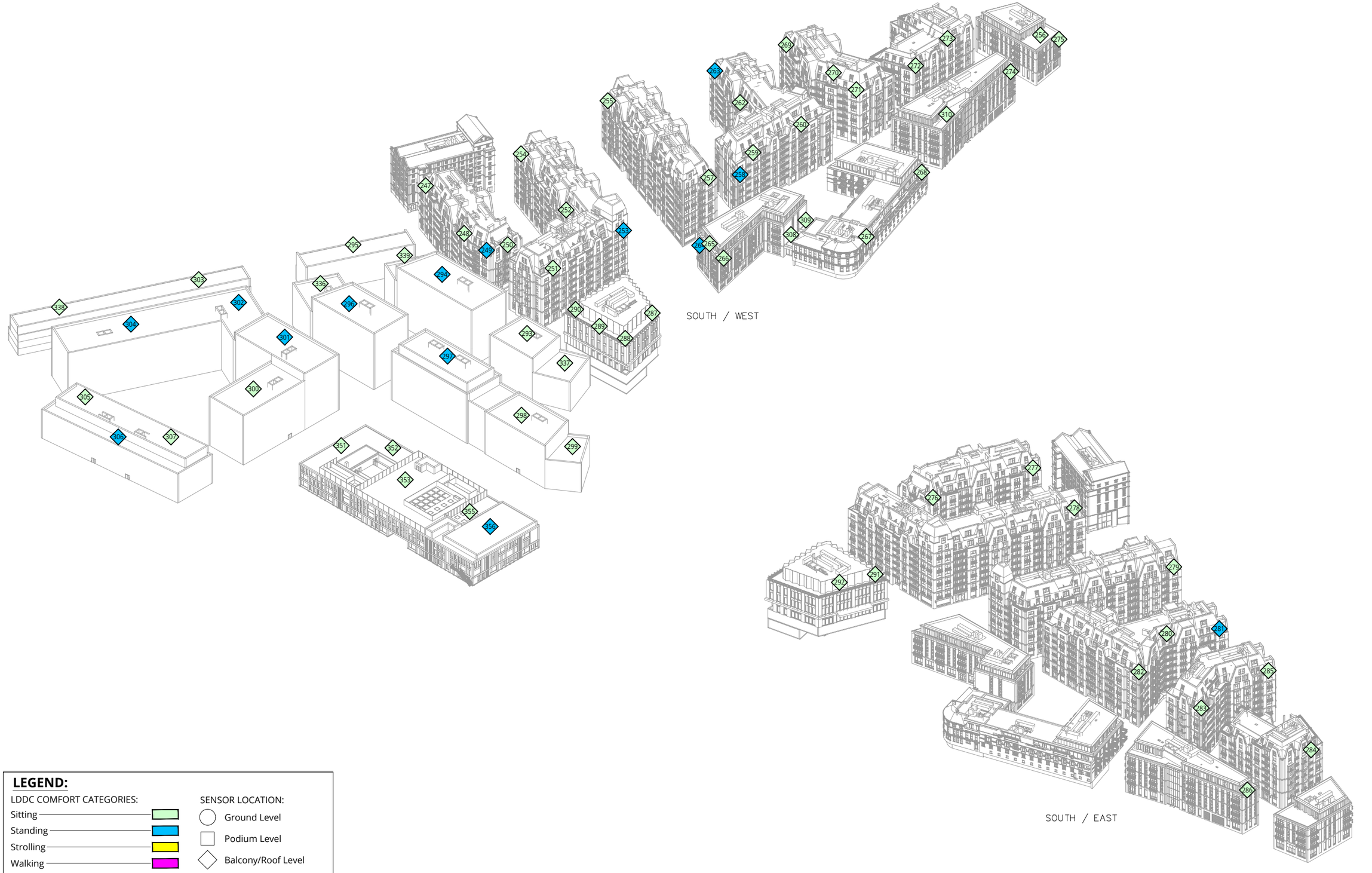

LEGEND:

LDDC COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:

- Ground Level
- Podium Level
- Balcony/Roof Level

0 30 60m

Pedestrian Wind Comfort Conditions - Isometric Views
Configuration 1: Proposed Development with the Existing Surrounding Buildings
Summer Season

Stag Brewery- Revised Scheme - London, UK

Project #1901953

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Date Revised:	Oct. 28, 2019		

LEGEND:

LDDC COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:

- Ground Level
- Podium Level
- Balcony/Roof Level

BLOCK 20
BLOCK 19
BLOCK 18
BLOCK 21
BLOCK 16
BLOCK 17
BLOCK 15
BLOCK 13
BLOCK 14
BLOCK 03
BLOCK 02
BLOCK 01
BLOCK 04
BLOCK 07
BLOCK 08
BLOCK 06
BLOCK 05
BLOCK 11
BLOCK 12
BLOCK 10
BLOCK 09
WILLIAMS LANE
LOWER RICHMOND ROAD
MORTLAKE HIGH STREET
VINEYARD PATH
SHEEN LANE
ALDER ROAD

0 40 80m

Pedestrian Wind Comfort Conditions - Ground Floor
Configuration 2: Proposed Development with Landscaping and the Existing Surrounding Buildings
Windiest Season

Stag Brewery- Revised Scheme - London, UK

True North

Project #1901953

Drawn by:	EN	Figure:	7
Approx. Scale @A3:	1:2000		
Date Revised:	Oct. 28, 2019		