

STATION HILL NORTH SITE

READING, UK

PEDESTRIAN LEVEL WIND MICROCLIMATE ASSESSMENT

RWDI #1803688 REV E

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SUBMITTED TO

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VERSION HISTORY

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1 EXECUTIVE SUMMARY

The objective of this study was to determine the ground and terrace level wind environment within and around the proposed Station Hill North Site development in Reading, UK.

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

- Configuration 1: Existing Site with the Existing Surrounding Buildings;
- Configuration 2: Interim Development Scenario with the Existing Surrounding Buildings;
- Configuration 3: Maximum Parameter Development with the Existing Surrounding Buildings; and
- Configuration 4: Maximum Parameter Development with the Cumulative Surrounding Buildings.

Following initial wind tunnel testing, wind conditions around the Proposed Development were improved through a massing workshop to optimise the form of the Phase 2 and Phase 3 buildings followed by a pair of wind mitigation workshops to refine wind conditions through iterative development and testing of wind mitigation workshops. The results of these workshops are presented over four configurations, namely:

- Mitigation: Interim Development Scenario with Landscaping, Wind Mitigation and the Existing Surrounding Buildings;
- Mitigation: Development Option 1 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings;
- Mitigation: Development Option 2 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings; and
- Mitigation: Development Option 3 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings.

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.

At the existing Site, wind conditions range from suitable for sitting to strolling use at and surrounding the North Site during the windiest season. Wind conditions at the south-eastern corner of Thames Tower are suitable for strolling use. Other thoroughfares would have conditions suitable for strolling use and existing entrance locations would be suitable for standing use or calmer. During the summer season wind conditions within existing amenity space would be suitable for sitting and standing use. There are instances of winds exceeding the strong wind threshold and a potential safety concern for cyclists and more vulnerable pedestrians at the south-eastern corner of Thames Tower and on Garrard Street south of Thames Tower.

In the Interim Development Scenario, conditions would range from suitable for sitting to walking use during the windiest season. Conditions would be windier than suitable on the podium thoroughfare north of Plot G. All other thoroughfares and entrance locations would have suitable wind conditions. During the summer season wind conditions at the Plot G terrace levels would be one category windier than suitable. Remaining amenity spaces would be suitable for the intended use. There would be strong winds with the potential to be a safety concern for cyclists and more vulnerable pedestrians at the south-eastern corner of Thames Tower, to the south of Plot G, on Garrard Street, to the north and the west of Plot G and on the upper Plot G terrace.



At the Completed Development, wind conditions on thoroughfares would be up to two categories windier than suitable at the junction of Station Hill, Greyfriars Road and Tudor Road and up to one category windier than suitable on Garrard Street, to the west and north-west of Plot G and at existing entrances of Tudor Road, Station Hill and Greyfriars Road during the windiest season. Conditions on other thoroughfares at the Site and at entrance locations would be suitable for the intended use. During the summer season wind conditions within ground floor and terrace level amenity spaces would be up to one category windier than suitable. Instances of strong wind which would be a safety concern for all pedestrians would occur on Station Hill, while strong winds with the potential to be a safety concern for cyclists and more vulnerable pedestrians would occur on Station Hill, Greyfriars Road, Garrard Street and at the north-western corner and west of Plot G. The development of cumulative schemes would result in local improvements in wind conditions, however, windy conditions and safety concerns would persist.

Wind mitigation measures were developed through wind tunnel testing to improve wind conditions and reduce the occurrence of strong winds. These measures are detailed in Section 7 'Mitigation'.

With the implementation of these measures, wind conditions in the Interim Development Scenario would be suitable for the intended use on thoroughfares. The eastern entrance to Plot G would be one category windier than suitable for the intended use. Other entrance locations would have suitable wind conditions. Ground floor amenity spaces would be suitable for the intended use or similar to those in the baseline scenario during the summer season. At terrace levels, conditions would be one category windier than suitable. There would be instances of strong winds with the potential to be a safety concern for cyclists and more vulnerable pedestrians at the south-eastern corner of Thames Tower. As these conditions are present at the existing Site, it would not be contingent on the application to further reduce the occurrence of these winds.

Wind mitigation measures at the Completed Development were assessed over three development options with the final design of Phase 3 being determined at a later date. In each of these three options, wind conditions on thoroughfares at and surrounding the Proposed Development would be suitable for the intended use during the windiest season, however, an entrance location on the north side of Station Hill and to Plot A at podium level would be suitable for strolling use, one category windier than would be acceptable. During the summer season wind conditions at ground floor level amenity spaces would be suitable for predominantly sitting use, with localised areas of standing use conditions in all three options, acceptable conditions provided seating provision is located in area suitable for sitting use. At terrace levels a majority of standing use conditions at the Plot B terrace level in Development Option 2 and the Plot G upper terrace level during Development Option 3 would be one category windier than suitable for amenity use. Balcony locations on Plot A would have conditions one category windier than suitable for private amenity use in Option 2. Balcony and terrace levels would otherwise be suitable for the intended use during the summer season. There would be no instances of strong winds at the development in Option 1 except areas which are only accessible to maintenance workers. However, instances of strong winds would persist with the potential to be a safety concern for cyclists and more vulnerable pedestrians on the Station Hill carriageway in Option 2 and Option 3 as well as at Plot A balcony locations in Option 2.

Overall, wind conditions at the Site in the Interim Development Scenario would predominantly be suitable for the intended use, however, additional landscaping would be beneficial at the Plot G terrace levels. At the Completed Development, wind conditions within Phase 2 would generally be suitable for the intended use, with windy conditions at terrace level likely improved with the implementation of dense planting at least 1.5m tall to shelter seating provision. Windy conditions and isolated areas with strong winds at and surrounding Phase 3 would be expected to be improved following refinement of wind mitigation measures during wind tunnel testing of the detail design of Phase 3.

2 INTRODUCTION

RWDI was retained to conduct a pedestrian level wind microclimate assessment for the North Site (Phase 2 and Phase 3) of the proposed Station Hill Development in Reading, UK. 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 7 "Conclusions".

Wind tunnel tests were conducted on a 1:300 scale model of the proposed Station Hill North Site development (referred to as the "Proposed Development"). The investigation quantifies the wind conditions within and around the Site through comparing the measured wind velocity and frequency of occurrence with the Lawson Comfort Criteria. Meteorological data from London Heathrow airport was analysed and adjusted to the Site conditions by modelling the effect of the surrounding terrain roughness on the wind velocities approaching the Site.

Measurements were taken at up to 262 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, terraces and balconies 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 configurations of the Proposed Development were tested in the wind tunnel:

- Configuration 1: Existing Site with the Existing Surrounding Buildings;
- Configuration 2: Interim Development Scenario with Landscaping and the Existing Surrounding Buildings;
- Configuration 3: Maximum Parameter Development with Landscaping and the Existing Surrounding Buildings; and
- Configuration 4: Maximum Parameter Development with Landscaping and the Cumulative Surrounding Buildings.

The Interim Development Scenario represents a scenario where by Phase 2 of the Development would be complete with the Phase 3 Site cleared by yet to commence construction. Similarly, due to the phased nature of the Development Phase 1 of the Development has been included within the existing surrounding context for the Interim and Completed Development scenarios.



Following initial testing of the above scenarios, wind conditions around the Proposed Development were improved through a massing workshop to optimise the form of the Phase 2 and Phase 3 buildings. Wind conditions around the resulting design options were refined through application of the draft landscaping scheme and development of wind mitigation measures through two iterative wind mitigation workshops. The results of these workshops are presented over four configurations, namely:

- Mitigation: Interim Development Scenario with Landscaping, Wind Mitigation and the Existing Surrounding Buildings;
- Mitigation: Development Option 1 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings;
- Mitigation: Development Option 2 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings; and
- Mitigation: Development Option 3 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings.

2.1 Site Description and Surroundings

The Site is located in Reading, to the south of Reading Station. The North Site is currently occupied by the Garrard Street multi storey car park and temporary event space to the west of Thames Tower and Xfinity House at the western end of the Site. The remainder of the Site is cleared and in use as surface parking and construction offices. The Site is bound by Garrard Street to the south, Greyfriars Road to the west, Station Hill to the north and Thames Tower and the Station Road plaza to the east. The Ordnance Survey Landranger grid reference is SU713737.

The surrounding buildings are generally low to medium rise. This surrounding terrain is typical of suburban terrain, which results in a lower mean wind speed and greater levels of turbulence than if the Site were surrounded by open country, but greater mean wind speeds and lower turbulence than if surrounded by dense urban terrain. A satellite view of the approximate Site location 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 Station Hill North Site consists of Phase 2 and Phase 3 of the wider Station Hill development. Phase 2 has been assessed in detail and Phase 3 in outline. Phase 2 comprises a ground plus part 8 / part 16 storey office and retail building and a landscaped podium (Plot G) with a link bridge over Garrard Street to Phase 1 of the Station Hill development. Public amenity space would be provided at podium level with commercial amenity at terrace levels.

Phase 3 would be a mixed-use development consisting of four buildings, Plots A, B, C and D, that would range in height from the tallest at 25 storeys above podium level to the lowest at 12 storeys along the western and southern Site boundary with Plot C at the centre of a communal podium level connecting to Phase 2.



Figure 2: Configuration 3 of the Proposed Development in the wind tunnel (view from the south, Phase 1 shown in Red, Phase 2 shown in Purple and Phase 3 shown in Orange)

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 360m centred on the Site.

The basic methodology for quantifying the Pedestrian Level Winds (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 of 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 station at London Heathrow airport and has been revised to standard conditions of 10m above open flat level country terrain. The set of data is then adjusted to the Site conditions using the methodology implemented in the BREVe3 software package.

Approximately thirty years' worth of data obtained from London Heathrow airport is presented in Appendix B, Figure 49 as seasonal 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 south-east England. In addition, there is a secondary peak from the north-east during the spring season. Combination of this meteorological data-set and the velocity ratios obtained from the Site using the wind tunnel permits the evaluation of time ratios that the wind velocity exceeds the Lawson Comfort Criteria.

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 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

Lawson also specified a lower limit strong wind threshold that is prescribed for winds exceeding 15m/s for more than 0.025% of the time (approximately 2.2 hours per year). Exceedance of this threshold may indicate a need for remedial measures and careful diagnosis of the expected use of that location. Winds that exceed 20m/s for more than 2.2 hours per year represent a safety concern for all members of the population and would require mitigation to provide an appropriate wind environment.

Generally, strong winds are associated with areas which would be classified as walking or as uncomfortable. In a mixed-use urban development scheme, such as the one in the Proposed Development, walking and uncomfortable conditions would not meet the 'target' wind environment and would require mitigation due to pedestrian comfort considerations. This mitigation measure 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 airport 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.

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	1.41	1.42	1.44	1.43	1.39	1.45	1.46	1.51	1.46	1.41	1.41	1.40

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 conditions at main entrances, drop off areas or taxi ranks, and bus stops throughout the year; and
3. Sitting conditions at outdoor seating and amenity areas 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.

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 presented graphically in Figures 3 to 32.

4.3.1 Configuration 1: Existing Site with the Existing Surrounding Buildings

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

- Figure 3: Windiest Season (Ground Level);
- Figure 4: Summer Season (Ground Level); and
- Figure 5: Annual Strong Winds Exceedances (Ground and Terrace Levels).

The existing Site was modelled with existing landscaping on Station Hill to the north of the Site.

4.3.2 Configuration 2: Interim Development Scenario with the Existing Surrounding Buildings

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

- Figure 6: Windiest Season (Ground and Terrace Levels);
- Figure 7: Summer Season (Ground and Terrace Levels); and
- Figure 8: Annual Strong Wind Exceedances (Ground and Terrace Levels).

This configuration includes the Interim Development Scenario with the existing surrounding buildings including Phase 1 of the Station Hill development and the Phase 2 landscaping scheme ('*SHRN-LDA-S2-ZZ-PL-L-100-101.pdf*' provided by LDA Design on 24/10/2019).

4.3.3 Configuration 3: Maximum Parameter Development with the Existing Surrounding Buildings

The wind microclimate results for Configuration 3 are shown in the following figures:

- Figure 9: Windiest Season (Ground and Terrace Levels);
- Figure 10: Summer Season (Ground and Terrace Levels); and
- Figure 11: Annual Strong Wind Exceedances (Ground and Terrace Levels).

This configuration includes Phase 2 with the Maximum Parameter Development of Phase 3 with the existing surrounding buildings including Phase 1 of the Station Hill development and the draft Phase 2 landscaping scheme.

4.3.4 Configuration 4: Maximum Parameter Development with the Cumulative Surrounding Buildings

The wind microclimate results for Configuration 4 are shown in the following figures:

- Figure 12: Windiest Season (Ground and Terrace Levels);
- Figure 13: Summer Season (Ground and Terrace Levels); and
- Figure 14: Annual Strong Wind Exceedances (Ground and Terrace Levels).

This configuration includes Phase 2 with the Maximum Parameter Development of Phase 3 with the cumulative surrounding buildings including Phase 1 of the Station Hill development and the draft Phase 2 landscaping scheme.

4.3.5 Mitigation: Interim Development Scenario with Landscaping, Wind Mitigation and the Existing Surrounding Buildings

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

- Figure 15: Windiest Season (Ground and Terrace Levels);
- Figure 16: Summer Season (Ground and Terrace Levels); and
- Figure 17: Annual Strong Wind Exceedances (Ground and Terrace Levels).

This configuration includes the Interim Development Scenario with the Phase 2 landscaping scheme (*'SHRN-LDA-S2-ZZ-PL-L-100-101.pdf'* provided by LDA Design on 24/10/2019), wind mitigation measures and the existing surrounding buildings.

4.3.6 Mitigation: Development Option 1 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings

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

- Figure 18: Windiest Season (Ground and Terrace Levels);
- Figure 19: Summer Season (Ground and Terrace Levels);
- Figure 20: Summer Season (Terrace and Balcony Levels);
- Figure 21: Annual Strong Wind Exceedances (Ground and Terrace Levels); and
- Figure 22: Annual Strong Wind Exceedances (Terrace and Balcony Levels).

This configuration includes Development Option 1 of the Completed Development with draft Phase 2 landscaping, illustrative Phase 3 landscaping and the existing surrounding buildings including Phase 1 of the Station Hill development.

4.3.7 Mitigation: Development Option 2 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings

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

- Figure 23: Windiest Season (Ground and Terrace Levels);
- Figure 24: Summer Season (Ground and Terrace Levels);
- Figure 25: Summer Season (Terrace and Balcony Levels);
- Figure 26: Annual Strong Wind Exceedances (Ground and Terrace Levels); and
- Figure 27: Annual Strong Wind Exceedances (Terrace and Balcony Levels).

This configuration includes Development Option 2 of the Completed Development with draft Phase 2 landscaping, illustrative Phase 3 landscaping and the existing surrounding buildings including Phase 1 of the Station Hill development.

4.3.8 Mitigation: Development Option 3 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings

The wind microclimate results for Development Option 3 are shown in the following figures:

- Figure 28: Windiest Season (Ground and Terrace Levels);
- Figure 29: Summer Season (Ground and Terrace Levels);
- Figure 30: Summer Season (Terrace and Balcony Levels);
- Figure 31: Annual Strong Wind Exceedances (Ground and Terrace Levels); and
- Figure 32: Annual Strong Wind Exceedances (Terrace and Balcony Levels).

This configuration includes Development Option 3 of the Completed Development with draft Phase 2 landscaping, illustrative Phase 3 landscaping and the existing surrounding buildings including Phase 1 of the Station Hill development.

4.4 Occurrence of Strong Winds

Areas with occasional strong winds exceeding the 15m/s or 20m/s thresholds are presented in the annual safety exceedances figures. Strong winds in excess of 15m/s are considered a safety issue and would require mitigation, apart from where these conditions are pre-existing and occurring in the baseline.

Table 3: Annual Exceedance of Strong Winds

Location	Strong Wind Exceedance	Main Wind Direction	Hours per Annum
Configuration 1: Existing site with existing surrounding buildings			
79	S15	200	3.3
87	S15	40	3.1
88	S15	290	2.6
Configuration 2: Interim Development Scenario with the Existing Surrounding Buildings			
79	S15	200	3.8
89	S15	280	3.4
90	S15	280	3.5
149	S15	10	2.4
155	S15	210	6.6
157	S15	210	3.8
176	S15	260	3.1
259	S15	210	7.4
Configuration 3: Maximum Parameter Development with the Existing Surrounding Buildings			
12	S15	10	3.0
14	S15	10	8.5
20	S15	300	5.3
29	S15	10	4.7
33	S15	10	6.0
36	S15	260	28.5
38	S15	10	26.2
39	S20	280	4.6
40	S15	280	14.3
41	S20	270	3.3
43	S15	10	7.9
46	S15	260	20.4
50	S15	220	2.5
51	S15	250	4.1
98	S15	240	4.7

107	S15	280	3.0
109	S15	280	8.7
114	S15	280	5.3
144	S15	60	3.3
149	S15	10	6.6
150	S15	10	5.5
174	S15	220	13.9
12	S15	160	2.8
14	S15	250	9.0

Configuration 4: Maximum Parameter Development with the Cumulative Surrounding Buildings

14	S15	0	3.9
20	S15	290	5.1
33	S15	30	3.2
36	S15	260	26.2
38	S15	260	23.1
39	S20	270	4.3
40	S15	280	10.6
41	S20	260	3.0
43	S15	240	2.9
46	S15	260	16.9
51	S15	240	3.0
98	S15	280	2.6
109	S15	290	7.5
114	S15	290	4.5
144	S15	40	2.8
149	S15	0	4.4
150	S15	0	4.2
174	S15	200	9.6

Mitigation: Interim Development Scenario with Landscaping, Wind Mitigation and the Existing Surrounding Buildings

79	S15	200	5.2
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Mitigation: Development Option 1 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings

174	S15	230	4.0
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Mitigation: Development Option 2 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings			
51	S15	230	2.5
174	S15	230	8.7
193	S15	60	10.8
198	S15	260	2.9
Mitigation: Development Option 3 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings			
30	S15	300	14.8
43	S15	280	2.2
174	S15	200	9.6

5 EXPECTED INTENDED USES

An assessment of the suitability of wind conditions at the Proposed Development is dependent on knowing the intended pedestrian use of any given area at or surrounding the Site. The table below outlines the expected intended pedestrian uses of the Site and surrounding area as understood by RWDI for the purposes of this assessment in reference to the measurement locations.

Table 4: Expected intended pedestrian use table (Completed Development)

Expected Intended Use	Measurement Locations
Thoroughfares	1, 2, 9, 11, 14, 18 - 46, 48, 49, 51, 53 - 55, 57 - 65, 67, 69, 71, 73 - 76, 79 - 82, 84 - 90, 92 - 98, 101 - 117, 121, 124, 128 - 130, 132 - 134, 136, 144, 145, 147 - 159, 161, 163 - 166, 169, 170, 172, 181 - 183, 185, 189, 211, 247, 258 - 261
Entrances	3 - 8, 10, 12, 13, 15 - 17, 50, 66, 68, 72, 77, 83, 119, 123, 126, 141, 142, 146, 162, 171, 262
Bus Stops	47, 52, 56, 78, 91, 184
Car Park	249 - 257
Ground Level Amenity	70, 118, 120, 122, 125, 127, 131, 135, 137, 138, 139, 140, 143, 160, 167, 168
Balconies	186 - 188, 190 - 210, 212, 213
Roof Amenity	175 - 180, 220, 221, 248
Inaccessible (except to maintenance workers)	173, 174

6 MITIGATION MEASURES

Initial wind tunnel tests of the Interim Development Scenario and Development Options 1, 2 and 3 identified a number of areas where conditions would be windier than suitable for the intended pedestrian uses and instances of strong winds with the potential to be a safety concern for pedestrians. An initial workshop was undertaken to optimise the massing of the buildings within Phase 2 and Phase 3, following which wind mitigation workshops were conducted to assess the effectiveness of the Phase 2 draft landscaping scheme ('2019 07 16 Station Hill North landscaping.dwg' provided by CRTKL on 19/07/2019) and Phase 3 illustrative landscaping scheme ('6516_Illustrative Plan Whole Site _190827.jpg' provided 05/09/2019) and, where necessary, develop wind mitigation measures.

Additional wind tunnel testing was undertaken on Phase 2 of the Proposed Development to further assess a range of wind mitigation measures. The following wind mitigation measures were developed through iterative wind tunnel testing and would be required in conjunction with the Phase 2 draft landscaping scheme ('SHRN-LDA-S2-ZZ-PL-L-100-101.pdf' provided by LDA Design on 24/10/2019) to achieve the results presented:

- Sculpture, 7m tall by 2m nominal width, approximately 50% overall porosity, located south of western podium access stairs;
- Planter north of north-western corner of Plot G moved west by 3m;
- Single 7m tall deciduous tree added west of planter north of north-western corner of Plot G;
- Dense planting 1.5m in height added beneath trees in planter north of north-western corner of Plot G;
- Two elevated porous (approximately 50% open) screens, 4m tall by 2m wide, with 3m clearance to ground added north of north-western corner of Plot G, continuing line of above planter;
- Two 7m tall deciduous trees added to the north and the south of the intended route to the Plot C entrance (either side of measurement location 149);
- Dense planting 1.5m in height beneath trees north and south of the intended route to the Plot C entrance;
- Three 7m tall deciduous trees added along southern edge of podium at south-western corner of Plot G;
- Porous canopy on western side of Plot G reduced to 2.5m in depth from ground level frontage;
- Three 7m tall deciduous trees added north of proposed loading bay on northern side of Garrard Street;
- Two 5m tall deciduous trees in planters between proposed Phase 1 trees on southern side of Garrard Street west of Merchant's Place;
- Dense planting on upper terrace, 1.5m in height.

Measures were developed to illustrate the potential for mitigating strong winds and windy conditions at Development Options 1, 2 and 3 of the Completed Development in the context of the cumulative surrounding buildings through iterative wind tunnel testing. The following measures were assessed for all three development options and would include measures around Phase 2 of the Proposed Development that would differ from those detailed above. Further to the July 2019 Phase 2 draft landscaping scheme ('2019 07 16 Station Hill North landscaping.dwg' provided by CRTKL on 19/07/2019) and Phase 3 illustrative landscaping scheme ('6516_Illustrative Plan Whole Site _190827.jpg' provided 05/09/2019) the following measures would be required for wind conditions at the Proposed Development as presented:



- Three 7m tall deciduous trees to the north of the north-western corner of Plot G, extending the proposed copse of trees north of Plot G by approximately 10m to the west;
- Dense shrubs or hedging at least 1m in height added below the above 7m tall trees;
- Eight 7m tall deciduous trees on the northern side of Garrard Street;
- Six 7m tall deciduous trees on the southern side of Garrard Street, three each to the east and west of the junction with Merchants Place; and
- One 7m tall deciduous tree on the western side of Merchants Place immediately south of the junction with Garrard Street;
- Porous (up to 50% open) canopy on Plot G western elevation, 4.5m deep, extending 22.5m south from north-western corner of Plot G at third floor level;
- Canopy around north-western corner of Plot A, changed from solid to porous (up to 50% open);
- Porous (up to 50% open) balustrade 1.5m tall segregating possible first floor level terrace at north-western corner of Plot A from porous canopy;
- North-western corner of Plot A chamfered at ground floor level (2m removed from Greyfriars Road and Station Hill facades);
- Columns at eastern edge of Plot C eastern undercut with full height porous (up to 50% open) screening at southern end;
- Hedging/dense shrubs at northern edge of podium between Plot A and Plot C, 1.5m tall;
- Hedging/dense shrubs backing amenity spaces between Plot A and Plot C at Plaza level, 1.5m tall;
- Hedging/dense shrubs between Plot C and Plot D, 1.5m tall;
- Hedging/dense shrubs bordering amenity/landscaping areas to west of Plot C, 1.5m tall;
- Hedging/dense shrubs on upper Plot G terrace; and
- Porous (up to 50% open) balustrades, 1.5m tall, on Plot A balconies.

7 CONCLUSIONS

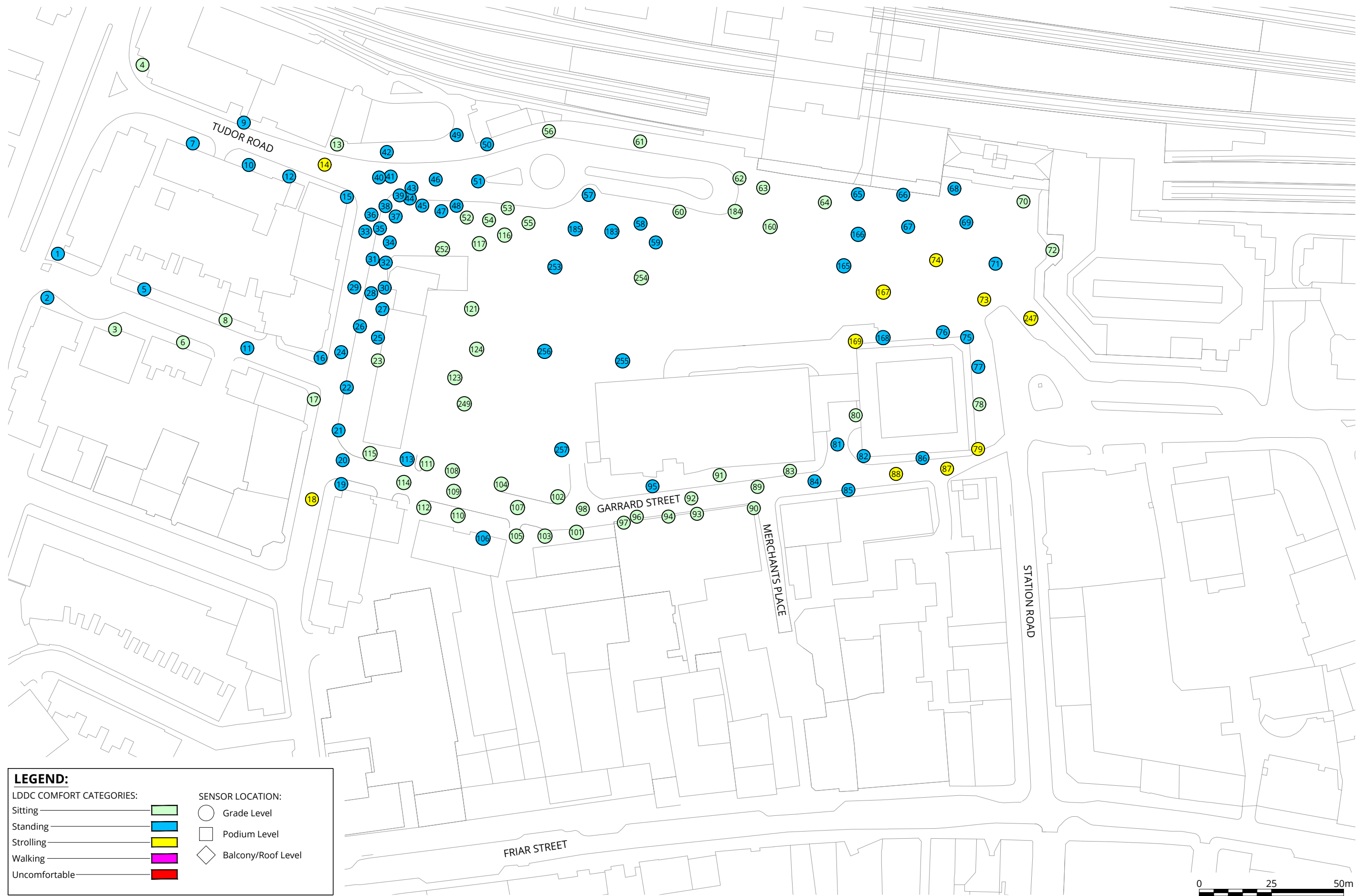
- The meteorological data for the Site indicates strong prevailing winds from the south-west quadrant throughout the year with secondary winds from the north-east direction which are more prevalent during the spring months.
- At the existing Site wind conditions range from suitable for sitting to strolling use during the windiest season. During the summer season wind conditions within existing amenity space would be suitable for sitting and standing use. At the existing Site there are strong winds at the south-eastern corner of Thames Tower and on Garrard Street, to the south of Thames Tower.
- In the Interim Development Scenario conditions would be windier than suitable at the north-western corner of Plot G during the windiest season. During the summer season wind conditions at the Plot G terrace level would be windier than suitable. Remaining amenity spaces would be suitable for the intended use. There would be strong winds with the potential to be a safety concern for cyclists and more vulnerable pedestrians on Garrard Street, at the south-eastern corner of Thames Tower and the north-western corner of Plot G.
- At the Completed Development, wind conditions on thoroughfares would be up to two categories windier than suitable at the junction of Station Hill, Greyfriars Road and Tudor Road and up to one category windier than suitable on Garrard Street and to the west and north-west of Plot G as well as entrance locations on Tudor Road, Station Hill and Greyfriars Road during the windiest season. During the summer season wind conditions within ground floor and terrace level amenity spaces would be up to one category windier than suitable. Strong wind which would be a safety concern for all pedestrians would occur on Station Hill, while strong winds with the potential to be a safety concern for cyclists and more vulnerable pedestrians would occur on Station Hill, Greyfriars Road, Garrard Street and at the north-western corner and west of Plot G. Cumulative developments would provide some localised shelter; however, windy conditions would persist.
- With the development of wind mitigation measures, wind conditions in the Interim Development Scenario would be one category windier than suitable at the eastern entrance to Plot G during the windiest season. During the summer season conditions at ground and podium level would be suitable for the intended use. At terrace levels, conditions would be one category windier than suitable. Instances of strong winds at the south-eastern corner of Thames Tower are present at the existing Site and as such it would not be contingent on the application to further reduce the occurrence of these winds.
- Three development options of the Completed Development were assessed. In each of these three options an entrance location on the north site of Station Hill and to Plot A at podium level would be one category windier than acceptable. During the summer season wind conditions at ground floor level amenity spaces would be suitable provided seating provision is located in area suitable for sitting use. At terrace level conditions at the Plot B terrace level in Option 2 and the Plot G upper terrace level would be one category windier than suitable. Balcony locations on Plot A would be one category windier than suitable for private amenity use in Options 2. There would be no instances of strong winds at the development in Option 1, except in areas only accessible to maintenance workers. However, instances of strong winds would persist with the potential to be a safety concern for cyclists and more vulnerable pedestrians on the Station Hill carriageway in Option 2 and Option 3 as well as at Plot A balcony locations in Option 2.



- Unless otherwise mentioned above, wind conditions would be suitable for the intended use. Overall the use of a massing workshop to optimise the building form and the development of wind mitigation measures have substantially improved wind conditions and reduced the occurrence of strong winds that would occur at the Site. Wind conditions would generally be suitable for the intended uses, however, localised persistent windy conditions and strong winds would require further wind mitigation measures to ensure a suitable wind environment.

FIGURES





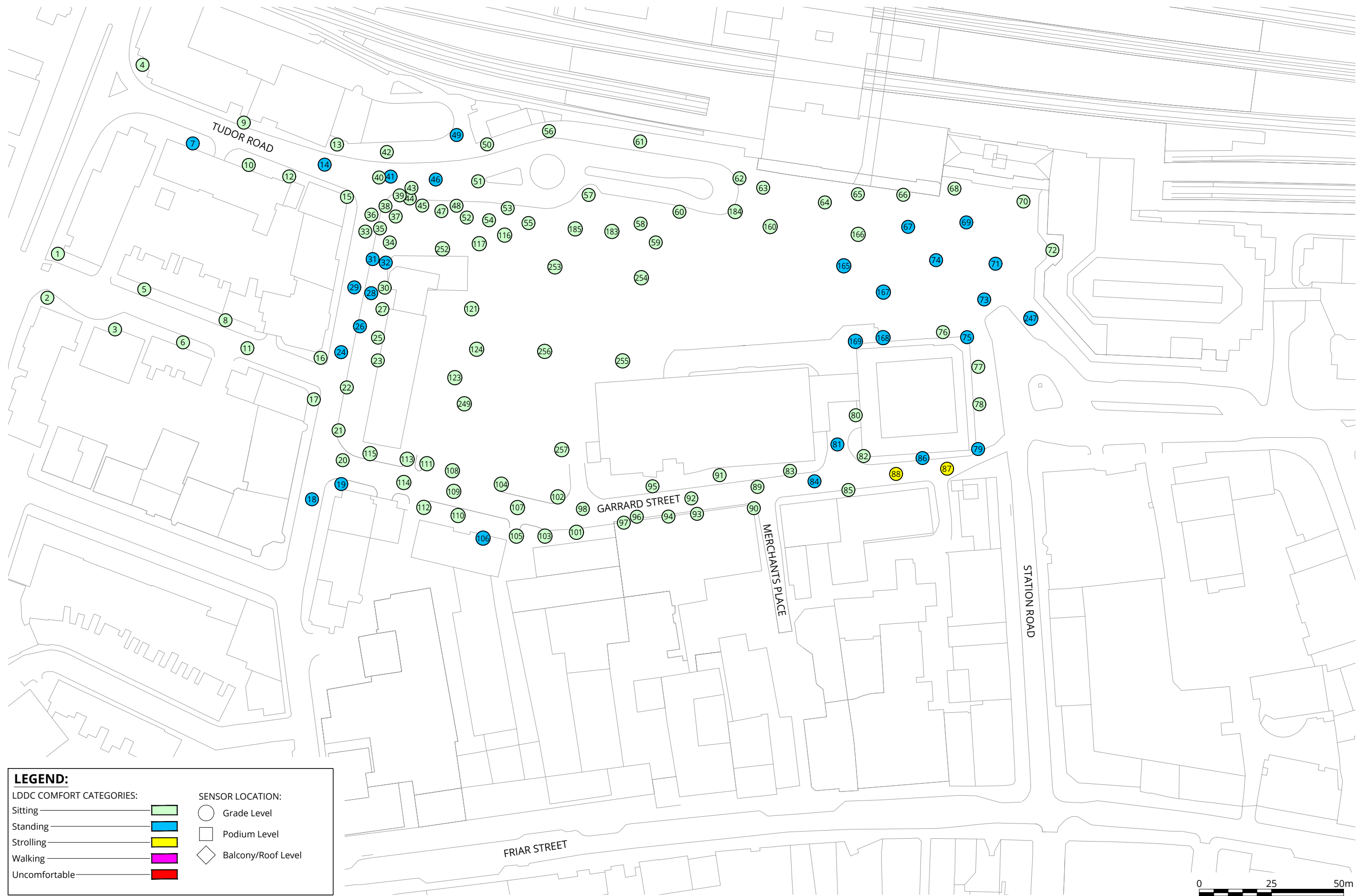
Pedestrian Wind Comfort Conditions - Ground Floor
 Configuration 1: Existing Site with Existing Surrounding Buildings
 Windiest Season

Station Hill - Reading, UK

Project #1803688

Drawn by: JLF	Figure: 3
Approx. Scale @A3: 1:1250	
Date Revised: Nov. 12, 2019	





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

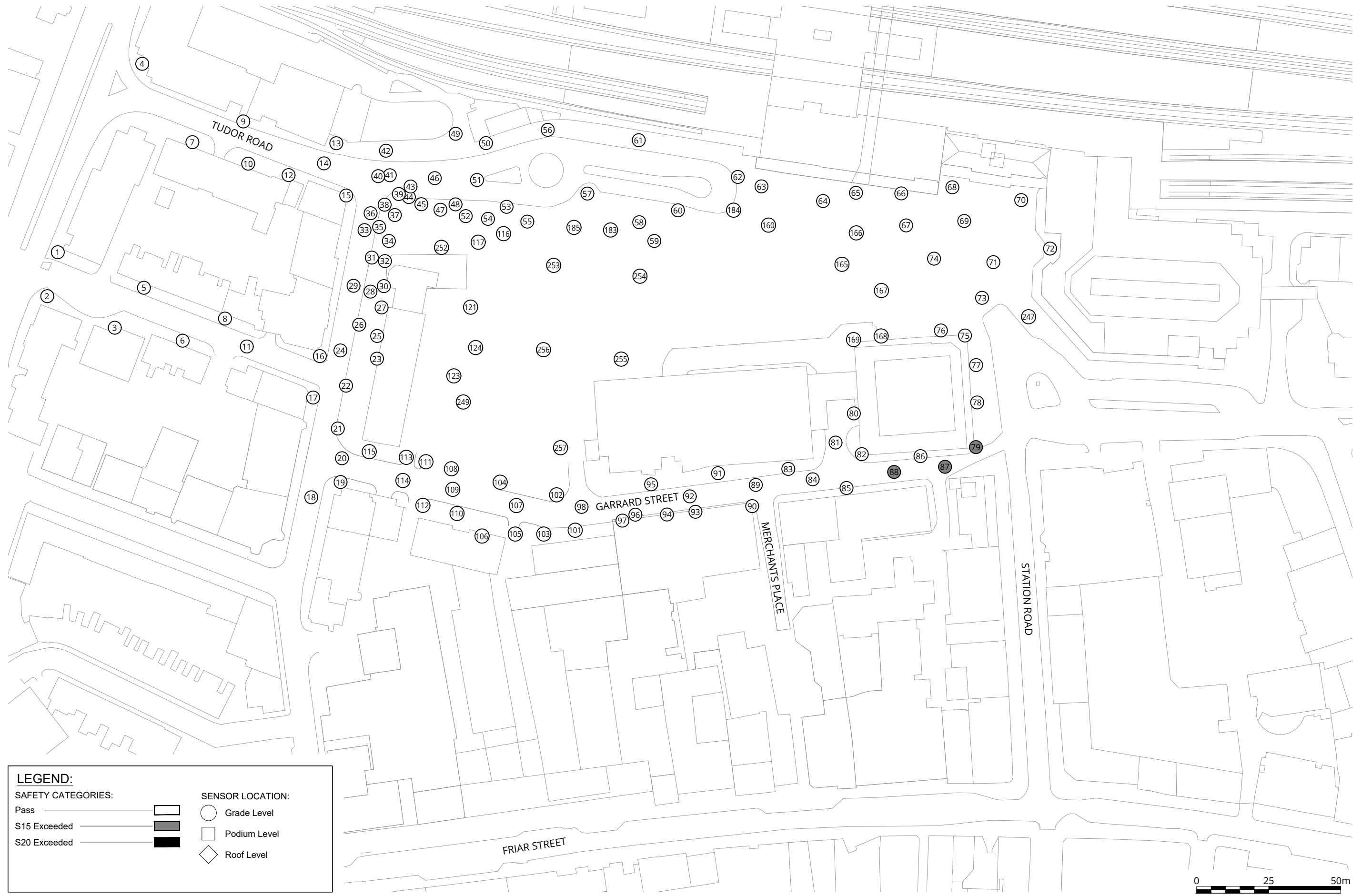
Station Hill - Reading, UK

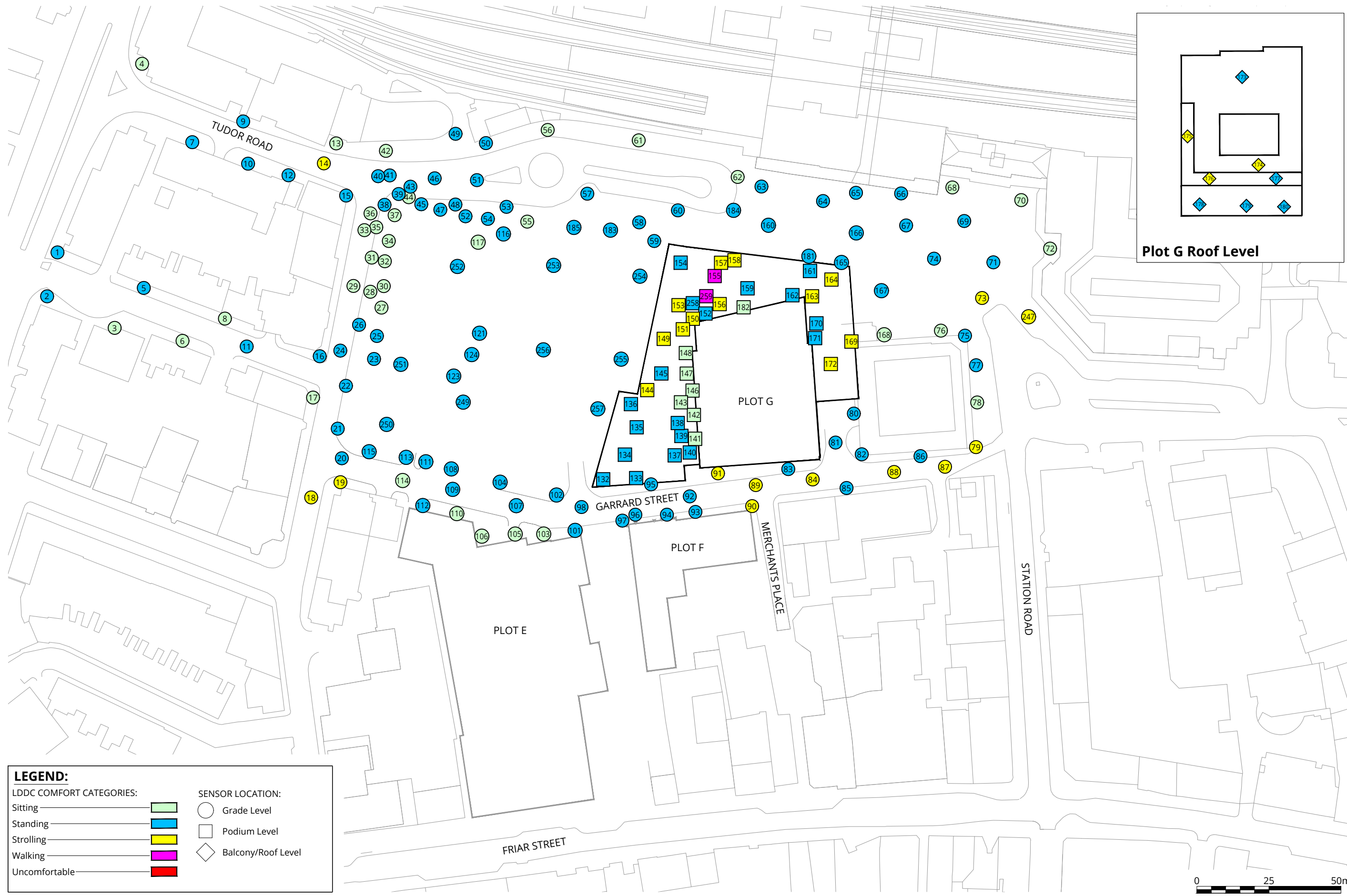


Project #1803688

Drawn by: JLF	Figure: 4
Approx. Scale @A3: 1:1250	
Date Revised: Nov. 12, 2019	







LEGEND:

LDDC COMFORT CATEGORIES:

Sitting

Standing

Strolling

Walking

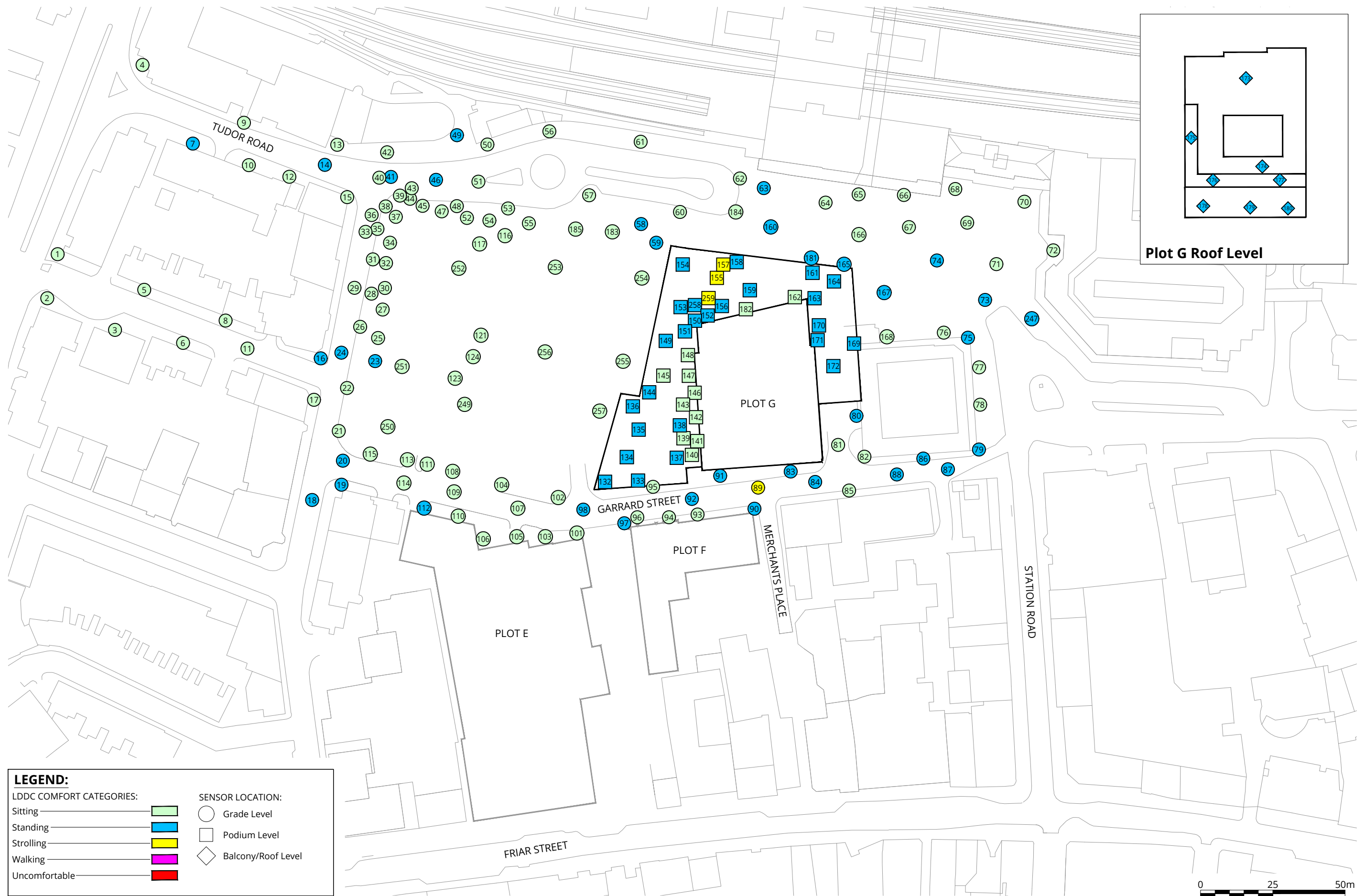
Uncomfortable

SENSOR LOCATION:

Grade Level

Podium Level

Balcony/Roof Level

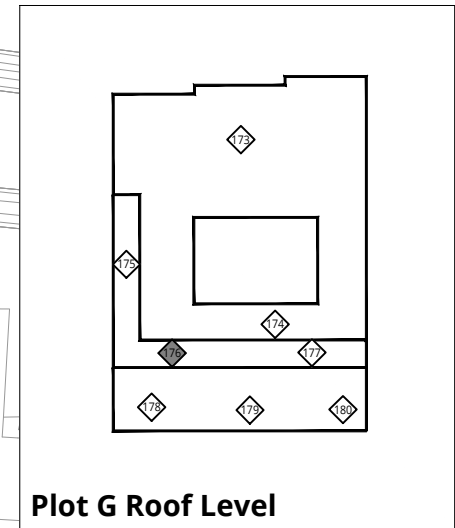
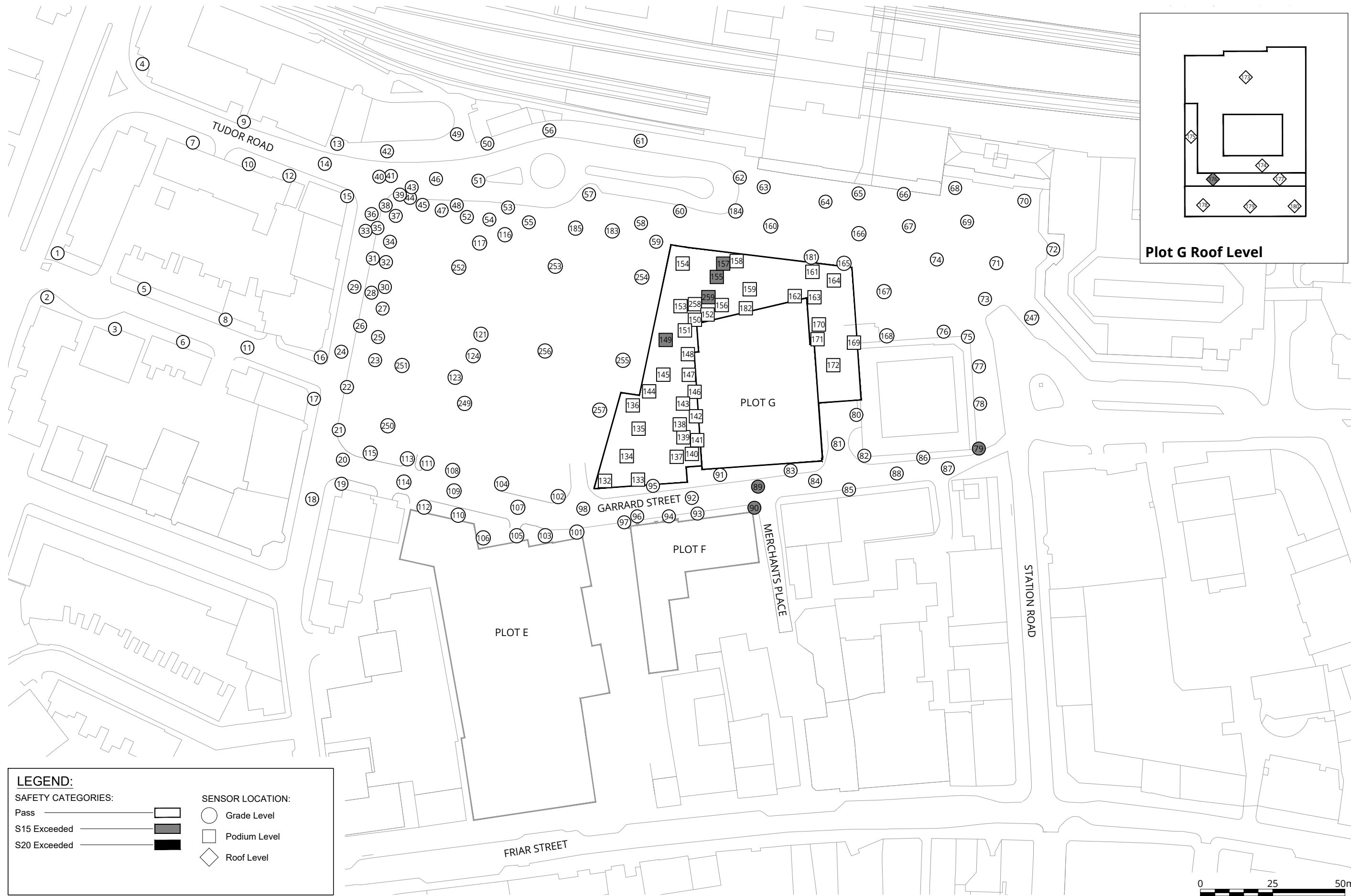


Pedestrian Wind Comfort Conditions - Ground and Terrace Levels
 Configuration 2: Interim Development Scenario with the Existing Surrounding Buildings
 Summer Season
 Station Hill - Reading, UK

Project #1803688

Drawn by: JLF Figure: 7
 Approx. Scale @A3: 1:1250
 Date Revised: Nov. 12, 2019





LEGEND:

SAFETY CATEGORIES:

Pass 

S15 Exceeded 

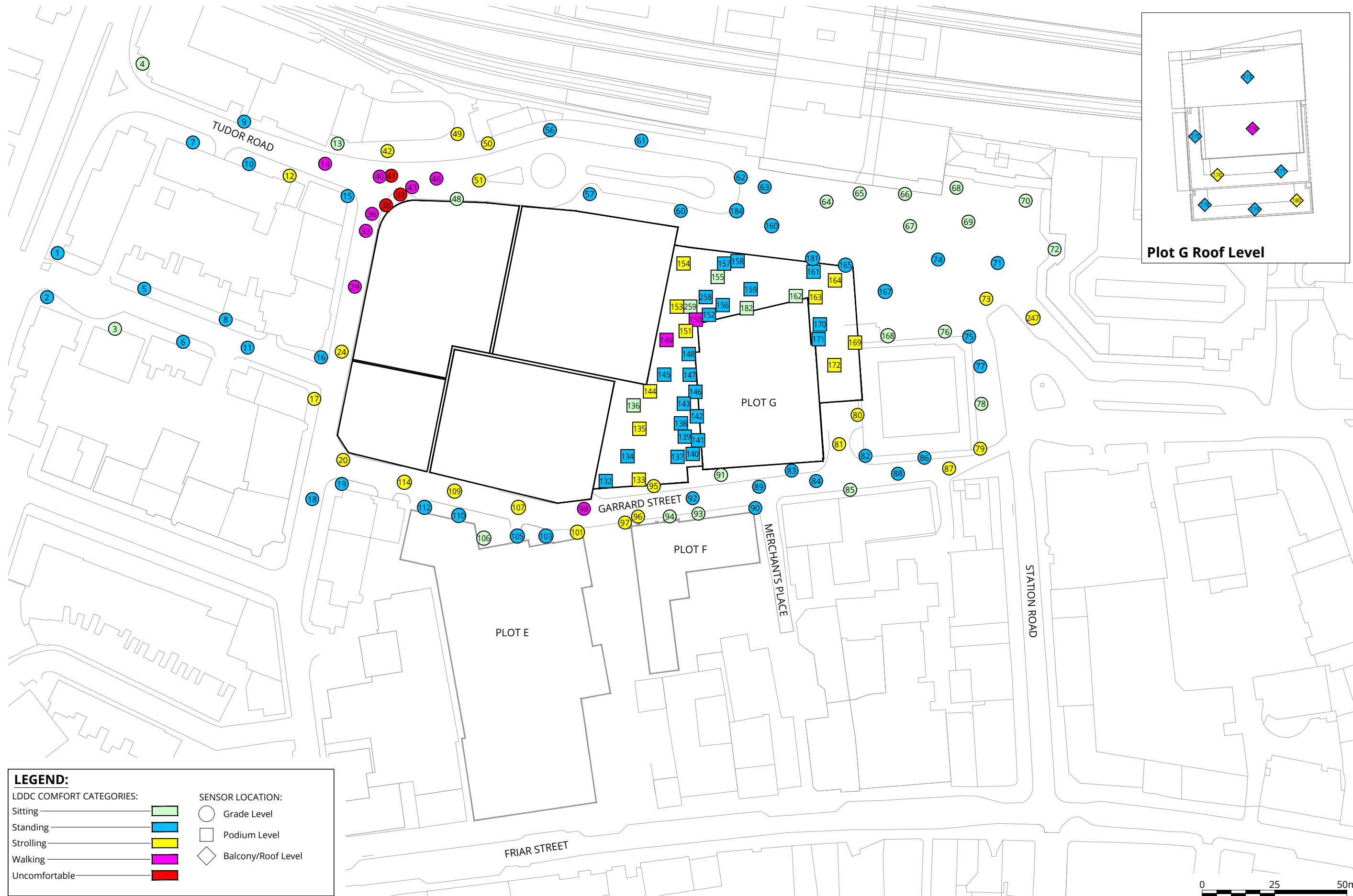
S20 Exceeded 

SENSOR LOCATION:

Grade Level 

Podium Level 

Roof Level 



Pedestrian Wind Comfort Conditions - Ground and Terrace Levels Configuration 3: Maximum Parameter Development with the Existing Surrounding Buildings Windiest Season

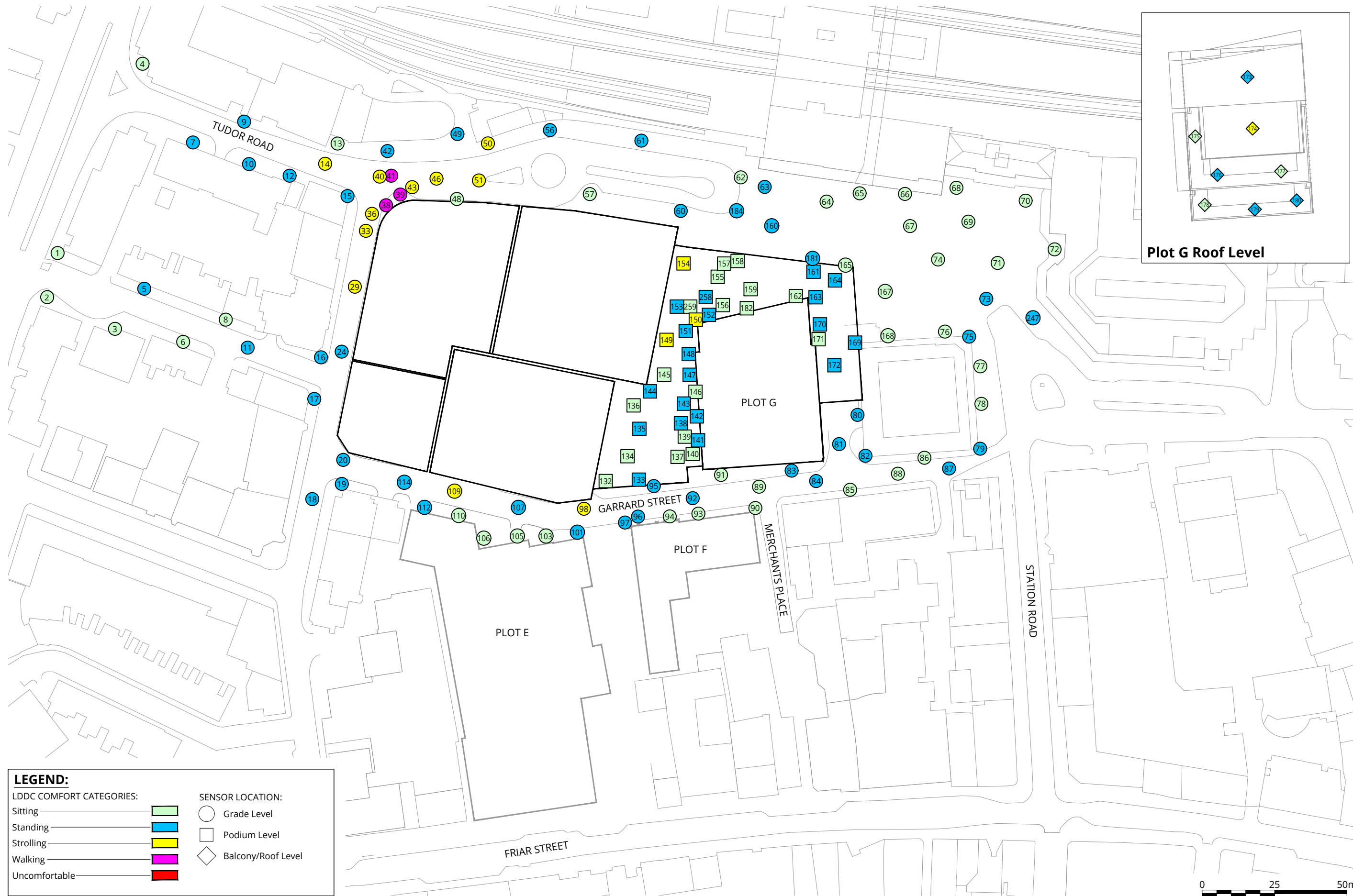
Station Hill - Reading, UK



Drawn by: JLF	Figure: 9
Approx. Scale @A3: 1:1250	
Date Revised: Sept. 27, 2019	

Project #1803688





LEGEND:

LDDC COMFORT CATEGORIES:

Sitting

Standing

Strolling

Walking

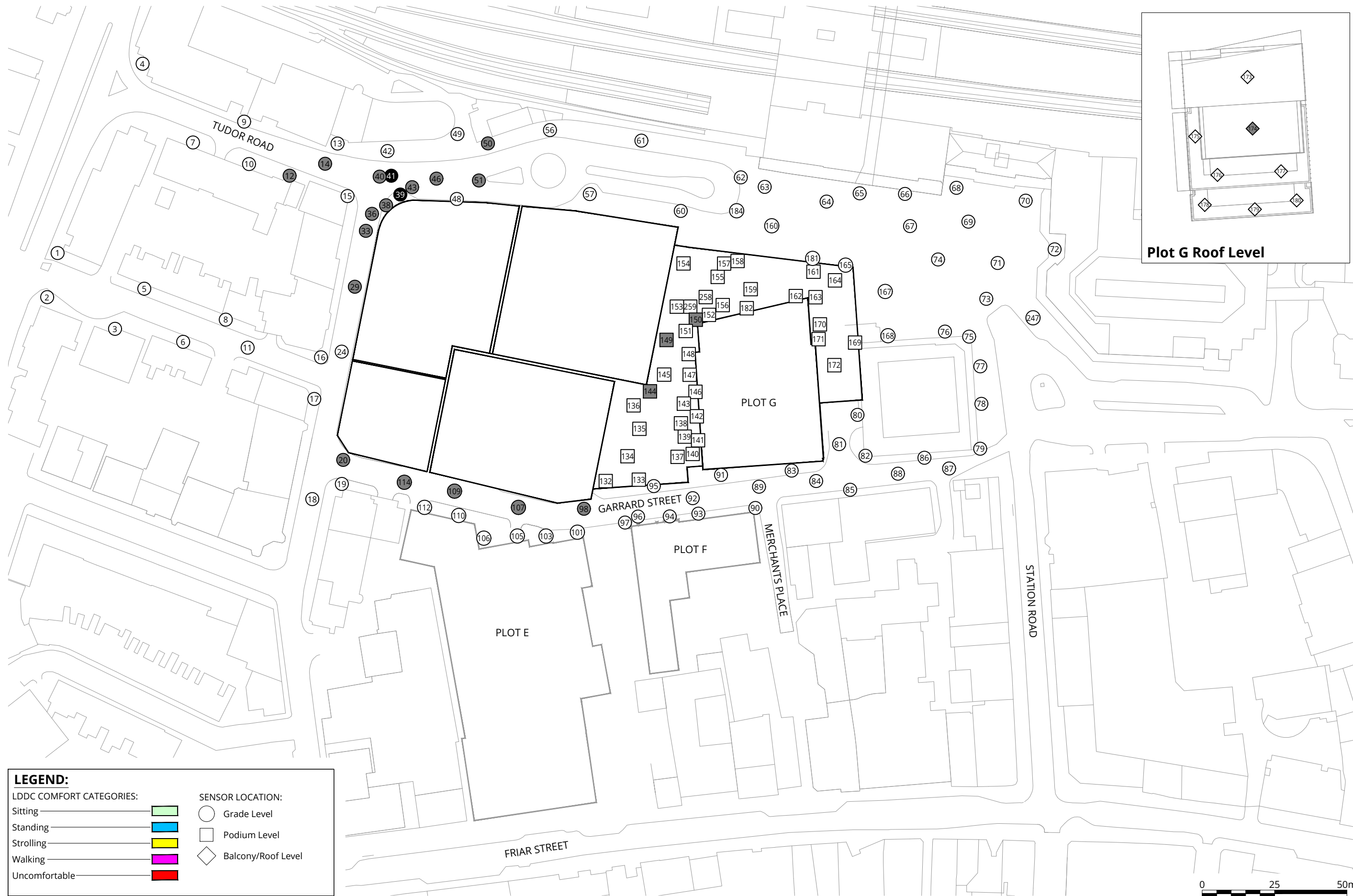
Uncomfortable

SENSOR LOCATION:

Grade Level

Podium Level

Balcony/Roof Level



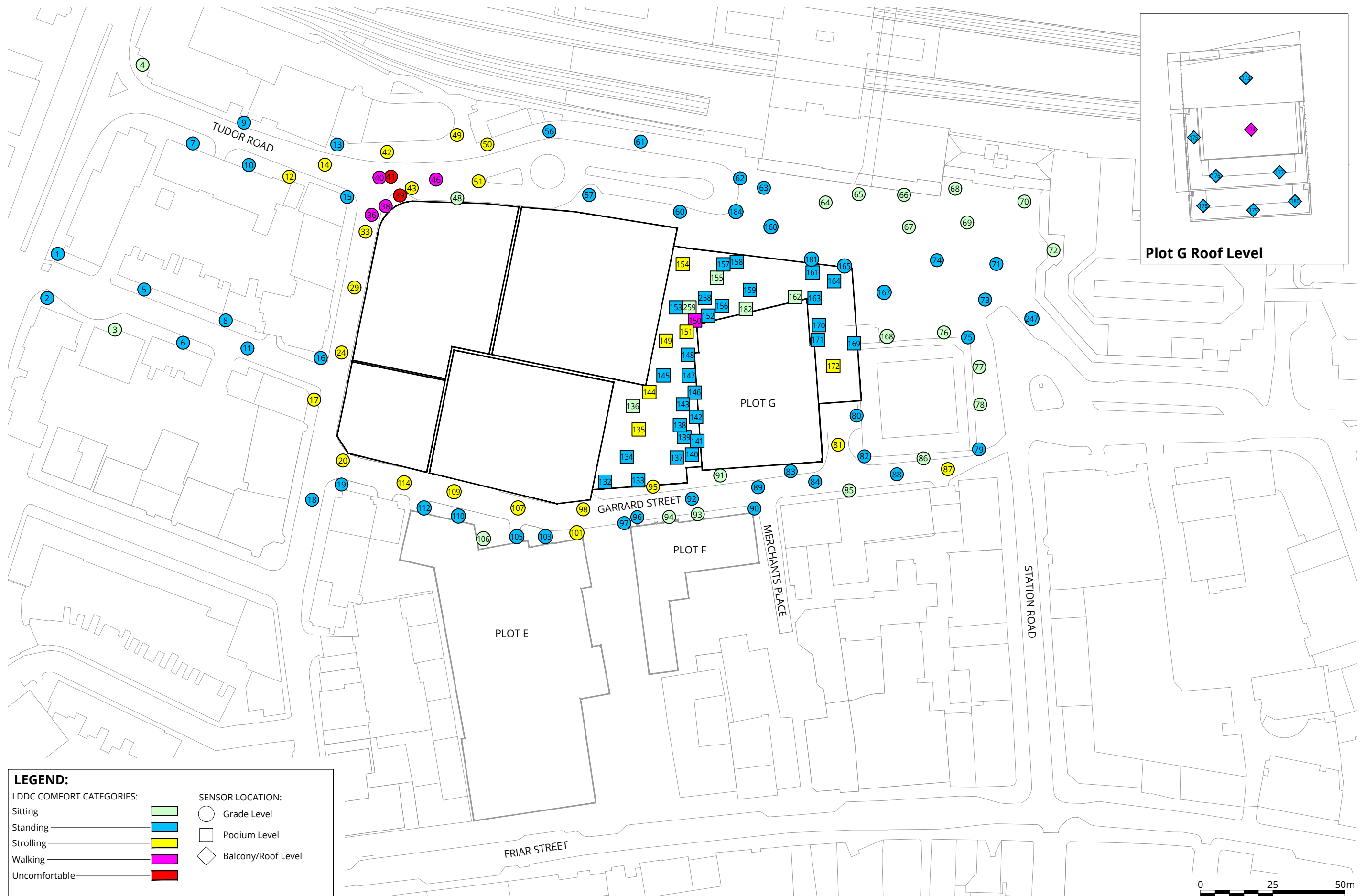
LEGEND:

LDDC COMFORT CATEGORIES:

Sitting	
Standing	
Strolling	
Walking	
Uncomfortable	

SENSOR LOCATION:

	Grade Level
	Podium Level
	Balcony/Roof Level



Pedestrian Wind Comfort Conditions - Ground and Terrace Levels
Configuration 4: Maximum Parameter Development with the Cumulative Surrounding Buildings
Windiest Season

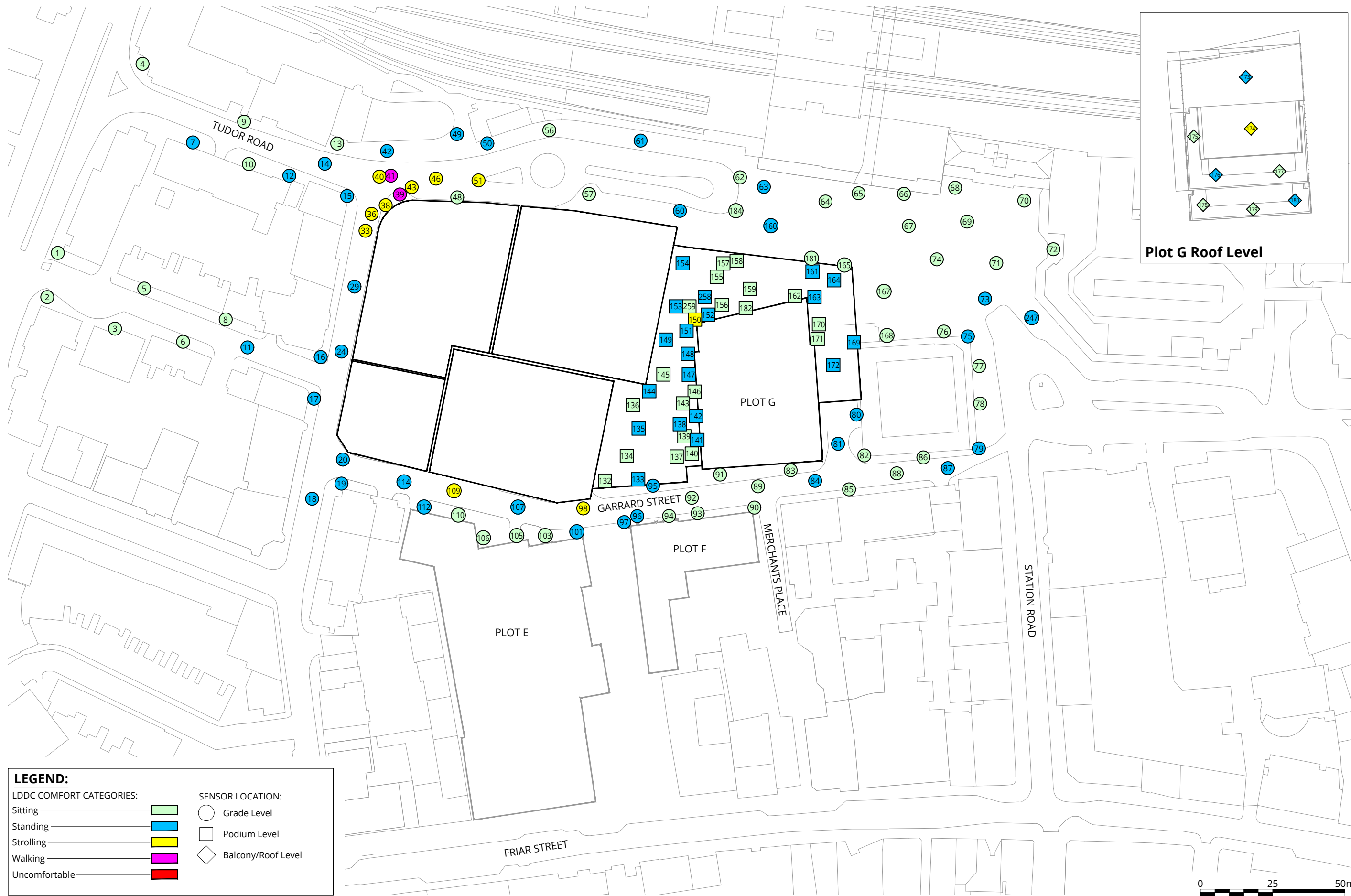
Station Hill - Reading, UK



Project #1803688

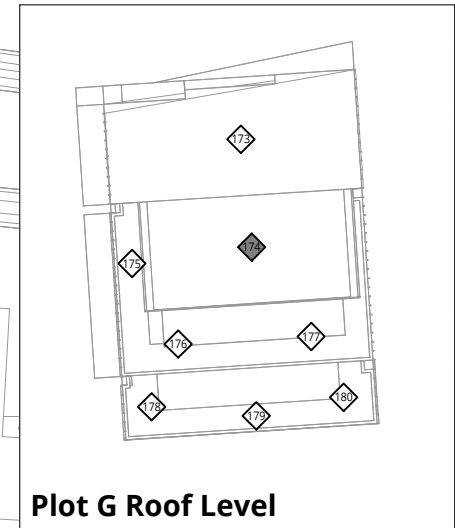
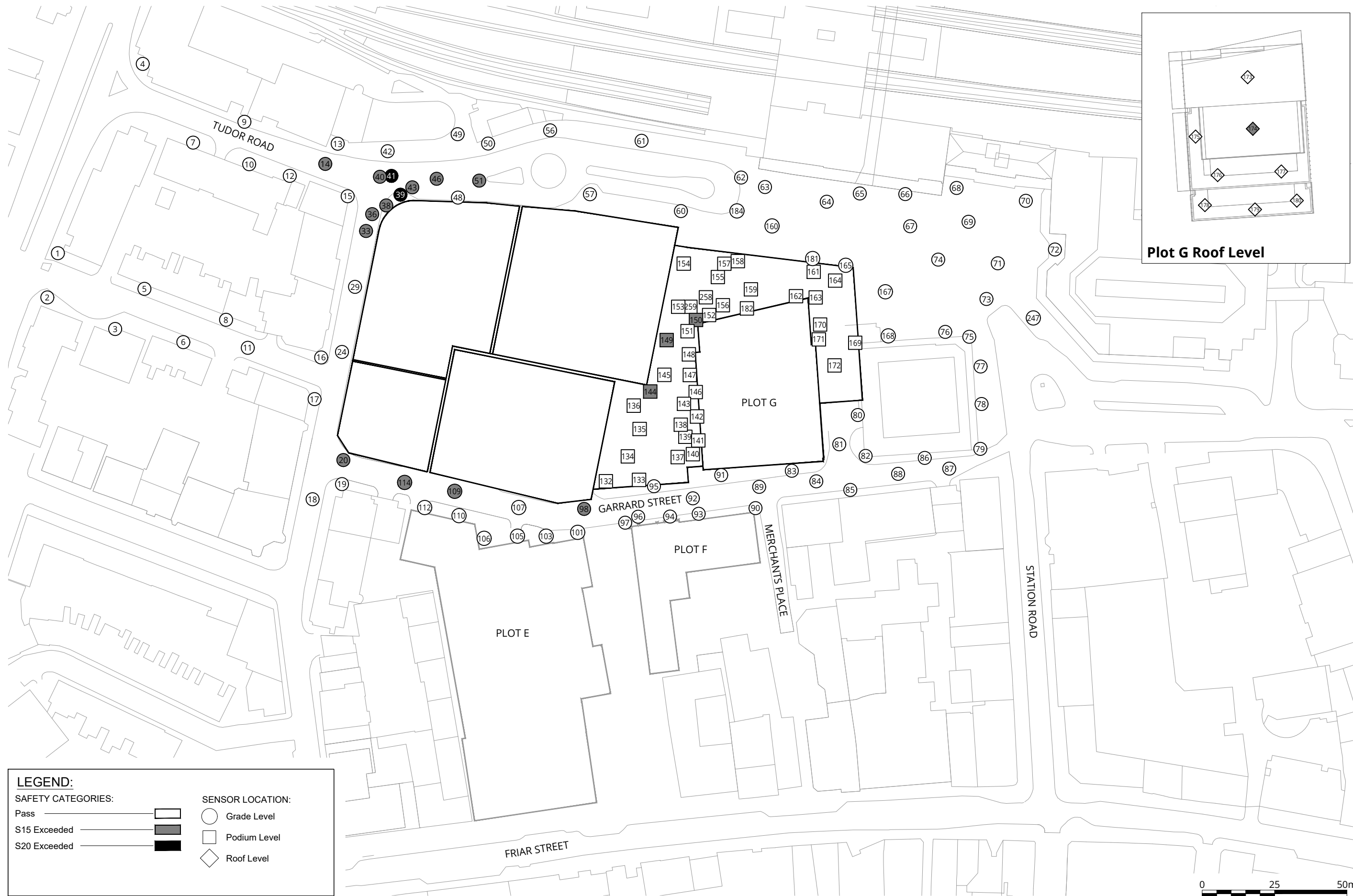
Drawn by: JLF	Figure: 12
Approx. Scale @A3: 1:1250	
Date Revised: Sept. 27, 2019	





LEGEND:

LDDC COMFORT CATEGORIES:	SENSOR LOCATION:
Sitting — 	 Grade Level
Standing — 	 Podium Level
Strolling — 	 Balcony/Roof Level
Walking — 	
Uncomfortable — 	



LEGEND:

SAFETY CATEGORIES:

Pass

S15 Exceeded

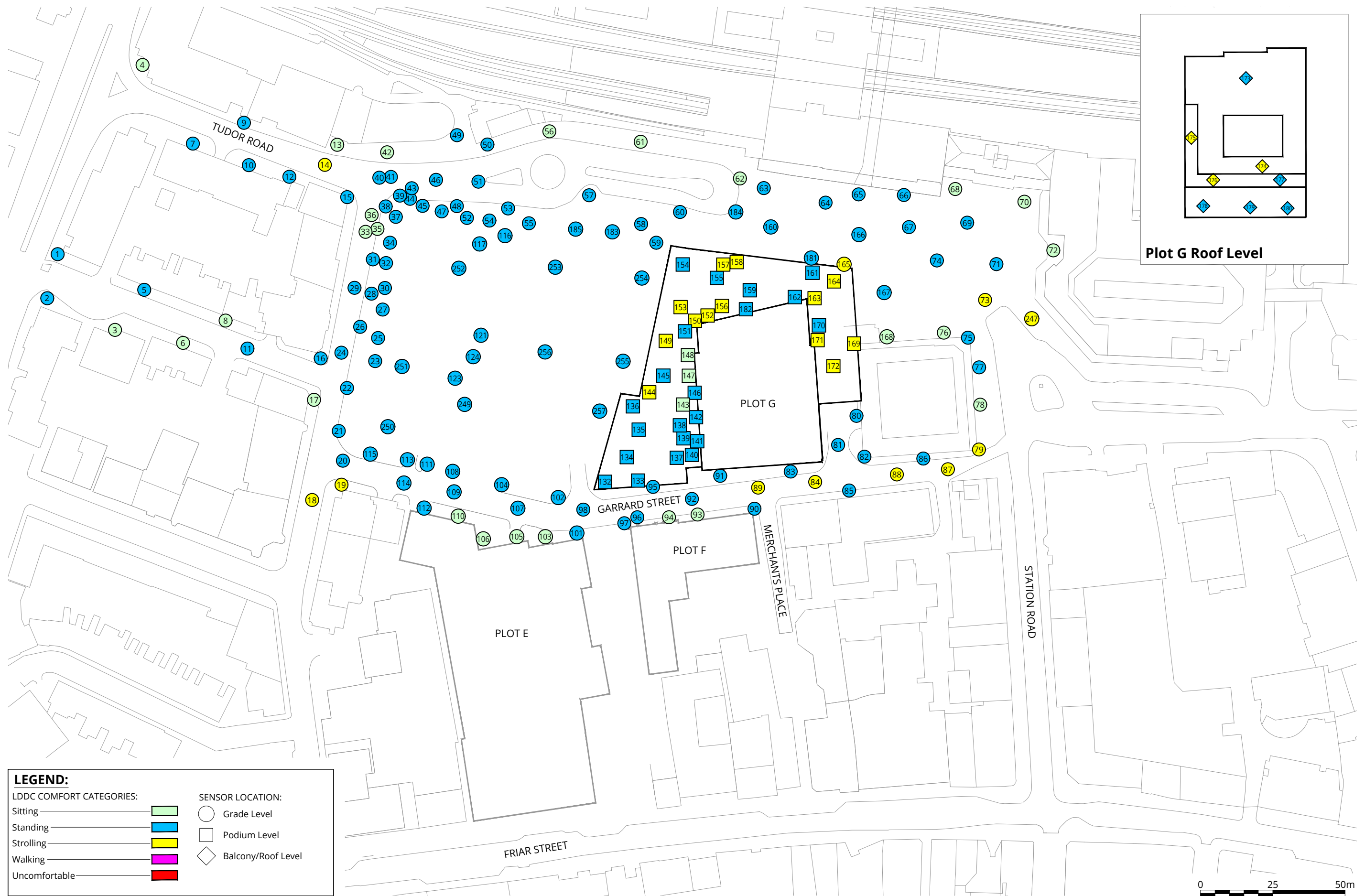
S20 Exceeded

SENSOR LOCATION:

○ Grade Level

□ Podium Level

◇ Roof Level



Pedestrian Wind Comfort Conditions - Ground and Terrace Levels

Mitigation: Proposed Development with Landscaping, Mitigation and Existing Surrounding Buildings
Windiest Season

Station Hill - Reading, UK



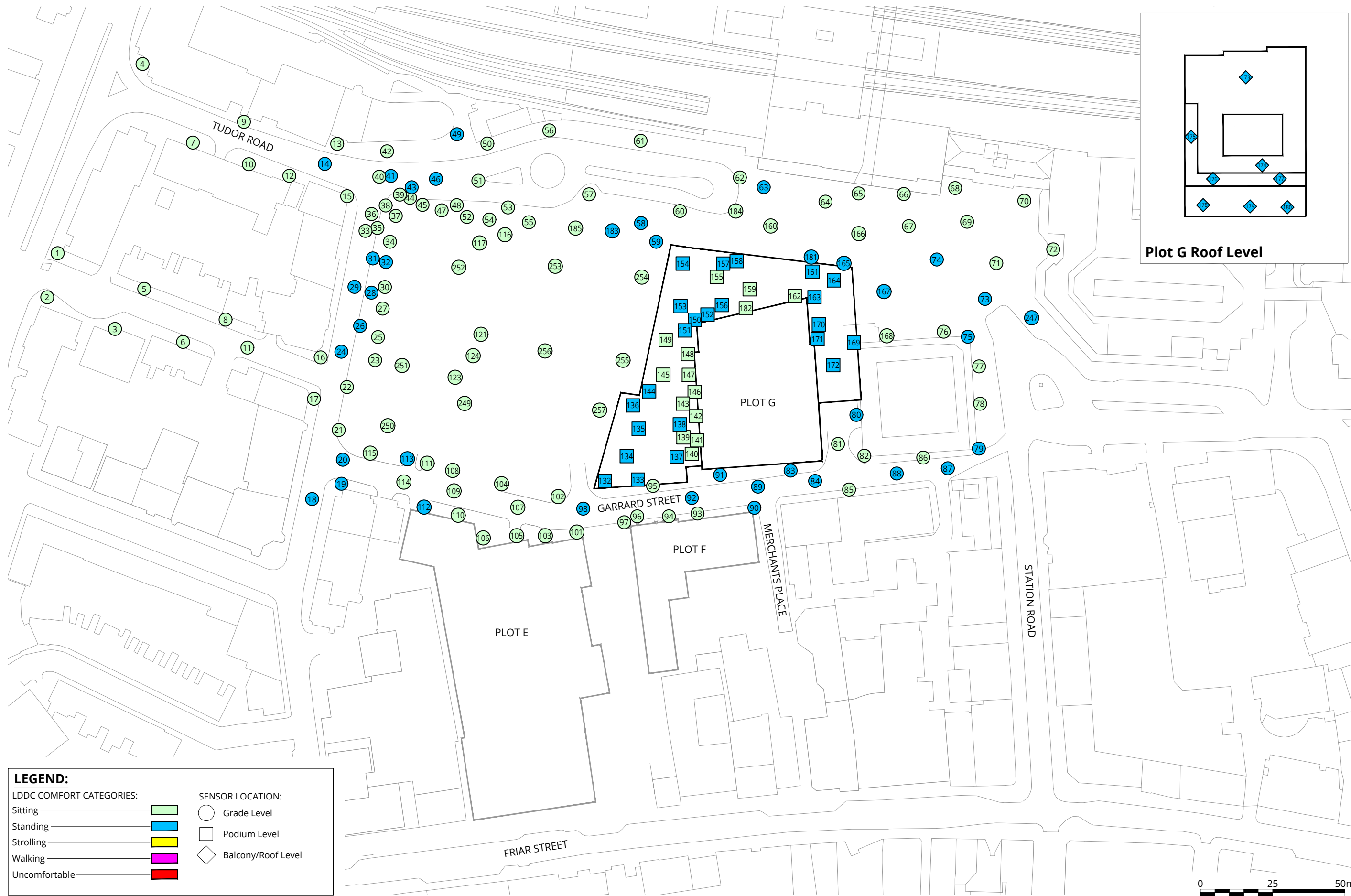
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Approx. Scale @A3: 1:1250

Date Revised: Nov. 4, 2019

Project #1803688





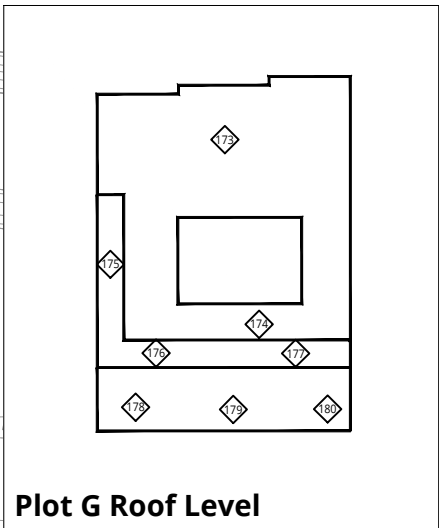
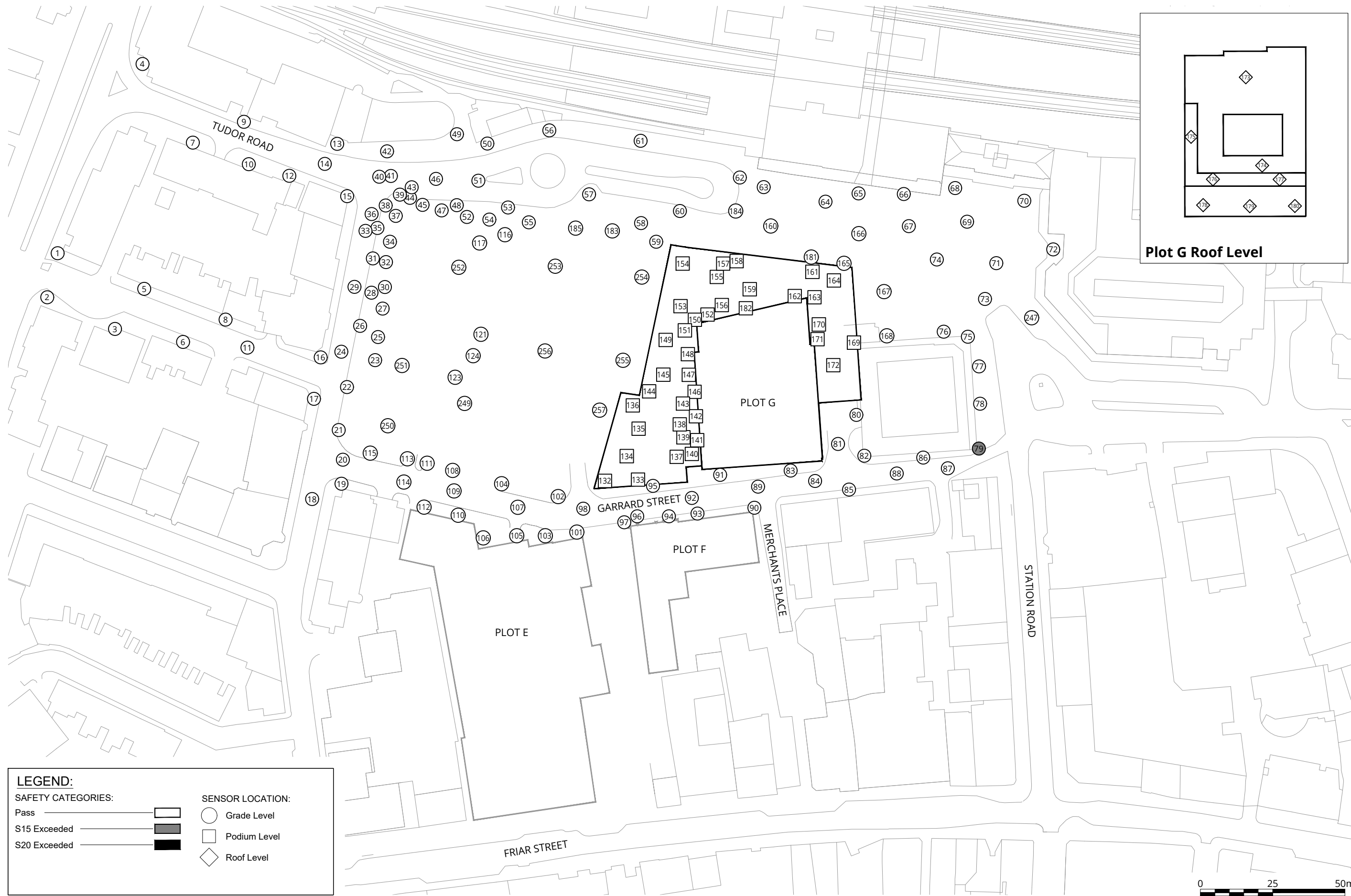
LEGEND:

LDDC COMFORT CATEGORIES:

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

SENSOR LOCATION:

- Grade Level
- Podium Level
- Balcony/Roof Level



LEGEND:

SAFETY CATEGORIES:

Pass 

S15 Exceeded 

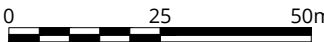
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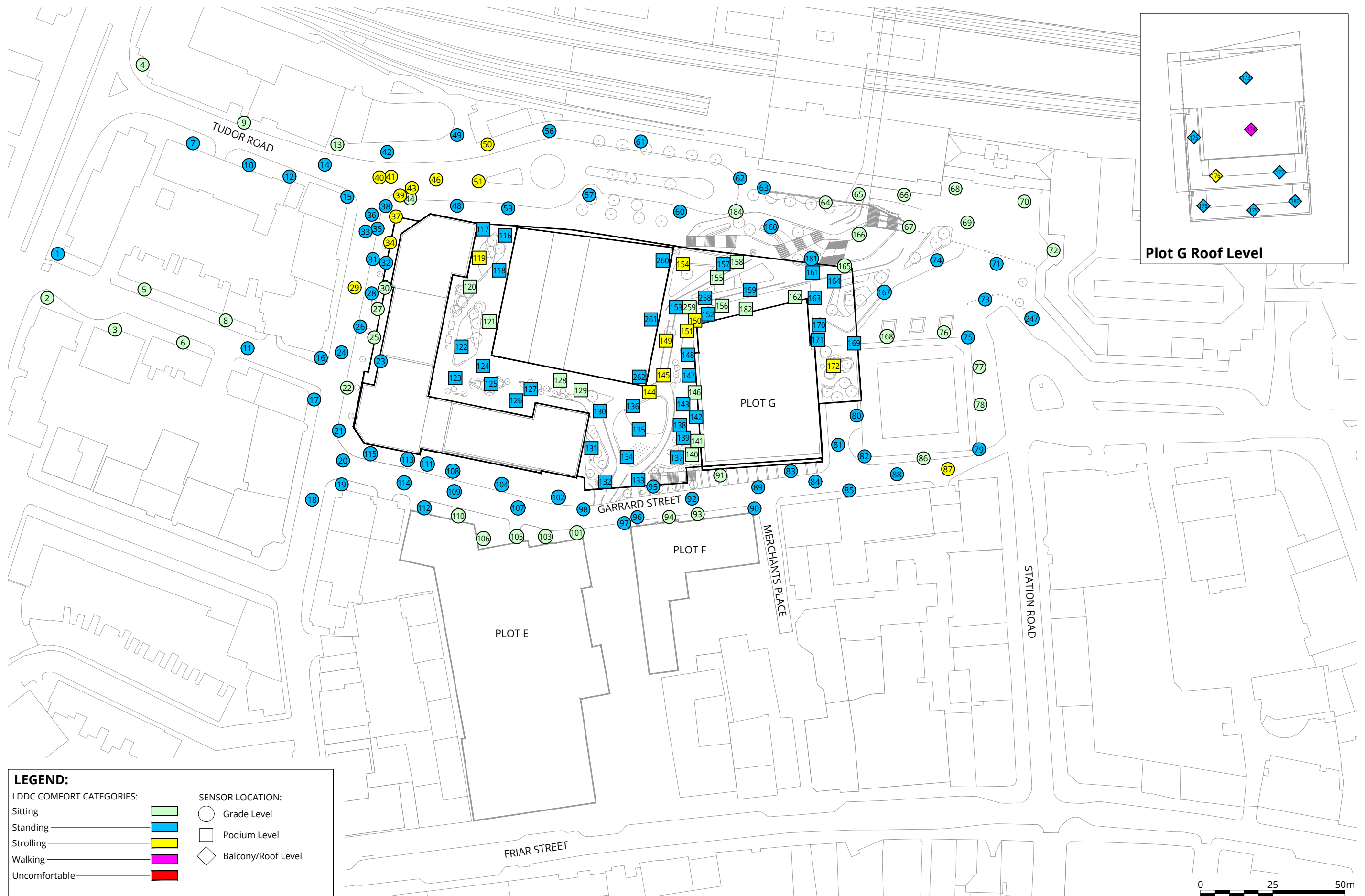
SENSOR LOCATION:

 Grade Level

 Podium Level

 Roof Level





Pedestrian Wind Comfort Conditions - Ground and Terrace Levels
Mitigation: Development Option 1 with Landscaping, Mitigation and Cumulative Surrounding Buildings
Windiest Season

Station Hill - Reading, UK



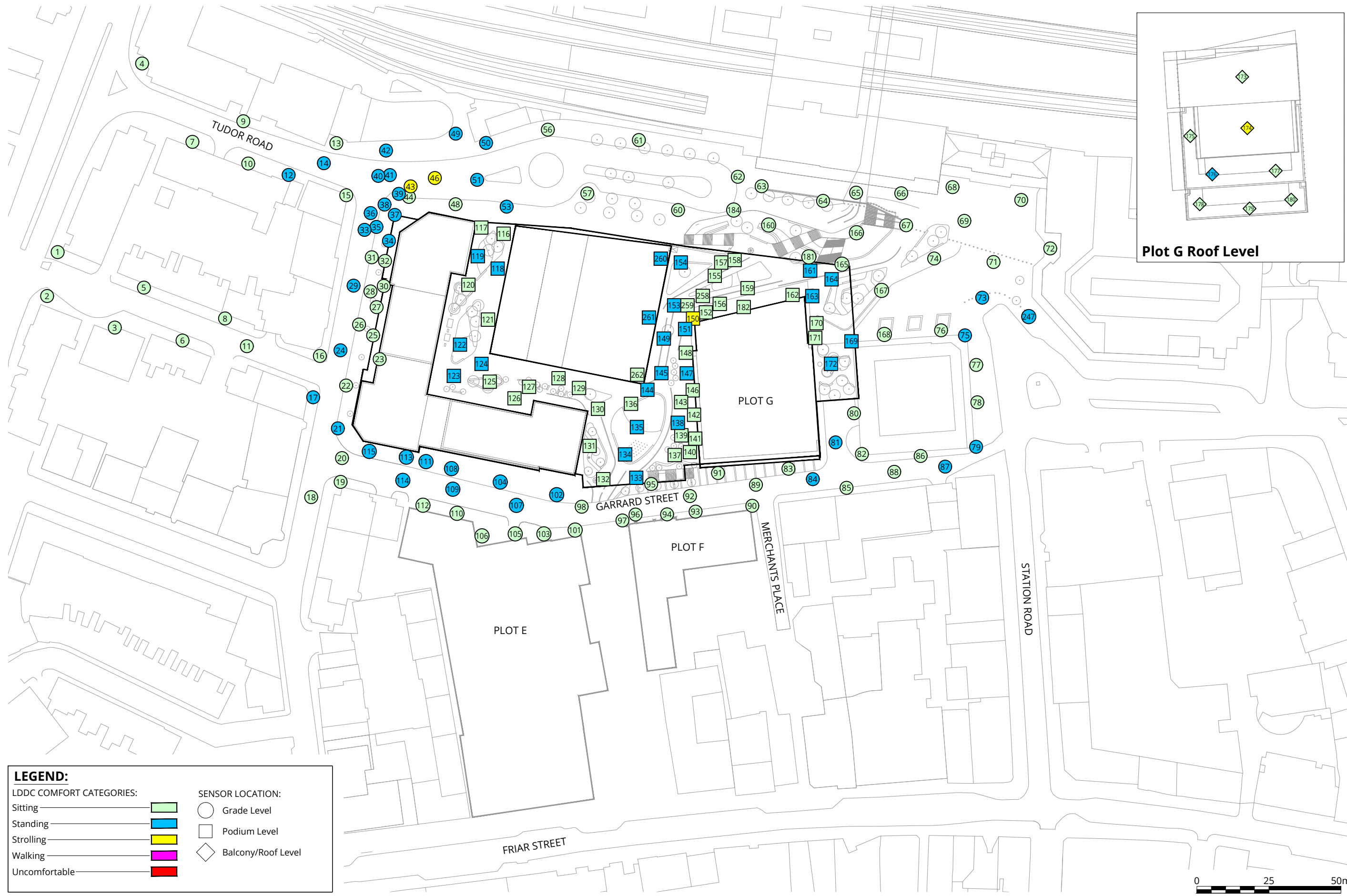
Drawn by: JLF Figure: 18

Approx. Scale @A3: 1:1250

Date Revised: Sept. 27, 2019

Project #1803688





LEGEND:

LDDC COMFORT CATEGORIES:

Sitting

Standing

Strolling

Walking

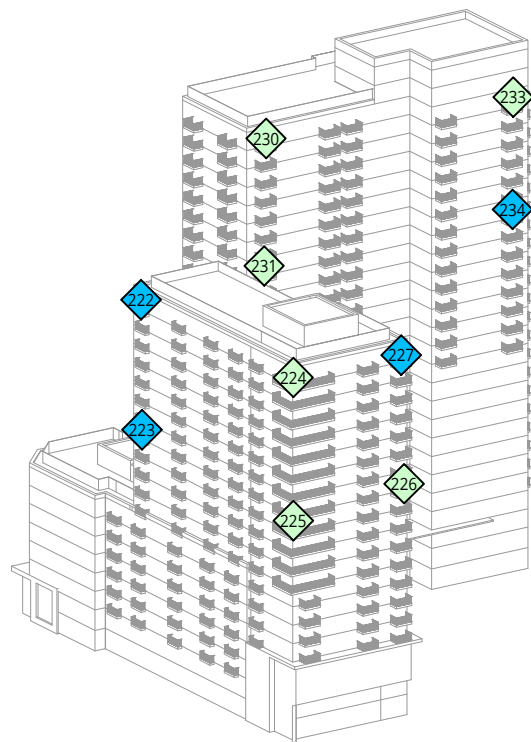
Uncomfortable

SENSOR LOCATION:

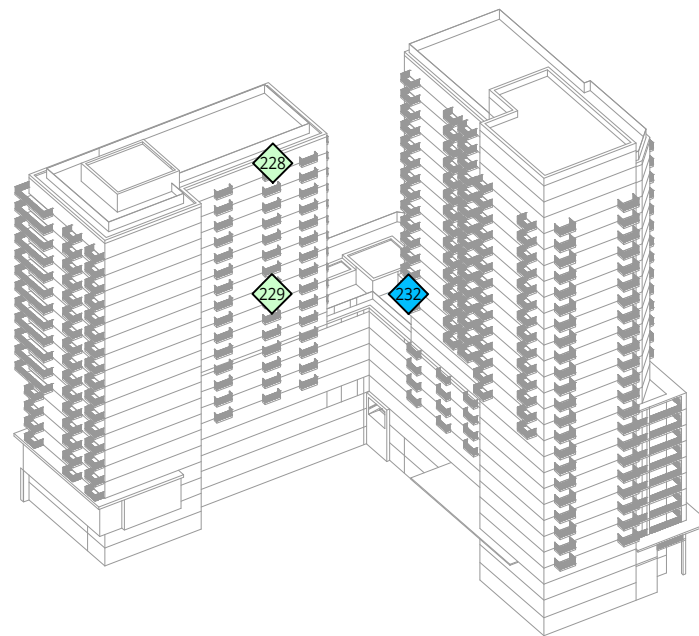
Grade Level

Podium Level

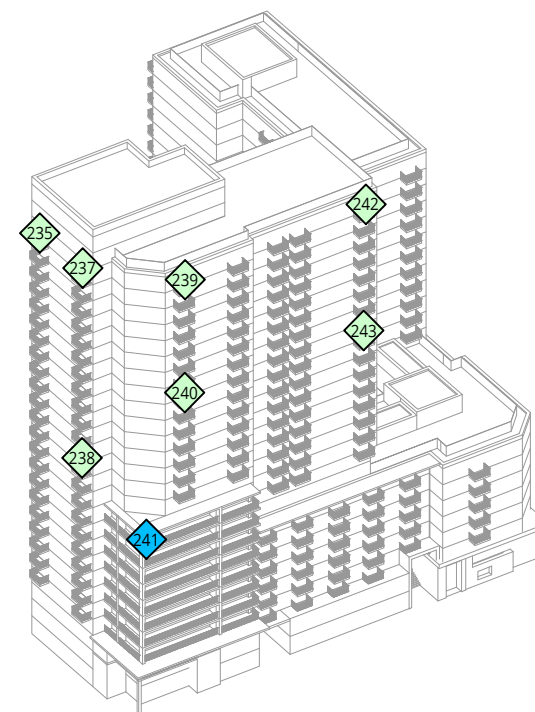
Balcony/Roof Level



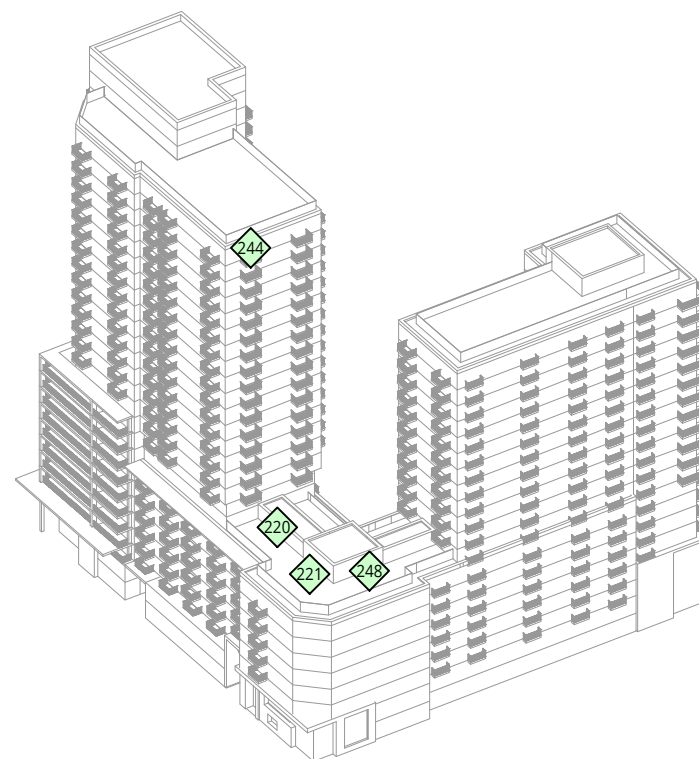
SOUTH / WEST



NORTH / EAST

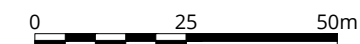


NORTH / WEST



SOUTH / EAST

LEGEND:	
LDDC COMFORT CATEGORIES:	
Sitting	
Standing	
Strolling	
Walking	
Uncomfortable	
SENSOR LOCATION:	
	Grade Level
	Podium Level
	Balcony/Roof Level



Pedestrian Wind Comfort Conditions - Isometric Views

Mitigation: Development Option 1 with Landscaping, Mitigation and Cumulative Surrounding Buildings
Summer Season

Station Hill - Reading, UK

Project #1803688

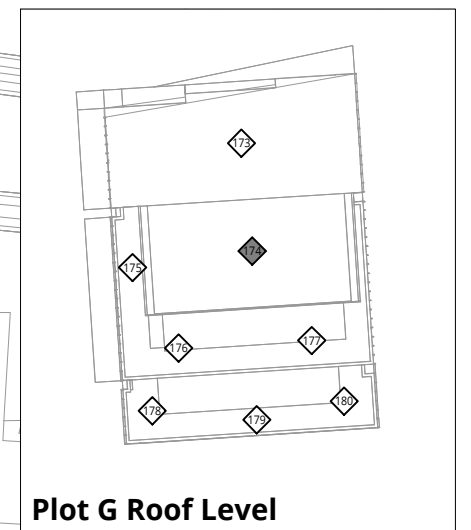
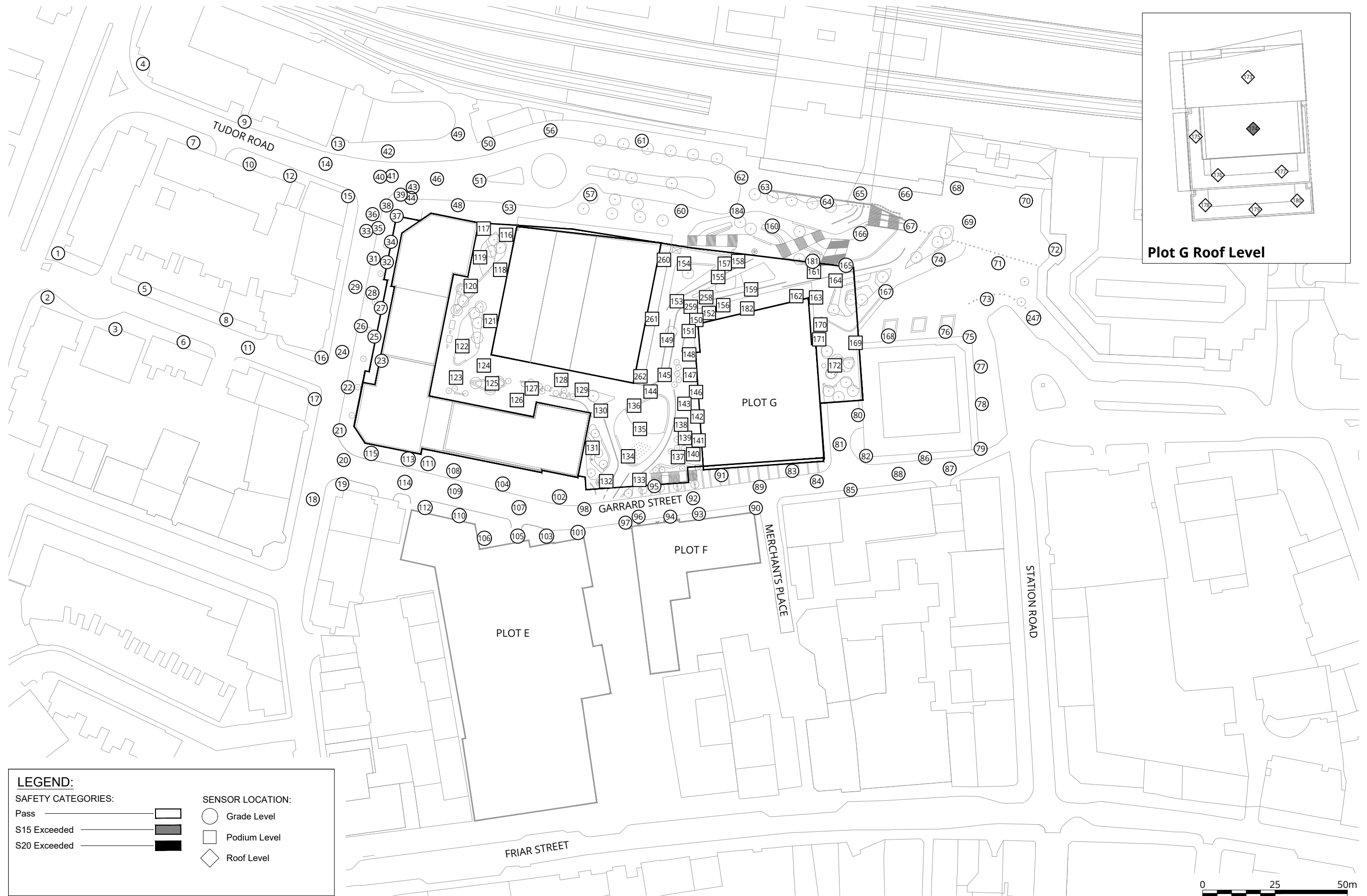
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Figure: 20

Approx. Scale @A3: 1:1250

Date Revised: Sept. 27, 2019





Pedestrian Wind Safety Conditions - Ground and Terrace Levels
Mitigation: Development Option 1 with Landscaping, Mitigation and Cumulative Surrounding Buildings
Annual

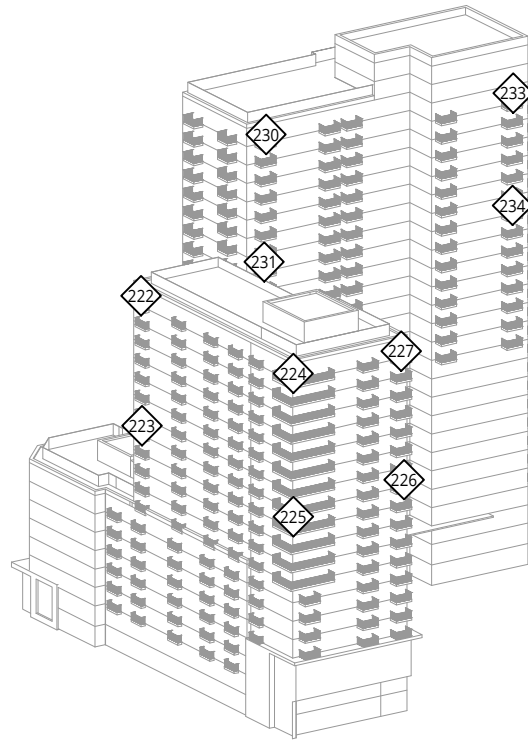
Station Hill - Reading, UK



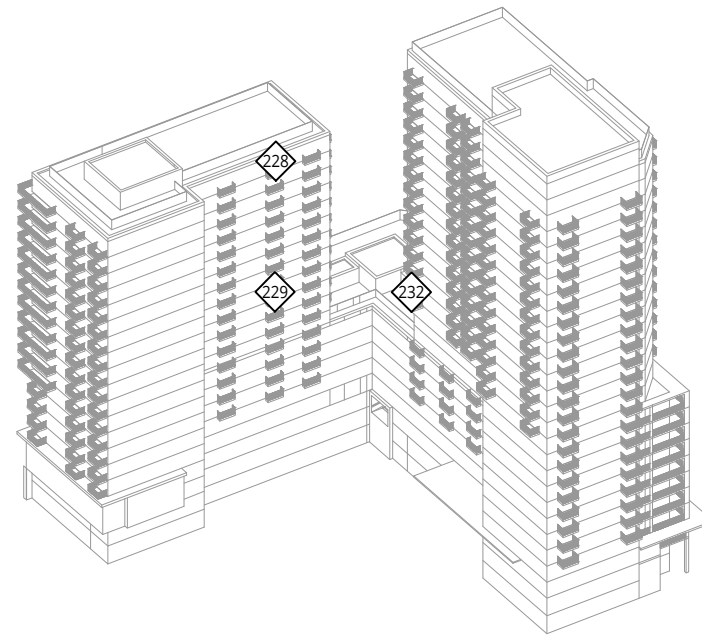
Project #1803688

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Approx. Scale @A3: 1:1250
Date Revised: Sep. 17, 2019

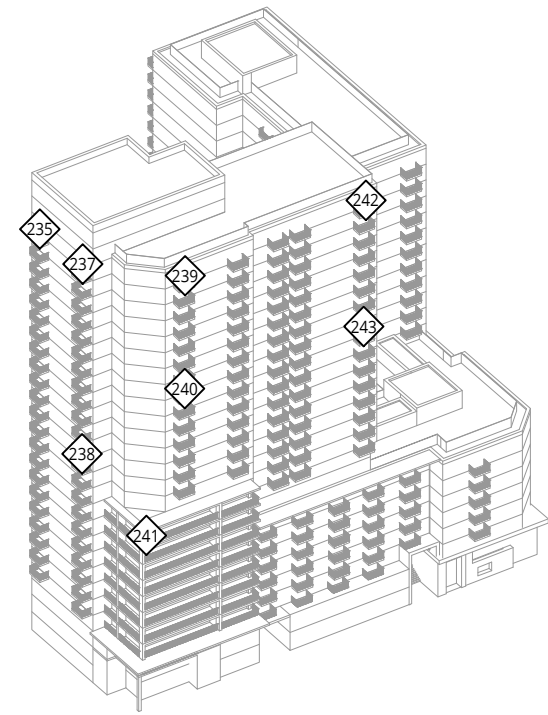




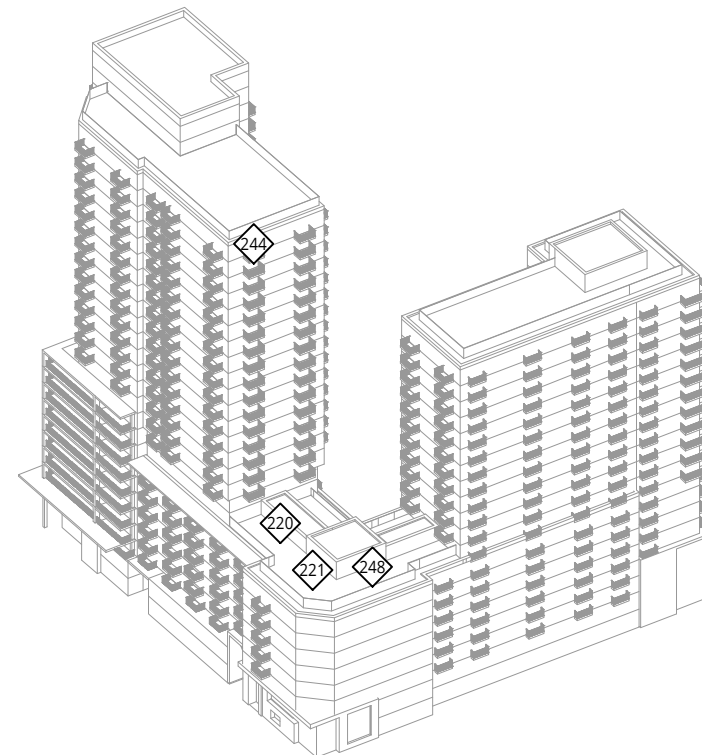
SOUTH / WEST



NORTH / EAST



NORTH / WEST



SOUTH / EAST

LEGEND:

SAFETY CATEGORIES:

Pass ———— 

S15 Exceeded ———— 

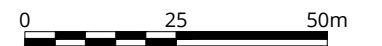
S20 Exceeded ———— 

SENSOR LOCATION:

 Grade Level

 Podium Level

 Roof Level



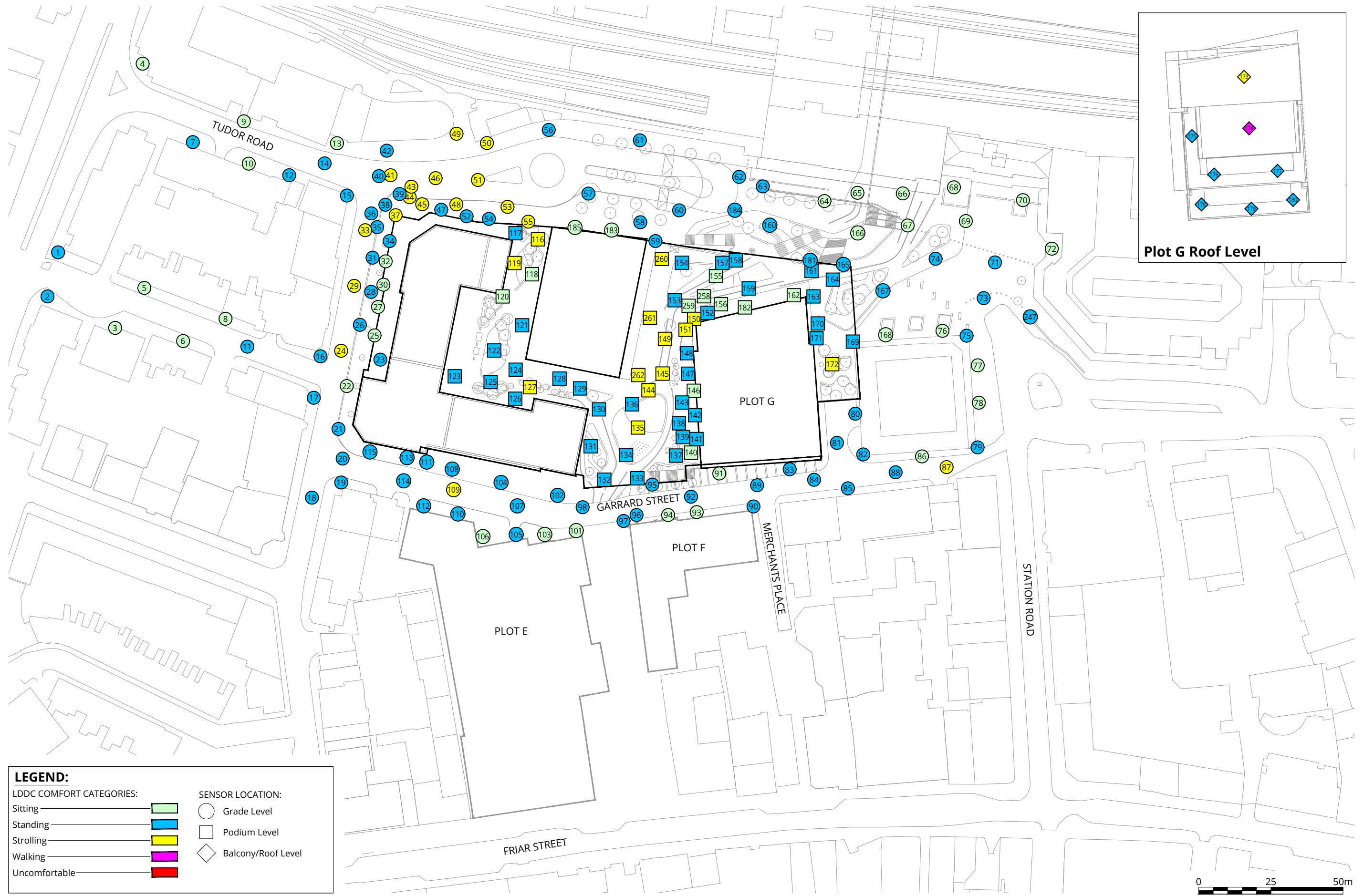
Pedestrian Wind Safety Conditions - Isometric Views
 Mitigation: Development Option 1 with Landscaping, Mitigation and Cumulative Surrounding Buildings
 Annual

Station Hill - Reading, UK

Project #1803688

Drawn by: JLF	Figure: 22
Approx. Scale @A3: 1:1250	
Date Revised: Sept. 27, 2019	





LEGEND:

LDDC COMFORT CATEGORIES:

Sitting	Light Green
Standing	Blue
Strolling	Yellow
Walking	Magenta
Uncomfortable	Red

SENSOR LOCATION:

Grade Level	Circle
Podium Level	Square
Balcony/Roof Level	Diamond

Pedestrian Wind Comfort Conditions - Ground and Terrace Levels
Mitigation: Development Option 2 with Landscaping, Mitigation and Cumulative Surrounding Buildings
Windiest Season

Station Hill - Reading, UK



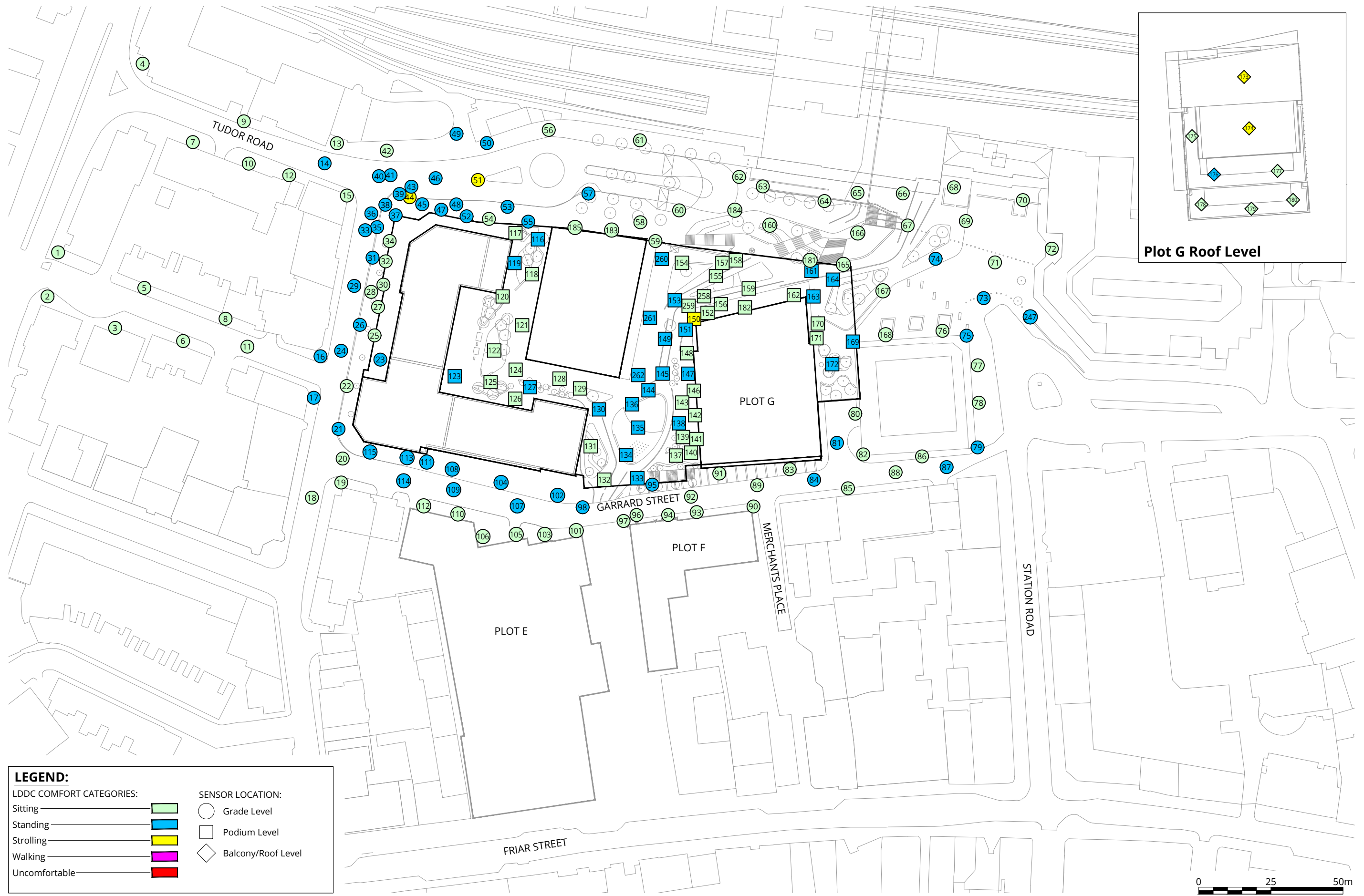
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Approx. Scale @A3: 1:1250

Project #1803688

Date Revised: Sep. 17, 2019





Pedestrian Wind Comfort Conditions - Ground and Terrace Levels
Mitigation: Development Option 2 with Landscaping, Mitigation and Cumulative Surrounding Buildings
Summer Season

Station Hill - Reading, UK



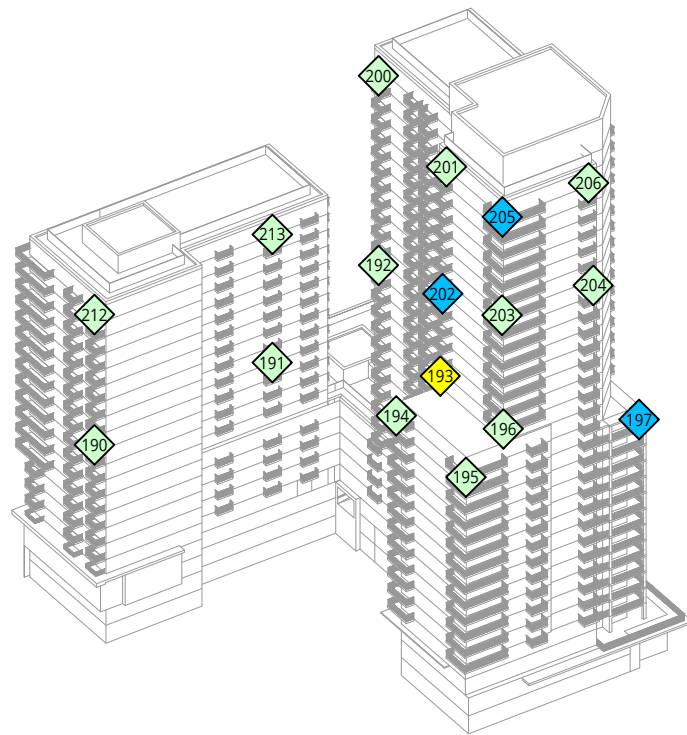
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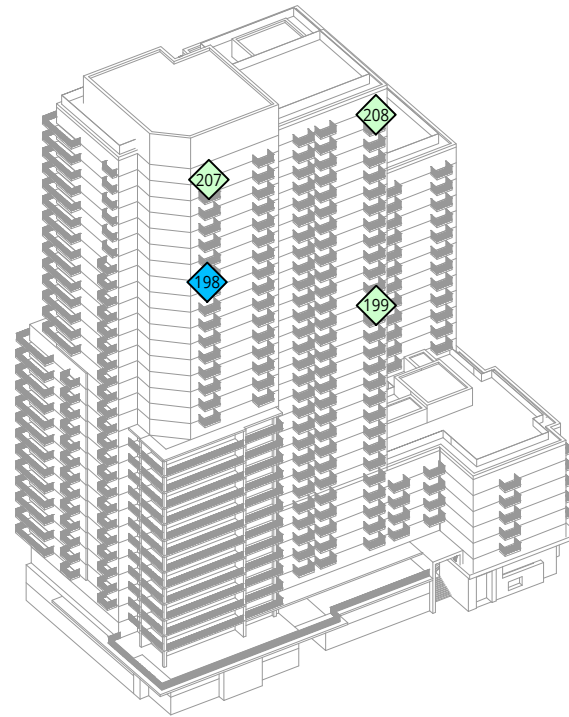
Date Revised: Sep. 17, 2019

Project #1803688

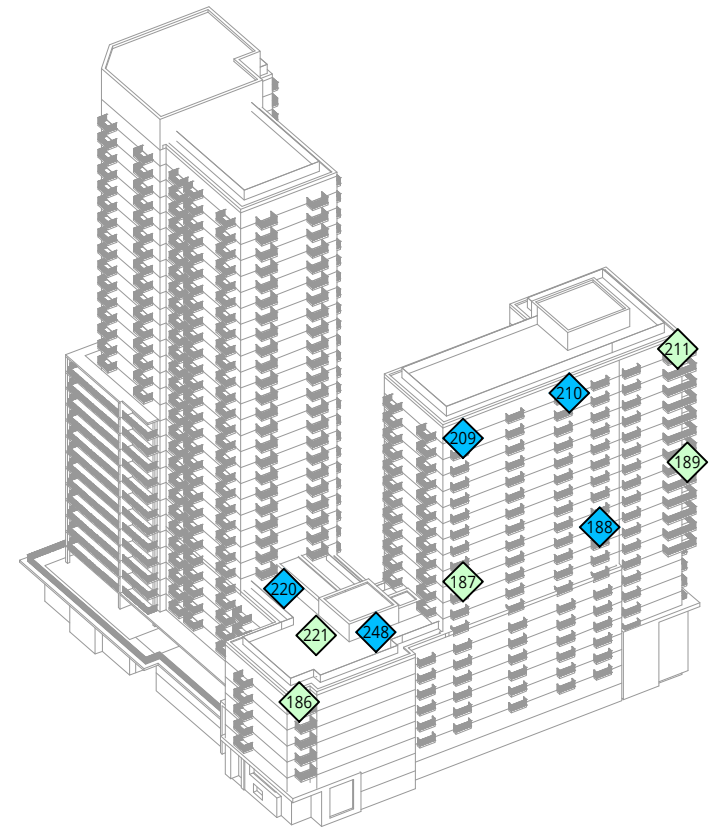




NORTH / EAST



NORTH / WEST



SOUTH / EAST

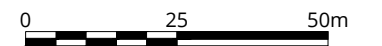
LEGEND:

LDDC COMFORT CATEGORIES:

Sitting	
Standing	
Strolling	
Walking	
Uncomfortable	

SENSOR LOCATION:

	Grade Level
	Podium Level
	Balcony/Roof Level



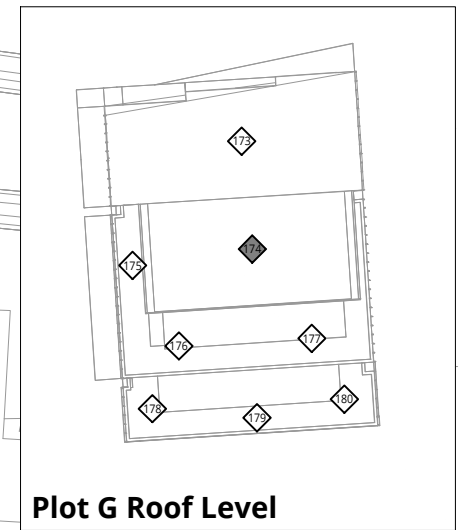
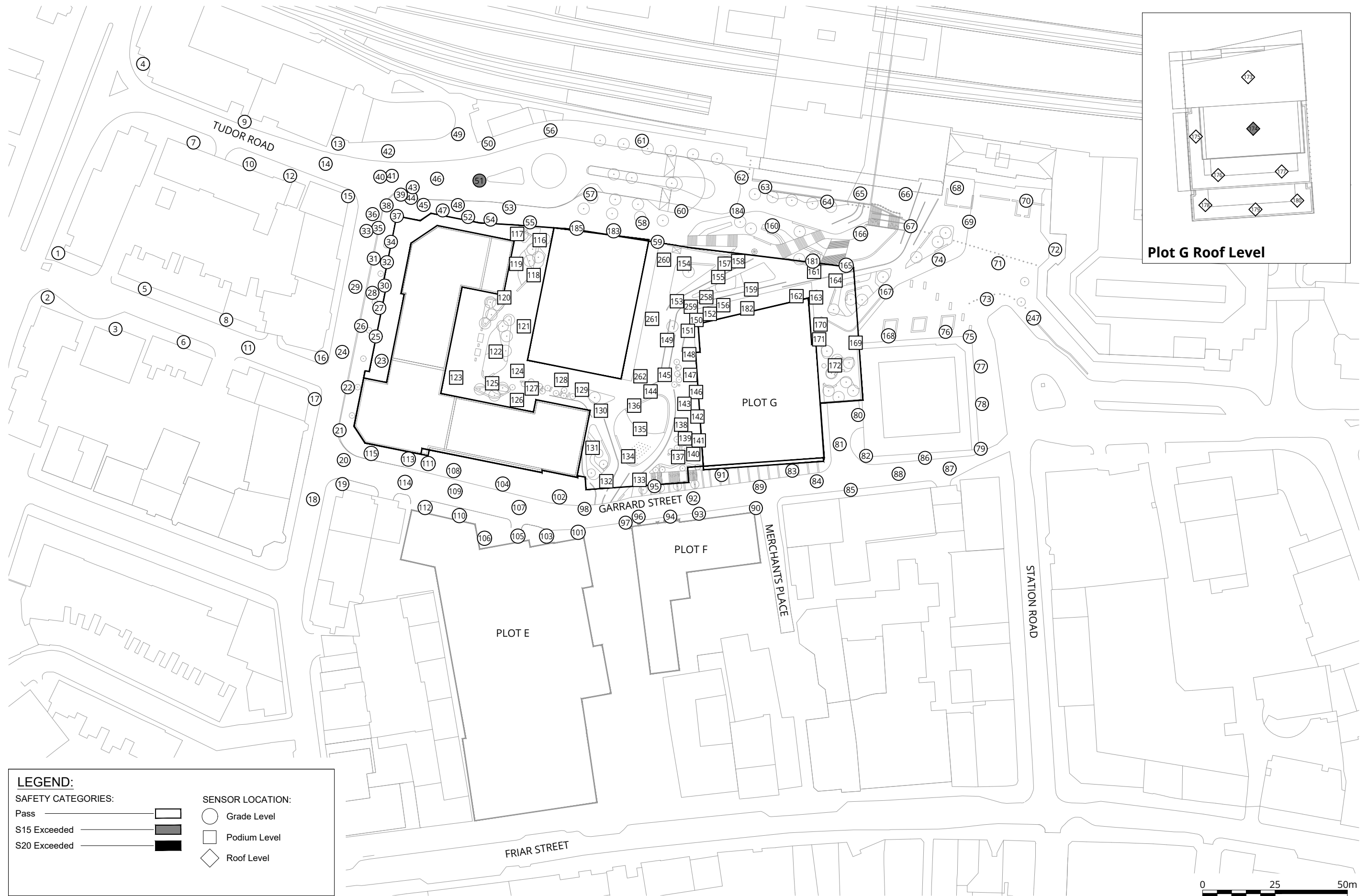
Pedestrian Wind Comfort Conditions - Isometric Views
 Mitigation: Development Option 2 with Landscaping, Mitigation and Cumulative Surrounding Buildings
 Summer Season

Station Hill - Reading, UK

Project #1803688

Drawn by: MW	Figure: 25
Approx. Scale @A3: 1:1250	
Date Revised: Sep. 17, 2019	





LEGEND:

SAFETY CATEGORIES:

Pass

S15 Exceeded

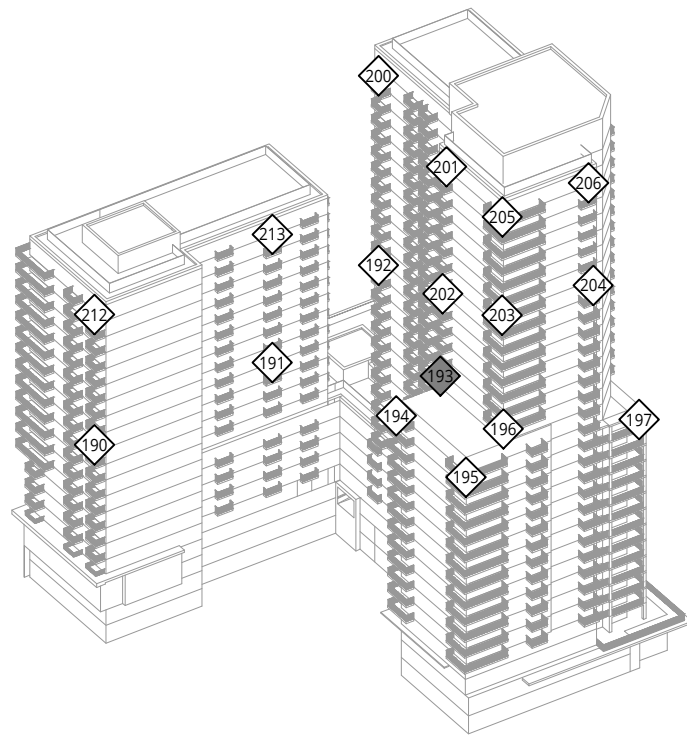
S20 Exceeded

SENSOR LOCATION:

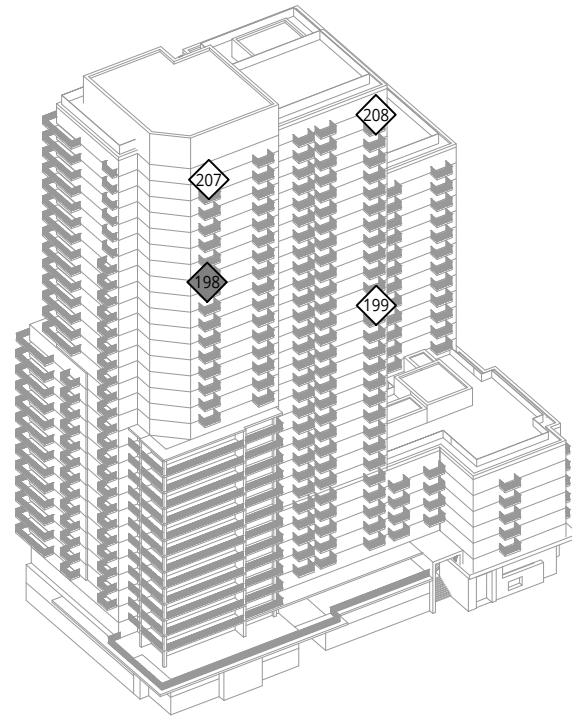
Grade Level

Podium Level

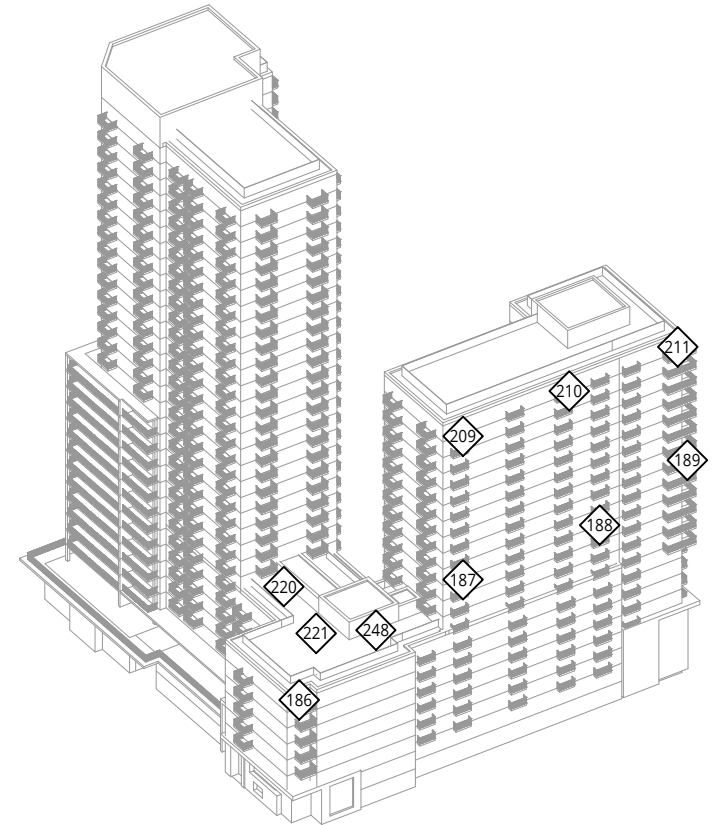
Roof Level



NORTH / EAST



NORTH / WEST



SOUTH / EAST

LEGEND:

SAFETY CATEGORIES:

Pass

S15 Exceeded

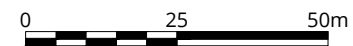
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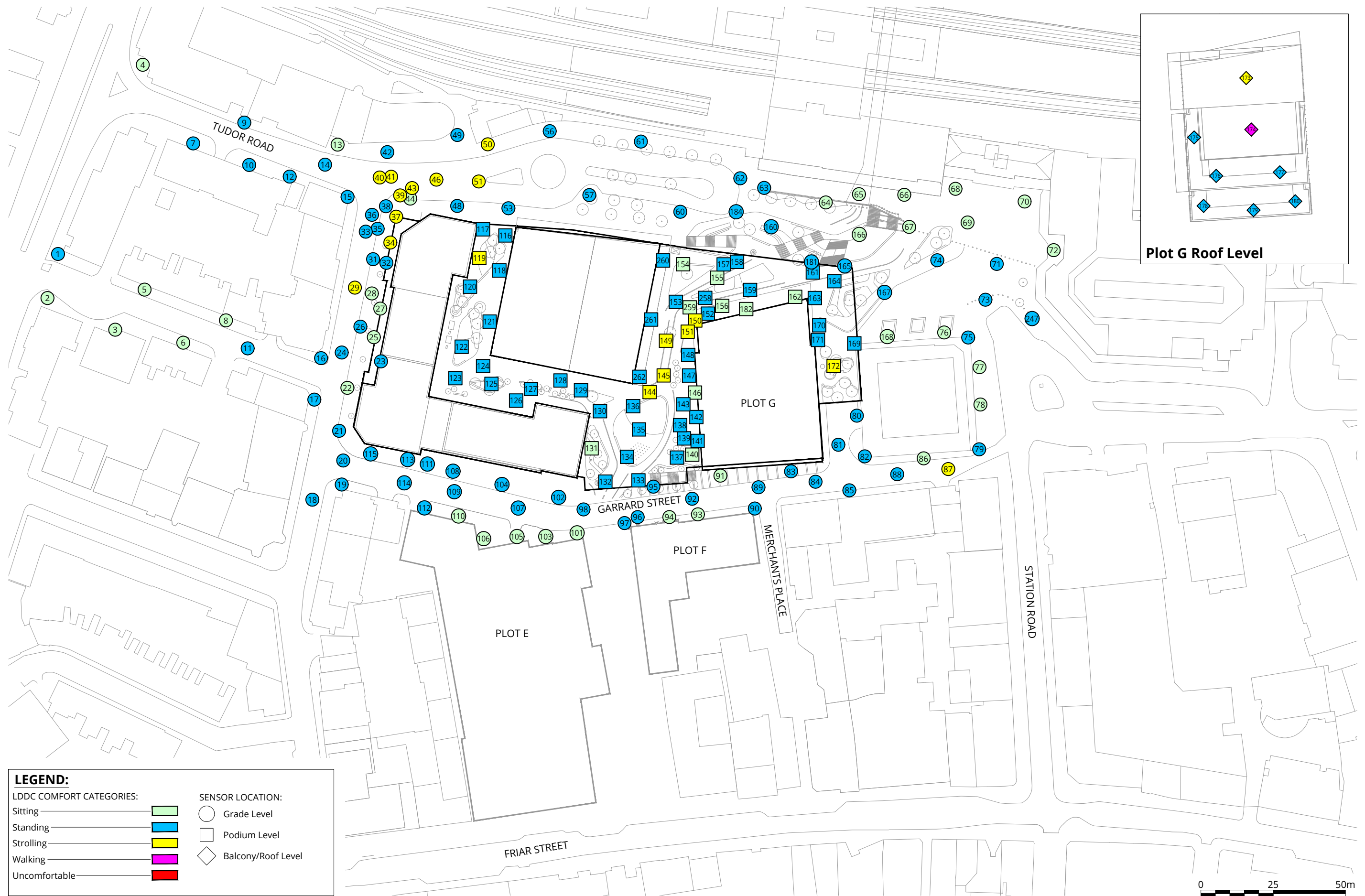
SENSOR LOCATION:

Grade Level

Podium Level

Roof Level





Pedestrian Wind Comfort Conditions - Ground and Terrace Levels Mitigation: Development Option 3 with Landscaping, Mitigation and Cumulative Surrounding Buildings Windiest Season

Station Hill - Reading, UK



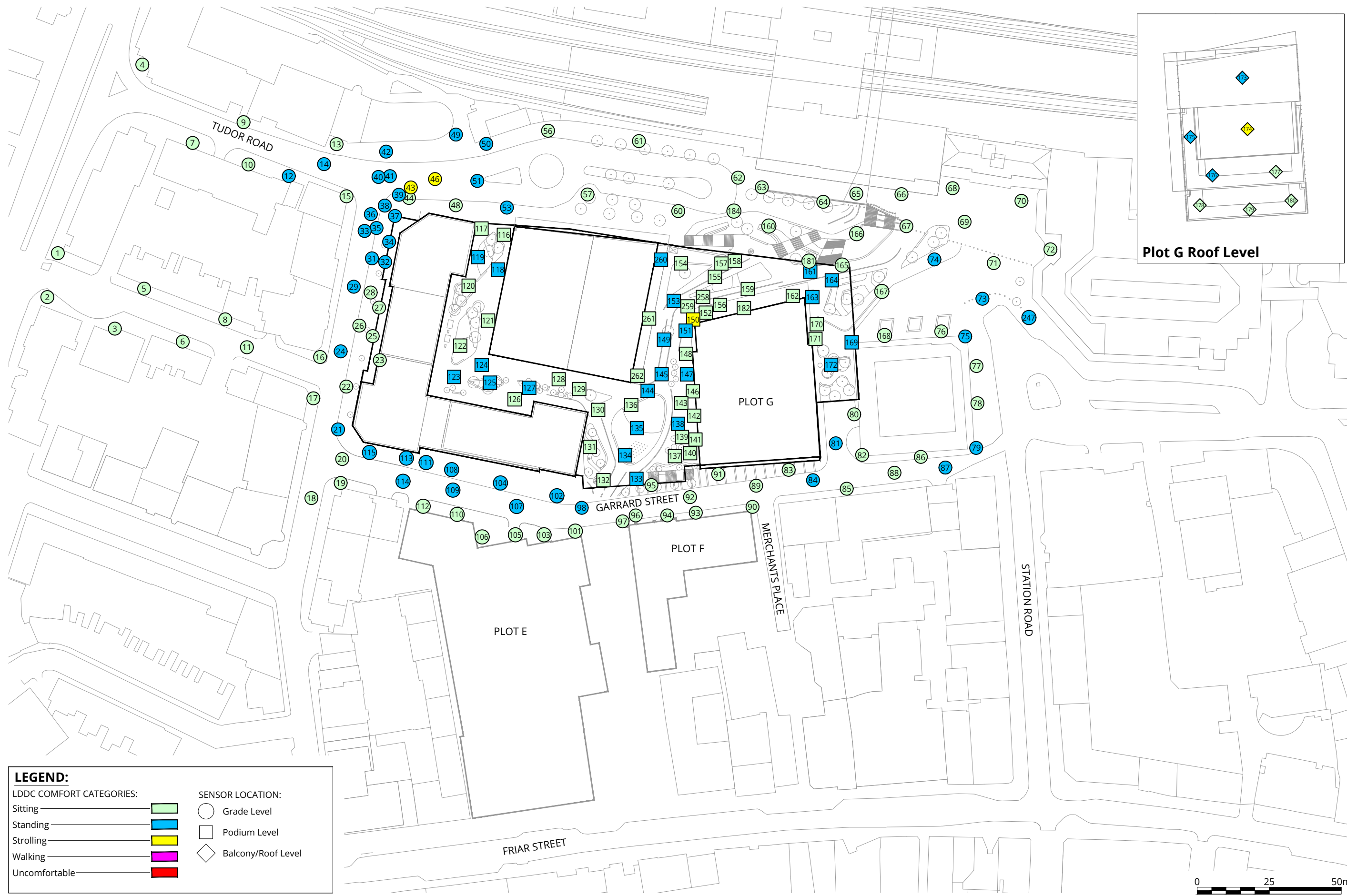
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Approx. Scale @A3: 1:1250

Date Revised: Sep. 17, 2019

Project #1803688





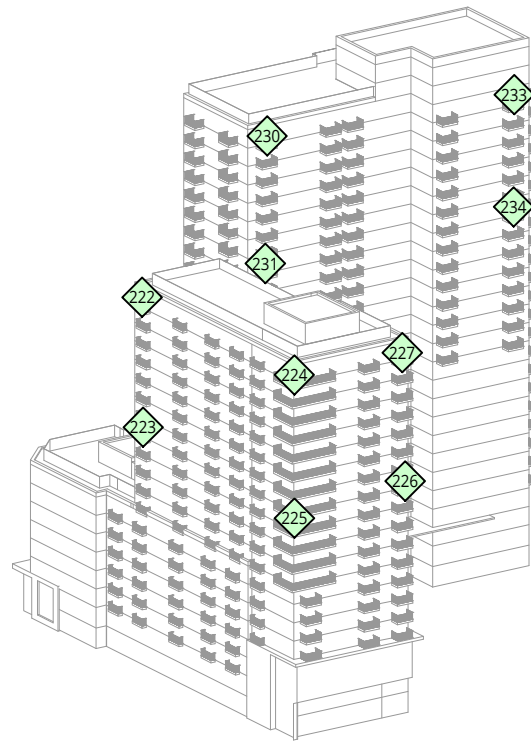
LEGEND:

LDDC COMFORT CATEGORIES:

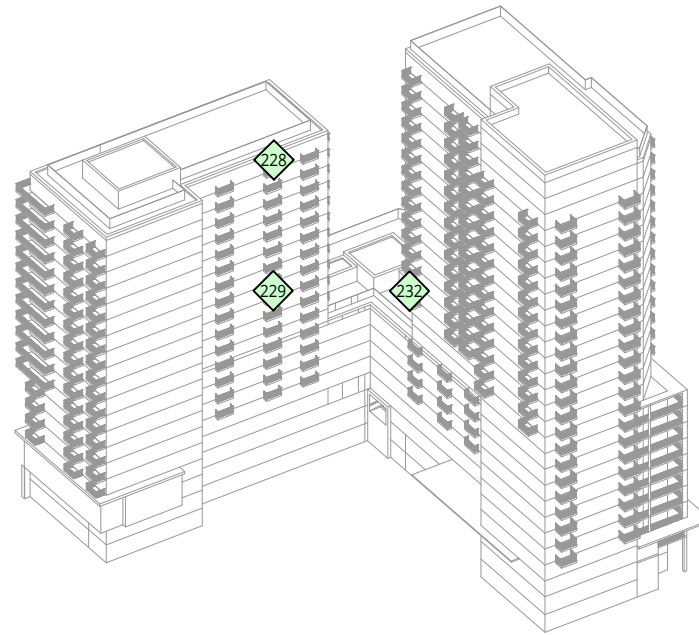
Sitting	Green square
Standing	Blue square
Strolling	Yellow square
Walking	Magenta square
Uncomfortable	Red square

SENSOR LOCATION:

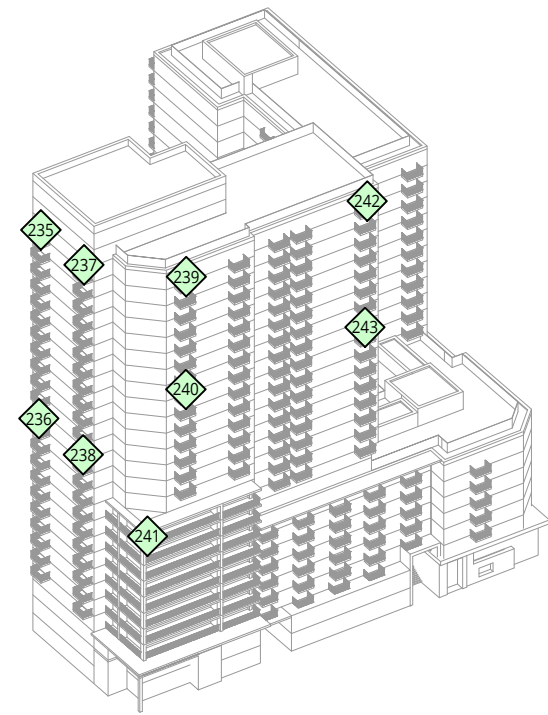
○ Grade Level
□ Podium Level
◇ Balcony/Roof Level



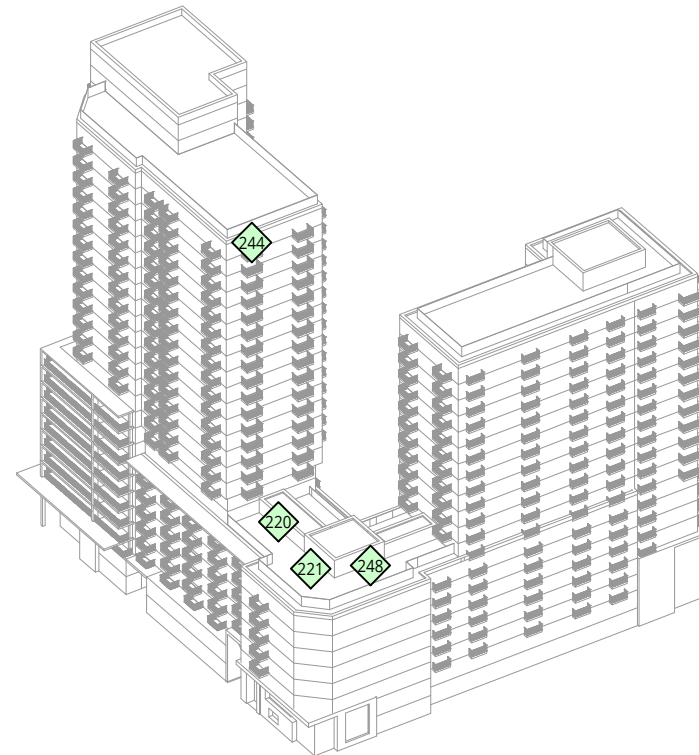
SOUTH / WEST



NORTH / EAST



NORTH / WEST



SOUTH / EAST

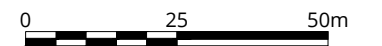
LEGEND:

LDDC COMFORT CATEGORIES:

Sitting	
Standing	
Strolling	
Walking	
Uncomfortable	

SENSOR LOCATION:

	Grade Level
	Podium Level
	Balcony/Roof Level

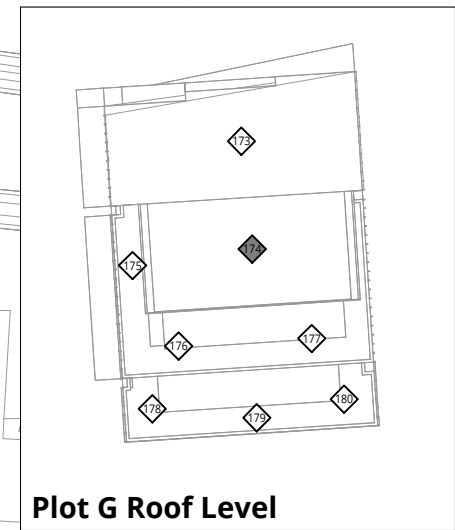
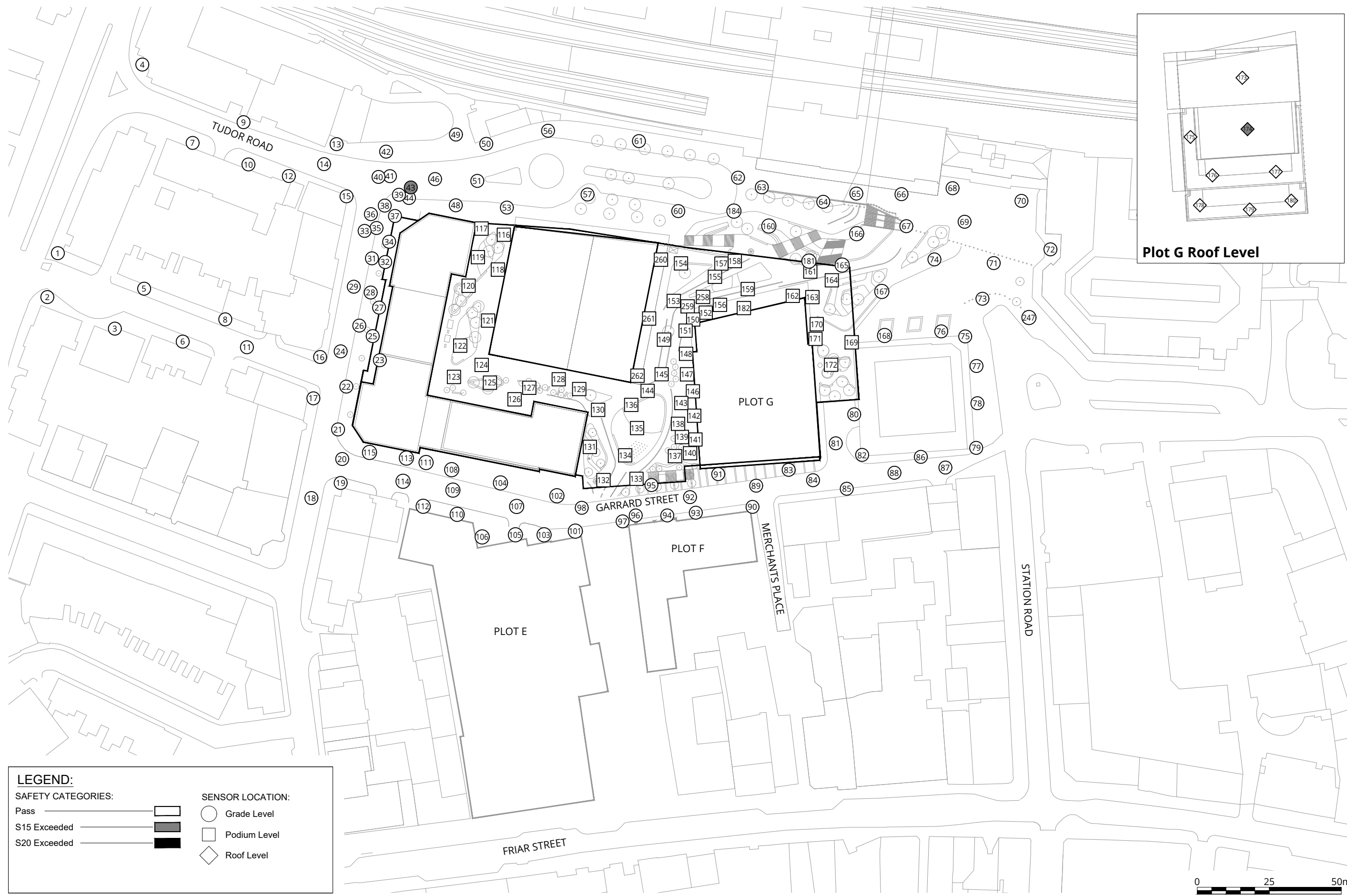


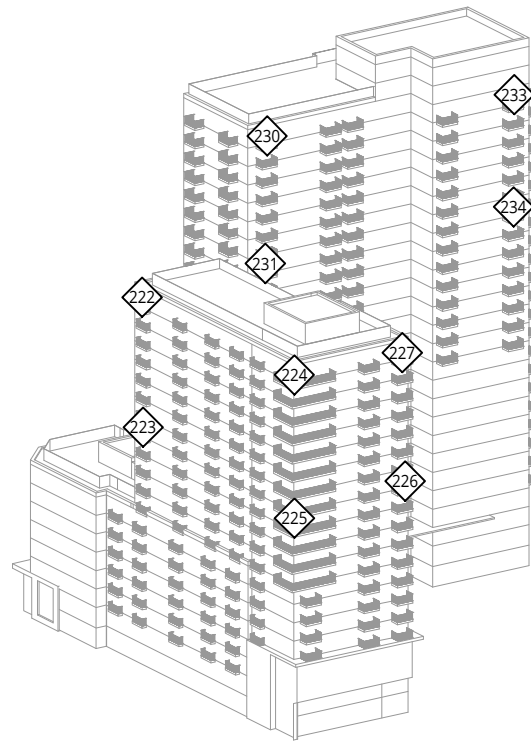
Pedestrian Wind Comfort Conditions - Isometric Views
 Mitigation: Development Option 3 with Landscaping, Mitigation and Cumulative Surrounding Buildings
 Summer Season

Station Hill - Reading, UK

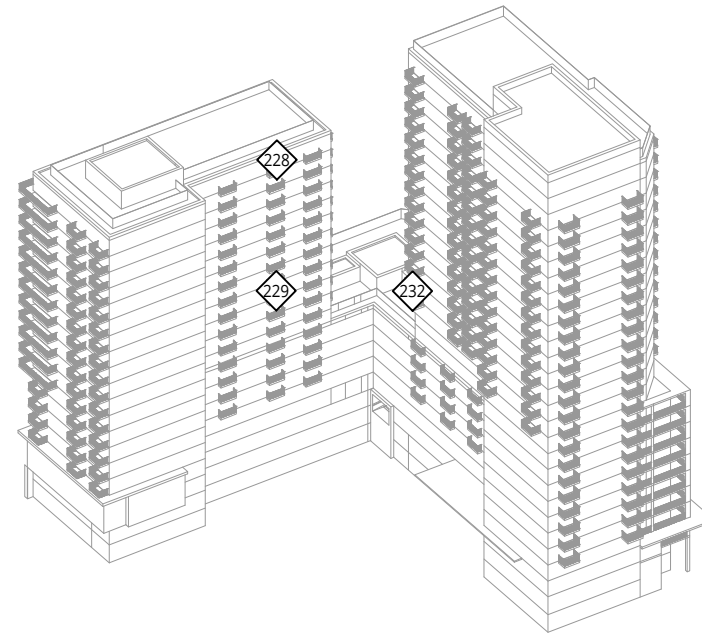
Project #1803688

Drawn by: MW	Figure: 30
Approx. Scale @A3: 1:1250	
Date Revised: Sep. 17, 2019	

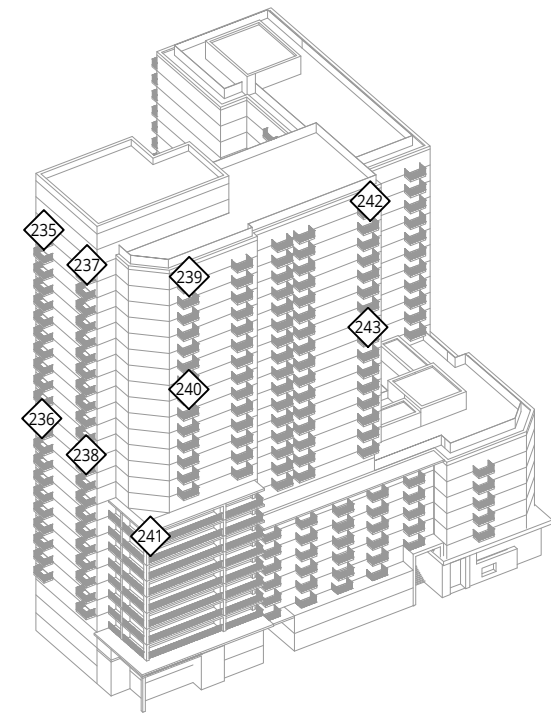




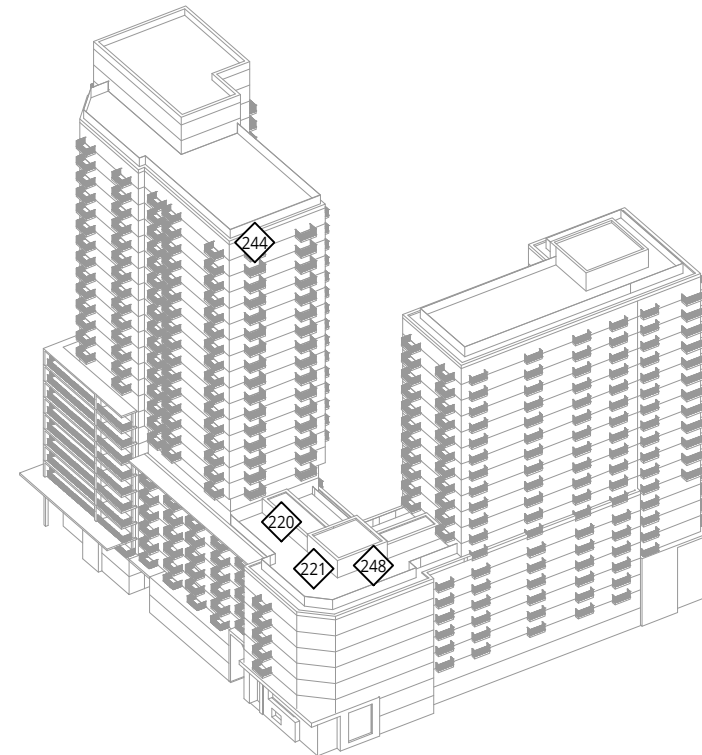
SOUTH / WEST



NORTH / EAST



NORTH / WEST



SOUTH / EAST

LEGEND:

SAFETY CATEGORIES:

Pass ———— 

S15 Exceeded ———— 

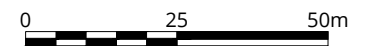
S20 Exceeded ———— 

SENSOR LOCATION:

 Grade Level

 Podium Level

 Roof Level



Pedestrian Wind Safety Conditions - Isometric Views
Mitigation: Development Option 3 with Landscaping, Mitigation and Cumulative Surrounding Buildings
Annual

Station Hill - Reading, UK

Project #1803688

Drawn by: MW Figure: 32

Approx. Scale @A3: 1:1250

Date Revised: Sep. 17, 2019



APPENDIX A



APPENDIX A: WIND TUNNEL PHOTOGRAPHS



Figure 33: Existing Site with the Existing Surrounding Buildings – View in the Wind Tunnel (from the north)

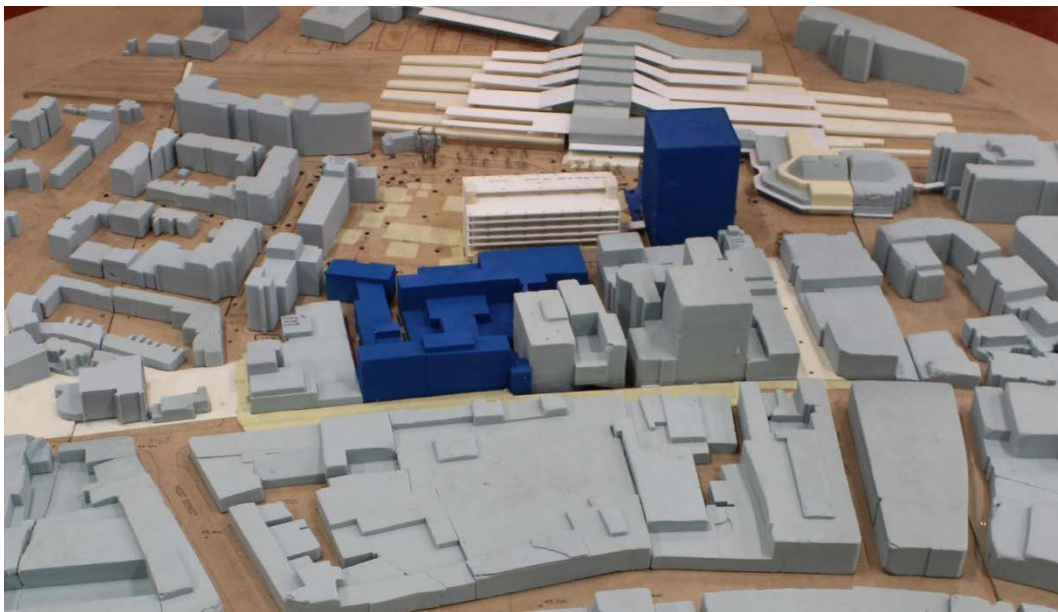


Figure 34: Existing Site with the Existing Surrounding Buildings – View in the Wind Tunnel (from the south)



Figure 35: Interim Development Scenario with Landscaping and the Existing Surrounding Buildings – View in the Wind Tunnel (from the north)



Figure 36: Interim Development Scenario with Landscaping and the Existing Surrounding Buildings – View in the Wind Tunnel (from the west)

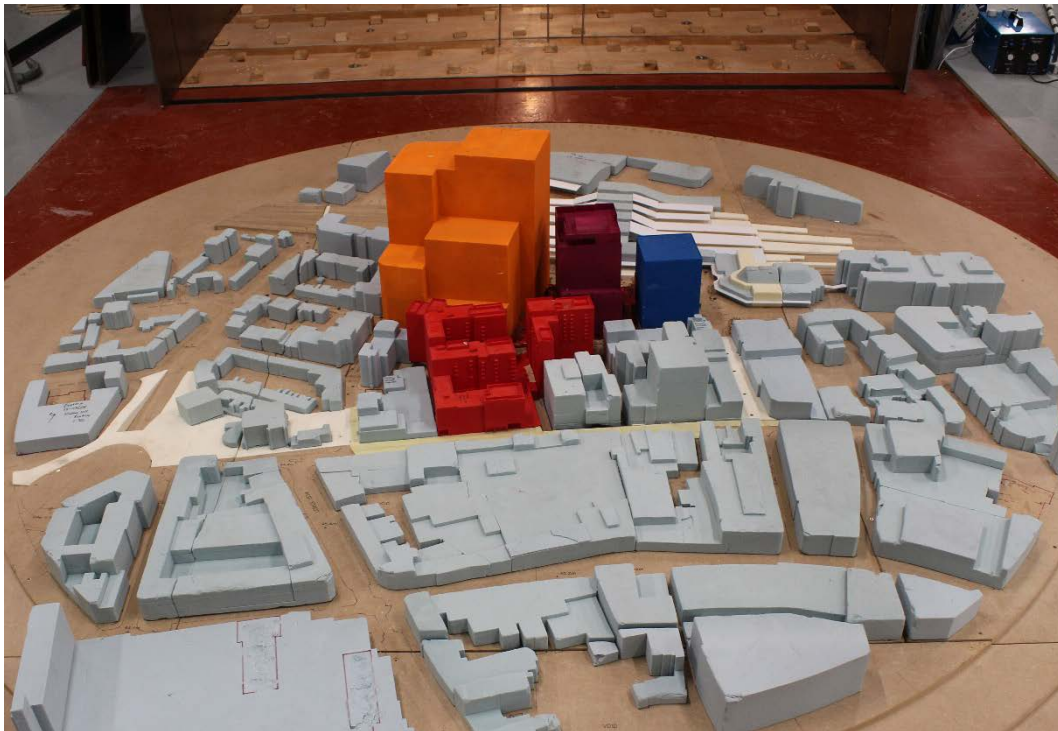


Figure 37: Completed Development Scenario with the Existing Surrounding Buildings – View in the Wind Tunnel (from the south)

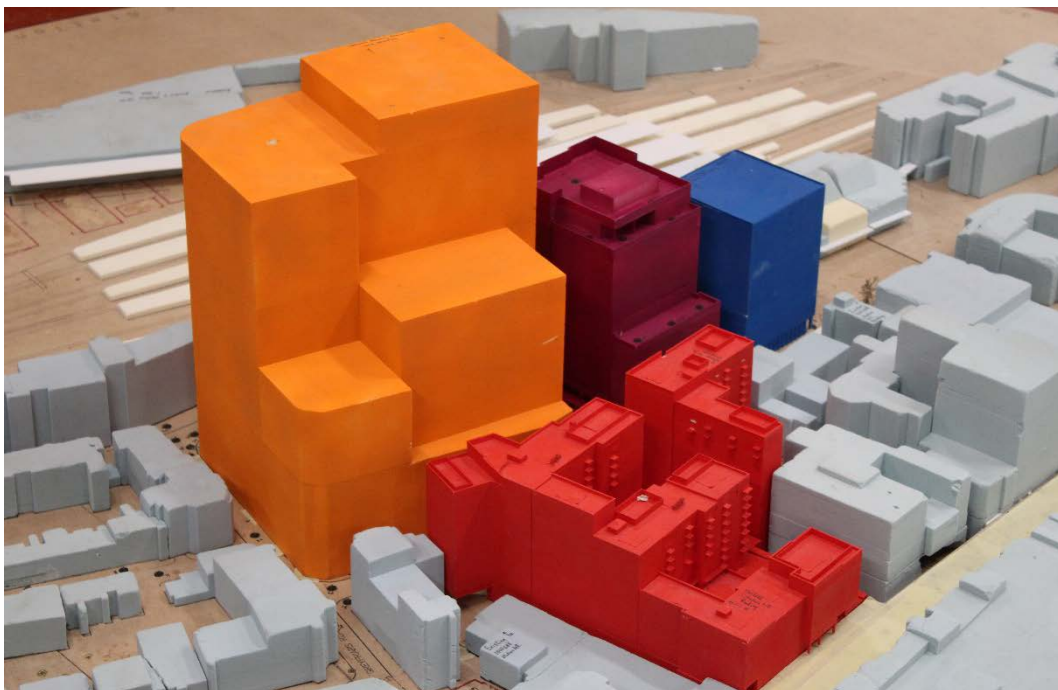


Figure 38: Maximum Parameter Development with the Existing Surrounding Buildings – View in the Wind Tunnel (from the south-west)

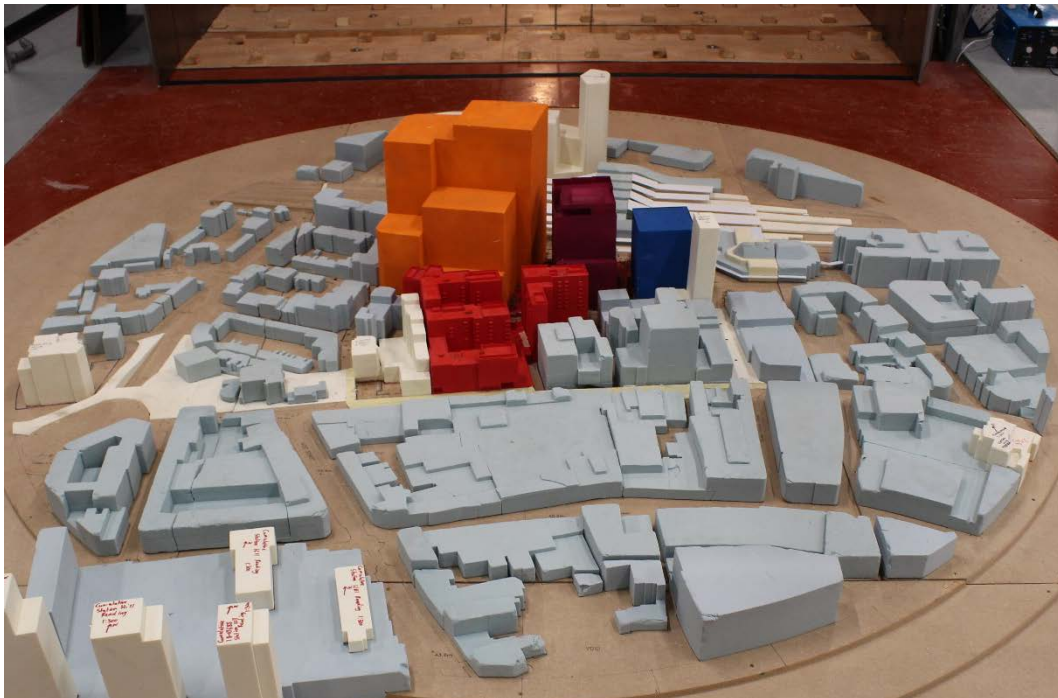


Figure 39: Maximum Parameter Development with the Cumulative Surrounding Buildings – View in the Wind Tunnel (from the south)

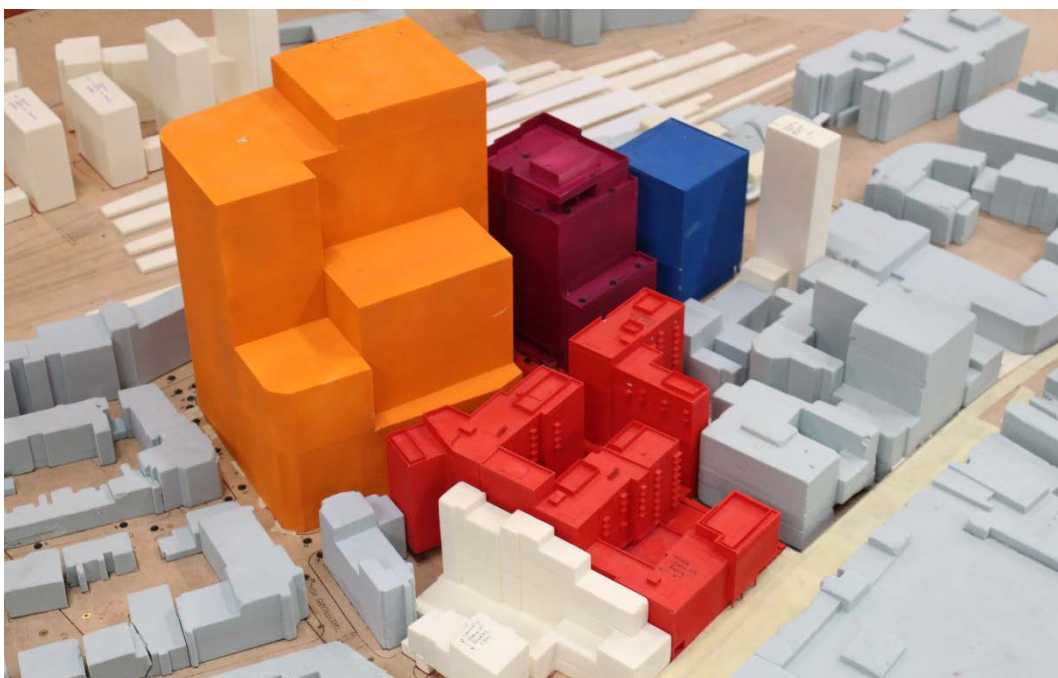


Figure 40: Proposed Development with Landscaping, Embedded Mitigation and the Cumulative Surrounding Buildings – View in the Wind Tunnel (from the south-west)



Figure 41: Interim Development Scenario with Landscaping, Wind Mitigation and the Existing Surrounding Buildings – View in the Wind Tunnel (from the south)



Figure 42: Interim Development Scenario with Landscaping, Wind Mitigation and the Existing Surrounding Buildings – View in the Wind Tunnel (from the west)

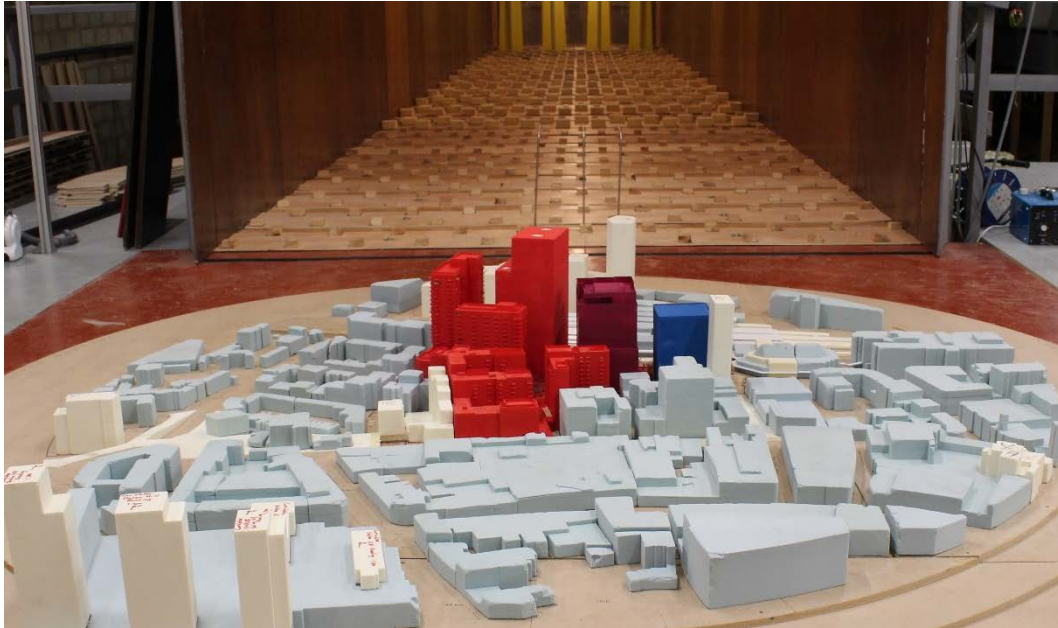


Figure 43: Development Option 1 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings – View in the Wind Tunnel (from the south)



Figure 44: Development Option 1 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings – View in the Wind Tunnel (from the south-west)

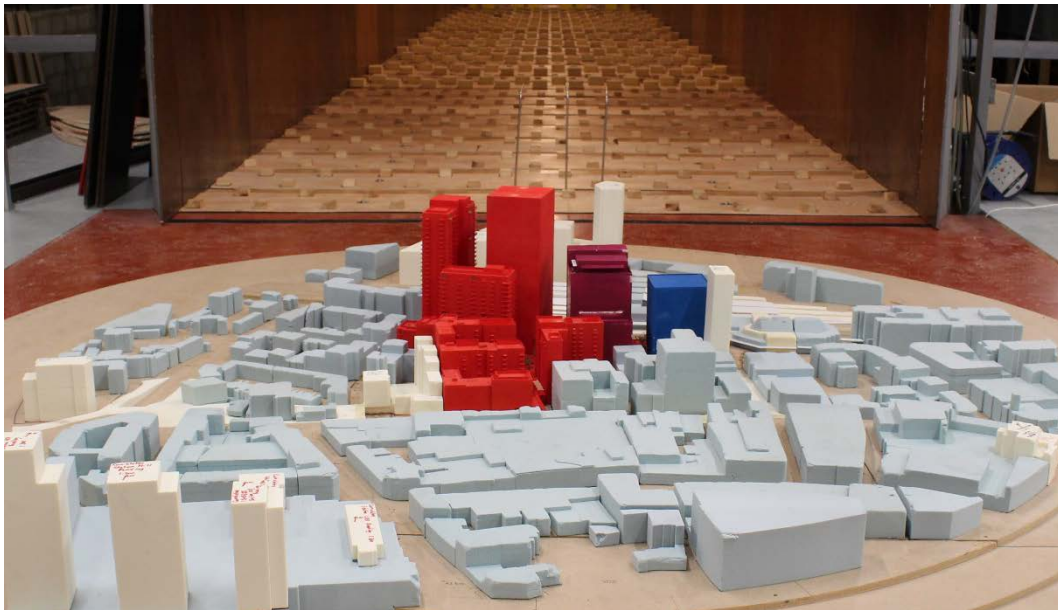


Figure 45: Development Option 2 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings – View in the Wind Tunnel (from the south)

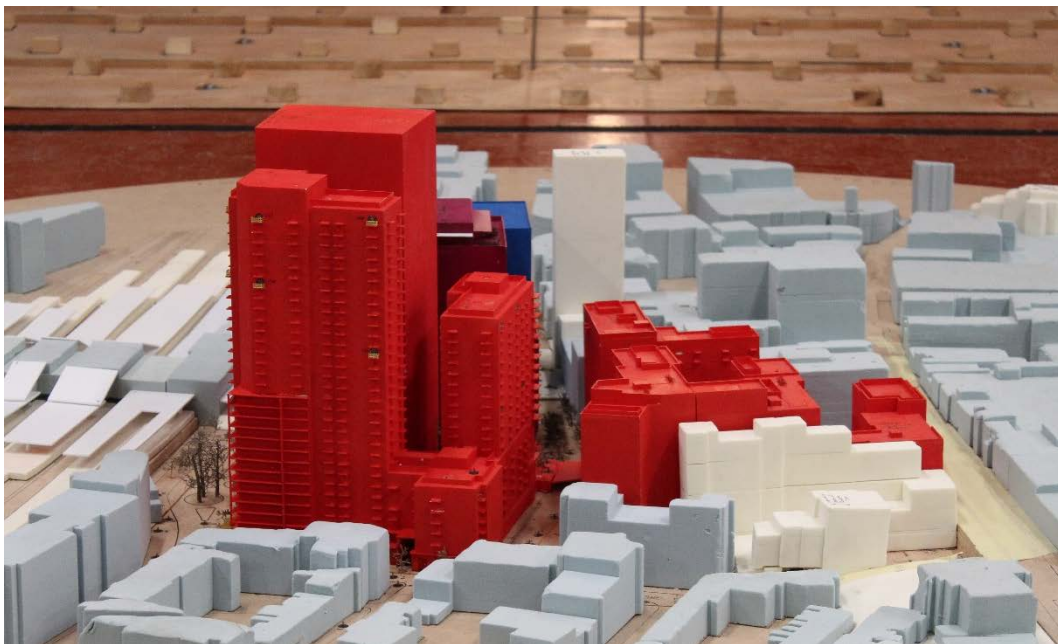


Figure 46: Development Option 2 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings – View in the Wind Tunnel (from the south-west)



Figure 47: Development Option 3 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings – View in the Wind Tunnel (from the south)



Figure 48: Development Option 3 with Landscaping, Wind Mitigation and the Cumulative Surrounding Buildings – View in the Wind Tunnel (from the south-west)

APPENDIX B



APPENDIX B: METEOROLOGICAL DATA

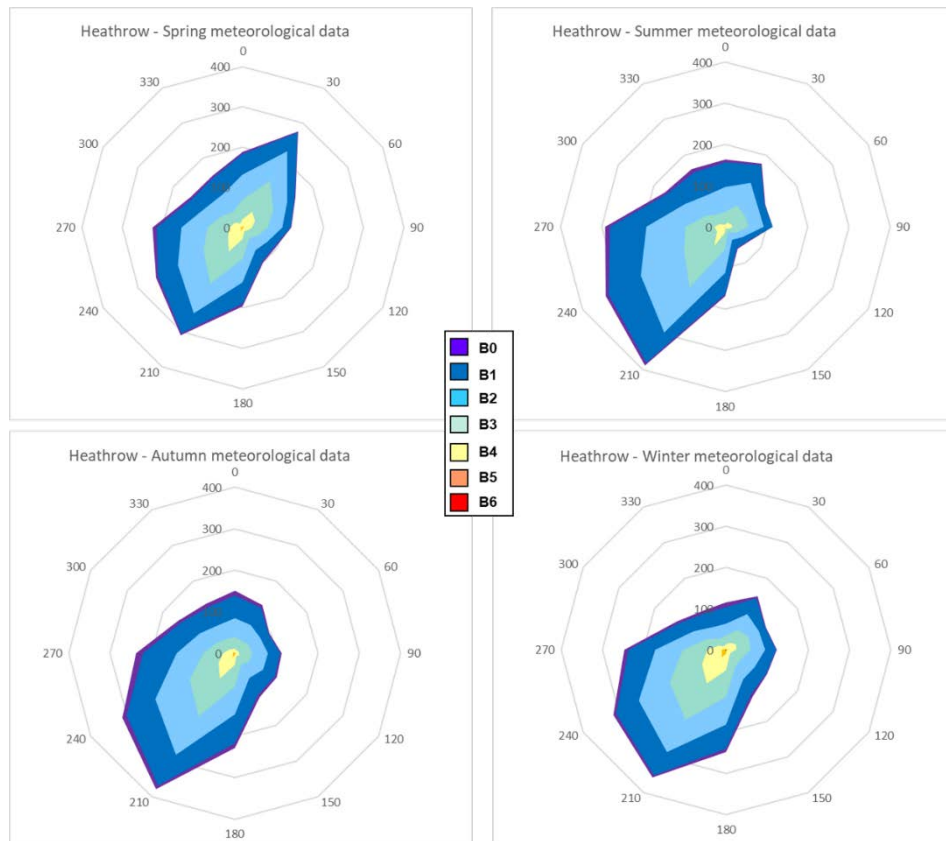


Figure 49: Seasonal wind roses for London Heathrow airport (in Beaufort Force) - (Radial axis indicates the hours for which the stated Beaufort Range is exceeded)

Table 5: 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.

APPENDIX C



APPENDIX C: MITIGATION DETAIL PHOTOGRAPHS



Figure 50: Interim Development Scenario – Sculpture, 7m tall by 2m nominal width, approximately 50% overall porosity, located south of western podium access stairs



Figure 51: Interim Development Scenario – Planter north of north-western corner of Plot G moved west by 3m with additional 7m tall tree, 1.5m height dense planting and two elevated porous (approximately 50% open) screens



Figure 52: Interim Development Scenario – Two 7m tall deciduous trees added to the north and the south of the intended route to the Plot C entrance with 1.5m tall dense planting



Figure 53: Interim Development Scenario – Three 7m tall deciduous trees added along southern edge of podium at south-western corner of Plot G



Figure 54: Interim Development Scenario – Three 7m tall deciduous trees added north of proposed loading bay on northern side and two 5m tall deciduous trees in planters between proposed Phase 1 trees on southern side of Garrard Street west of Merchant's Place



Figure 55: Interim Development Scenario – Dense planting on upper terrace, 1.5m in height

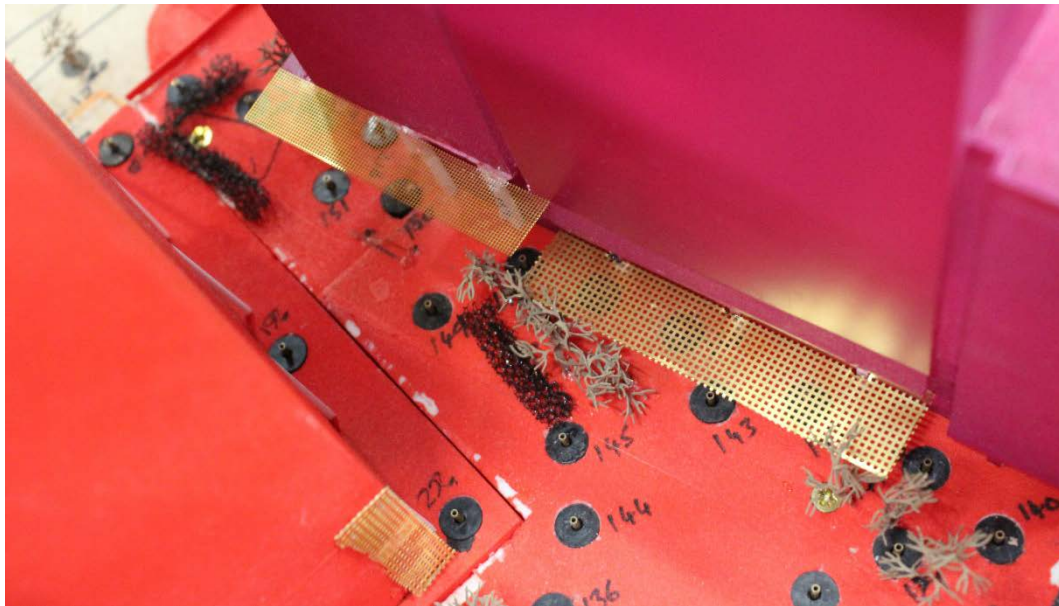


Figure 56: Completed Development Options – Porous canopy on Plot G western elevation, full height porous (up to 50% open) screening at southern end of Plot C undercut and dense planting bordering amenity/landscaping areas to west of Plot C



Figure 57: Completed Development Options – Porous canopy around north-western corner of Plot A, chamfer at Plot A north-western corner ground floor and 1.5m tall porous (up to 50% open) balustrade



Figure 58: Completed Development Options – Dense planting backing amenity spaces between Plot A and Plot C



Figure 59: Completed Development Options –Dense planting at northern edge of podium between Plot A and Plot C and between Plot C and Plot D