1 Triton Square & St Anne's

Internal Daylight Study

OCTOBER 2016

1 TRITON SQUARE & ST ANNE'S PLANNING DOCUMENTS

EXISTING & PROPOSED DRAWINGS VOL. 1 (1 TSQ)
EXISTING & PROPOSED DRAWINGS VOL. 2 (ST ANNE'S)
DESIGN & ACCESS STATEMENT VOL. 1 (1 TSQ)
DESIGN & ACCESS STATEMENT VOL. 2 (ST ANNE'S)
HOUSING STUDY
TOWNSCAPE & VISUAL IMPACT ASSESSMENT
HERITAGE STATEMENT
LANDSCAPE MASTERPLAN
PLANNING STATEMENT
STATEMENT OF COMMUNITY INVOLVEMENT
TRANSPORT ASSESSMENT
ENERGY STATEMENT
SUSTAINABILITY STATEMENT
DAYLIGHT AND SUNLIGHT STUDY
OVERSHADOWING STUDY

INTERNAL DAYLIGHT STUDY

AIR QUALITY ASSESSMENT
SURFACE WATER DRAINAGE PROFORMA
CONSTRUCTION MANAGEMENT PLAN
SOCIO-ECONOMIC ASSESSMENT
ARBORICULTURAL ASSESSMENT

Internal Daylight and Sunlight Amenity Within The Site

St. Anne's

Project No: 5615

21 October 2016

Client	British Land Property Management Ltd
Architect	Matthew Lloyd Architects
Project Title	St. Anne's
Project Number	5615
Report Title	Internal Daylight and Sunlight Report
Dated	21 October 2016

Prepared by	NC/MM
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1. EXECUTIVE SUMMARY

The purpose of this report is to ascertain whether the daylight and sunlight amenity within the residential accommodation of the proposed St. Anne's development can be considered acceptable. To this end, technical assessments have been undertaken on all proposed habitable rooms.

The results of the daylight assessments show that 81.2% of all habitable rooms will meet or exceed Building Research Establishment's (BRE) recommendations for daylight quantity and 90.6% will achieve levels of sky visibility in line with guidance. These can be considered good results for a central London location, where the daylight availability is typically restricted due to the density of the urban fabric.

All proposed living/kitchen/dining rooms and bedrooms will achieve acceptable daylight levels as they meet or exceed the levels recommended by BRE, with the exception of one living/kitchen/diners that marginally falls short. The few living rooms falling short of recommendation will do so marginally owing to the obstruction caused by balconies, which have been provided in accordance with the London Housing Design Guide. The majority of rooms achieving levels of daylight lower than those suggested by BRE are kitchens, which have been located in the areas of lower daylight potential to prioritise the daylight ingress into living areas.

The results of the sunlight assessments show that the majority of rooms will receive good levels of sunlight both throughout the year and during the winter months. The living areas served solely by windows located behind recessed balconies will fall short of recommendation as balconies typically act as shading devices, however future occupants of these units will be able to enjoy sunlight through the use of their private amenity spaces. During the winter months, when the sun is lower in the sky, its rays will be partially intercepted by the surrounding buildings and as a result the living areas located on the lowest floors will receive levels of sunlight slightly lower than those suggested. These living areas will have good access to sunlight in the summer, when it is generally most appreciated.

With the vast majority of rooms achieving levels of daylight and sunlight in line with guidance and most of those falling short of recommendation doing so just marginally, the proposed development is considered to provide good daylight and sunlight amenity for future occupants.

2. INTRODUCTION AND OBJECTIVE

GIA has been instructed to provide a report upon the potential availability of Daylight and Sunlight to the proposed accommodation within the residential scheme prepared by Matthew Lloyd Architects. GIA was specifically instructed to carry out the following:

- To create a 3D computer model of the proposal based upon drawings prepared by Matthew Lloyd Architects.
- Carry out a daylight assessment using the methodologies set out in the BRE guidelines for Average Daylight Factor, No-Sky Line and Room Depth Criterion.
- Carry out a sunlight assessment using the methodologies set out in the BRE guidelines for Annual Probable Sunlight Hours (APSH) to the fenestration facing within 90 degrees of due south.
- Prepare a report setting out the analysis and our findings.

3. BRE GUIDELINES

The Building Research Establishment (BRE) have set out in their handbook *Site Layout Planning for Daylight and Sunlight a Guide to Good Practice (2011)*, guidelines and methodology for the measurement and assessment of daylight and sunlight within proposed buildings. This document states that it is also intended to be used in conjunction with the interior daylight recommendations found within the *British Standard BS8206-2:2008* and *The Applications Manual on Window Design* of the Chartered Institution of Building Services Engineers (CIBSE).

The guide also provides advice on site layout planning to determine the quality of daylight and sunlight within open spaces between buildings.

It is important to note, however, that this document is a guide whose stated aim *"is to help rather than constrain the designer"*.

The document provides advice, but also clearly states that it *"is not mandatory and this document should not be seen as an instrument of planning policy."* The report acknowledges also in its introduction that *"in special circumstances the developer or planning authority may wish to use different target values. For example, in a historic City centre a higher degree of obstruction may be unavoidable if new developments are to match the height and proportions of existing buildings."*

It is an inevitable consequence of the built up urban environment that daylight and sunlight will be more limited in these areas. It is well acknowledged that in such situations there may be many other conflicting and potentially more important planning and urban design matters to consider other than just the provision of ideal levels of daylight and sunlight.

3.1. DAYLIGHT

The BRE set out various methods for assessing the daylight within a proposed building within section 2.1 and Appendix C of the handbook. The summary of this, given at the end of section 2.1 of the guide, states as follows:

> *"In general, a building will retain the potential for good interior diffused daylighting provided that on all its main faces:*
>
> *A. No obstruction, measured in a vertical section perpendicular to the main face, from a point two metres above ground level, subtends an angle of more than 25 degrees to the horizontal;*
>
> *Or*
>
> *B. If (A) is not satisfied, then all points on the main face on a line two metres above ground level are within four metres (measured sideways) of a point which has a vertical sky line component of 27% or more."*

3.1.1. VERTICAL SKY COMPONENT (VSC)

This method of assessment can be undertaken using a skylight indicator or a Waldram diagram. It measures from a single point, at the centre of the window (if known at the early design stage), the quantum of sky visible taking into account all external obstructions. Whilst these obstructions can be either other buildings or the general landscape, trees are usually ignored unless they form a continuous or dense belt of obstruction.

The VSC method is a useful 'rule of thumb' but has some significant limitations in determining the true quality of daylight within a proposed building. It does not take into account the size of the window, any reflected light off external obstructions, any reflected light within the room, or the use to which that room is put. Appendix C of the guide goes into more detail on these matters and sets forward alternative methods for assessment to overcome these limitations.

Paragraph 2.1.21 of the BRE states that:

"Obstructions can limit access to light from the sky. This can be checked by measuring or calculating the angle of visible sky 'theta' , angle of obstruction or Vertical Sky Component (VSC) at the centre of the lowest window where daylight is required. If VSC is:

- *at least 27% ('theta' is greater than 65 degrees, obstruction angle less than 25 degrees) conventional window design will usually give reasonable results.*
- *between 15% and 27 % ('theta' is between 45 degrees and 65 degrees, obstruction angle between 25 degrees and 45 degrees) special measures (larger windows, changes to room layout) are usually needed to provide adequate daylight.*
- *between 5% and 15% ('theta' is between 25 degrees and 45 degrees, obstruction angle between 45 degrees and 65 degrees) it is very difficult to provide adequate daylight unless very large windows are used.*
- *less than 5% ('theta' less than 25 degrees, obstruction angle more than 65 degrees) it is often impossible to achieve reasonable daylight, even if the whole window wall is glazed."*

Appendix C of the BRE guide: Interior Daylighting Recommendations, states:

> *"The British Standard for daylighting, and the CIBSE Applications manual: window design, contain advice and guidance on interior daylighting. This guide to good practice is intended to be used in conjunction with them, and its guidance is intended to fit in with their recommendations.*
>
> *For skylight, the British Standard and the CIBSE manual put forward three main criteria, based on the average daylight factor, room depth, and the position of the no skyline."*

3.1.2. AVERAGE DAYLIGHT FACTOR (ADF)

> *"If a predominantly daylit appearance is required, then adf should be 5% or more if there is no supplementary electric lighting, or 2% or more if supplementary electric lighting is provided. There are additional recommendations for dwellings, of 2% for kitchens, 1.5% for living rooms and 1% for bedrooms. These last are minimum values of Average Daylight Factor, and should be attained even if a predominantly daylit appearance is not required."*

This method of assessment takes into account the total glazed area to the room, the transmittance quality of the glazing proposed, the total area of the room surfaces including ceilings and floors, and the internal average reflectance for the room being assessed. The method also takes into account the Vertical Sky Component and the quantum of reflected light off external surfaces.

This is, therefore, a significantly more detailed method of assessment than the Vertical Sky Component method set out above.

3.1.3. ROOM DEPTH CRITERION (RDC)

Where it has access to daylight from windows in one wall only, the depth of a room can become a factor in determining the quantity of light within it. The BRE guidance provides a simple method for examining the ratio of room depth to window area. However, whilst it does take into account internal surface reflections, this method also has significant limitations in that it does not take into account any obstructions outside the window and therefore draws no input from the quantity of light entering the room.

3.1.4. NO SKY LINE (NSL)

This third method of assessment is a simple test to establish where within the proposed room the sky will be visible through the windows, taking into account external obstructions. The assessment is undertaken at working plane height (850mm above floor level) and the method of calculation is set out in Appendix D of the BRE handbook.

Appendix C of the BRE handbook states *"if a significant area of the working plane lies beyond the no skyline (i.e., it receives no direct skylight), then the distribution of daylight in the room will look poor and supplementary electric lighting will be required."* To guarantee a satisfactory daylight uniformity, the area which does not receive direct skylight should not exceed 20% of the floor area, as quantified in the BS 8206 Part2 2008.

3.1.5. SUMMARY

The Average Daylight Factor gives a more detailed assessment of the daylight within a room and takes into account the highest number of factors in establishing a quantitative output.

However, the conclusion of Appendix C of the BRE guide states:

"All three of the criteria need to be satisfied if the whole of the room is to look adequately daylit. Even if the amount of daylight in a room (given by the Average Daylight Factor) is sufficient, the overall daylight appearance will be impaired if its distribution is poor."

In most urban areas it is important to recognise that the distribution of daylight within a room may be difficult to achieve, given the built up nature of the environment. Consequently, most local authorities seek to ensure that there is sufficient daylight within the room as determined by the Average Daylight Factor calculation. However, the additional recommendations of the BRE and British Standard for residential accommodation, set out above, ought not to be overlooked.

3.2. SUNLIGHT

The BRE provide guidance in respect of sunlight quality for new developments within section 3.1 of the handbook. It is generally acknowledged that the presence of sunlight is more significant in residential accommodation than it is in commercial properties, and this is reflected in the BRE document.

It states, *"in housing, the main requirement for sunlight is in living rooms, where it is valued at any time of the day, but especially in the afternoon. Sunlight is also required in conservatories. It is viewed as less important in bedrooms and in kitchens where people prefer it in the morning rather than the afternoon."*

The BRE guide considers the critical aspects of orientation and overshadowing in determining the availability of sunlight at a proposed development site.

The guide proposes minimizing the number of dwellings whose living room face solely north unless there is some compensating factor such as an appealing view to the north, and it suggests a number of techniques to do so. Further more, it discusses massing solutions with a sensitive approach to overshadowing, so as to maximize access to sunlight.

At the same time it acknowledges that the site's existing urban environment may impose orientation or overshadowing constraints which may not be possible to overcome.

To quantify sunlight access for interiors where sunlight is expected, it refers to the BS 82606-2 criterion of Annual Probable Sunlight Hours. APSH is defined as *"the total number of hours in the year that the sun is expected to shine on unobstructed ground, allowing for average levels of cloudiness at the location in question."* In line with the recommendation, APSH is measured from a point on the inside face of the window, should the locations have been decided. If these are unknown, sunlight availability is checked at points 1.6m above the ground or the lowest storey level on each main window wall, and no more than 5m apart. If a room has multiple windows on the same wall or on adjacent walls, the highest value of APSH should be taken into account. If a room has two windows on opposite walls, the APSH for each can be added together.

The summary of section 3.1 of the guide states as follows:

"In general, a dwelling or non-domestic building which has a particular requirement for sunlight, will appear reasonably sunlit provided that:

At least one main window faces within 90 degrees of due south;

and

The centre of at least one window to a main living room can receive 25% of annual probable sunlight hours, including at least 5% of annual probable sunlight hours in the winter months between 21 September and 21 March. "

In paragraph 3.1.11 the BRE guidance suggests that if a room faces significantly North of due East or West it is unlikely to meet the recommended levels proposed by the BS 8206-2. As such, it is clear that only windows facing within 90 degrees of due South can be assessed using this methodology.

It is also worth noting how paragraph 5.3 of the BS 8206-2 suggests that with regards to sunlight duration *"the degree of satisfaction is related to the expectation of sunlight if a room is necessarily north facing or if the building is in a densely-built urban area, the absence of sunlight is more acceptable than when its exclusion seems arbitrary".*

4. METHODOLOGY

In order to undertake the daylight and sunlight assessments set out above, we have prepared a three dimensional computer model and used specialist lighting simulation software.

The three dimensional representation of the proposed development has been modelled using the scheme drawings provided to us by Matthew Lloyd Architects. This has been placed in the context of its surrounding buildings which have been modelled from survey information, photogrammetry, OS and site photographs. This allows for a precise model, which in turn ensures that analysis accurately represents the amount of daylight and sunlight available to the building facades, internal and external spaces, considering all of the surrounding obstructions and orientation.

4.1. SIMULATION ASSUMPTIONS

Where no values for reflectance, transmittance and maintenance factor were specified by the designer the following values from *BS 8206-2:2008, Annex A, tables A.1-A.6* were used for the calculation of Average Daylight Factor values. These values are shown in Table 1. A medium veneer has been assumed for the reflectance value of the internal floor.

Reflectance values:	
Surrounding	0.2
Pavement	0.2
Grass	0.1
Water	0.1
Yellow brick	0.3
Red brick	0.2
Portland Stone	0.6
Concrete	0.4
Internal walls (light grey)	0.68
Internal ceiling (white paint)	0.85
Internal floor (medium veneer)	0.3
Internal floor (light veneer)	0.4
Transmittance values:	
Triple glazing:	
Pilkington K Glass 4/12/4/12/4 Argon filled 90%	Tv= 0.63
Double glazing:	
Pilkington K Glass 4/16/4 Argon filled 90%	Tv= 0.75
Single glazing:	
Pilkington Optifloat Clear, Annealed, 4mm	Tv=0.90
Translucent glazing:	
Pilkington Optifloat Opal - 4mm K /16/4mm Opal	Tv= 0.74

Maintenance factors:	**Tv(normal)**	**A.3**	**A.4**	**A.5**	**A.6**	**Tv(total)**
Triple Low-E (frames modelled)	0.63	8	1	1	1	0.58
Triple Low-E (frames not modelled)	0.63	8	1	1	0.8	0.46
Triple Low-E (inclined, frames modelled)	0.63	8	2	1	1	0.53
Triple Low-E (inclined, frames not modelled)	0.63	8	2	1	0.8	0.42
Triple Low-E (horizontal, frames modelled)	0.63	8	3	1	1	0.48
Triple Low-E (horizontal, frames not modelled)	0.63	8	3	1	0.8	0.38
Double Low-E (frames modelled)	0.75	8	1	1	1	0.69
Double Low-E (frames not modelled)	0.75	8	1	1	0.8	0.55
Double Low-E (inclined, frames modelled)	0.75	8	2	1	1	0.63
Double Low-E (inclined, frames not modelled)	0.75	8	2	1	0.8	0.50
Double Low-E (horizontal, frames modelled)	0.75	8	3	1	1	0.57
Double Low-E (horizontal, frames not modelled)	0.75	8	3	1	0.8	0.46
Single (frames modelled)	0.9	8	1	1	1	0.83
Single (frames not modelled)	0.9	8	1	1	0.8	0.66
Single (inclined, frames modelled)	0.9	8	2	1	1	0.76
Single (inclined, frames not modelled)	0.9	8	2	1	0.8	0.60
Single (horizontal, frames modelled)	0.9	8	3	1	1	0.68
Single (horizontal, frames not modelled)	0.9	8	3	1	0.8	0.55
Double Translucent Low-E (frames modelled)	0.74	8	1	1	1	0.68
Double Translucent Low-E (frames not modelled)	0.74	8	1	1	0.8	0.54
Double Translucent Low-E (inclined, frames modelled)	0.74	8	2	1	1	0.62
Double Translucent Low-E (inclined, frames not modelled)	0.74	8	2	1	0.8	0.50
Double Translucent Low-E (horizontal, frames modelled)	0.74	8	3	1	1	0.56
Double Translucent Low-E (horizontal, frames not modelled)	0.74	8	3	1	0.8	0.45

Table 1: Typical reflectance, transmittance and maintenance factors

5. CONCLUSIONS

5.1. CONCLUSION ON DAYLIGHT

Technical assessments of Average Daylight Factor (ADF), No Sky Line (NSL) and Room Depth Criterion (RDC) have been undertaken on all habitable rooms within the proposed scheme.

The results show that 81.2% of all proposed habitable rooms will meet or exceed BRE's recommendations for ADF and 90.6% will achieve levels of NSL in line with guidance. All rooms have been designed in accordance with the RDC where this is applicable. These can be considered good results for a central London location, where the daylight availability is typically restricted due to the density of the urban fabric.

All proposed living/kitchen/dining rooms with the exception of one will meet or exceed the ADF level suggested by BRE. The remaining living/kitchen/dining room will achieve 1.9% where 2% is the suggested minimum. This can be considered a technical failure unlikely to be perceived, therefore this room is also considered acceptable. With all living/kitchen/dining rooms also achieving good NSL levels, we believe they offer good daylight amenity.

Of the five living rooms seeing ADF levels lower than those suggested, four will do so just marginally (by 0.1-0.2%). The remaining living area falling short of recommendation will achieve 1.2% ADF where 1.5% is BRE's suggestion, however a good sky visibility will be enjoyed within this room. A number of living areas falling short of recommendation for ADF do so due to balconies, which restrict the daylight ingress to the rooms below and behind them. As the provision of private amenity areas is required by the London Housing Design Guide, this is a trade-off of different types of amenity which occurs throughout London. All proposed living areas will offer good sky visibility, with levels of NSL in excess of the suggested 80%. Overall therefore, the daylight performance of the proposed living areas is deemed to be acceptable and commensurate with expectations for a scheme of this nature.

All proposed bedrooms will see good levels of ADF and only three will achieve NSL levels lower than BRE's recommendation. These three rooms are located on the first and second floors, where the obstruction caused by the surrounding buildings is greatest, and the sky will be visible from more than 50% of the rooms' area. Bedrooms are therefore also considered to perform well in terms of daylight amenity.

The proposed kitchens have been located in the areas of lowest daylight availability in order to prioritise the daylight ingress into living areas, where the daylight amenity is generally regarded as more important. As a consequence, the levels of daylight in the kitchens will be lower than those suggested by BRE, however future occupants of the proposed development will be able to enjoy daylight within their living areas.

With the majority of habitable rooms achieving good levels of daylight and sky visibility, it can be concluded that the proposed development will provide good daylight amenity for future occupants.

5.2. CONCLUSION ON SUNLIGHT

BRE states that sunlight is most appreciated in living areas and the greatest expectation of sunlight is in south-facing rooms, therefore an assessment of Annual Probable Sunlight Hours (APSH) has been undertaken on all windows serving living areas facing within 90 degrees of due south.

The results of the assessments undertaken show that the proposed scheme will perform well, with the vast majority of living areas receiving sunlight levels in line with guidance both throughout the year and during the winter months.

The inset balconies located in the southeast corner of the three top floors will act as shading devices, intercepting the sun's rays during the summer months and letting more sunlight through in winter. The living areas located behind them will therefore receive low levels of sunlight in the summer and levels slightly lower than those suggested by BRE in the winter months. The balconies' glazed balustrades have also been assessed to show that good levels of sunlight will reach the balconies throughout the year and therefore future occupants of these units will be able to enjoy sunlight through the use of their private amenity spaces.

Three living areas located in the southwest corner of the first and second floors will receive sunlight levels slightly below recommendation in winter, as is typical of dense urban environments where the surrounding buildings block the sun's rays when they are lowest.

With the majority of rooms receiving good levels of sunlight, the proposed development is considered to offer acceptable sunlight amenity for future occupants.

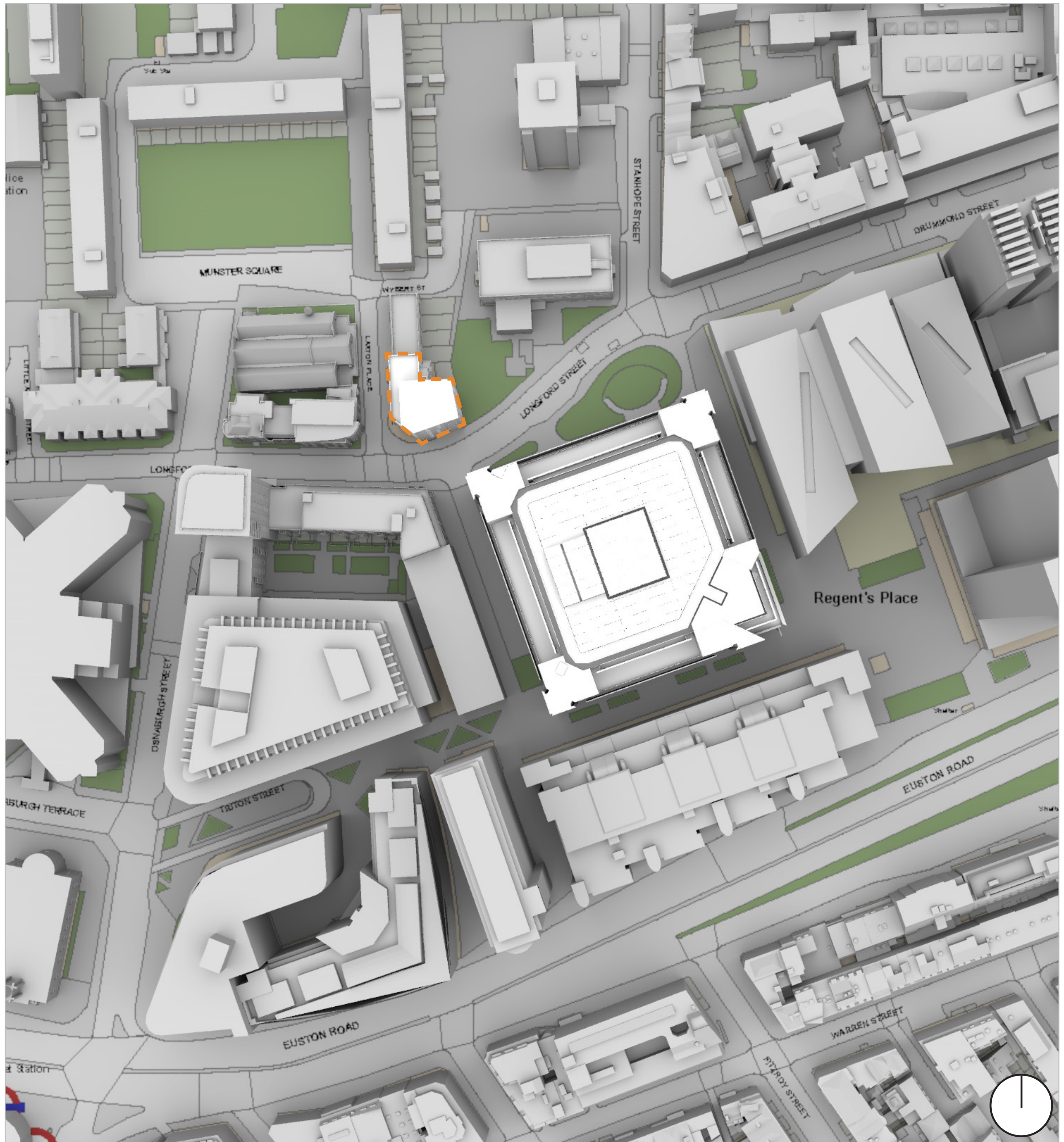


Figure 1: Top View

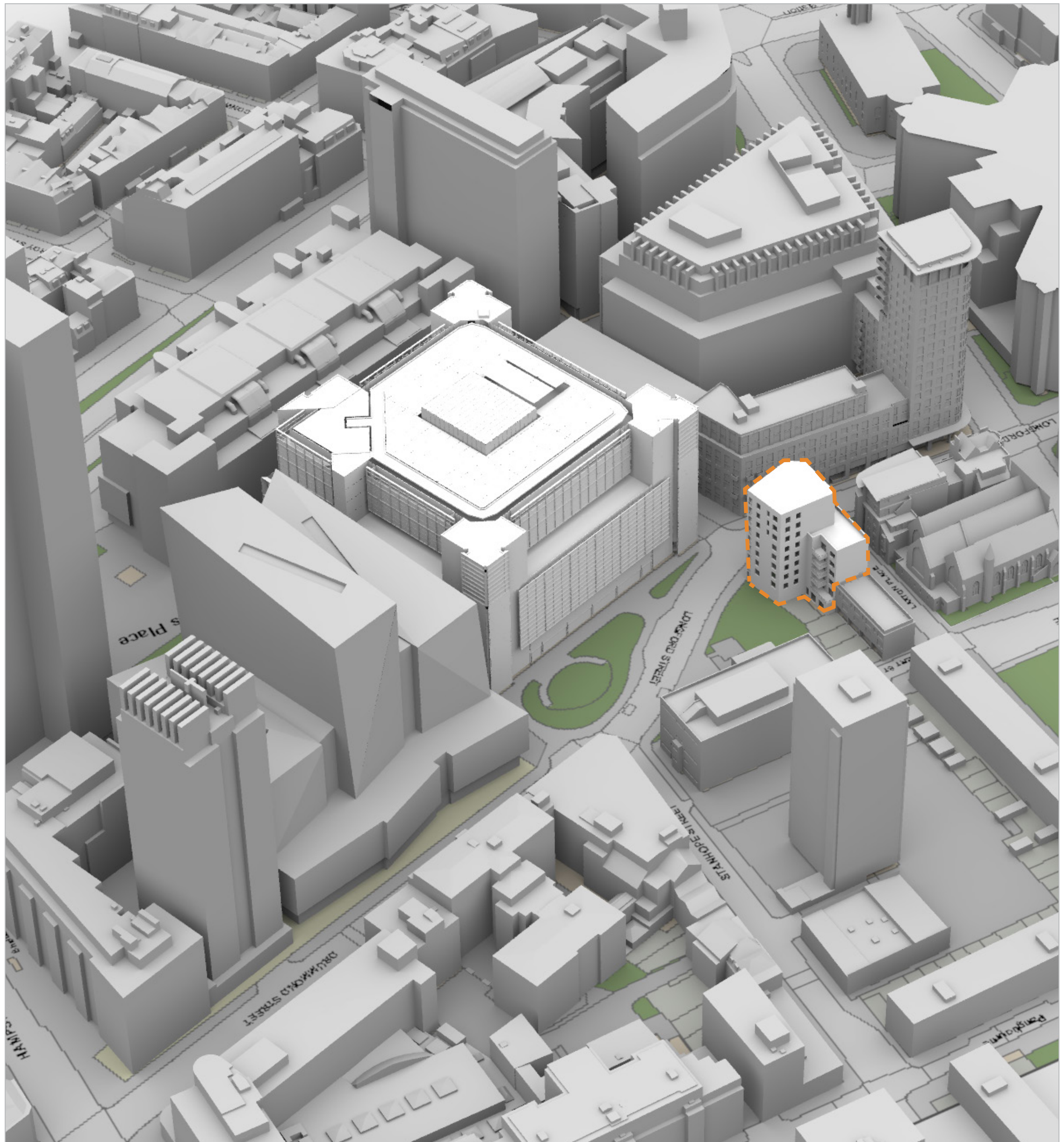


Figure 2: Perspective View

Room Ref.	Room Use	Daylight Quantum ADF (%)	Distribution of Daylight NSL (%)	RDC
Ground Floor				
1	Bedroom	1.4	84	N/A
2	Bedroom	2.4	87	Met
3	L/K/D	2.0	86	Met

Table 2: Assessment Data

Figure 3: Floor Plan

		Daylight Quantum	Distribution of Daylight	
Room Ref.	Room Use	ADF (%)	NSL (%)	RDC
First Floor				
4	Bedroom	1.8	93	Met
5	Bedroom	4.2	97	N/A
6	Bedroom	2.8	87	N/A
7	Kitchen	0.6	85	Met
8	Living Room	1.2	91	Met
9	Living Room	1.3	85	N/A
10	Kitchen	0.2	9	Met
11	Bedroom	1.4	64	Met
12	Bedroom	1.4	68	Met
13	Bedroom	1.7	80	Met
14	Bedroom	1.5	84	Met
15	L/K/D	2.0	90	Met

Table 3: Assessment Data

Figure 4: Floor Plan

		Daylight Quantum	Distribution of Daylight	
Room Ref.	Room Use	ADF (%)	NSL (%)	RDC
Second Floor				
16	Bedroom	1.9	93	Met
17	Bedroom	4.4	97	N/A
18	Bedroom	2.4	89	N/A
19	Kitchen	0.6	86	Met
20	Living Room	1.3	94	Met
21	Living Room	1.4	88	N/A
22	Kitchen	0.3	18	Met
23	Bedroom	1.7	76	Met
24	Bedroom	1.8	80	Met
25	Bedroom	2.0	87	Met
26	Bedroom	2.4	99	Met
27	Bedroom	2.1	94	Met
28	L/K/D	1.9	90	Met

Table 4: Assessment Data

Figure 5: Floor Plan

		Daylight Quantum	Distribution of Daylight	
Room Ref.	Room Use	ADF (%)	NSL (%)	RDC
Third Floor				
29	Bedroom	2.0	95	Met
30	Bedroom	4.5	97	N/A
31	Bedroom	2.5	92	N/A
32	Kitchen	0.7	86	Met
33	Living Room	1.4	96	Met
34	Living Room	1.6	94	N/A
35	Kitchen	0.3	30	Met
36	Bedroom	1.9	92	Met
37	Bedroom	2.1	91	Met
38	Bedroom	2.4	97	Met
39	Bedroom	2.7	99	Met
40	Bedroom	2.4	96	Met
41	L/K/D	2.0	91	Met

Table 5: Assessment Data

Figure 6: Floor Plan

Room Ref.	Room Use	Daylight Quantum ADF (%)	Distribution of Daylight NSL (%)	RDC
Fourth Floor				
42	Bedroom	2.1	95	Met
43	Bedroom	4.6	98	N/A
44	Bedroom	2.6	93	N/A
45	Kitchen	0.7	87	Met
46	Living Room	1.5	99	Met
47	Living Room	1.8	97	N/A
48	Kitchen	0.4	48	Met
49	Bedroom	2.3	98	Met
50	Bedroom	2.6	91	Met
51	Bedroom	2.7	99	Met
52	Bedroom	2.9	99	Met
53	Bedroom	2.5	96	Met
54	L/K/D	2.1	93	Met

Table 6: Assessment Data

Figure 7: Floor Plan

		Daylight Quantum	Distribution of Daylight	
Room Ref.	Room Use	ADF (%)	NSL (%)	RDC
Fifth Floor				
55	Bedroom	2.3	97	Met
56	Bedroom	4.8	98	N/A
57	Bedroom	2.8	94	N/A
58	Kitchen	0.8	88	Met
59	Living Room	1.6	99	Met
60	Living Room	2.1	99	N/A
61	Kitchen	0.6	65	Met
62	Bedroom	2.5	98	Met
63	Bedroom	2.8	91	Met
64	Bedroom	2.9	99	Met
65	Bedroom	3.0	99	Met
66	Bedroom	2.6	96	Met
67	L/K/D	3.2	94	Met

Table 7: Assessment Data

Figure 8: Floor Plan

Room Ref.	Room Use	Daylight Quantum ADF (%)	Distribution of Daylight NSL (%)	RDC
Sixth Floor				
68	Bedroom	2.5	97	Met
69	Bedroom	4.8	98	N/A
70	L/K/D	2.0	93	N/A
71	L/K/D	2.3	99	N/A
72	Bedroom	2.2	99	N/A
73	Bedroom	3.2	99	Met

Table 8: Assessment Data

Figure 9: Floor Plan

Room Ref.	Room Use	Daylight Quantum ADF (%)	Distribution of Daylight NSL (%)	RDC
Seventh Floor				
74	Bedroom	2.5	97	Met
75	Bedroom	4.9	99	N/A
76	L/K/D	2.0	93	N/A
77	L/K/D	2.4	99	N/A
78	Bedroom	2.3	99	N/A
79	Bedroom	3.1	99	Met

Table 9: Assessment Data

Figure 10: Floor Plan

		Daylight Quantum	Distribution of Daylight	
Room Ref.	Room Use	ADF (%)	NSL (%)	RDC
Eight Floor				
80	Bedroom	2.5	97	Met
81	Bedroom	5.0	99	N/A
82	L/K/D	2.1	94	N/A
83	L/K/D	2.6	99	N/A
84	Bedroom	2.3	99	N/A
85	Bedroom	3.1	99	Met

Table 10: Assessment Data

Figure 11: Floor Plan

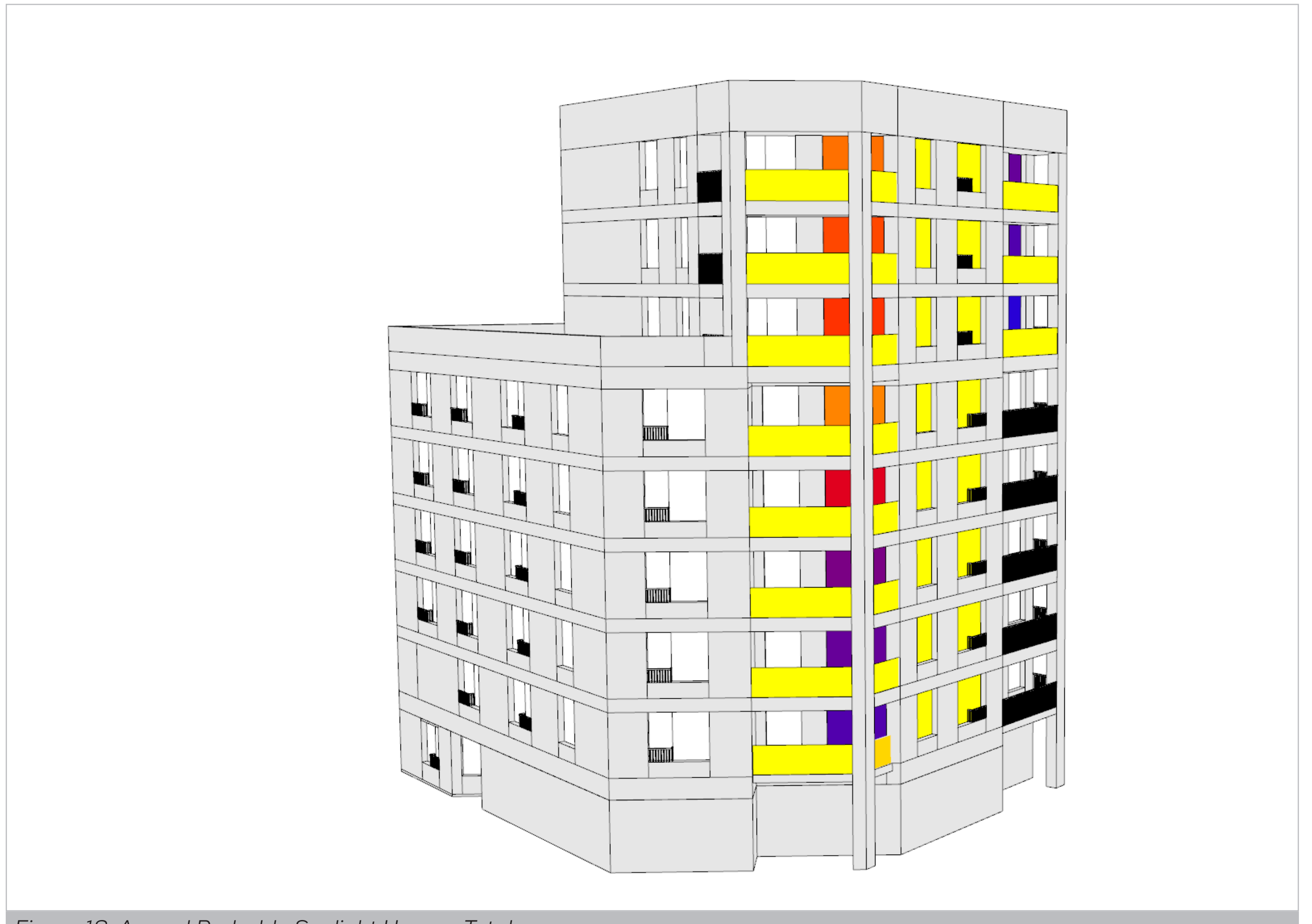
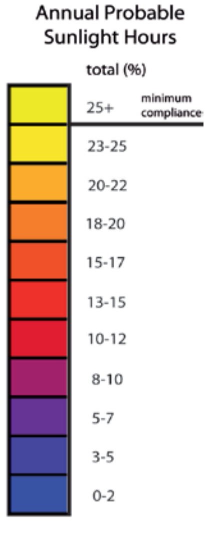
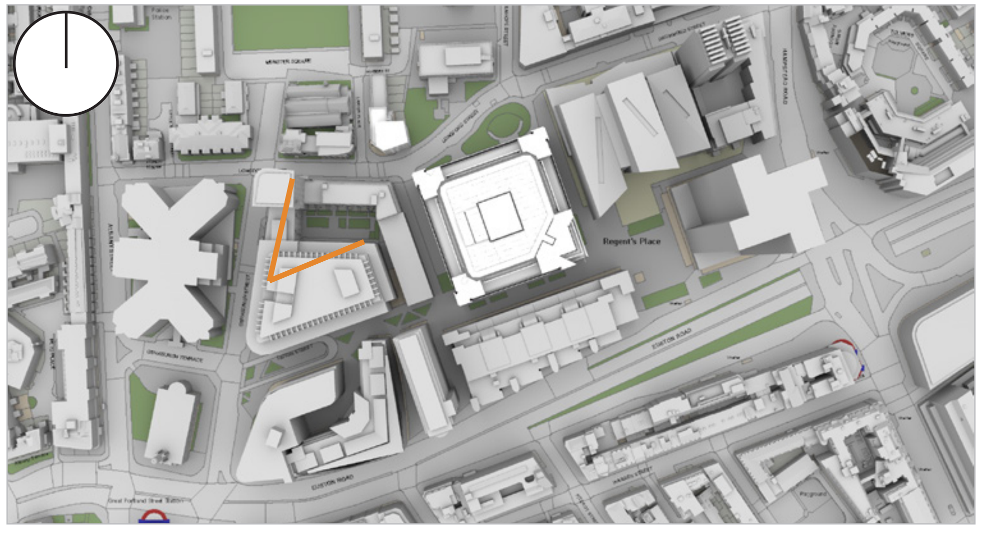
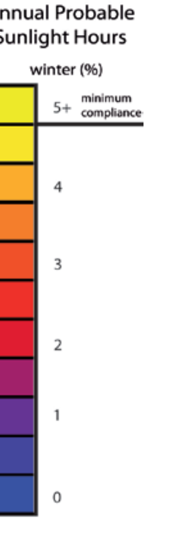


Figure 12: Annual Probable Sunlight Hours - Total

Figure 13: Annual Probable Sunlight Hours - Winter







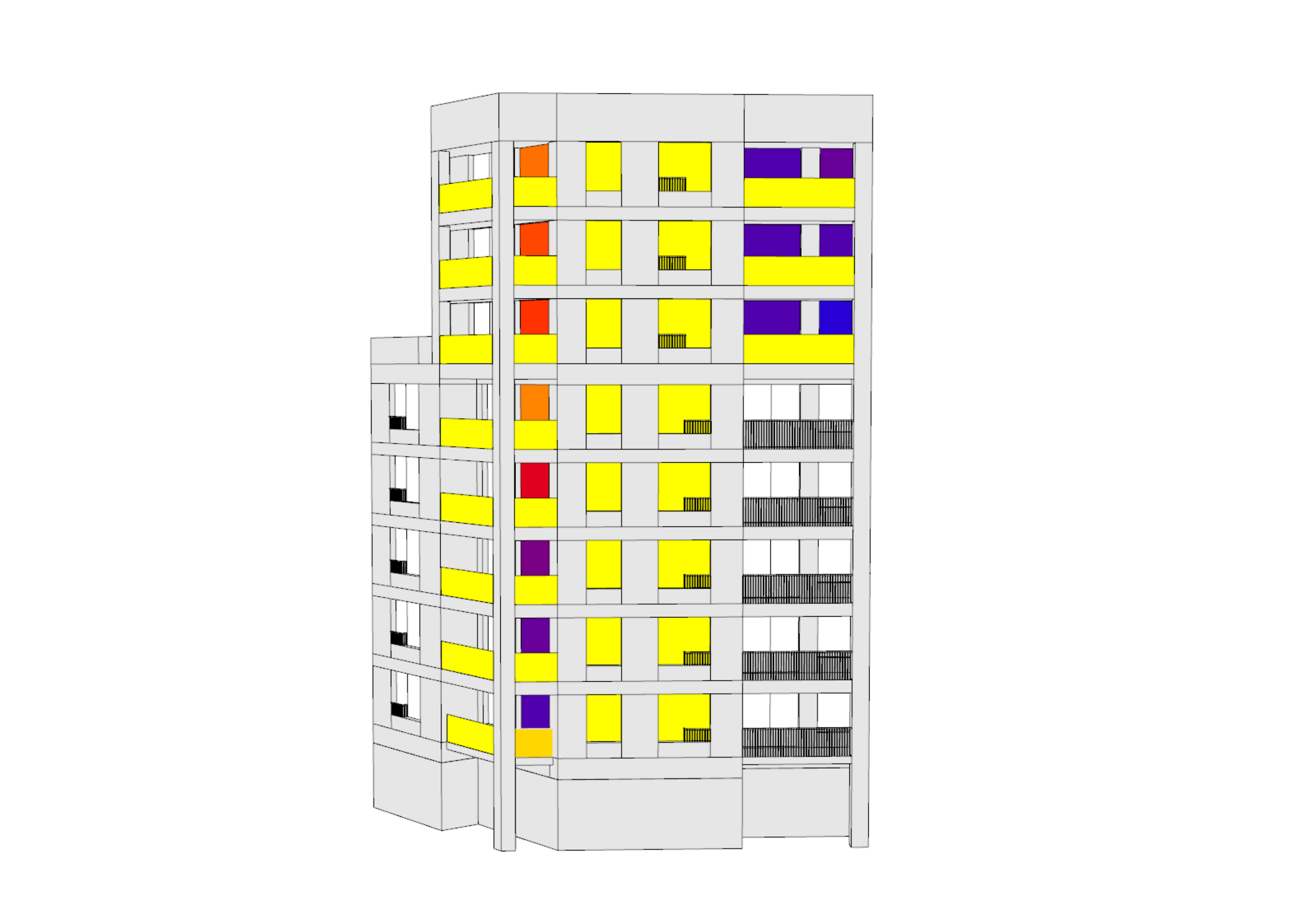
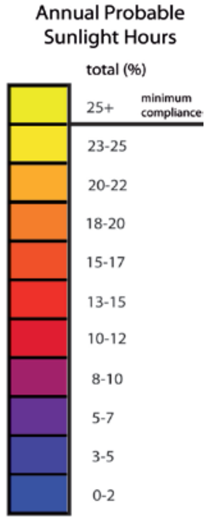
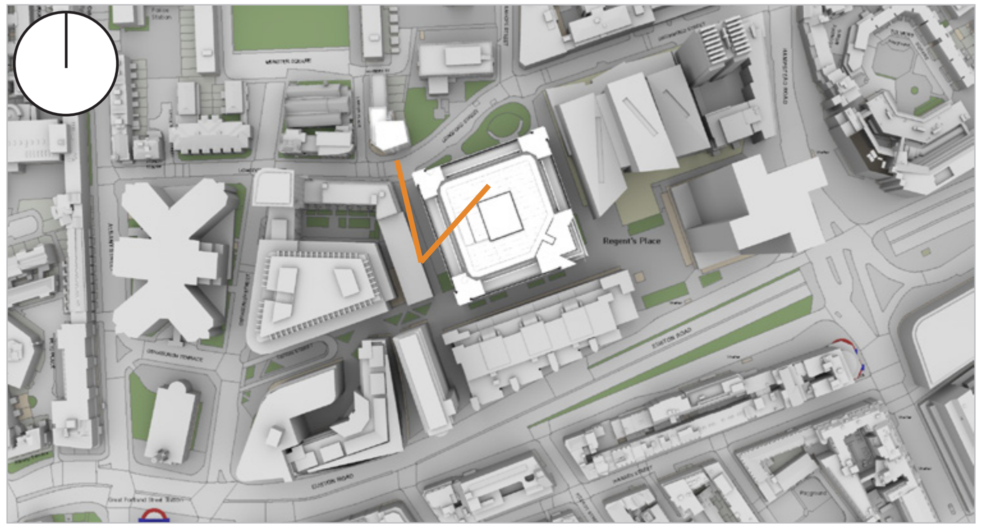
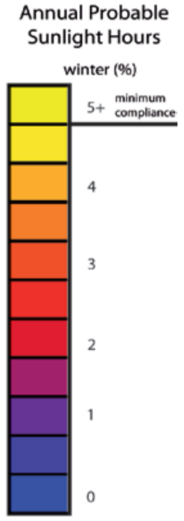


Figure 14: Annual Probable Sunlight Hours - Total

Figure 15: Annual Probable Sunlight Hours - Winter







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