

University Academy Long Sutton

DEIR 078 Daylight Report

SRP1155-ARP-XX-XX-T-O-6301

P01 | 18 January 2024

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It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job Number: 288774-27

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4.5 - Daylight Analysis

Introduction

The school daylight strategy has been developed specifically for the context of University Academy Long Sutton influencing and informing the building form, fenestration and academic/internal layout. The primary focus of which being to optimise the delivery and quality of daylight to internal spaces to provide a healthy indoor environment designed to support educational attainment.

The design has been developed to not only achieve base compliance with the DfE’s Generic Design Brief (GDB) daylight requirements but to “go beyond basic requirements” by following the best practice processes presented within Lighting Guide 5: Lighting for Education (LG5) and the DfE Technical Annex 2E to ensure that the potential and quality of the lit environment is maximised.

A holistic approach has been taken to optimise the internal daylit conditions based upon on 5 key basic principles:

- Understand the site context and local influences (weather, existing buildings/obstructions etc).
- Optimise the building potential through consideration of massing, positioning, orientation and curriculum layout.
- Develop the basic classroom form and allow for other design influences (size, location, teaching orientation and technical performance) in response to the site conditions and setting.
- Establish design principles to inform the facade development, yet be flexible to meet curriculum and architectural requirements.
- Refine the final proposal through advice on materials, finishes and how best to use and deploy shading devices when needed.

Climate Based Daylight Modelling (CBDM) analysis is a key analysis tool used through the steps above to inform and verify the performance of the internal lit environment. These principles have been used throughout the ITT engagement process to refine the Bowmer + Kirkland base offering and create an optimised, site specific solution for University Academy Long Sutton .

Through following best practice guidance, with knowledge of how to apply and manipulate daylight within the built environment, it is possible to optimise the daylight provision without adding significant cost to the overall scheme.

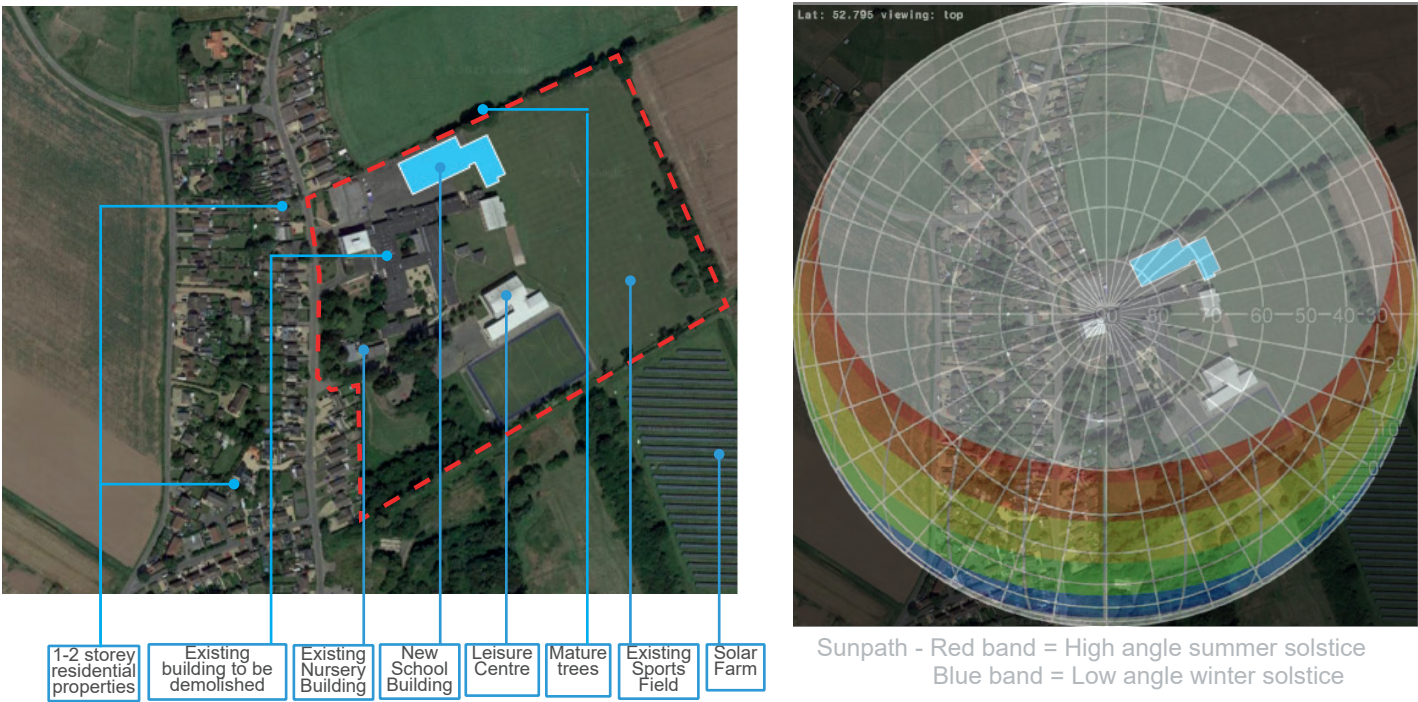
Site Context Analysis

The site is located in Little London, Long Sutton, Spalding. Latitude: 52.794, Longitude: 0.131.

The surrounding context presents a low density, residential/rural area.1-2 storey residential properites border the site to the West with open fields and recreational ground to all other orientations. There is a border of mature trees immediately to the North of the school and other mature trees further South of the school.

The current development comprises the existing University Academy Long Sutton school building to the South which will be demolished following construction of the new building. Immediately to the East of the proposed school building is a sports field which is to be retained. To the South of the school is a 1-storey nursery building and a double height leisure centre to be retained.

The proposed school comprises of a 3-storey building with teaching spaces located in Northeast, Northwest, Southeast and Southwest orientations.



Surface Finishes and Reflectances

Reflectance and transmission criteria have been moderated and refined to reflect the proposed finishes and types. The following surface material properties and reflectance/transmission values have been utilised within final calculations:

Surface	R/T*	MF**	Commentary
Internal Walls	0.7	0.9	Internal walls will have a white paint finish with a reflectance of 0.85. The 0.7 value has been applied as a room area weighted average to allow for wall displays and colour finished 'feature' walls etc.
Floors Classrooms	0.2	0.9	Proposed classroom finishes will have a reflectance of 11% for carpet tile and 18% for vinyl areas surrounding clean-up areas. A 20% value has been used to allow for contribution of higher reflectance from desk top surfaces in accordance with Technical Annex 2D, Clause 9.1.1.4.
Corridors	0.2	0.9	Loop carpet tile
Window cills	0.44	0.9	Grey painted satin/matt finish to control specular reflections and risk of glare from reflected sunlight (reflectance @ 60deg < 15%).
Ceilings Classrooms	0.84	0.9	Area weighted average to allow for 2/3 white painted exposed concrete and 1/3 basic white plasterboard to bulkhead, with allowance for luminaires/Acoustic foils
Corridors	0.876	0.9	Basic white ceiling tile
External Glazing	0.67	0.95	Standard double glazing (Guardian SunGuard) or equivalent
Internal Glazing	0.88	0.95	Single glazed clear laminated glass
Surrounding Obstructions	0.3	N/A	Industry standard average lighting reflection for surrounding buildings, trees and external walls of the new development
Ground	0.3	N/A	Industry standard average lighting reflection for external ground surfaces

*Reflectance/transmission value

**Maintenance factors applied to the reflectance/transmission values in the adjacent column in accordance with Technical Annex 2E
Table A - Surface properties and maintenance factors used in calculations

CBDM Analysis Methodology

CBDM analysis has been undertaken using Radiance ray-tracing lighting analysis software utilising bespoke scripts and algorithms developed and verified by Arup over a number of years. This unique approach means that the daylight analysis and outputs can be tailored and adapted to the criteria set within the GDB; offering greater flexibility of analysis and output than currently offered by commercially available software packages.

Calculations have been undertaken in accordance with the requirements detailed in Technical Annex 2E, Section 9.

The daylight analysis has been carried out using the closest available “real” weather data for Hemsby taken from the Energy Plus website, which has been applied within the analysis process using Climate Based Daylight Modeling (CBDM) techniques.

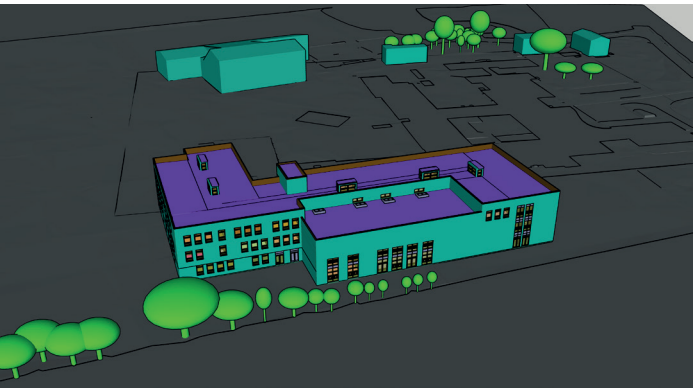
Analysis has been undertaken between the hours of 8:30am and 4:00pm throughout the year at 15 minute time-steps.

Calculations have utilised the Architect’s 3D BIM layouts directly, therefore represent accurately the proposals at each stage of development. All main structural elements and window fenestration/framing detail; have been included within the analysis.

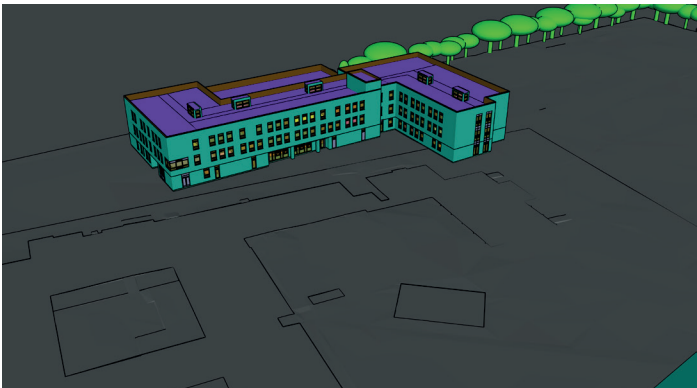
All analysis grids are positioned at heights in accordance with Appendix 2E, table 3, with an offset of 500mm from walls and a grid spacing of 500mm.

Where a number of adjacent rooms have similar characteristics, the rooms expected to have poorer light distribution have been tested. It can therefore be accepted that adjacent spaces will perform equally well, if not better.

Trees within the development site have been modeled and approximated in line with the arboricultural report. Although trees have been included within the analysis, it should be noted that, due to the limitations of the analysis software, it is not possible to accurately simulate the natural translucency of foliage, growth or seasonal changes to density. As a result, trees are modeled as solid, opaque forms representing a worst case scenario.



View From North



View From South

CBDM Compliance Criteria

The GDB defines six categories of spaces specified daylight requirements:

Space Category	Space type	Space examples	Daylight requirement	Percentage of spaces required to meet daylight requirements	Requirements for spaces that do not meet primary performance criteria
L1	Teaching spaces and constantly occupied offices	Classroom, workshop, general office, science prep room	sDA > 50% UDI -a> 80%	80%	Daylight access required to achieve levels as near to those for compliant spaces as possible and visual connection to adjoining daylit spaces to provide visual comfort.
L2	Large informal study and social spaces	Sports Hall, dining, LRC	UDI -a> 80%	65%	Daylight access
L3	Offices, support and small learning spaces	Staff work rooms, group rooms, meeting rooms	UDI -a> 80%	50%	None
L4	Circulation and prep spaces	Corridors, stairs,	Daylight access	Stairwells and wherever possible elsewhere	None
L5	Storage and hygiene spaces	Storerooms, toilets, plant rooms	No requirement	100%	N/A
L6	Spaces with blackout requirements	Drama studio, control room, dark room	Daylight to be excluded	100%	N/A

Table B - Daylight requirements taken from the GDB Annex 2E

Space categories with a defined performance criteria requirement are assessed against Useful Daylight Autonomy (UDI) targets and/or Spatial Daylight Autonomy (sDA) targets

- Spatial Daylight Autonomy (sDA 300/50%) – Percentage of the task plane which receives at least 300lux for at least 50% of the annual occupied hours by daylight alone (target illuminance at 300 Lux for all spaces, including science laboratories and specialist teaching spaces, in accordance with the Area Data Sheets (ADS) and clarified by the DfE).
- Useful Daylight Index (UDI) – Percentage of the year where the natural light levels, taken as an average over the working plane, can be considered to be within a useful band between 100lux and 3000lux (UDI-a). UDI-e and UDI-s results indicate when natural light levels are above or below the useful band respectively.

Analysis

The CBDM Analysis has taken a 5-step approach to establishing the daylight strategy for University Academy Long Sutton:

1. Baseline classroom analysis – review of Bowmer + Kirkland’s baseline classroom offering in context of the local weather climate and orientation of the proposed University Academy Long Sutton.
2. Indicative classroom verification of baseline analysis findings in coordination with the specific site context.
3. Understanding and quantification of potential glare and visual discomfort caused by sunlight penetration; including the impact of the use of user operated shading/blinds.
4. Calculations undertaken on the final architectural model to demonstrate compliance with the CBDM criteria.
5. Verification of compliance with the GDB daylight requirements.

1 - Baseline Classroom Analysis

Initial CBDM analysis was undertaken 12 typical classroom orientations to establish a general strategy through the understanding of site specific weather conditions and ventilation requirements.

The results of this analysis were used to identify the basic set of principles which have been applied to the teaching spaces within the context of University Academy Long Sutton including:

- Understanding the implications of site specific weather conditions
- Informing rooms dimensions, specifically in relation to room depth
- Establishing floor to ceiling heights, window head heights and sill heights
- Understanding the impact of the ventilation and heating strategy on the daylighting strategy
- Defining the glazing requirements and fenestration strategy proposals

2 - Indicative Classroom Verification

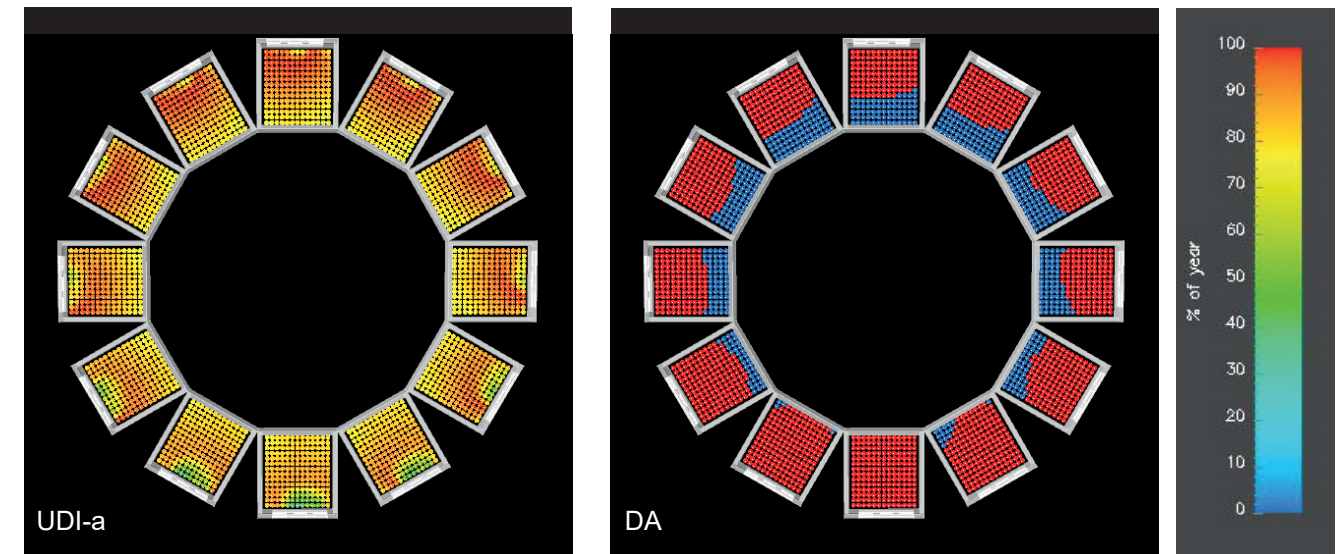
Indicative room analysis was undertaken to consider the impact of the established building principles within the context of the University Academy Long Sutton site.

Multiple iterations where undertaken to refine the design and track the development of the scheme through design process to optimise natural daylight penetration into the building.

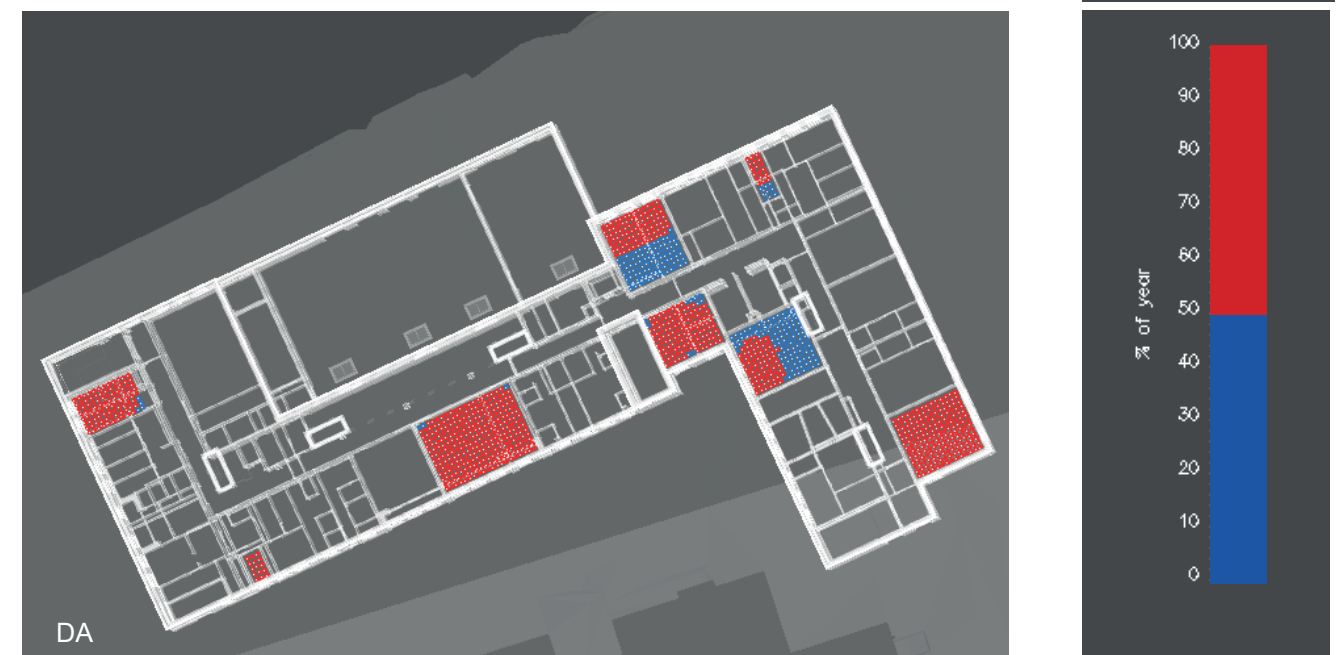
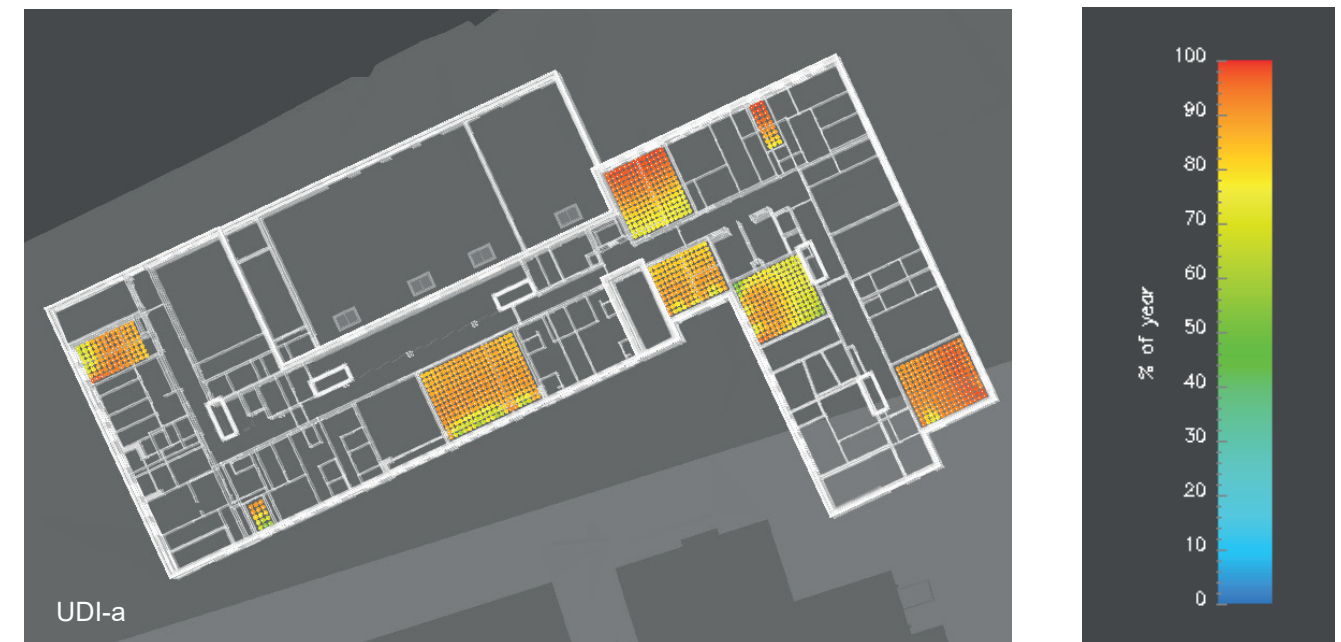
While the GDB criteria set a minimum level of compliance within the teaching spaces they currently do little to demonstrate “quality” of daylight distribution or uniformity of natural light. To ensure that the proposed scheme provides the best natural lit environment possible the Bowmer + Kirkland team have gone beyond minimum compliance criteria and compared analysis outputs against other CBDM metrics to gain a better understanding of internally lit performance, looking at UDI-a (300-2000lux), UDI-s max and UDI-e max.

This development gave clear guidance, and established:

- Performance of fenestration strategy.
- Impact of overshadowing from adjacent existing buildings and trees.
- Indication of blind requirements to control excessive natural light levels.



Baseline classroom analysis



Indicative classroom verification results

3 - Glare and Visual Comfort

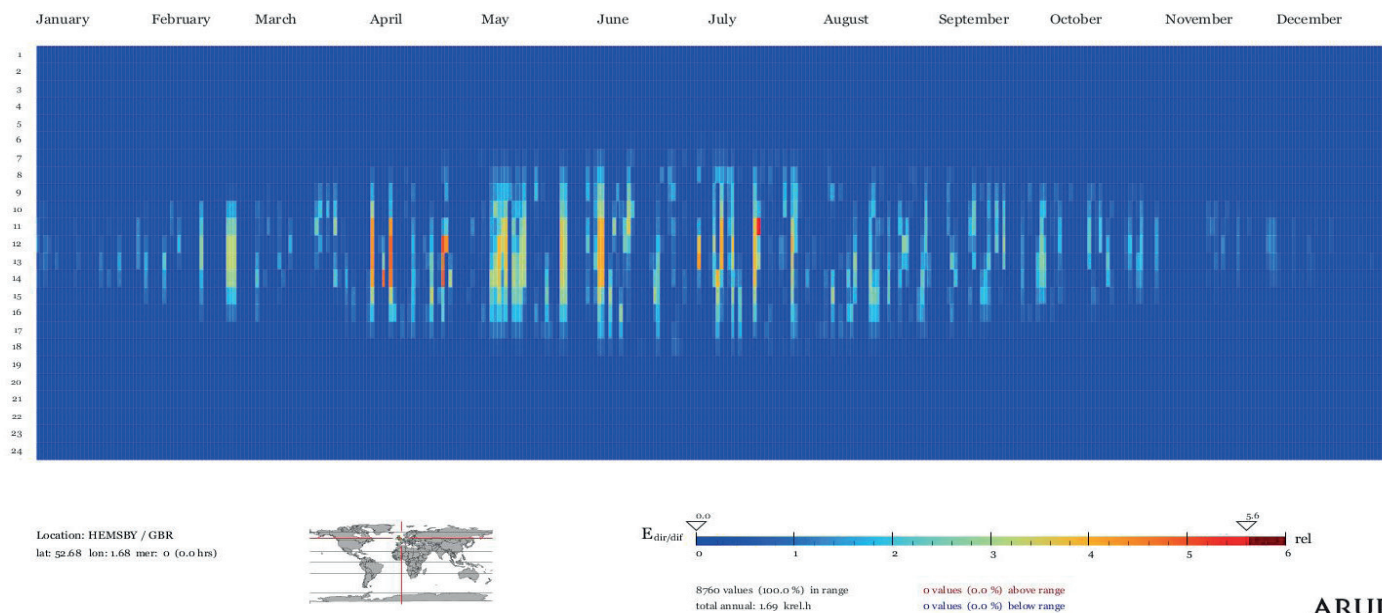
Adequate provision for the moderation of direct sunlight into spaces is key to providing a high quality, comfortable learning environment. The admission of direct sunlight into teaching rooms has the potential to cause visual discomfort to occupants, obscure teaching surfaces and make visual communication more difficult.

The potential sunlight penetration into typical teaching spaces on sunny days within operational school hours are shown opposite. Analysis has been undertaken on typical teaching spaces on the four primary aspects of the development, using top floor spaces where building self-shadowing would be at a minimum, therefore representing a worst case scenario.

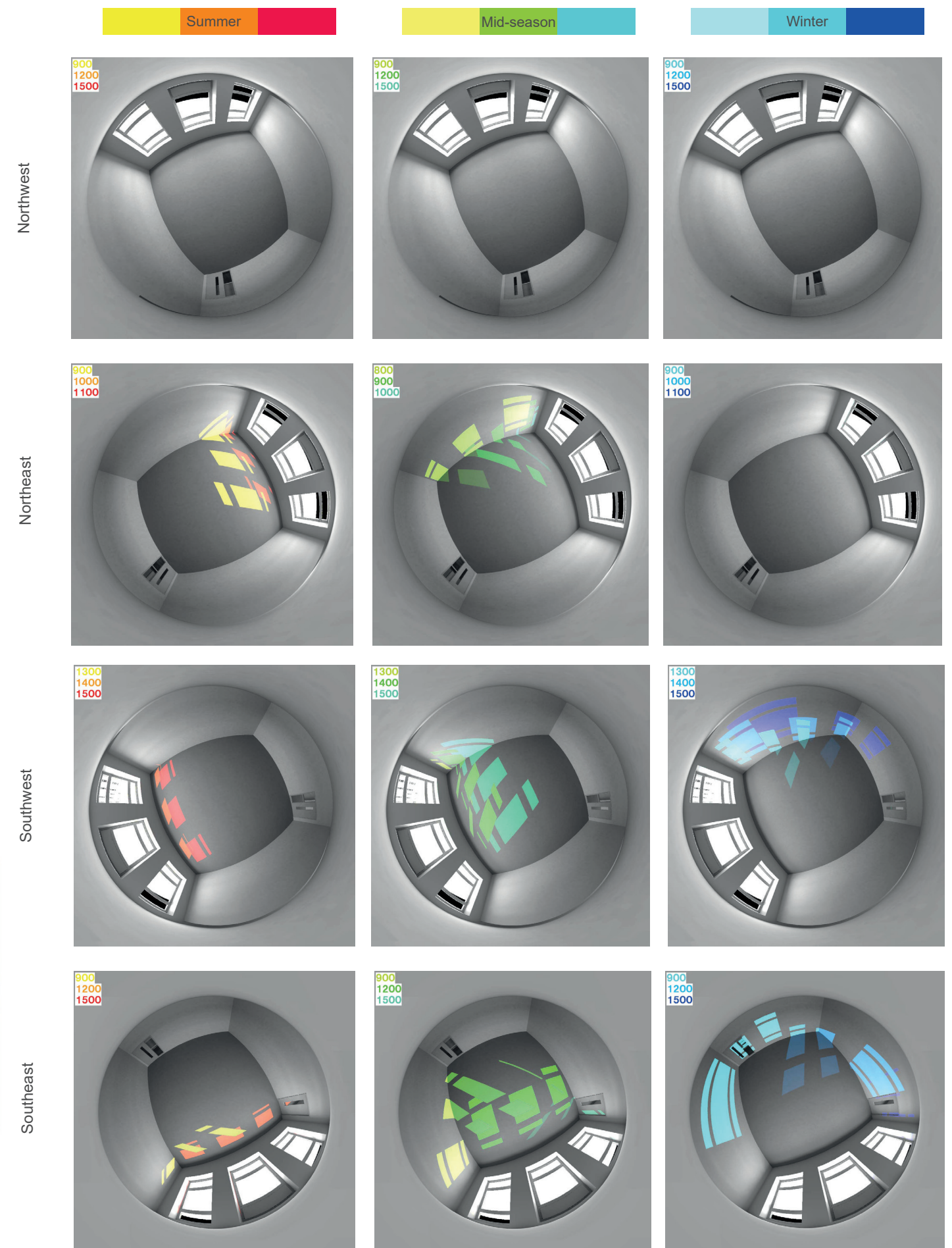
The surrounding buildings are included in the model to demonstrate overshadowing. However, trees have been excluded due to their changeable nature across the seasons, and to represent a worst-case scenario of sunlight penetration.

- Northwest facing spaces should not expect sunlight penetration during school hours at any point during the year.
- Northeast facing spaces should experience direct sunlight penetration during the early morning hours of Summer and mid-season months. Low angle sun penetrates deep into the space and may impact teaching surfaces.
- Southwest facing spaces should experience direct sunlight penetration throughout the year, especially during mid-afternoon hours. During Summer, sunlight penetration is generally limited to the horizontal plane adjacent to windows. In mid-season and Winter months, sunlight penetrates deeper into the space and may impact teaching spaces.
- Southeast facing spaces should experience direct sunlight penetration throughout the year, for all school hours. The horizontal and vertical planes are impacted, with deeper sunlight penetration during mid-season and winter months that may affect teaching surfaces.

While the sun track diagrams opposite indicate when sunlight may penetrate into teaching spaces, in reality this will only be true when the sun is shining from a cloudless sky. Analysis of the annual weather file demonstrates that a sunny sky does not represent the typical sky condition, however the shading strategy should be capable of dealing with direct sunlight throughout the year.



Hemsby weather data - ratio of hourly direct to diffuse irradiance, e.g. Direct sunlight marks represent times of the year where direct illuminance is equal to or greater than diffuse contribution and therefore considered to be sunny.



Shading Strategy

To maintain an appropriate internal environment, internal adjustable shades will be provided to moderate the impact of direct sunlight during certain periods of the year (over-lighting and glare) and provide a comfortable visual environment for staff and students.

The following plans illustrate the provision of blinds across the proposed building:

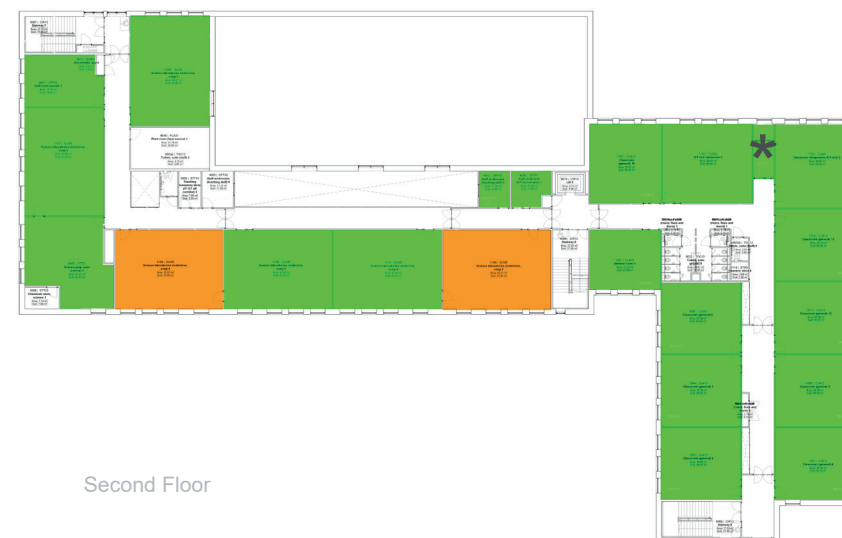
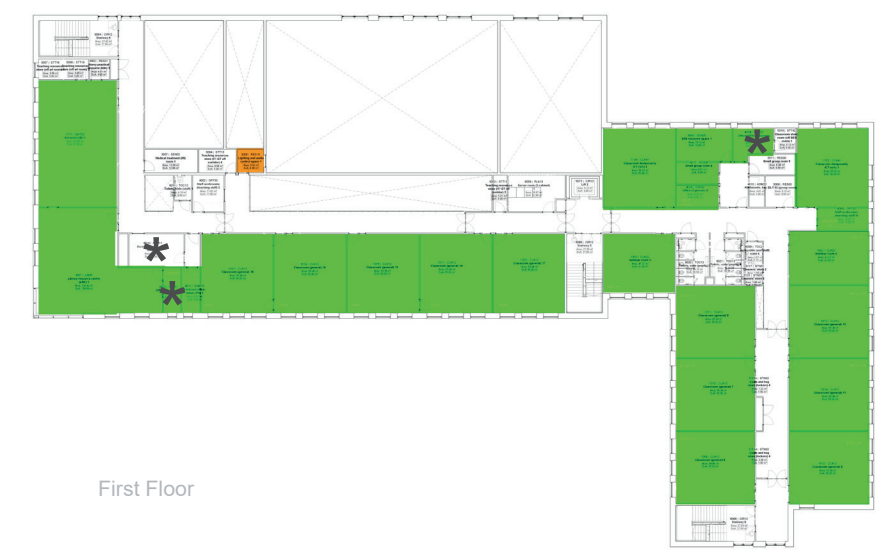
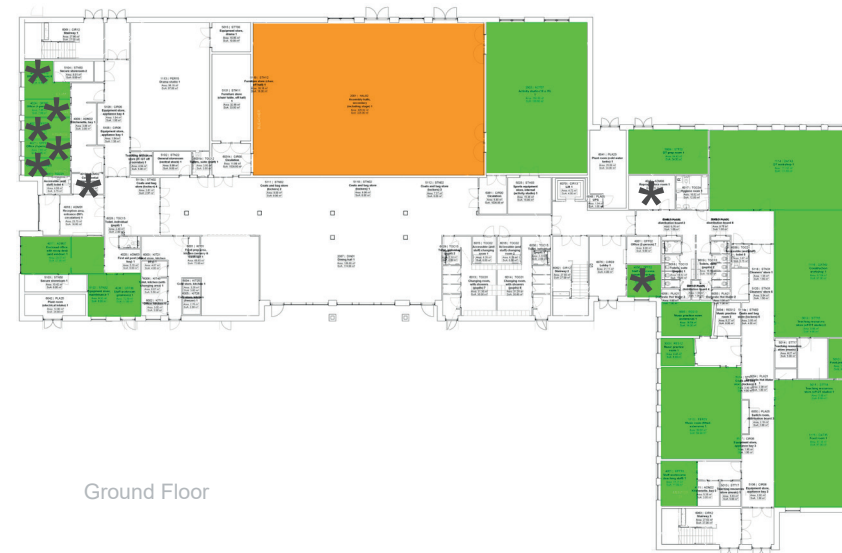
- Wide slat venetian blinds will be provided to teaching spaces on all required aspects.
- Fabric roller blinds will be provided to other occupied spaces such as offices and group rooms
- Local fabric roller blinds will be provided to internal vision panels for privacy in required staff spaces.
- Blackout blinds including internal vision panels to be provided at one of three science laboratories to facilitate experiments
- Blackout blinds including internal vision panels to be provided to main hall to facilitate performances and presentations

Where roller blinds are proposed:

- In accordance with Technical Annex 2E on all aspects, roller blind material shall have a total visible light transmission of 5-7%
- In accordance with Technical Annex 2E on South, East and West aspects, where blinds are required for solar glare control, the openness of the roller blind material will be no greater than 3%.

Key

- Space to be provided with blinds to external windows. Where roller blinds are used the material openness shall be appropriate to control solar glare.
- Space to be provided with blackout blinds/curtains to all glazing (including to internal vision panels).
- ✱ Blinds provided to internal vision panels for privacy.



4 - Analysis Results

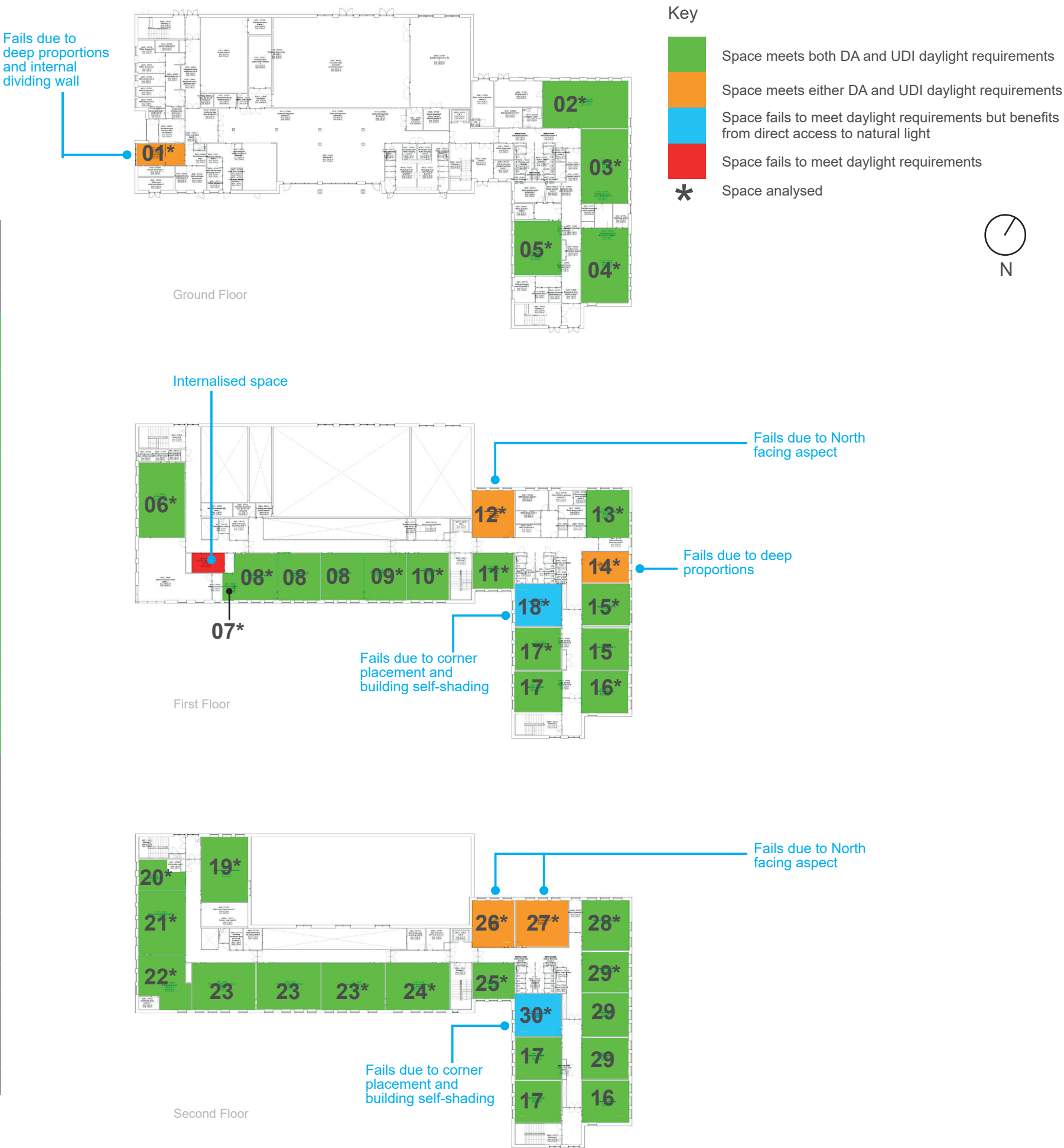
Category L1

Of the 42No. category L1 spaces, 34No. fully meet the daylight requirements, demonstrating 81.0% compliance.

97.6% of spaces benefit from direct access to natural light either directly or via internal glazing into a daylit space.

#	Space Type	DA	UDI-a Mean	UDI-s Mean	UDI-e Mean	UDI-e + UDI-s
01	Enclosed office	0.62	0.66	0.23	0.11	0.34
02	DT workshop	0.61	0.88	0.12	0.00	0.12
03	Construction workshop	0.55	0.89	0.11	0.00	0.11
04	Food room	0.80	0.90	0.09	0.01	0.10
05	Music room	0.69	0.84	0.11	0.05	0.16
06	Art room	0.98	0.88	0.07	0.05	0.12
07	Enclosed office, admin	0.71	0.84	0.11	0.05	0.16
08	Classroom	0.95	0.84	0.08	0.08	0.16
09	Classroom	0.95	0.84	0.09	0.07	0.16
10	Classroom	0.93	0.84	0.09	0.07	0.16
11	Seminar room	1.00	0.85	0.09	0.06	0.15
12	Classroom	0.41	0.83	0.17	0.00	0.17
13	Classroom	0.95	0.94	0.06	0.00	0.06
14	Seminar Room	0.46	0.82	0.17	0.00	0.18
15	Classroom	0.59	0.89	0.11	0.00	0.11
16	Classroom	1.00	0.92	0.06	0.02	0.08
17	Classroom	0.69	0.84	0.11	0.05	0.16
18	Classroom	0.35	0.76	0.22	0.02	0.24
19	Science laboratories	0.56	0.88	0.12	0.00	0.12
20	Staff room	0.75	0.85	0.10	0.05	0.15
21	Science laboratories	0.90	0.87	0.08	0.05	0.13
22	Science prep room	0.98	0.80	0.06	0.14	0.20
23	Science laboratories	0.98	0.85	0.08	0.06	0.15
24	Science laboratories	0.96	0.85	0.09	0.06	0.15
25	Seminar room	0.98	0.85	0.09	0.06	0.15
26	Classroom	0.49	0.86	0.14	0.00	0.14
27	ICT-rich classroom	0.46	0.86	0.14	0.00	0.14
28	Classroom	0.95	0.94	0.06	0.00	0.06
29	Classroom	0.62	0.89	0.11	0.00	0.11
30	Classroom	0.37	0.77	0.20	0.03	0.23

Table of results



Category L2

Of the 4No. category L2 spaces, 4No. fully meet the daylight requirements, demonstrating 100% compliance.

#	Space Type	DA	UDI-a Mean	UDI-s Mean	UDI-e Mean	UDI-e + UDI-s
01	Assembly Hall	0.39	0.83	0.17	0.00	0.17
02	Activity Studio	0.36	0.80	0.20	0.00	0.20
03	Dining Hall	0.75	0.84	0.12	0.04	0.16
04	LRC	1.00	0.81	0.04	0.15	0.19

Table of results

Key

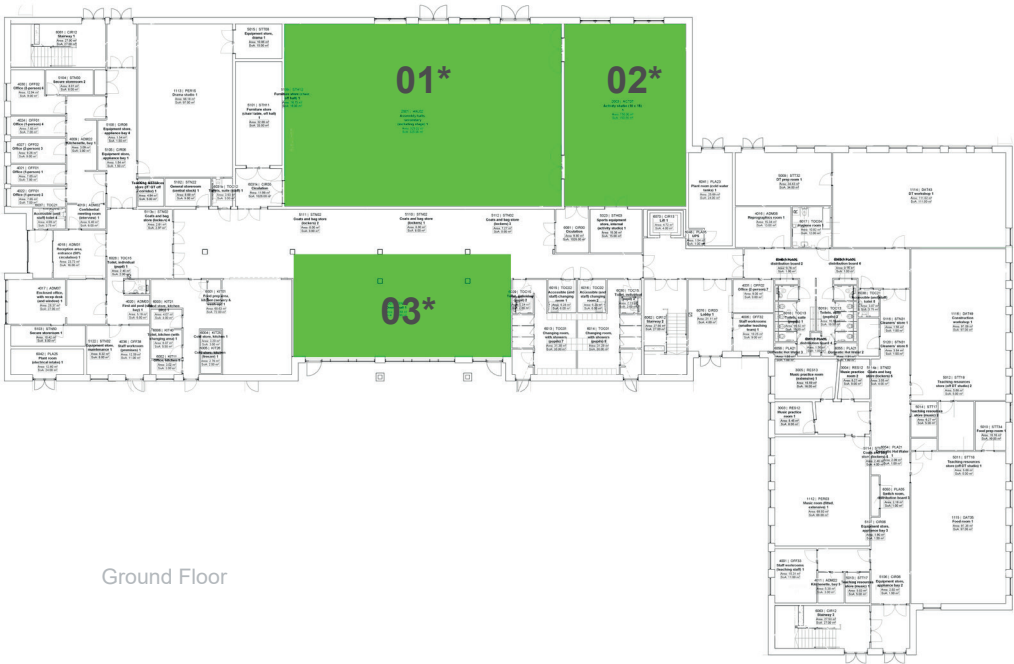
Space meets both UDI requirements

Space benefits from daylight access

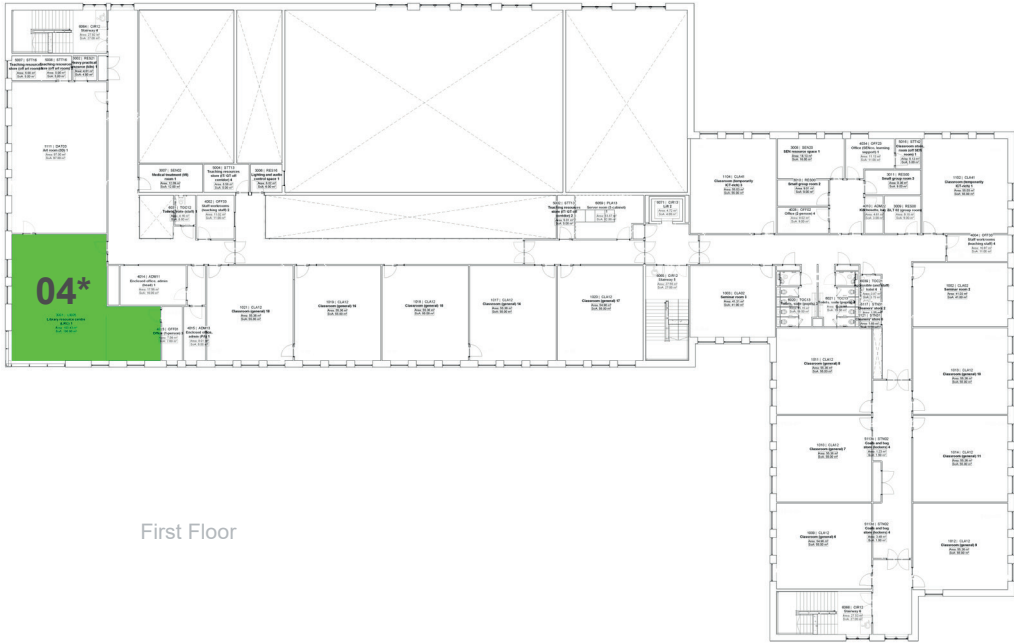
Space fails UDI requirements

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Space analysed



Ground Floor



First Floor

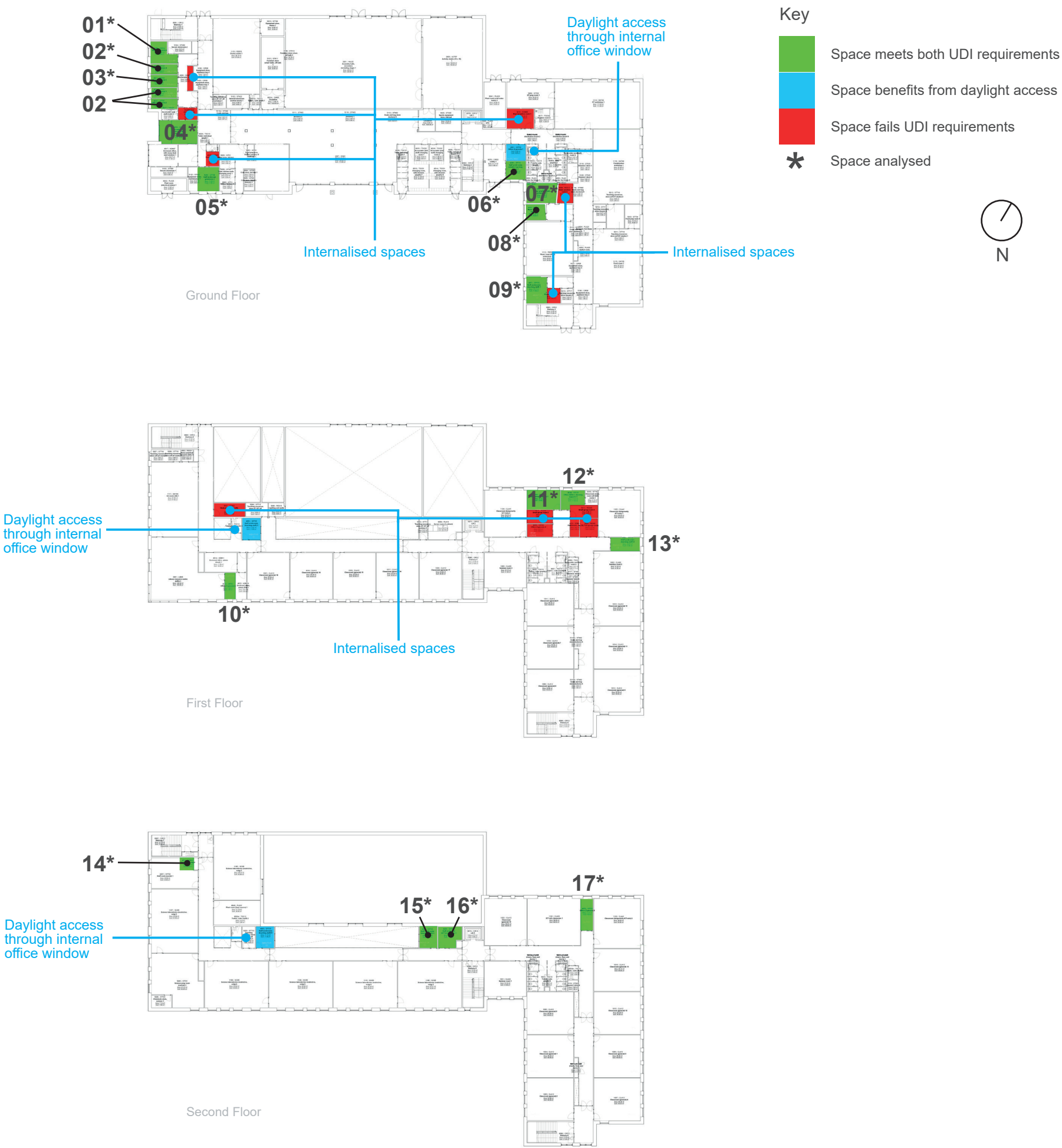
Category L3

Of the 34No. category L3 spaces, 19No. fully meet the daylight requirements, demonstrating 55.9% compliance.

64.7% of spaces benefit for direct access to natural light either directly or via internal glazing into a daylit space.

#	Space Type	DA	UDI-a Mean	UDI-s Mean	UDI-e Mean	UDI-e + UDI-s
01	Office	1.00	0.88	0.04	0.08	0.12
02	Office	1.00	0.83	0.05	0.12	0.17
03	Office	0.57	0.84	0.13	0.03	0.16
04	Reception area	0.59	0.84	0.11	0.05	0.16
05	Staff workroom	1.00	0.86	0.04	0.10	0.14
06	Staff workroom	1.00	0.86	0.07	0.07	0.14
07	Music practice room	0.53	0.81	0.16	0.03	0.19
08	Music practice room	0.95	0.85	0.09	0.07	0.15
09	Staff workroom	1.00	0.84	0.03	0.12	0.16
10	Office	0.71	0.85	0.10	0.05	0.15
11	SEN resource space	0.96	0.95	0.05	0.00	0.05
12	Office	0.78	0.91	0.09	0.00	0.09
13	Staff workroom	0.63	0.89	0.10	0.01	0.11
14	Kitchenette	0.00	0.81	0.19	0.00	0.19
15	Staff workroom	0.00	0.83	0.17	0.00	0.17
16	Staff workroom	0.00	0.80	0.20	0.00	0.20
17	Office	0.67	0.89	0.11	0.00	0.11

Table of results



Category L4, L5 and L6

Access to natural light has been provided to all Category L4 spaces wherever possible, either directly or by borrowed light from adjacent daylit spaces through vision panels.

Category L5 spaces have no requirement for natural light and, as such, have not been highlighted.

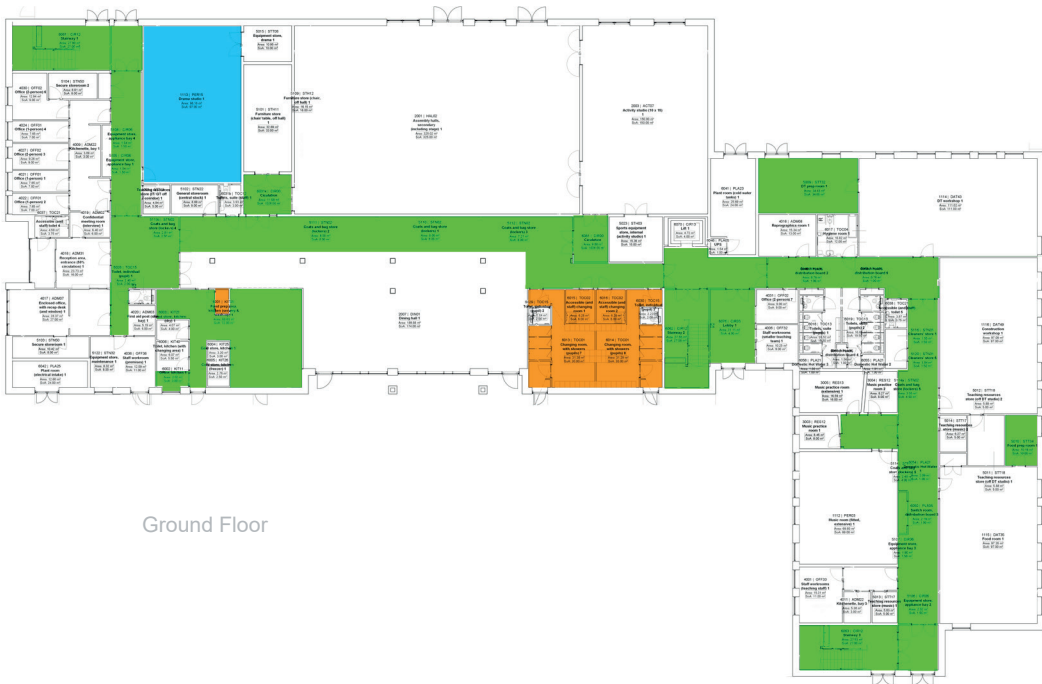
Daylight has been excluded from all L6 spaces.

Key

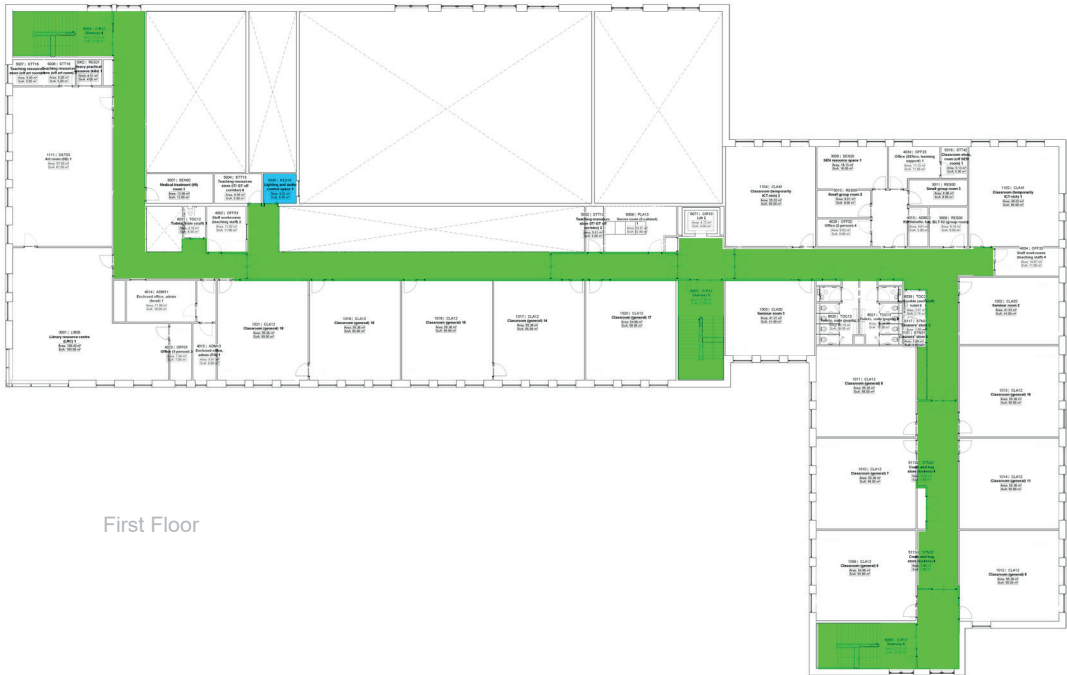
Category L4 space with access to natural light

Category L4 space without access to natural light

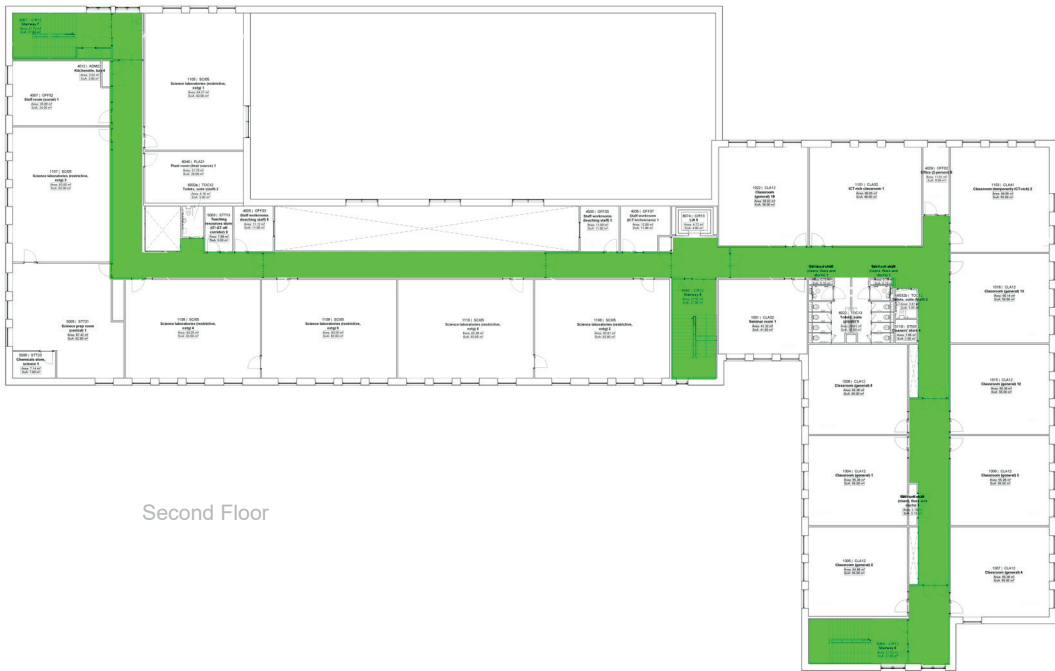
Category L6 space with daylight excluded via blackout blinds/curtains or omitted fenestration



Ground Floor



First Floor



Second Floor

5 - Compliance Statement

Calculations have been carried out on the final architectural model to verify performance against the CBDM criteria.

Individual spaces have been selected to provide a cross section of the different room types within the school. Where a number of adjacent rooms have similar characteristics, the rooms expected to have poorer light distribution have been tested. It can therefore be accepted that adjacent spaces will perform equally well, if not better.

Technical Annex 1A and 1B clearly defines the lighting category, assessment and compliance criteria for all teaching, learning and administration spaces. These spaces have been analysed to benchmark performance against the GDB requirements for daylight.

The table below summaries the results for each category:

Category	% Required	Achieved
L1	80%	81.0% (97.6% of spaces benefit from access to natural light)
L2	65%	100%
L3	50%	55.9% (64.7% of spaces benefit from access to natural light)
L4	Stairwells and wherever possible elsewhere	Stairwells and wherever possible elsewhere
L5	N/A	N/A
L6	100% of spaces	N/A

The results of the CBDM analysis demonstrate that the proposed University Academy Long Sutton design performs well against the criteria. Natural light distributes well throughout teaching and non teaching spaces and compliance with the GDB requirements is achieved for all categories.