Environment Report / **Conversation Club**

Hudson Street, Gateshead / Laurence Elsdon

Site and Climate

Figure 1
Site Context

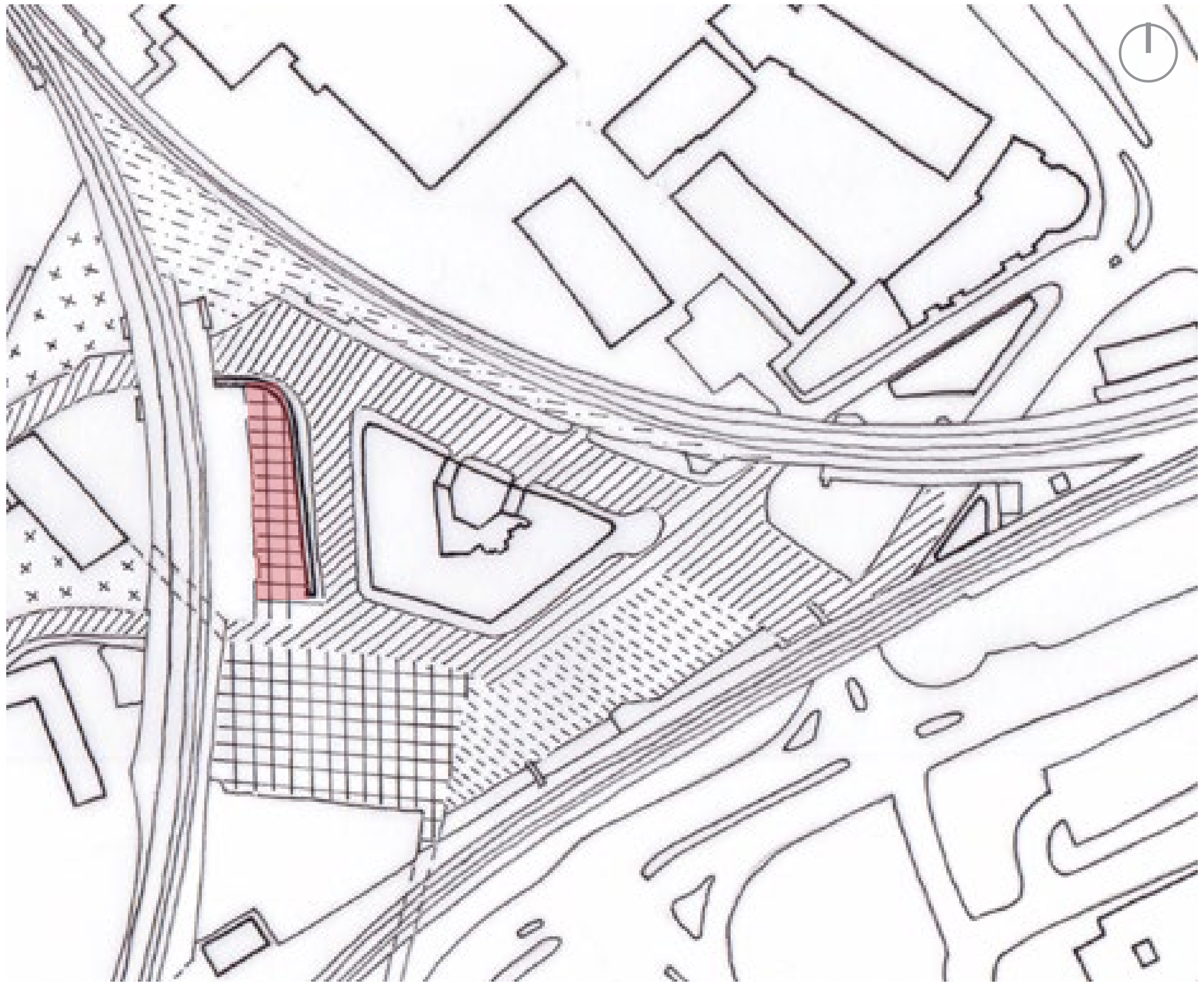
🟥 The Site

🟨 Roads

🟦 Railway

🟩 Buildings

Figure 2
Site Textures



⊗ Soft / Landscaped

▨ Asphalt / Public

⊞ Asphalt / Private

▤ Loose / Granular

▦ Scrub / Derelict

Figure 3
Sun Analysis

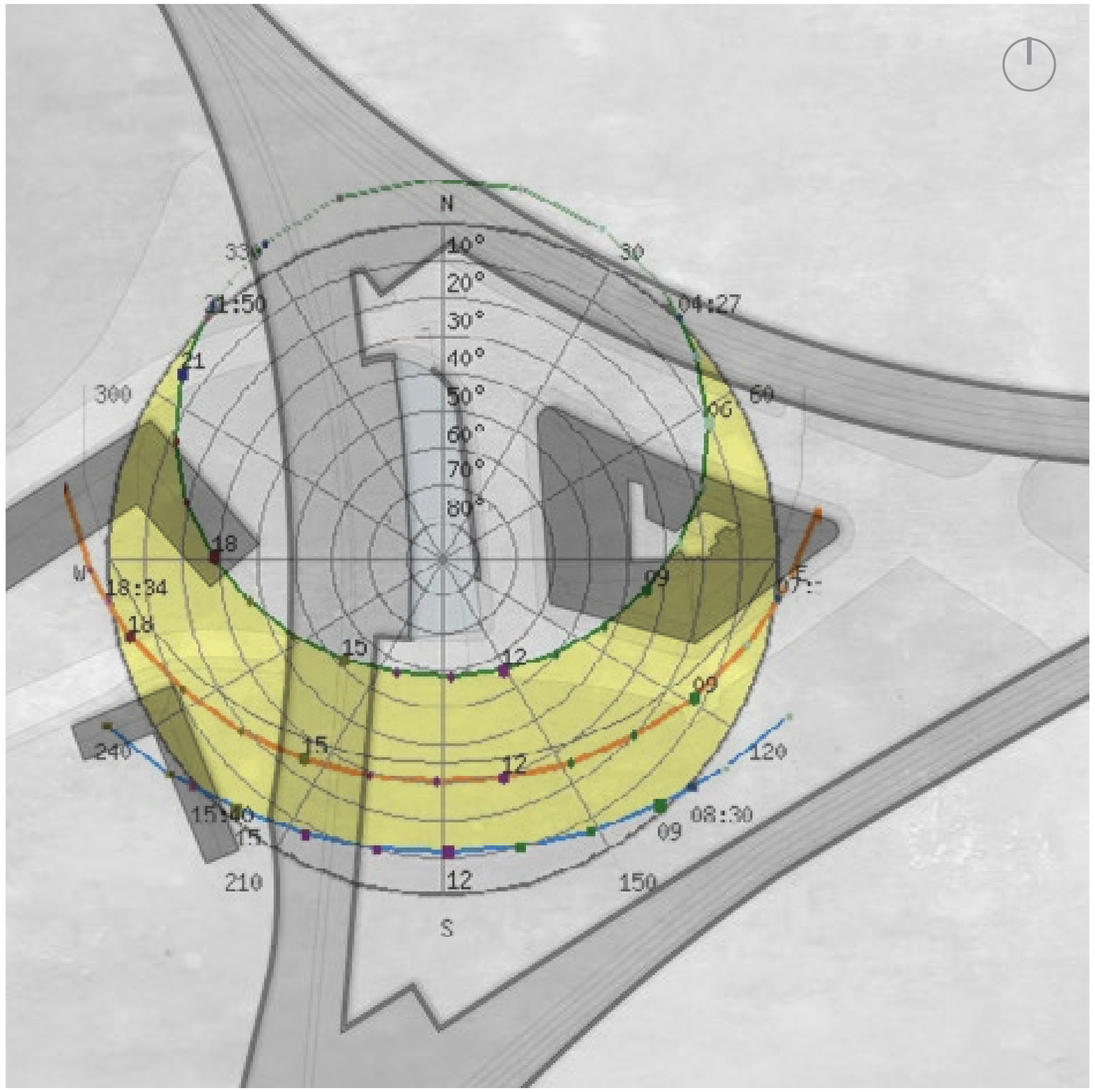


Figure 4
Wind Analysis

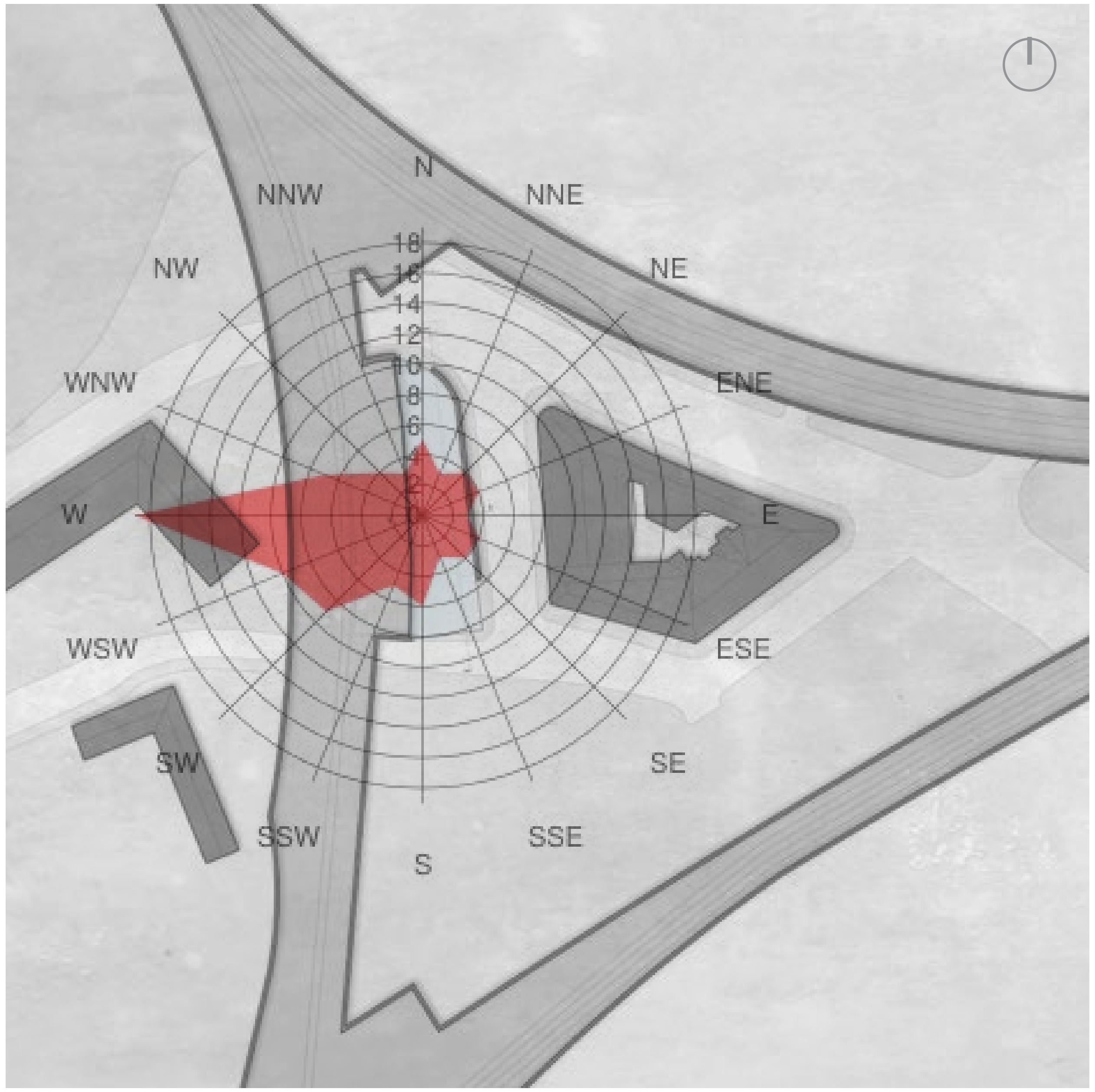
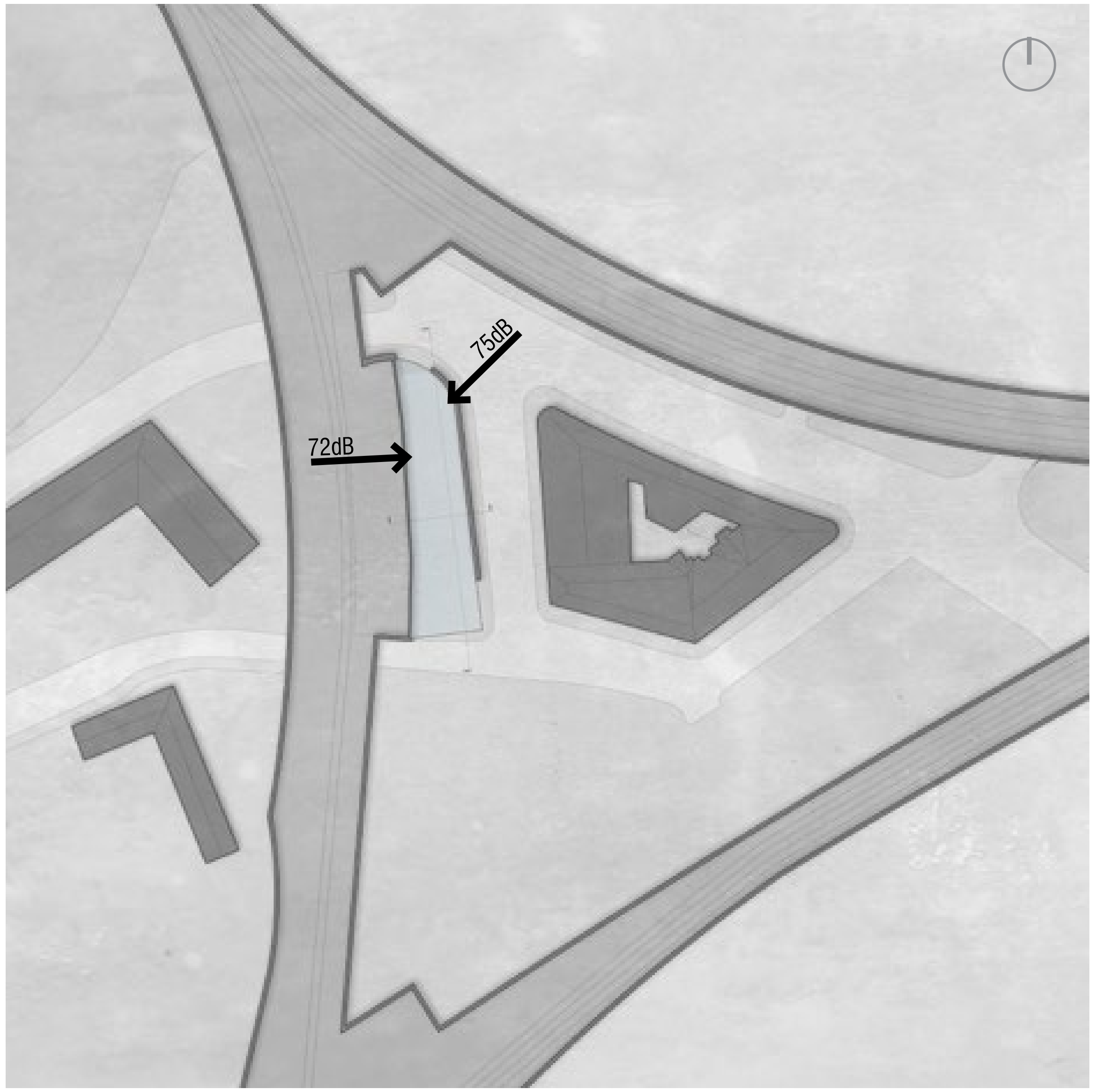


Figure 5

Noise Sources



- \+ Trains go past the site slowly and subsequently are not the greatest noise source.
- \+ Peak dB levels for a train were 72dB and peak for a bus going past 75 dB. Average traffic levels were around 50dB.

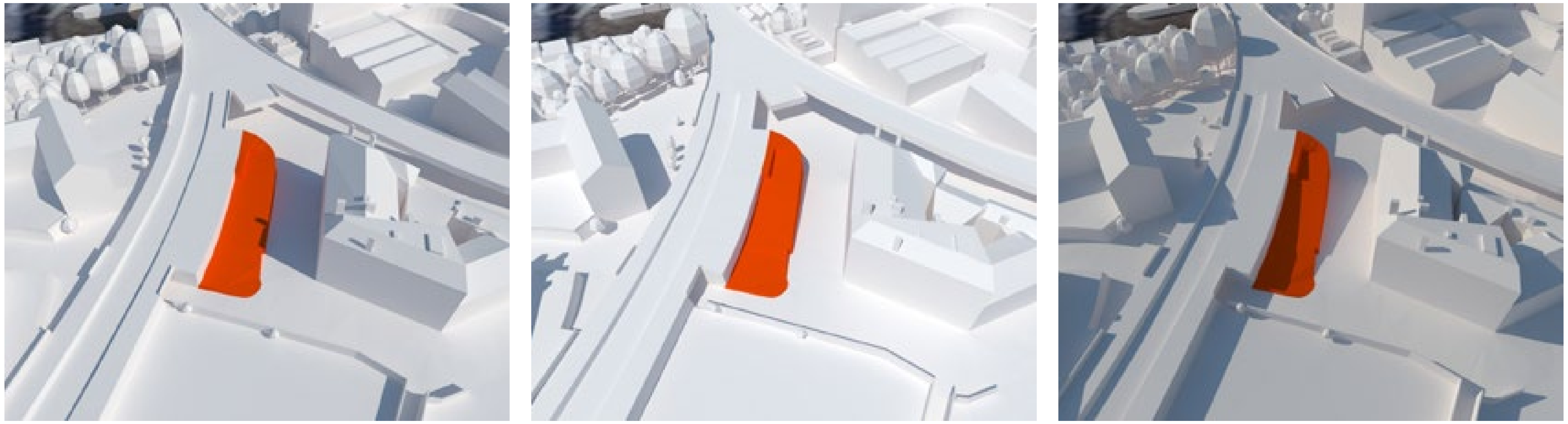


Figure 6
Sunlight and Shadows
Summer
(0900, 1300, 1700)

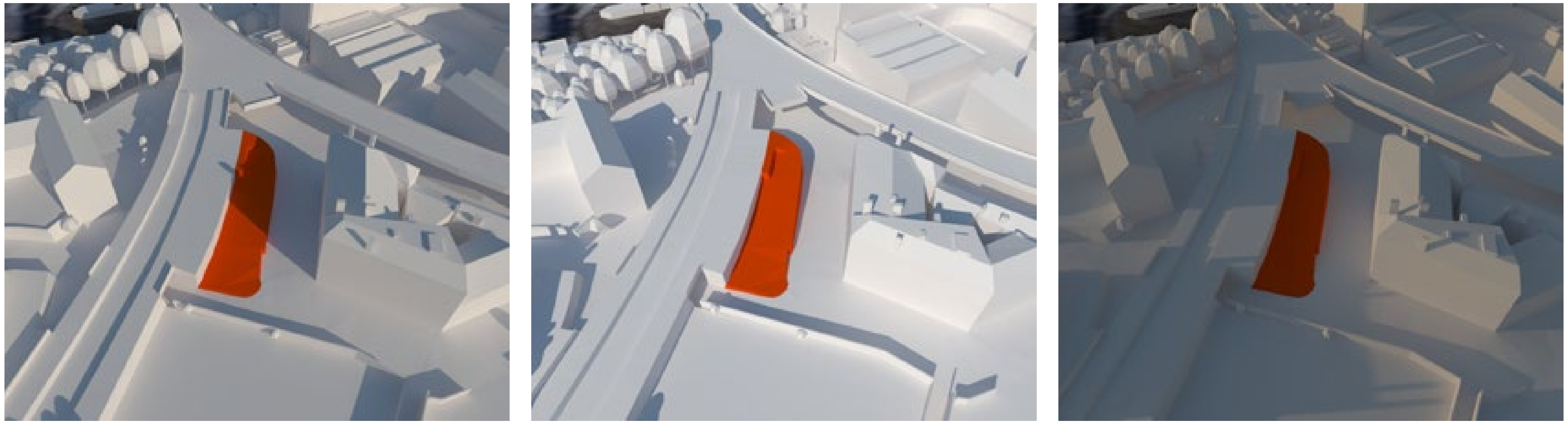


Figure 7
Sunlight and Shadows
Equinox
(0900, 1300, 1700)

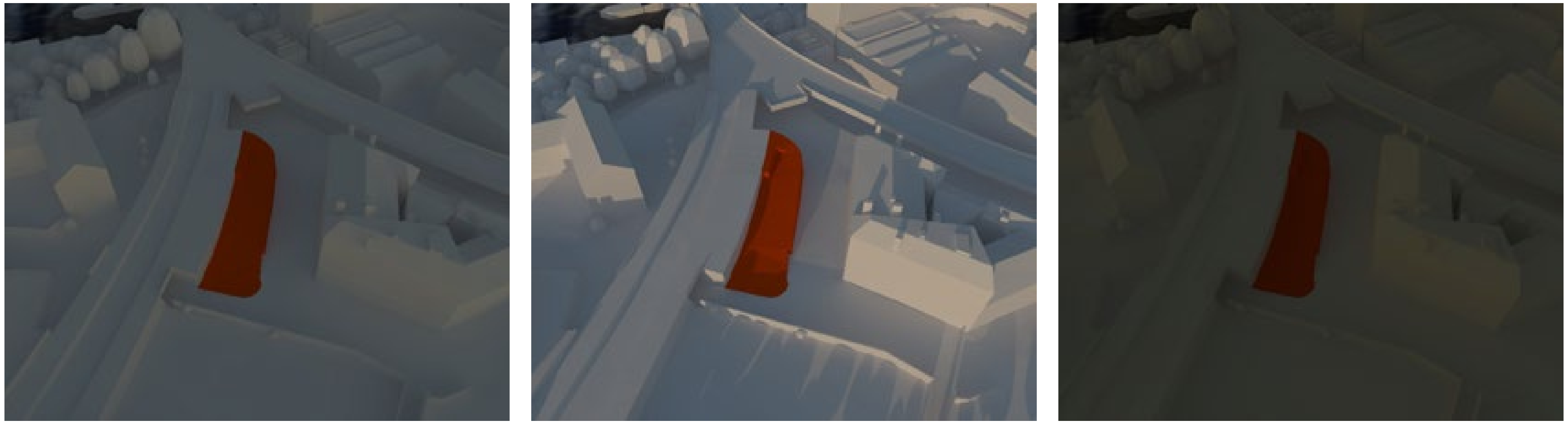


Figure 8
Sunlight and Shadows
Winter
(0900, 1300, 1700)

Key Conditions

Key Conditions

The main aim of environmental design is to achieve optimal human comfort within the scheme utilising natural resources wherever possible and minimising reliance on mechanical systems. This is achievable through the application of sustainable theory and technology.

Human comfort is a balance of the following factors: ‘thermal, visual and acoustic conditions, indoor air quality, electromagnetic fields and static electricity’ (CIBSE, 2006).

The Chartered Institution of Building Services Engineers (CIBSE) has set forward guidelines to ‘specify measurable limits or ranges for each of the environmental factors’ (CIBSE, 2006). These guidelines provide a framework with which to design appropriate environmental conditions for each space within the Conversation Club.

Comfort Criteria

The library space can be divided into specific environments: discussion / lecture, reading / studying, book retrieval / shelving, storage and cafe / relaxation. The varied activity and occupancy levels of these spaces result in different performance requirements. For instance, the lecture space will have a greater density of people and as such will require greater ventilation and increased cooling compared to the reading space. The book retrieval space may have a lower temperature requirement than the reading space as more energy is exerted in walking than sitting, thus more heat is released. Comfort criteria recommendations for internal temperatures vary between winter and summer, due to variations in occupant clothing levels.

Lecture

The comfortable temperature ranges for a lecture space according to the CIBSE guide are 19 - 21°C and 21–23°C for winter and summer respectively. The suggested air supply per person is 10 litres per second per person and 500 lux of illumination are required so visitors can comfortably read and write notes at will. A background noise rating of 25 - 35 will give the audience comfortable auditory conditions to hear the orator.

Reading and Study

The temperature criteria for a study space are 22 - 23°C, 24 - 25°C (winter and summer respectively), 10 litres per second per person, 500 lux and noise rating of 30 - 35.

The study areas will wish to avoid glare from daylighting, as white paper has a high reflectivity and under direct light glare can make reading uncomfortable.

If computers, particularly desktop computers are to be placed in the study areas the temperature ranges may be lower to compensate for the additional heat electrical equipment generates.

Book Retrieval

Book retrieval is suggested to be comfortable within the following criteria: temperatures between 19 - 21°C, 21 - 23°C (winter and summer respectively), ventilation of 10 litres per second per person, 200 lux of illuminance and a noise rating of 30–35.

Storage

The storage areas are only accessible by staff members and are not frequently inhabited as such the comfort requirements are lower. 15°C and 200 lux of illuminance are sufficient and no specific guidance is given on air changes or noise ratings.

Entrance Lobby

The entrance lobby is frequently used but not inhabited for any significant duration, for winter a comfortable temperature range is 19 - 21°C and 21 - 23°C during summer. 100 - 200 lux are sufficient and a noise rating of 35 - 40 is acceptable. The baseline air supply of 10 litres per second per person is suitable.

The entrance will be naturally ventilated by opening of the main doors and subsequently their may be no need for additional ventilation to this space.

Cafe and Lounge

The cafe comes under the criteria of a bar / lounge. 20 - 22°C and 22-24°C winter and summer respectively, 10 litres per second per person, a noise rating of 30 - 40 and just 100 - 200 lux illuminance.

The counter and preparation area will require a slightly greater illuminance and if hot food is to be served then there may be a requirement for more air changes per hour.

The Scheme


NEWCASTLE
GATESHEAD
SCOTSWOOD
BLAYDON
ELSWICK
From North Wylam
Scotswood Bridge
TYNE
CENTRAL STA.
High Level Bridge
King Edward Bridge
QUAYSIDE
JESMOND STA.
HEATON STA.
BYKER
MANORS NORTH
MANORS EAST
DUNSTON STAITHS
DUNSTON-ON-TYNE
NORWOOD JUNC.
REDHEUGH
BENSHAM
LOW FELL STA.
SWALWELL
SWALWELL BRANCH
DERWENTHAUGH GOODS
From Consett
From Tanfield
From Blyth

The Scheme

The majority of the Conversation Club scheme is open plan in order to maximise daylighting potential and the performance of natural ventilation.

Daylight and Solar Protection

The Conversation Club's envelope – including the roof form – is polycarbonate with a high translucency this, in combination with the open plan nature of the scheme, enables a generous daylight penetration within the scheme.

Skylights, and subsequently a glazed roof allow '2.5 times more daylight' (Fielden, 2010) into a building than windows, this is illustrated in figure 9. Another rule of thumb states that if you can see the sky from within a building that space is sufficiently day lit; following this rule figures 11 - 14 indicates the areas of the scheme that are suitably lit by natural daylight.

The translucency of the polycarbonate is beneficial to daylight in two forms, first it diffuses the natural light reducing glare and providing a more uniform lighting, second it reflects a percentage of the light which reduces the amount of solar thermal gain.

Solar gain is both a positive and a negative, it reduces the need for heating during cold periods but it increases the need for cooling in warm periods. As such a balance must be struck between the two. This can be achieved with louvres which shade windows from the peak solar gain. For the Conversation Club however the polycarbonate can be specified with a suitable solar gain.

The only spaces within the scheme that are not daylit are the interiors of the book lined rotundas and the subterranean space of the lower ground floor. It is inevitable that some spaces will need to be artificially lit and the uses of these spaces benefit from controlled lighting.

Daylight Factors

A daylight factor of 3-4% indicates a well lit room. Given the high area of translucent material in the envelope the daylight factor is very high. Using the simplified daylighting rule of thumb (DF = 0.1 x percentage of glazed area to floor area) (University of Wolverhampton, no date) the scheme indicates a daylight level of 17%. However this formula makes a couple of assumptions, first we're using transparent glazing, second the internal surfaces are relatively light with a high internal reflectance. For the Conversation Club these assumptions are untrue, the polycarbonate envelope will have a considerably lower diffuse transmittance and the internal surfaces are quite dark which will not lead to significant reflectance.

The light transmittance of polycarbonate is variable depending on the material thickness of sheets, number and structure of cells. We can change the daylight factor formula to determine the ideal transmittance for the polycarbonate that will lead to a suitable daylighting level. The result is a light transmittance of around 20%. A single sheet of polycarbonate has a transmittance of 35%, and so the Rodeca 60 mm hollow cell will provide the ideal daylighting levels of 4%.

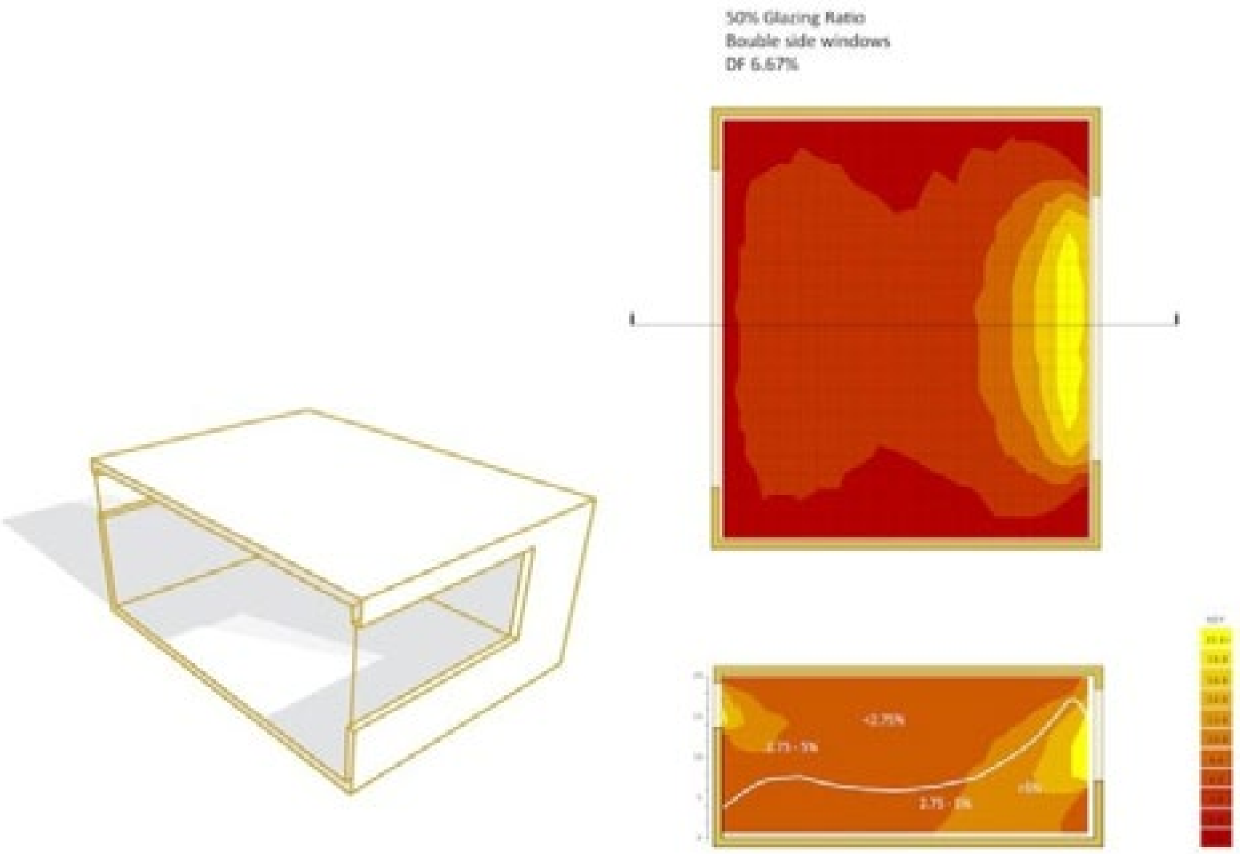


Figure 9
Daylight Penetration with 50% glazing

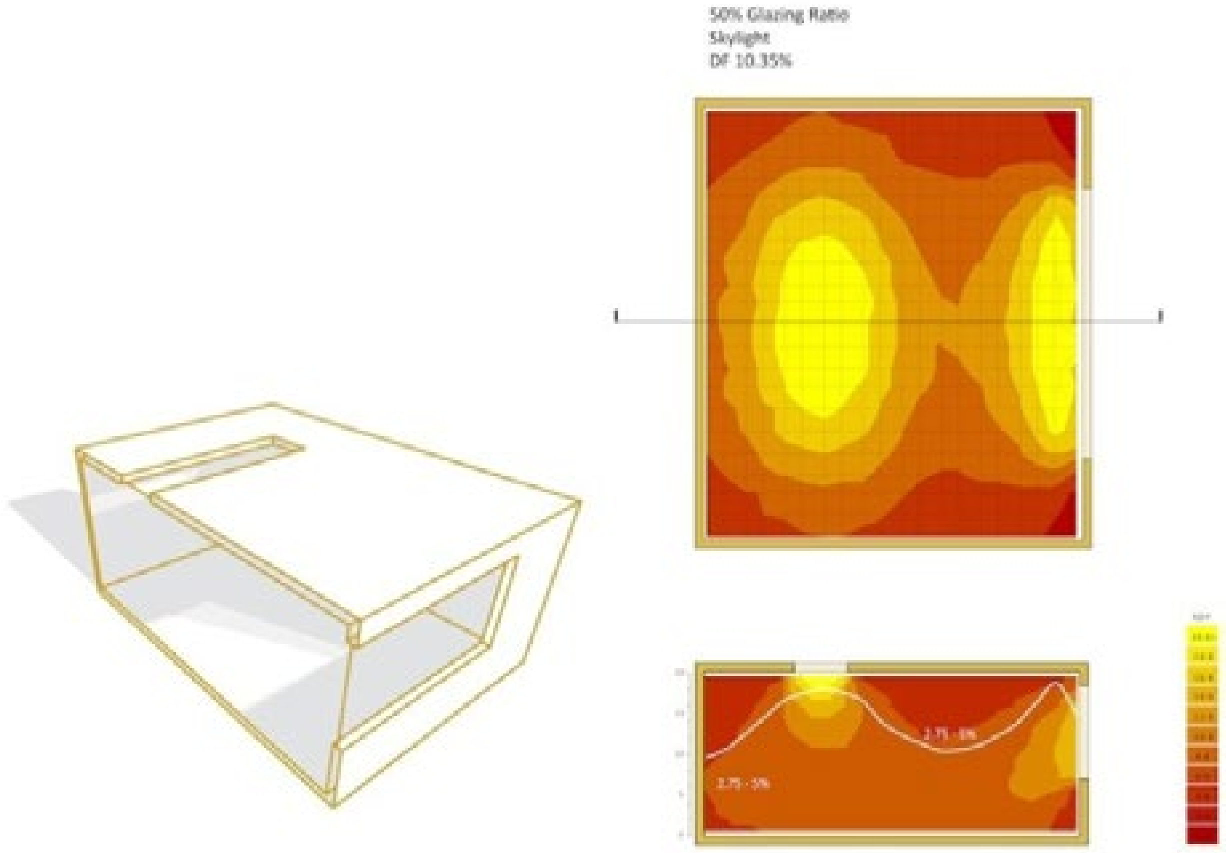


Figure 10
Daylight Penetration with 50% glazing and skylight

Figure 11

Lower Ground Floor
Daylight Penetration

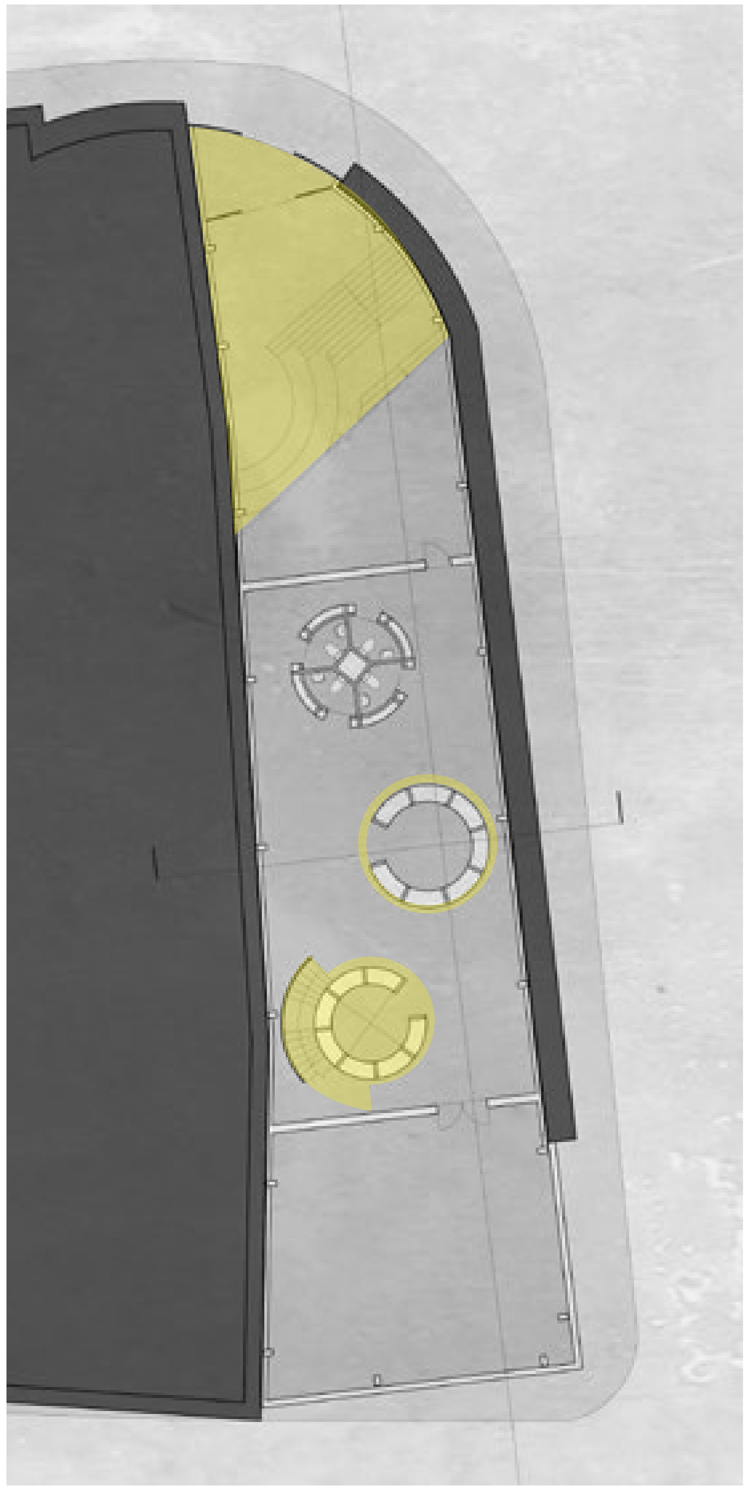


Figure 12

Upper Ground Floor
Daylight Penetration

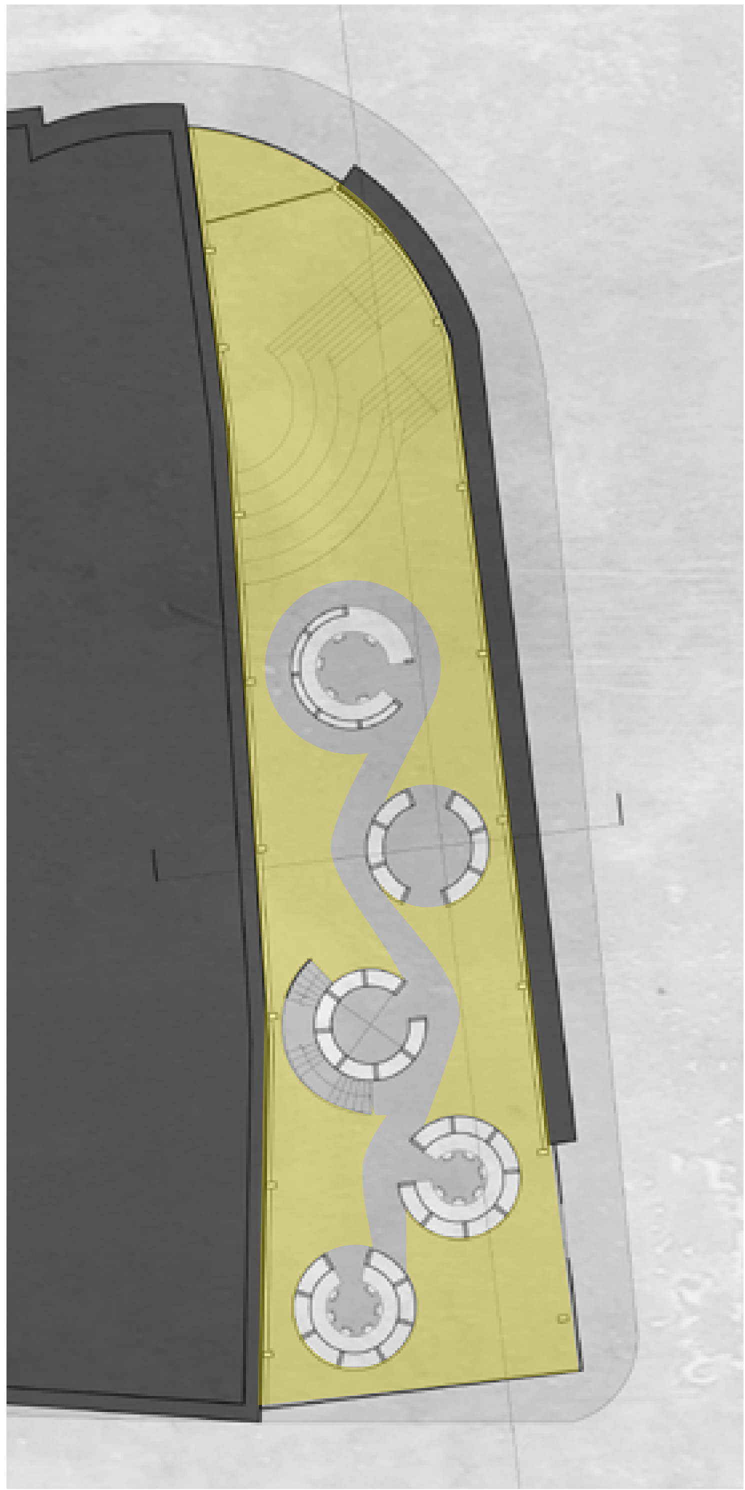


Figure 13

First Floor
Daylight Penetration

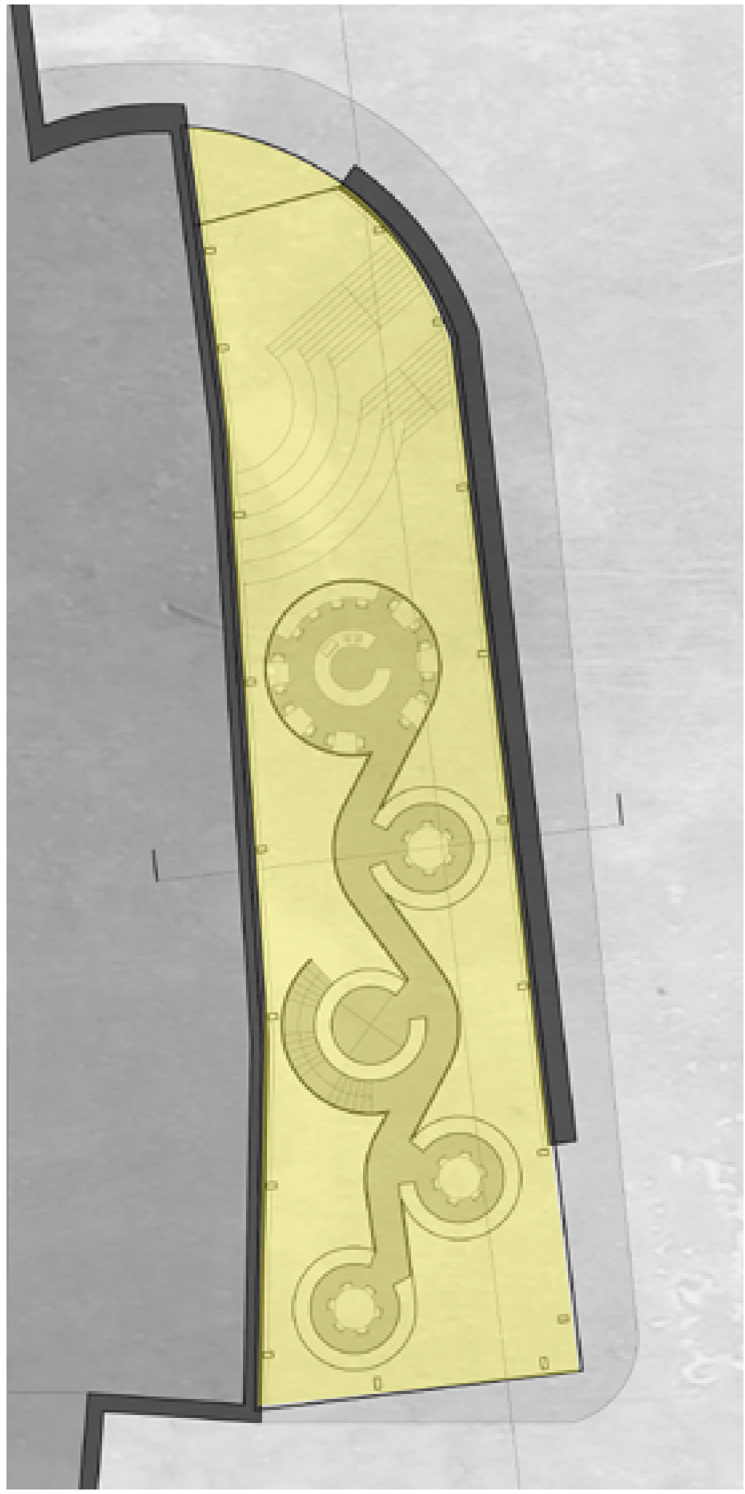
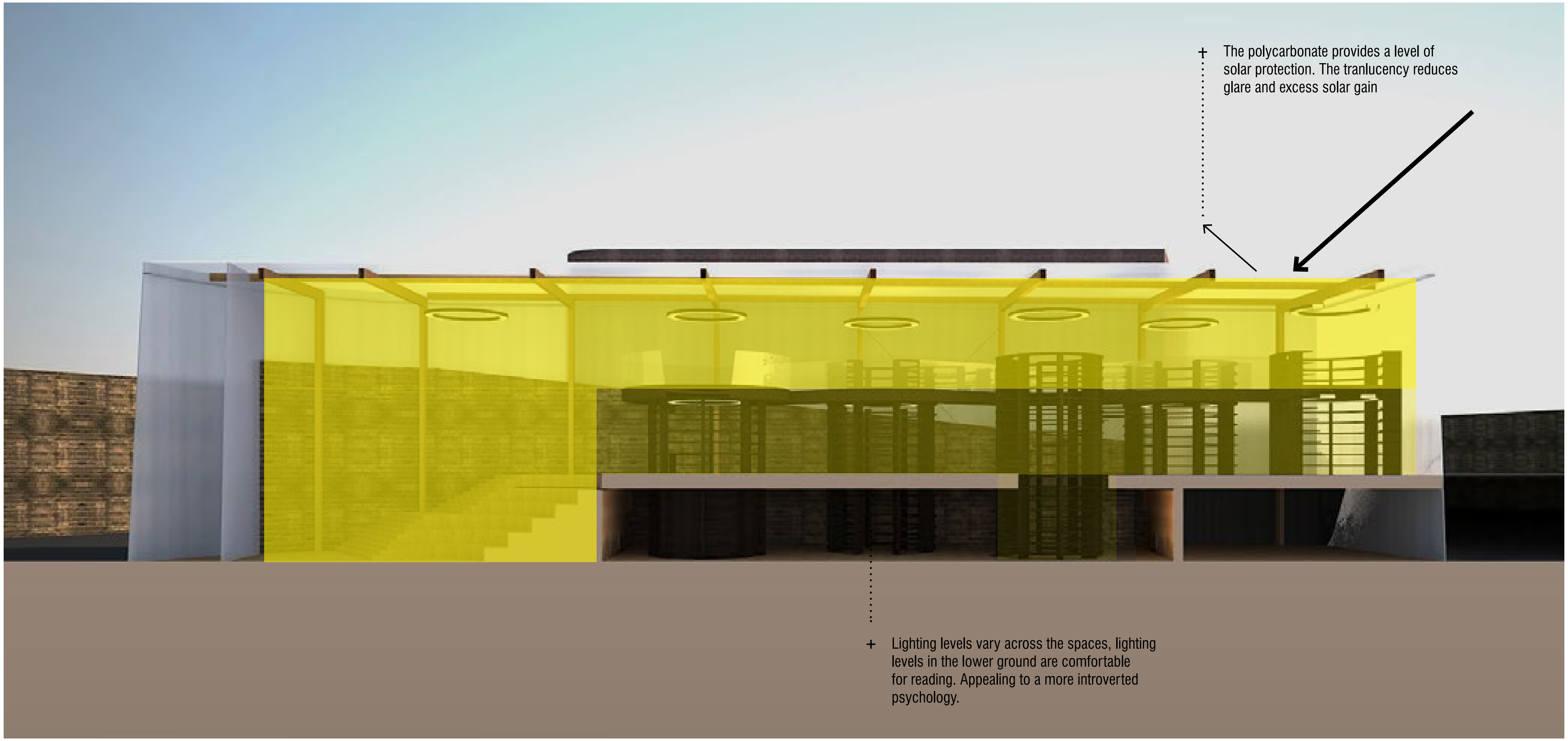


Figure 14
Daylight Penetration



The polycarbonate provides a level of solar protection. The tranlucency reduces glare and excess solar gain

Lighting levels vary across the spaces, lighting levels in the lower ground are comfortable for reading. Appealing to a more introverted psychology.

Ventilation

Figure 18 illustrates how the scheme utilises natural ventilation assisted by an AirSpan fan to induce gentle air movement. Cool air enters through lower level ventilation inlets, while warm air rises and is expelled through high level outlet vents.

Thermal Mass

The majority of the interior walls are coated with Stone Crete (figure 19), this material has the capacity to act as a thermal mass.

The theory is during winter months the thermal mass stores thermal energy from solar gain throughout the day and releases it throughout the evening and night, thus maintaining a consistent temperature and as such the building requires less heating the following morning.

In summer months the building is cooled over night by natural ventilation and as the building is heated the following morning, by solar gain, the thermal mass cools the building, again maintaining a consistent temperature.

Mechanical

The AirSpan fan creates a more pleasant working environment by moving large volumes of air gently. An AirSpan fan can 'generate 376,804 CFM (cubic feet per minute) and covers approximately 20,000 sq. ft' (MacroAir, no date).

During the coldest periods of the winter it may not be practical to use natural ventilation as this will result in significant heat losses. There will also be a necessity to induce ventilation in the subterranean lower ground space where natural ventilation openings are impossible. For these situations mechanical ventilation will be necessary, The air ducts will run through the floor deck, from a unit in the lower ground plant room. The outlets will be in the floor deck to encourage stack ventilation.

Systems

The natural heating and ventilation achieved within the scheme should be sufficient to provide a comfortable environment however there will be cases when the thermal mass, daylighting and ventilation strategy are not sufficient.

Ground Source Heat Pump

The scheme integrates underfloor heating pipes (figures 16 & 17) into the timber floor deck, these are connected to a ground source heat pump to provide additional heating and cooling on demand.

A ground source heat pump makes use of the stable temperatures underground. Figure 15 shows how the system functions, water is pumped deep underground where the temperature is a stable 8-11 °C, once the water has been pre-warmed (or cooled) to a suitable temperature it is returned to the surface. Before being fed through the underfloor heating pipes the water may require additional heating or cooling.

Ground source pumps are flexible in that they can provide heating during winter months where the underground temperature is above the surface temperature or cooling in the summer where the underground temperature is cooler.

Ground source heat pumps are not always economically efficient, they require an electrical input, for the most part the electrical energy input is a fraction of the energy output (in terms of water heating or cooling). However the cost of electricity is approximately 4 times greater than gas, subsequently if the coefficient of performance (output energy over input energy) is lower than 4 then it would have been more financially cost effective to use gas for heating.

Figure 15

Ground Source Heat Pump

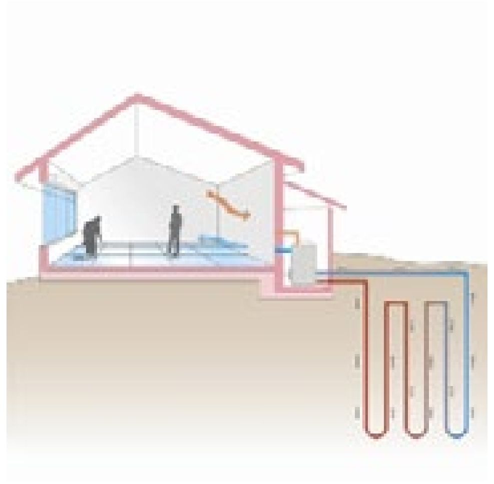


Figure 16

Lower Ground Floor Deck

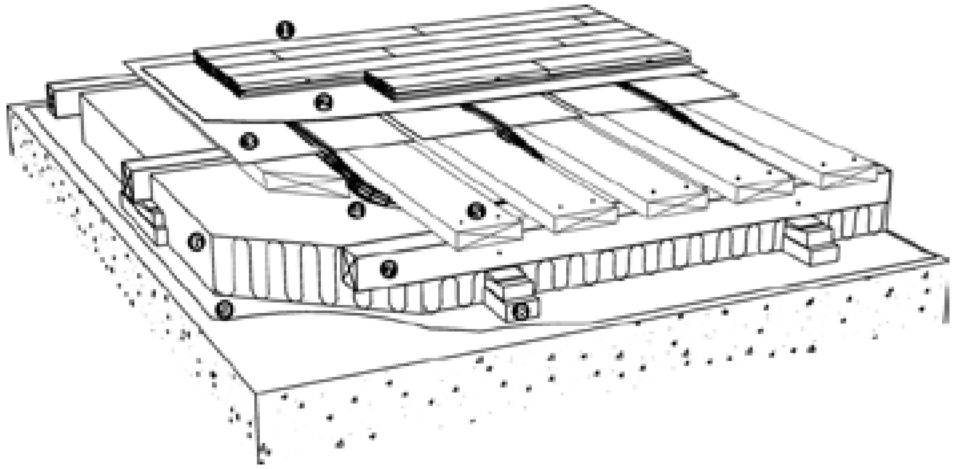


Figure 17

Upper Ground Floor Deck

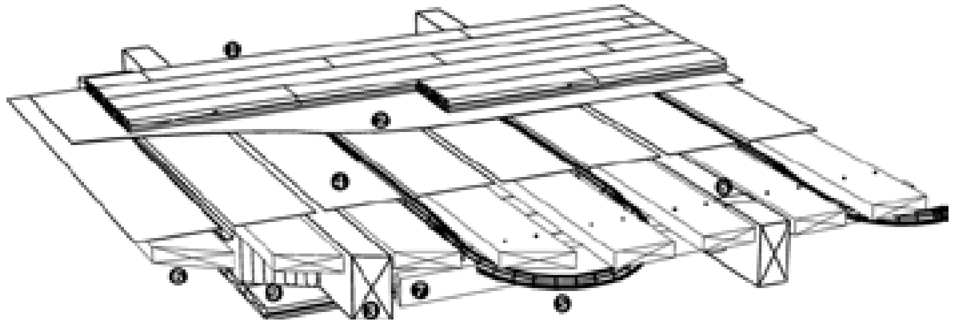
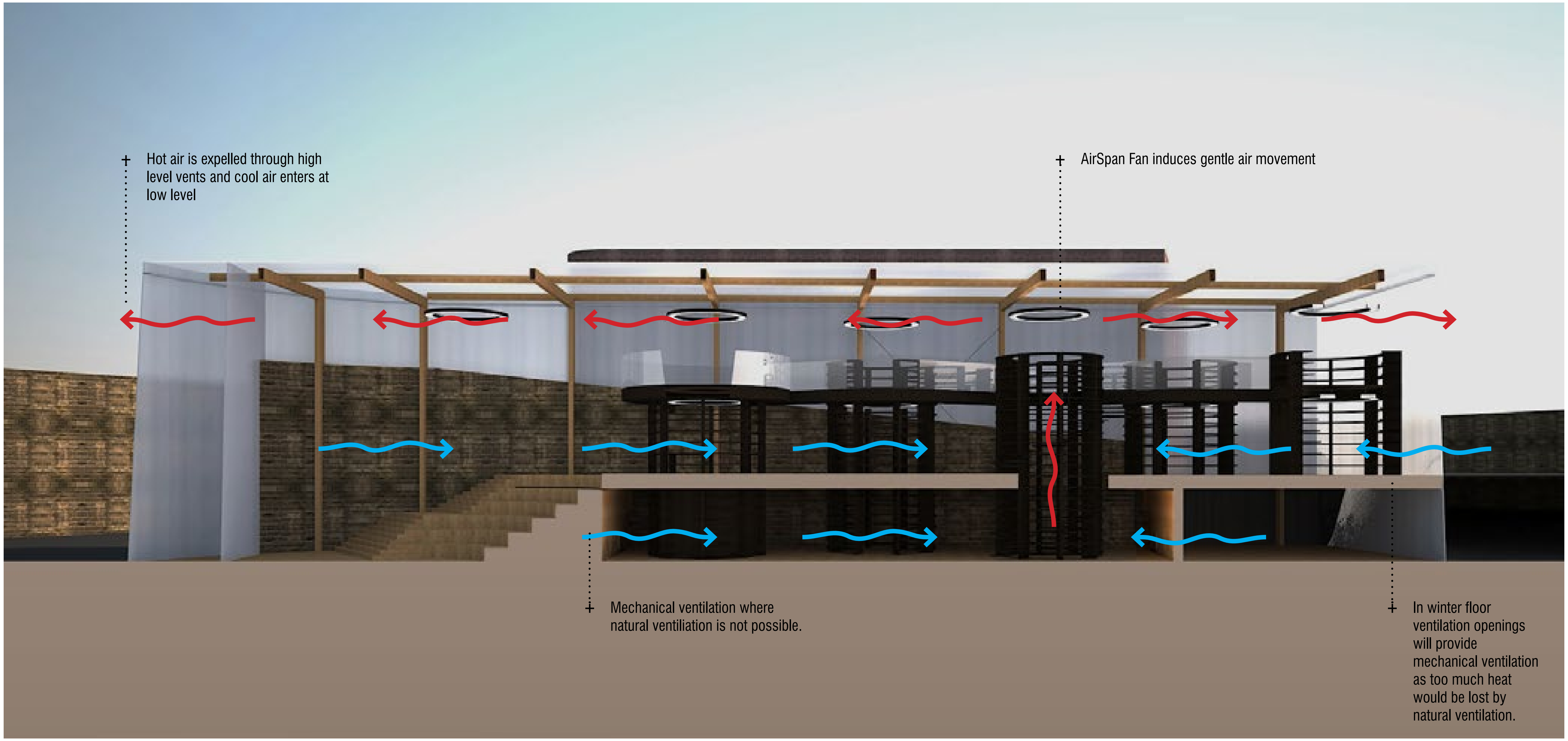


Figure 18

Ventilation Strategy



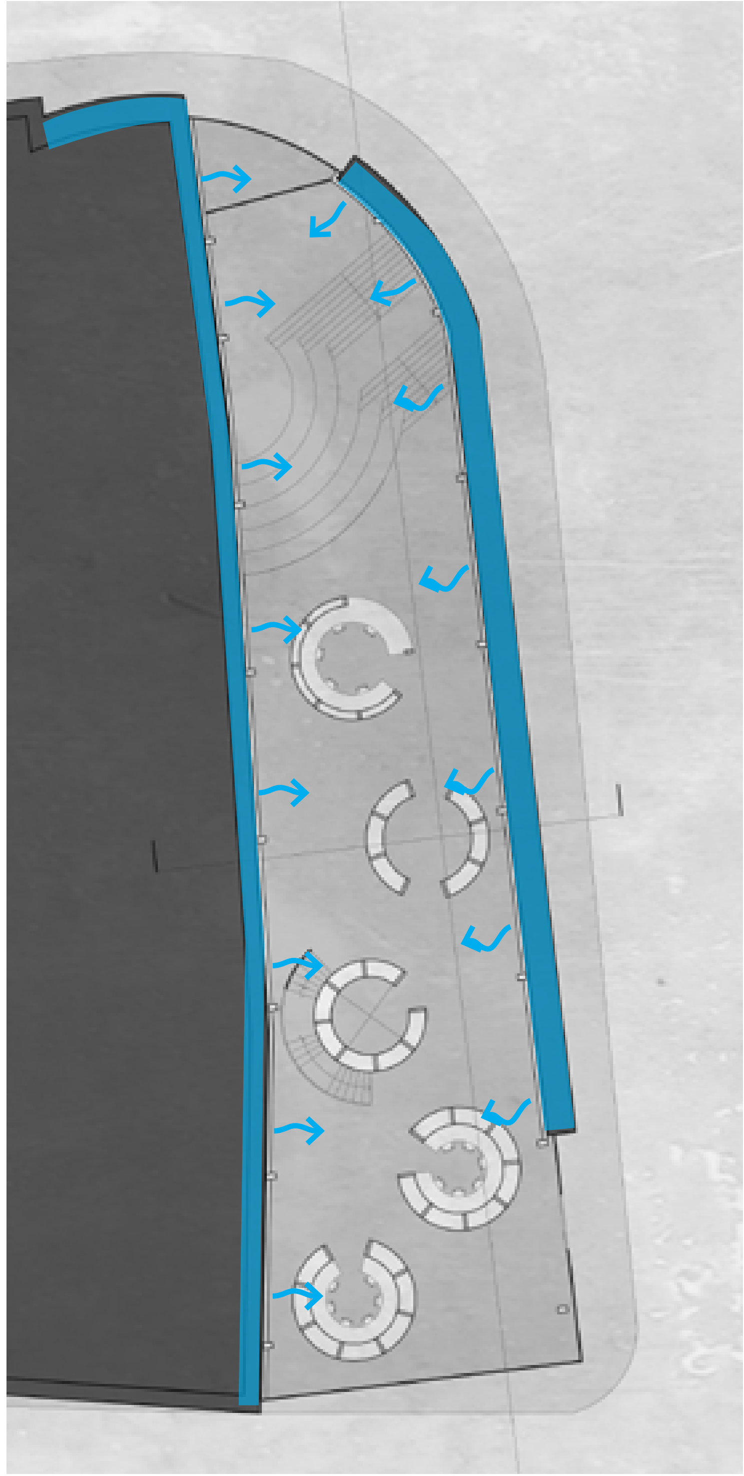
Hot air is expelled through high level vents and cool air enters at low level

AirSpan Fan induces gentle air movement

Mechanical ventilation where natural ventiliation is not possible.

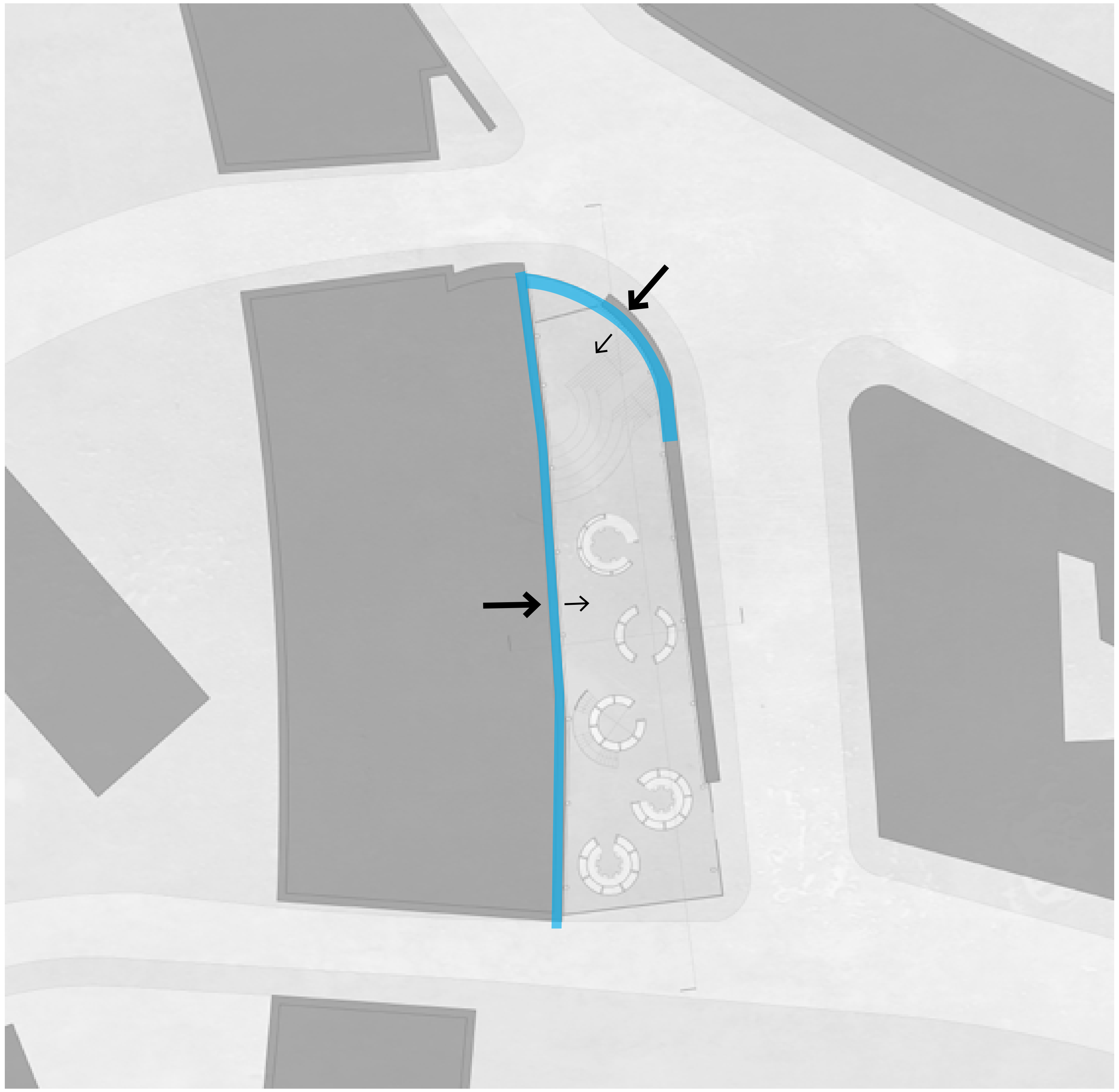
In winter floor ventilation openings will provide mechanical ventilation as too much heat would be lost by natural ventilation.

Figure 19
Thermal Mass



- The thermal mass provides comfort cooling.
- During hot summer days the building can be natrally ventilated over night to cool the termal mass. Which will then maintain a comfortable level throughout the day,

Figure 20
Noise Attenuation



- The 60 mm polycarbonate reduces sound levels by up to 28 dB.
- This makes the road and rail noises barely audibl within the building.

Low Carbon Strategies

The Conversation Club is an environmentally sensitive scheme, one of the most significant features of which is the glulam timber primary structure. ‘Converting trees into a usable building material takes far less energy, and therefore generates far less carbon dioxide, than virtually any other alternative, including aluminium, steel and concrete’ (The Environmental Handbook, 2010).

The ground source heat pump is similarly a low carbon strategy it utilises the thermal mass of the ground rather than unsustainable fuels for heating and cooling.

Energy

Heat Loss

The major envelope material is the Rodeca Polycarbonate, this has a U-value of 0.71 W/m^{2}K (Rodeca, no date). The where the stone wall has been retained it has been insulated with Kingspan K12 framing board, this should give a U-value of around 0.2 W/m^{2}K (Kingspan, no date). The floor is insulated with Kingspan Thermafloor with a U-value of 0.2 W/m^{2}K.

Figure 21 shows the total fabric heat loss for the entire scheme; as expected the major losses are through the polycarbonate. However the polycarbonate also benefits from a high G-value of 0.68 (Rodeca, no date), subsequently what energy is lost through the fabric can be compensated by solar gain which is absorbed by the high surface area of thermal mass.

Double glazing has a typical U-value of 2.8, in this context the polycarbonate is a substantially more efficient material. If the scheme was clad in glazing rather than polycarbonate the envelope fabric loss would be 44,408W compared to 11,261W; a difference of four times.

Building Regulations

Table 4 of Approved Document L (figure 22) shows the maximum U-values for each surface. The stonework and floor easily pass these requirements and the polycarbonate roof and walls are permissible given they are curtain walling and rooflights; however the U-value of 0.68 is significantly higher than the minimum 0.25 for a roof.

Benchmarks

Lanchester Library at Coventry University has publicised its energy consumption for 2004. These will serve as an energy benchmark for the Conversation Club. The Lanchester Library similarly utilises natural ventilation but it has a significantly larger floor area of 9000m sq. The performance data is shown in figure 23.

The Conversation Club will have a higher figure for cooling, but lower figure for heating as it has a greater area of openings which will contribute solar gain. As the Lanchester Library has a larger floor area we will rely on the figures for consumption per sq m.

Figure 21

Scheme Fabric Heat Loss

	Surface Area	
	Stone	Polycarbonate
West	344	86
North	25	70
East	245	178
South	27	64
Roof	0	395
Floor	394	0
Total Fabric Heat Loss	**4,140**	**11,261**

Figure 22

Building Regulation Maximum U-Values

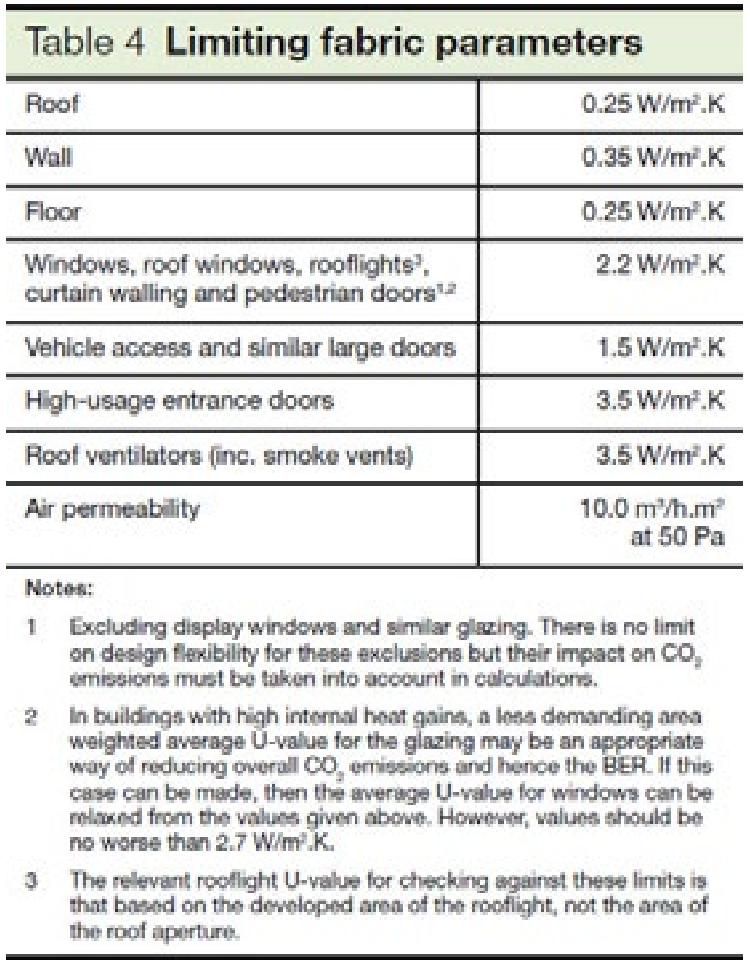


Table 4 **Limiting fabric parameters**

Roof	0.25 W/m².K
Wall	0.35 W/m².K
Floor	0.25 W/m².K
Windows, roof windows, rooflights[3], curtain walling and pedestrian doors[1,2]	2.2 W/m².K
Vehicle access and similar large doors	1.5 W/m².K
High-usage entrance doors	3.5 W/m².K
Roof ventilators (inc. smoke vents)	3.5 W/m².K
Air permeability	10.0 m³/h.m² at 50 Pa

Notes:

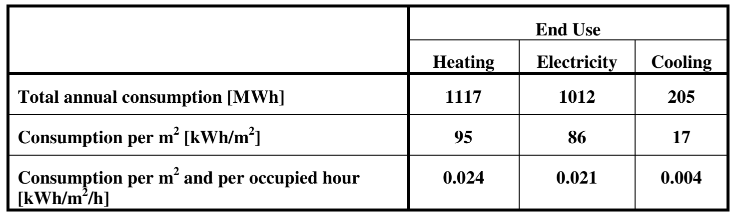
1 Excluding display windows and similar glazing. There is no limit on design flexibility for these exclusions but their impact on CO_2 emissions must be taken into account in calculations.

2 In buildings with high internal heat gains, a less demanding area weighted average U-value for the glazing may be an appropriate way of reducing overall CO_2 emissions and hence the BER. If this case can be made, then the average U-value for windows can be relaxed from the values given above. However, values should be no worse than 2.7 W/m².K.

3 The relevant rooflight U-value for checking against these limits is that based on the developed area of the rooflight, not the area of the roof aperture.

Figure 23

Lanchester University Energy Consumption Benchmark



	End Use		
	Heating	**Electricity**	**Cooling**
Total annual consumption [MWh]	**1117**	**1012**	**205**
Consumption per m^2 [kWh/m^2]	**95**	**86**	**17**
Consumption per m^2 and per occupied hour [kWh/m^2/h]	**0.024**	**0.021**	**0.004**

Figure 24
Artificial Lighting

References


NEWCASTLE
GATESHEAD
SCOTSWOOD
BLAYDON
ELSWICK
JESMOND
HEATON
BYKER
MANORS
CENTRAL STA.
High Level Bridge
K.G. Edward Bridge
QUAYSIDE
DUNSTON STAITHS
DUNSTON-ON-TYNE
REDHEUGH
BENSHAM
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R T Y N E

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