# 09

## technology & sustainability

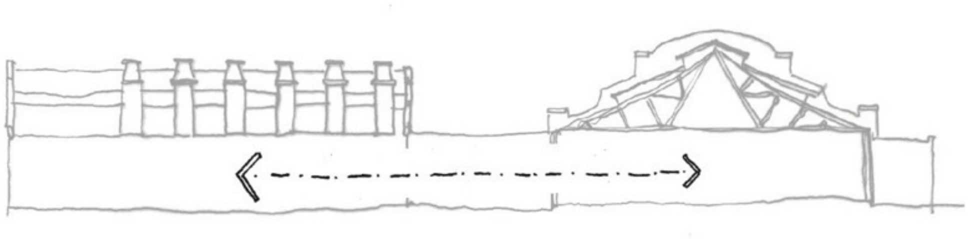
The next chapter builds on the final design through a technological and sustainable lens.

Figure 226: Photograph of brick detailing, southern facade: *(Author 2021)*

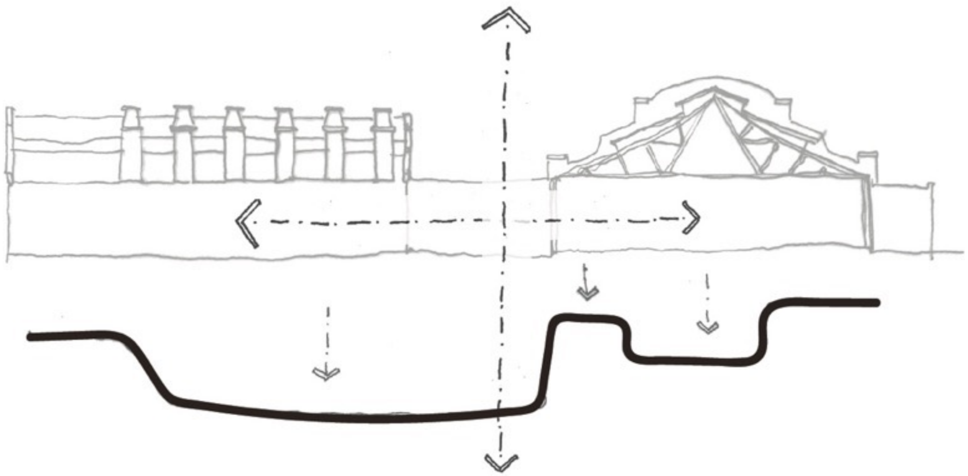
# TECHNOLOGICAL CONCEPT

## Transmission:

The concept of transmission is continued from a horizontal notion of social exchange across space as an architectural concept, towards a more vertical relationship in space as a technological concept.



ARCHITECTURAL



TECHNOLOGICAL

Figure 227: Technological Concept Introduced: *(Author 2021)*

# TECHNOLOGICAL CONCEPT

## Transmission:

The overall architectural strategy towards heritage is addition which describes "link[ing] new with old using an independent joining element to retain the identity of both parts" (Barker 2020: 142). In this way, any technological insertions will act to retain the integrity of both old and new elements whilst still connecting them in some way.

The strategy of connection or detail expression is intersection which "requires the meeting of both conditions through a junction that could be additive or penetrative" (Barker 2020: 143).

The technological definition of transmission then completes this junction by "cause[ing] something, [heat, light, air or other energy] to pass or be conveyed through space or a medium" or through this connection which is additive or penetrative (Merriam-Webster Dictionary, not dated).

The technological intention is therefore to retain the integrity of existing architecture whilst simultaneously mediating between disparities (old and new buildings, different materials, or stereotomic and tectonic elements) through the transmission of natural elements in a junction which is additive or penetrative (figure 228).

The structural approach further adopts this notion of transmission by allowing light, ventilation, and water to be passed through the structure at various junctions in the new tectonic intervention of the link area (figure 229).

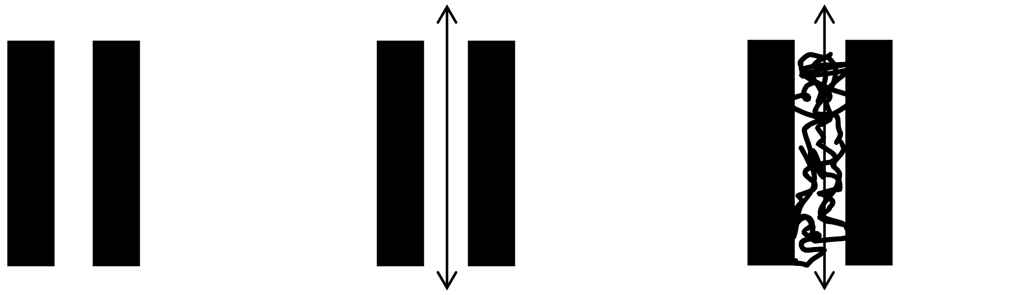
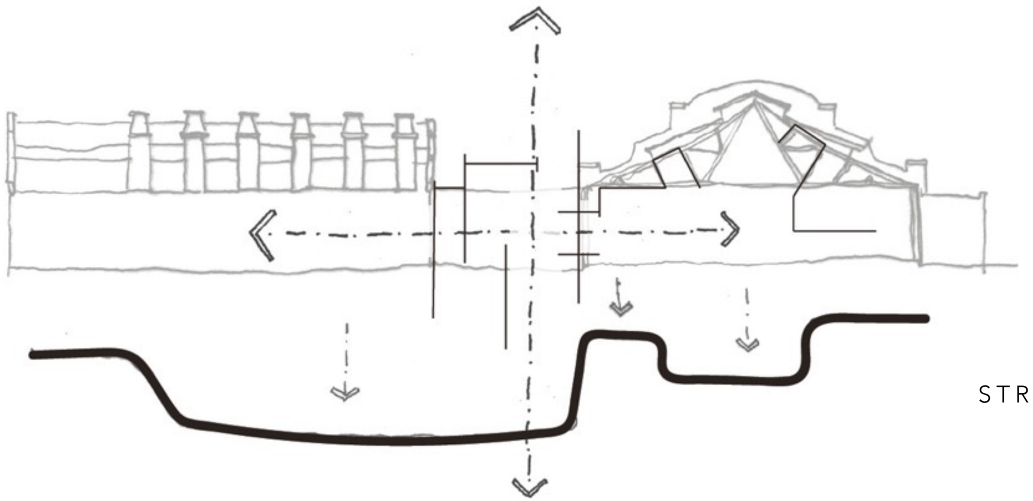



Figure 228: Technological Concept: *(Author 2021)*



STRUCTURAL

Figure 229: Structural Approach *(Author 2021)*

# STRUCTURAL SYSTEM: LINK AREA

## Primary Structure:

The primary structural system consists of combined sawtooth portal frames. When the columns of two portal frames are brought together, this enables space for a downpipe to be placed between them. As a result, rainwater is able to travel from the gutter between every sawtooth frame and into the basement through the columns.

Furthermore, south light is collected from the orientation of the roofs to provide natural light into this link area.

Therefore, through rainwater harvesting and daylighting, transmission occurs structurally in two ways through the link area.

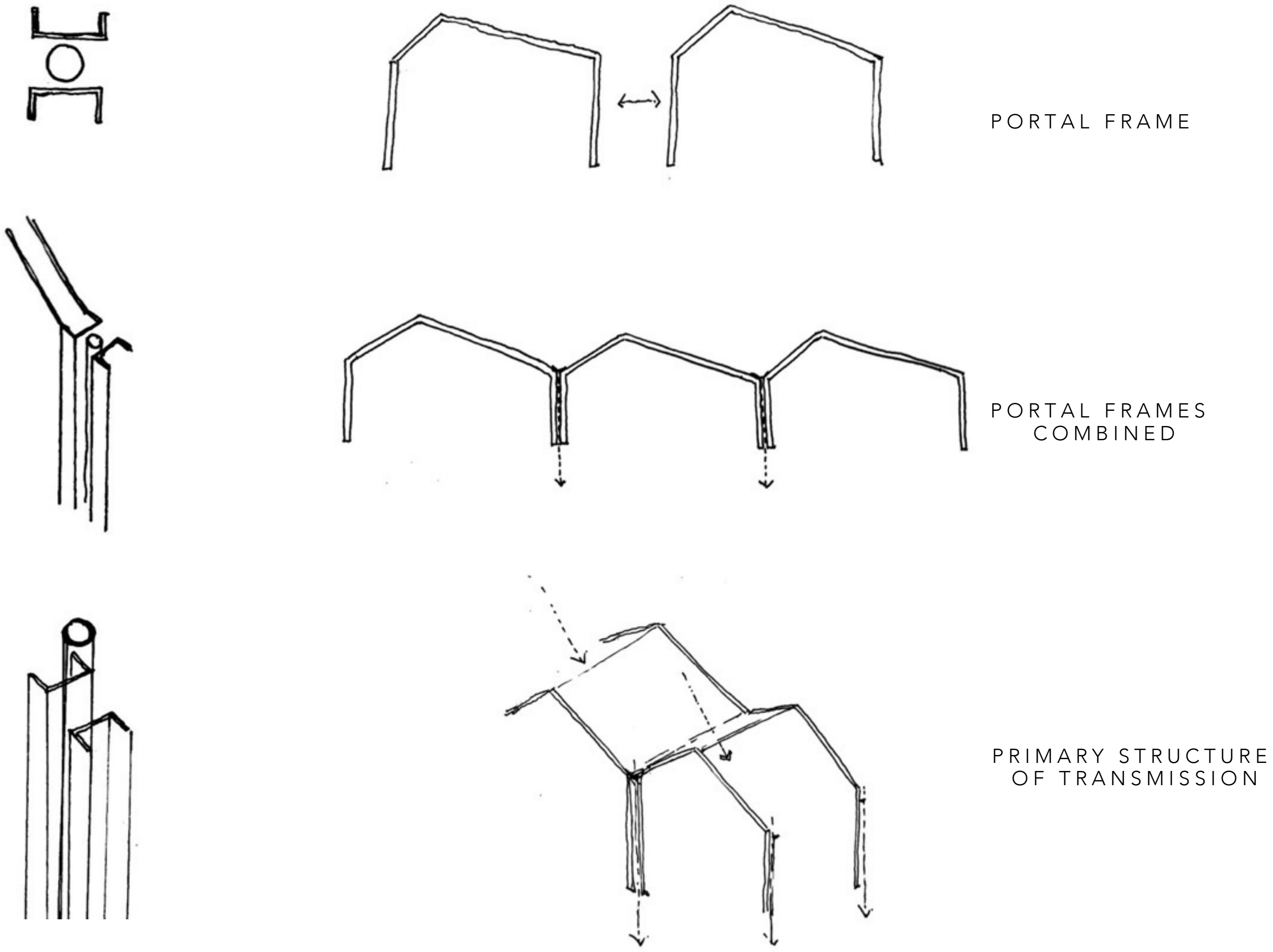



Figure 230: Structural System, Primary *(Author 2021)*

# STRUCTURAL SYSTEM: LINK AREA

## Secondary and Tertiary Structure:

The secondary and tertiary structure relate back to the principle of circulation space as threshold, which mediates between existing heritage and the new intervention.

Through the addition of cross beams that tie the portal frames together in the east-west direction, circulation spaces are created below on either end of this link area.

Rhinowood timber battens with polycarbonate sheeting above, allow dappled sunlight to be brought into this extended eating area, creating another moment of transmission.

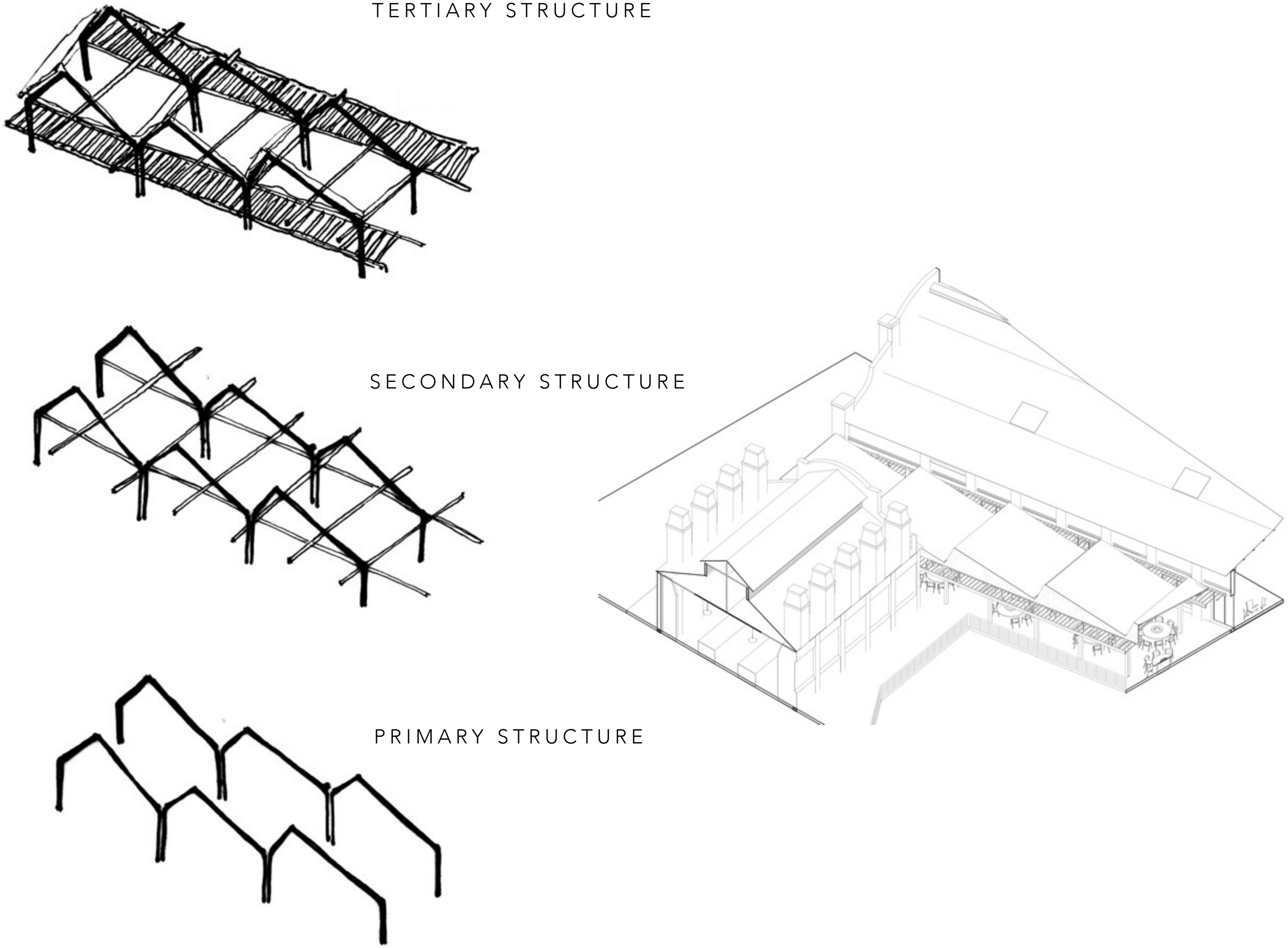



Figure 231: Structural System, Primary, Secondary and Tertiary *(Author 2021)*

# STRUCTURAL SYSTEM: SEED RESEARCH CENTRE

The portal frame structural approach of the link area and the concept of transmission is continued through to the construction and technology of the new Seed Research Centre.

Portal frames divide the various zones and allow light to be transmitted into the internal spaces through polycarbonate panels above at various intervals.

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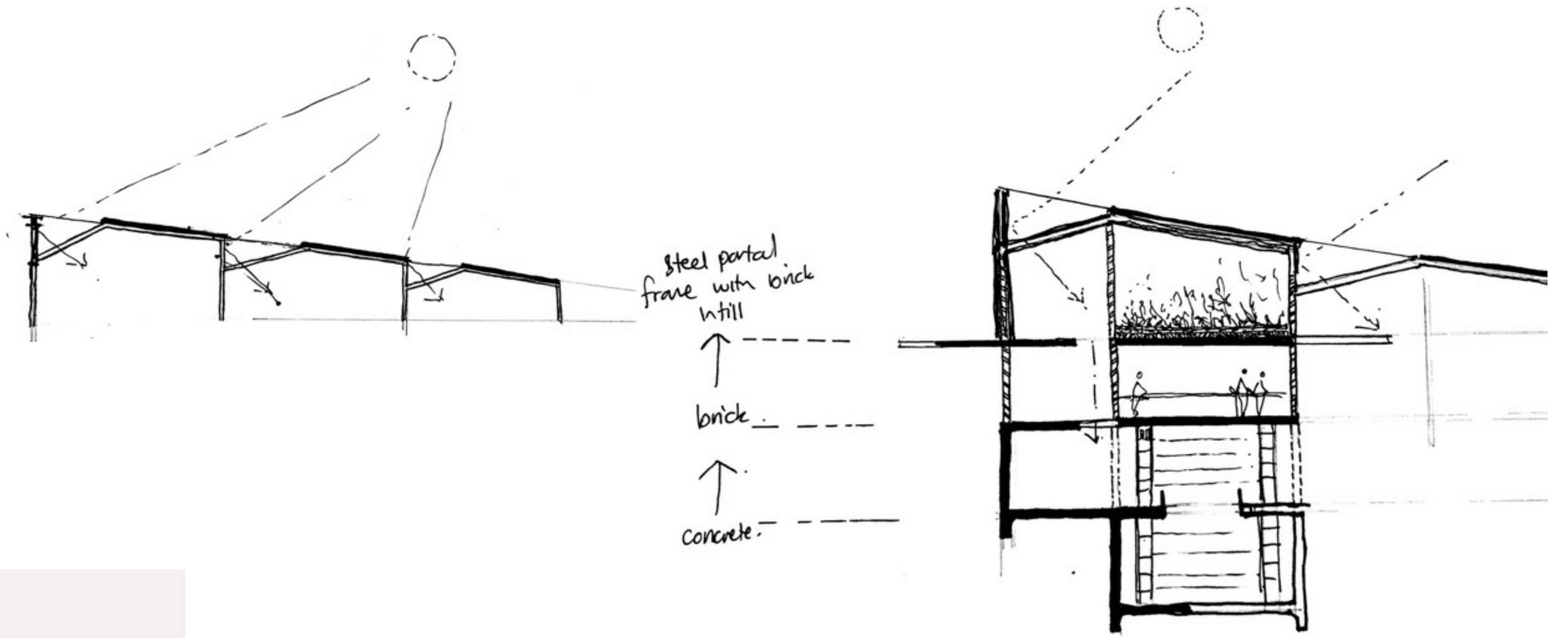



Figure 232: Structural concept, Seed Research Centre *(Author 2021)*

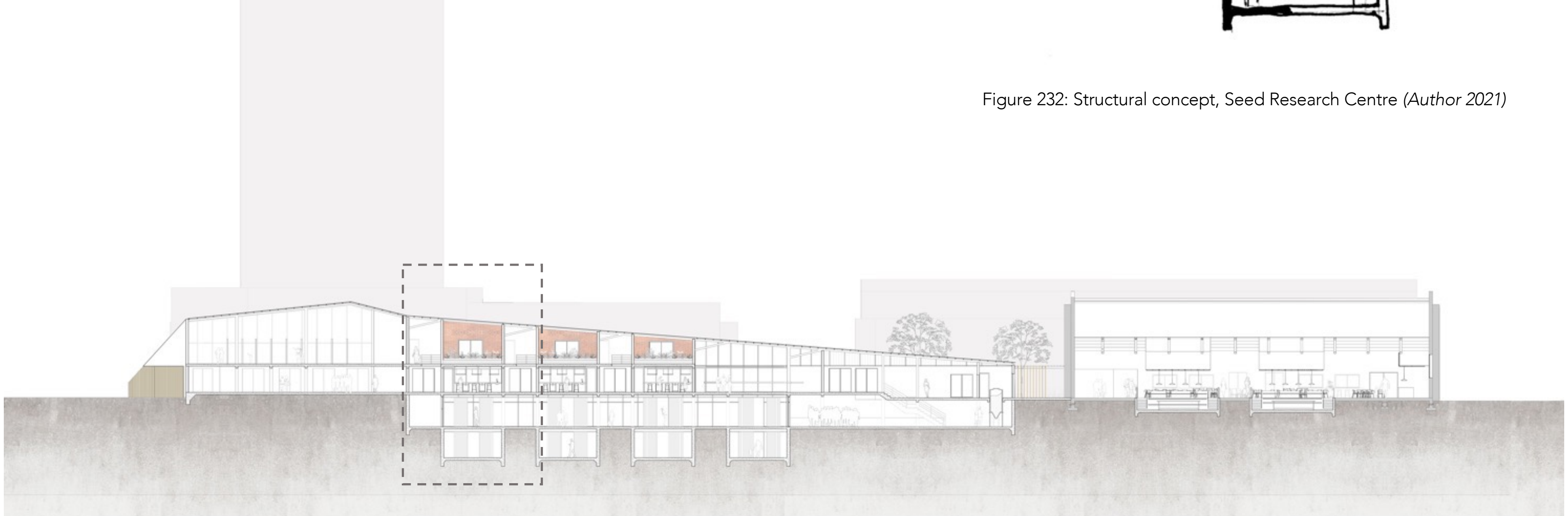


Figure 233: Key Section, Section BB *(Author 2021)*

# STRUCTURAL SYSTEM: SEED RESEARCH CENTRE

## Section: Seed Research Unit 1:50

The seed research units are designed so that functions all related to one another stack vertically and are separated by circulation intervals which are naturally lit from above.

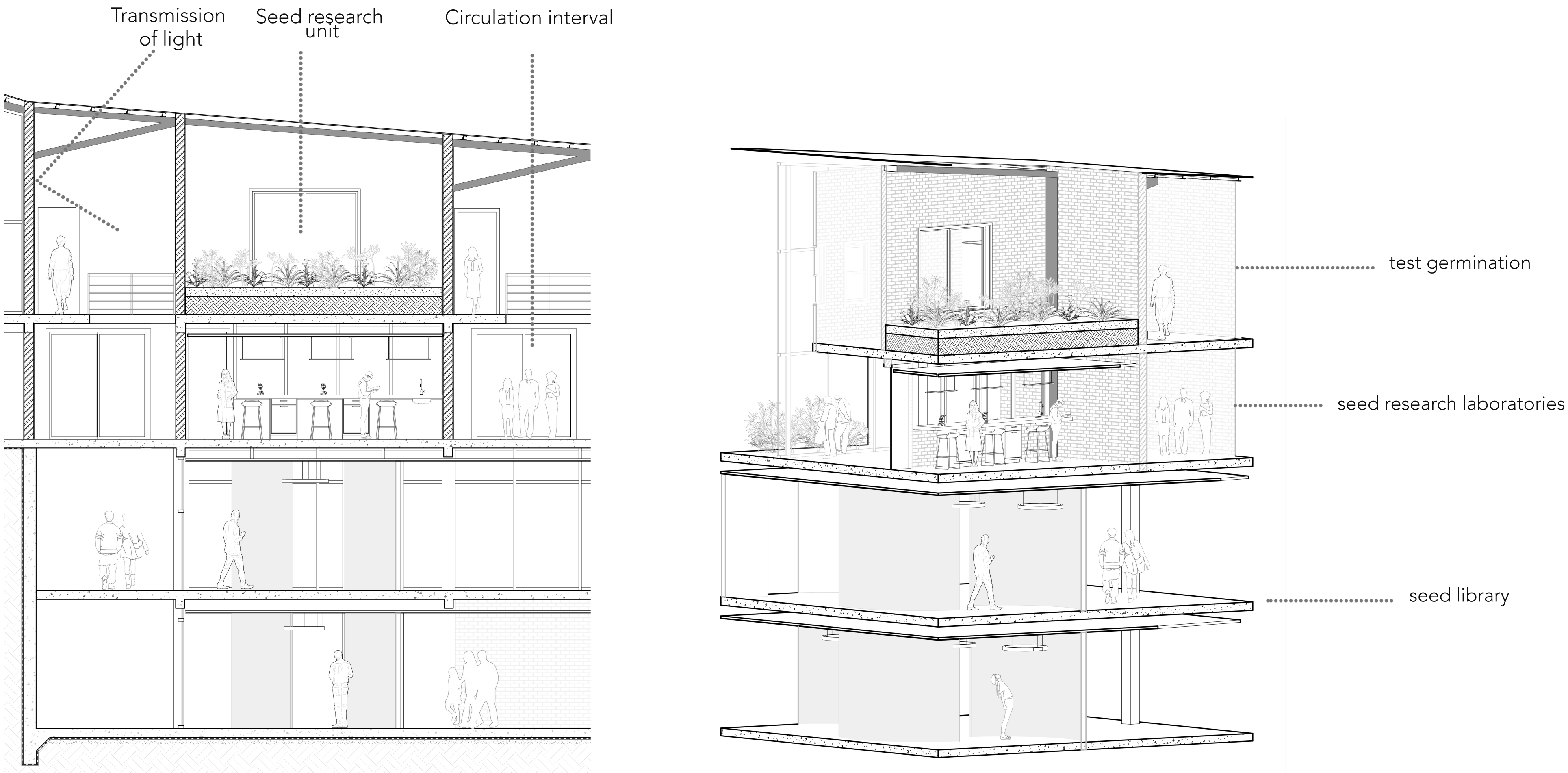



Figure 234: Seed Research Unit *(Author 2021)*

# MATERIALITY

## Layering of new tectonic onto existing stereotomic:

The existing materiality on site consists of fibre cement roof sheeting, red brick detailing through brick plinth walls, old timber trusses and steel roof trusses.

The new intervention is predominantly tectonic in its materiality, consisting of timber, polycarbonate and steel.

EXISTING MATERIALITY

NEW MATERIALITY

Figure 235: Material Palette: *(Author 2021, individual photographs referenced in list of figures)*

# MATERIALITY

## Configuration of chosen materials

Fibre cement of a lighter colour to the existing, is used as cladding and roofing in the new intervention (figure 236). Red clay brick, as existing on site through the two halls, is continued in the new building through the Seed Research Centre (figures 236 & 237).

This ensures a continuation of the existing materiality while simultaneously enabling old and new to retain their integrity and stand independently.

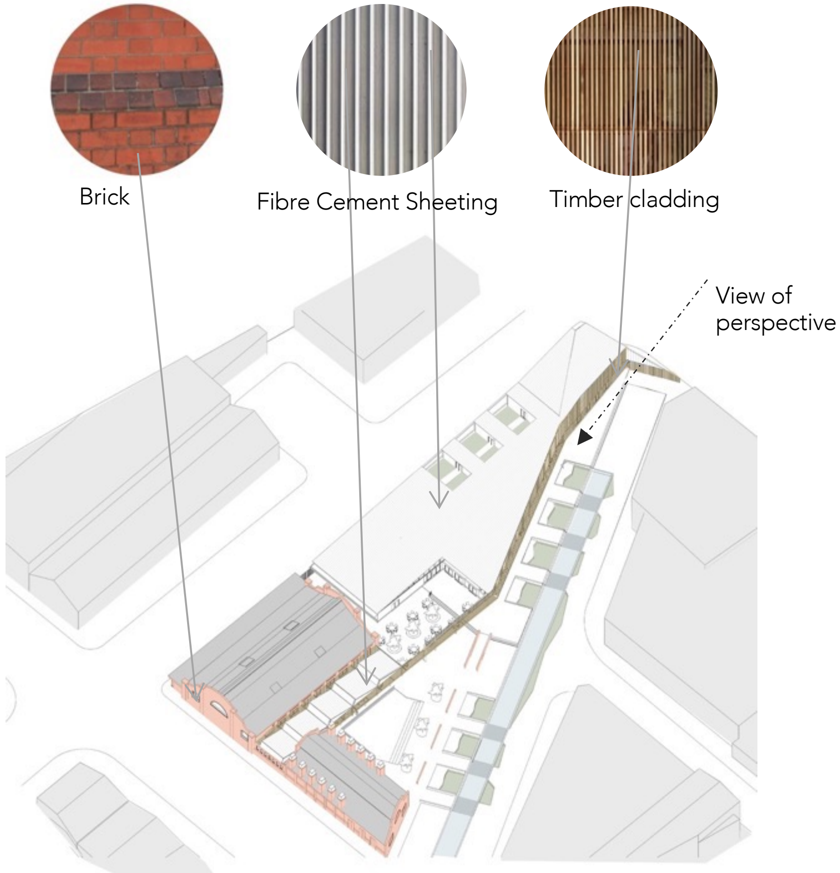



Figure 236: Configuration of chosen materials: *(Author 2021)*

Figure 237: Proposed materiality of Seed Research Centre *(Author 2021)*

# MATERIALITY

## Sustainability of chosen materials

Marley Super 6 fibre cement sheets are chosen for the roof and cladding of the new seed research centre and link area. This material is economical, easy to install, durable in the face of rust and corrosion, as well as being highly robust. In addition, fibre cement requires minimum maintenance over time, and has excellent thermal properties (Marley Roofing, not dated).

Furthermore, Marley Roofing is a South African company with a branch and stockist in Durban which reduces energy spent on transport of this material.

Rhinowood is the chosen material for the pergola, shading screen and ceiling cladding in the eating hall. Rhinowood only utilizes timber from "purpose-grown South African forests" (Rhinowood, not dated) which enables it to be an environmentally sustainable option for any application of timber on site. In addition to its sustainability, it is strong and durable with zero toxicity in its production (Rhinowood, not dated).

For any interior skylights, Multilite multiwall polycarbonate sheets are used which provide 92% of light transmission whilst simultaneously offering 99% UV protection. This material is fire resistant, sustainable, lightweight and impact resistant (Multilite, not dated). Furthermore, for exterior sheeting that doesn't need to be insulated, Natralite polycarbonate profiled sheeting is used. Similarly to Multilite, Natralite offers 92% light transmission whilst keeping the heat out, 99% UV protection, is wind, fire and chemical resistant (Natralite not dated).

For any other glazing on site, Low-e laminated glass is used which provides thermal and acoustic insulation, offers UV control and improves the energy efficiency of the space (PG Smart Glass 2016 : 2-9).

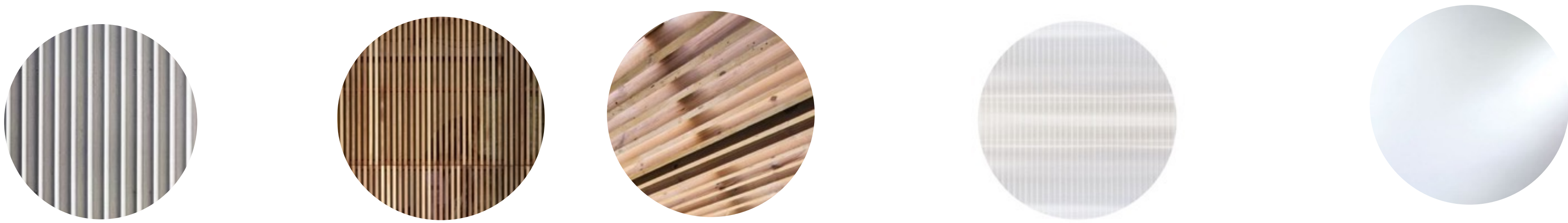


Figure 238: Sustainability of proposed materials : *(Author 2021, individual photographs referenced in list of figures)*

# DESIGN SECTION

The main 1:20 design section is taken across the link area between the kitchen and the eating hall to demonstrate how transmission between junctions can act to redefine the relationship between the new interventions and the existing heritage fabric of the site (figures 239 & 240

Moments of transmission are demonstrated in a number of places throughout the section (Figure 239).

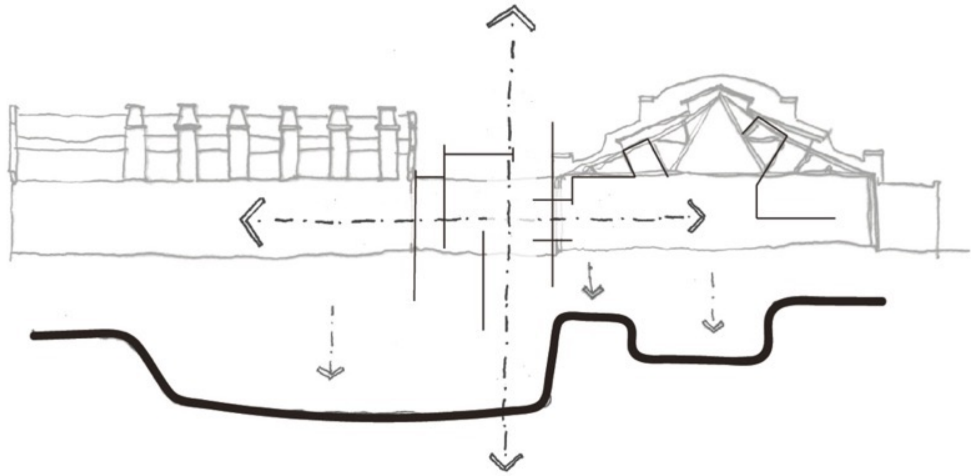



Figure 239: Concept Drawing for main design section : *(Author 2021)*

Figure 240: Plan showing where design section is taken through: *(Author 2021)*

# FULL DESIGN SECTION A-A

1:20

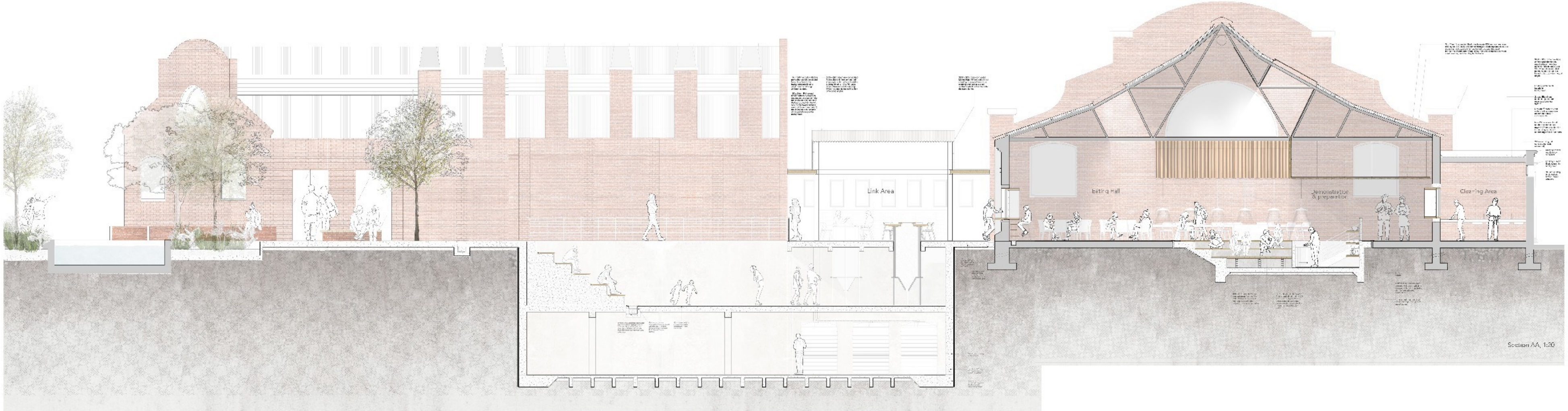



Figure 241: Full Design Section A-A: *(Author 2021)*

# DESIGN SECTION A-A, Part A

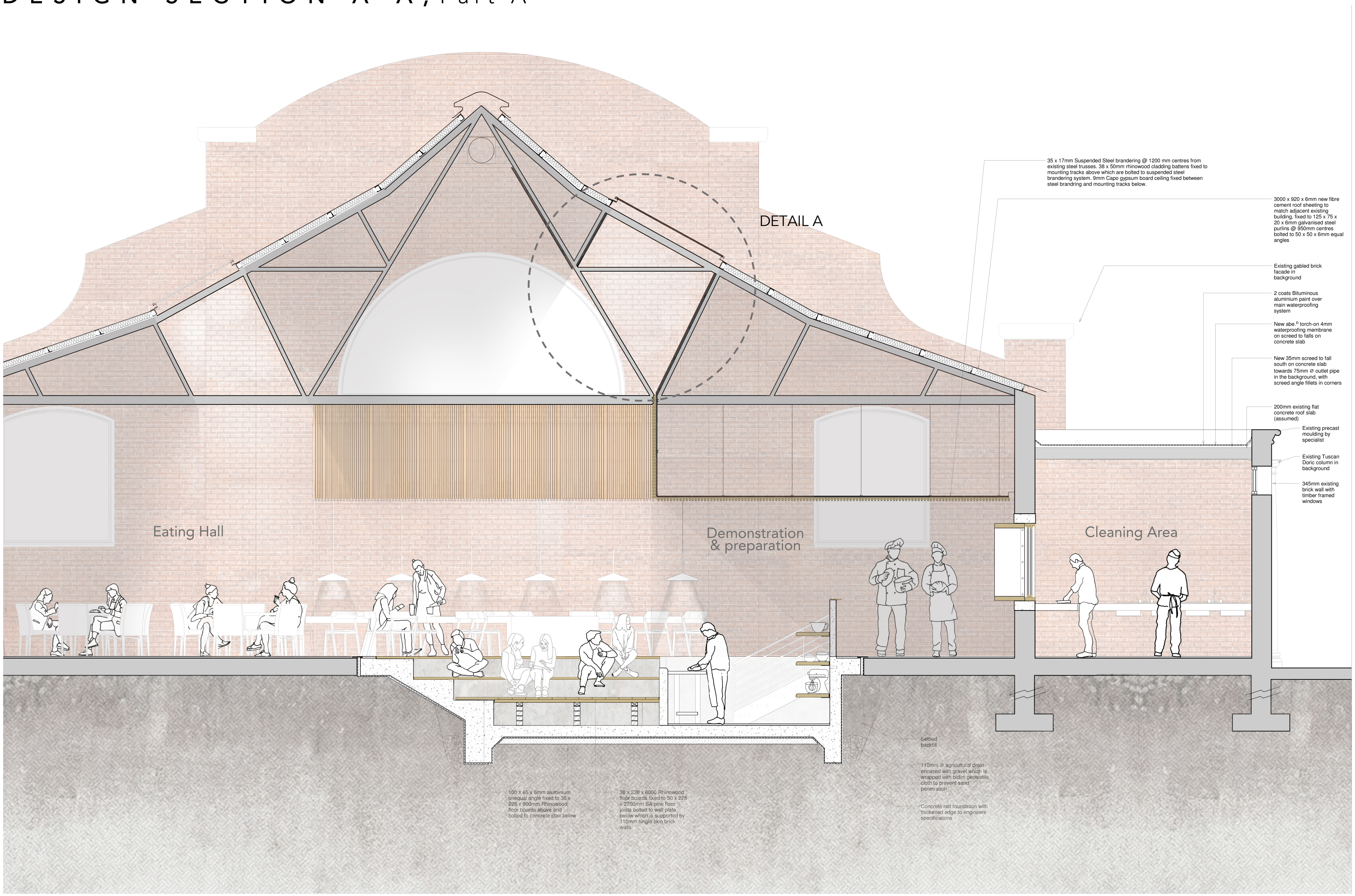


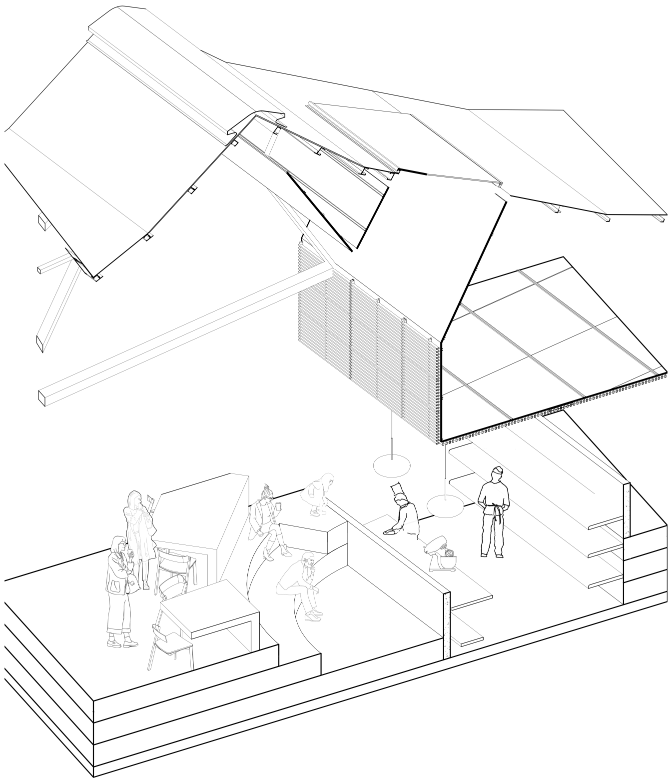

Figure 242: Design Section A-A, part A: *(Author 2021)*

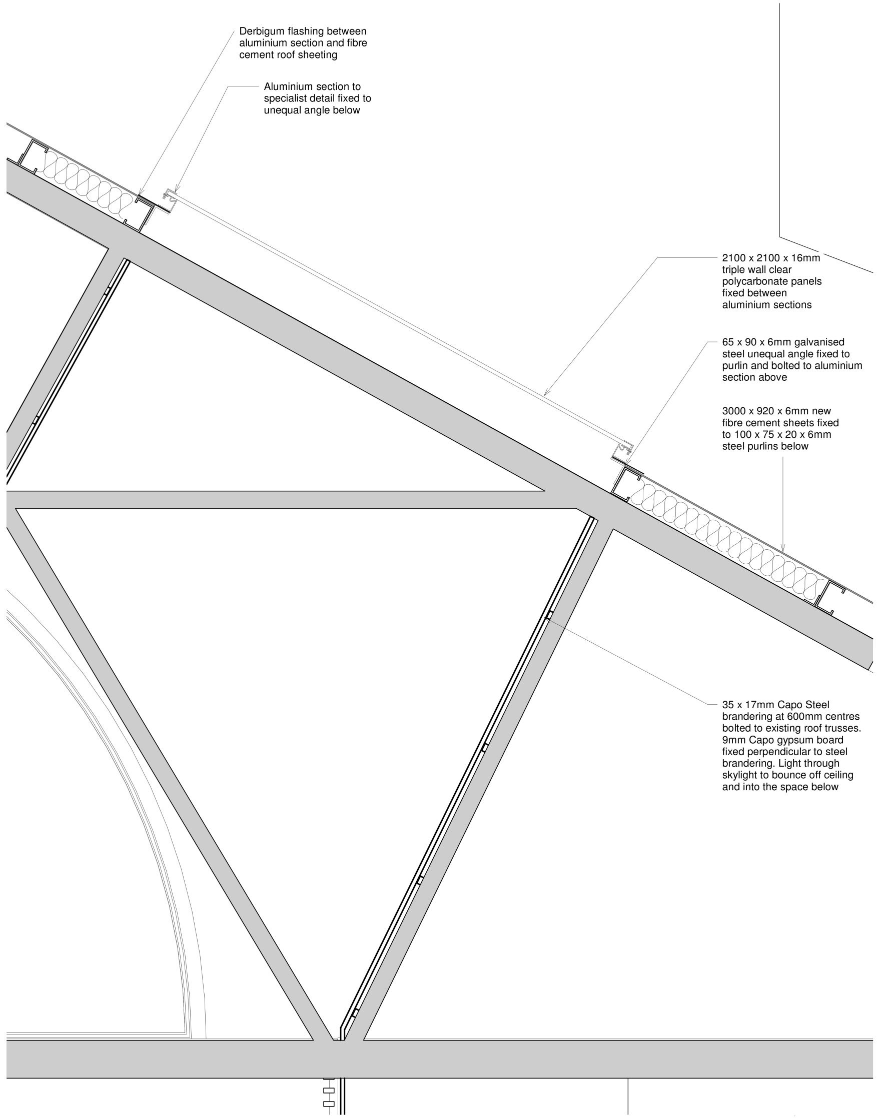
# DETAIL A

## TRANSMISSION: SUNLIGHT, 1:10

The first moment of transmission is the new inserted skylight between the existing steel trusses in the eating hall. This new intervention acts to transmit natural light into the eating area to improve the interior daylighting quality of the space below.

Light bounces off a new ceiling that is fixed between the existing trusses into the interactive edge and eating area below. The new ceiling is continued and lowered to create a new internal volume that provides additional artificial lighting for the bakery production processes below. This manipulation of the ceiling volume as well as the new inserted skylights, create a differentiation between functions whilst still retaining the integrity of the existing roof trusses.





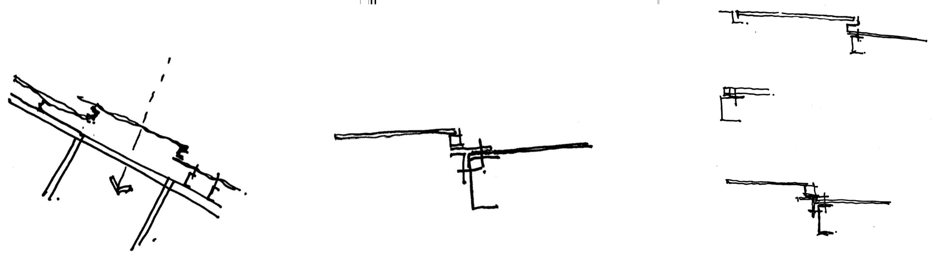



Figure 243: Detail A: *(Author 2021)*

# DESIGN SECTION A-A, Part B

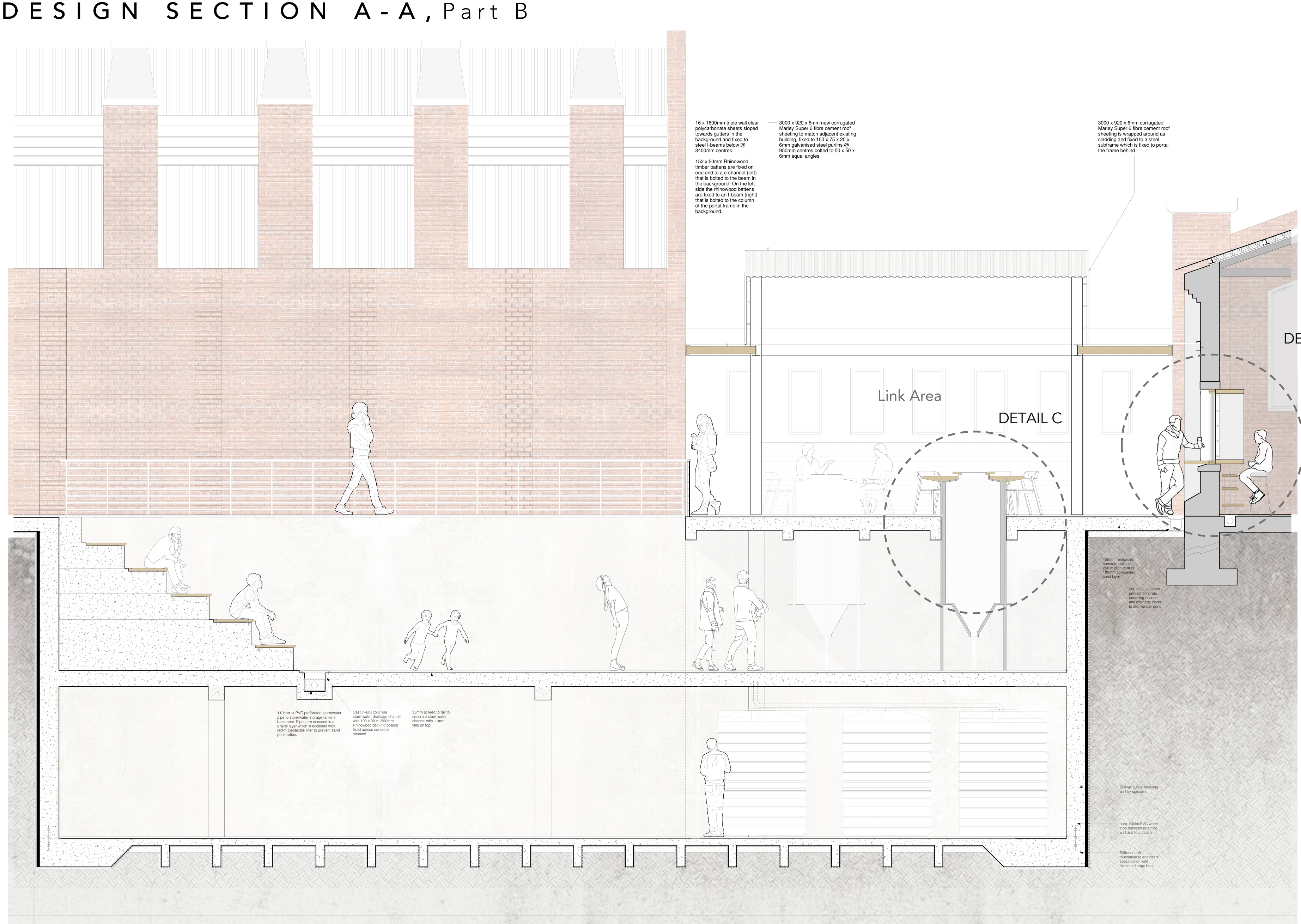
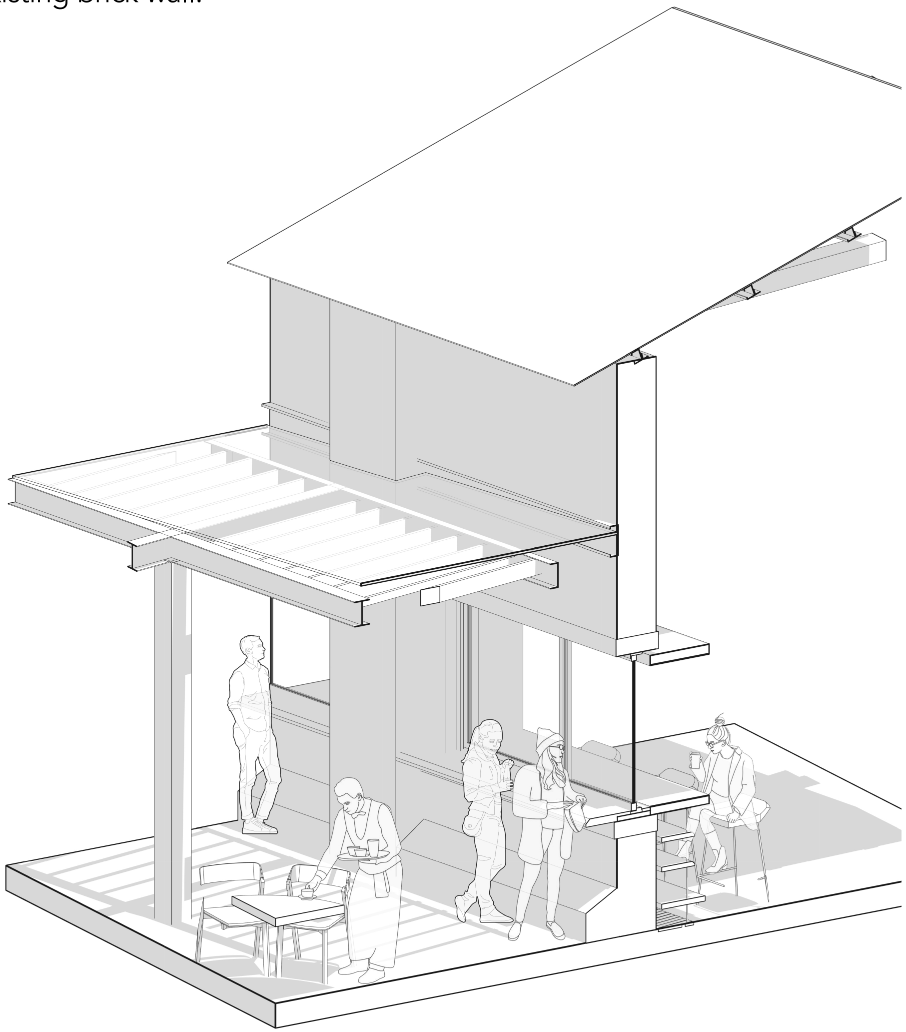



Figure 244: Design Section A-A, part B: (*Author 2021*)

# DETAIL B

## TRANSMISSION: SOCIAL EXCHANGE, 1:10

The next scenario of transmission occurs through a horizontal moment of social exchange. This is depicted through the intervention of a new box window in the existing brick wall.



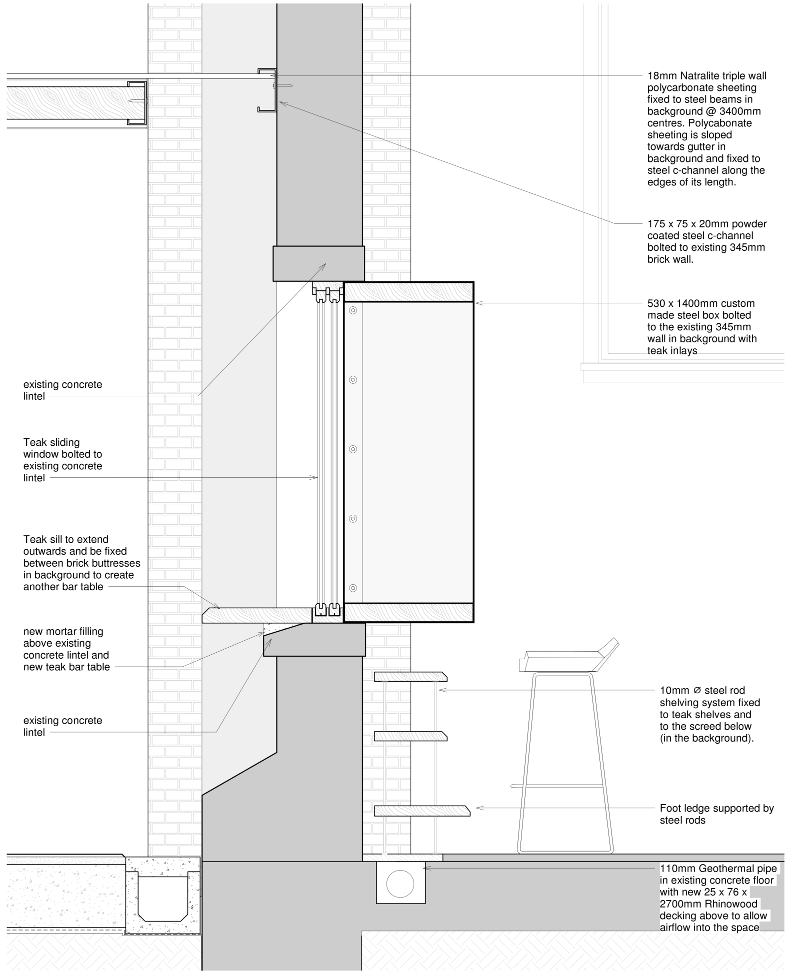



Figure 245: Detail B: *(Author 2021)*

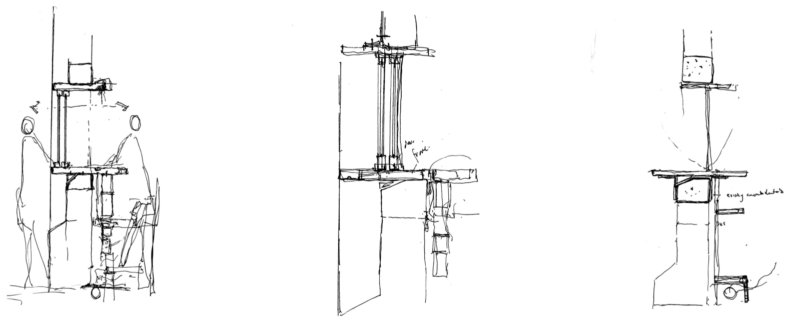
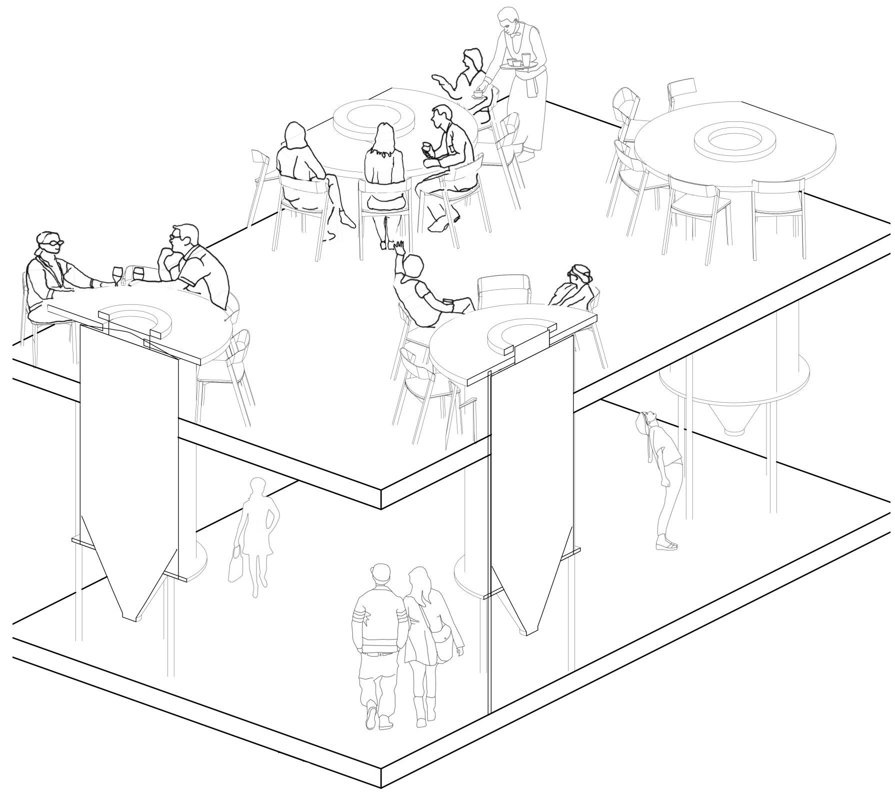


Figure 246: Process Diagrams of Detail B: *(Author 2021)*

# DETAIL C

## TRANSMISSION: GRAIN SILO, 1:10

The concept of transmission also occurs vertically. This is depicted through a grain silo which connects the basement and ground floor above. This is achieved by being emptied at the bottom and filled at the top on the ground floor whilst simultaneously acting as eating tables on this level as well.



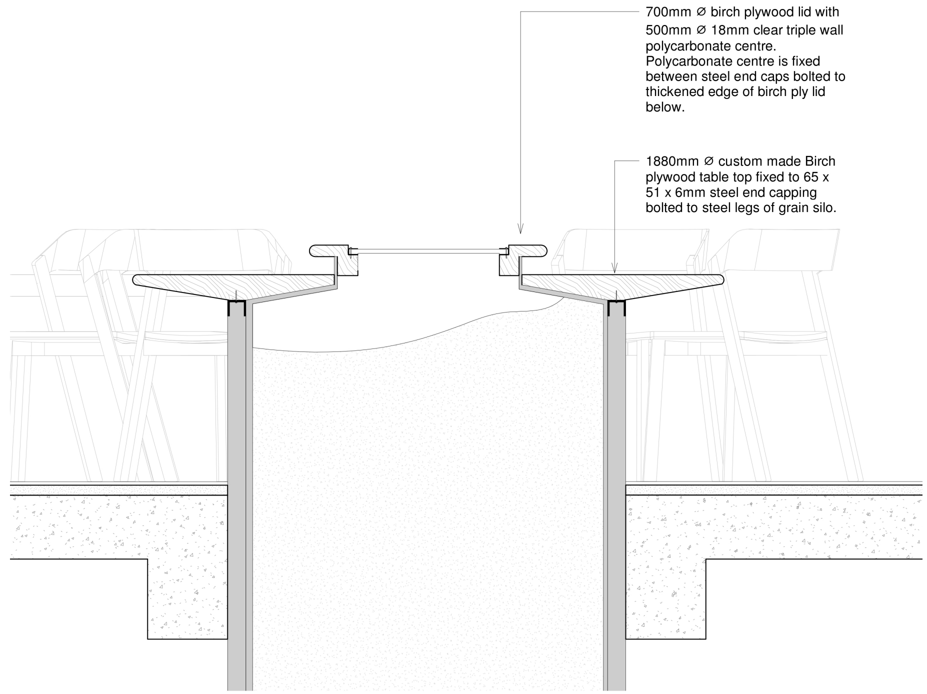



Figure 247: Detail C: *(Author 2021)*

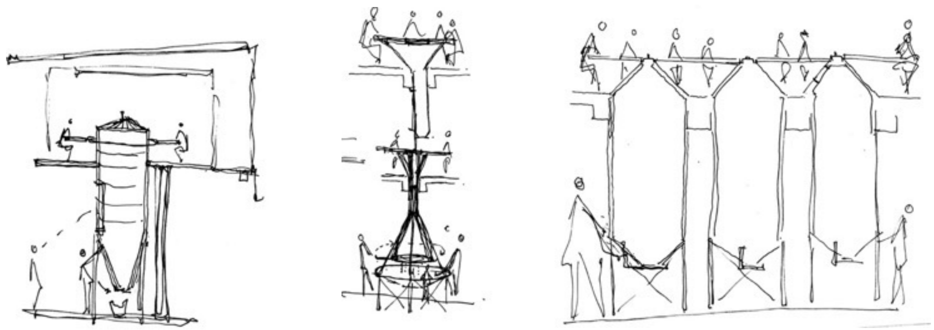


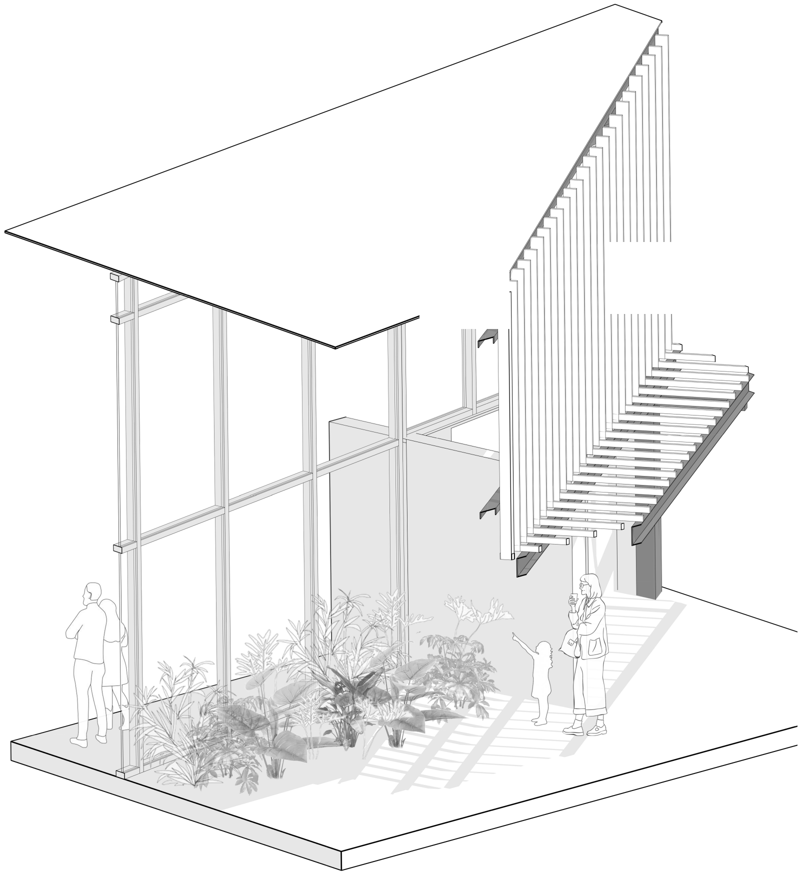
Figure 248: Process diagrams of Detail C: *(Author 2021)*

# DETAIL D

## TRANSMISSION: TIMBER SCREEN & PERGOLA, 1:10

The next moment of transmission in the scheme occurs as a climatic response.

Glazing on east and west facades of the seed research centre is shaded by Rhinowod vertical cladding to increase the internal comfort of these spaces. Furthermore, a timber pergola is used as a connective device between the seed research centre edge and the link area. This device maintains a human scale along the eastern edge of the scheme whilst announcing certain entrances into the exhibition space and allowing light and rain at certain points to penetrate it for the planted edges below.



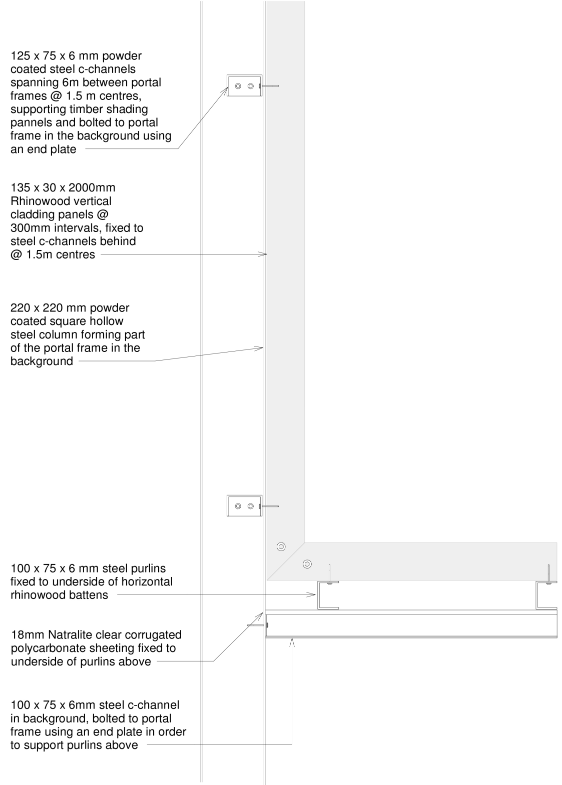



Figure 249 : Detail D, Timber pergola and shading: *(Author 2021)*

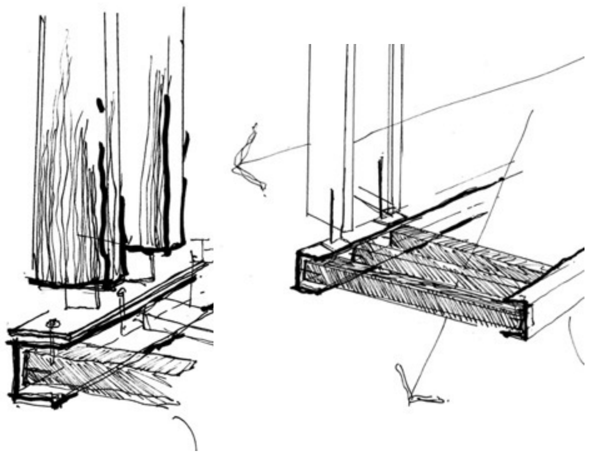


Figure 250 : Process diagrams of Detail D : *(Author 2021)*

# SERVICES

## Rainwater, Stormwater & Greywater

The main service for the scheme deals with the filtering, harvesting and storage of rainwater and stormwater.

Rainwater on the roof of the link area travels to gutters in the sawtooth cervices and through down pipes at every second column where it is filtered via UV filtration and stored in the basement. This rainwater is then reused for potable use on site and through the bakery production processes (figure 253).

From the heritage value survey, it was evident that the out buildings were significant in their eastern edge condition (figure 251). Consequently, the out buildings are re-signified in two ways through the reuse of the site. Firstly, the exterior wall is lowered and transformed into a bench between the canal and the scheme (figure 252, yellow line). Secondly, a drainage channel is positioned over the footprint of the interior line of the out buildings (figure 252, red line).

The roof of the Seed Research Centre also collects rainwater in a perimeter gutter travels through downpipes in the courtyard. This run-off then flows through the courtyard to the drainage channel over the trace of the out building. This stormwater run-off and any other greywater received at this point flows into the basement and is filtered and stored to be reused on site for non-potable use (figure 253).

Figure 251 : Photograph of Outbuildings: *(Author 2021)*

Figure 252: Traces of out buildings in plan: *(Author 2021)*

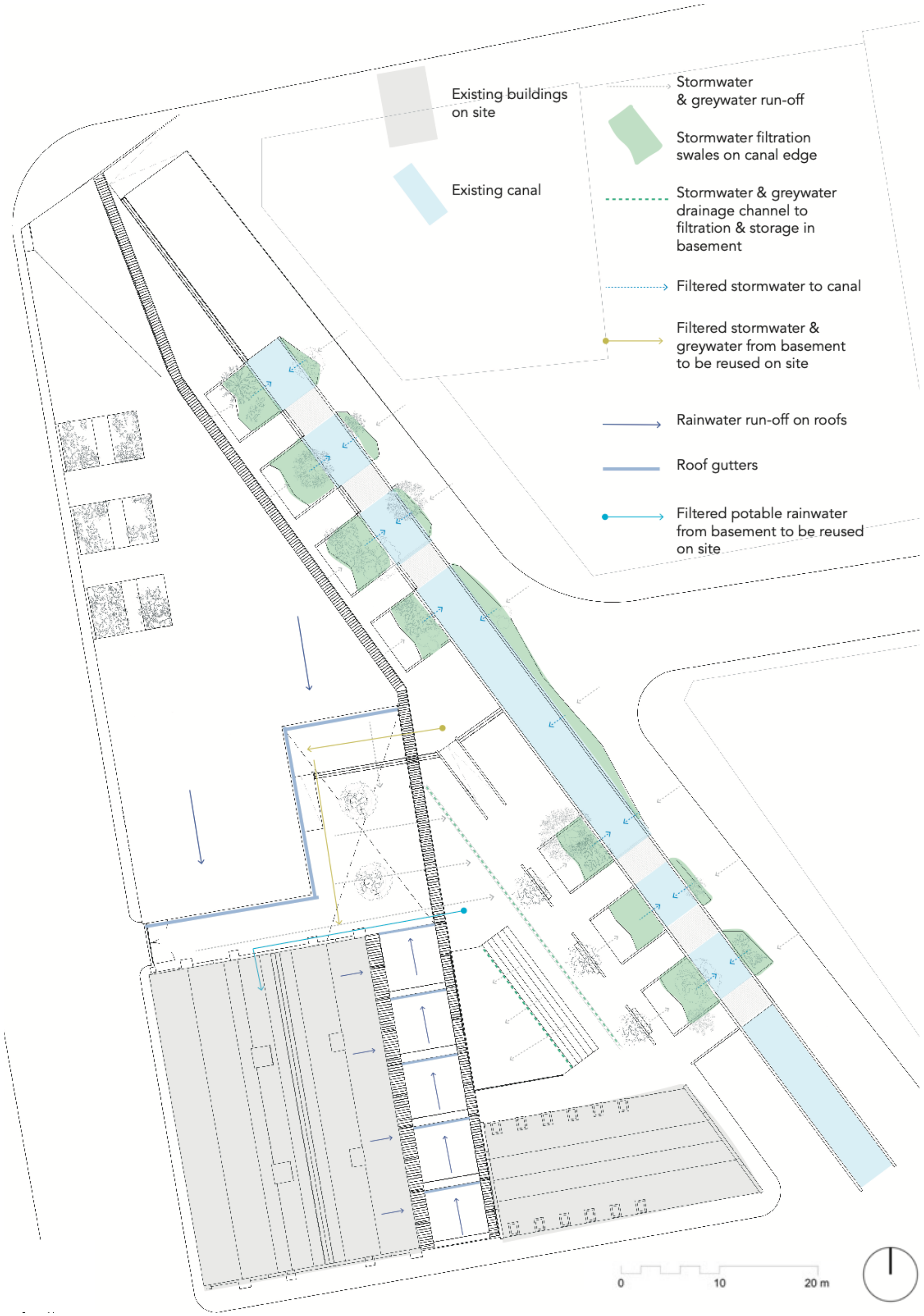



Figure 253: Water Catchment Strategy: *(Author 2021)*

# SERVICES

## Stormwater

### Canal Edge 1:25

Stormwater run-off near the canal flows into adjacent bioswales and planted areas which act to filter the water before it enters the canal (figures 254 & 255).

This section (figure 255) is taken through the canal edge and aims to illustrate the ecological contribution and intervention of the existing canal.

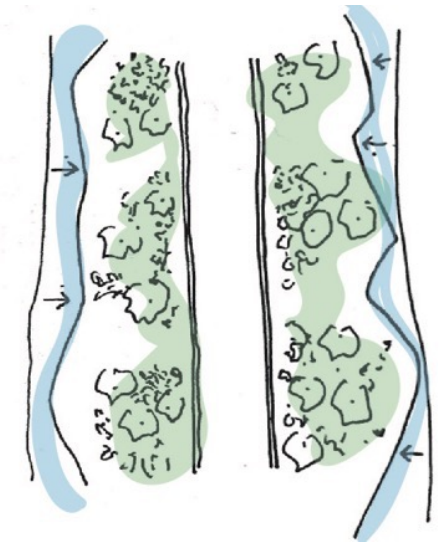



Figure 254: Urban Strategy: *(Author 2021)*

Figure 255: Section through ecological urban strategy of canal edge: *(Author 2021)*

# SERVICES

## Rainwater Calculations

### Rainwater

| Demand for potable water: |
|---|
| **Estimated for 100 people on site:** |
| 4L hand wash x 3/day/person:1200L |
| 500ml glass of water x 3/day/person: 450L |
| 190L/ loaf of bread for 200 loaves: 38 000L |
| **Total Estimated potable water demand:40 000 L ( 39 650L) = 40m3** |

Based on the calculations presented, there is sufficient monthly supply of rainfall to meet the site's potable demand of 40m3/month. In addition, there is surplus water available every month for the irrigation of edible plants.

The storage tanks need to be sized accordingly to accommodate 71m3 (75 000L to be safe) of accumulated water over the course of the year.

Therefore, the basement will hold 15 x 5000L tanks for rainwater storage and filtration.

| **Water Budget (Rainwater roof runoff - Potable Water)** | | | | |
|---|---|---|---|---|
| A: Total Roof Area = 674m² | | | | |
| C: Run-off Coefficient = 0.9 (roof) | | | | |
| Month | Average Rainfall in Durban (m/month) = P | Yield (m³/month) = P x A x C | Demand (m³/month) | Monthly accumulative balance for storage tank |
| January | 0,099 | 61 | 40 | 21 |
| February | 0,084 | 60 | 40 | 41 |
| March | 0,103 | 62,5 | 40 | 63,5 |
| April | 0,078 | 47 | 40 | 70,5 |
| May | 0,048 | 29 | 40 | 59,5 |
| June | 0,03 | 18 | 40 | 37,5 |
| July | 0,046 | 28 | 40 | 25,5 |
| August | 0,04 | 24 | 40 | 9,5 |
| September | 0,064 | 39 | 40 | 8,5 |
| October | 0,097 | 59 | 40 | 27,5 |
| November | 0,101 | 61 | 40 | 48,5 |
| December | 0,103 | 62,5 | 40 | 71 |
| **Annual Total** | **0,893** | **551** | **480** | **71** |

Figure 256: Rainwater Calculations: *(Author 2021)*

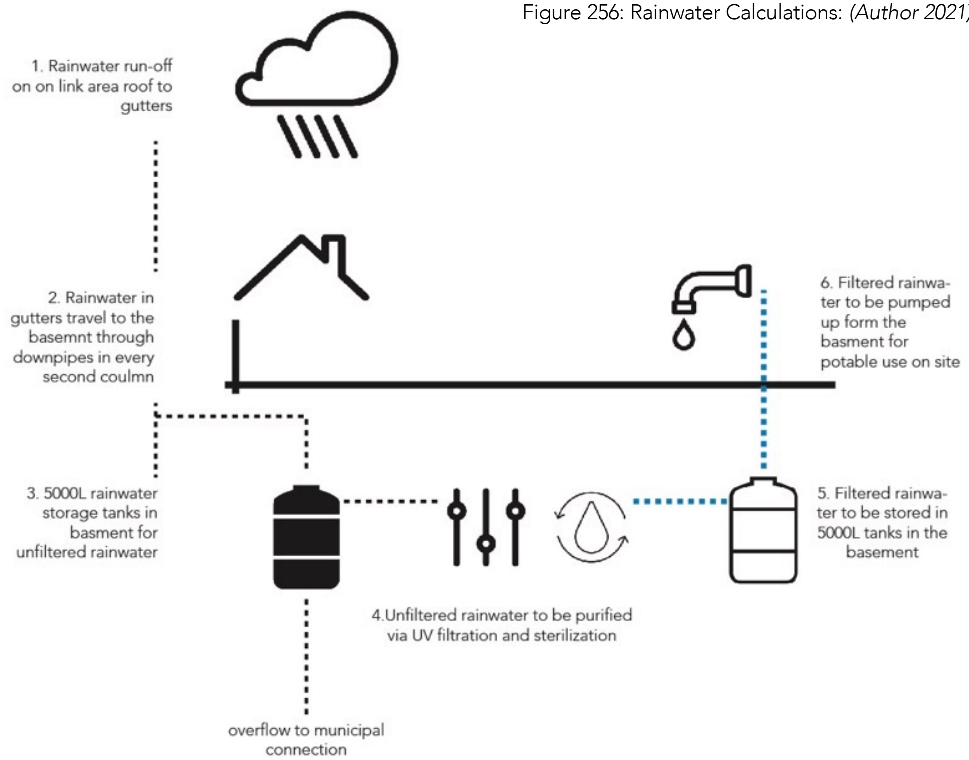



Figure 257: Rainwater Strategy: *(Author 2021)*

# SERVICES

## Stormwater Calculations

### Stormwater

| Demand for non-potable (greywater) use: |
|---|
| **Estimated for 100 people on site:** |
| 40L x 12 wash basins:480L |
| Cleaning of surfaces and floors: 130L |
| 9L flush x 3/day/ person: 2700L |
| **Total rough Estimated potable water demand:3310L= 3,3 m³ rounded to 4m³ to be safe** |

Similarly to the previous rainfall calculations, there is sufficient monthly stormwater run-off to meet the site's non-potable, greywater demand.

The site will harvest a maximum of 6m3/month. The storage tanks need to be sized accordingly to accommodate 24m3 (30 000L to be safe) of accumulated water over the course of the year.

30 000/5 000= 6 x 5000L greywater storage tanks needed in the basement.

| **Water Budget (Stormwater: Non-Potable Water)** | | | | |
|---|---|---|---|---|
| A : Total area of stormwater run-off = 1950m² | | | | |
| Seed Resarch Centre roof = 1100m2 | | | | |
| Paving in courtyard = 850 m2 | | | | |
| C : Run-off Coefficient = 0.9 (roof | | | | |
| C : Run-off Coefficient = 0.8 (paving) | | | | |
| Therfore, average co-efficient (C) used is 0.85 | | | | |
| Month | Average Rainfall in Durban (m/month) = P | Yield (m³/month) = P x A x C | Demand (m³/month) | Monthly accumulative balance for storage tank (m³) |
| January | 0,099 | 164 | 4 | 160 |
| February | 0,084 | 139 | 4 | 295 |
| March | 0,103 | 170 | 4 | 461 |
| April | 0,078 | 129 | 4 | 586 |
| May | 0,048 | 79 | 4 | 661 |
| June | 0,03 | 50 | 4 | 707 |
| July | 0,046 | 76 | 4 | 779 |
| August | 0,04 | 66 | 4 | 841 |
| September | 0,064 | 106 | 4 | 943 |
| October | 0,097 | 160 | 4 | 1099 |
| November | 0,101 | 167 | 4 | 1262 |
| December | 0,103 | 170 | 4 | 1428 |
| **Annual Total** | **0,893** | **1476** | **48** | **1428** |

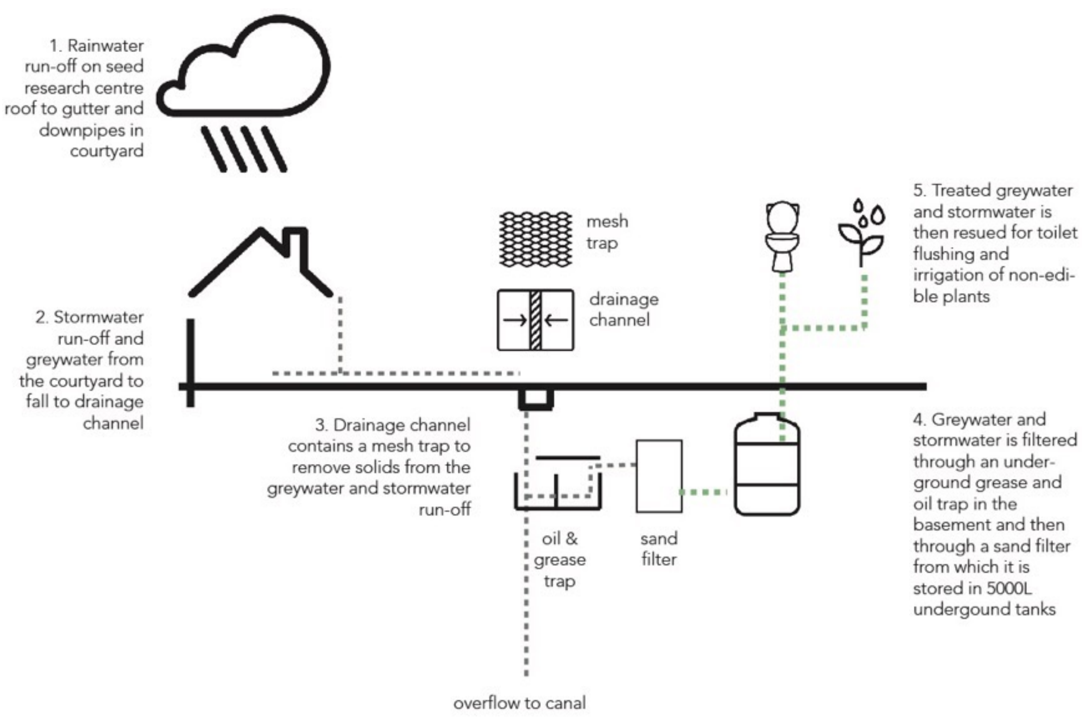
| If I only collect Maximum 6m3 per month for non-potable use : | | | | |
|---|---|---|---|---|
| Month | Average Rainfall in Durban (m/month) = P | Yield (m³/month) = P x A x C | Demand (m³/month) | Monthly accumulative balance for storage tank (m³) |
| January | 0,099 | 6 | 4 | 2 |
| February | 0,084 | 6 | 4 | 4 |
| March | 0,103 | 6 | 4 | 6 |
| April | 0,078 | 6 | 4 | 8 |
| May | 0,048 | 6 | 4 | 10 |
| June | 0,03 | 6 | 4 | 12 |
| July | 0,046 | 6 | 4 | 14 |
| August | 0,04 | 6 | 4 | 16 |
| September | 0,064 | 6 | 4 | 18 |
| October | 0,097 | 6 | 4 | 20 |
| November | 0,101 | 6 | 4 | 22 |
| December | 0,103 | 6 | 4 | 24 |
| **Annual Total** | **0,893** | **72** | **48** | **24** |

Figure 258: Stormwater Calculations: *(Author 2021)*

# S E R V I C E S

## R a i n w a t e r ,  G r e y w a t e r  &  S t o r m w a t e r

### Greywater & Stormwater treatment (courtyard)




### Stormwater treatment (canal edge)

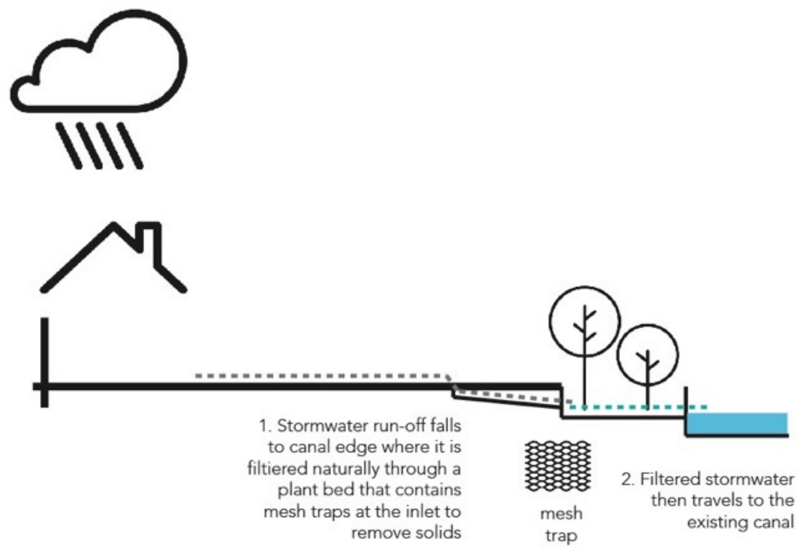



Figure 259: Greywater & Stormwater Strategy Diagrams: *(Author 2021)*

# S U S T A I N A B I L I T Y

## E n v i r o n m e n t a l   S y s t e m :   D a y l i g h t i n g

The main environmental service for this scheme is daylighting. This is demonstrated through the new skylights in the eating hall as well as the sawtooth roof and circulation roofs of the link area (figure 260). The space that is modelled in Sefaira is the eating hall.

### Sefaira daylighting:

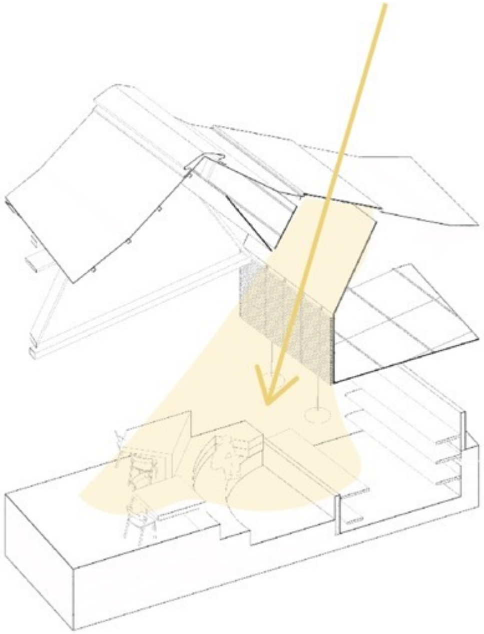
Daylighting is modelled in terms of illuminance (Lux) , Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE).

Definitions:

**Illuminance:** "the luminous flux incident on unit area of a surface. It is measured in lux" (Collins English Dictionary, not dated).

**sDA:** "Spatial daylight autonomy (sDA) refers to the percentage of floor area where 30 fc [322 lux] is achieved for at least 50 percent of the workday" (Fitzgerald Pitts, 2013 : 2).

**ASE**: "identifies the percentage of the floor area that receives intense [direct] daylight, exceeding 100 fc [1076 lux], for more than 250 work hours every year" (Fitzgerald Pitts, 2013 : 2).


EATING HALL

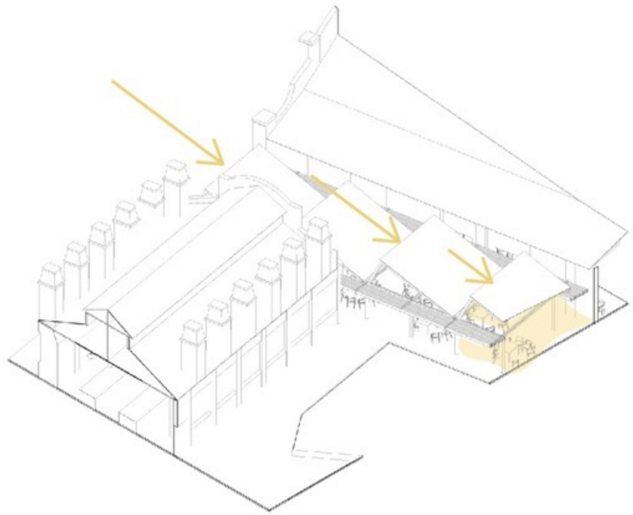

LINK AREA

Figure 260: Daylighting Diagram: *(Author 2021)*

# S U S T A I N A B I L I T Y

## E n v i r o n m e n t a l   S y s t e m :   D a y l i g h t i n g

**Illuminance:** The optimum illuminance percentage in Sefaira is 75% or more for most of the floor area. The illuminance in Sefaira modelling was set to a minimum of 46 footcandles (495 (500) lux) which is the required lux for kitchens and restaurants (Green Business Light, 2020).

**sDA:** Similarly, 75-100 % is the optimum value for sDA.
**ASE**: The lower the ASE value, the better the daylighting quality in the space. To achieve a the LEED v4 Daylight credit, the ASE value should be maximum 10 % (Fitzgerald Pitts, 2013 : 2).

### Existing building:

Most of the floor area of the existing building receives between 0 – 25% of the desired lux levels (figure 262). Only a small portion of floor area, at the two gable ends, achieves a lux of 500 for 75 % of the time. Therefore, for required lighting levels of the proposed bakery production processes and eating area in this space, the percentage of occupied hours at the lux of 500 needs to be dramatically increased.

In terms of the sDA, the existing building is heavily underlit and does not achieve the desired natural daylighting levels of 75%-100% (figure 262).

The ASE is sufficient but not uniform throughout the space, creating disproportionate interior lighting qualities. Sefaira classified the building in its entirety to be "mostly underlit" (figure 261). Consequently, more energy is used for artificial lighting, resulting in the energy usage is to be "lighting dominated" (figure 261).


Figure 261: Sefaira Results: Existing building *(Author 2021 adapted from Sefaira)*

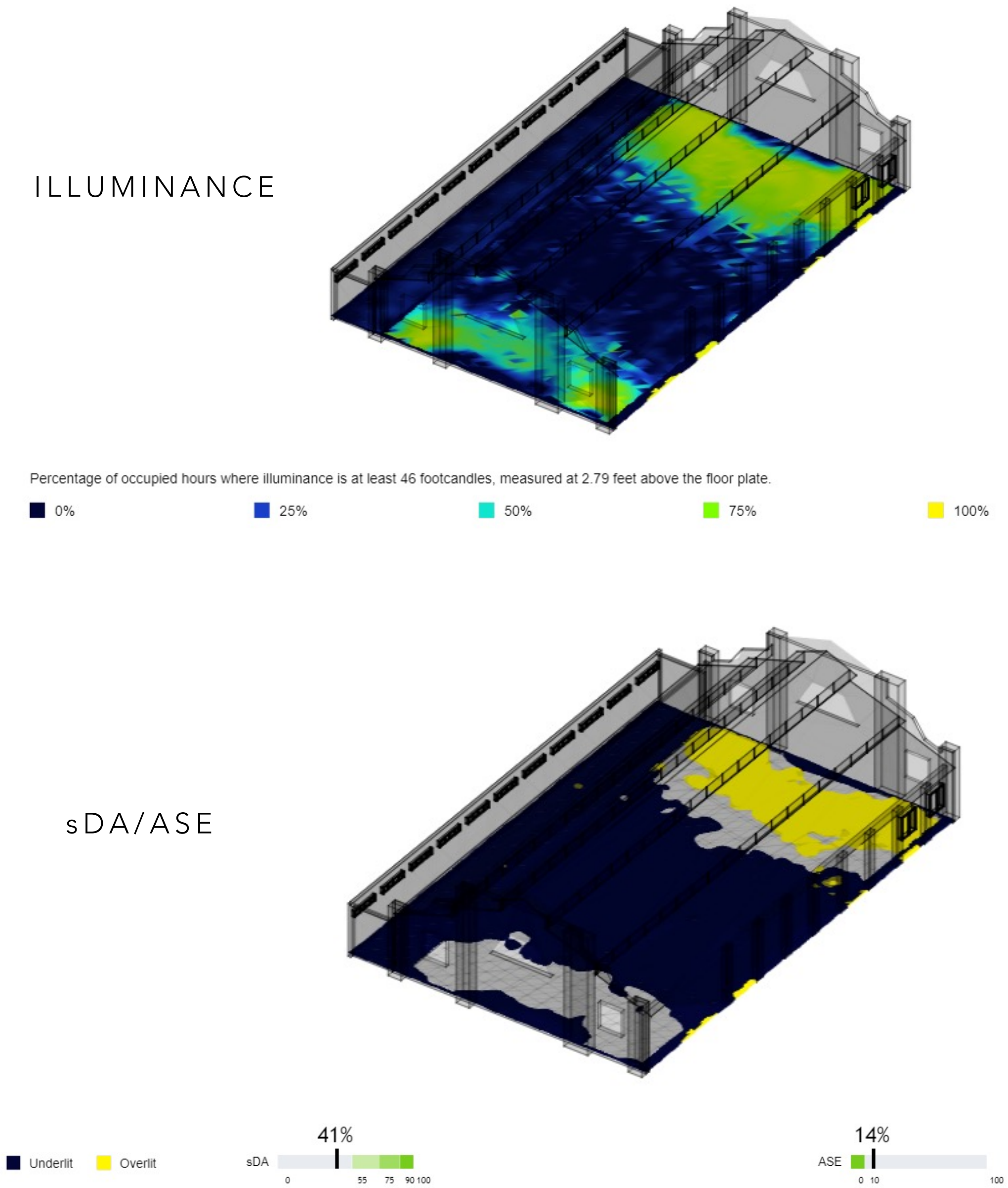



Figure 262: Sefaira Daylighting Modelling: Existing building *(Author 2021 adapted from Sefaira)*

## Environmental System: Daylighting

**Proposed design :**

Owing to the new skylights, additional windows and doors, the illuminance levels of the building have dramatically improved. Most of the floor area now receives 56-75% of the required lux of 500 (figure 264). This daylighting condition is now sufficient for the required functions proposed in this space.

In terms of the sDA, the new proposed building with added skylights, windows, doors and shading achieves the desired natural daylighting levels of between 75%-100% (84% (figure 264). The new intervention is a dramatic improvement of the sDA levels of the space.

The ASE value has increased with the added natural sunlight, however, it is now spread evenly throughout the interior instead of depicting disproportionate harsh light qualities in the space. This figure could perhaps be lowered further with additional modelling in Sefaira.

The proposed design receives a "mostly well-lit" classification (figure 263) and consequently has reduced in energy usage to "equipment dominated" instead of "lighting dominated" as less artificial lighting is now required (figure 263).

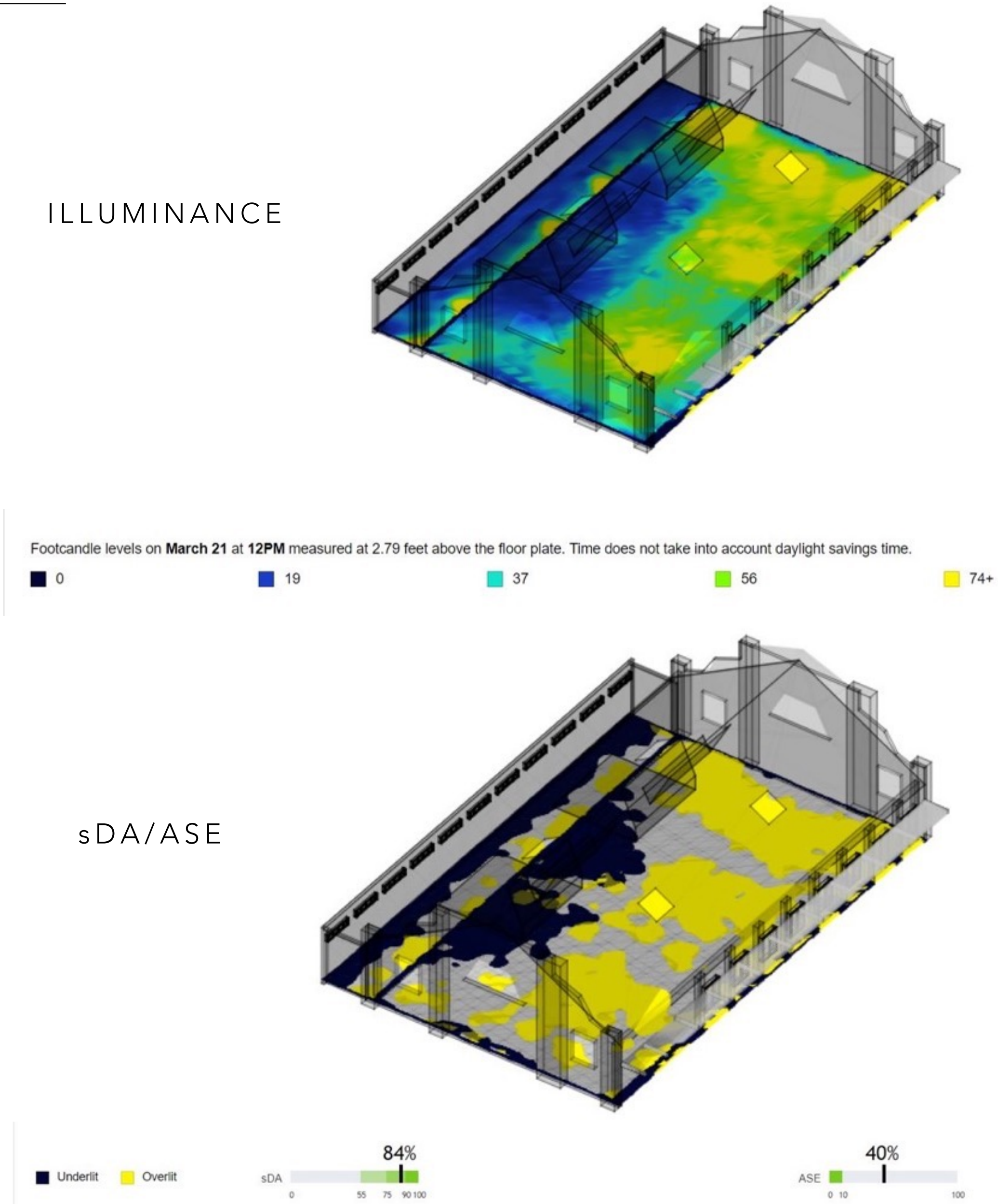




Figure 263: Sefaira Results: New building *(Author 2021 adapted from Sefaira)*

Figure 264: Sefaira Daylighting Modelling: New building *(Author 2021 adapted from Sefaira)*

# SUSTAINABILITY

## Environmental System: Ventilation

Owing to Durban's very humid climate and warm temperatures (pg 36), it is vital that internal spaces are kept cool with relatively sufficient ventilation and air flow throughout the building.

Ventilation is, therefore, also another very important sustainability consideration in Durban. The ventilation service makes use of ground cooling through the link area at the south of the site (figure 265). Geothermal pipes are inserted into the earth below and brought through the ground floor slab and into the floors of the eating hall and kitchen.

Cool air travels from these pipes in the floor through the internal spaces and out of the highest point through the ridge vent of the eating hall and through the existing clerestory windows of the kitchen.  A mechanical fan in ducts below each ridge vent assists the vertical movement of this airflow.

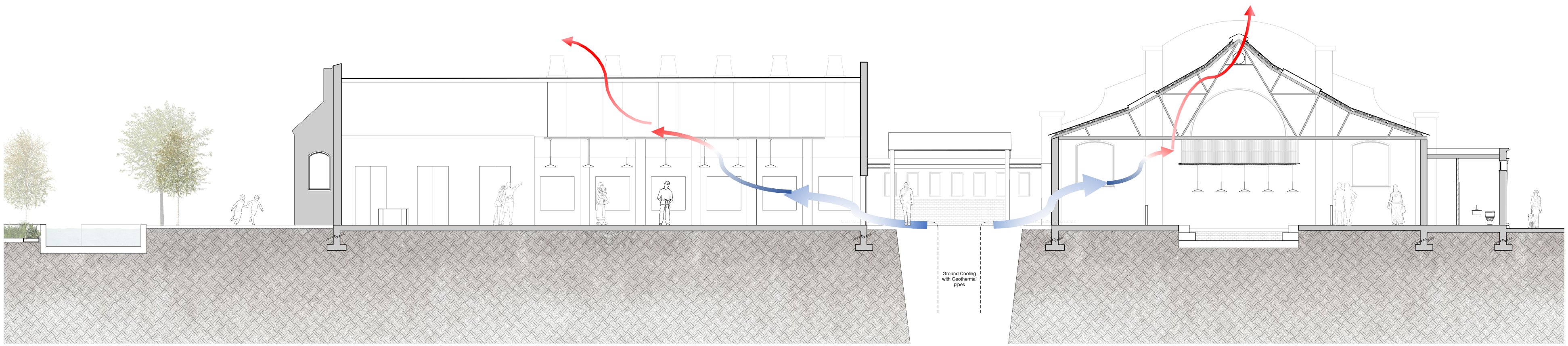



Figure 265: Ventilation System: *(Author 2021)*

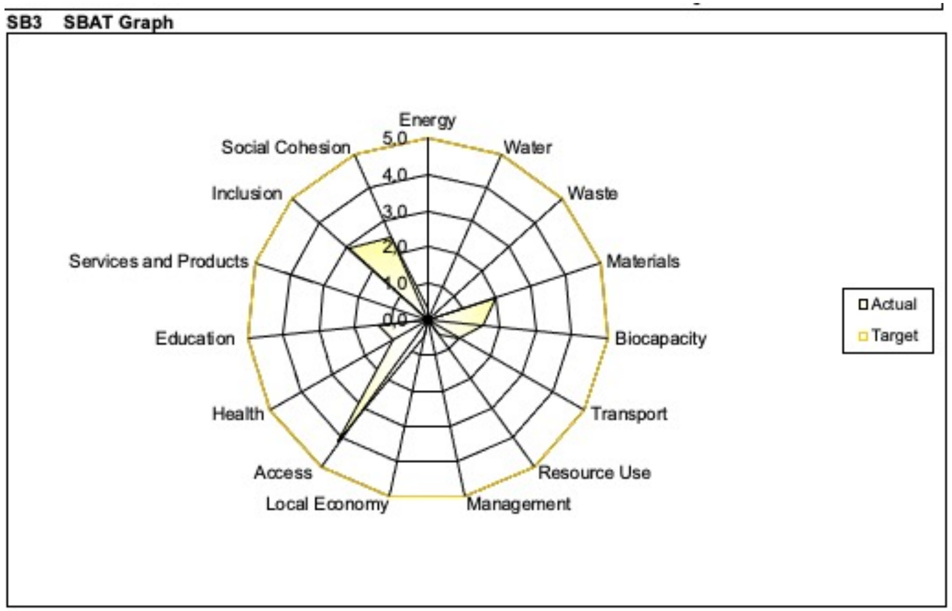
# SUSTAINABLE BUILDING ASSESSMENT TOOL (SBAT)

## Existing building

From the SBAT tool it is evident that the existing site lacks sufficient environmental, economic and social contribution to towards the greater Rivertown precinct (figure 266).

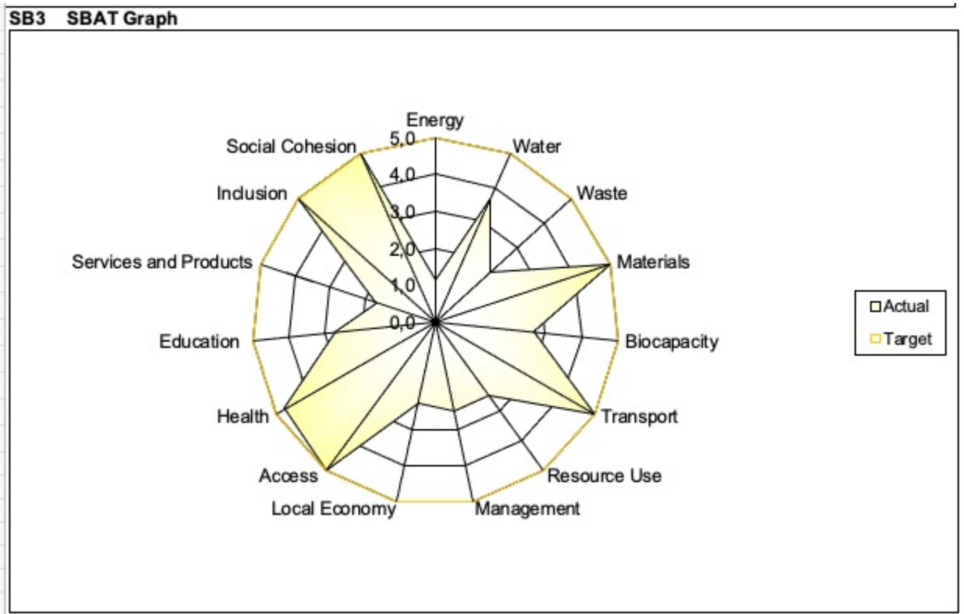
## Proposed building

The proposed changes and intervention on site result in an SBAT rating of more than double the results of the existing buildings (figure 267). One of these factors lies in the social and economic contribution and inclusion that this new intervention offers Rivertown through its change in function, public space of the canal, and overall accessibility of the heritage, all which aim to foster social exchange. The transport category is also improved from the pedestrianized and new cycles routes proposed along the canal edge. Furthermore, the environmental and water scores are increased as a result of the harvesting of rainwater on site and the filtering of stormwater in the canal. In addition, the materiality indicator has increased because of locally and sustainably sourced materials, particularly in the timber screen of the building where Rhinwood is utilized.




| SB4 Environmental, Social and Economic Performance | Score |
|---|---|
| Environmental | 0,8 |
| Economic | 1,2 |
| Social | 1,6 |
| SBAT Rating | 1,2 |

Figure 266: SBAT Tool: Existing buildings before intervention *(Author 2021 adapted from SBAT tool)*




| SB4 Environmental, Social and Economic Performance | Score |
|---|---|
| Environmental | 2,9 |
| Economic | 3,5 |
| Social | 3,8 |
| SBAT Rating | 3,4 |

Figure 267: SBAT Tool: New building *(Author 2021 adapted from SBAT tool)*