Chapter 7:
Developing of space

TECHNICAL INVESTIGATION

7.1 Concept

The design concept was to create exchanges between the site, infrastructure and the user. In a similar way the tectonic concept was to highlight how these exchanges happen, to look at how services can create space and change their language, in a similar way as the High-Tech architects approached the design services in their buildings. To do this a focus was placed on to the services spaces and how they provide for the served spaces. Articulation of these service spaces would give an understanding to the user of these exchanges. Articulation of the services themselves to reveal them to the user, such as services pipes and ducts.

The exchanges in the two spaces serve different entities on site. In the vermiculture building most of the exchanges serve the landscape or site, but in the case of the public interface exchanges cater for the user, in the majority.

Highlighting these two exchanges groups gave different forms to the sections. The vermiculture building looked at integrating itself into the landscape and growing out of it, whereas the public interface building attached itself to the existing infrastructure.

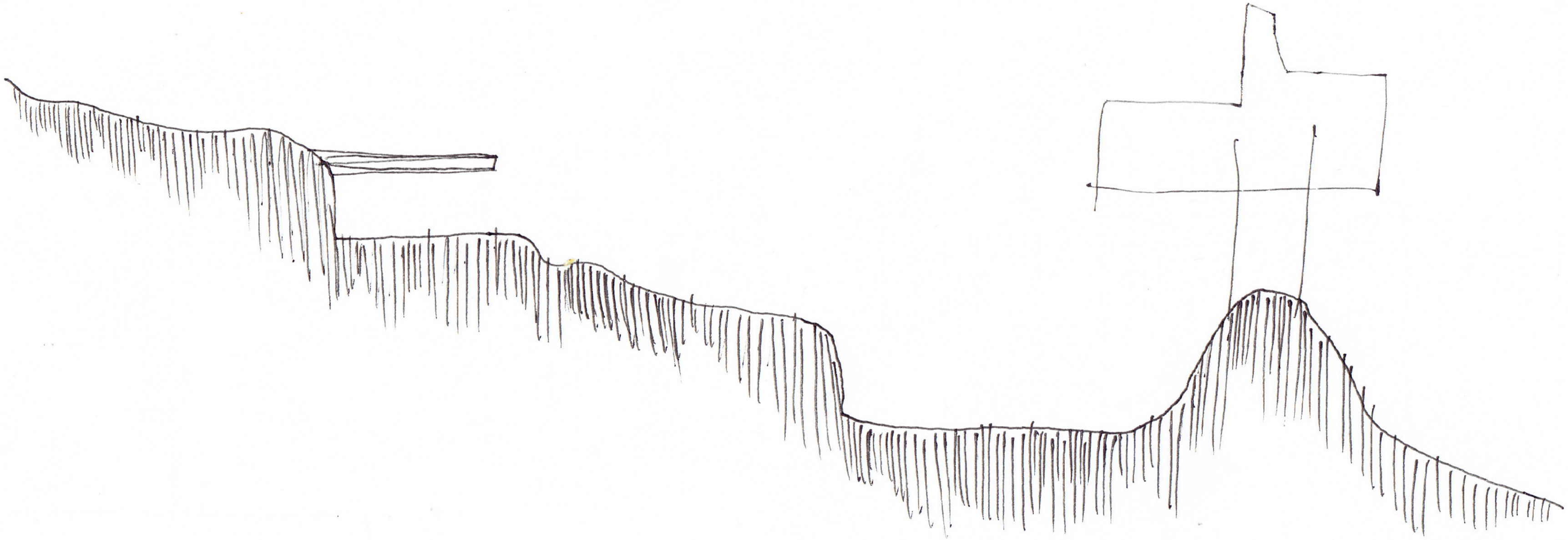


Fig 7.1 Tectonics sections of whole site (Author, September 2016).

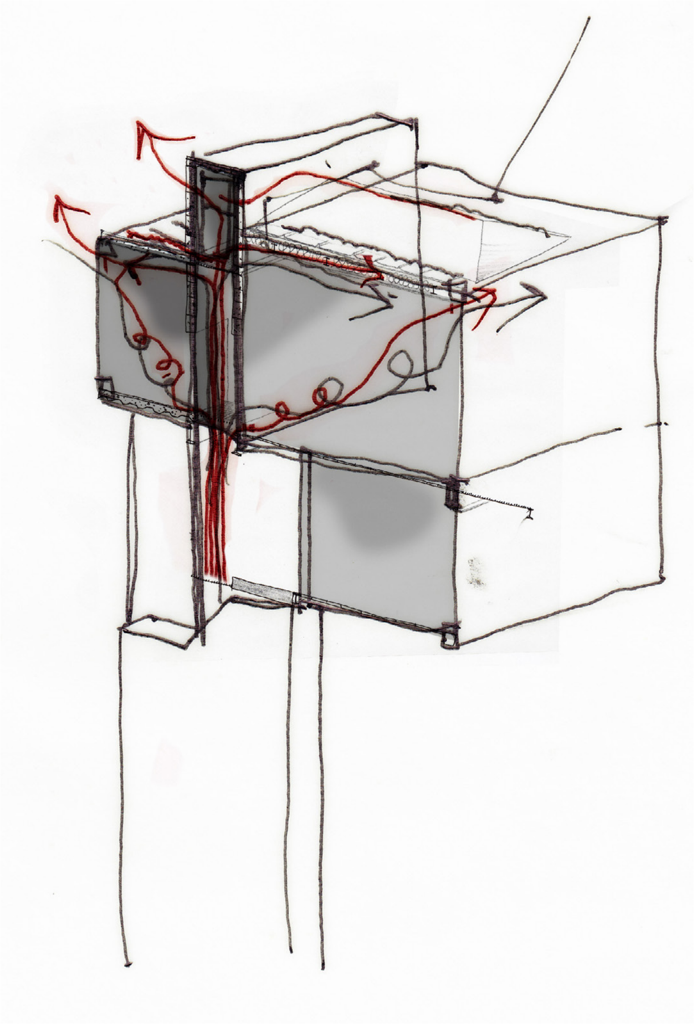
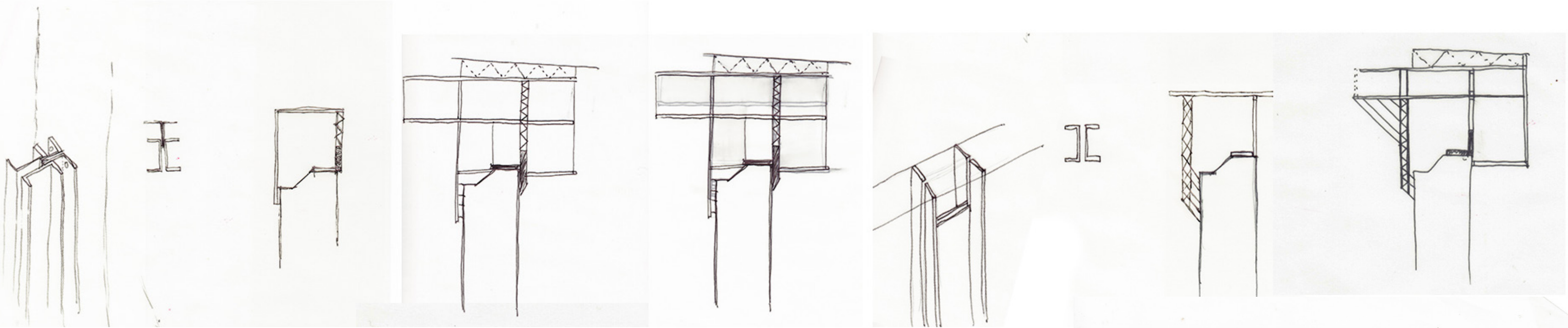


Figure 7.2 shows the flow of exchanges through the service core and into the public interface. These exchanges range from electricity to air flow.

Fig 7.2 Tectonics sections (Author, September 2016).

Fig 7.3 longitudinal section (Author, September 2016).



Section development shown here was to investigate the relationship to the existing infrastructure and how the new building attaches itself to this. Through this it was identified that floor materials were a key element in identifying which kind of space the user is in.

Portal frames were identified as being the primary structure. They could be pre-assembled offsite and then simply brought to site and erected in place by means of an extendable crane. This eliminates the difficulty of building scaffolding on site as there is little to no space to do this. This portal frame would then be used to build the rest of the structural form.

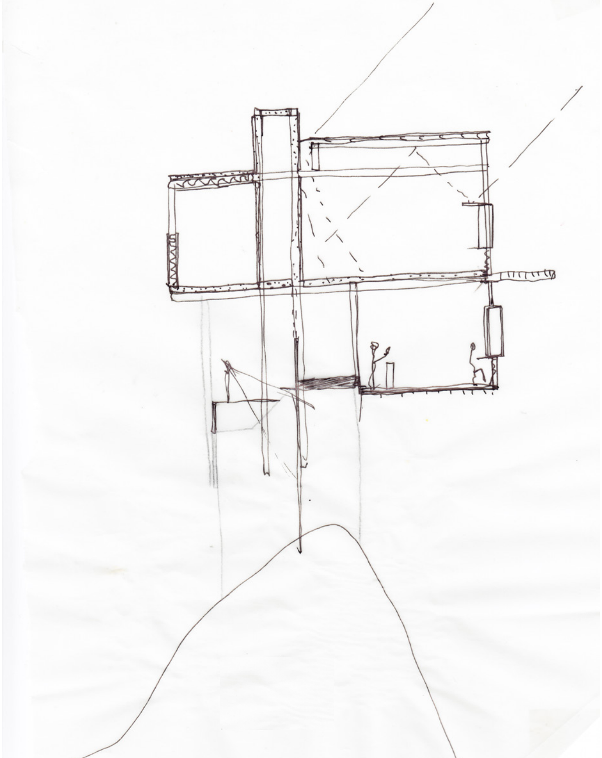


Fig 7.4 section development (Author, May 2016).

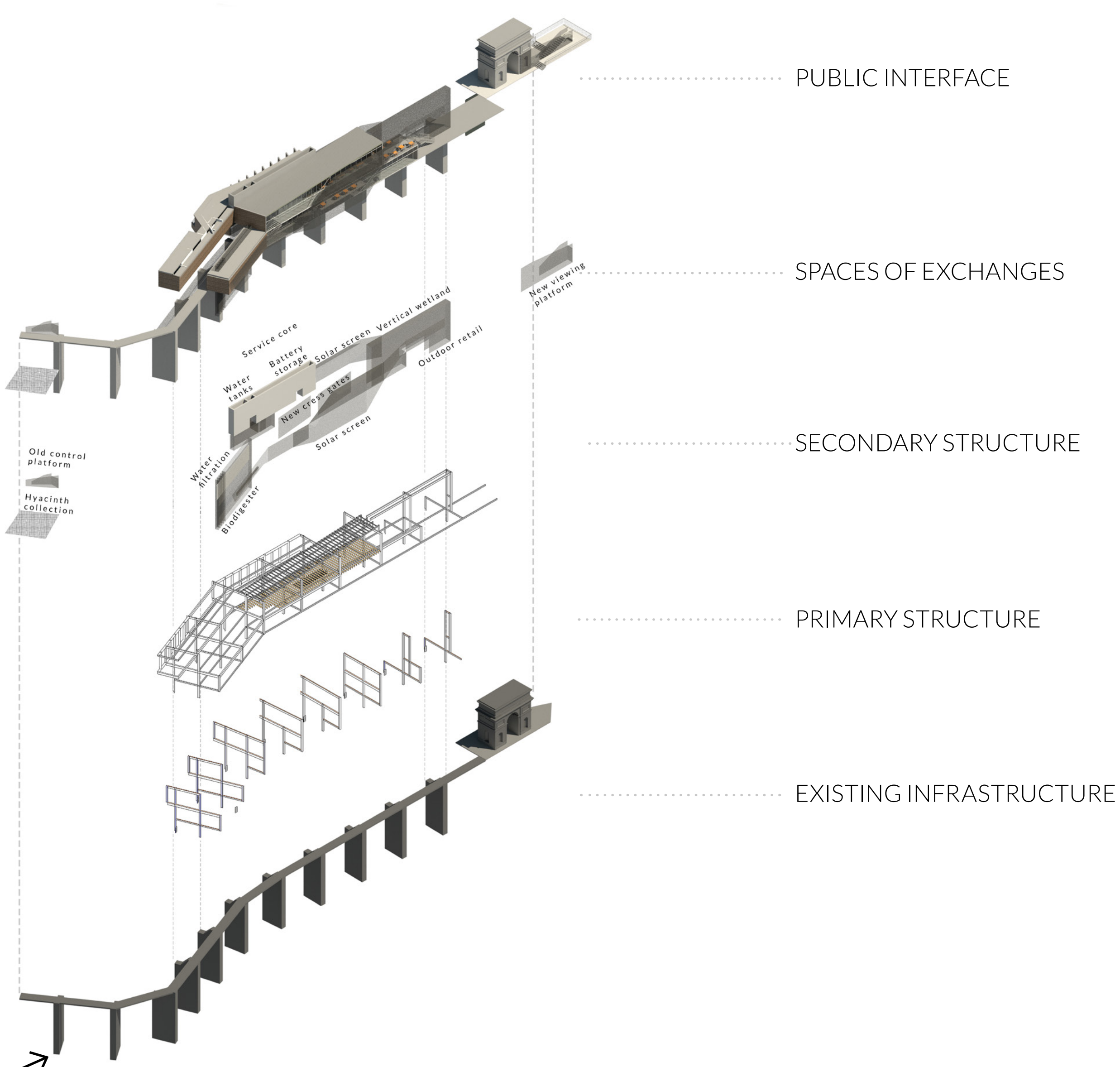


Fig 7.5 Layers of building and structure (Author, September 2016).

7.2 Structure

Figure 7.5 expresses the five layers of the building.

The existing infrastructure was used as a support for the new building giving it a new function and changing its role in society.

The primary structure is made up of steel portal frames that change throughout the length adapting to the form of the building. These portal frames are made from H columns and I beams that then support the secondary structure.

The secondary structure is made up of many different members and materials. For the substructure of the walls there are steel square hollow sections and Lipped c channels that make up frames that are bolted to the steel portal frames. For the floor there are timber beams that are hung between I beams that span between the portal frames.

The roof is made up of I beams as rafters that span between the portal frames and on top of this there are lipped c channels as purlins.

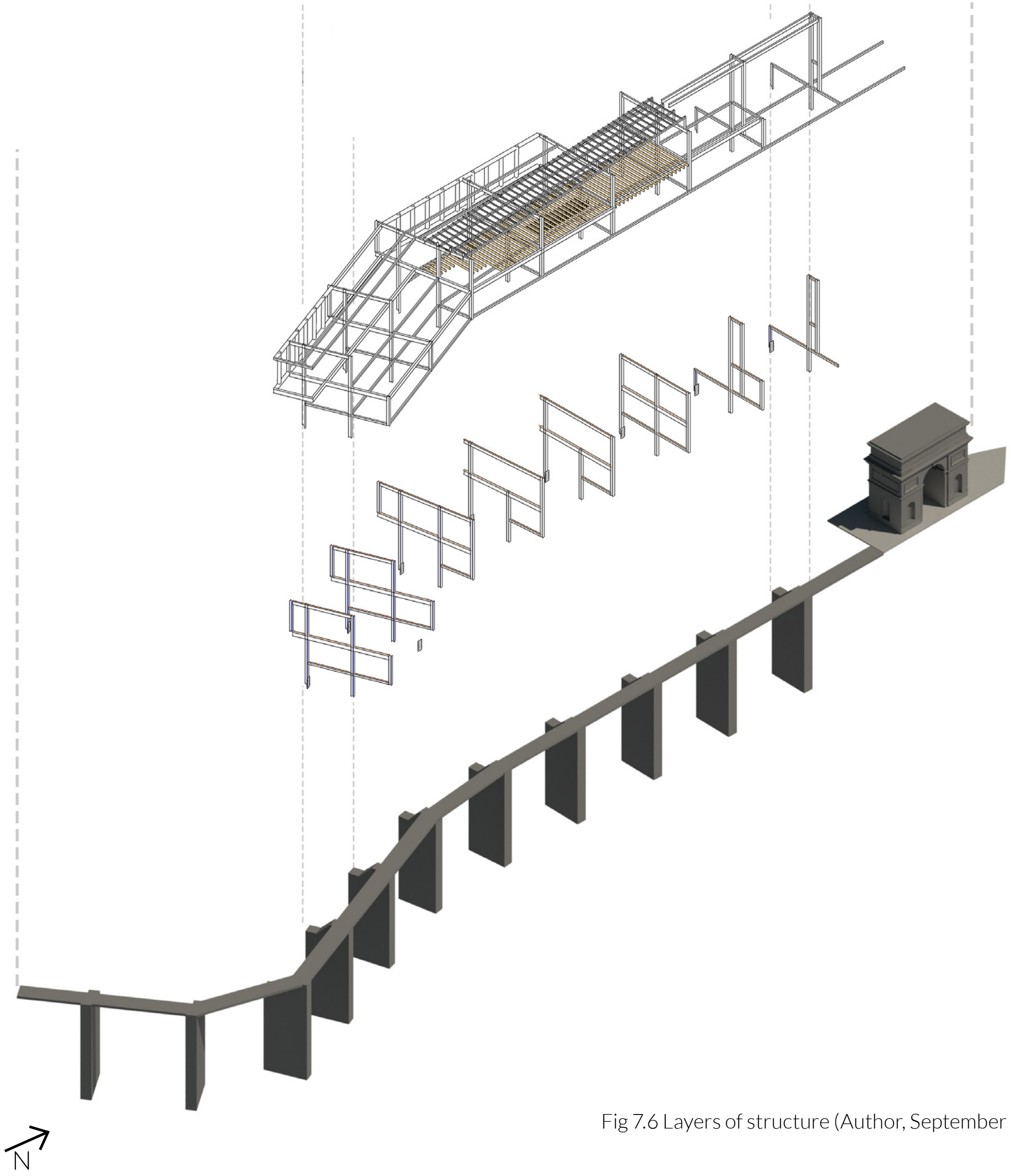


Fig 7.6 Layers of structure (Author, September 2016).

The spaces of exchanges that twist through the building create service spaces for the public interface which become served spaces. The series of exchanges range from being an entire space within the building to a singular wall that plays a specific role in the exchanges. The primary service core that runs between the kitchen and the restaurant space deals with many different exchanges. Contained within the wall there would be water tanks for water collection, batteries for power storage and ducts to facilitate air movement into the spaces.

The public interface is made up of the restaurant space and retail space below. The kitchen being primarily a services space is seen as part of the spaces of exchange but partly in the public interface such as the offices spaces.

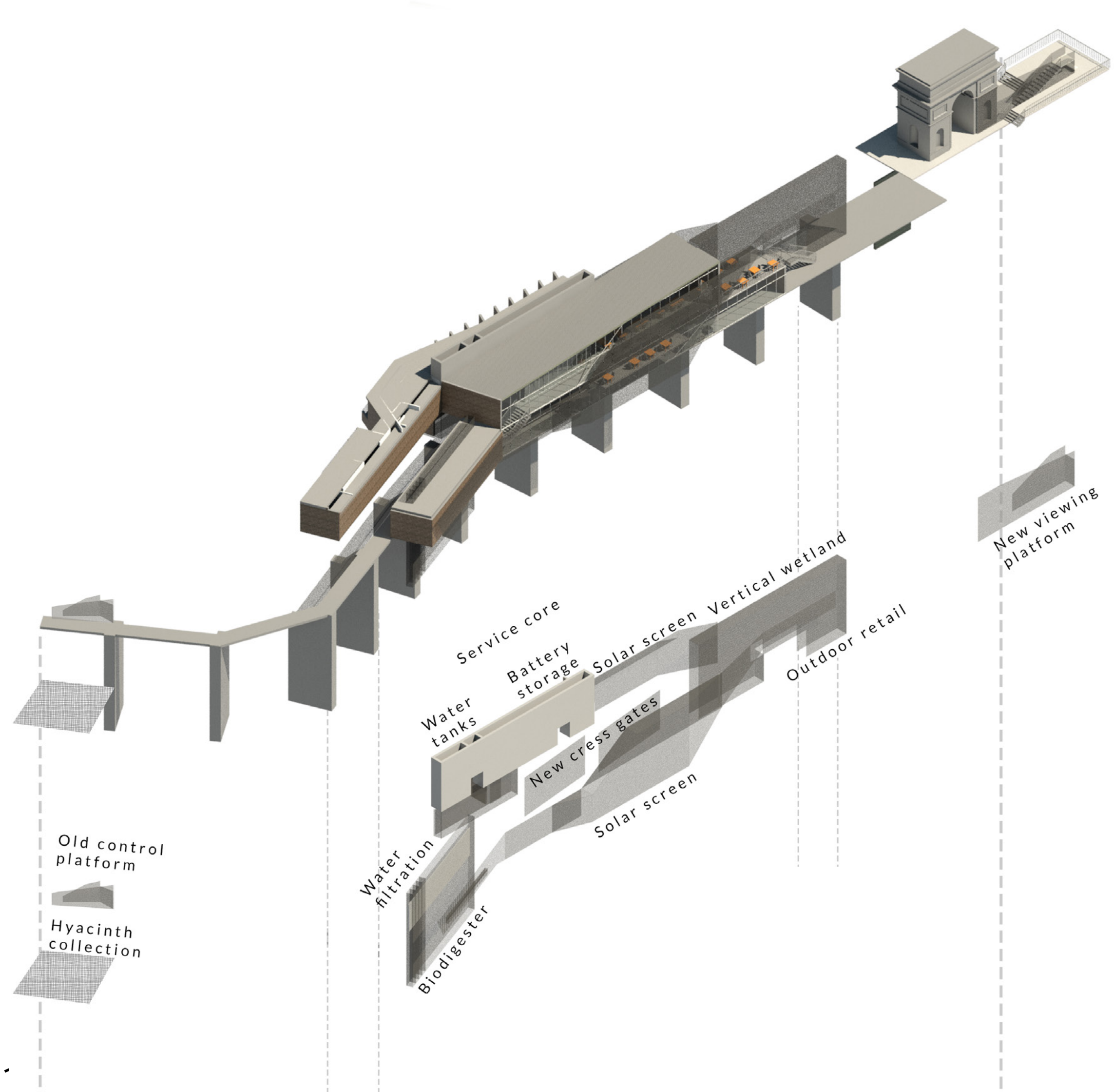


Fig 7.7 Layers of building (Author, September 2016)..

7.3 Material

Existing materials

The materials on site that exists now had to be analysed in order to make decisions on materials for the new design.

The infrastructural materials consist of concrete and steel of the crest gates. The dam wall itself is also made from concrete and steel but only the concrete is visible.

The most important material on site, water, has turned to a green pea soup colour due to the eutrophication. This element clearly shows that the site is unbalanced and needs to be rectified. This material has the most potential but yet is actually causing the most issues.

The bedrock has been exposed through the construction of the dam as they had to cut into the "poort" in order to dam the water. This has become quite an important material that surrounds the site.

Fig 7.8 Crest Gate (Author, September 2016).

Fig 7.9 Water (Author, September 2016).

Fig 7.10 Bedrock (Author, September 2016).

The Public Interface, restaurant and retail spaces

The public interface has a defined services core, where exchanges run vertically as well as horizontally into the restaurant space and retail space. These exchanges range from creating ventilation for climatic reasons, to housing of batteries for storage of power that then feed into the spaces.

Due to the difficulty of construction on site, wet construction was kept to a minimum. Prefabricated elements were rather used as they could be brought onto the site and erected quickly. This became a challenge when choosing wall materials. As the substructure was already to be steel, some kind of cladding could be placed upon this. Alucabond was identified as a good material for wall application

Structural members

Steel sections are the main structural members throughout the project; this is because of their large span capability. The joints between these members would mainly be bolted together on site. This would allow the smaller elements to be transported to site and then assembled in place.

All of these members would be pre-painted and galvanised in order to minimise finishes on site because of the difficulty of placing of scaffolding.

Large steel I beams and H sections make up the main portal frame. The secondary structure is primarily made from square hollow sections and C sections. This forms the sub structure for the wall cladding.

Fig 7.11 Square hollow section (bracket sand bolts, 2016).

Fig 7.12 C section (bracket sand bolts, 2016)

Fig 7.13 I section (bracket sand bolts, 2016)

As the building continues to perform its role in changing the way that society interacts with water then the water should start to change back to a more natural colour. This means that water is the key element to engage the effectiveness of understanding. This means that water needs to be expressed in the building in the same state it is in the dam, forcing a direct interaction with the problem.

Water will be used to change the hue of the light that enters into the space, by passing light through it or reflecting it off the water. This hue will change with the quality of the water over time. This will give a very direct and tangible relationship to the water and its quality.

Lights will be installed below the water so at night when they are turned on, the building will be washed with the colour of the water and constantly change as the water moves.

Fig 7.14 Torafu Architects (Water Projection Art Installation, 2016).

Wall materials

It was necessary for the services core to have a different material language then the served spaces. For this the existing site was looked at for inspiration, the previous series element was the crest gates which are made from concrete and steel, therefore these became the materials of choice for the new service core. Foam concrete panels were used as a substitute, due to the weight of in situ concrete. These panels will be pre-manufactured and then brought onto site and erected onto a light square gauge hollow section frame.

The public spaces such as the restaurant and the retail space would be made from lighter elements such as the suspended timber floors, Alucabond and glazing to highlight views. Alucabond was identified as a good material as it is durable and relatively maintenance free which was a key aspect because of the harsh environment, constant water condensation and direct sunlight. The aluminium composite panel consists of a non-combustible high-filled mineral core. The system has it own unique substructure which can be added onto the steel frame. A tray panel fixing system will be used for this project, as the panels will be able to be fixed from the inside.

Alucobond spectra sakura finish was chosen to be the primary finish. As can be seen in fig. 7.16.1, this finish allows the surrounding colours to be reflected in the facade without creating glare or mirroring the surroundings. In this way the building will pick up the colours of the water and the landscape around it, slowly changing as the systems take effect. The building will also change from the east to the west side. On the east side it would reflect the colours of the natural ground and bedrock but on the west side it would reflect the colour of the water and hyacinth.

Fig 7.15 Foam concrete (Buildbase, 2016).

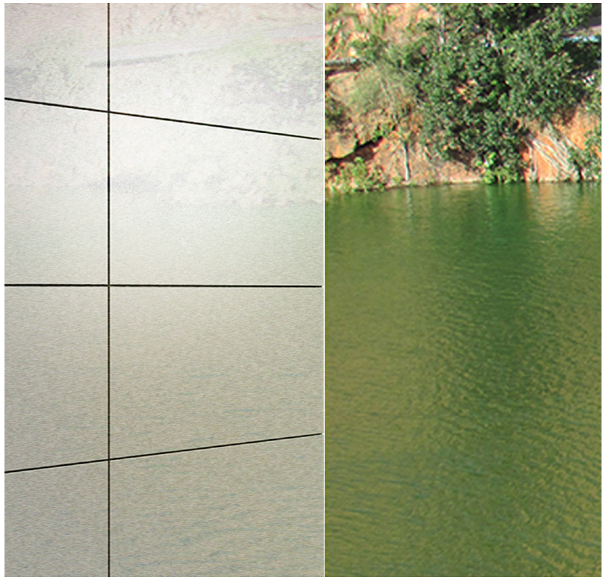


Fig 7.16.1. Alucobond panels reflecting colours of site(Adapted by author. June 2016).

Fig 7.16.2. Alucobond panels (Alucobond, 2016).

Flooring materials

As already stated throughout the design process, floor material was identified as being a good way to indicate which kind of space the user was in. Three main materials were identified; precast concrete slabs, suspended timber floors and steel gratings.

Originally concrete precast slabs were looked at as a flooring method as they would be simply brought to site and placed in the correct location. Due to weight and large spans on a suspended area of the building this would not be possible. Alternatively wood suspended floors have been investigated. This material would also create a better contrast between the existing infrastructure concrete walkway and the new interface.

Precast concrete slabs would be used in the kitchen and offices space. These spaces made up part of the service spaces and therefore needed to reflect somewhat the previous materials of the service element on site.

Steel grating would be used as the floor for the service core as this would make it transparent from below so that the public could see into the space from the existing walkway on site. This will also allow air movement that would ventilate the spaces on either side.

Suspended timber floors were decided on for the restaurant, bar and retail space. This would create a visual, tactile and audible contrast between the existing concrete walkway and the lighter timber floor. Due to the constructability it was necessary to choose a lighter flooring solution.

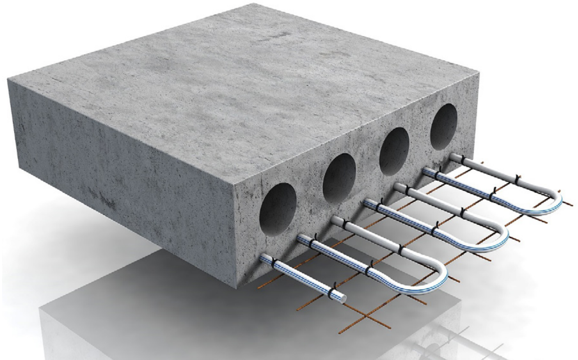


Fig 7.17 Pre cast concrete slab (Hollowcore, 2016).

Fig 7.18 Steel grating floor (Hollowcore, 2016).

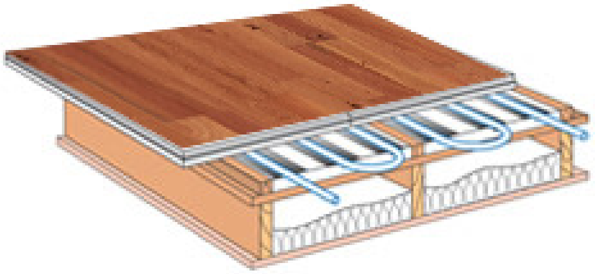


Fig 7.19 suspended timber floor (Hollowcore, 2016).

Roof materials

The roof structure will be supported on steel I beams that span between the main portal frames. Between these beams will be cold formed steel lipped c channels as purlins. Expanded polystyrene will be in between the purlins as insulation. The roofing material will be klip-lok 700 at a 3° pitch. The roof sheets would be pre-painted with colour tech G4 grey to reflect as much light as possible. This roof surface is very large and therefore is a key point to stop heat gain and loss.

In the kitchen and office spaces, pre-cast concrete slabs would be used as a roof structure which would need a screed with a fall to it. On top of this would be a dual reinforced membrane specified for exposed waterproofing. Derbigum Special Polyester 4 mm Roofing is a UV stable, polymer modified bitumen waterproofing membrane that would could be used in this environment. (Derbigum, 2016)

Fig 7.20 steel lipped channel (bracket sand bolts, 2016).

Fig 7.21 Expanded Polystyrene (Globalroofs, 2016).

Fig 7.22 Klip-lok 700 (Globalroofs, 2016).

The Vermiculture and wetland creation space

The vermiculture building had very different material requirements compared to the public interface. This building aimed to rehabilitate the scarred landscape and was sunken into it via a cut and fill method. This meant that there would be a large amount of broken bedrock that could be utilised. Wet construction would be possible to construct on this part of the site and therefore was used. The roof structure became the most important element to continue the landscape and rehabilitation of it.

In situ concrete could be used for the floor and roof of the structure. Due to the one edge being completely sunken into the landscape water proofing problems needed to be dealt with. Two layers of walls would be used; in situ concrete as a exterior retention wall and as the internal surface a gabion wall would make use of the crushed bedrock that has been created on site.

This would make the internal space reflect the site condition, reminding the user of their location.

The planted roof aims to continuing the broken landscape over the building. This planted roof would be used to grow crops and herbs for the restaurant space. It would also, similarly as the double skinned wall, serve as a very good insulation.

Fig 7.23 Insitu concrete floor (Hollowcore, 2016).

Fig 7.24 Gabion wall (Turbosquid, 2016).

Fig 7.25 Planted concrete roof (Author, June 2016).

Services

The use of services themselves can become a material if they express the flow of energy from the systems. This will make the architecture understandable to any user and how the systems allow for the building to operate. Figure 7.6 show good examples of exposed and articulated services, such as water pipes and electrical conduits. Each of these services can be expressed in a different material in order for the user to differentiate between the different energy systems.

The exposing of the services will also indicate where the energy is coming from. This is necessary as not all the systems are visible from the internal spaces, such as the solar panels that create energy for lighting. By the use of exposed services these systems can be expressed in the interior spaces.

Fig 7.26. Exposed water and electrical conduits (Masquespacio 2016).

Fig 7.27. Expression of services (Archdaily. 2016).

Fig 7.28. Articulation of electrical wiring (josephine-road, 2013).

Fig 7.29. Lighting expression of power and energy (101pallets, 2013).

7.4 Section- Vermiculture and wetland creation space

To continue iterating each architectural language, sections were done through the vermicultural space as well as the restaurant space.

The vermiculture section looks at the space created in this building and how it portrays the intent of the architecture. Figure 7.27 shows the plan and where the section is cut through the building.

This building makes use of wet construction as it is much easier to construct on this site. The one side of the building, being completely sunk, is made of gabion walls to give a grounded feeling within the building. The gabion wall makes use of the excavated bed rock that would be created on site to sink the building into the scar. This space is lined with a much lighter walkway that facilitates movement along the space and then changes in structure to lead your eye directly across to the public interface on the crest gates to the east.

The section shows the lightwells that were introduced to bring diffuse light into the space due to the requirements of the vermiculture process. This also facilitates removal of heat through vents in the light shaft.

This building has a significant amount of thermal mass, as well as being sunk in underground, therefore temperature would remain constant all year round.

Due to the fact that there would be a constant flow of compost in and out of this area, the space needed to be easily cleaned. Rougher materials that would appear more natural in its context and showing less dirt were chosen.

The earthy smell of the vermiculture meant that ventilation needed to be thought of and therefore the vents in the light wells became quite important for air circulation.

Water is a crucial element in both the activities shown in the section, vermiculture and the growing of crops and herbs. It is therefore necessary to have a large storage tank. This tank was designed in such a way that it showed the change in activities from the upside. The tank was integrated into the wall between the public space of the vermiculture building and the actual vermiculture systems, which can be seen in elevation in the section of figure 7.29.

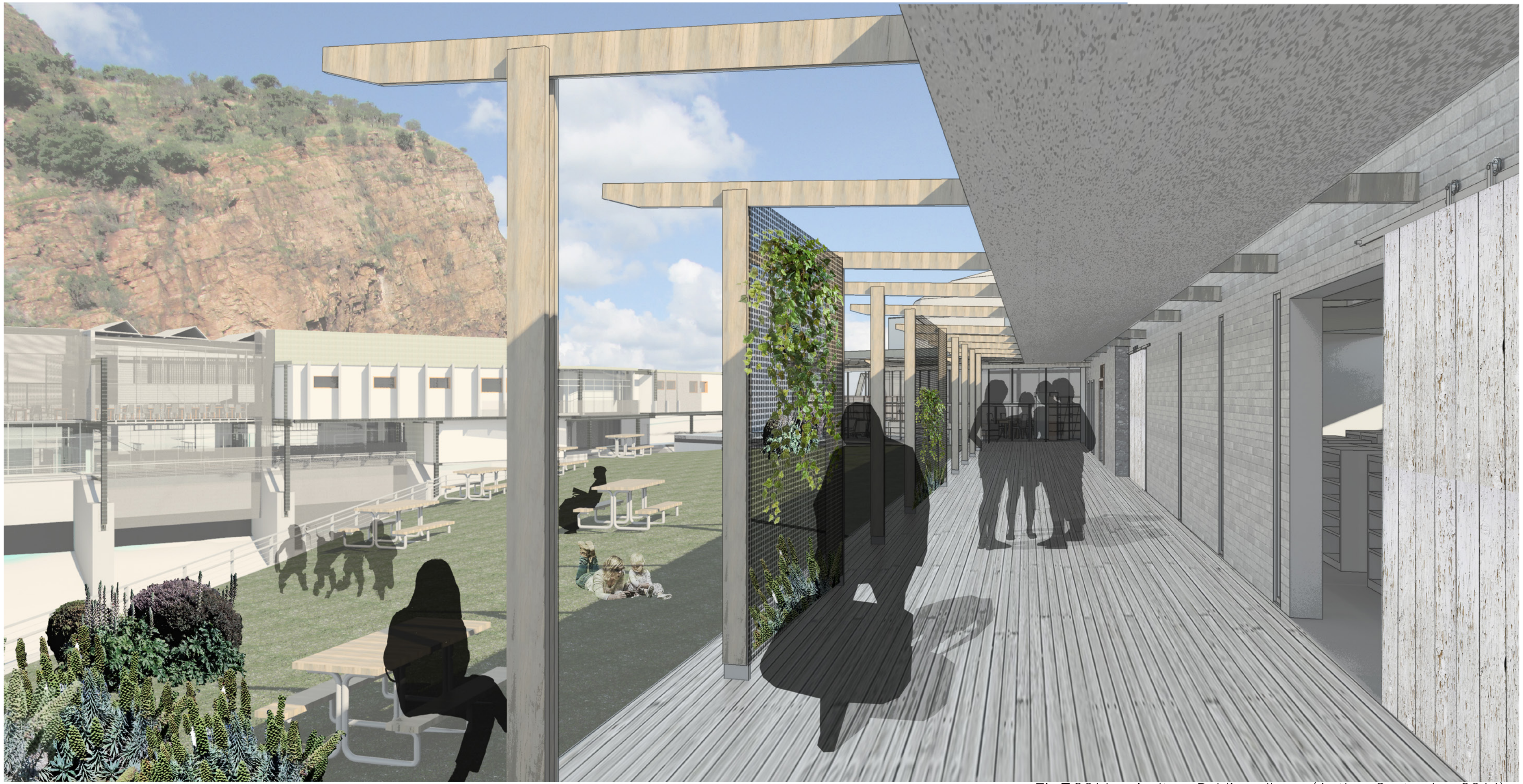


Fig 7.30 Vermiculture Public walkway (Author, September 2016).

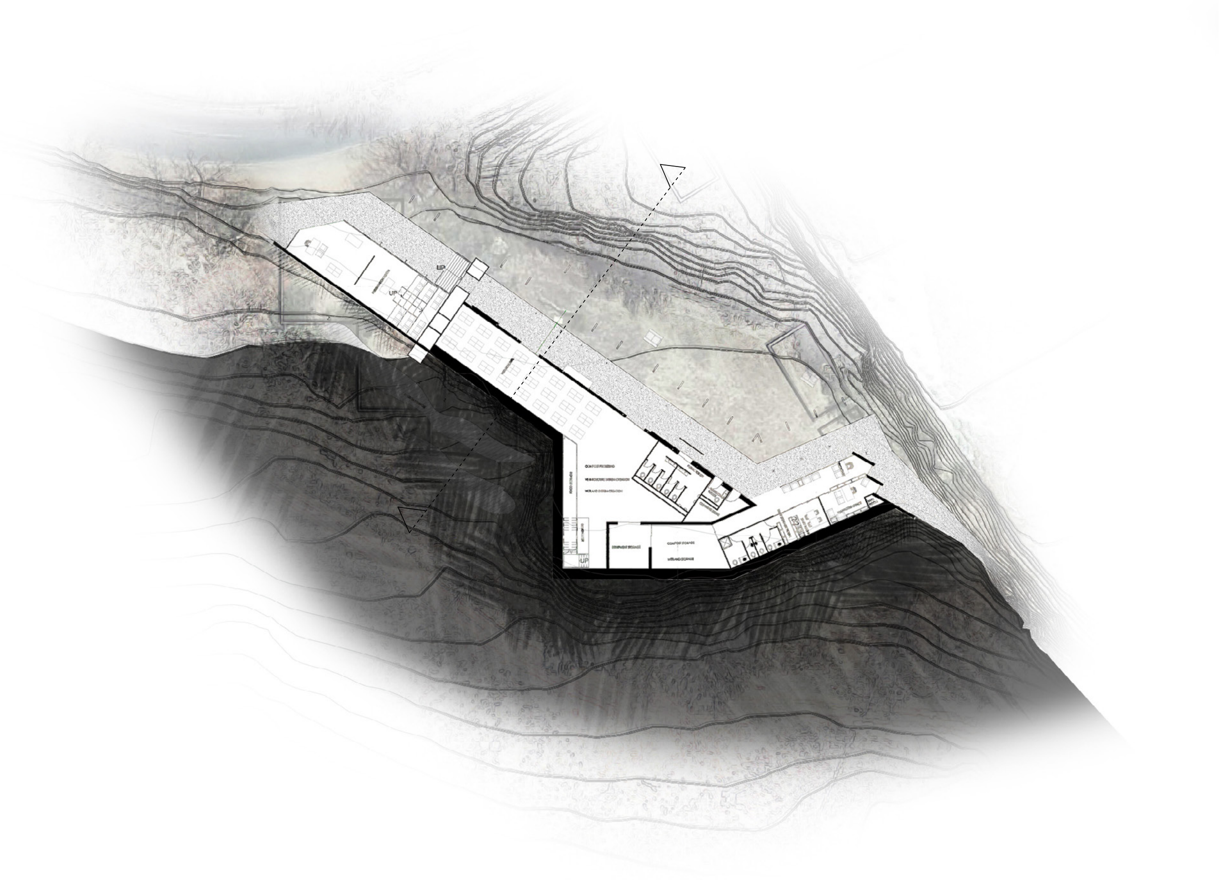


Fig 7.31. Vermiculture Building Plan (Author, June 2016).

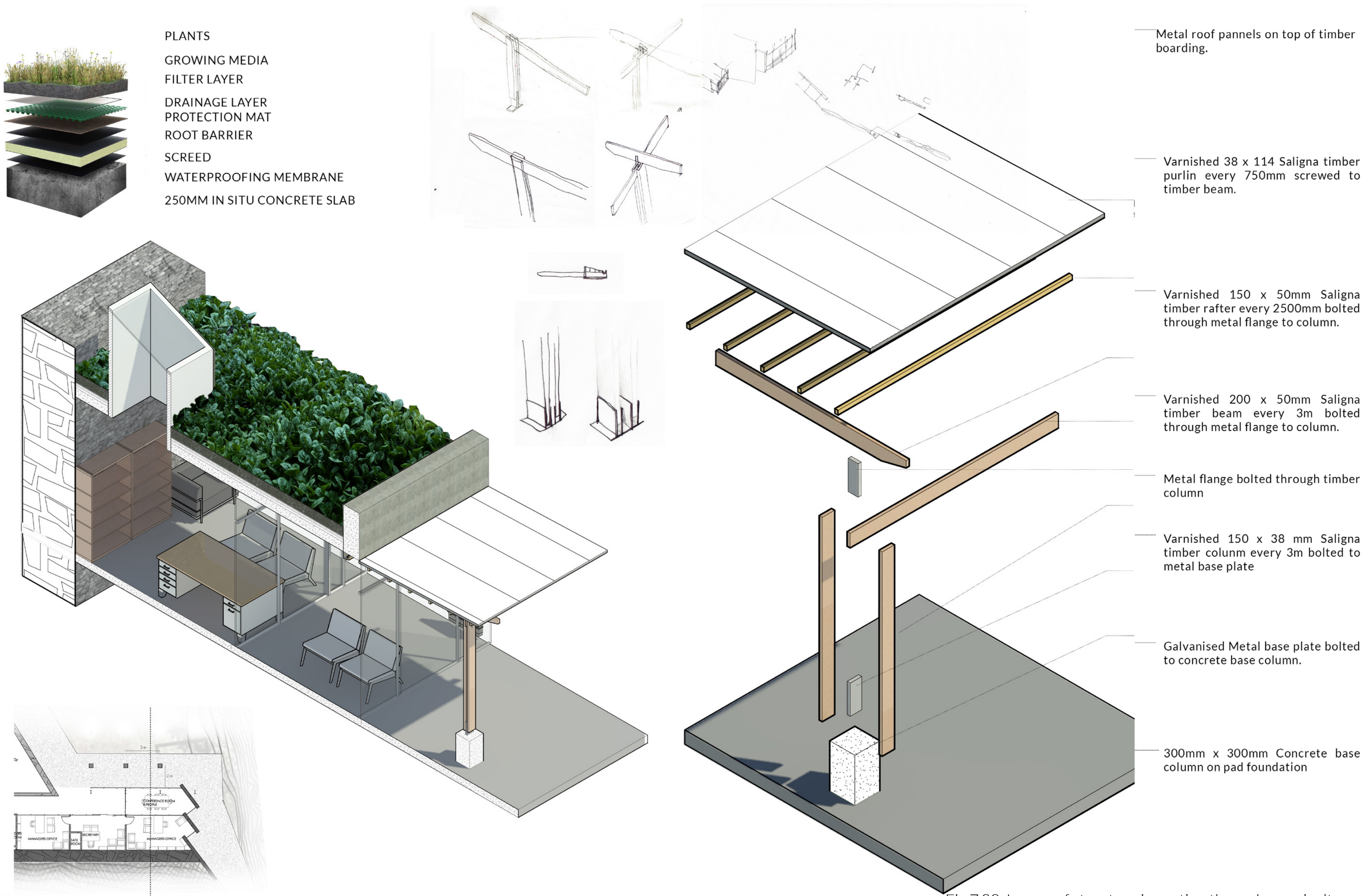
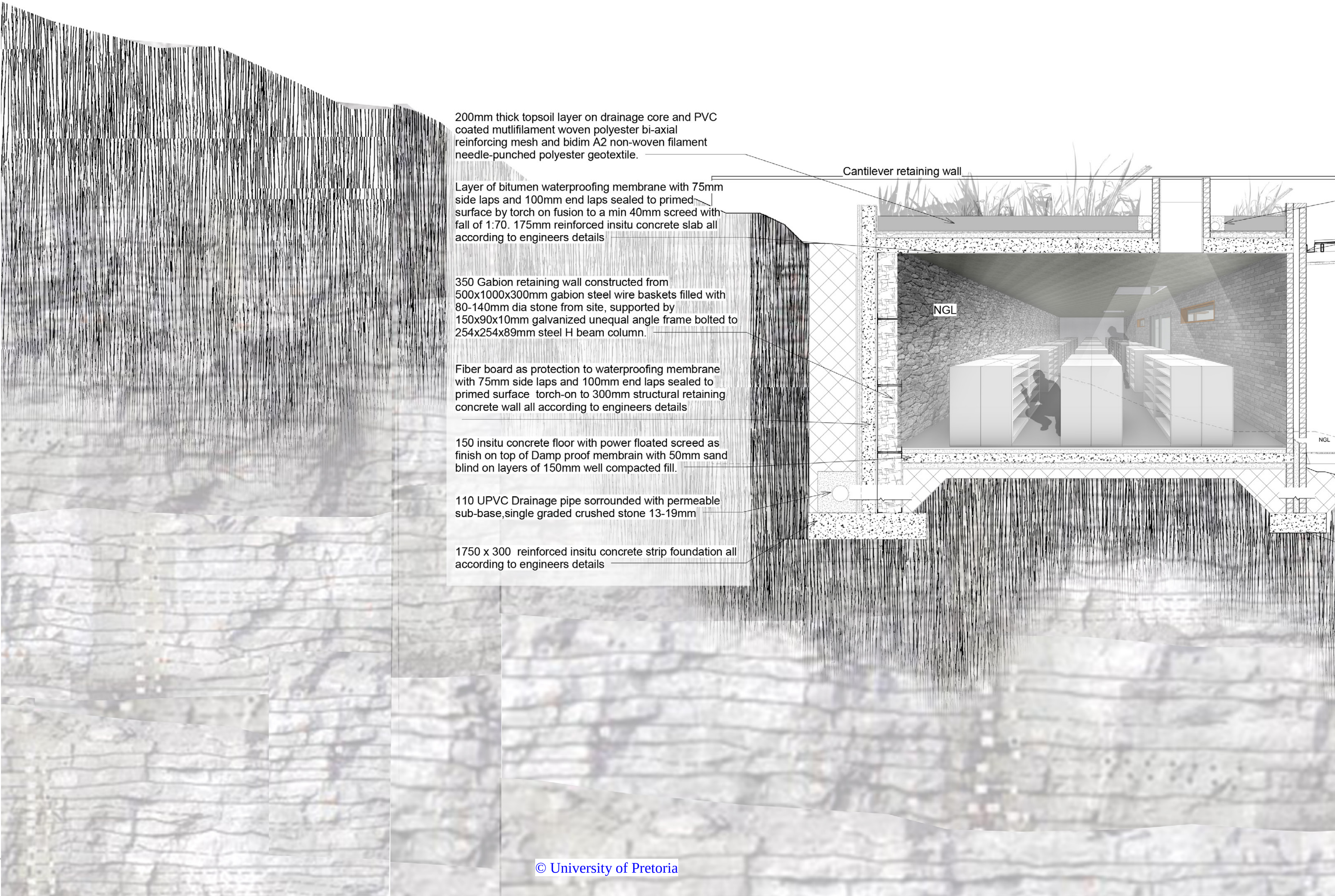


Fig 7.32. Layers of structure in section through vermiculture (Author, August 2016).



200mm thick topsoil layer on drainage core and PVC coated mutlifilament woven polyester bi-axial reinforcing mesh and bidim A2 non-woven filament needle-punched polyester geotextile.

Layer of bitumen waterproofing membrane with 75mm side laps and 100mm end laps sealed to primed surface by torch on fusion to a min 40mm screed with fall of 1:70. 175mm reinforced insitu concrete slab all according to engineers details

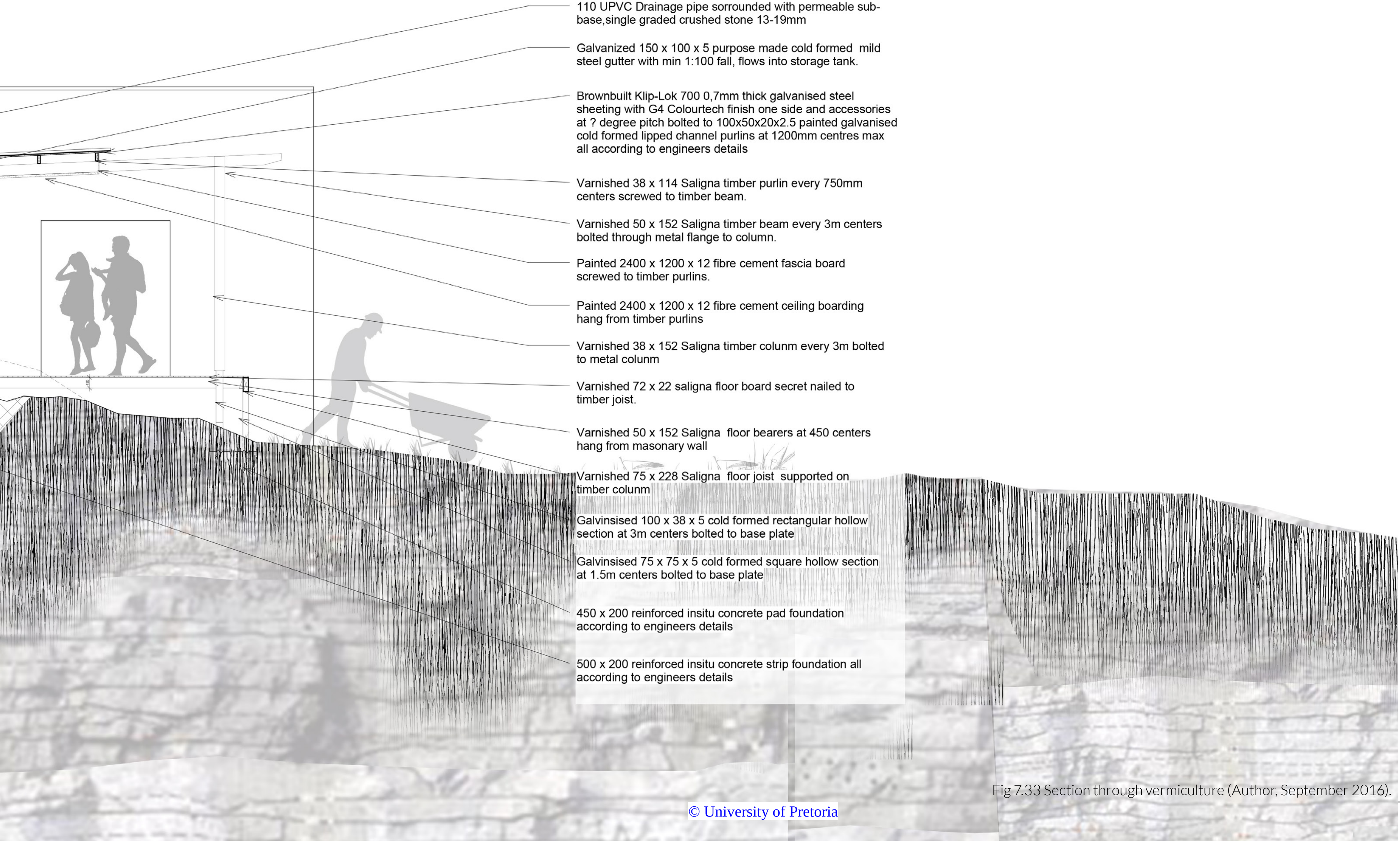
350 Gabion retaining wall constructed from 500x1000x300mm gabion steel wire baskets filled with 80-140mm dia stone from site, supported by 150x90x10mm galvanized unequal angle frame bolted to 254x254x89mm steel H beam column.

Fiber board as protection to waterproofing membrane with 75mm side laps and 100mm end laps sealed to primed surface torch-on to 300mm structural retaining concrete wall all according to engineers details

150 insitu concrete floor with power floated screed as finish on top of Damp proof membrain with 50mm sand blind on layers of 150mm well compacted fill.

110 UPVC Drainage pipe sorrounded with permeable sub-base,single graded crushed stone 13-19mm

1750 x 300 reinforced insitu concrete strip foundation all according to engineers details



110 UPVC Drainage pipe sorrounded with permeable sub-base,single graded crushed stone 13-19mm

Galvanized 150 x 100 x 5 purpose made cold formed mild steel gutter with min 1:100 fall, flows into storage tank.

Brownbuilt Klip-Lok 700 0,7mm thick galvanised steel sheeting with G4 Colourtech finish one side and accessories at ? degree pitch bolted to 100x50x20x2.5 painted galvanised cold formed lipped channel purlins at 1200mm centres max all according to engineers details

Varnished 38 x 114 Saligna timber purlin every 750mm centers screwed to timber beam.

Varnished 50 x 152 Saligna timber beam every 3m centers bolted through metal flange to column.

Painted 2400 x 1200 x 12 fibre cement fascia board screwed to timber purlins.

Painted 2400 x 1200 x 12 fibre cement ceiling boarding hang from timber purlins

Varnished 38 x 152 Saligna timber colunm every 3m bolted to metal colunm

Varnished 72 x 22 saligna floor board secret nailed to timber joist.

Varnished 50 x 152 Saligna floor bearers at 450 centers hang from masonary wall

Varnished 75 x 228 Saligna floor joist supported on timber colunm

Galvinsised 100 x 38 x 5 cold formed rectangular hollow section at 3m centers bolted to base plate

Galvinsised 75 x 75 x 5 cold formed square hollow section at 1.5m centers bolted to base plate

450 x 200 reinforced insitu concrete pad foundation according to engineers details

500 x 200 reinforced insitu concrete strip foundation all according to engineers details

Fig 7.33 Section through vermiculture (Author, September 2016).

7.5 Section- Restaurant and kitchen space.

Figure 7.31 shows the plan and where the section is cut through the building. This section shows the restaurant space, bar area and kitchen space. As well as the service core which houses water tanks, ducts and power batteries.

Through the iterations of the section it was clear that the roof plane and shading device became an environmental skin to the building and had to protect it from the sun, wind and rain. This made the living box within it a more comfortable space for the user.

The service core becomes the most important feeder to the other spaces. It needed to express the flow of exchanges. For example, the electric fittings would branch out from the service core. Similarly water pipes would run on the surface and then branch out into the kitchen. Even air ventilation would come through the metal grating in the service core and then into the spaces.

This section shows the different floor materials and how each space is characterised by its materials. It also shows where the structural members are and how they are revealed in certain places. A good example is the Vierendeel truss where, the wall reveals the square hollow section and at other times conceals it.

The materials clearly define what space the user is in, the kitchen and service core are made from stereotomic materials such as concrete, whereas the served spaces are much lighter and hang off the existing infrastructure. These spaces make use of light material such as timber and Alucobond.

The articulation of the roof plan was explored and the roof structure lifted off the primary portal frame as the volume increases lengthways to the building.

The crest gate moves up into the space blocking the view from the existing walkway down to the spillway when opened. When closed it becomes a balustrade for people to lean on.

The downstairs bar area opens up onto the existing walkway as well as on the dam side to allow an open and contained space.

It is visible in this section how the different power systems, such as the solar panel on the roof and the Pelton wheel are connected to the crest gate.

Fig 7.34 Restaurant space (Author, September 2016).

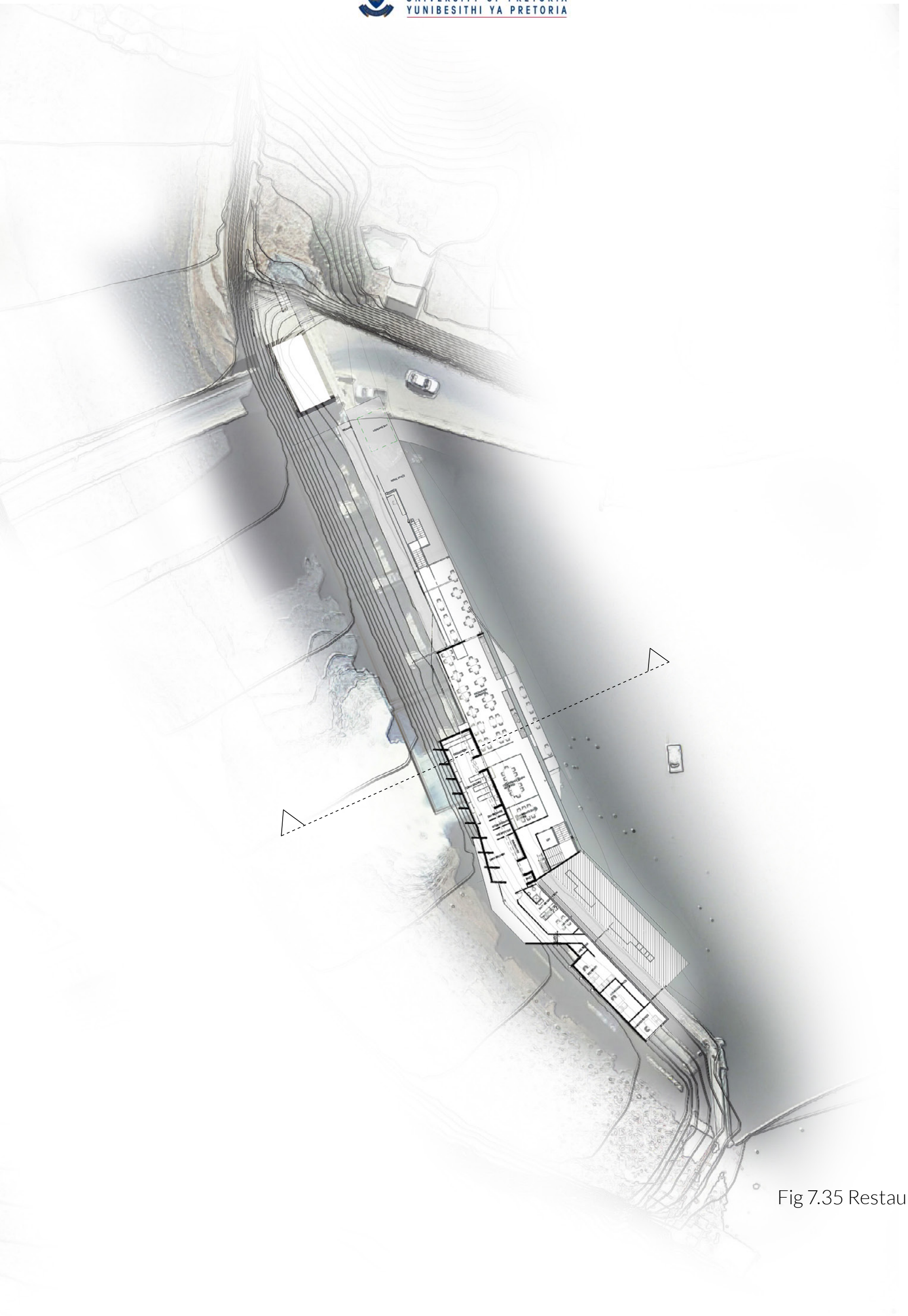


Fig 7.35 Restaurant Building Plan (Author, June 2016).

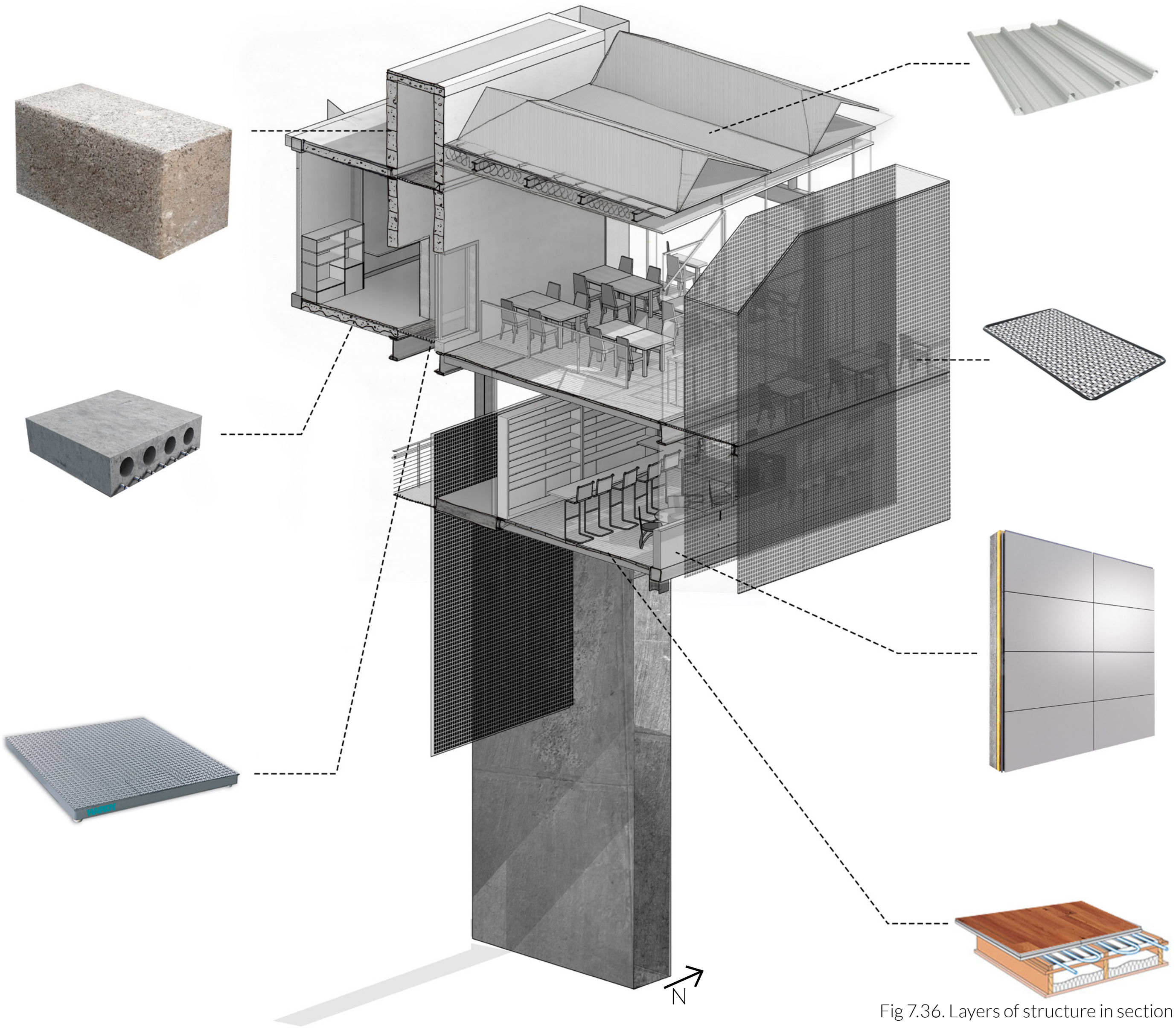


Fig 7.36. Layers of structure in section through restaurant (Author, August 2016).

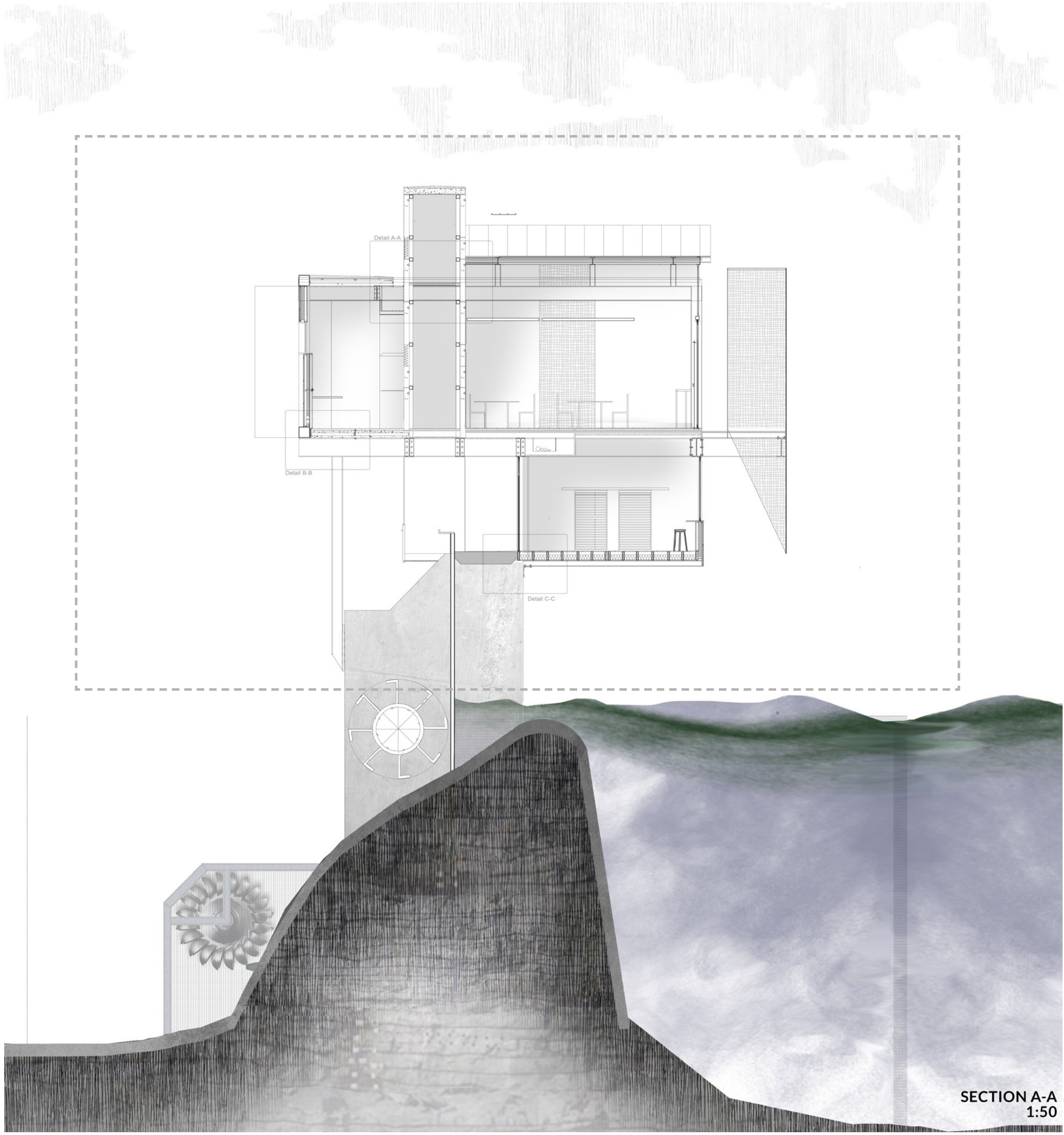
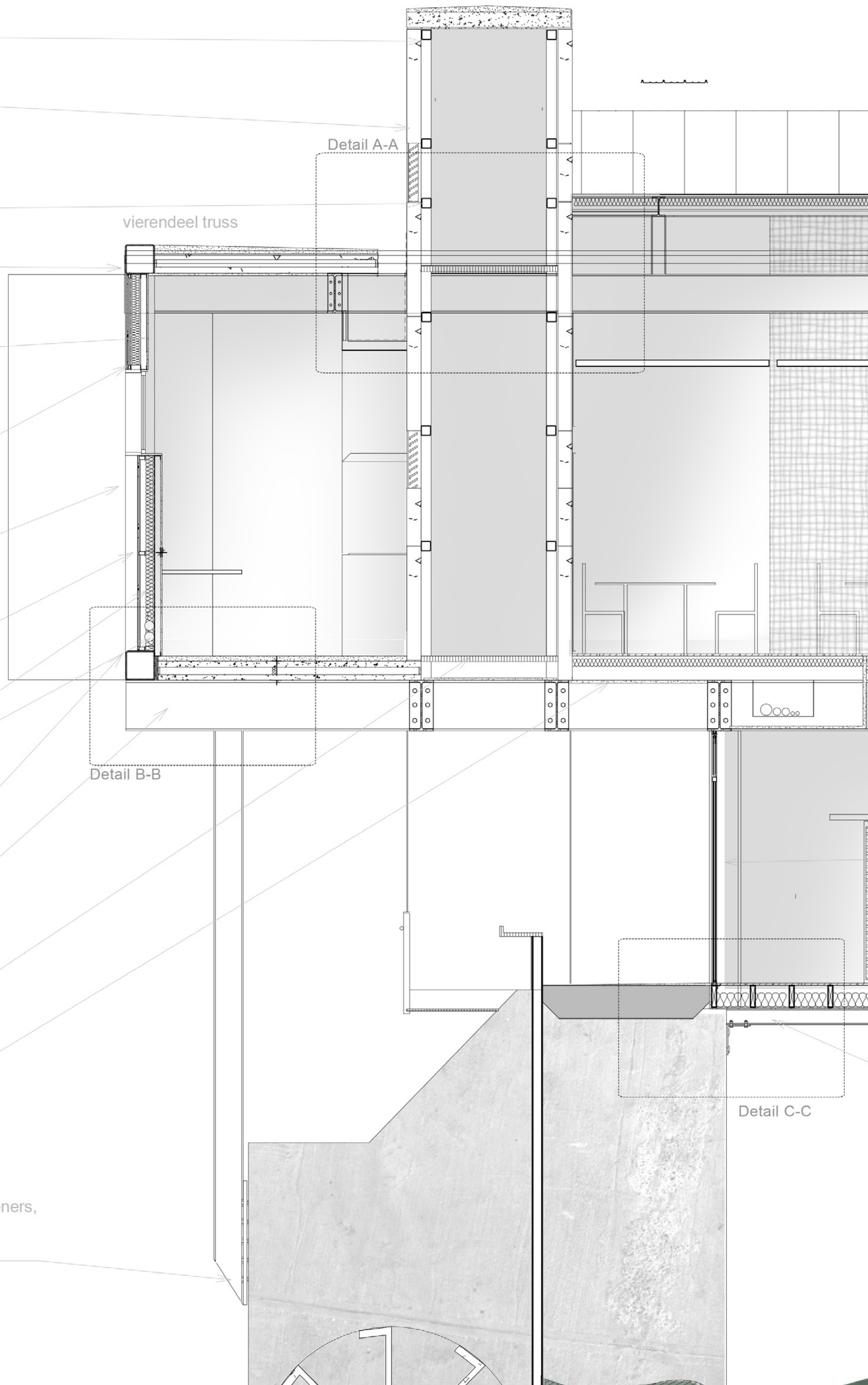


Fig 7.37 Section through restaurant (Author, September 2016).



Pre-painted galvanised 152x102 cold formed steel hollow rectangle column with steel welded base plate fixed every 1200mm according to engineers details

unpainted 600x1200 precast foam concrete panels fixed to steel frame with cast in M24 bolts according to engineers details

Pre-painted galvanised 102x102 cold formed steel hollow square beam fixed every 1200mm according to engineers details

Pre-painted galvanised 350 x 350 x 10 hot rolled steel hollow square beam fixed every 11m

Painted 2400 x 1200 x 12.5 high density gypsum plasterboard with noise absorption properties screw to aluminum stud 600 centers

Pre-painted galvanised 100 x 50 x 20 x 3 cold formed steel lipped C channel beam fixed every 2.4 to pre-painted galvanised 100 x 100 cold formed steel square hollow section column to engineers details

Pre-painted galvanised 350 x 350 hot rolled steel hollow square column fixed every 3m according to engineers details

1200 x 900 x 4 Alucobond aluminum panels tray hanger from steel profile fixed to lipped C channel beam every

2440 x 1220 x 100mm expanded polystyrene rigid insulation

Anti condensation membrane

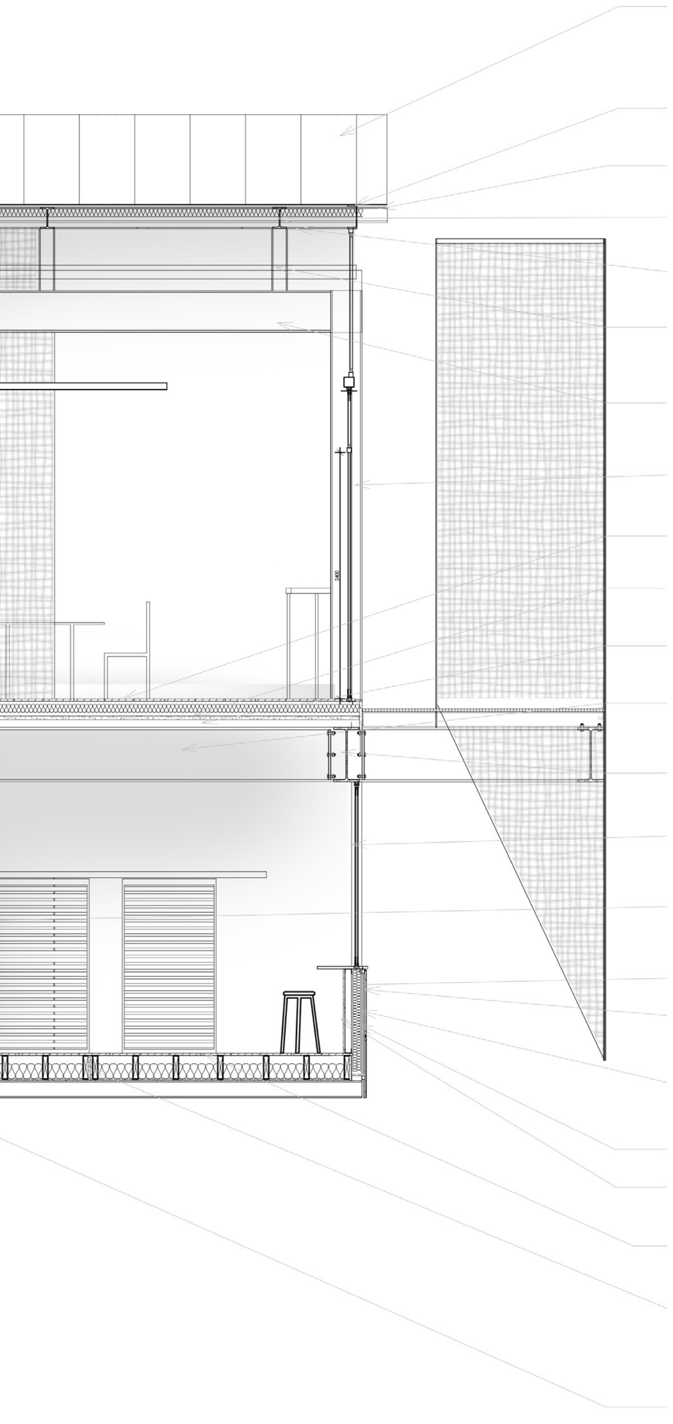
Pre-painted galvanised 350 x 350 hot rolled steel hollow square beam fixed every 11m all according to engineers details

epoxy flooring on top of screed with a 200 precast concrete slab supported on steel portal frame

Pre-painted galvanised steel grid floor bolted to steel I beam.

Painted 12.7 x1200 fibre cement boarding hang from timber floor

Pre-painted galvanised 305x305mm hot rolled steel H column with stiffeners, welded to base plate 555 x 750mm fixed with chemically anchored m30 bolts every 11m to concrete wall of existing cress gates according to engineers details



Brownbuilt Klip-Lok 700 0,7mm thick galvanised steel sheeting with G4 Colourtech finish one side and accessories at ? degree pitch bolted to 100x50x20x2.5 painted galvanised cold formed lipped channel purlins at 1200mm centres max all according to engineers details

Pre-painted galvanised 150 x 75 x 20 x 3 cold formed steel lipped C Channe bolted to steel purlins

Pre-painted galvanised 150 x 75 x 20 x 3 cold formed steel lipped C Channel purlins 1.5m centers bolted to I beam.

Pre-painted galvanised 203 x 133 x 25 hot rolled steel I beam bolted every 11m according to engineers details

600 x 900 x 12.7 acoustical ceiling panels hang steel purlin

Pre-painted galvanised 160 x 82 x 20 hot rolled steel H column every 2.4 centers bolted to portal frame according to engineers details

Pre-painted galvanised 406 x 140 x 39 hot rolled steel I beam every 11m bolted to column.

12mm double glazing supported by a aluminum mullion

Varnished 72 x 22 Saligna floor board secret nailed to timber joist.

600 x 900 x 12.7 acoustical ceiling panels hang from timber floor

Varnished 50 x 228 Saligna floor joist at 450 centers hang from steel frame

Pre-painted galvanised 533 x 210 x 82 hot rolled steel I beam every 6m bolted to column according to engineers details

Pre-painted galvanised 533 x 210 x 82 hot rolled steel I beam every 11m bolted to base plate of portal frame according to engineers details

Pre-painted galvanised 150 x100 x 4 cold formed steel rectangle hollow column every 2400 bolted to base plate of portal frame according to engineers details

Pre-painted galvanised 305x305 hot rolled steel H column that is chemically anchored m30 bolts every 11m to concrete wall of existing cress gates according to engineers details

2440 x 1220 x 100mm expanded polystyrene rigid insulation

1200 x 900 x 4 Alucobond aluminum panels tray hanger from steel profile fixed to lipped C channel beam every

Pre-painted galvanised 100 x 50 x 20 x 3 cold formed steel lipped C channel beam fixed every 2.4 to pre-painted galvanised 100 x 100 cold formed steel square hollow section column to engineers details

Anti condensation membrane

Painted 2400 x 1200 x 12.5 high density gypsum plasterboard with noise absorption properties screw to aluminum stud 600 centers

Add to floor sub structure on site Varnished 102 x 22 Saligna floor board secret nailed to timber joist.

Floor sub structure: 2400 x 2400 panels made from pre painted 2400 x 1200 x 12 fibre cement boarding screwed to varnished 50 x 228 Saligna floor joist at 350 centers and gaps filled with 2440 x 1220 x 150mm expanded polystyrene rigid insulation.

Pre-painted galvanised 160 x 82 x16 hot rolled steel I beam every 2.4m centers bolted to 150 x 100 x 16 unequal angle that is chemically anchored m30 bolts every 2.4m existing cress gates according to engineers details

Fig 7.38. Section through restaurant (Author, September 2016).

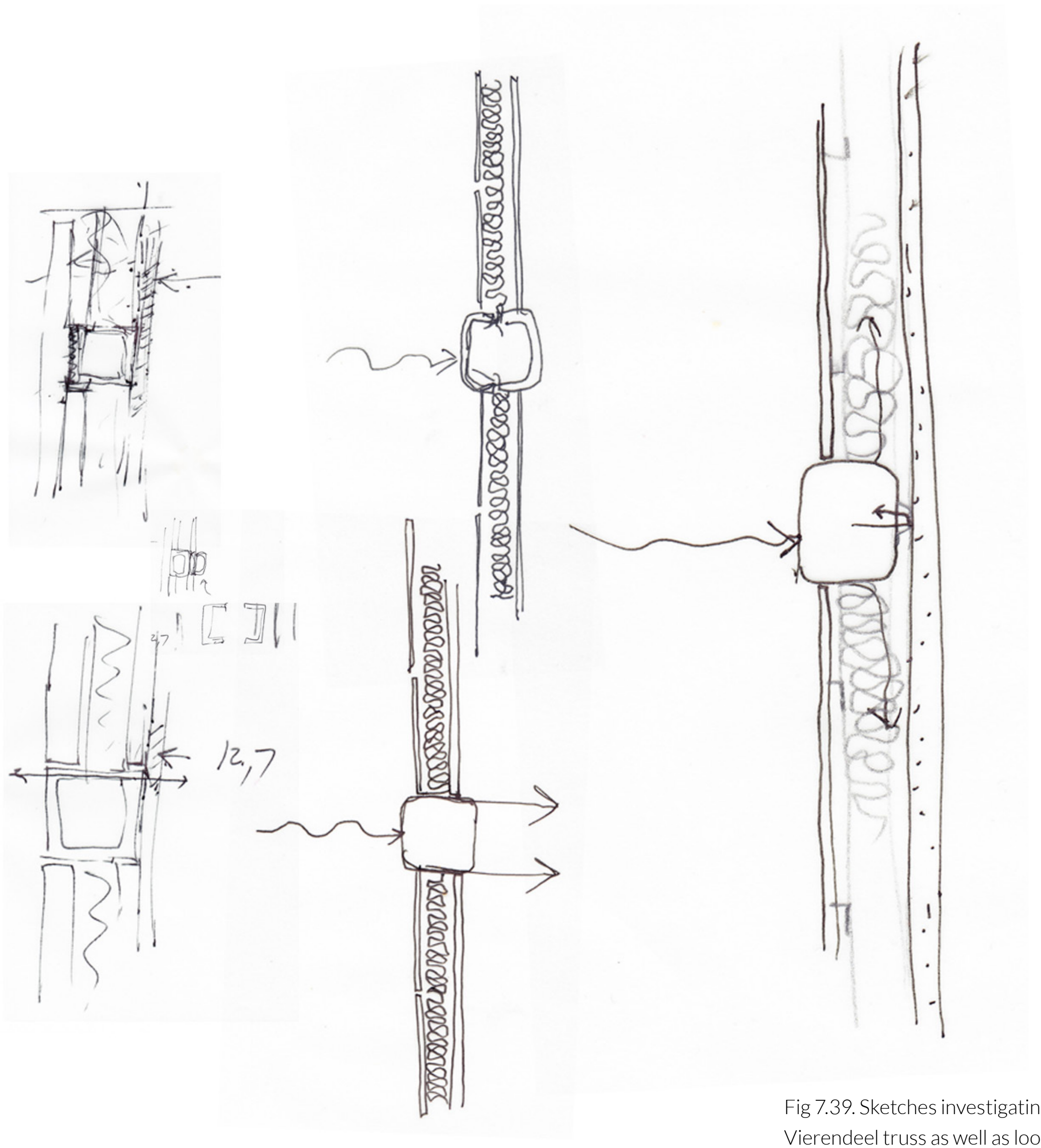
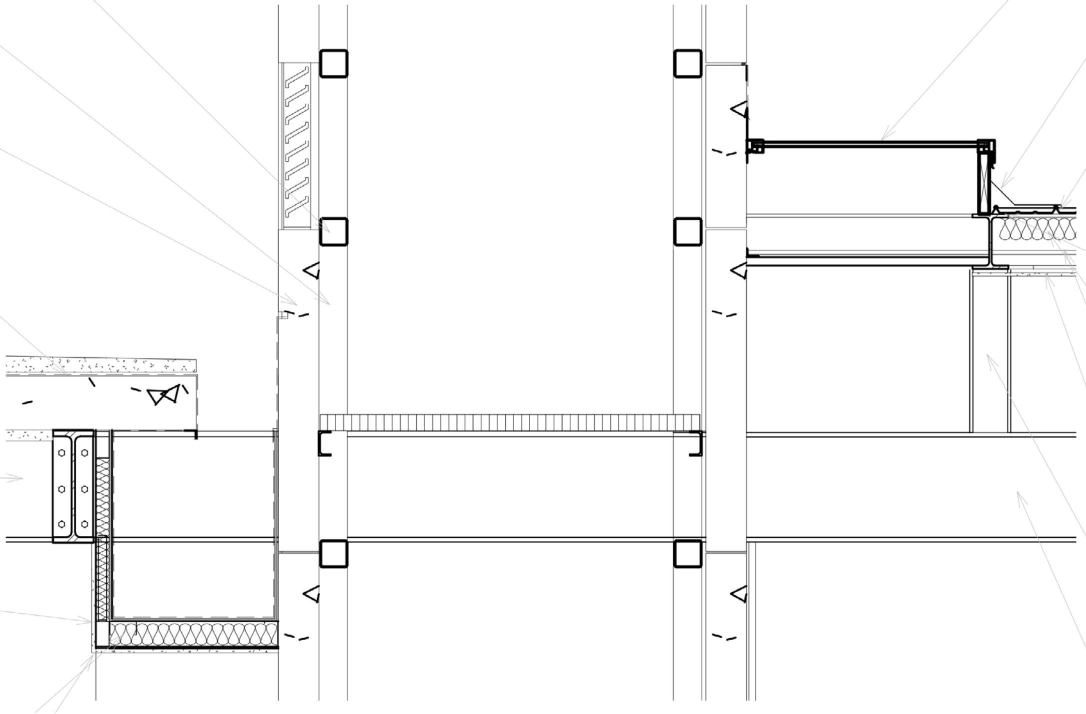


Fig 7.39. Sketches investigating revealing and concealing the Vierendeel truss as well as looking at thermal breaks (Author, September 2016).



Pre-painted galvanised 102x102 cold formed steel hollow square beam fixed every 1200mm according to engineers details

Pre-painted galvanised 152x102 cold formed steel hollow rectangle column with steel welded base plate fixed every 1200mm according to engineers details

Unpainted 600x1200 precast foam concrete panels fixed to steel frame with cast in M24 bolts according to engineers details

Layer of bitumen waterproofing membrane with 75mm side laps and 100mm end laps sealed to primed surface by torch on fusion to a min 40mm screed with fall of 1:70. 175mm reinforced insitu concrete slab all according to engineers details

Pre-painted galvanised 533 x 210 x 82 hot rolled steel I beam every 11m bolted to base plate of portal frame according to engineers details

Purpose made 600 x 700 hot press steel water tank fitted with ball value and pump. 50 x 100 x 6 cold formed lipped channel frame hang from portal frame and bolted to concrete wall

2440 x 1220 x 100mm expanded polystyrene rigid insulation

600 x 900 x 12.7 acoustical ceiling panels hang from timber floor

Double glazing skylight with a thermal break aluminum frame fixed to concrete wall and 38 x 228 timber beam

Counter flashing from under aluminum frame ar fixed to roof sheeting with s10 clip

Brownbuilt Klip-Lok 700 0,7mm thick galvanisec steel sheeting with G4 Colourtech finish one sid and accessories at ? degree pitch bolted to 100x50x20x2.5 painted galvanised cold formed lipped channel purlins at 1200mm centres max according to engineers details

Pre-painted galvanised 203 x 133 x 25 hot rolle steel I beam bolted every 11m according to engineers details

2440 x 1220 x 100mm expanded polystyrene rigid insulation

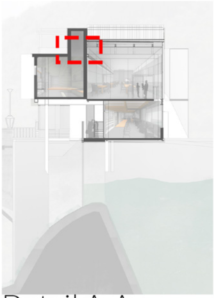
Pre-painted galvanised 150 x 75 x 20 x 3 cold formed steel lipped C Channel purlins 1.5m centers bolted to I beam.

600 x 900 x 12.7 acoustical ceiling panels hang from timber floor

Pre-painted galvanised 160 x 82 x 20 hot rolled steel H column every 2.4 centers bolted to portal frame according to engineers details

Pre-painted galvanised 406 x 140 x 39 hot rolled steel I beam every 11m bolted to column.

Fig 7.40 Detail A (Author, September 2016).



Detail A-A

1:10

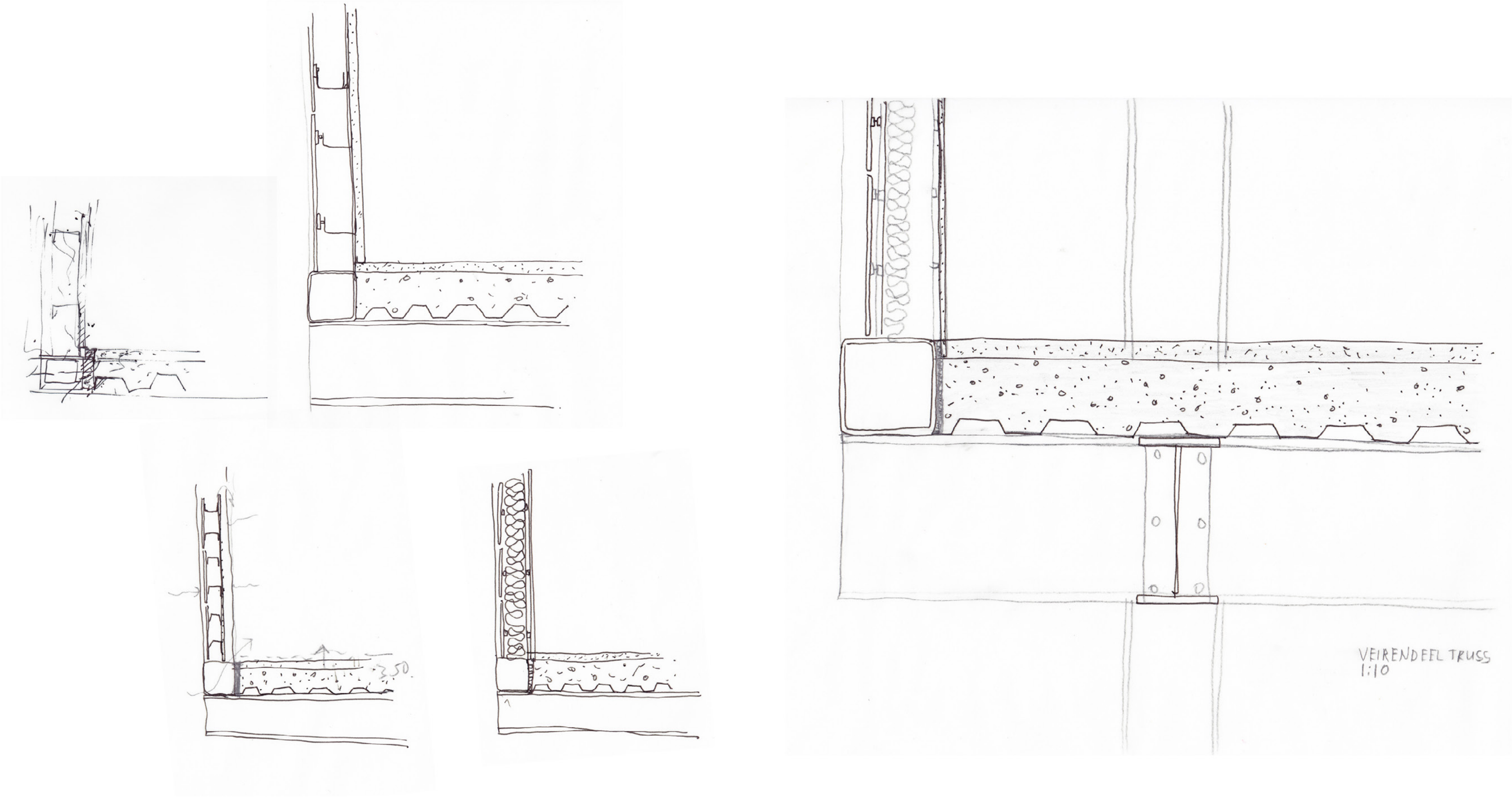
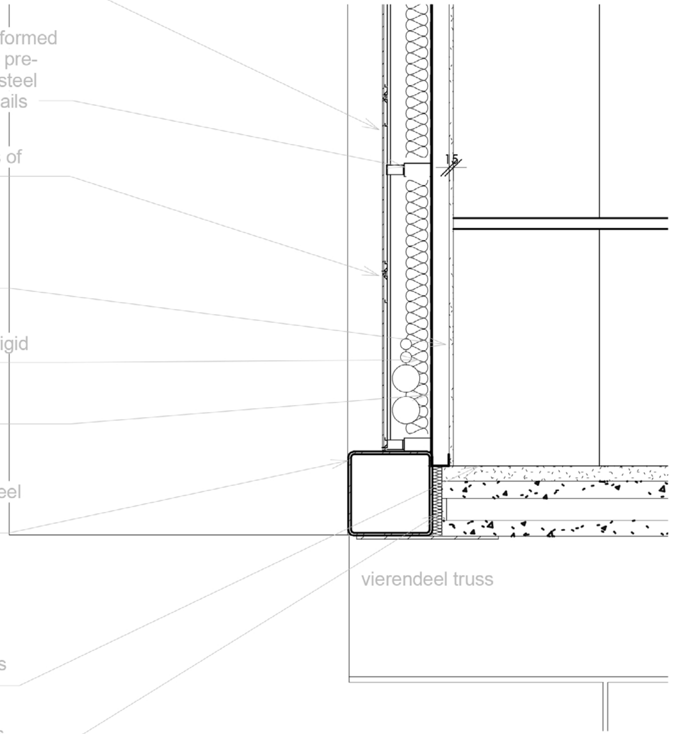


Fig 7.41 Sketches investigating junction of the Vierendeel truss, Alucobond and the pre-cast concrete floor slab, as well as looking at thermal breaks (Author, September 2016).



1200 x 900 x 4 Alucobond aluminum panels tray hanger from steel profile fixed to lipped C channel beam every 1.2 m

Pre-painted galvanised 100 x 50 x 20 x 3 cold formed steel lipped C channel beam fixed every 2.4 to pre-painted galvanised 100 x 100 x 3 cold formed steel square hollow section column to engineers details

Backer rod with polysulfide seal between joints of Alucobond aluminum panels

Painted 2400 x 1200 x 12.5 high density gypsum plasterboard with noise absorption properties screw to aluminum stud 600 centers

2440 x 1220 x 100mm expanded polystyrene rigid insulation

Anti condensation membrane

Pre-painted galvanised 350 x 350 hot rolled steel hollow square beam fixed every 11m all according to engineers details

Epoxy flooring on top of screed with a 200 precast concrete slab supported on Pre-painted galvanised 10mm steel base plate pre-welded to 350 x 350 hot rolled steel hollow square beam all according to engineers details

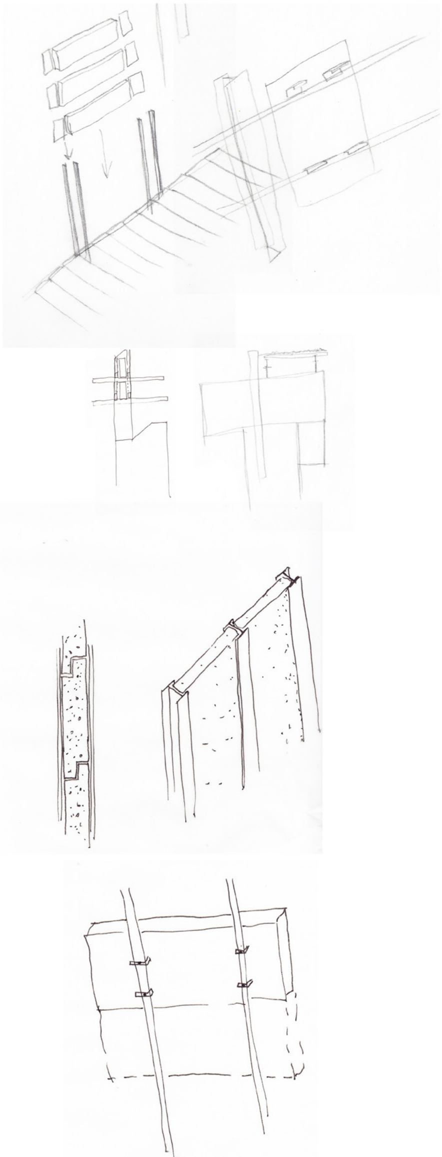
35mm expanded polystyrene rigid insulation as thermal break between beam and internal space

vierendeel truss

Fig 7.42 Detail B (Author, September 2016).

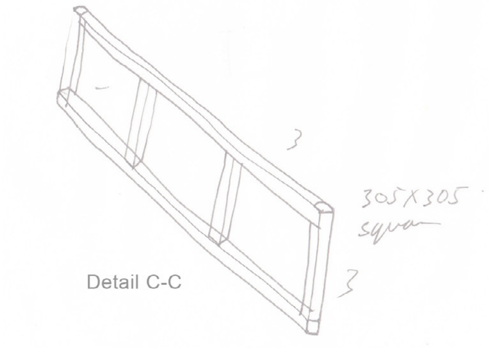
Detail B-B

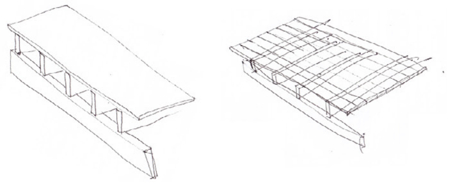
1:10



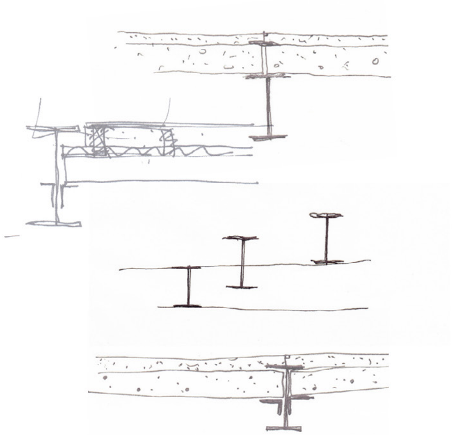
Pre-cast concrete panels for service core wall.

Understanding the Vierendeel truss and its' components



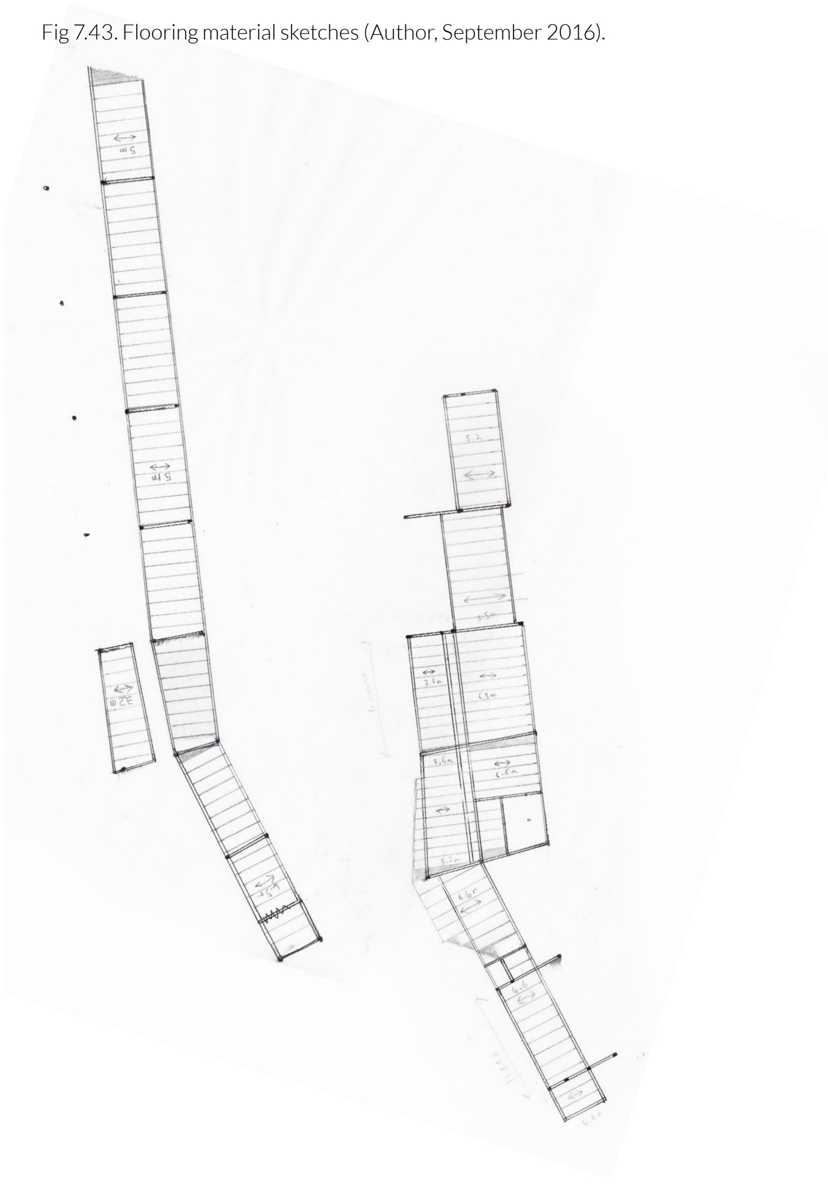


Understanding the Timber floor joists and tongue and groove timber floor boards

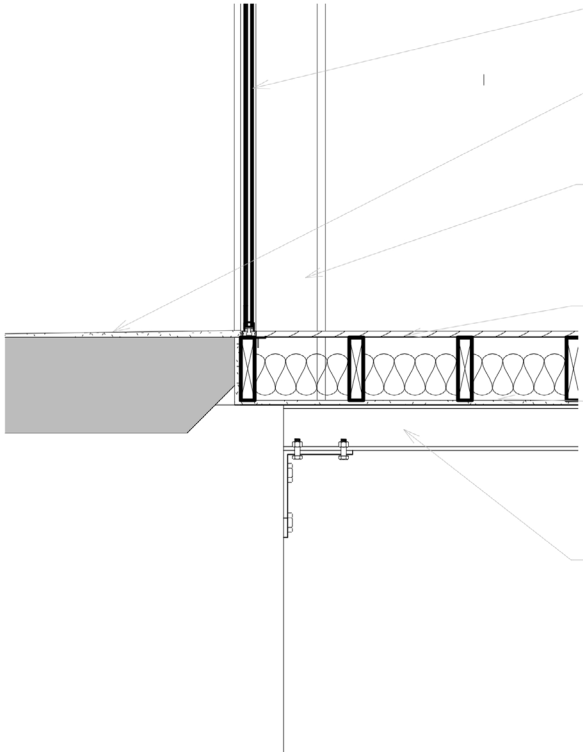


Sketches investigating revealing and concealing the steel portal frame

Fig 7.43. Flooring material sketches (Author, September 2016).



Layout of the pre-cast concrete floor slabs to work out possibility of using this material and span directions. This was later changed to a light timber floor due to weight of concrete.



2100 x 850 Concertina sliding doors with flush bottom rail to screed.

Waterproof screed with min 1;70 fall on top of existing concrete walkway of existing cress gates according to engineers details

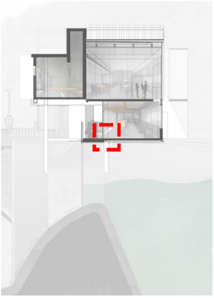
Pre-painted galvanised 305x305 hot rolled steel H column that is chemically anchored m30 bolts every 11m to concrete wall of existing cress gates according to engineers details

Add to floor sub structure on site Varnished 102 x 22 Saligna floor board secret nailed to timber joist.

Floor sub structure: 2400 x 2400 panels made from pre painted 2400 x 1200 x 12 fibre cement boarding screwed to varnished 50 x 228 Saligna floor joist at 350 centers and gaps filled with 2440 x 1220 x 150mm expanded polystyrene rigid insulation.

Pre-painted galvanised 160 x 82 x16 hot rolled steel I beam every 2.4m centers bolted to 150 x 100 x 16 unequal angle that is bolted chemically anchored m30 bolts every 2.4m to concrete wall of existing cress gates according to engineers details

Fig 7.44 Detail C (Author, September 2016).



Detail C-C

1:10

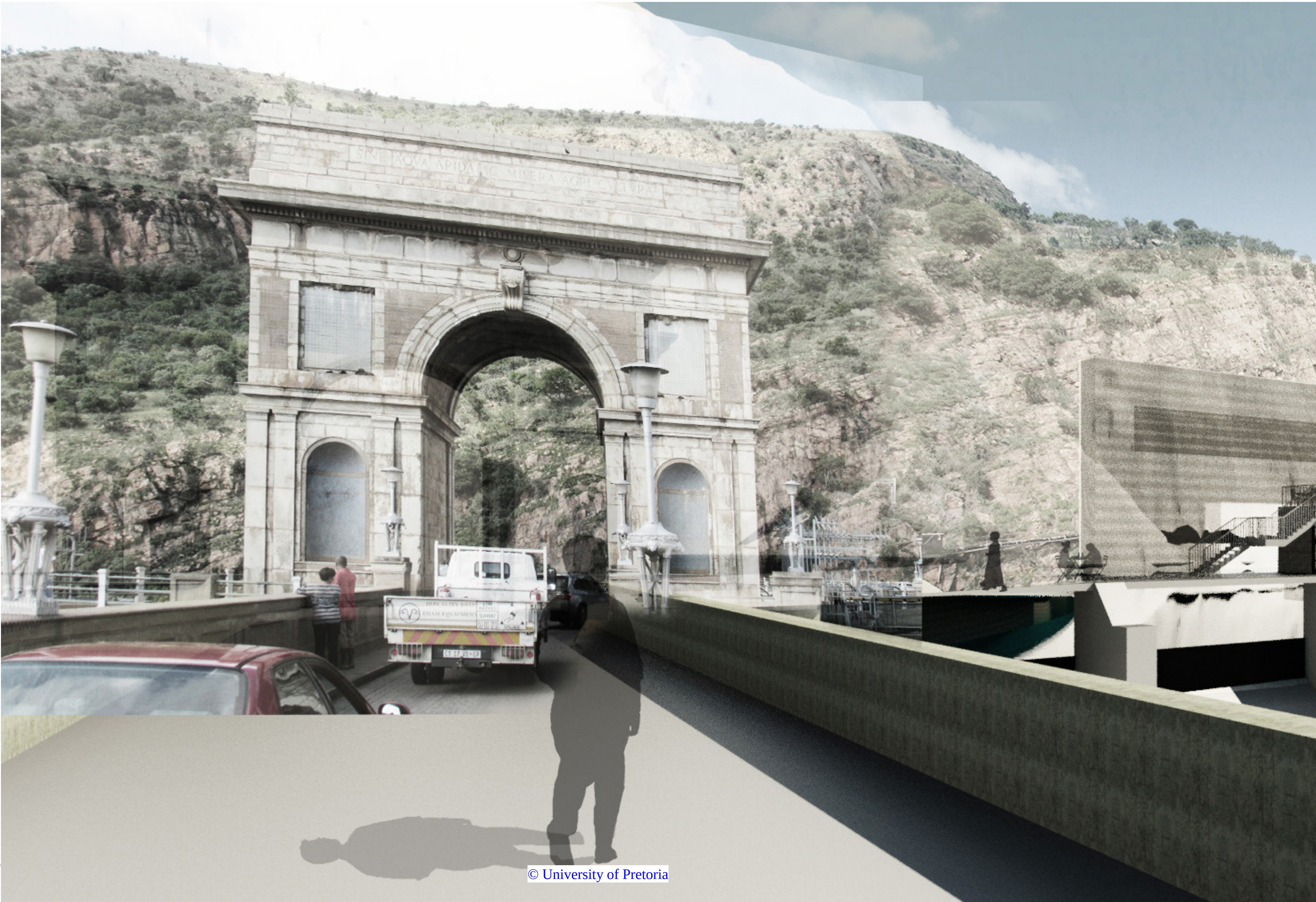

SINE AQVA ARIDA AC MISERA AGRI CVLTVRA

Fig 7.45 View of new infrastructure (Author, September 2016).

7.6 Systems

Figure 7.10 shows the different exchanges that happen on site. The didactic exchange happens with the user throughout the route as explained in the haptic understanding of site. These exchanges can be broken down into subcategories of food, water, waste and power.

Each one of these subcategories of exchanges will be explained in depth in the next few pages. It is important to note that these exchanges do not happen in isolation within each subcategory, but are intertwined. The inputs of one exchange can be the outputs of another and this allows the systems to flow as a series of closed loop systems.

The project aims to create new understanding for the user. An understanding of what is happening on site and why. This means that these exchanges needs to be expressed throughout the building. The articulation of these exchanges need to be clear and legible to the user. For example water pipes should not be hidden in the wall but exposed on the surface of it. The service core should be transparent and open to be viewed by the public. There needed to be an understanding so as to create an appreciation of the systems at work and what role water played in them.

Flows of materials in systems

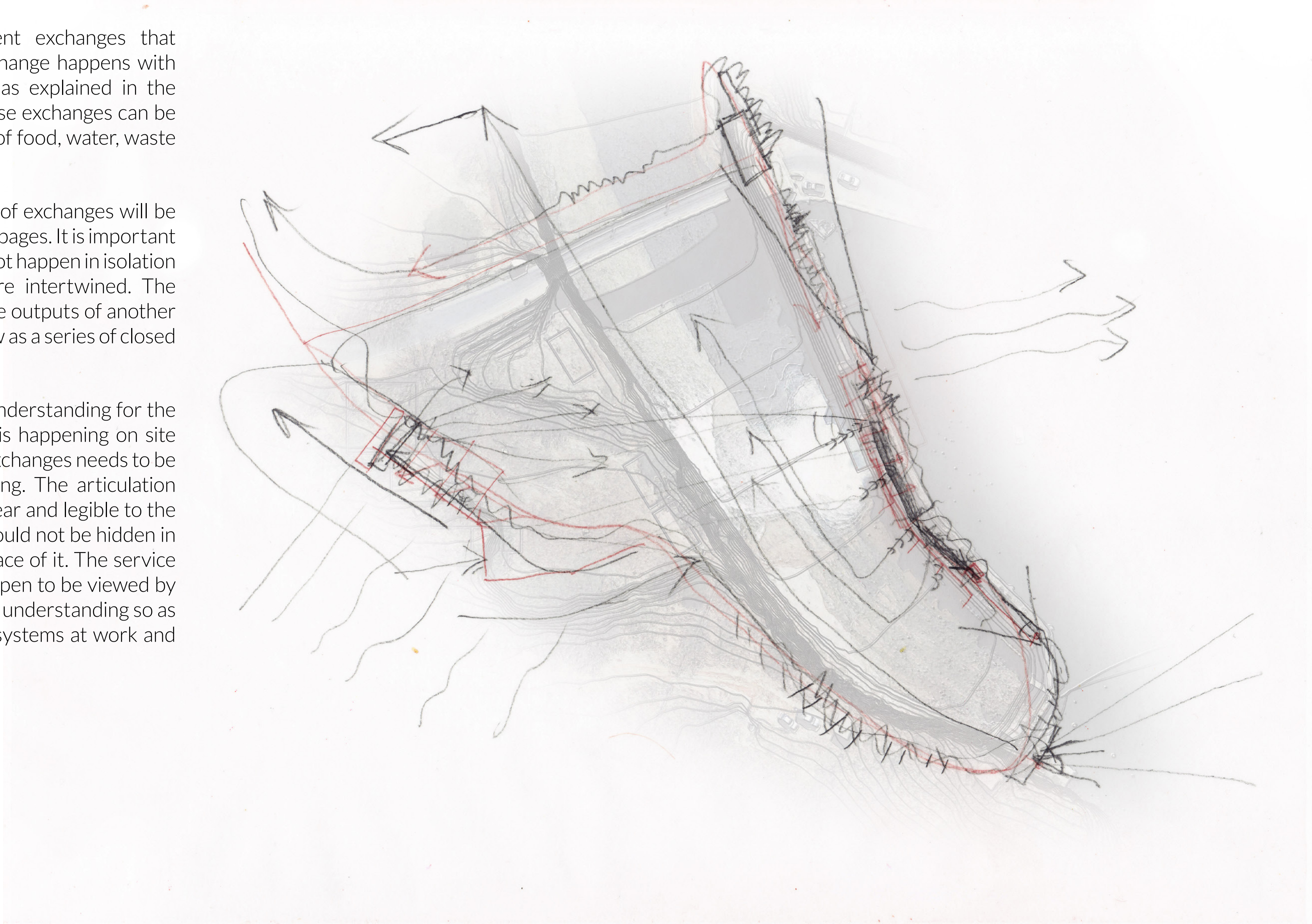


Fig 7.46. Diagram of exchanges (Author. June 2016).

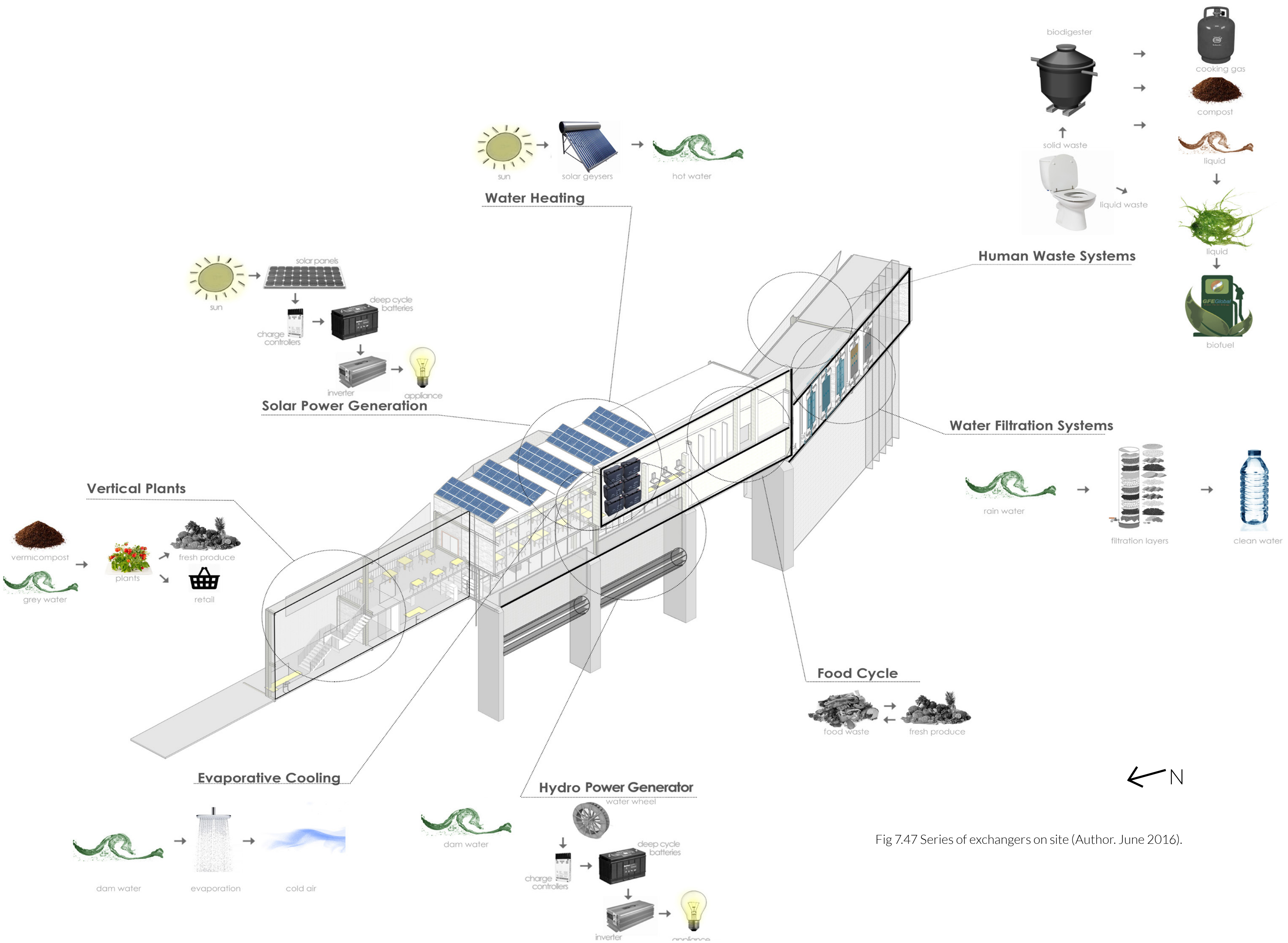


Fig 7.47 Series of exchangers on site (Author. June 2016).

Water exchanges

There are a range of different water exchanges on site. To deal with potable water demand rainwater would need to be collected from the roofs as well as the dam, as the roof area is quite small. This water would then need to be sent through a purification system in order to become potable water.

Grey water harvesting would also be carried out in order to reduce the amount of potable water used on site.

There are also water demands for irrigation of the scarred landscape as well as the crops and herbs growing for the restaurant space. Water would also be needed in the vermiculture space as moisture is needed in the system in order for it to function correctly.

Appliances that use as little water as possible will be implemented even though the site has abundance of water, it is still a precious resource and needs to be preserved. Due to the kitchen having the largest demand for potable water the tank should be located as near as possible to this. The second largest demand would be irrigation; this would mean that there would also need to be a secondary tank near the vermiculture building.

As already stated water would also be used to change the hue of light. Thus creating further exchanges between heat as well as light, integrating them into the spaces would be key to creating better understanding.

This will be done through fountains in public spaces to cool them down. Pools of water which lead to irrigation canals through public spaces in order to foster a direct engagement with water.

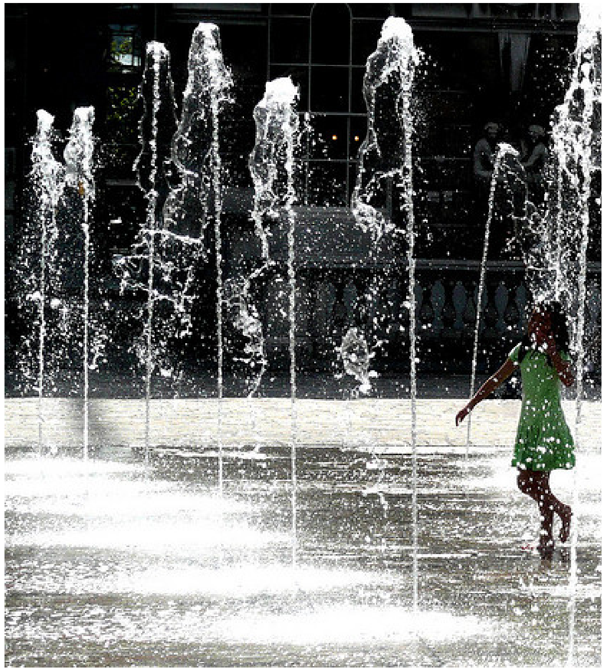


Fig 7.48 Water in public space (mindshapedbox, 2011).


Fig 7.49 Water in public space (90La, 2014).


Fig 7.50 Water in public space (Project for public spaces, 2016).

Water Yields Graph

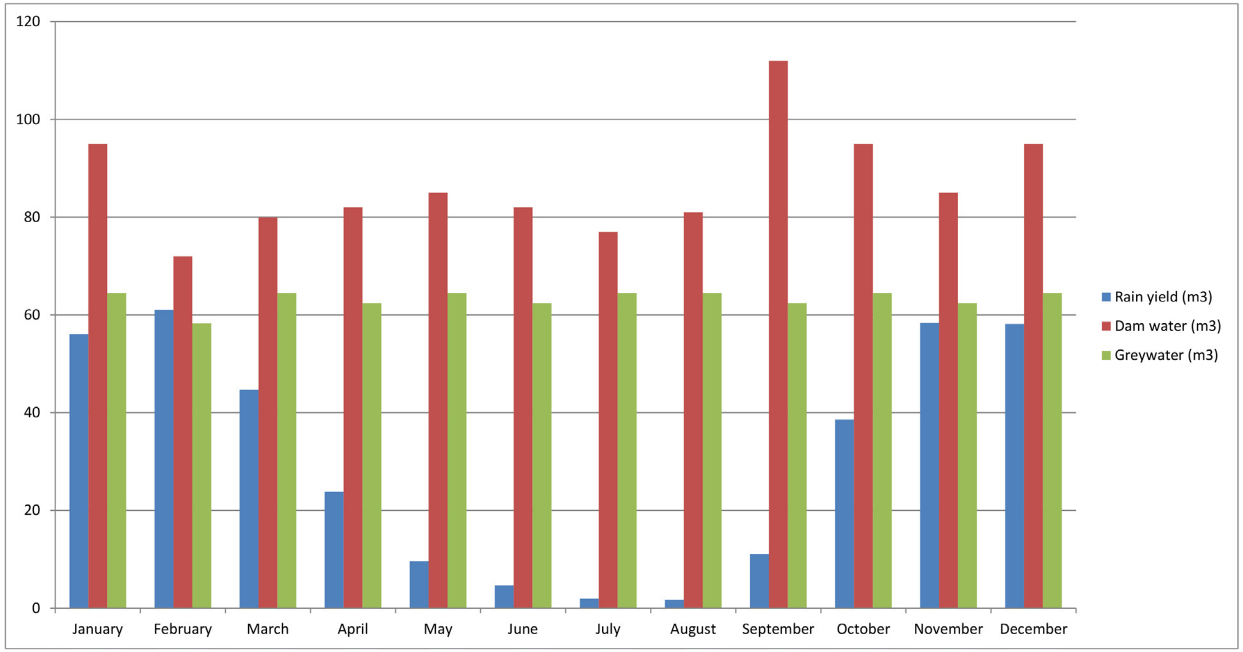


Fig 7.51 Water calculations yield (Author, September 2016).

Water yields

Due to the small footprint of the building, only 600 m^2, it was not possible to collect enough rain water for the functions of the building. The vermiculture building is also planted which means that there is little collection of water. This meant that dam water would also need to be used. This water would need to be extracted from the dam and put through a filtering system in order for it to become potable water, similarly with the rain water.

The amount of water taken out from the dam can fluctuate to the needs of the building, less during summer as there is more rain water and more in the winter when it is drier.

Grey water collection would also be needed for irrigation of the planted area and rehabilitation of the site. Biodegradable soaps could be used in the kitchen and ablutions spaces so that this water could be used for irrigation purposes.

Primary Water Demand Graph

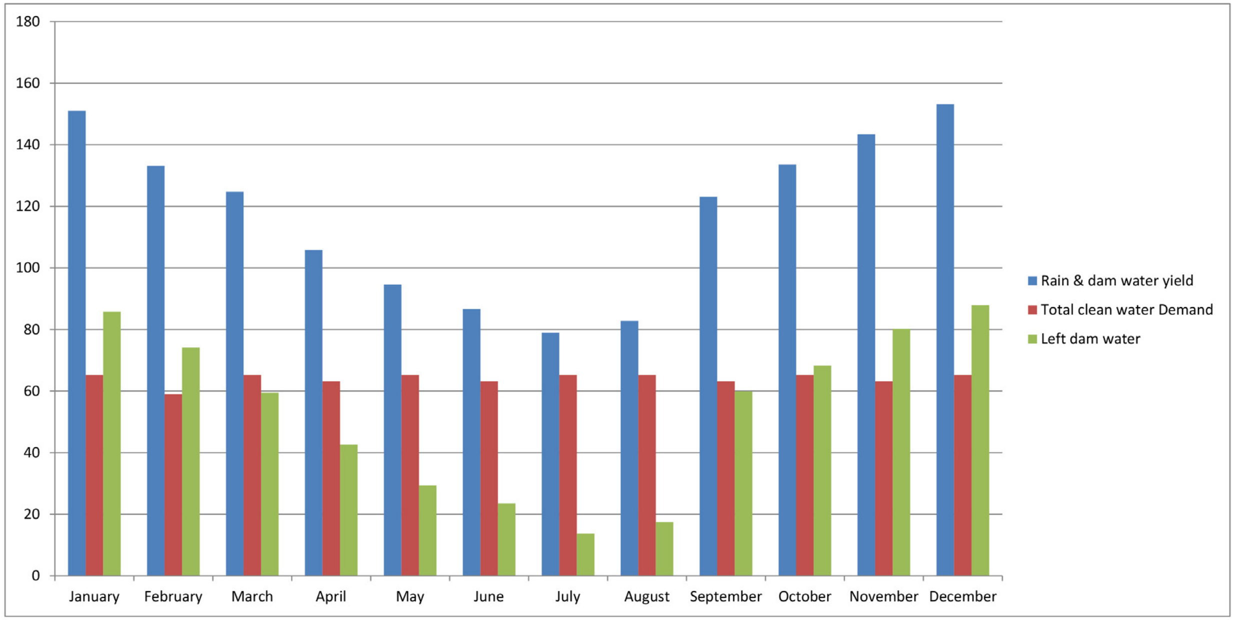


Fig 7.52 Primary water demand (Author, September 2016).

Water demand

Primary

Water demand was split into two groups. Primary water demand would be satisfied with potable water. Under this category are activities such as shower, food preparation and washing of hands. The secondary water demand would be made up of grey water and dam water cleaned to a certain point. This water would then be used for irrigation of plants and ablutions. This water would also be needed for the vermiculture.

The primary water demand graph shows the total yield from rainwater and dam water, the total primary water demand and how much water would be left. This demand is very consistent all year and would be at about 60 m^3.

Secondary Water Demand Graph

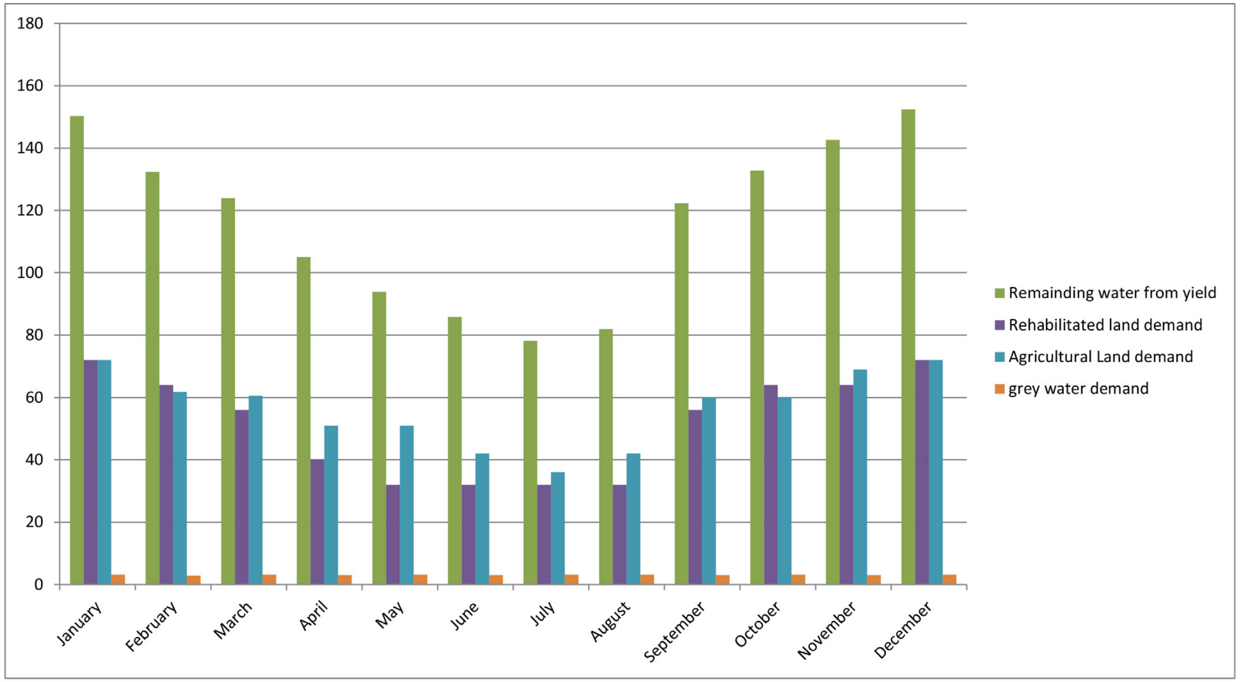


Fig 7.53 Secondary water demand (Author, September 2016).

Water demand

Secondary

This second graph shows the secondary water demands, the largest being irrigation demands ranging from 70m^3 in summer to 30m^3 in winter.

Water Budget Graph

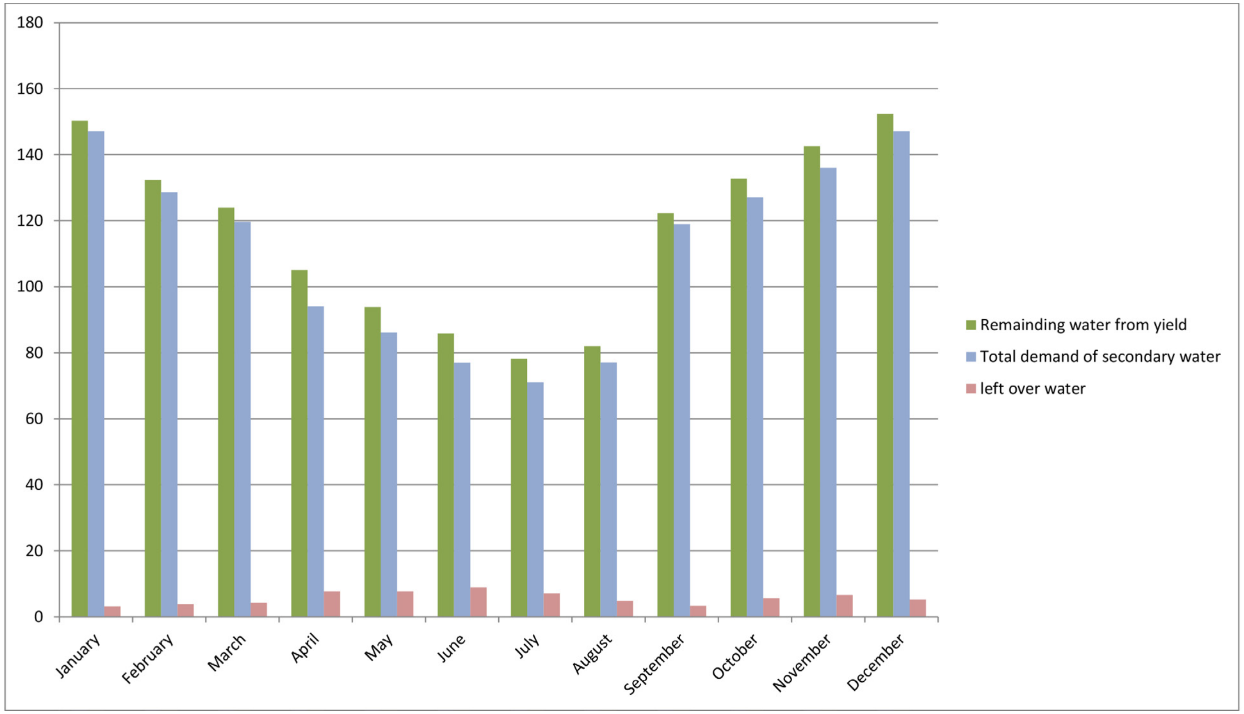


Fig 7.54 Secondary water demand (Author, September 2016).

Water budget

To satisfy all the demands a filtration system and tank size would need to be designed correctly. In order to satisfy the primary demands a tank size for rainwater and dam water would need to be approximately 175 m^3. But the fact that the water is always readily available at the dam means that the tank can be significantly smaller and the filtration system can constantly replenish it when needed. This tank could be approximately 75 m^3 in size to hold at least one summer months' worth of rain that would then be used up before the next month's rain.

The grey water tank could be half the size of the total grey water of one month as this water would consistently be used for irrigation. The total grey water of one month 65 m^3 and therefore the tank can be 35 m^3

There are a range of different water systems-

Starting with collection of rainwater, this will be collected from the roofs and flow into a surge tank where, at a later time, it will be pumped into the purification system.

The water purification system is made up of five different steps. The first is to remove floating debris, such as litter and hyacinth. This will be done by simply submerging the inlet valve in the dam. The second is an oil trap to remove pollutants lighter than water such as oils.

The third is a 10 m^3 settlement tank where the heavier pollutants will settle and then the clean water can be drained off the top. At this point some of the water will be removed that will be used for irrigation purposes as well as the vermiculture activities. This water will be stored in the 40 m^3 grey water tank as well as the 25 m^3 grey water tank.

The rest of the water will be pumped into the fourth stage which is a vertical wetland where the plants roots will extract the minerals from the water. These plants will grow produce for the restaurant as well as be sold as products from the retail space.

And lastly to remove pathogens the water will need to go through a UV filter and a sand filter. At this point the potable water will be pumped into the storage tank where it will stay until it is utilised. There are two storage tanks, one on the vermiculture side (70 m^3) and one in the service core of the restaurant (25 m^3).

Purpose made hot press steel tank construction to 25m^3 and 40m^3. Inlet and outlet with built in pump, equipped with man hole for inspection and maintenance

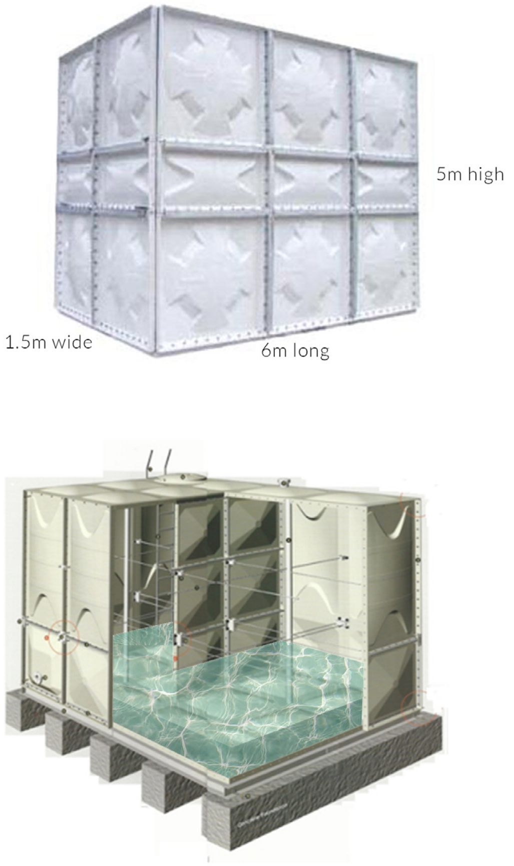
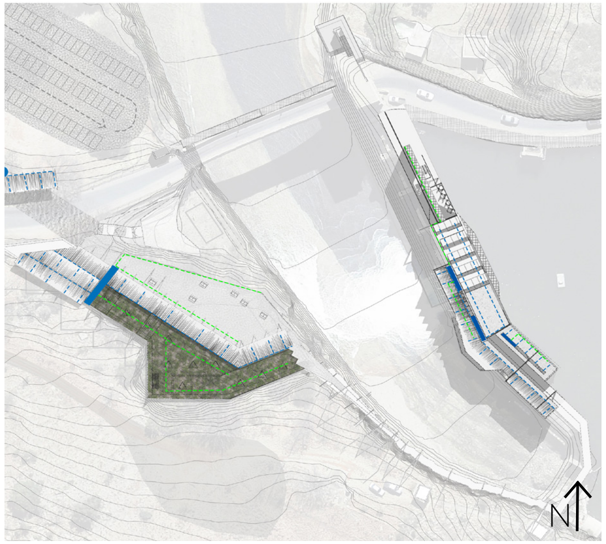
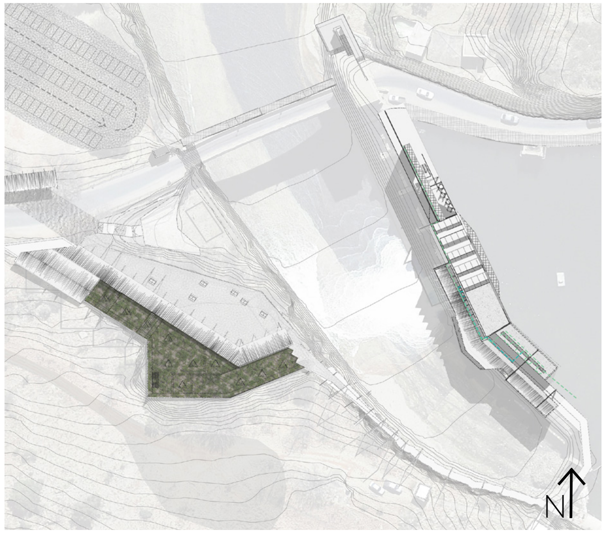


Fig 7.56 Water calculations result (Author, September 2016).



WATER CATCHMENT AND USE

Fig 7.55 Water Catchment and use (Author, September 2016).



WATER FILTRATION SYSTEM

Fig 7.57 Water Filtration system (Author, September 2016).

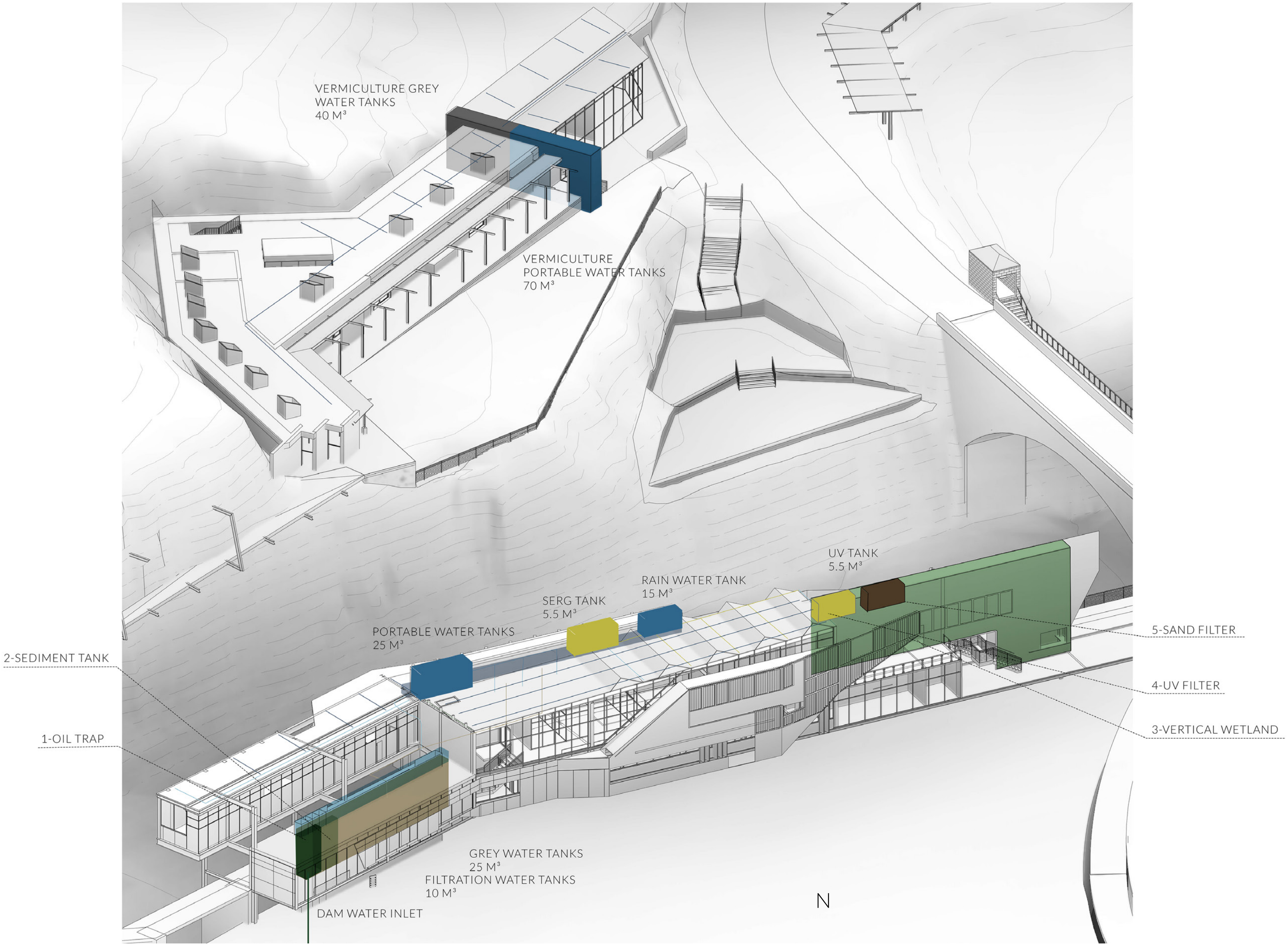


Fig 7.58 Water System on site (Author, September 2016).

Water yields calculations

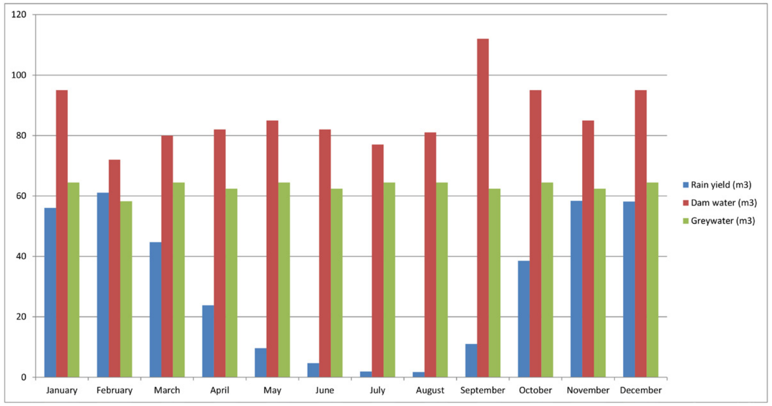
Catchment surface
Roof

	Area (m2)	Runoff coefficient weighted	Area of catchment weighted
	600	0.9	540
			540

Rainwater yield calculation

	Ave. monthly percepitation	Area of catchment weighted	Rain yield (m3)	Dam water (m3)	Yield (m3)
January	0.1038	540	56.052	95	151.052
February	0.1131	540	61.074	72	133.074
March	0.0828	540	44.712	80	124.712
April	0.0441	540	23.814	82	105.814
May	0.0178	540	9.612	85	94.612
June	0.0086	540	4.644	82	86.644
July	0.0036	540	1.944	77	78.944
August	0.0032	540	1.728	81	82.728
September	0.0205	540	11.07	112	123.07
October	0.0714	540	38.556	95	133.556
November	0.1081	540	58.374	85	143.374
December	0.1077	540	58.158	95	153.158
Total	0.6847	6480	369.738	1041	1410.738

Water yields graph



Grey Water Harvisting

visitors			
150	Handwashing:spray taps	2	300
0	Clothes washing machine	4	0
75	Dishwashing machine	3	225
0	Shower	25	0
75	Drinking, food preparation and cooking	15	1125
			1650
Permanent workers			
30	Handwashing:spray taps	2	60
0	Clothes washing machine	25	0
15	Dishwashing machine	3	45
2	Shower	50	100
15	Drinking, food preparation and cooking	15	225
			430
	Total grey water back as yeild		2080

Grey Water Harvisting

Month	Days/month		Working days/month		Water capita/Day	Water capita/month	Greywater Domestic Harvisting/month (m3)
January	31	430	31	1650	2080	64480	64.48
February	28	430	28	1650	2080	58240	58.24
March	31	430	31	1650	2080	64480	64.48
April	30	430	30	1650	2080	62400	62.4
May	31	430	31	1650	2080	64480	64.48
June	30	430	30	1650	2080	62400	62.4
July	31	430	31	1650	2080	64480	64.48
August	31	430	31	1650	2080	64480	64.48
September	30	430	30	1650	2080	62400	62.4
October	31	430	31	1650	2080	64480	64.48
November	30	430	30	1650	2080	62400	62.4
December	31	430	31	1650	2080	64480	64.48
						759200	759.2

Fig 7.59 Water yield calculation (Author, September 2016).

Water demand calculations

Permanent workers

Permanent people	Appliances	Litres/day/person served	total demand per day
30	Handwashing:spray taps	2	60
30	Urinial flushing 8h day	1	30
15	Dishwashing machine	3	45
5	Shower	25	125
15	WC flushing-urinals provided	0	0
15	Drinking, food preparation and cooking	15	225
			485

WATER CAPITA/DAY (L)

Visitors

Public People	Appliances	Litres/day/person served	total demand per day
150	Handwashing:spray taps	2	300
70	Urinial flushing 8h day	1	70
75	Dishwashing machine	3	225
35	WC flushing-urinals provided	0	0
75	Drinking, food preparation and cooking	15	1125
			1720

RAIN WATER & DAM WATER DEMAND

Month	Days/month		Working days/month		Water capita/Day	Water capita/month	Domestic demand/month (m3)
January	31	410	31	1425	1835	56885	56.885
February	28	410	28	1425	1835	51380	51.38
March	31	410	31	1425	1835	56885	56.885
April	30	410	30	1425	1835	55050	55.05
May	31	410	31	1425	1835	56885	56.885
June	30	410	30	1425	1835	55050	55.05
July	31	410	31	1425	1835	56885	56.885
August	31	410	31	1425	1835	56885	56.885
September	30	410	30	1425	1835	55050	55.05
October	31	410	31	1425	1835	56885	56.885
November	30	410	30	1425	1835	55050	55.05
December	31	410	31	1425	1835	56885	56.885
						669775	669.775

DAM WATER DEMAND

Month	Days/month		Working days/month		Water capita/Day	Water capita/month	Domestic demand/month (m3)
January	31	**45**	31	225	270	8370	8.37
February	28	45	28	225	270	7560	7.56
March	31	45	31	225	270	8370	8.37
April	30	45	30	225	270	8100	8.1
May	31	45	31	225	270	8370	8.37
June	30	45	30	225	270	8100	8.1
July	31	45	31	225	270	8370	8.37
August	31	45	31	225	270	8370	8.37
September	30	45	30	225	270	8100	8.1
October	31	45	31	225	270	8370	8.37
November	30	45	30	225	270	8100	8.1
December	31	45	31	225	270	8370	8.37
						98550	98.55

Primary water demand graph

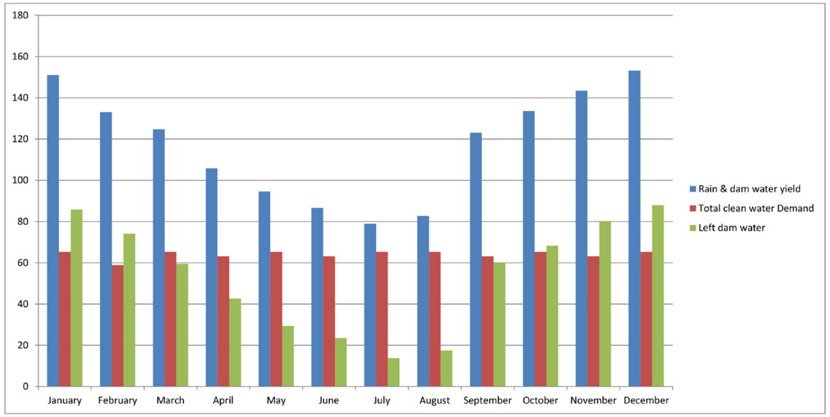


Fig 7.60. Primary water demand calculation (Author, September 2016).

Water demand calculations

GREY DEMAND

Month	Days/month		Working days/month		Water capita/Day	Water capita/month	Domestic demand/month (m3)
January	31	30	31	70	100	3100	3.1
February	28	30	28	70	100	2800	2.8
March	31	30	31	70	100	3100	3.1
April	30	30	30	70	100	3000	3
May	31	30	31	70	100	3100	3.1
June	30	30	30	70	100	3000	3
July	31	30	31	70	100	3100	3.1
August	31	30	31	70	100	3100	3.1
September	30	30	30	70	100	3000	3
October	31	30	31	70	100	3100	3.1
November	30	30	30	70	100	3000	3
December	31	30	31	70	100	3100	3.1
						36500	36.5

Fig 7.61 Secondary water demand calculation (Author, September 2016).

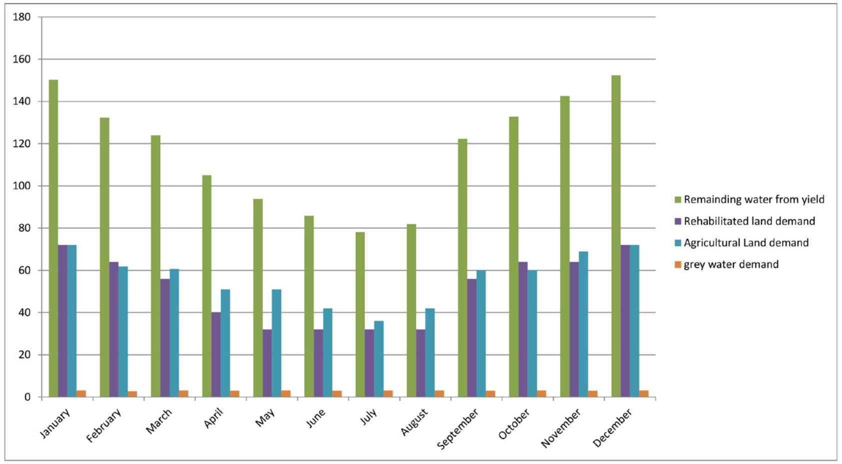
Irrigation Demand
Agricultural Land

	Planting Area (m2)	Irr. Depth/ month	Agricultural Land Irrigation demand (m3
January	600	0.12	72
February	600	0.103	61.8
March	600	0.101	60.6
April	600	0.085	51
May	600	0.085	51
June	600	0.07	42
July	600	0.06	36
August	600	0.07	42
September	600	0.1	60
October	600	0.1	60
November	600	0.115	69
December	600	0.12	72
		Total	677.4

Irrigation Demand
Rehabilitated landscape

	Planting Area (m2)	Irr. Depth/ month	Rehabilitated landscape demand (m3
January	800	0.09	72
February	800	0.08	64
March	800	0.07	56
April	800	0.05	40
May	800	0.04	32
June	800	0.04	32
July	800	0.04	32
August	800	0.04	32
September	800	0.07	56
October	800	0.08	64
November	800	0.08	64
December	800	0.09	72
		Total	616

Secondary water demand graph



Water budget calculations

Clean Water Demand Cal	Dam water	RAIN WATER & DAM WATER DEMAI	DAM WATER DEMAND				
	Rain & dam water yield	Domestic demand/month (m3)	Domestic demand/month (m3)	Total clean water Demand	Left dam water		Tank size 500 m3
January	151.052	56.885	8.37	65.255	85.797	399.618	500
February	133.074	51.38	7.56	58.94	74.134	473.752	500
March	124.712	56.885	8.37	65.255	59.457	533.209	500
April	105.814	55.05	8.1	63.15	42.664	575.873	500
May	94.612	56.885	8.37	65.255	29.357	605.23	500
June	86.644	55.05	8.1	63.15	23.494	628.724	500
July	78.944	56.885	8.37	65.255	13.689	0	433
August	82.728	56.885	8.37	65.255	17.473	17.473	455.63
September	123.07	55.05	8.1	63.15	59.92	77.393	500
October	133.556	56.885	8.37	65.255	68.301	145.694	500
November	143.374	55.05	8.1	63.15	80.224	225.918	500
December	153.158	56.885	8.37	65.255	87.903	313.821	500
Total	1410.738	669.775	98.55	768.325	642.413		

Grey water demand								
	Greywater Domestic Harvisting/month (m	Left dam water	Remainding water from yield	Rehabilitated land demand	Agricultural Land demand	grey water demand	Total demand of secondary water	le
January	64.48	85.797	150.277	72	72	3.1	147.1	
February	58.24	74.134	132.374	64	61.8	2.8	128.6	
March	64.48	59.457	123.937	56	60.6	3.1	119.7	
April	62.4	42.664	105.064	40	51	3	94	
May	64.48	29.357	93.837	32	51	3.1	86.1	
June	62.4	23.494	85.894	32	42	3	77	
July	64.48	13.689	78.169	32	36	3.1	71.1	
August	64.48	17.473	81.953	32	42	3.1	77.1	
September	62.4	59.92	122.32	56	60	3	119	
October	64.48	68.301	132.781	64	60	3.1	127.1	
November	62.4	80.224	142.624	64	69	3	136	
December	64.48	87.903	152.383	72	72	3.1	147.1	
Total	759.2	642.413	1401.613	616	677.4	36.5	1329.9	

Water Budget Graph

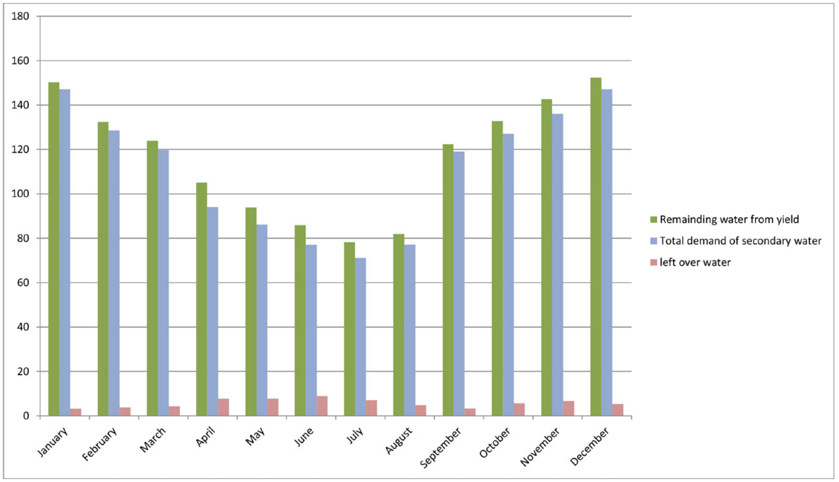


Fig 7.62 Water Budget calculation (Author, September 2016).

Food exchanges

Exchanges of food start at the vermiculture building, with the changing of the hyacinth into compost in the productive landscape, which is then used to grow plants and herbs in the synthetic landscape.

There are two points where the crops and herbs are grown; the planted roof above the vermiculture space will be utilised for this, as well as in the vertical wet land that will purify the water by absorbing the minerals in the roots of the plants. Smaller plants such as the herbs and vegetables for example coriander, basil, lettuce, tomatoes and strawberries will be growing in the hanging water channels and the larger plants such as cauliflower, broccoli, carrots, rosemary and thyme would be grown on the planted roof space.

These plants and herbs are then utilised in the kitchen space to make meals to be sold in the restaurant space. Picnic baskets are also made up to be sold in the retail space to engage a range of different people. Any food scraps left over from the kitchen would then enter into the biodigester and help that system to be more effective.

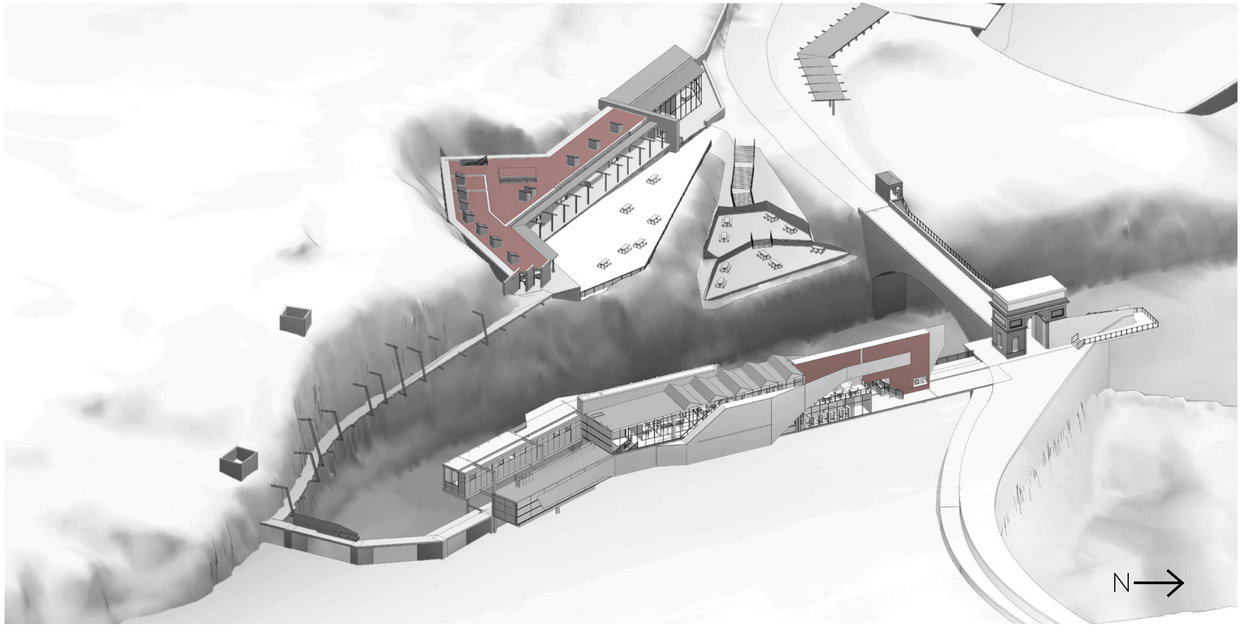


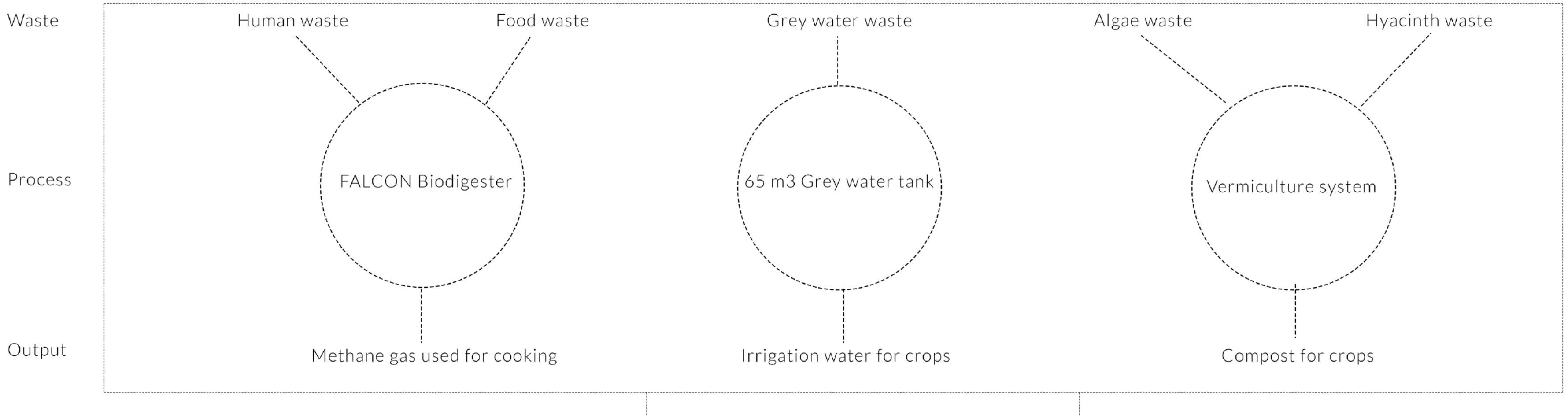
Fig 7.63 Food exchanges (Author, September 2016).

Waste exchanges

Human waste will enter into a biodigester that will create methane gas that can be used as cooking gas. A secondary by product of the system is also a compost sludge that can be placed on the plants and herbs. To further this process, any scraps or waste from the kitchen will also be placed into the system in order to increase productivity.

A secondary system is the vermiculture process that will deal with algae and hyacinth from the dam water and creating compost. The compost will then be used to grow new crops

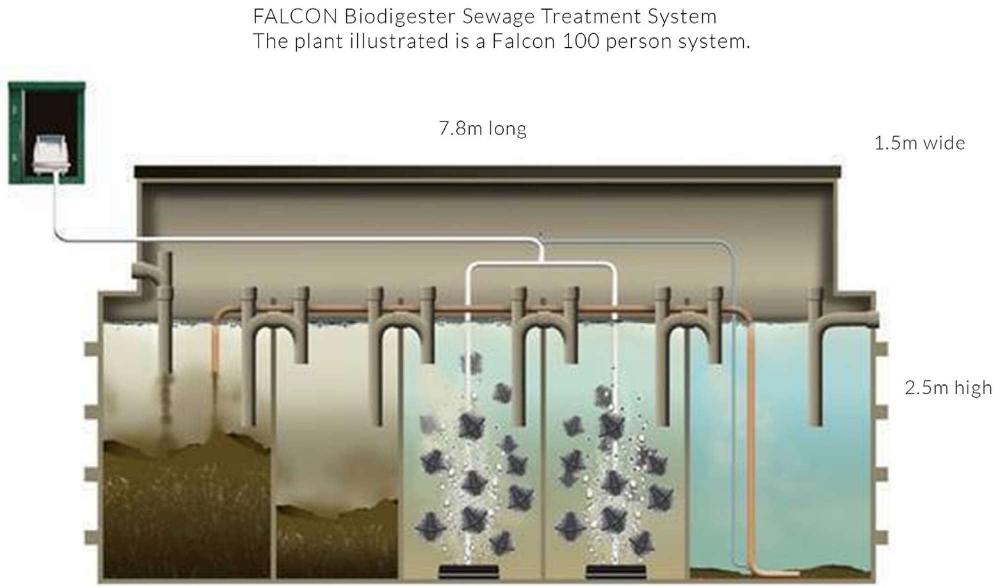
WASTE SYSTEMS

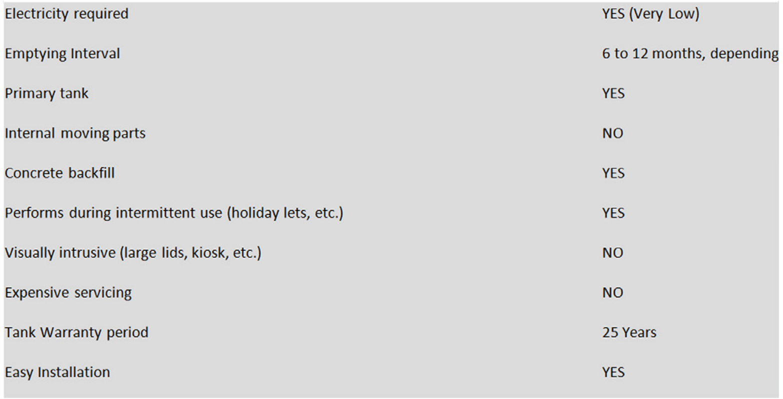


The biodigester would have to be of a significant size due to the number of users. The Falcon which is a domestic sewage treatment biodigester was looked at to fulfil this need. Falcon creates biodigesters to cater for 20 to 300 people, but the system size for this site would only need to cater for 100 people (Water Technology Engineering, 2016).

The system is an extremely effective and unobtrusive means of dealing with sewage disposal. It has a very low electrical consumption, very high effluent quality and minimal services required. This system deals with periodic use which most biodigester are unable to handle. This may occur at this site during the winter months when there are not as many users (Water Technology Engineering, 2016).

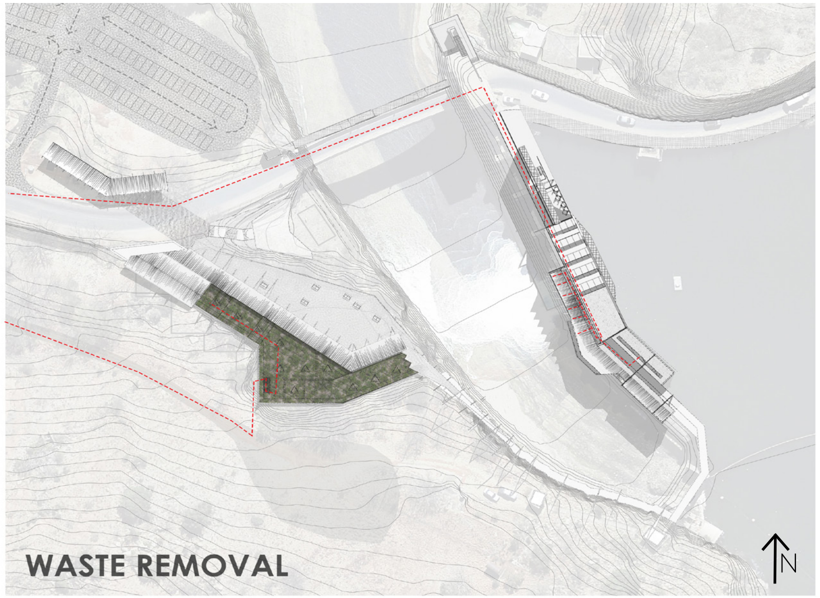
Due to its significant size it would have to be hung from the primary portal frames below the ablutions block, to free up space above. This way the toilets can feed directly into the system. The gas bladder would sit above this in front of the ablutions wall and from this point the gas would flow in pipes to the kitchen.

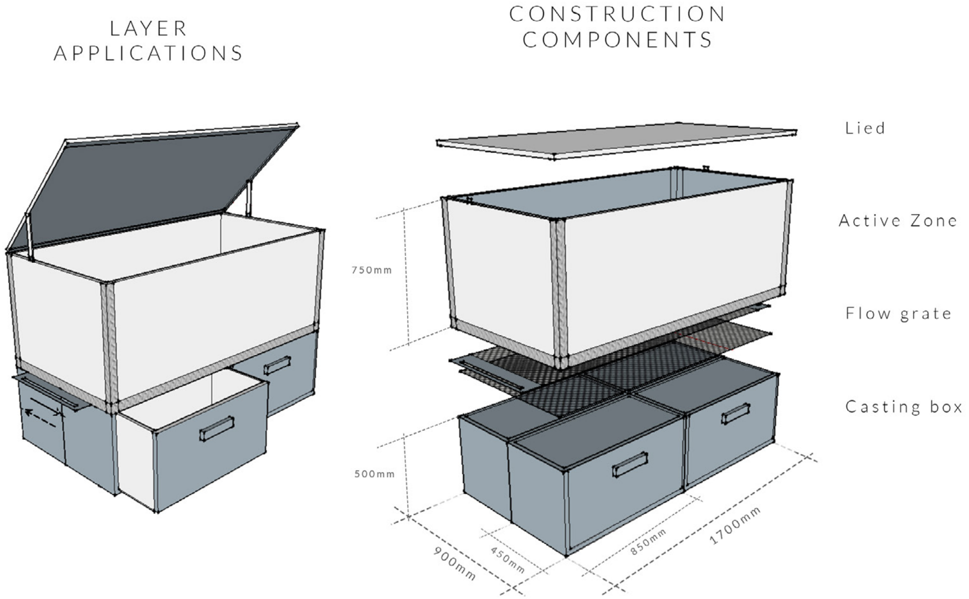




Electricity required	YES (Very Low)
Emptying Interval	6 to 12 months, depending
Primary tank	YES
Internal moving parts	NO
Concrete backfill	YES
Performs during intermittent use (holiday lets, etc.)	YES
Visually intrusive (large lids, kiosk, etc.)	NO
Expensive servicing	NO
Tank Warranty period	25 Years
Easy Installation	YES

Fig 7.64. Biodigester (Crystaltank, 2016).





Electricity required	YES (Very Low)
Emptying Interval	1 months, depending on use
Labour intervals	1 week
Internal moving parts	NO
Smell	NO
Performs during intermittent use (holiday lets, etc.)	YES
Expensive od capital	Small
Expensive servicing	NO
Tank life period	10 Years
Easy Installation	YES

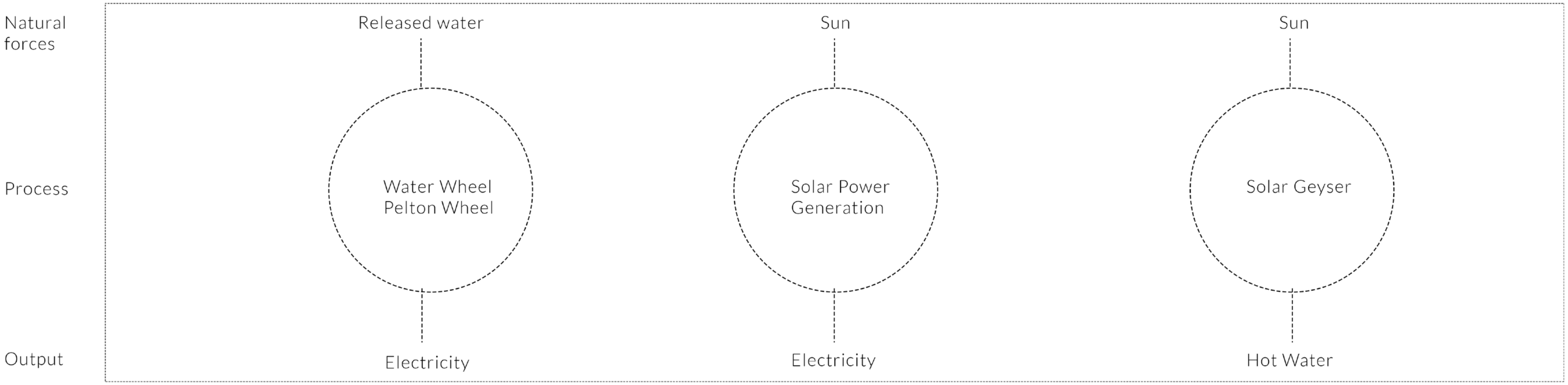
Fig 7.65 Vermiculture system (Author, September 2016).

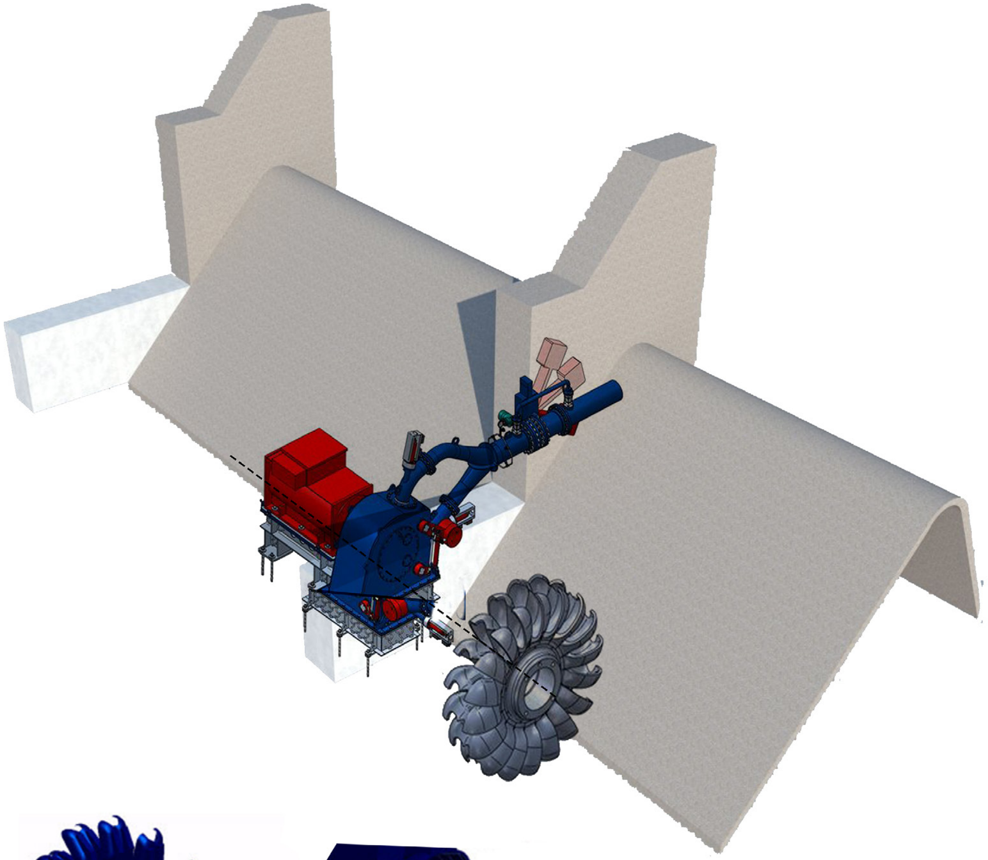
Power exchanges

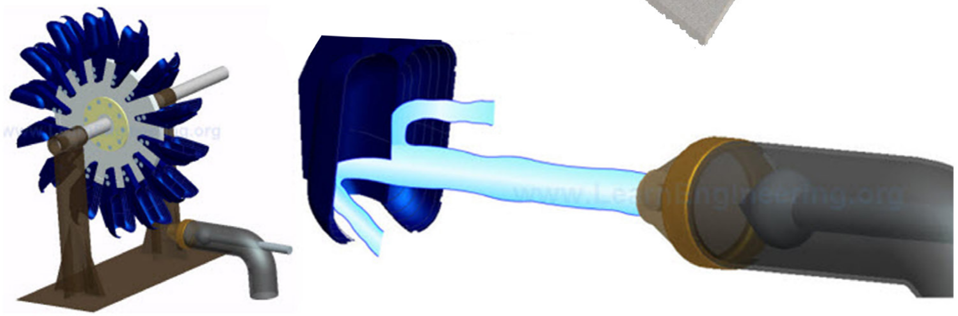
Currently there is no power generation from the dam water but this is the place where power could be generated easily. The integration of a water wheel could be placed at certain crest gates and at the other gates a very effective Pelton wheel could be placed which is small and would not disrupt the current system.

A secondary system of solar panels can be integrated into the roof so that in times of drought water would not have to be wasted in order to gain power. Similarly, to generate hot water a solar hot water geyser system can be integrated into the roof. Hartbeespoort Dam receives a large amount of solar hours, making both of these effective systems.

POWER GENERATION







The Pelton wheel was designed by Lester Allan Pelton in the 1870s (Wikipedia, 2014). It is an impulse type water turbine, this means that it extracts energy from impulse of moving water through a jet. This allows you to use a very little amount of water to generate a lot of power. The most important part of the Pelton wheel is the paddle which is uniquely designed to extract as much dynamic energy as possible, making this a very effective system.

The dam has a constant outflow of water on the eastern side of the dam through a pipe. This is in order to keep the river with a base flow, this water then feeds the agricultural land. This means when power is needed the water could rather be diverted through the jets on to the Pelton wheel in order to generate electricity without wasting any additional water.

The system could be integrated into the existing concrete crest gate walls. The downfall to the system is that there is not much visual link to it as it is contained with in a structural frame. This will not lead to much understanding by the viewer and this is why it is proposed that one crest gate has a regular water wheel.

This water wheel will run periodically and only when the crest gate is open. The system is not as effective as the Pelton wheel as it wastes a large amount of water.

Fig 7.66. Pelton wheel (learn engineering, September 2016).

The electrical requirements are relatively large due to the kitchen space (260 kW per day). There needs to be a minimum of 300m² solar panels (900x1800). Rather then doing this, it would be more appropriate to have a hybrid system. 125m² of solar power and hydroelectrically through the Pelton wheel.

The hydro-electrical system can also be turned on during peak hours when needed. This is also a more reliable energy source as it can run at night with out having to store energy from the day. Peak hours of the restaurant will be at night so this system will function better. The Pelton wheel uses less water than a conventional hydroelectrically system, even in water shortages the system can function.

Figure 7.64 shows the roof plan with the extent of the solar panels. Integrated into this would also be solar geysers to create hot water needed for the ablution block as well as the kitchen.

For maintenance and repairs, access to the roof will be needed. There will be two points of access to the roof; one from between the screens as a simple ladder and the other would be above the stairwell that would be a drop-down ladder.

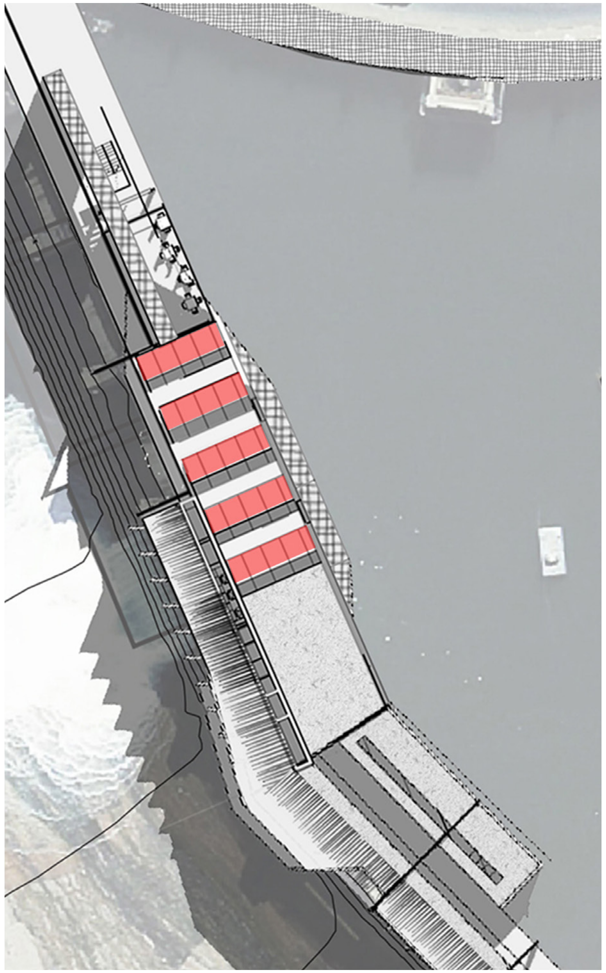


Fig 7.67 Solar panels (Author, September 2016).

7.7 Climatic responses to over heating

Climatic responses mainly had to deal with the overheated period due to local climate. The following diagrams show different responses that the building will use to become climatically comfortable.

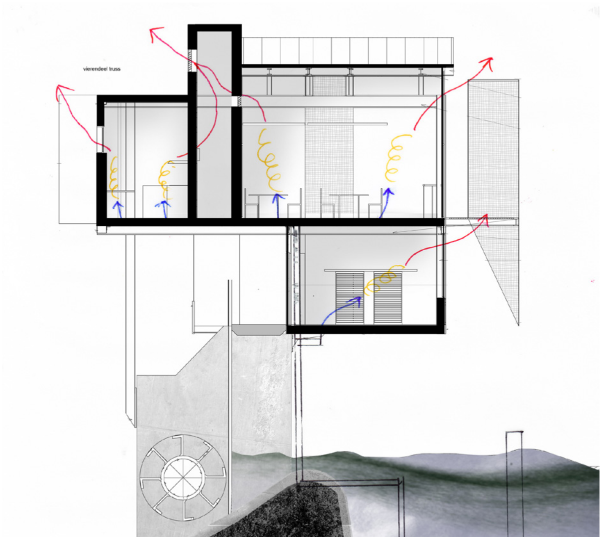
As previously stated the outdoor air will be channelled through the poort of the mountains and, as this draws air over the water body, it will create evaporative cooling. This will greatly reduce the local temperature. This means air needs to be drawn into the space from the north and east to make the most of this cool breeze.

Cross ventilation

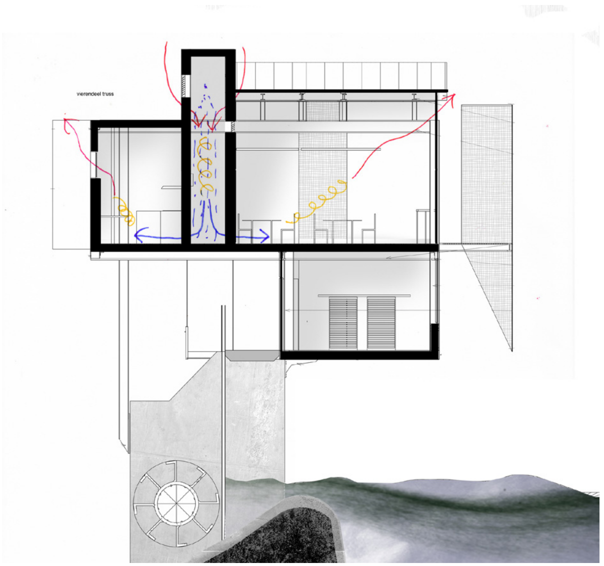
As the spaces range between 6m and 8m wide, it was possible to have cross ventilation. This natural cool air could be drawn in from the services core and then through controllable vents in the spaces. Openable windows under the ceiling level will be places on the east and west façade for the extraction of hot air.

Evaporative cooling

Evaporative cooling towers are to be used. Pretoria has dry summers and the hot dry air uses heat to evaporate the water therefore cooling it and integrated water elements to continue the education of the user in the potential of water.



Cross ventilation



Evaporative cooling towers

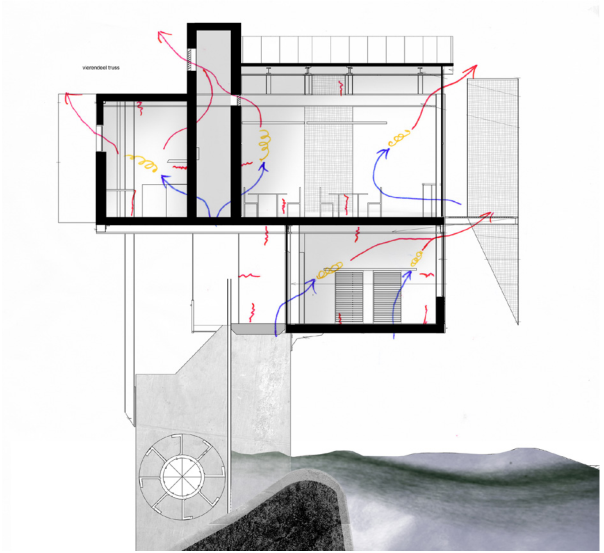
Fig 7.68. Overheating (Author. September 2016).

Night flushing

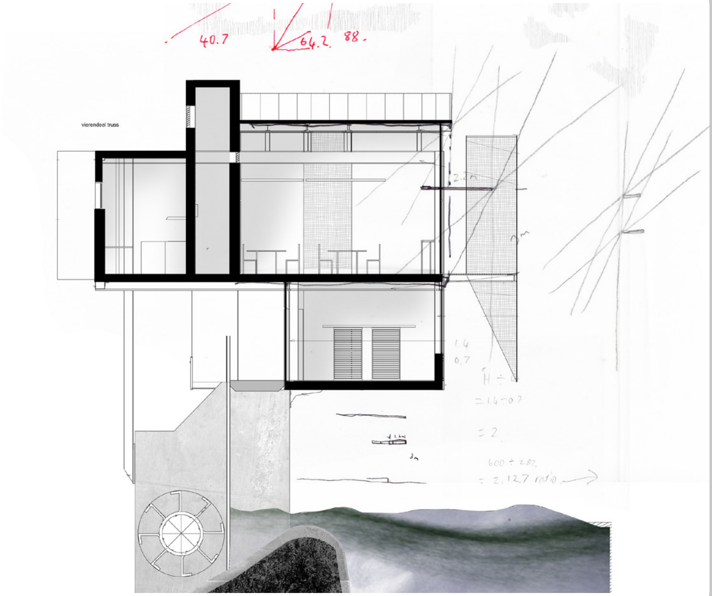
The night flushing system is very effective in this climate to lose the heat build-up in the thermal mass of the building in order for it to absorb heat the next day again. The system is also easy to be implemented as it uses the same elements as cross ventilation. It does need good management of opening and closing of the windows at night, for the system to function.

Solar screen

With regards to the over heated periods and the fact that there are large amounts of glazing on the facade for views meant that the solar screen needed to be articulated very carefully in order to let as little direct sun light into the space in summer but the maximum in winter while always allowing the view to be seen.



Night flushing



Solar angles. North vs. east & west

Fig 7.69. Cooling (Author. September 2016).

7.8 Climatic responses to under heating

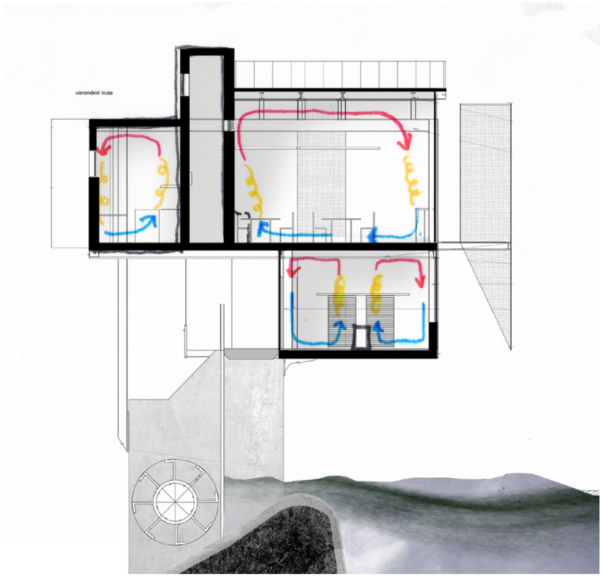
Climatic responses mainly had to deal with the overheated period, but due to the fact that there is little thermal mass in the building and large amounts of glazing on the facade for views, heating in winter would also become a factor. The following diagrams show different responses that the building will use to become climatically comfortable.

Fireplaces

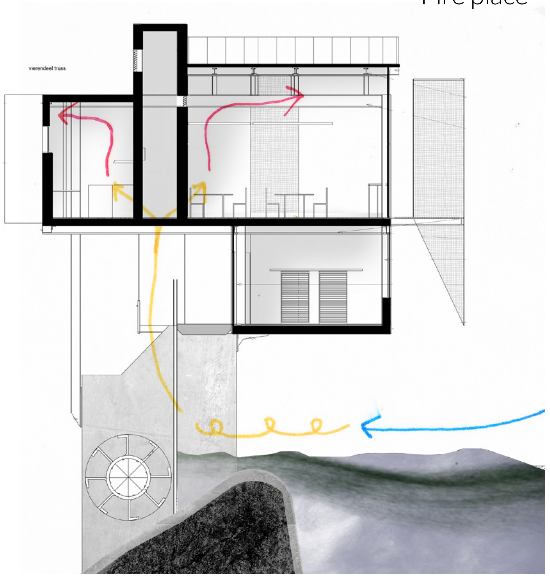
Fireplaces will be set into the thermal mass elements of the building such as the concrete services core. Any heat created in the kitchen will also be utilised and circulated through the public space. The solar screen that covers the large glazing has also been articulated at the right angle to allow winter light to penetrate deep into the spaces.

Large water body

In winter the large body of water will keep a more constant temperature and therefore air that is drawn across this will heat up and can be brought into the space for air change.



Fire place



Large water body

Fig 7.70. Under heated (Author. September 2016).

Solar screen

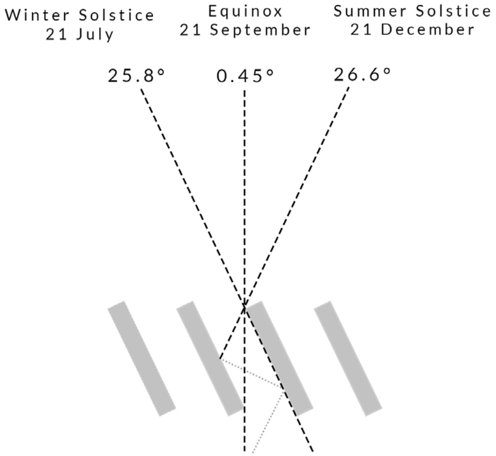
As already stated the articulation of the solar screen to allow maximum light into the space in the winter months was crucial. The design of the screen looked at the optimum solar angles. Through the investigation it was found that vertical louvres rotated at an angle of 25° would allow in winter solstice light and the spacing between the louvres could be played with to allow in the equinox light. These louvres would block the direct summer solstice light but reflect indirect light into the space.

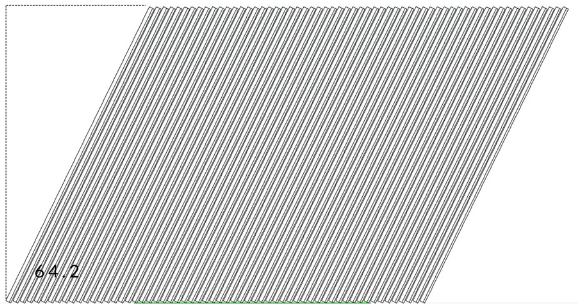
To allow no direct sunlight during the summer solstice the louvres would actually need to be at 64° from the horizon and not directly vertical at 90° (rotated to an angle of 25°). This would allow very little view out and was rather kept to vertical louvres

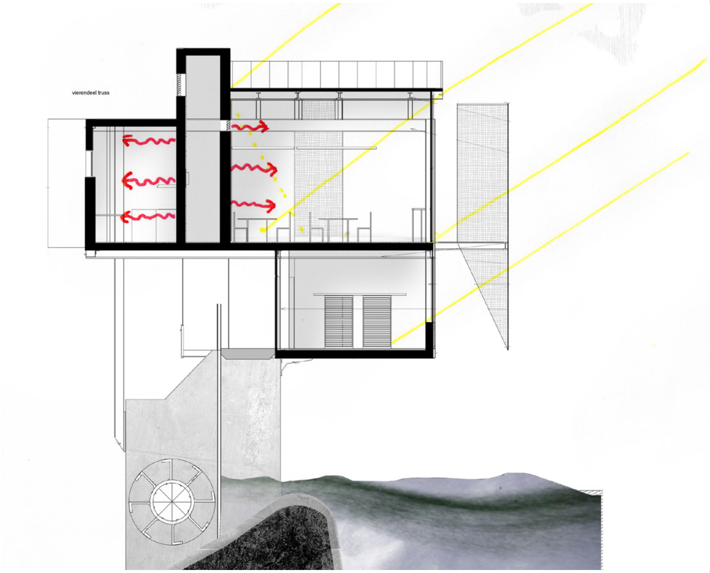
Thus creating the best screen possible mediating these two informants (design and environmental needs). A glazed gap was placed between the service core and the roof plane to wash the concrete service core with natural light. This will warm up and then radiate heat back into the space to keep a more constant temperature.

Gas heaters

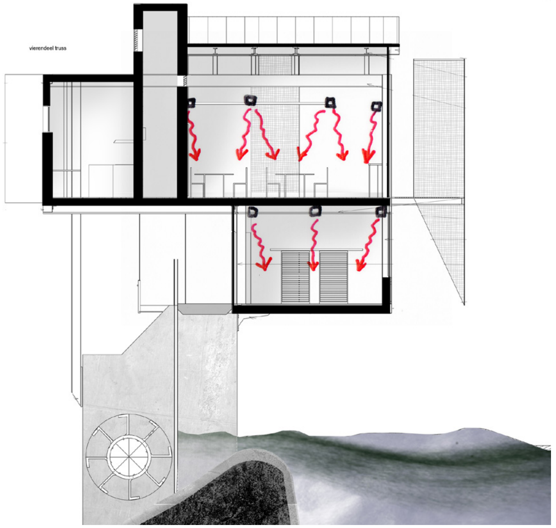
Simple gas heaters could be introduced into the space as gas has already been created on site through the biodigester.







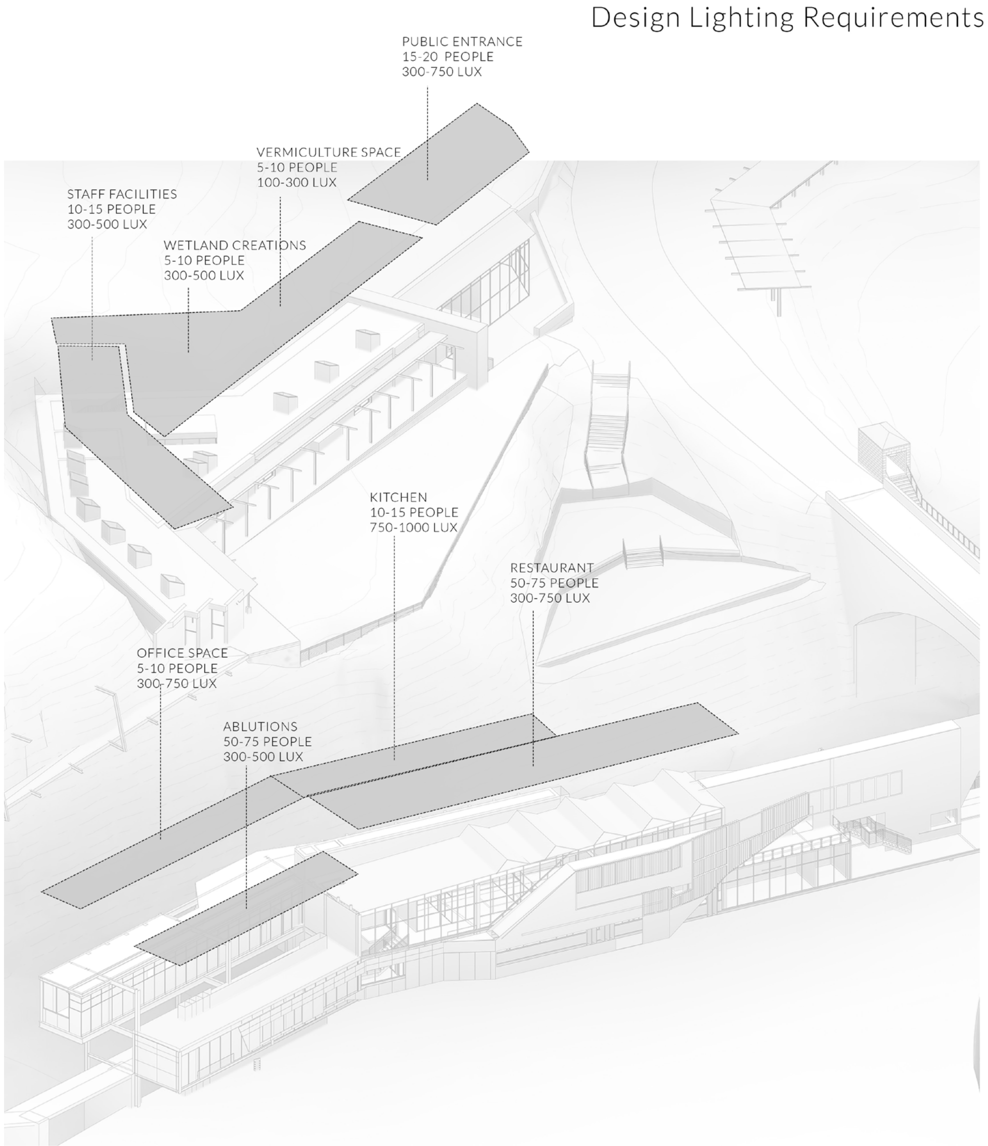
Deep penetration of light



Gas heaters

Fig 7.71. Heating systems (Author. September 2016).

7.9 Lighting exchanges



Analysis program

In order to test the lighting quality of the iterations, a computer program called Sefaira was used. In this program it is possible to set the required lux levels of the space and the program would generate three main analysis tools; Daylight factor, annual illuminance, underlit and overlit spaces.

The underlit and overlit analysis tool gave a good indication of specific spaces that needed more or less light. "Spatial Daylight Autonomy (sDA) is used to evaluate whether a space receives enough usable daylight throughout the year. Annual Sunlight Exposure (ASE) helps to identify whether a space is subject to overlighting" (Sefaira, 2016).

Daylight analysis tool also produced an average daylight factor which then could be used to gauge the overall lighting condition throughout the spaces (Sefaira, 2016).

"Minimum Daylight Factor shows the lowest value of Daylight Factor in the area, excluding a perimeter zone around the walls. This is the "worst case" value within the area" (Sefaira, 2016).

Fig 7.72. Lighting requirements (Author, September 2016).

Lighting requirements

The two main activities need very different kinds of lighting. The vermiculture building needs a constant low lux light level (100-300 lux) with very little to no direct sunlight. This is due to the fact the worms enjoy dark spaces. Skylights were introduced to bring in natural light but the light was bounced down a light tube to avoid any direct sunlight. The public interface to the vermiculture space needs to have control over the light as presentations could be done in the space. The wetlands creation space needed a higher lux level (300-500 lux) and therefore a large skylight was used to allow natural light into the space. The vermiculture building is only active during the day so making the most of natural light to avoid lots of electrical lights was critical.

The restaurant space is made up of two main areas, the kitchen space which needs high lux (750-1000 lux) for food preparation and the restaurant space which needs a lower lux level (300-750 lux) but it needs to be a constant light. This was a challenge as there are amazing views from this point and therefore a lot of glazing was introduced into the facade this meant that the solar screen needed to be designed correctly in order to allow light in during winter and block light out in summer but have all year round views through to the landscape.

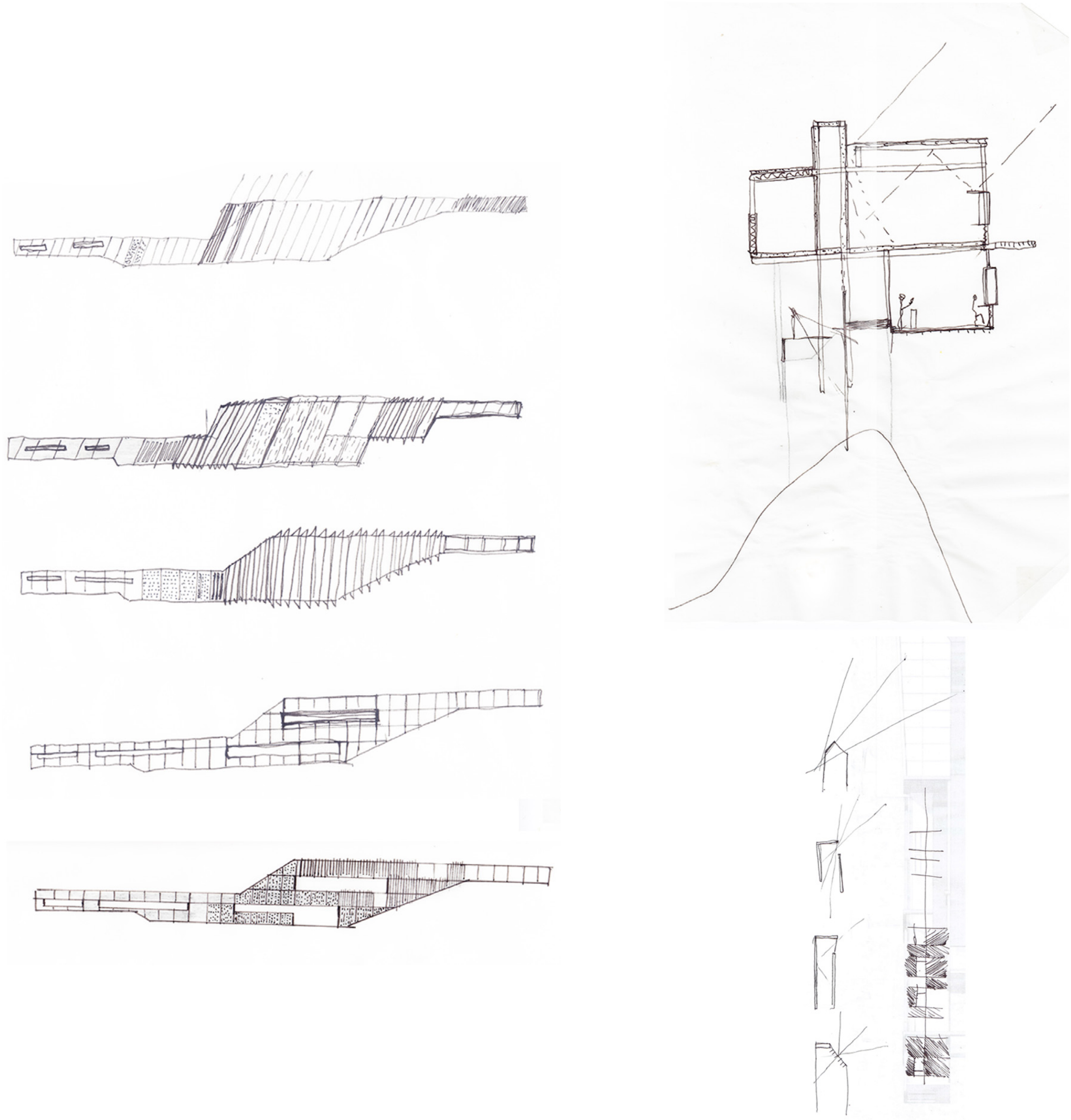


Fig 7.73. Lighting sketches (Author, September 2016).

Iteration 1

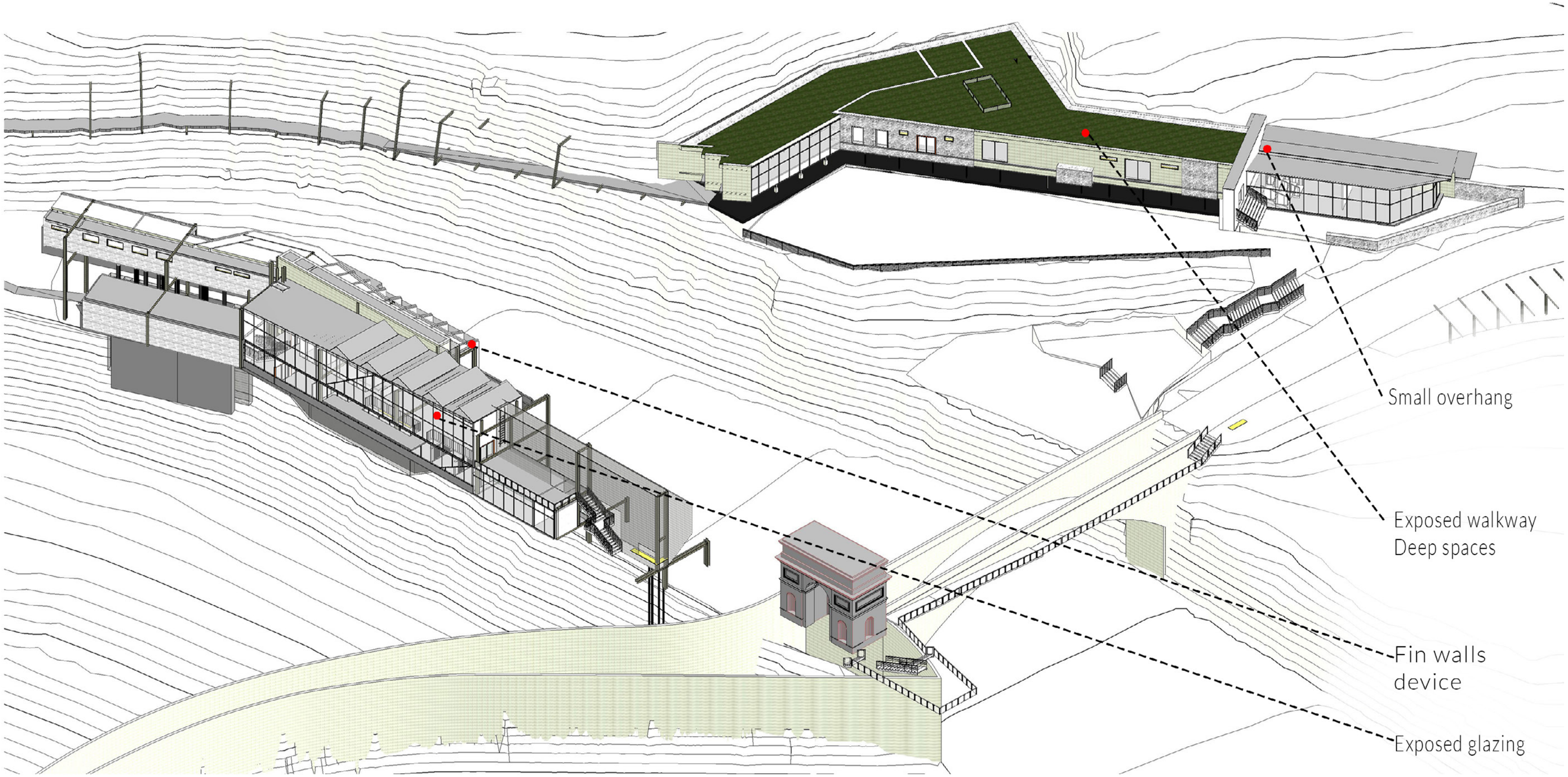


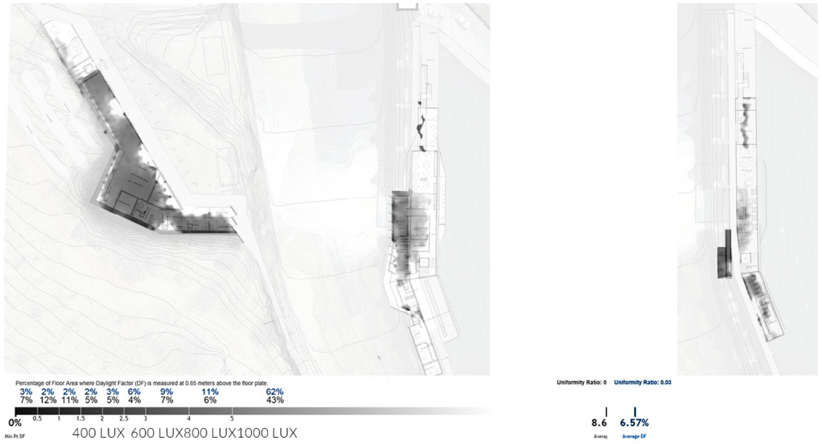
Fig 7.74 iteration 1 (Author, September 2016).

Iteration 1

The initial design had quite severe light problems. This was due to the small overhangs of the roofs as well as the exposed glazing in order to gain views of the site. The vermiculture building also had a large exposed walkway that would have made an uncomfortable space for people to walk along. There was too much light in the vermiculture space and a significant amount of light in the restaurant space, glare was a major issue.

Due to deep spaces the front would be overlit and the back would be dark and underlit. This is clearly visible in the wetland creations space.

Daylight Factor



Annual Illuminance

Underlit and Overlit

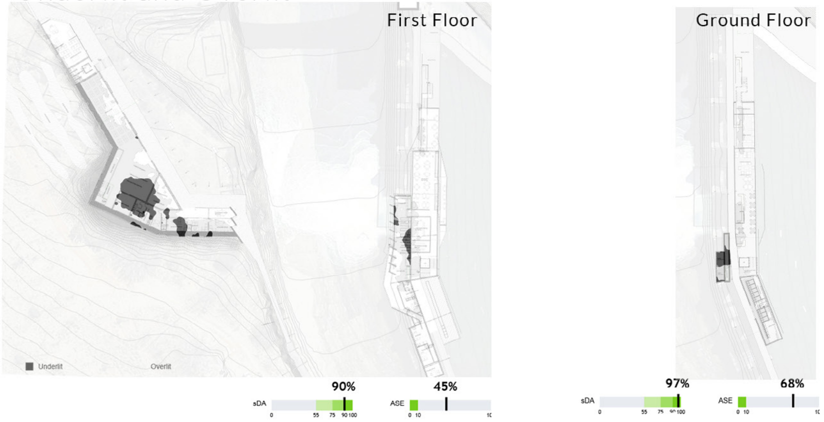


Fig 7.75 iteration 1 results (Author, September 2016).

Iteration 2

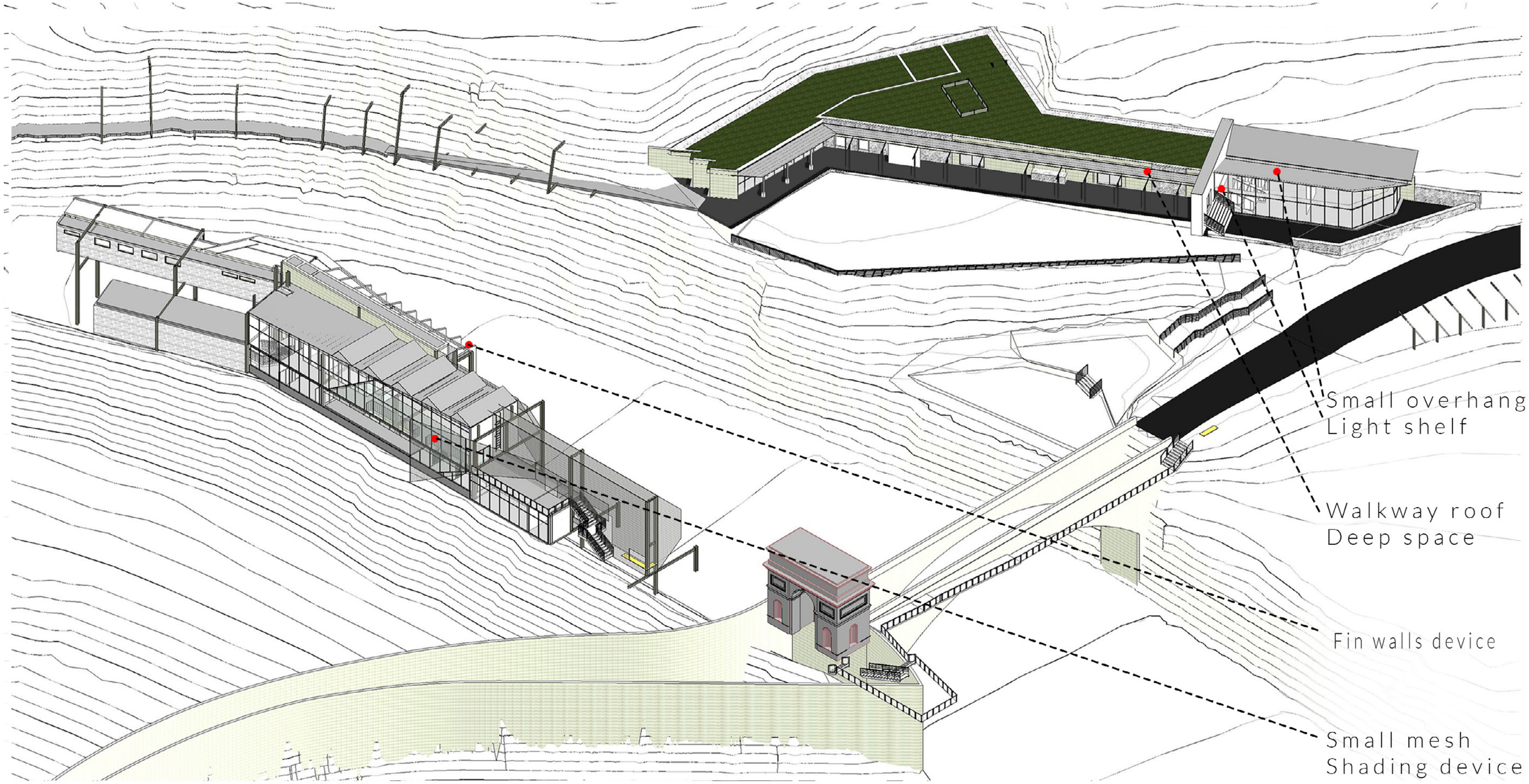
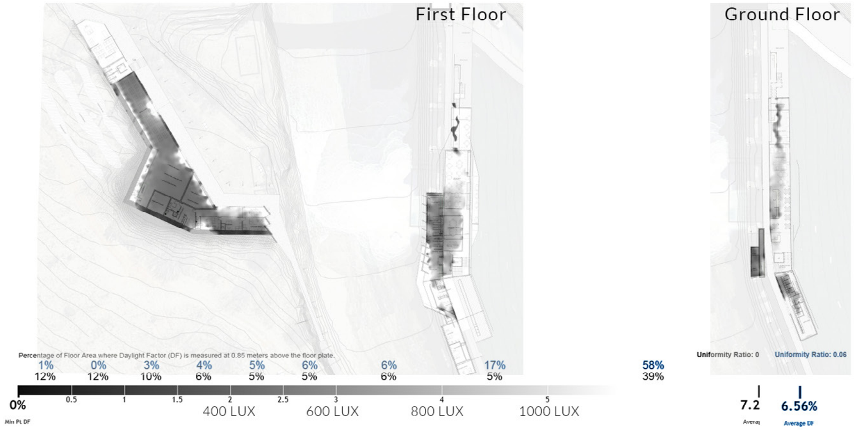
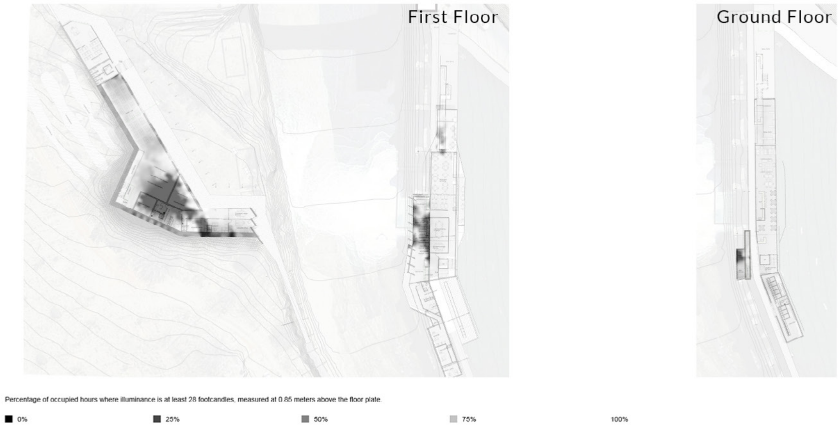


Fig 7.76. Iteration 2 (Author, September 2016).

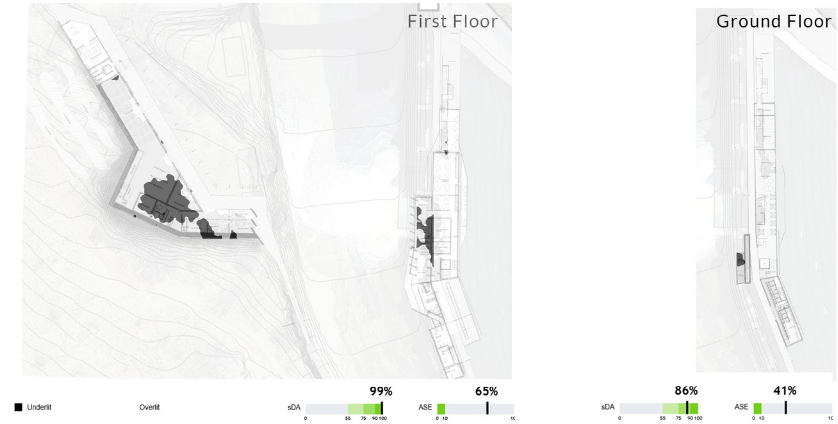
Daylight Factor



Annual Illuminance



Underlit and Overlit



Iteration 2

A small mesh shading device was added to cover the large amount of glazing in the restaurant, This helped to an extent but the space was still overlit. A roof was placed over the walkway of the vermiculture space, this would make the space more comfortable but little light then entered into the offices and wetland creation space.

In the public space of the vermiculture building light shelves were installed to bounce light into the back corners of the room. Deep rooms in the vermiculture space were still a problem.

Fig 7.77. Iteration 2 results (Author, September 2016).

Iteration 3

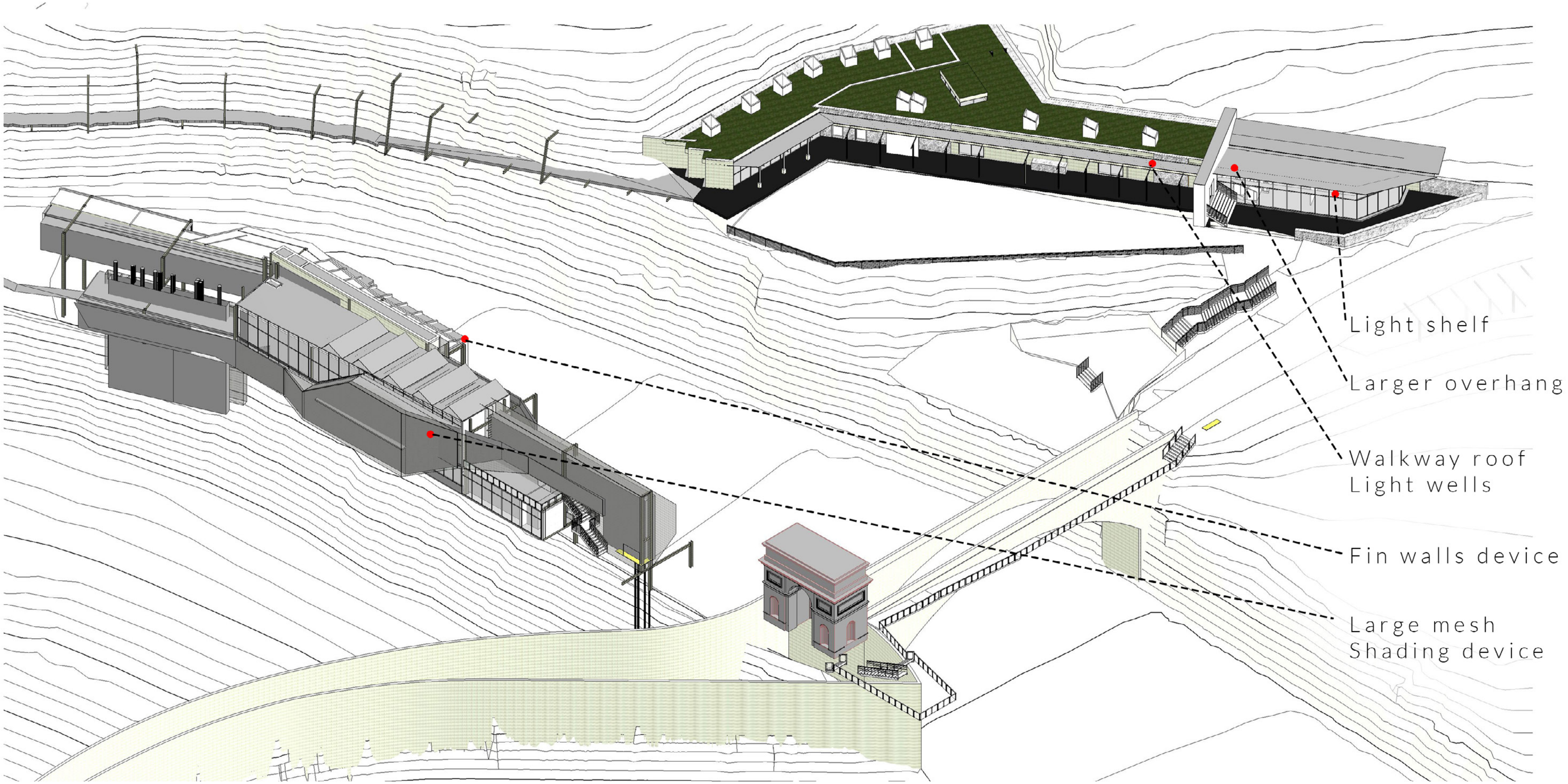
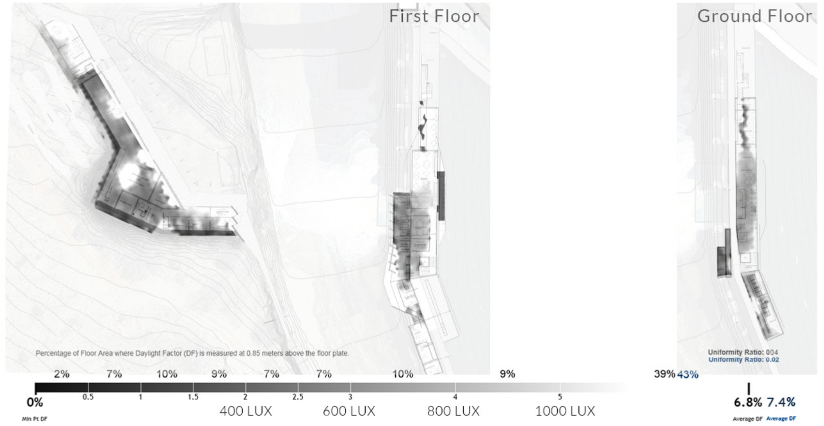


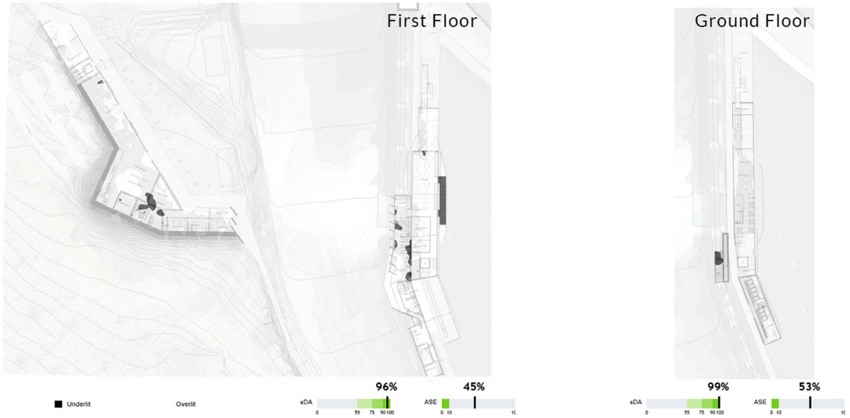
Fig 7.78. Iteration 3 (Author, September 2016).

Daylight Factor



Annual Illuminance

Underlit and Overlit



Iteration 3

A much larger, less perforated, shading device was added to the restaurant space which helped with glare and overlit spaces.

Along the vermiculture walkway, the roof was kept and light wells were introduced into the back corners of deep spaces. The light wells significantly helped with creating a better light quality. This also meant that they could be articulated in such a way as to bring in diffuse light into the vermiculture space which required this.

The light shelves in the public space of the vermiculture building were increased in size as well as a larger overhang was introduced which created a better light.

Fig 7.79. Iteration 3 results (Author, September 2016).

Iteration 4

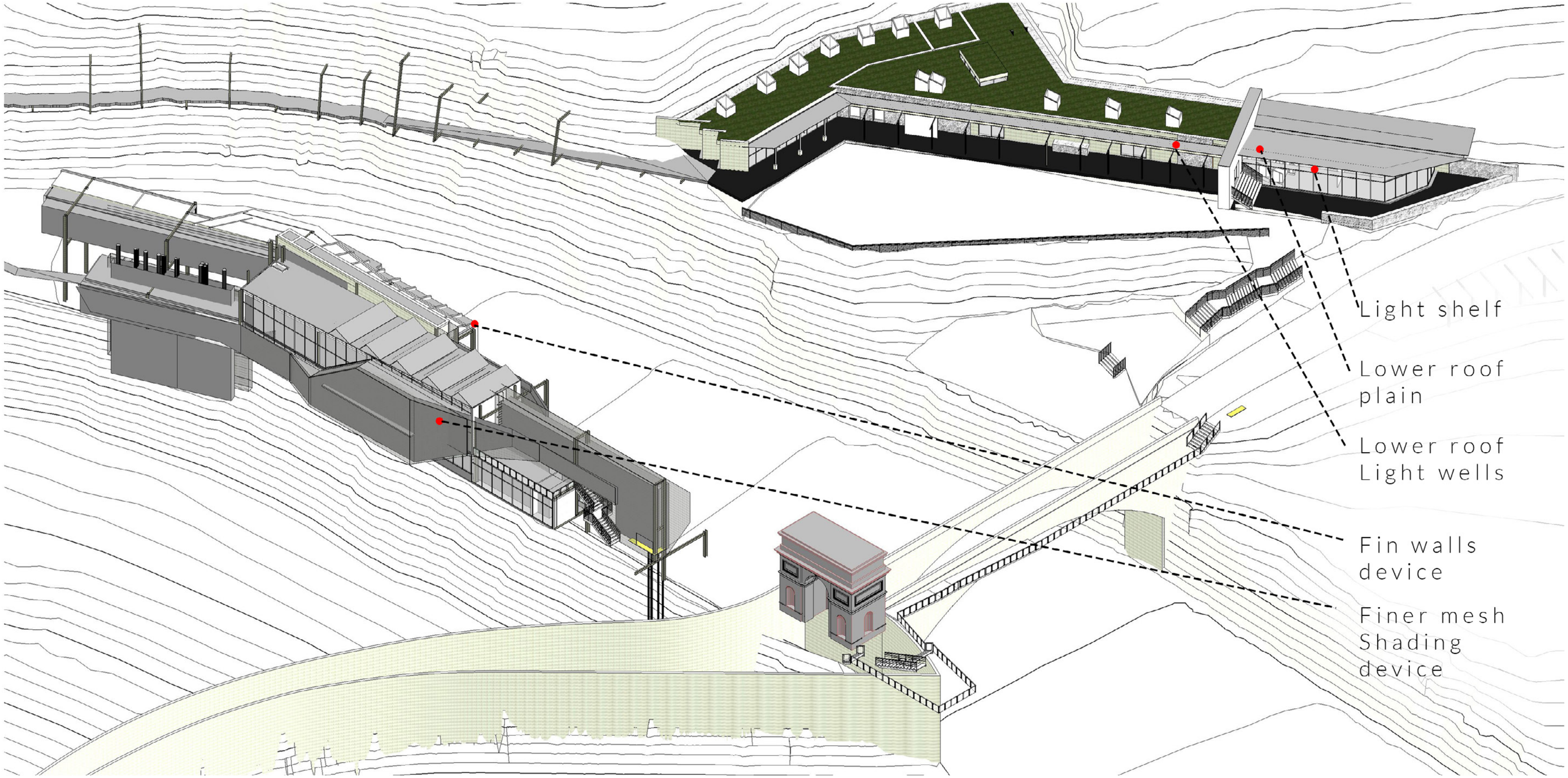
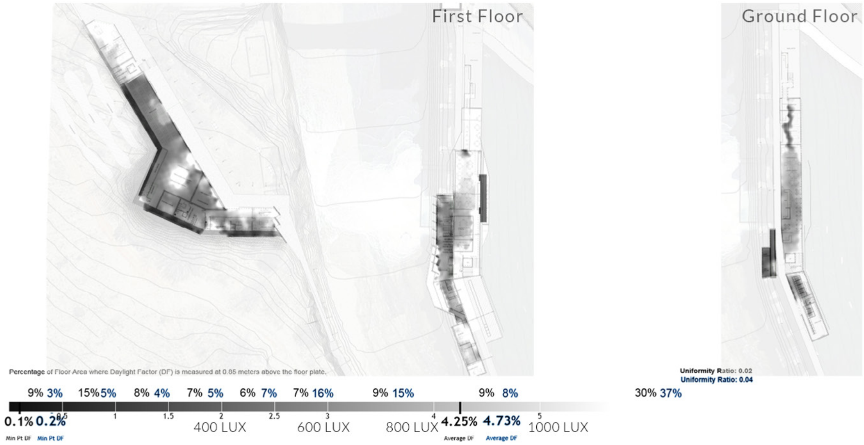


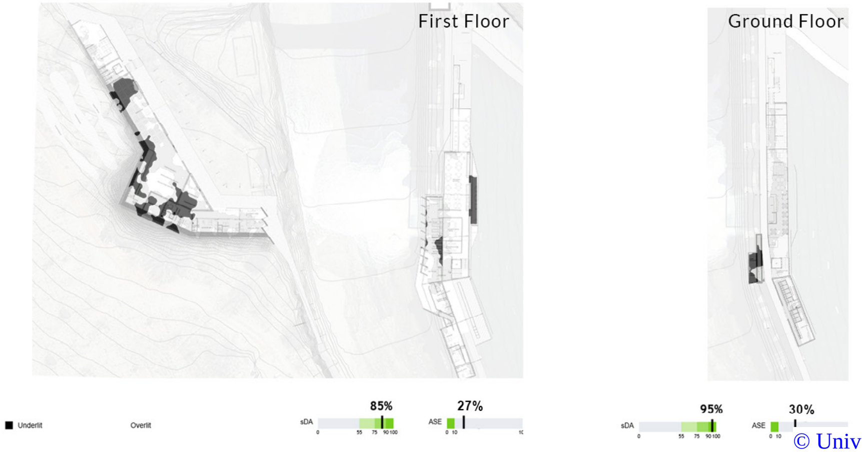
Fig 7.80 Iteration 4 (Author, September 2016).

Daylight Factor



Annual Illuminance

Underlit and Overlit



Iteration 4

The volume of the public space of the vermiculture was lowered so that less light would penetrate into the space, the large light shelves were kept. This created a much more consistent light. There were also louvres introduced to the one side that could be controlled for different functions in the space such as presentations.

A larger light well was introduced directly over the wetland creation space in order to bring more light into this space for more detailed work. Windows in the vermiculture space were changed from high vertical windows to thin slits that light up the space. The space now has a good consistent light. The vermiculture space was a much lower lux which is what was required.

A finer mesh was introduced for the shading device of the restaurant which made the space have a very consistent light throughout and minimized glare. The lux levels in the space were now becoming more appropriate for the function of the space but are still too high 800 lux.

Fig 7.81. Iteration 4 results (Author, September 2016).

Final Design

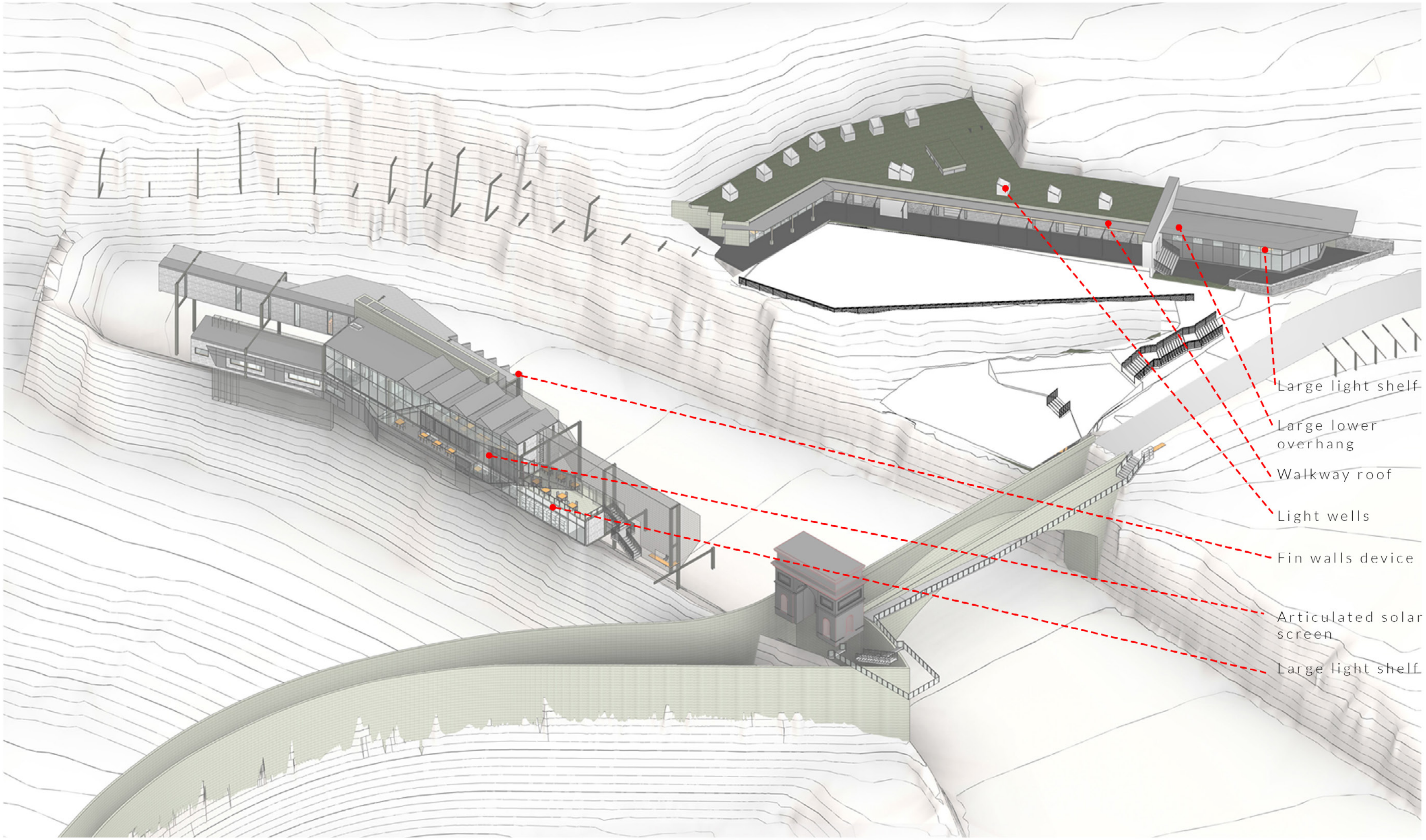
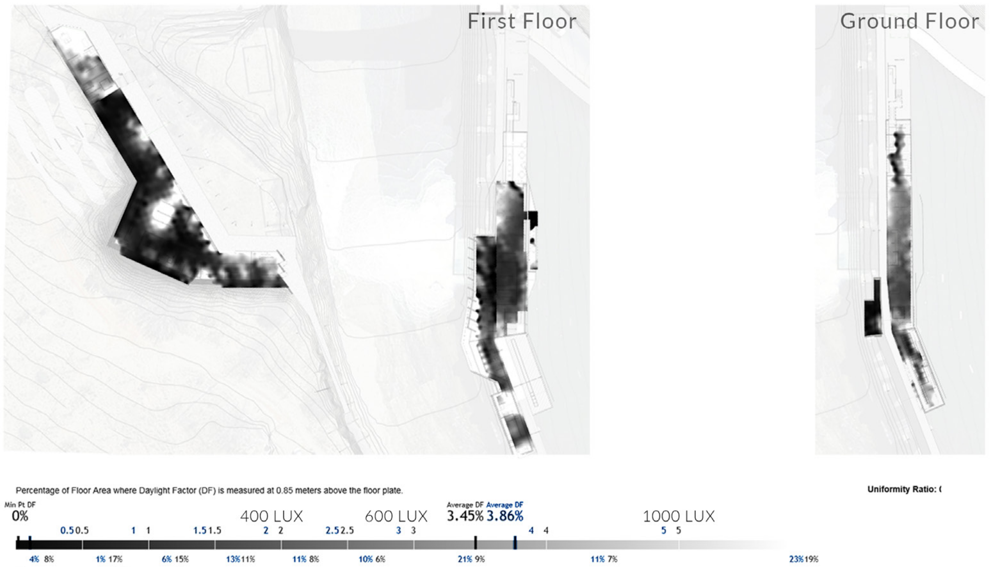


Fig 7.82. Final iteration (Author, September 2016).

Final Design

Daylight Factor



Annual Illuminance

Final Iteration

Daylight factor

The daylight factor analysis showed a more consistent light throughout the space except for the wetland creation space, directly below the large skylight. The skylight may still need additional articulation of a shading device.

As for the restaurant space it has a consistent light due to the articulation of the shading screen, with an average daylight factor of 3.45%.

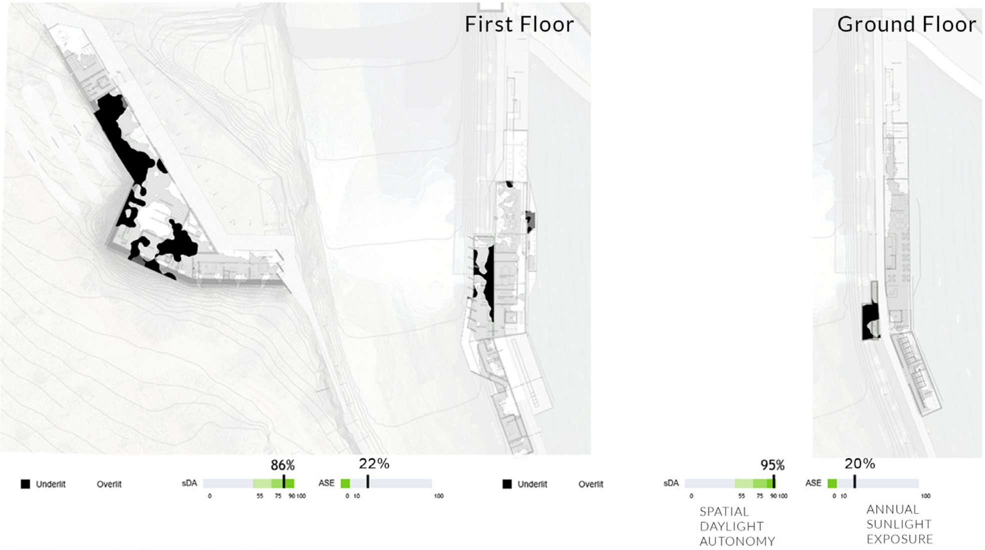
Annual illuminance

This iteration shows the louvres closed in the public space of the vermiculture building and how the space can be made dark for presentations.

The vermiculture space has a good consistent light with a low lux level. The wetland creation space has more light and there maybe a problem with contrast between these two spaces. The restaurant space lux has also been lowered to a more appropriate light level of 500 lux, glare is also now much better.

Fig 7.83. Final iteration results (Author, September 2016).

Underlit and Overlit



Direct Sunlight

Winter Solstice
Jun 21

Underlit and overlit

The wetland creation and vermiculture space, even though they require very different amounts of light, were set to have the same lux levels in the program. As can be seen from the underlit and overlit analysis the vermiculture space is significantly darker than the wetland creation space as required.

In the kitchen space, the service core was underlit, this was not able to be naturally lit as there are services running overhead such as water tanks, ducts and batteries. This space would need artificial light to a high lux level as it is where food is prepared. Similarly the dirty kitchen on the ground floor was underlit and would need to be artificially lit.

Direct sunlight

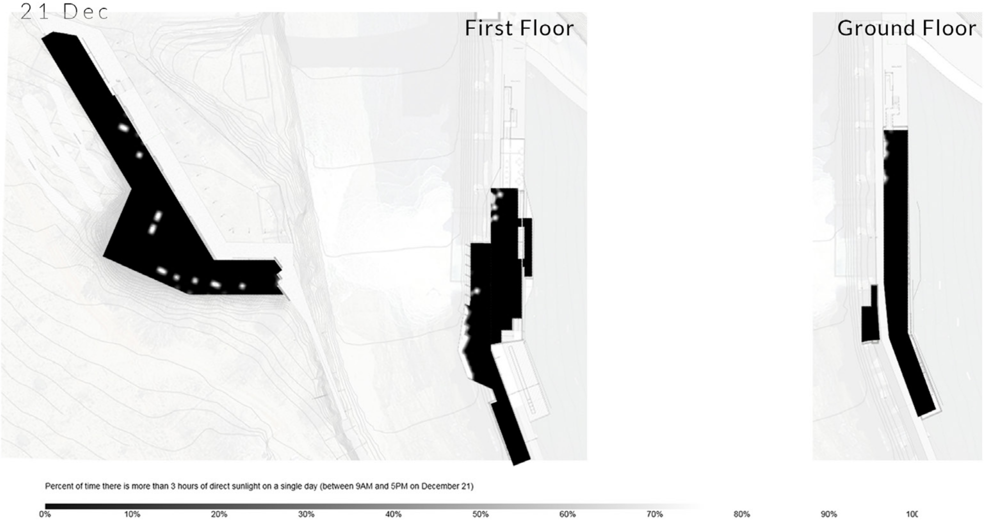
This analysis shows the percent of time that there is more than three hours of direct sunlight in a single day (represented as white). This tool was used to gauge how well the screen and the skylights were working.

As can be seen from the winter solstice analysis there are larger and more frequent white areas. In the ground floor of the restaurant space it is visible that the light is penetrating deep into the space through the screen as designed. The wetland creation space is also being well lit from the skylight. The smaller skylights are also letting in a good amount of light and can be seen as dotted white areas along the back wall as well is in the vermiculture space.

Fig 7.84. Final iteration results (Author, September 2016).

Equinox
21-Sep

Summer Solstice
21 Dec



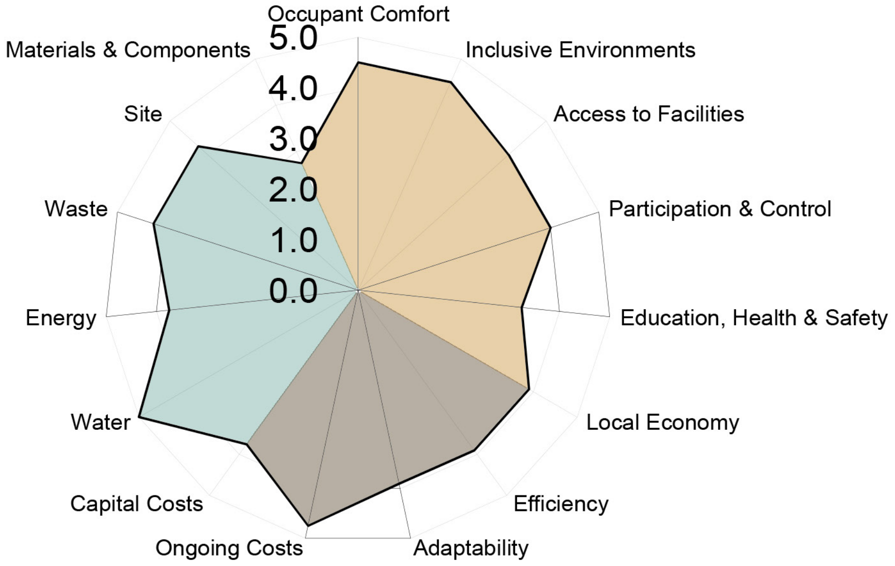
During Equinox these white spaces become smaller and less frequent, with the exception of the wetland creation skylight, as already stated might need a further articulation. Moving into summer there are only a few white dots mainly under the skylight in the office space and as for the restaurant space it is completely black meaning that the screen articulation is working correctly.

This proves that the skylights have been articulated correctly to allow the low angle of the winter sun to penetrate into the spaces and block out as much of the direct sunlight in the summer months to avoid overheating. This does not mean that the spaces will be underlit in summer as this analysis only gauges direct sunlight.

Fig 7.85. Final iteration results (Author, September 2016).

SUSTAINABLE BUILDING ASSESSMENT TOOL (SBAT- P) V1

PROJECT	
Project title:	Celebrating the unseen
Location:	Hartbeespoort dam wall
Building type:	Vermiculture andRestaurant
Internal area (m2):	1711 m2
Number of users:	120



Social	4.1	Economic	4.0	Environmental	4.0
Overall	4.0	Classification	Good		

Fig 7.86 SBAT analysis (Author, September 2016).

7.10 Sustainable building assessment tool

SBAT tool was completed for the entire building in order to gain an indication of the performance of the building in terms of sustainability. This too could be used for schools, housing, restaurants and offices. SBAT is normally used directly after the building has been completed. But in this case the building would score a higher score during the life cycle of the building as the systems become more effective.

As can be seen from the SBAT tool the capital cost would be quite significant for this building, but as the systems start to become more and more effective the ongoing cost would be relatively low and the building will start to repay the capital put in to this project.

Inclusive design was very important to this project and a difficult task as there are so many levels that need to be negotiated by a disabled person. This was able to be fulfilled by mostly ramps but in the restaurant space a lift was required.

Participation and control as well as education were very important to this project but the way that SBAT rates these, the project scored relatively low. SBAT rate takes education as amount of seminar rooms and libraries which is not the way that this building educates people. It educates people through the understanding of exchanges, which can only be understood through sight, touch, hearing.

Moving on to environmental aspects, energy was quite low even though renewable energy was being created on site. The requirements under the energy category is how people commute to this building but due to the location there is little public transport. Specifically at night when the restaurant space would be used frequently. This meant that people would have to arrive in cars and a parking lot would have to be constructed.

Materials and components scored lowest on the list, this is due to the embodied energy in the materials. As already discussed this was necessary due to the harsh environment as well as the difficulty of construction on the site. As well as little to no materials were able to be recycled in the new building. Only the gabion wall in the vermiculture building would make use of material on site.

Overall the three categories, social economical and environmental, scored an average of four points which classifies the building as good.