CHAPTER 8
TECHNE

Constructing a regenerative precinct

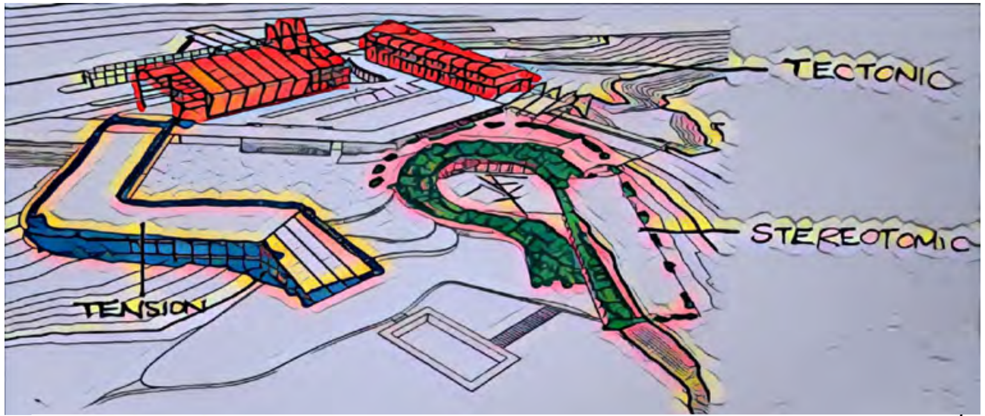


FIG 123 : TECTONIC CONCEPT (Author, 2017)

8.1 TECTONIC CONCEPT

The tectonic or formal concept has been explored in the design development and theory chapter. The mining belt essentially had a juxtaposed or contrasting set of issues and needs. That being the preservation of cultural heritage and the need for ecological reform. This bring a strong theme of tension, contrast and transition into play.

This concept is realized in the form of a transitioning journey from rigid to organic. From heritage to landscape. There are 2 completely different building typologies and aesthetics. The one beings a tectonic steel heavy portal frame construction and the other being a stereotomic reinforced concrete post and lintel type construction. The steel structure is large, imposing and pronounced, whereas the stereotomic structure is set into the landscape sensitively, in this case replacing and echoing the past topography. This concept harbours an experiential quality as the site is being explored by the user from building to landscape.

The technical exploration is done to document and resolve this journey, from exposed joinery and celebrating the genesis of construction and mining heritage to a landscape-aware hidden construction that still has a focus on relationship to site.

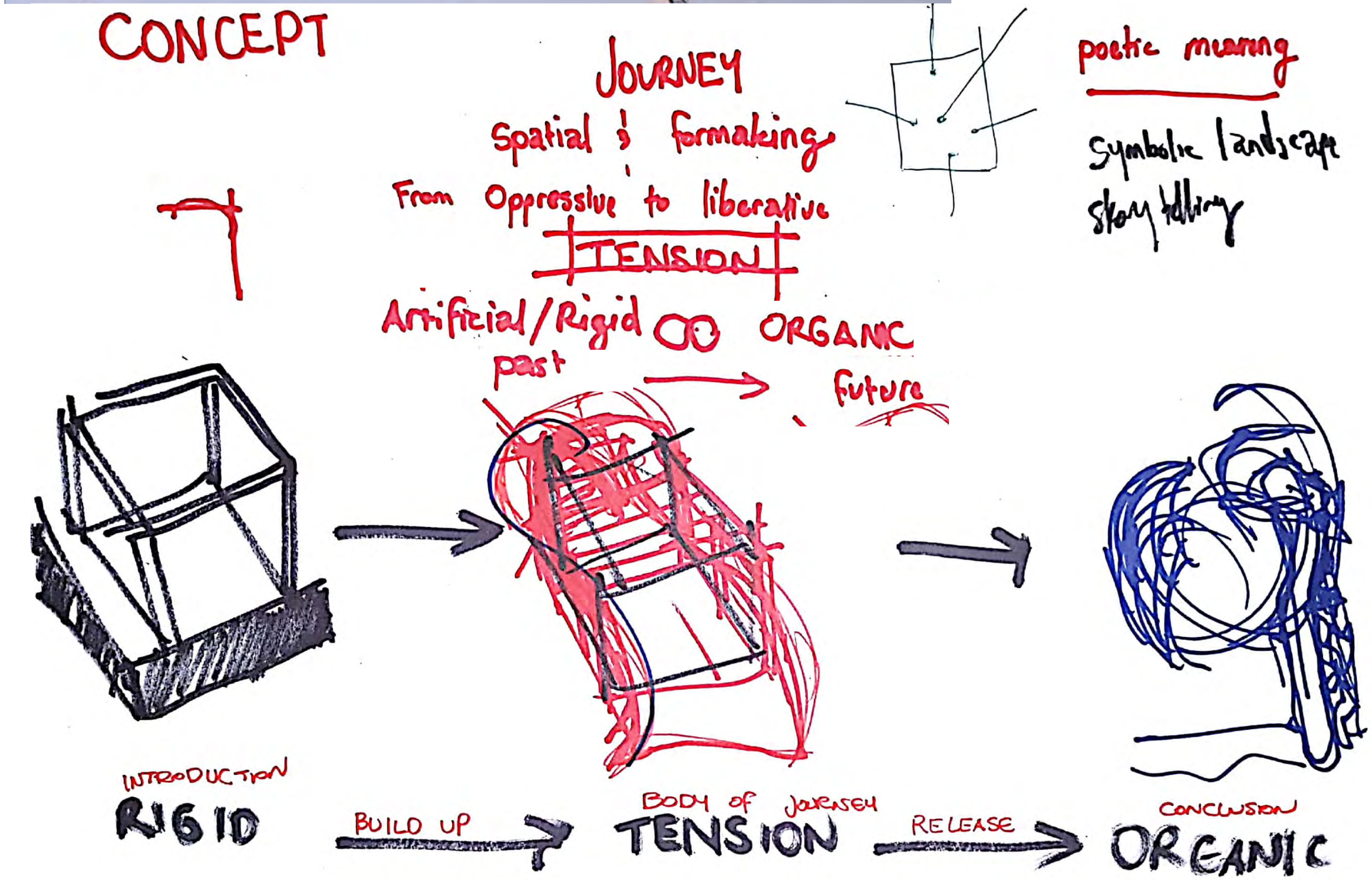


FIG 124 : CONCEPT EXPLORATION (Author, 2017)

8.2 STRUCTURAL SYSTEM AND MATERIALITY

In line with the tectonic concept the theme of tension and contrast is solidified in 2 opposing construction methods. Portal frame steel construction and composite, steel and reinforced concrete construction.

8.2.1 SUBSTRUCTURE

Due to the top layer of infected soil having to be removed the top half of the site sits on an underlying substructure in the form of basement parking and the train station, this structure is made of reinforced concrete columns and a waffle slab marked by the yellow outlined region in the image below. This slab is used for its strength, to carry the heavy automotive loads above. The rest of the buildings on site use and conform to the topography which drops 8m towards the water mass.

8.2.1.1 PRIMARY STRUCTURE

Two basic but opposing concepts form the primary structures, firstly The top half of the site displays a steel heavy design with the extensive use of portal frames welded to base plates and bolted to the concrete substructure or pad footings on the bottom half of the site.

The bottom half of the site which features more organic landscape inspired buildings has a composite structure of steel beams, reinforced concrete retaining walls, with drainage voids and double yellow brick walls (manufactured on site by utilizing processed mine tailing waste) which sit on strip or pad reinforced concrete footings. These columns and walls support castellated and I-beams which transfer the point loads to the relevent column or wall.

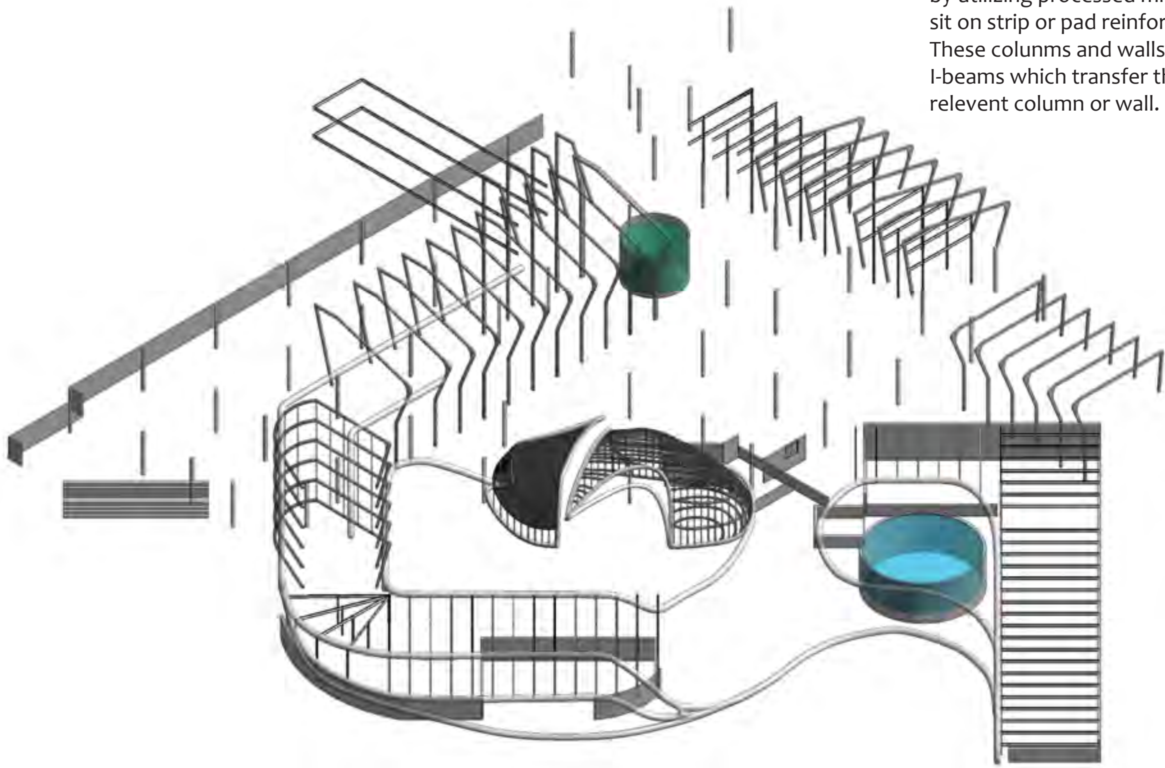


FIG 125 : PRIMARY STRUCTURAL COMPONENTS (Author, 2017)

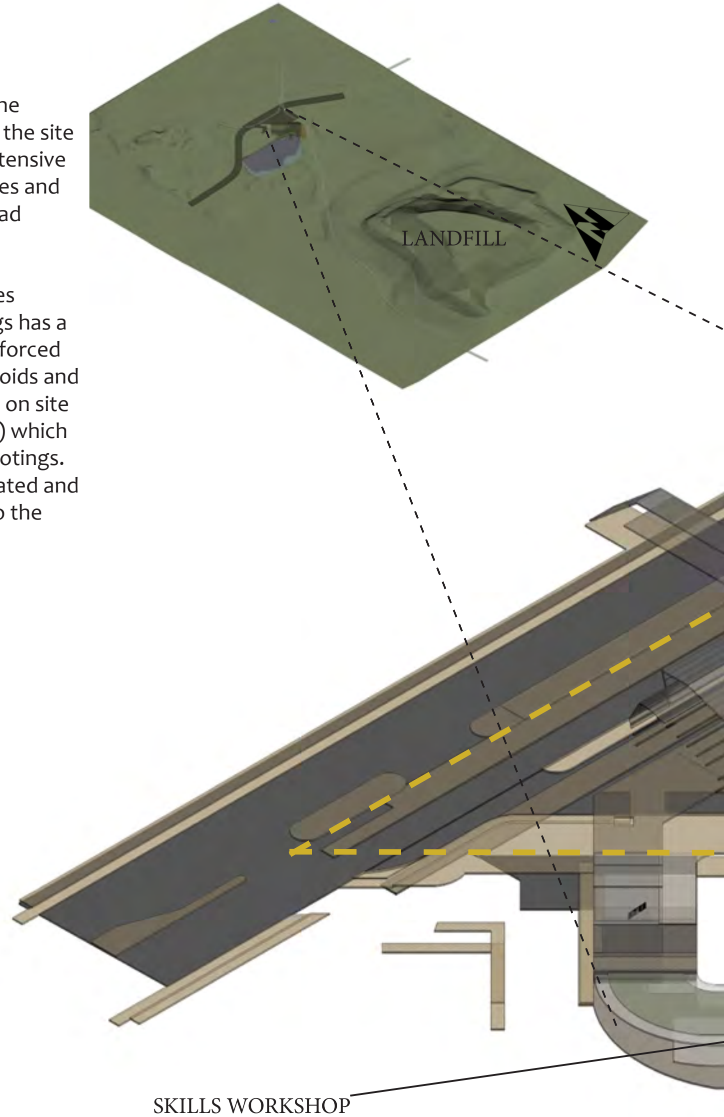


FIG 126 : SECONDARY STRUCTURAL FLOOR PLANES (Author, 2017)

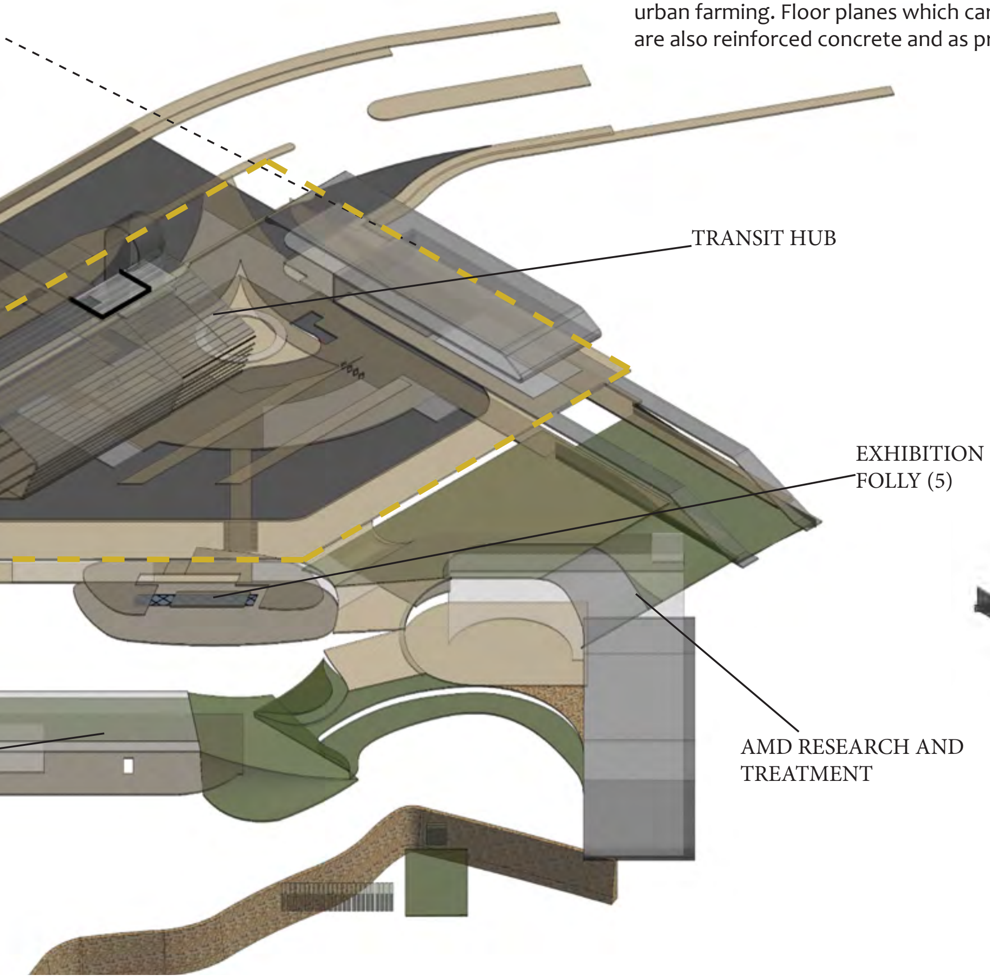
8.2.2 SECONDARY STRUCTURE
8.2.2.1 LATERAL PLANES

The expression of floor planes is critical to this interventions conceptual articulation. At points the floor melts into the ground forming a stated transition from building to landscape. This is done using reinforced concrete slabs which are finished with natural stone, or green roofs which host urban farming. Floor planes which carry people are also reinforced concrete and as previously stated the roads and transit hub is supported by a heavy duty waffle slab.

The transition space from building to landscape blurs the line between roof and ground. In a less sensitive interaction between site and building the Transit hub hosts an insulated steel sheeting roofing structure which is bolted to purlins which are in turn bolted to the primary structure(portal frame)

8.2.2.2 WALLS, CURTAIN WALLS AND OTHERS

The Walls which do not carry weight in the form of retaining walls form part of the secondary structure. They will use the bricks manufactured on site as mentioned in the Urban plan. Curtain walls have been used to channel light into the sunken and topographically inspired buildings. The internal qualities such as floor finished will compliment the steel structure by using blue-gum wood which has contextual significance as explored in the context chapter.



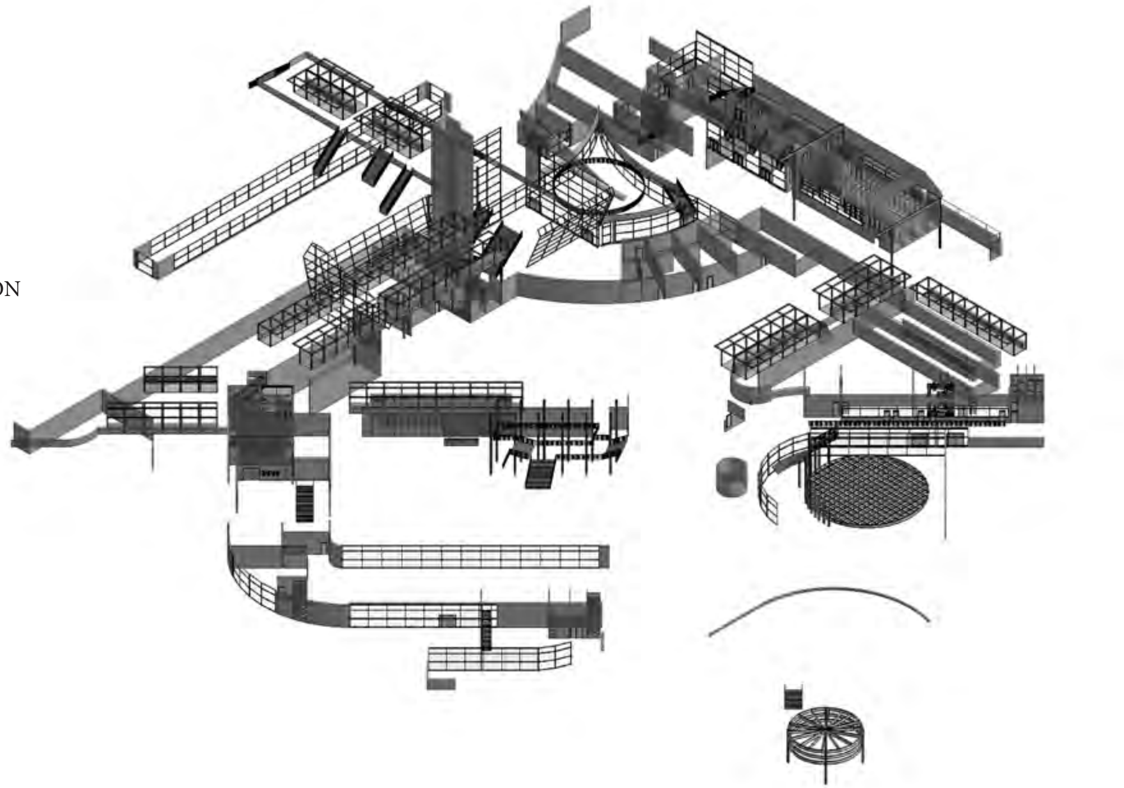


FIG 127 : SECONDARY STRUCTURAL WALLS AND COMPONENTS (Author, 2017)

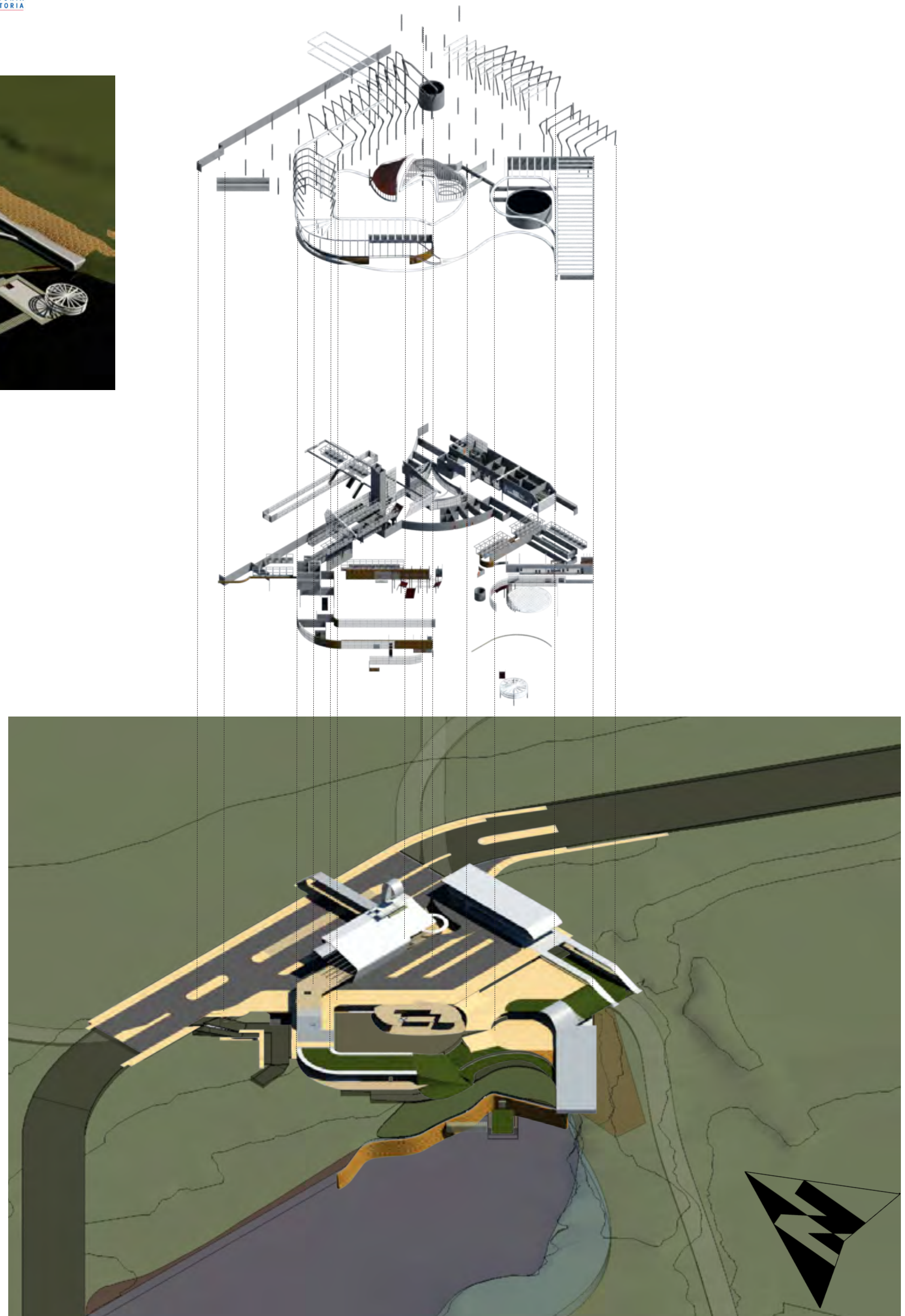
8.2.3 STRUCTURAL COMPOSITION

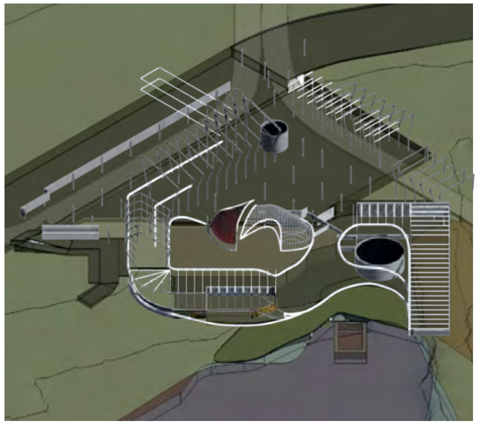
The structures composition displays the structural components relationship with the site as well as with each other.

To achieve the desired aesthetic different areas have been treated differently. In some areas of the design structural framing is exposed and the cladding is pulled back whereas in other areas the opposite is true, The structural framing is hidden and can only be seen from the internal space, giving the appearance of a "non -building" such as in the case of the Acid Mine Drainage treatment facility.

The connections between elements have not been covered up in a scenographic way but rather sensitively placed as to only be exposed where appropriate.

In places like the transit hub the connections between ground and "site" are exposed where the base plate is exposed flush with the blue-gum wood floor finish.





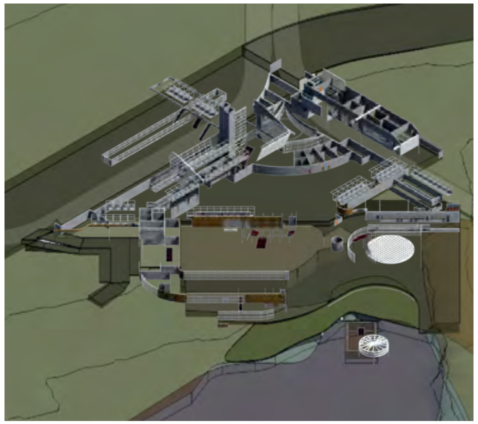


FIG 128 :STRUCTURAL COMPOSITION (Author, 2017)

8.2.4 MATERIAL PALETTE

The material choices were contextually driven with it being in direct relation to the tectonic concept, to display the journey from rigid steel based design to landscape. The materials follow this trend going from processed steel to fully natural elements like natural stone and grass.

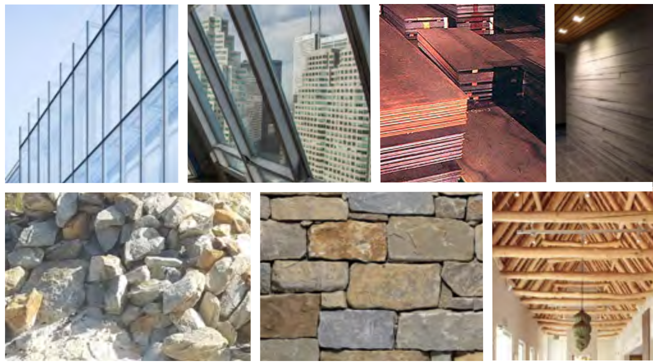
EXISTING

The existing site is a wasteland of toxic yellow soil and water dappled with mounds of natural stone, wood and greenery

STRUCTURE

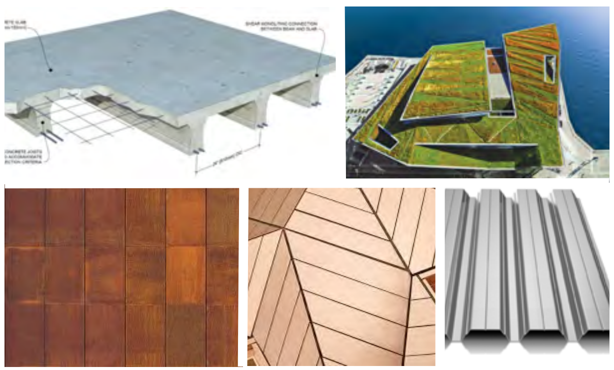
Steel H and I beams will be used from NJR Steel, a joint venture will be undertaken to acquire composite recycled steel members.
Lower down in the stereotomic landscape buildings oxidized steel members from Gary steel company will be used.
Reinforced PPC concrete will be used for the stereotomic elements.
Yellow Bricks made on site from the reprocessed mine waste will be employed structurally and in infill.

INFILL



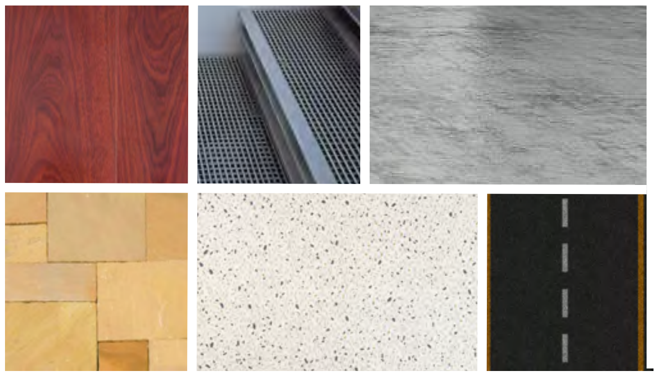
The infill elements will be both manufactured such as curtain walls with aluminum mullions and cor-ten steel being used as an accent material,
and natural with the use of natural stone both processed and left in its rough state. Finally Bluegum wooden poles will form part of sun-shading and accent elements within the design.

ROOF



A waffle slab will form the Roof of the basement parking to carry heavy loads
Green Roofs will top the stereotomic buildings and will grow vegetables
The transit station will employ a mix or new corrugated steel sheeting and copper which will weather with time contributing to the active nature of the site

FLOOR

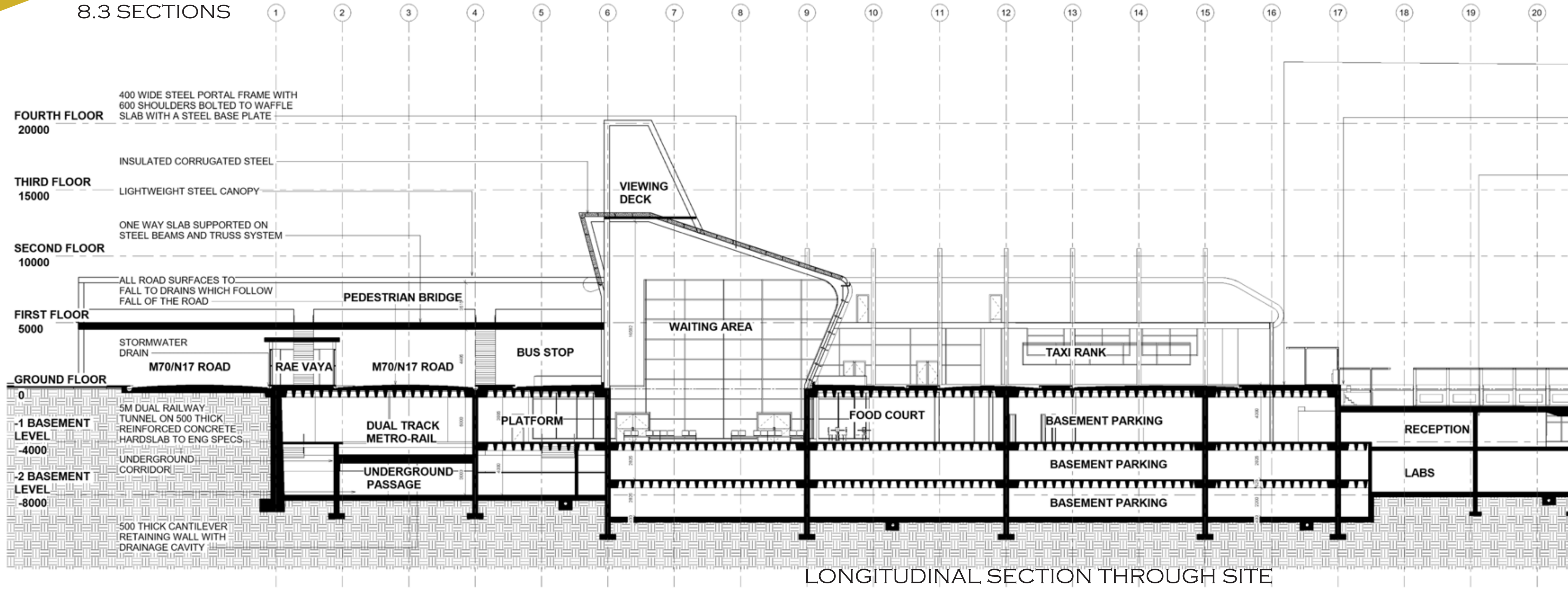


The inside floors will comprise of polished concrete, steel catwalks
and Blue gum floors.

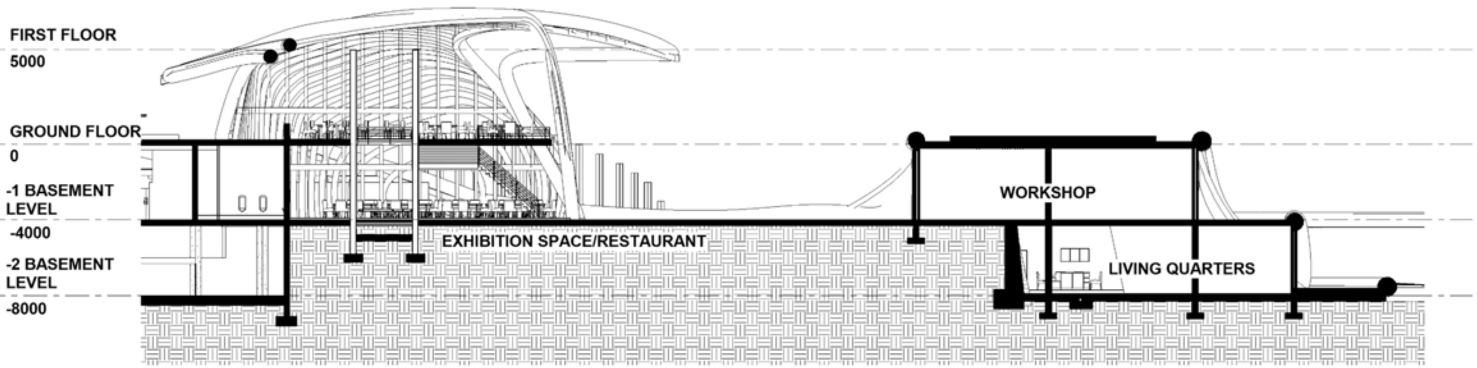
The outside aesthetic will include yellow paves made by the cement factory on site in the same way the bricks are manufactured, terrazzo flooring using processed mine waste as a mix and finally the road with an asphalt finish.

FIG 129 : MATERIAL COMPOSITION (Author, 2017)

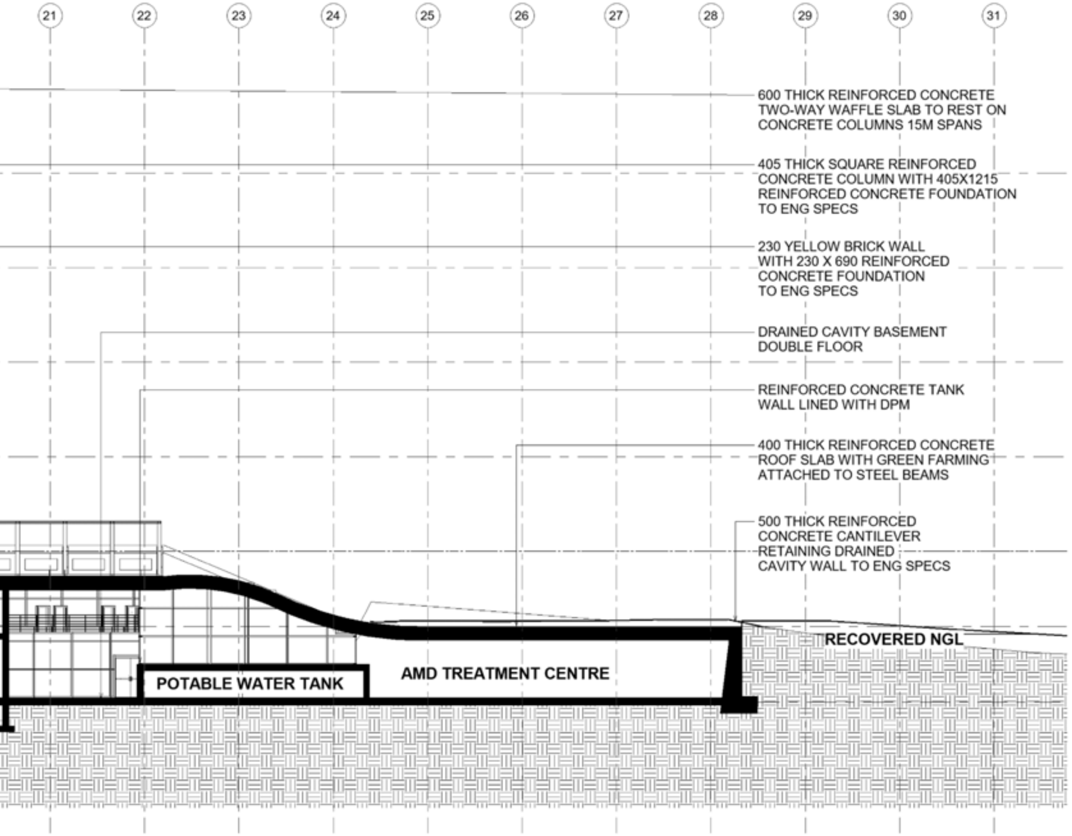
8.3 SECTIONS

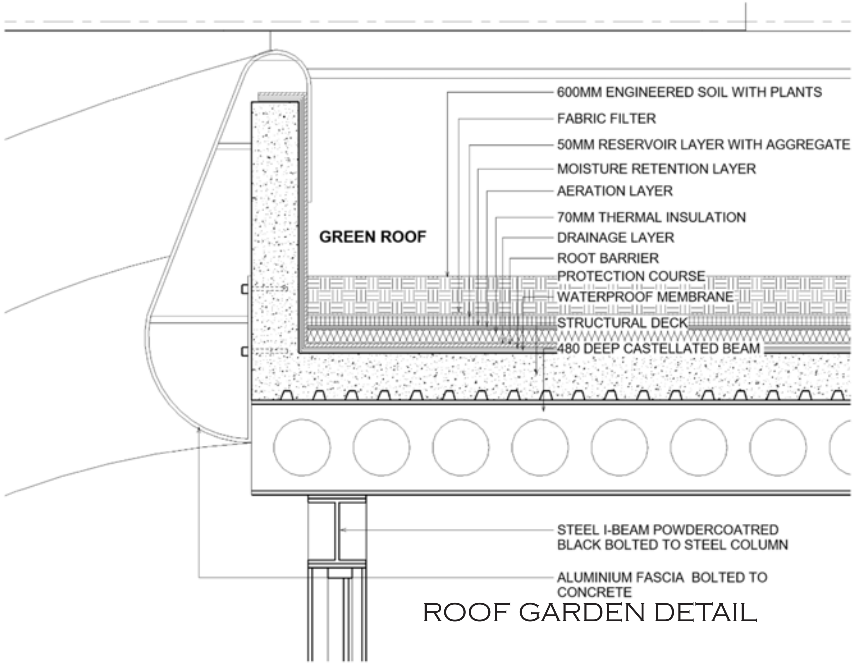


LONGITUDINAL SECTION THROUGH SITE

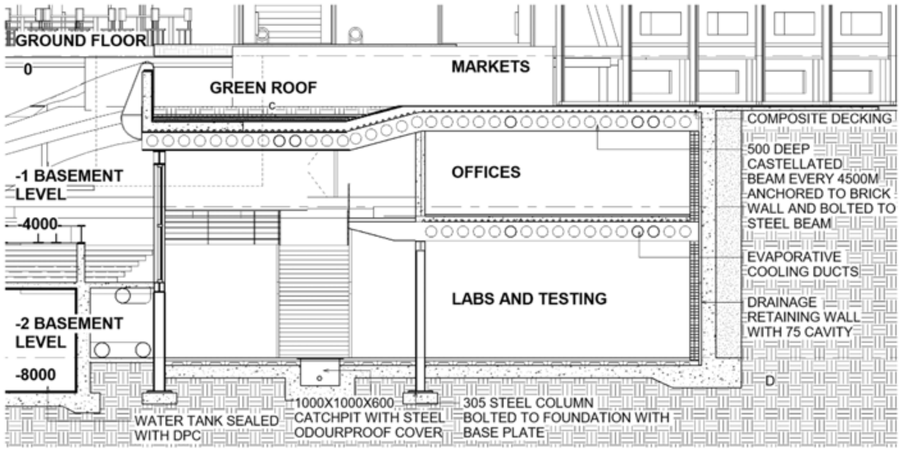


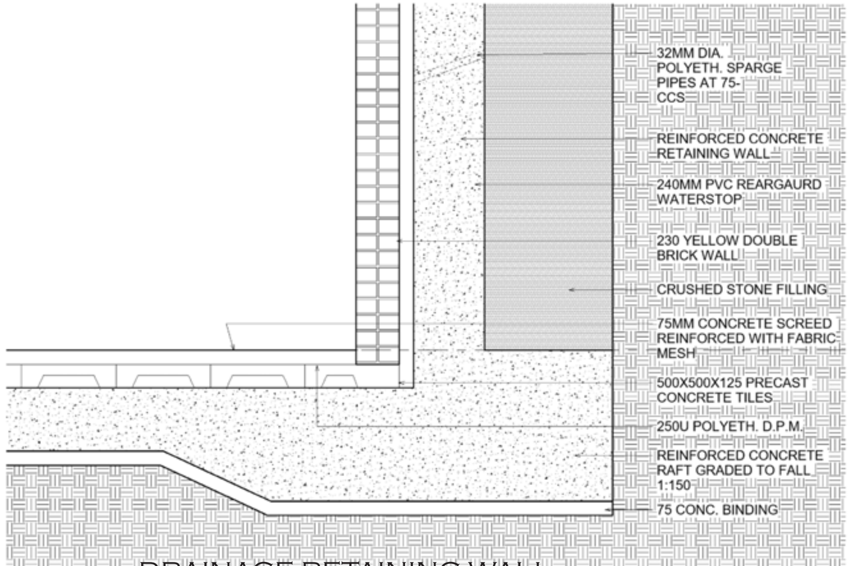
SECTION THROUGH AMD TREATMENT FACILITY



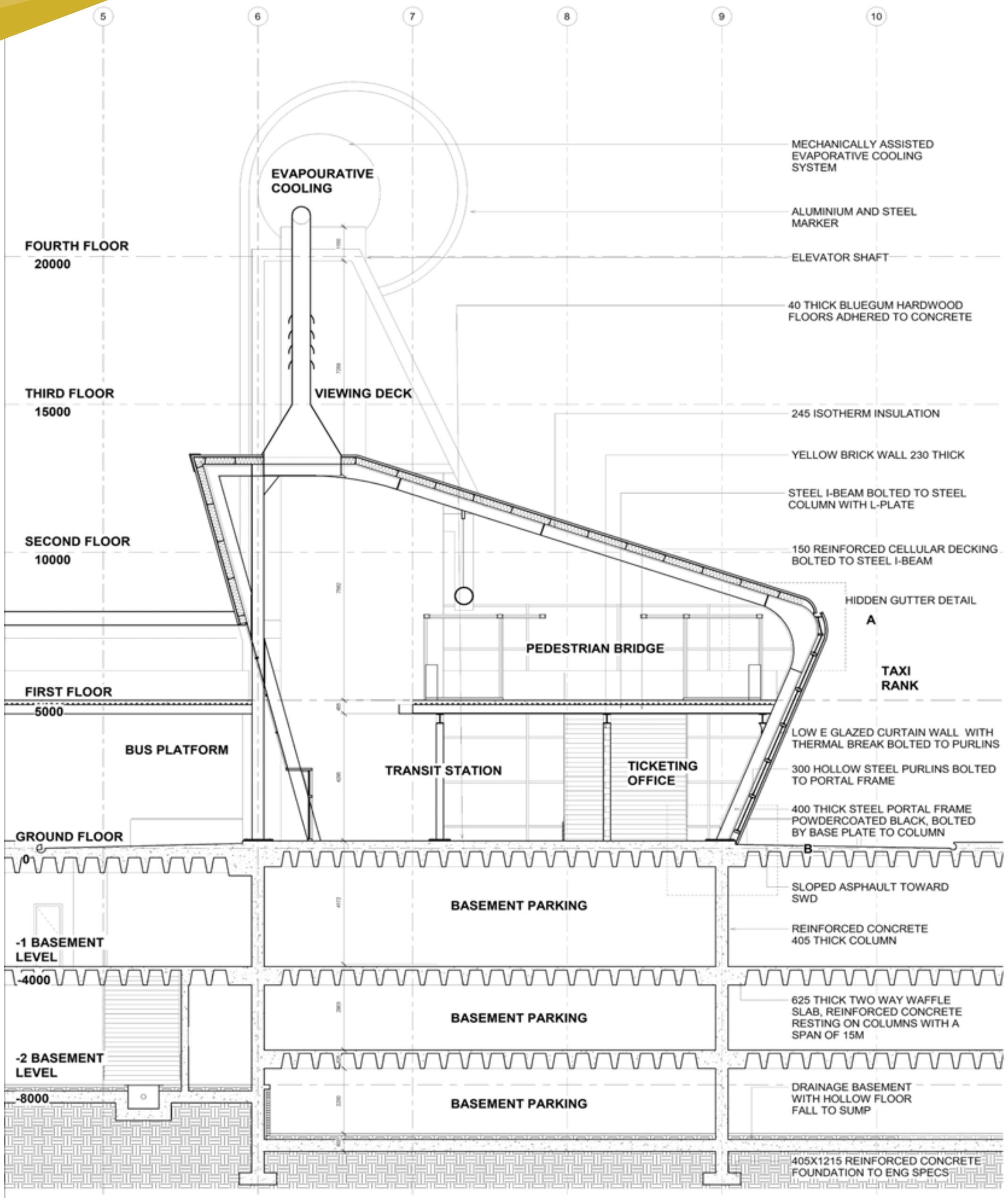


ROOF GARDEN DETAIL

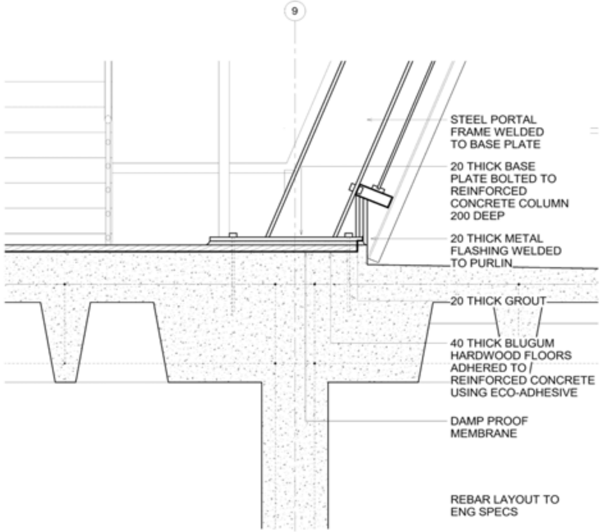




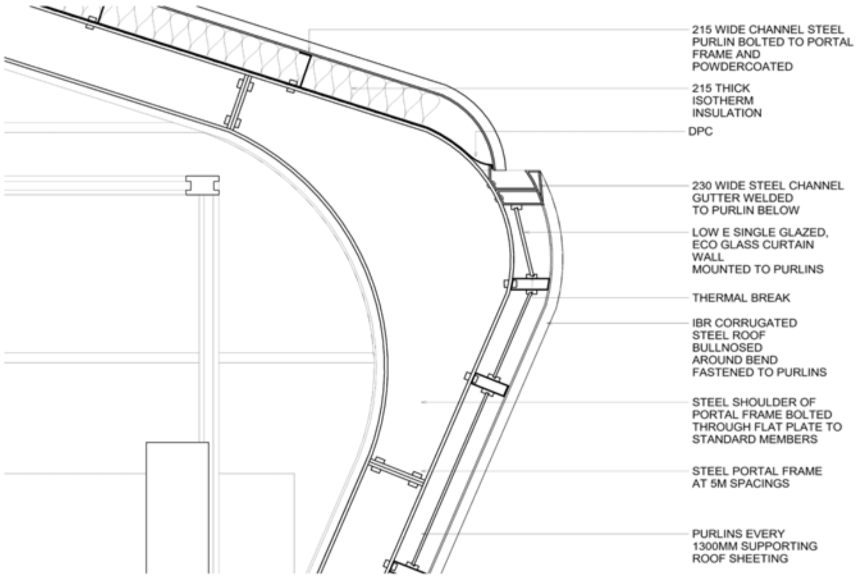
DRAINAGE RETAINING WALL DETAIL



SECTION THROUGH TRANSIT STATION



PORTAL FRAME FOOTING DETAIL



HIDDEN GUTTER DETAIL

FIG 130 : Sectional Exploration (Author, 2017)

8.4 SEFAIRA MODELING AND ITERATIONS

BASELINE SANS 204

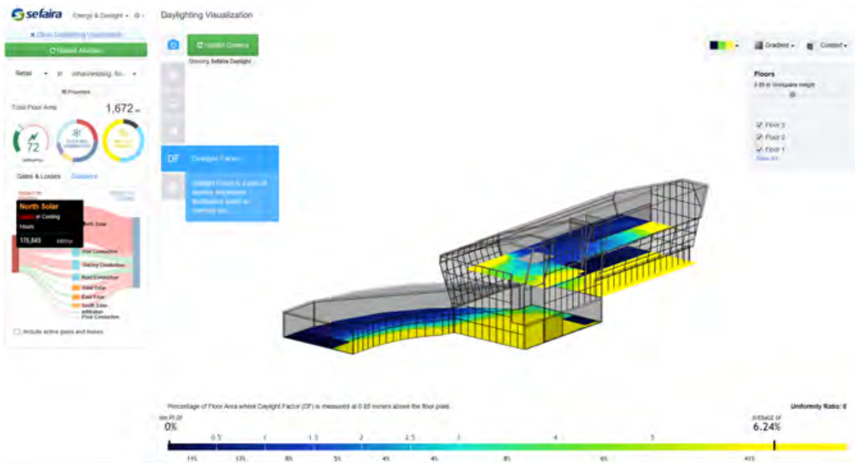


FIG 131 : Sefaira Modeling SANS 204 base (Author, 2017)

The Sans 204 Guideline was far above the performance of my building at the current time due to the face the truss and roofing material was exposed metal and has terrible insulation making it not only an uncomfortable space but also an expensive one. The daylight factor was also above the targeted range.

ITERATION 1

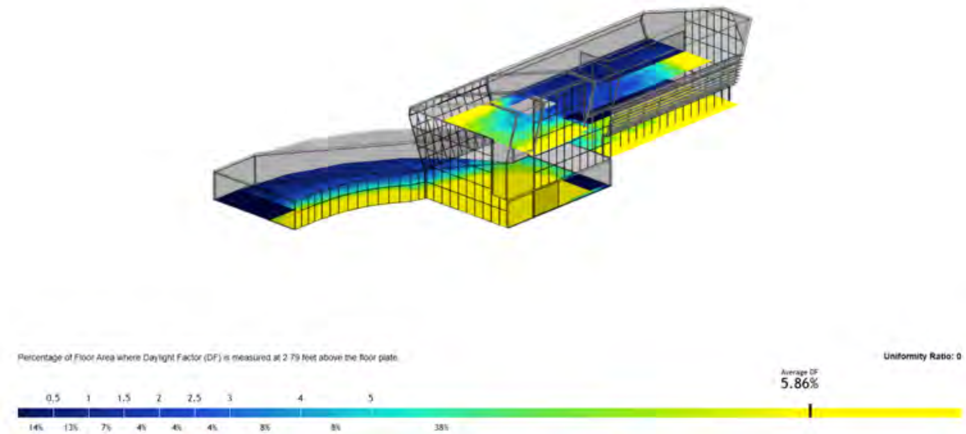


FIG 132 : Sefaira Modeling iteration 1 (Author, 2017)

The first iteration was focused on reducing the daylight factor and some heat gain as can be seen from above the major contributor was the North Facade and as a result a shading device was added to a portion of the northern facade This decreased the daylight factor by 0.4%

ITERATION 2

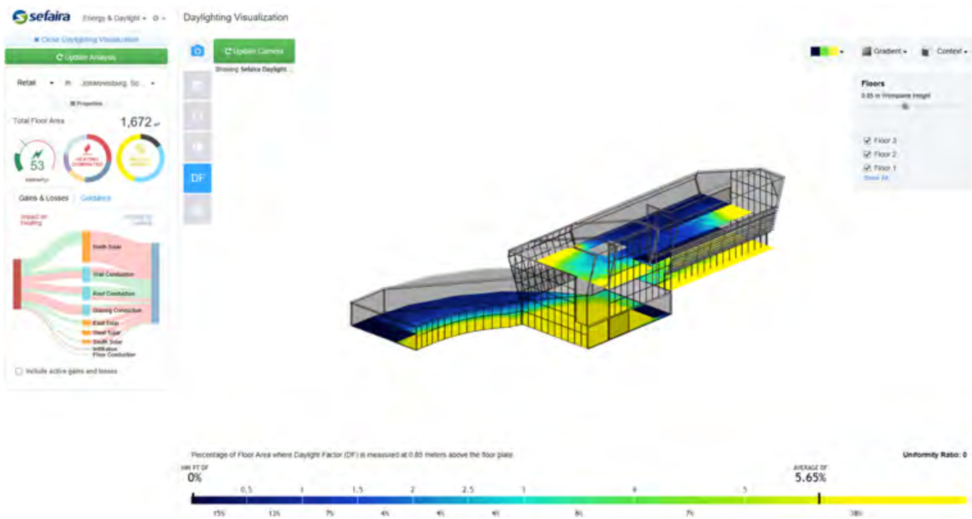


FIG 132 : Sefaira Modeling iteration 2 (Author, 2017)

The Second iteration involved lowering the SHGC and providing a better glazing U-values which would impact on the energy usage. It also effected the DF by 0.1% and the energy usage was significantly impacted by about 20kwH/m2/yr

ITERATION 3

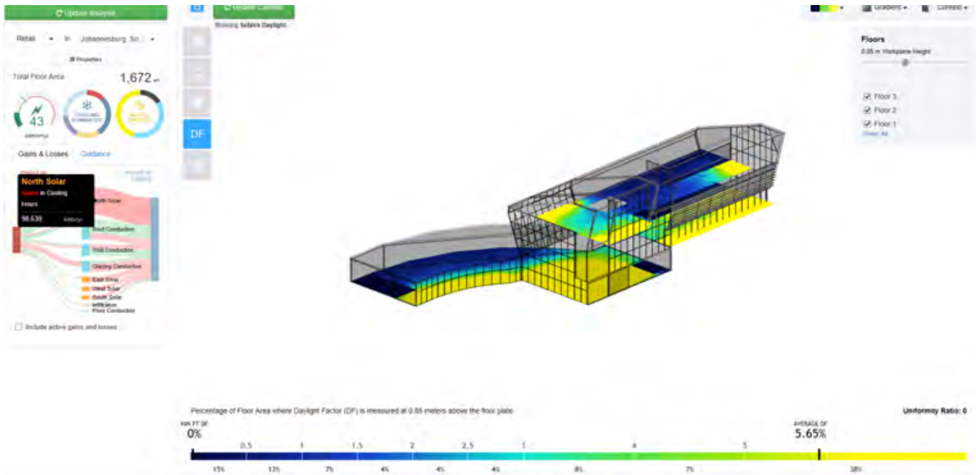


FIG 133 : Sefaira Modeling iteration 3 (Author, 2017)

This iteration was to lower the power usage and thermal comfort further by adding insulation and a ceiling to the roof. This heavily impacted the performance of the building being able to hold heat and became mainly cooling dominated load wise. There was a 10kwH/m2/yr drop in energy usage

ITERATION 4

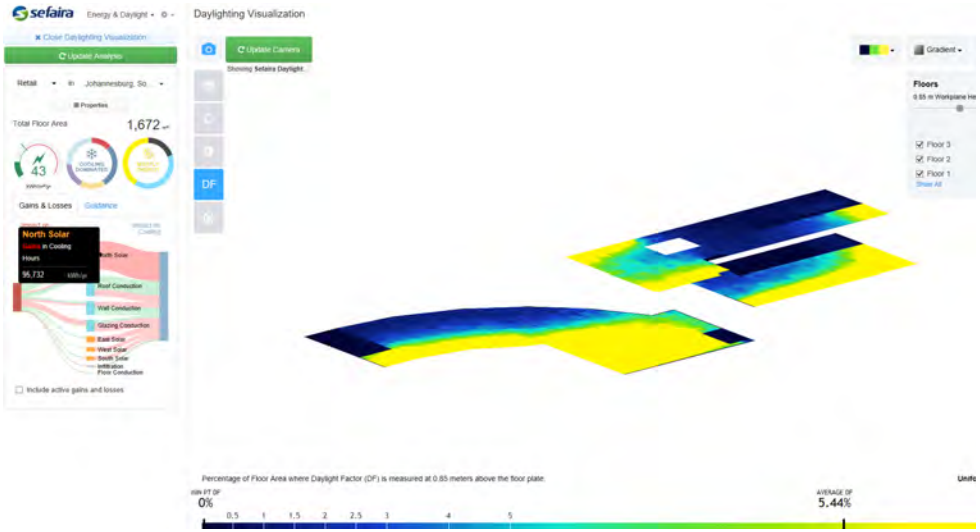


FIG 134 : Sefaira Modeling iteration 4 (Author, 2017)

The final iteration looked at lowering the DF, to add a variable quality the sun shading was made into mechanical louvers assuming a closed position to provide a comfortable level of light within the building minimizing glare. There was a 0.2% drop in DF

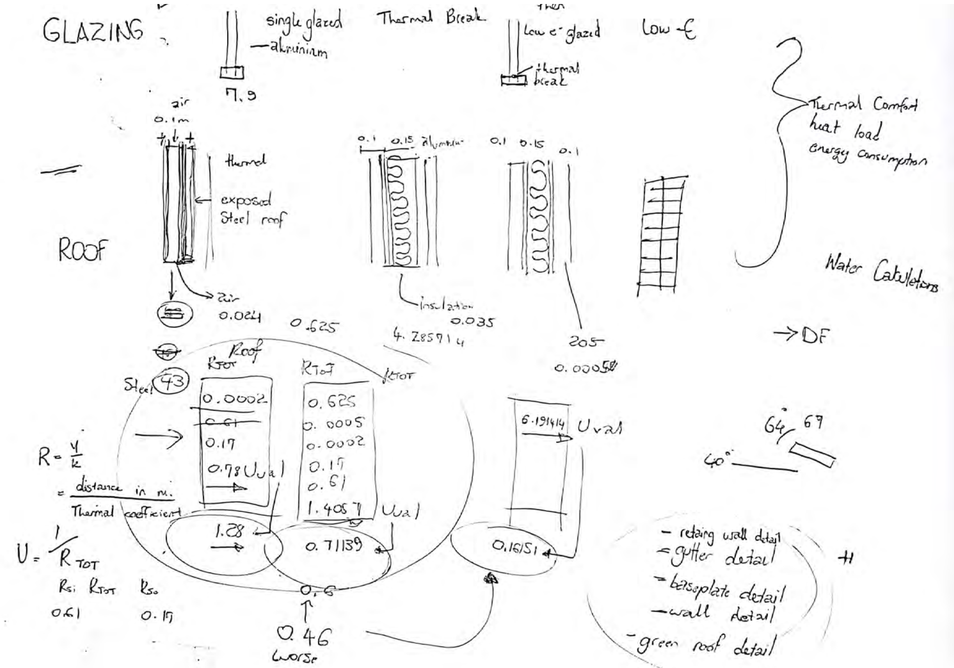


FIG 135 : Process thermal calculations for roof cladding (Author, 2017)

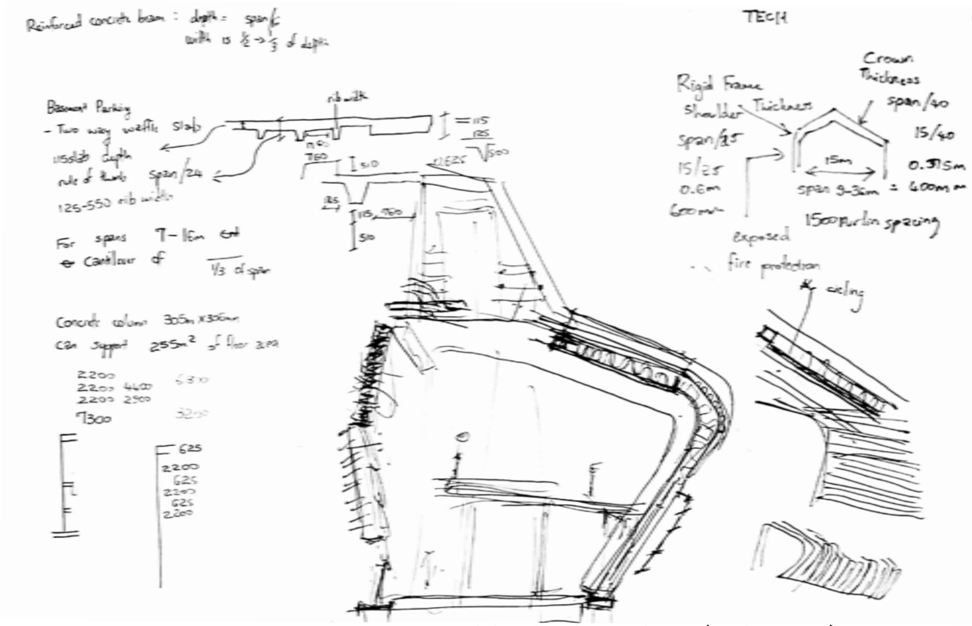


FIG 136 : Process constructional detail and compilation (Author, 2017)

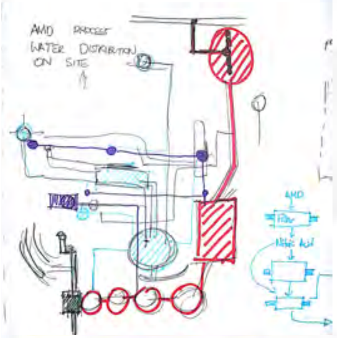


FIG 137 : Flow Diagram showing water movement on site (Author, 2017)

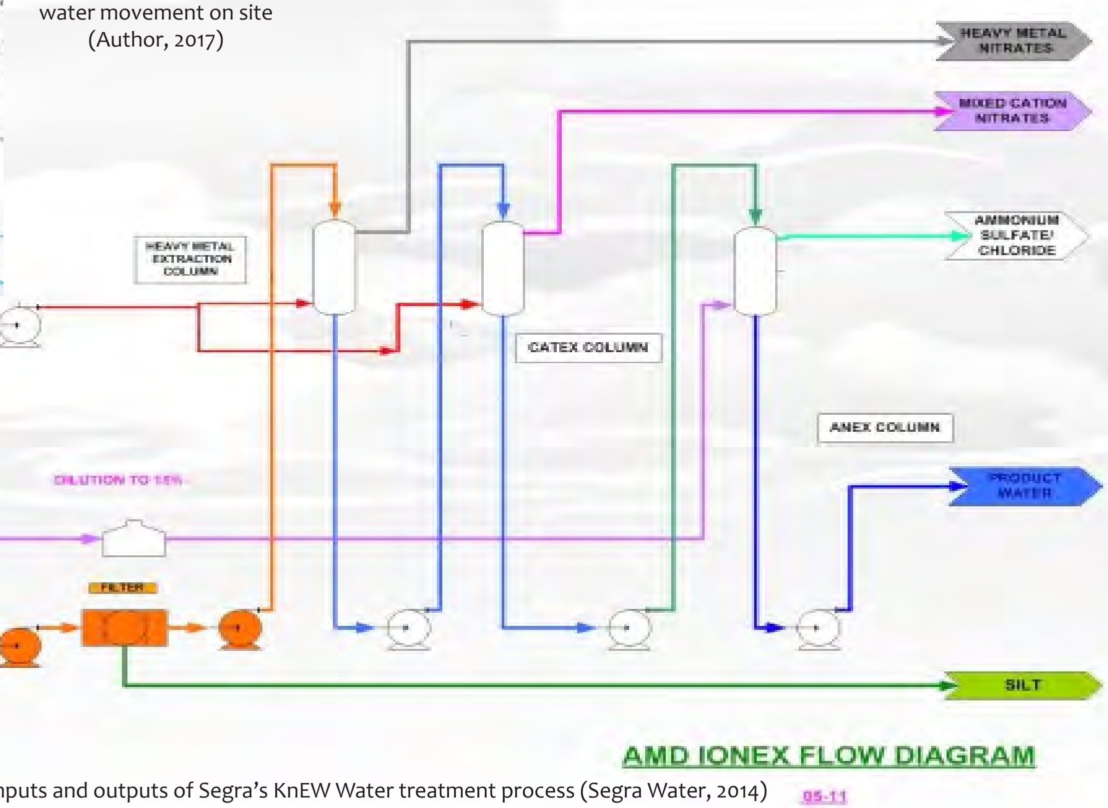


FIG 138 : Flow Diagram showing inputs and outputs of Segra's KnEW Water treatment process (Segra Water, 2014)

FIG 139 : Collage depicting Segra Waters pilot plant (Segra Water, 2014)

8.5 ENVIRONMENTAL SYSTEMS

This intervention has 3 environmental systems to note. The main environmental system is that of AMD water treatment which treats and reticulates water within the site. The second is a subsidiary system using the treated water to achieve thermal comfort in the form of Evaporative cooling. The third includes extensive green roofs which are used for small scale urban farming on site as well as providing a thermal buffer for spaces below it.

8.5.1 AMD TREATMENT

According to SEGRA water, the KNeW process was developed as an economically viable treatment process of AMD water, this process will turn an almost immediate profit. While Reverse osmosis produces a brine substance that cannot be discharged into the natural environment this process produces no waste only usable outputs in various forms of fertilizers and chemicals to be sold to the relevant industries. This process has a low start-up cost and high return and produces zero toxic waste, water can be industrial grade or potable and the radioactivity is completely removed. It is currently being implemented in the East Rand's Decanting Station.

Segra Group is the company looking to develop this mode of treatment into a profitable ecological initiative. In 2014 a pilot plant was constructed in which the scalability and profitability of the system was displayed. This system which was fitted into a shipping container processed around 10000l/h of AMD water
This facility includes a testing centre which is proposed to move to the new junction and site to test and optimize the outputs both water and profitable material. The intention is to supply the precinct with water and become an off the grid system only contributing overflow back into the system. According to CBECS, 2012 the water consumption of large commercial building are 20 gallons per square foot. this converts to about 820l x 150m^2(size of precinct)
=120m^3 of water usage per day.
Accounting for a 5 day capacity takes into accounts weekends and public holidays, when the treatment centre wont be generating water. This figure then comes to a total need of 600m^3 of potable water.

8.5.2 EVAPORATIVE COOLING

The sites thermal comfort and cooling requirements, as established in the sefaira modeling are achieved using evaporative cooling methods. Evaporative cooling is biomimicry in motion, mimicking the body's mechanism of perspiration to cool down a building. In the same way water changes from a liquid to a gas using energy in the form of heat to do so from the surrounding hot air, as do evaporative cooling systems. They provide water to a ventilation system and allow this natural system to cool the air.

The system will focus on cooling internal spaces with a mechanically assisted evaporative cooling system and the external spaces with evaporative cooling sprayers or misters. These systems are effective due to Johannesburg's hot and dry climate.

The system will draw hot air with fans from inside the highest points of the building, with outside air inlets. This air will pass through a pad which is saturated with water, which cools the air through its phase change. The air is then reticulated back into the lower parts of the building through a series of fans and ducts to be articulated in the final design. The basic concept is that of a mechanically assisted cooling tower that works along the length of the building such as in the Transit station.

This system feeds directly off of the AMD treatment centre, using the treated water stored below ground in the tanks to essentially mediate the temperature above ground. This water will be reticulated in a cyclical fashion forming a closed system as well as " displaying" the water throughout the site.

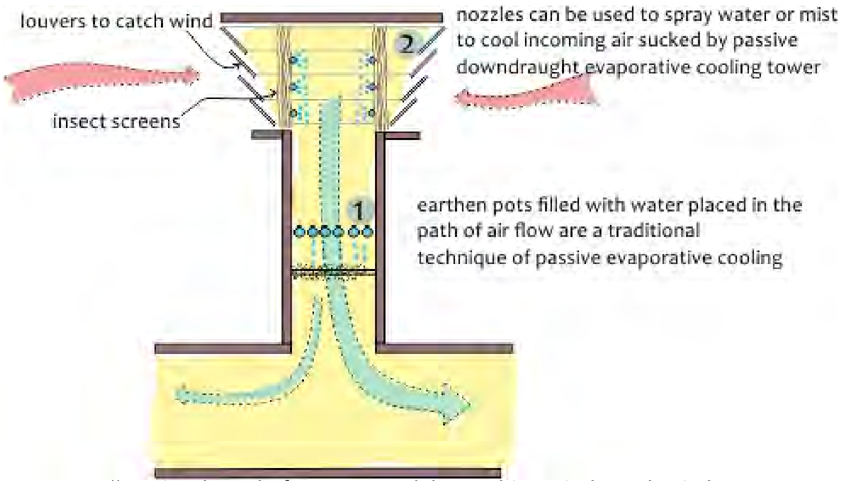


FIG 140 : "Passive downdraft towers catch hot ambient air through wind scoops at the top. The air is cooled either through mechanical systems like nozzle sprays or through passive systems like water filled vessels. The heavy air will sink to the bottom , efficiency is dependent on the difference of air temperature between inside and outside when operating passively" (USAID PACE-D, 2017)

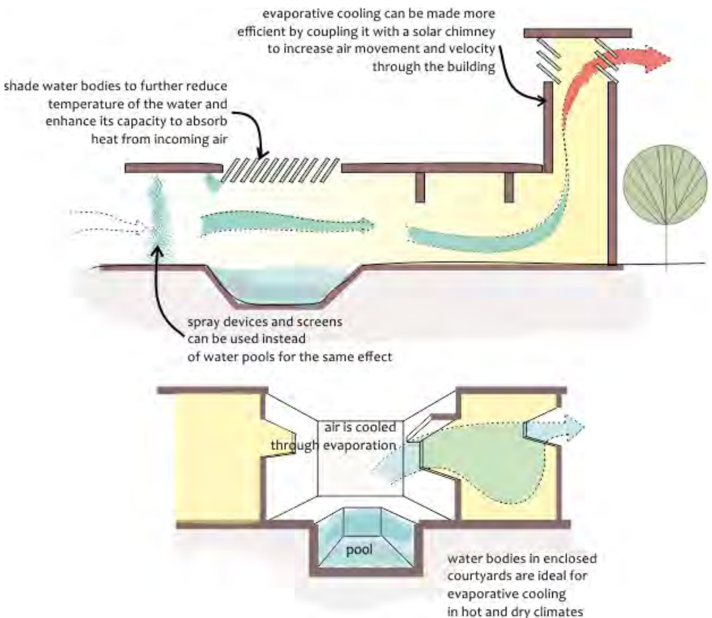


FIG 141 : "Air in direct contact with the cooling media, water, in direct evaporative cooling. The most commonly used methods are water bodies and water sprays." (USAID PACE-D, 2017)

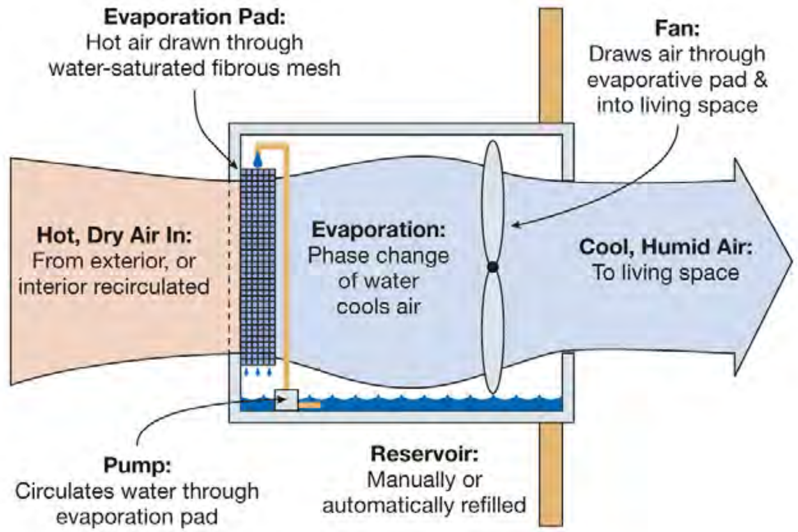


FIG 142 : Evaporative cooling method (Kelley , 2013)

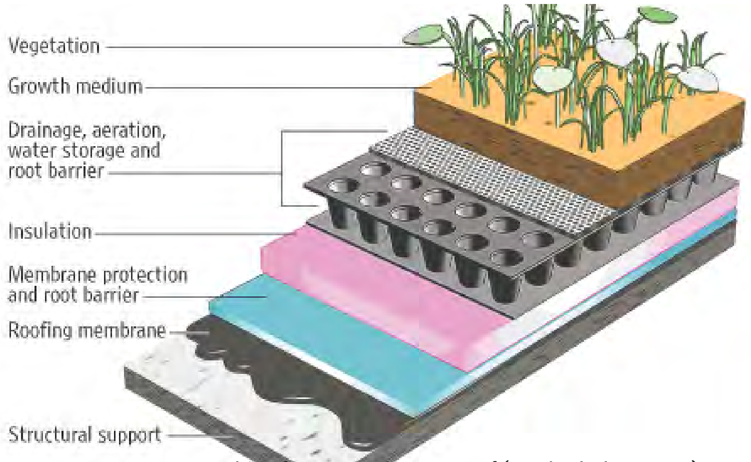


FIG 143 : 3D graphic of vegetated green roof (Earth-pledge , 2010)

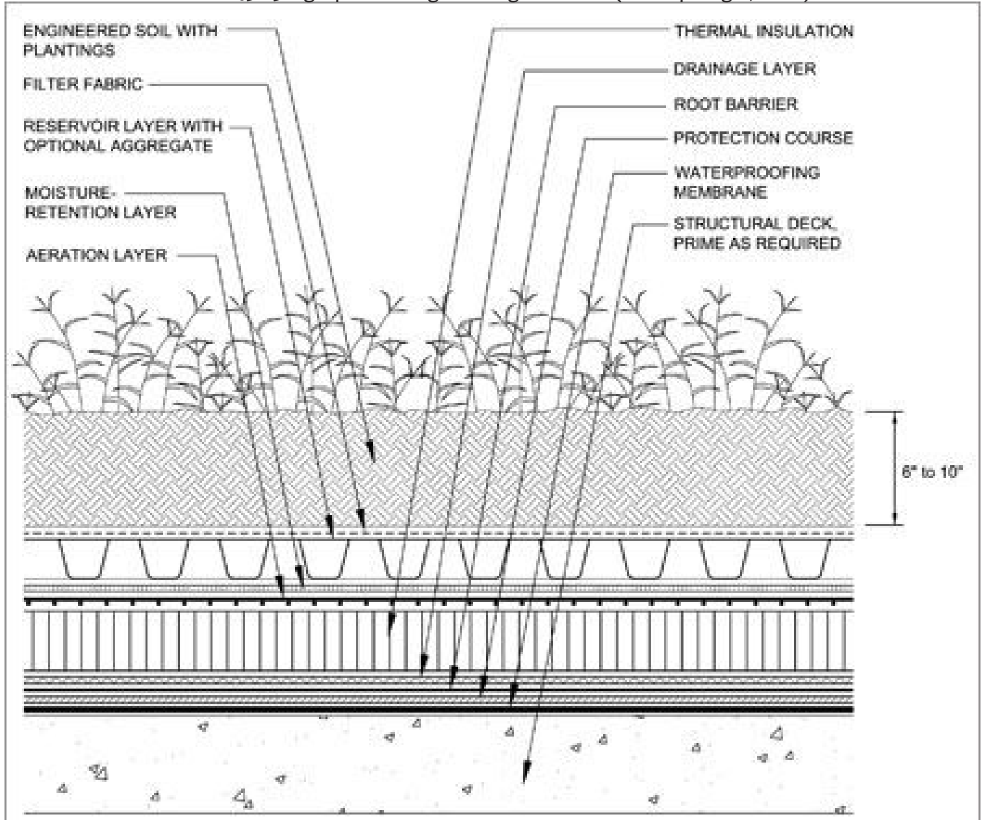


FIG 144 : Detail Section through a intensive green roof (Roofing Magazine , 2008)

8.5.3 SMALL SCALE URBAN FARMING ON GREEN ROOFS

A green roof is a vegetation covered roof Green Roofs form an essential part of achieving the conceptual framework on site, providing the aesthetic of a blurred building and landscape line. These Green roofs will double as a source of production in the production landscape, growing an assortment of vegetables and herbs to be sold at the market and cooked at the restaurant. Thus this green roof will be an intensive system with a large soil and drainage layer which will include an irrigation system. These green roofs will be formed by a system of trays and embedded into the slab

Green roofs also reduce the cooling load within the building by providing a large thermal buffer by which the space below remains cooler than with conventional roofing methods. This is essential for spaces sunken into the ground with little natural ventilation. The roof requires a thick layer of soil around 600mm to allow for the growth of root vegetables like carrots and sweet potatoes. The types of plants that will be grown on this roof are beets, lettuce, onions, spinach, cabbage, broccoli, cherry tomatoes, eggplants, peas and peppers as well as herbs like basil, thyme and mint.

This feature builds upon the much needed green lung of not only the city but the transit precinct providing a fresh supply of oxygen and intake of CO2 so instead of the mining belt giving off harmful dust it now becomes and oxygen generator that sits sensitively in the landscape, a regenerative powerhouse.

These 3 processes will be consolidated within the final design with final numbers, flow diagrams and sections.