



# RE-FORGING INDUSTRY

POST MINING LANDSCAPES

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AUTHOR \\  
Peter C. Harrison

STUDY LEADER \\  
Mr Abre Crafford

COURSE LEADER \\  
Prof. Athur Barker

FEILD OF STUDY \\  
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## PROJECT SUMMARY \\ \

PROGRAMME \\ \	Education College, Artisans workshops and Carbonisation Facility
SITE LOCATION \\ \	Portion 3 of Elandsfontein Farm No. 480 JR, Cullinan Diamond Mine, Cullinan, Gauteng
SITE DESCRIPTION \\ \	Education College, Artisans workshops and Carbonisation Facility
SITE ADDRESS \\ \	103 Oak Ave, Cullinan, Gauteng
GPS COORDINATES \\ \	25° 40' 14.90" S ; 28° 30' 40.36" E
CLIENTS \\ \	Cullinan Community Trust, The Council for Scientific and Industrial Research (CSIR), Cullinan Diamonds
THEORETICAL APPROACH \\ \	Sustainability, Resilience and Regenerative theories
ARCHITECTURAL APPROACH \\ \	Education College, Artisans workshops and Carbonisation Facility

In accordance with Regulation 4(e) of the General Regulations (G.57) for dissertations and theses, I declare that this thesis, which I hereby submit for the degree of Master of Architecture (Professional) at the University of Pretoria, is my own work and has not been previously submitted by me for a degree at this or any other tertiary institution. I further state that no part of my thesis has already been or is currently being, submitted for any such degree, diploma or other qualification.

I further declare that this thesis is substantially my own work. Where reference is made to the work of others, the extent to which that work has been used is indicated and fully acknowledged in the text and list references.

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Peter C. Harrison

## ABSTRACT \\\

The aim of this research is to explore the possibilities of the reuse and re-adaption of historical mining sites and towns in a postmining scenario. The threat of mine closure looms over South Africa and because the mining industry forms such a major part of the country's economy as well as labour market, this is not a threat that can be ignored any further. Mine closures occur for various reasons, namely; the fall of global commodity prices, domestic cost pressures have risen too quickly (electricity prices and wages), uncertainty over the government's mining policy and a fall in productivity of mines (viability) (Baxter, 2016). Because mining towns and the mines they support have, up until this stage, have been very lucrative. There has been no need for residents to diversify, or develop alternative streams of income. The mining companies see no reason to invest in infrastructure that doesn't directly benefit the mine or meet minimum legislative requirements. Mine closures do not have to spell the end for mining towns and their communities. If mining infrastructure and related industrial buildings can be used to house alternative forms of industry, then these communities have a chance of surviving.

Die doel van hierdie navorsing is om die moontlikhede van hergebruik en heraanpassing van historiese myngebiede en dorpe in 'n postmining-senario te ondersoek. Die dreigement van mynbou van myn sluiting hang oor Suid-Afrika en omdat die mynbedryf so 'n groot deel van die land se ekonomie sowel as arbeidsmark vorm, is dit nie 'n bedreiging wat verder geïgnoreer kan word nie. Myn sluiting vind om verskeie redes plaas, naamlik; die val van wêreldwye kommoditeitspryse het binnelandse kostedruk te vinnig gestyg (elektrisiteitspryse en lone), onsekerheid oor die mynboubeleid van die regering en 'n daling in produktiwiteit van myne (lewensvatbaarheid) (Baxter, 2016). Aangesien myndorpe en die myne wat hulle ondersteun het tot op hierdie stadium baie winsgewend was, was daar geen behoefte aan inwoners om alternatiewe inkomstestrome te diversifiseer of te ontwikkel nie. Die mynmaatskappye sien geen rede om te belê in infrastruktuur waarin die myn direk baat vind of aan die minimum wetgewende vereistes voldoen nie. Myne sluit nie die einde vir myndorpe en hul gemeenskappe nie. As mynbou-infrastruktuur en verwante industriële geboue gebruik kan word om alternatiewe industrieë te huisves, dan het hierdie gemeenskappe 'n kans om te oorleef.

## ACKNOWLEDGEMENTS \\\

This research started off as a topic that interested me, but through the guidance supervision and inspiration that I have received from my supervisor it has turned a project of the heart and something that I truly believe in.

Thank you Mr Crafford for all the guidance that has led me to be able to produce this document and hopefully further research on this interesting topic. I also need to thank Prof. Barker for his guidance and enthusiasm on my topic. This year has been a significant learning curve for me and this degree has taught me to look at sustainability in a completely different context.

Thank you to my friends, Richard and Gareth for their enduring motivation through the past 12 months, and for putting up with my complaints. Thank you to Carla for all your help and inspiration you have given me through the hardest parts of this year. And last, but not least to my family, my father, mother and sister, thank you for always believing in me, and pushing me to produce the best. I can never thank you enough for the support and inspiration that you have given me.

To my parents and my twin, for always being my compasses in life.

Anthony, Vicky and Antonia Harrison

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# CHAPTER 01 \\ BACKGROUND AND HISTORY

# BACKGROUND \

## A HISTORY OF MINING IN SOUTH AFRICA

The history of mining in South Africa is essentially the modern history of the country. For the past one and a half centuries the economy of South Africa has been directly linked to the state of the mining industry. To a lesser degree this is still true to this day.

Archaeologists have made discoveries that indicate that South Africa had active copper, tin and iron-ore mines from the 5th century onwards. The first modern mines in South Africa were located in the copper rich Namaqualand in the Northern Cape. These mines started developing from 1852 onwards.

Gold was discovered in the Transvaal in 1875 which sparked one of the world's biggest gold rushes. Gold was initially discovered on the Kroomdraai farm, near Krugersdorp. Seven years later in 1883 the "Pioneer" reef was discovered and three years later the "Main" reef was discovered. The "Main" reef is one of the richest gold veins ever discovered. The discovery of these gold rich veins turned South Africa into the world's biggest gold producer up until 2006. (USA Gold, 2017)

As a result of these discoveries the authorities in control had to find vast amount of labour. Most often this labour was supplied by other African countries, that were also under control of the colonial powers. The result of the influx of mine labourers resulted in policies that were formulated "to drive the African population into the developing urban mining centres (without effectively integrating them into society)" (Hanns Seidel Foundation, 2013, p. 3). Along with the initial slavery

policies of the VOC (Dutch East India Company) these migrant labour and separation policies formed the precursors of Apartheid. "This set of assumptions and policies informed the development of segregationist ideology and later (from 1948) apartheid" (Government Communication and Information System, 2012, p. 22).

## DIAMOND MINING IN SOUTH AFRICA

### HISTORY

Diamonds were discovered in the then, Cape Colony, in 1867 by a 15-year-old boy on the southern bank of the orange river. The diamond he found was named the Eureka and weighed 21.25 carats (Damarupurshad, 2007). Over the next decade South Africa produced more diamonds than India had produced in the previous 2000 years. (Cape Town Diamond Museum, 2017). These initial diamond discoveries were alluvial, meaning they were removed from their primary source by natural erosion, normally ending up in rivers and river banks. (Shimansky, 2018)

In 1869 the De Beers brothers discovered diamonds on their farm 55km North-East of Kimberley, far from any river or stream. This discovery was the first discovery of a Kimberlite pipe (Shimansky, 2018). Kimberlite pipes would go on to form the backbone of the South African diamond industry and would produce 95% of the world's diamonds (Cape Town Diamond Museum, 2017).

The initial mining method for these kimberlite pipes was open pit mining. However, this method inevitably became economically unfeasible and too dangerous to continue. It was at this stage that underground operations commenced.

## CURRENT STATE OF MINING IN SOUTH AFRICA

### GENERAL MINING INDUSTRY

The current state of the mining industry in South Africa is vitally important to the state of the economy, as the mining industry still makes up a large portion of the overall economy in terms of GDP (Gross Domestic Product) (Statistics South Africa, 2017). The mining industry is also one of the larger employers in the economy, despite years of downsizing and yet another year (2016-2017) of retrenchments (SA Mine, 2017). Mining used to be the only lifeblood of South Africa, but over time its control over the economy has lessened. It has become a much more volatile market than it was before, owing to several factors. Some of these factors are controllable by the government, through policy, but others are subject to the world economy. The relationship between the commodity price and the South African exchange rate is the biggest factor when determining the strength of the sector. Despite the fact that more material might be produced in a certain time period the exchange rate and commodity price can mean that the mine makes a loss.

The South African mining industry is also fairly volatile because of the political situation, government policies (such as the New Mining Charter (SA Mine, 2017)), and labour unrest and disputes. Factors that affect the industry range from political talk about nationalisation of the mines to labour unrest protest, such as that seen at Marikana in 2012.

## DIAMOND MINING INDUSTRY

The diamond mining industry in general is a little more stable than the overall mining industry in South Africa. There are several factors that allow for this. Firstly, the commodity price (although more complex to work out) is more stable than that of other materials mined in the country. Whilst metals are priced per ton of ore, diamonds are priced on the very specific Gemmological Institute of America 4C's scale. The scale looks at the 4C's to determine quality and therefore value. The 4C's that are used to determine this are cut, colour, carat weight and clarity. (Cape Town Diamond Museum, 2018) A diamond of exceptional quality can fetch tens of millions of dollars and therefore a single discovery can make huge profits for the company.

Secondly the industry is a lot smaller than other mining sectors, with fewer mines, fewer employees (18000, in comparison to Platinum 175 000) (Chamber of Mines South Africa, 2017) and on average higher wages. Whilst bringing the ore to the surface and the diamond recovery process is expansive, transportation costs are minimal and the product can be sold easily in a cut or raw state.

The South African Diamond Industry is the 8th biggest producer in the world, behind only Botswana and Russia. (Chamber of Mines of South Africa, 2006)



Figure 1.1 - Diamond miners sorting diamonds on the Orange River (Shimansky - [www.shimansky.com](http://www.shimansky.com))



Figure 1.2 - Mine claims at the Kimberly Mine (Shimansky - [www.shimansky.com](http://www.shimansky.com))



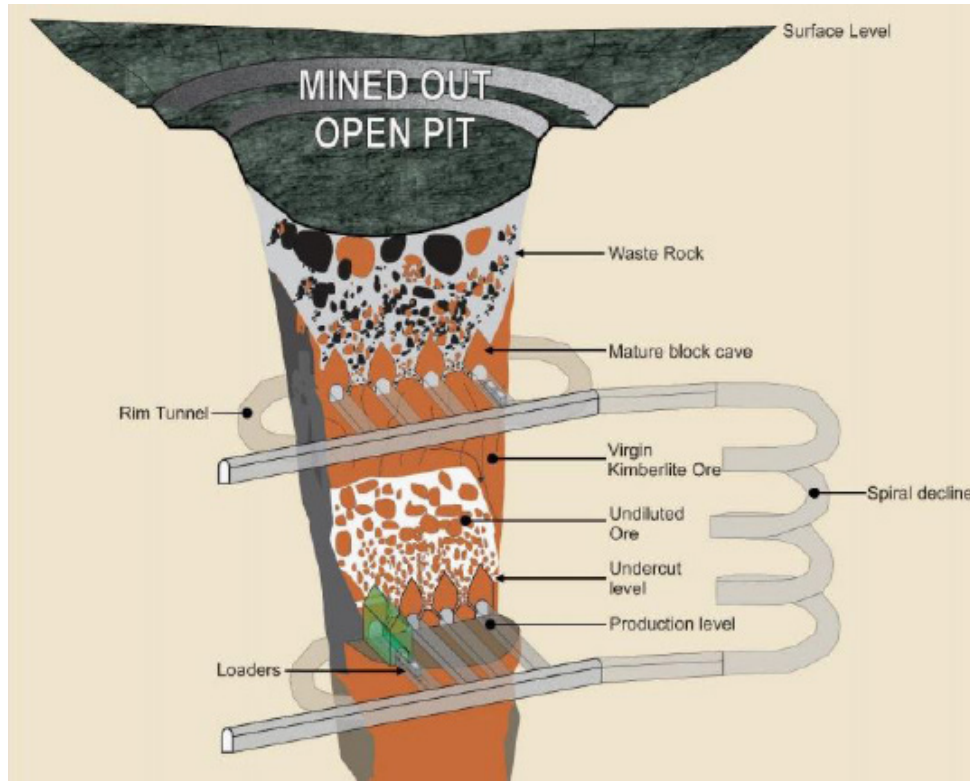


Figure 1.3 - Diagram of Kimberlite diamond pipe (Shimansky - [www.shimansky.com](http://www.shimansky.com))

## DIAMOND MINING METHODS

### ALLUVIAL

Alluvial (secondary deposits) diamonds are found when kimberlite pipes have been eroded over thousands of years by wind, rain, streams or rivers. The kimberlite ore contains rough diamonds, that are then washed downstream and lodge in river banks, river beds, new or old. The initial discoveries of diamonds in South Africa were all from alluvial deposits. Because alluvial deposits are not the primary source of kimberlite, the deposits were generally smaller and therefore these mining operations did not last for extended periods of time. (Cape Town Diamond Museum, 2017).

### OPEN PIT MINING

Open pit mining is a method that is not only used for diamond mining, but various other metals and other materials. In diamond mining it generally occurs when there has been a discovery of a kimberlite pipe. The top layers of sand and overburden are removed till the kimberlite is reached. The kimberlite ore is then blasted to break it up into manageable pieces. This material is then transported to a primary ore crusher, where it is broken down into smaller pieces. The kimberlite ore is then processed until all the diamonds have been removed from it, this is done by both physical and chemical processes. (Cape Town Diamond Museum, 2017)

## UNDERGROUND MINING

Underground diamond mining is only undertaken when open pit mining has become economically unfeasible. This is by far the most expensive and dangerous method of mining as mines can reach depths of up to 4000m. 8 of the 10 deepest mines in the world are located in South Africa. The method for underground diamond mining is to drill two shafts parallel to the kimberlite pipe. Tunnels are then dug horizontally into the kimberlite pipe, the ore is then blasted and removed through the tunnels to the shafts where the ore is then brought to the surface for the extraction process. (Cape Town Diamond Museum, 2017)

## BLOCK CAVE MINING

Block cave mining is the mining method that is currently in use by Petra Diamonds on their Cullinan mine. Block cave mining is one of the most effective ways to mine large ore bodies, it is also one of the most economically feasible methods of underground mining. This is because it allows for "higher ore extraction percentages" (Petra Diamonds, 2018). Block cave mining uses the same shaft and tunnel system, however instead of blasting the kimberlite horizontally, caves are created above the main level. 'Fingers' are blasted into the kimberlite above the caves. The ore body above these fingers is then blasted progressively upwards until the ore body is allowed to cave in. The ore then falls into the tunnels below where it is hauled to the surface for processing.

Block cave mining is "initially a capital-intensive process, requiring

considerable investment in infrastructure and development before production can commence. However, once the caves have been propagated, it is a low-cost mining method which is capable of automation to produce an underground rock factory" (Petra Diamonds, 2018).

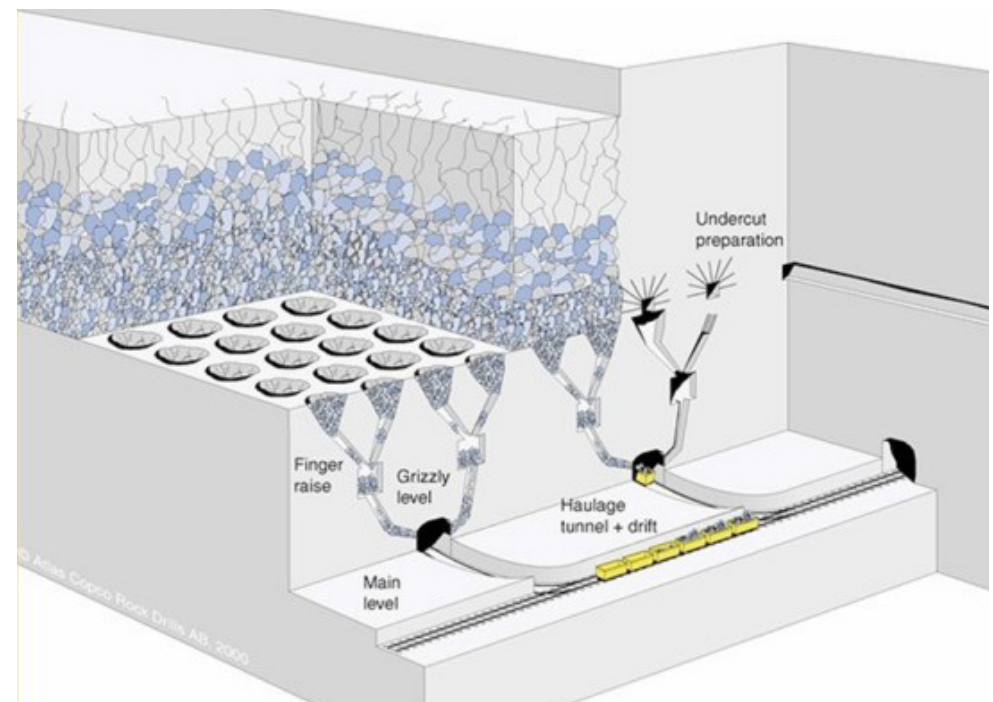


Figure 1.4 - Diagram showing the block cave mining method (Petra Diamonds - [www.petradiamonds.com](http://www.petradiamonds.com))

## DEVELOPMENT OF MINING TOWNS

The development of mining towns or boomtowns revolves around the material being mined. A boomtown is defined as “a community undergoing rapid growth due to a sudden economic shock” (Ohio State University, 2018). These towns were initially developed to house the miners that were required to extract the material. Most often the first building to be built was a washer building or a crusher building that was central to the recovery of whatever material was being mined. Due to the nature of the discovery of the material that was discovered at a particular site, most often in a remote area, prospectors or miners would flock to the area even though there was no formal infrastructure. Therefore, it can be said that almost all mining towns started off as mining camps. This meant that most mining towns started off by housing prospectors or miners in tents.

Depending on the success of the mine, and the amount of material that was available these conditions would become somewhat formalised. Specifically, whatever mining company owned the site would start to build formal houses for its high-level employees, such as mine managers etc. Another common attribute of frontier mining town is that one of the first formal buildings to be erected would be a church.

The mine and the church would be situated on opposite sides of the main street, and the town would then develop around that main street. The development of mining towns hasn't changed since, they follow the same principles today as they did in the 19th century. The initial stage is the discover, exploration and acquisition of the land. The second stage is the construction of mining infrastructure. The third

stage is the development of the supporting supply chain. And the final stage is the mature stage of production.

## HISTORICAL GOVERNANCE OF MINING TOWNS

Due to the nature of the development of mining towns and the fact that the land was almost always owned completely by the mining enterprise. The mines had an effective autocracy over the rules and regulations that governed the workers and miners living on that land. These rules were and are particularly strict on diamond mines where a diamond can be smuggled out of the mine in a piece of clothing or stuck to the bottom of a boot. Some mining companies who still own towns do not allow even non-direct family members to visit their workers whilst they are on a work rotation. Special permission has to be given in such cases. An example of this is Oranjemund in the Namibia, the town is run by Namdeb, a subsidiary of De Beers.

This kind of autocratic control is by no means new. It has been practiced since the beginning of mining towns in South Africa. Because of this control, different types of people were given certain rules to abide by and others were given different rules. At first this separation was based on a persons' standing within the company. For example, the first permanent dwelling erected on the Cullinan mine was the General Managers house. Everybody else on the site was living in tents.

## FAILURE OF MINING TOWNS

Mining towns exist under the natural monopoly of the mining company. This is most often due to the remote location of the mine, meaning that the majority of residents of the mining town were drawn to the site because they had jobs on the mine. Some mine workers dependents relocate with mine workers; however, this mostly happens with mine managers and upper levels of employees. The lower levels of employees are migratory, living in the towns for most of the year and travelling home once a year over the holiday period.

## POST-MINING TOWNS

Post-mining is exactly as the name suggests, mining towns that no longer have operational mines. As previously mentioned the town's main industry is the mine and they are effectively 'service' towns that are created to supply the mine with the necessary materials, labour and services for the mine to operate optimally. As discussed, the governance of mining towns has a large role to play in why they cannot operate effectively in a post mining scenario. The location along with the lack of alternative industry or source of income means that once the mine closes there are very few alternative jobs that can provide income to the population that used to work at the mine.

It is due to the many reasons for mining town failure that these towns become effective ghost towns, only inhabited by those who have nowhere else to go and nothing else to do. This generates increasing poverty and resentment.

## INTRODUCTION

“Diamonds are the most prized and highly valued of all gemstones. Throughout history they have been admired by royalty and worn as a symbol of strength, courage and invincibility. Over the centuries the diamond acquired unique status as the ultimate gift of love, in myth and reality. It is the hardest known substance yet has the simplest chemical composition, consisting of crystallized carbon, the chemical element that is fundamental to all life.”

Marijan Dundek, (Dundek , 2009)

The word Diamond is derived from the Greek word *adámas* (ἀδάμας), which translates into “unconquerable or indestructible” (Cape Town Diamond Museum, 2016).

Diamonds have however, been revered throughout history. It is generally accepted that diamonds were first actively mined in India 3000 years ago and they held great religious significance. Initially India was thought to be the only source of diamonds in the world. When their mines were depleted the search started for a new source. Small deposits were found in Brazil but the demand for diamonds far outweighed the supply. (Brilliance, 2018)

The value of diamonds is intrinsically a man-made construct and is largely so because of the efforts of Cecil John Rhodes, De Beers Consolidated Mines Ltd (De Beers) and a century of calculated advertising. In 1948 De Beers hired advertising agency N.W. Ayer to create an advertising campaign to help boost the sales of diamonds. “The brilliant concept was to create an emotional link to diamonds, the sentiment

being love, like diamonds, is eternal” (De Beers Group, 2018).

Cullinan is the site of the discovery of the world’s largest diamond, and as such sparked a ‘diamond rush’ in 1903. The town of Cullinan was developed as a support town for the mine and developed rapidly into a ‘boom town’. Diamond mining has remained the town’s largest industry for the past 115 years and as such the relationship between the town and the mine is woven deeply into the fabric of the area.

The Cullinan mine, as with all mines of non-renewable resources, will reach a stage where that the resource will eventually become depleted, or it will become too expensive to mine in relation to its value. At such a point the mine will be decommissioned and the town, whose survival is so intertwined with that of the mine, will become yet another post-industrial, post-mining ghost town.

## PROBLEM STATEMENT

The closure of mines spells doom for mining towns and their associated communities. Alternative industry must be developed in these scenarios to create sustainability and resilience in these communities. This should be done in conjunction with using existing heritage industrial infrastructure that will become unused when the mines close.

## GENERAL ISSUE

The general issue surrounding this project is the fact that the mine will be decommissioned in the not too distant future. There are time estimates for its closure ranging from 13-30 years. The result of this is that an estimated 1000 mineworkers will be retrenched and all supporting industries will also cease to exist, creating further unemployment and economic ruin. Industry in the area will essentially come to a halt because it is currently very mono-dimensional.

The mining process has already had very large negative effects on the environment.

This degradation will only worsen with the closing of the mine. There is also the matter of the industrial infrastructure that exists on the actual mine and the relationship that the mine has with the town itself. The mine closure would also affect this infrastructure.

The mine's current closure plan includes returning the vast majority of the site to its original form, so it can be incorporated into the existing premier nature reserve, which at present occupies an adjacent land area.

## URBAN ISSUE

Understanding the Cullinan's urban issues requires that we understand the history of the town. The site was bought by Thomas Cullinan in 1902, and the mine first started operating in 1903. The town was established with the purpose of supporting the mine. Due to the fact that the town was a colonial style mining town it was laid out using the well-established English linear blueprint. In this style the village is laid out along a strong linear axis, being the main road or high street. The main road normally links important landmarks in the village such as a church or town hall. In this instance the 'high' street (Oak Street) links the church at one end and at the other the mine. From this main linear axis, the town was able to expand outwards but always keeping the axis its central point.

The mine itself, did not follow any form of spatial development planning and simply expanded when and where it needed to. Typically it expanded closest to where the material was coming from.

There was some kind of pattern that developed over time. This pattern was determined by new processes that were introduced to the mining infrastructure.

Because the mine has developed only due to its production needs there is very little in the way of spatial framework. Part of this project is to develop a new spatial framework that will help to address the issues of disconnection between the town and the mine, as well as the relationship between the mine's industrial infrastructure.



## ARCHITECTURAL ISSUE

When the mine is decommissioned it will leave an industrial wasteland behind. All the infrastructure will become redundant and superfluous to any present need. The link between the town and the mine will become even more disconnected and the entire reason for the town's existence will be lost. Along with this much of the town's heritage value will be endangered and even its tourism value will be greatly diminished. For residents of the community, including residents of the Refilwe township located 4km away from the mine, will lose their sense of belonging and purpose in the landscape.

The Minerals Act, 1991 (Act 50 of 1991) "provides statutory requirements enforcing environmental protection, the management of the environmental impacts and the rehabilitation of the affected environment of prospecting and mining in South Africa." This act essentially provides that once mining has ceased on a claim that it be restored to its original state. However, this takes vast amounts of money and also long periods of time. It also does not consider the historical or heritage value of the infrastructure itself. As well as negating the fact that industrial infrastructure has the possibility to be readapted and repurposed for alternative programmes and purposes. Simply restoring the property to its original state is not attainable in the greater sense of the word.

Whilst Petra Diamonds has made some provision for keeping part of the mine to remain as tourism sites, namely the Cullinan pit, buildings housing the treatment machinery and the No.1 headgear, whilst returning the rest of the site to its natural state, this will only serve to further disconnect the historical industrial landscape from the town. It will also greatly detract from the heritage value of the industrial landscape because it would then be incomplete. Specific buildings and structures sitting in a 'natural' landscape would look 'uncomfortable'.

The town of Cullinan has always had, although reduced over time, a direct relationship with the mine. Once the mine closes that relationship will only be physical. Through the creation of new industry, adaptive reuse of buildings and regenerative architecture within the mine site, Cullinan can once again have a symbiotic relationship with its industrial landscape.

## RESEARCH QUESTIONS

### ECOLOGICAL

What role can an architectural solution play in the rehabilitation of the mine site, that does not include complete de-industrialisation and returning the scarred landscape back to its supposed natural state?

### SOCIAL AND CULTURAL

Is there an alternative method to mine closure and site rehabilitation that can continue to connect society with the heritage of the mine and the industrial infrastructure that otherwise be dismantled?

How can an architectural solution help to retain and or rebuild the connection between the town and the mine?

Can the development of the post-industrial site build an appreciation for the industrial heritage of the site?

### ECONOMIC

Can the development of new industry in the post-industrial site help to prevent the economic failure of the town and the dependent communities around the site?

## DISSERTATION QUESTIONS

- How can a new approach to industrial heritage create sustainability and resilience in Cullinan?
- How can a mixture of new architecture and adaptive reuse of existing heritage infrastructure create a new public interaction between the industrial heritage and the new industries?
- Can an architectural intervention help to restore the link between the town of Cullinan and the mining site?
- Can the development of new industry within the existing mine site help to create economic sustainability for the surrounding community that has been relying on a single industry for so long?

## INTENTION OF DISSERTATION

The intention of this dissertation is to further the work of a dissertation that was completed in 2017 (MARCH Sustainable Energy Efficient Cities, Wits). The interest in this topic stemmed for several years working in the mining town of Kathu in the Northern Cape, which faces many of the same issues that are facing Cullinan. This previous dissertation focussed on Independent Power Producers (IPP's) Socio-Economic Development (SED) and Enterprise Development (ED) funding models that could help facilitate the creation of sustainability and resilience in post-mining towns in South Africa. The previous dissertation was a theoretical framework that would allow for the development of resilience and sustainability in post-mining towns.

This dissertation seeks to understand how physical architectural intervention can facilitate that development, through the utilisation of the industrial landscape that remains in post-mining scenarios. The proposals set forward in this dissertation are specific to the Cullinan context and are not a 'blanket solution' that can be applied to all post-mining towns in South Africa or for that matter globally. There is a very specific dynamic that exists in each one of these towns and care needs to be taken to understand those dynamics before any intervention can be designed and certainly before it can be built. In many cases of post-mining town development, it is not the fact that there is not enough infrastructure to sustain the town but rather that the infrastructure that exists or has been built is not appropriate.

*"One of the major issues in these towns is a lack of 'appropriate' infrastructure, and what infrastructure there is has often been incorrectly*

*designed or scaled and is therefore either being used incorrectly or underutilised."* - (Harrison, 2017)

## RESEARCH METHODOLOGY

This section serves to frame the research methodologies that have been utilised to address the outlined questions of the dissertation and thereby develop an appropriate architectural response.

### Mapping:

Mapping of the existing site and its surroundings allowed for the development of a framework which then lead to the development of a master plan for the site. The mapping process was important to understand the existing infrastructure, the heritage value of that infrastructure, the physical condition of the site, the social and cultural components of the community, the relationship that the existing site has with the town, climatic conditions, ecological conditions and circulation and movement through and around the site. Initially the mapping was conducted through a desktop study and then further information was collected on site.

### Participant Observation:

Whilst a vast amount of knowledge can be gained from the study of relevant literature, maps, areal images and reports, it was vitally important to spend time on the site documenting the actual goings on of the site. This method allows for the understanding of the 'feeling', spatial quality, processes of the site. The existing condition was explored both by attending a guided tour of both the surface and underground mining operations and the historical town. Further time was then spent on site conducting site interviews. From these

tours, along with the desktop research it was possible to formulate a framework with a working knowledge of the existing conditions on site.

### Archive:

The study of aerial images, both current and historical, site photos, relevant literature on mine closure and industrial heritage, articles and reports, allowed for the better understanding of the site and the possibilities for the development of sustainability and resilience for Cullinan. Data and reports were also collected from both Petra Diamonds and the McHardy Museum.

### Precedent and Case Studies:

In order to better understand the programmes and possibilities that the industrial heritage allows, careful study of precedents was conducted. Relevant experts in the various industries were consulted to further understand the programmes and their requirements from an architectural standpoint. This in turn allowed for the development of an architectural solution.

### Descriptive and interpretive approach Method:

This method was used to evaluate the appropriateness of existing strategies for the closure and rehabilitation of the Cullinan mine and its site. Through this analysis it was possible to understand where

alternative strategies were required. A study of relevant theoretical literature and case studies helped to understand the shortcomings of the existing strategies.

#### Applied Research:

By using the above research methodologies, it was possible to apply the learned knowledge and develop a conceptual design approach that responded to the dissertation intention, in the form of an architectural solution. This conceptual approach was then used to develop a tectonic concept. The tectonic concept was then used to develop the technical resolution and the detailing of the architectural solution.

## DELIMITATIONS OF STUDY

At this current point in time the Cullinan Diamond Mine is still operational and Petra Diamonds, the owners of the mine, expect the mine to be economically viable for + - 10 years. For the purposes of this dissertation it is to be assumed that the mine is no longer economically viable and therefore has been closed. The buildings and mining infrastructure are no longer in use and the site has been decommissioned. This dissertation is not an attempt to create a global solution to the issues of post-mining communities, but is rather a case study of possible solutions to current South African mine closure strategy (which focuses on de-industrialisation), focussing specifically on the scenario currently facing Cullinan. This dissertation will not focus on any economic analysis or economic viability of this proposed strategy.

This dissertation seeks to develop an alternative strategy to the global trend of de-industrialisation, which can build sustainability and resilience for post mining towns. The author of this dissertation is in no way an expert on any of the production processes of the proposed industrials, but every effort has been made to consult respective experts in each industry to try and gain a better understanding of these processes. Because the topic of this dissertation relates to architecture and not specifically to the respective industries, they only serve the purpose of forming a basis upon which an architectural design and solution can be developed.



## CHAPTER 02 \\ CONTEXT AND SITE ANALYSIS



## INTRODUCTION

The Cullinan Mine is set to become just another name on the list of hundreds of mining operations that have closed in South Africa in the past decades. Unfortunately, due to the nature of mining operations in South Africa and the towns that support them, Cullinan town is also set to join the list of post-mining towns that have 'failed' in the past decades.

The Premier Mine, as it was then known, and the town of Cullinan are synonymous with the Cullinan diamond, the largest diamond ever mined. The following chapter will highlight the events and timeline that has led this picturesque town but 40 minutes' drive from Pretoria, to the inevitability of become another South African post-mining ghost town.

This chapter will contain a macro-analysis for the urban scale, precinct scale and a micro-analysis on a site scale. Through the conclusions of this analysis it will be possible to develop informants for the architectural response.

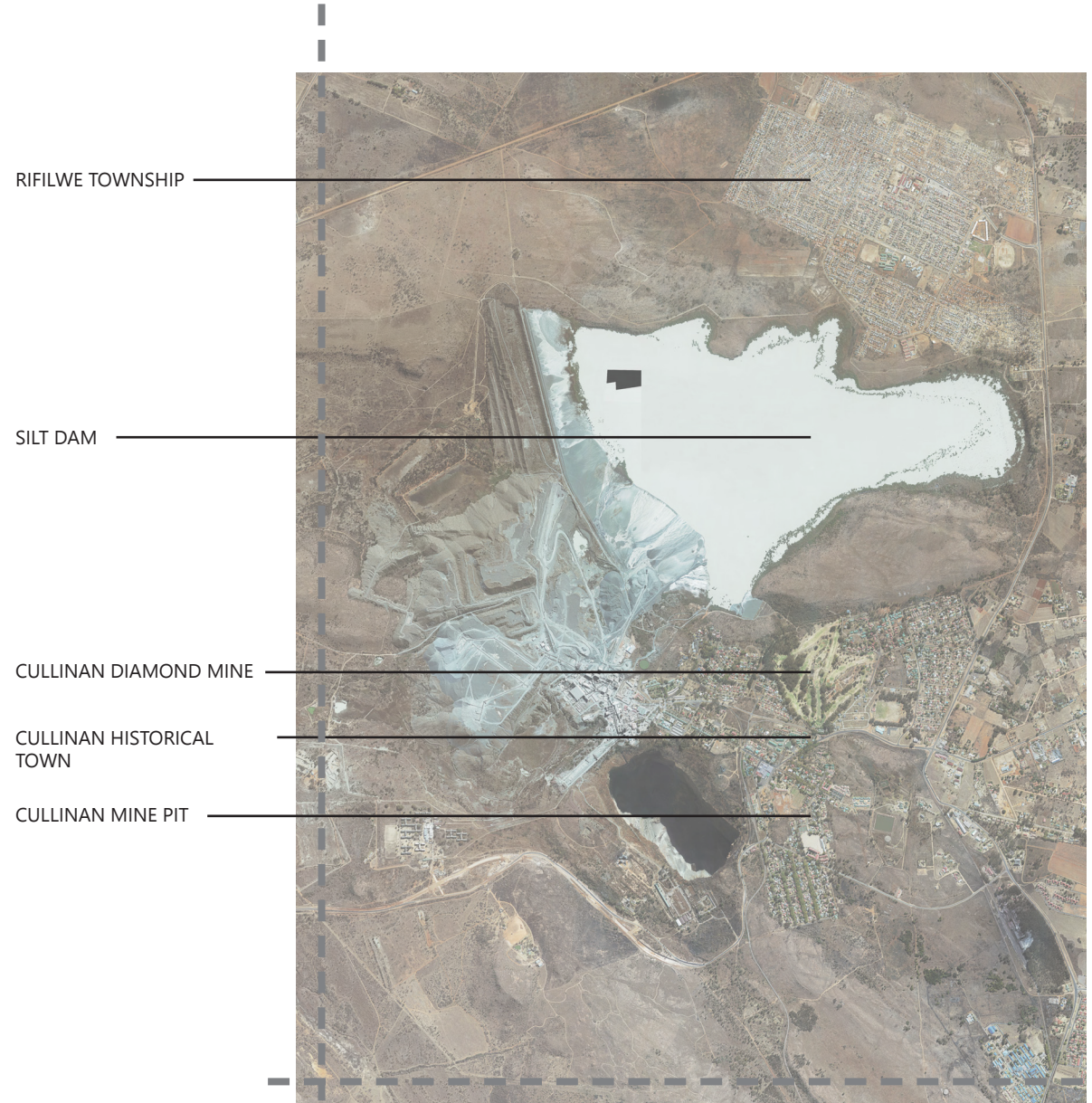


Figure 2.1 - Map showing Cullinan and its surrounds - Author 2018



# CULLINAN MAP OF EXISTING

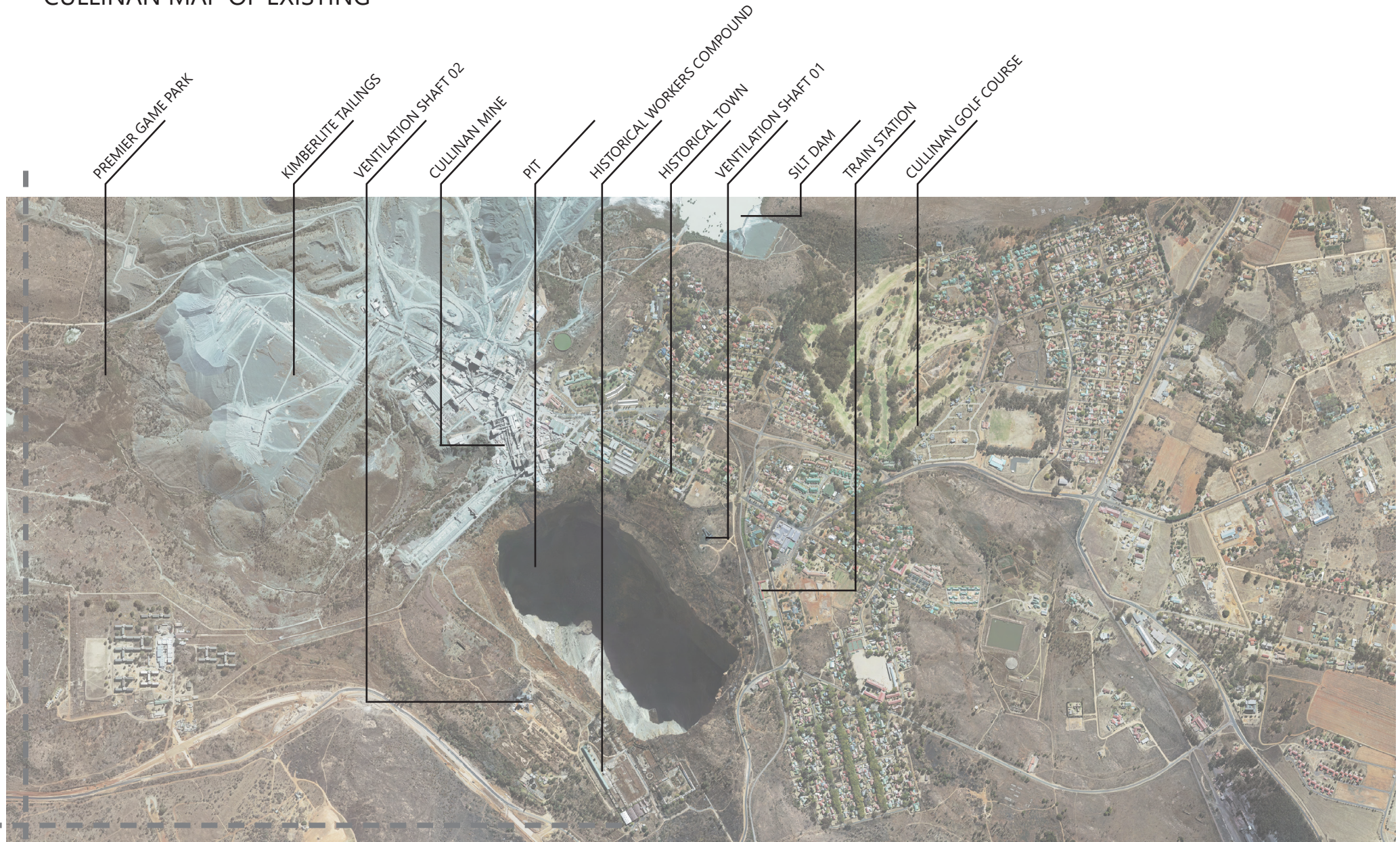


Figure 2.2 - Map showing Cullinan and its surrounds - Author 2018

## THE STORY OF CULLINAN

In 1859 the Elandsfontein farm was surveyed and set out by the popular 2-hour horseback method. The survey was conducted by Cornelius Jacobus Minnaar.

The 2-hour horseback method states that the applicant must determine a central point which will serve as the crossing. The applicant must also select the location where the first stone beacon will be laid. The surveyor then rides on horseback, walking at a steady pace, for an hour in an east-west direction, crossing over the preselected centre point. The process is then repeated in a north-south direction once again crossing over the predetermined central point. Stone beacons are laid at all the end points and they designate the extent of the farm. (Lincoln, 2011)

Sometime during 1861, Cornelius sold a small portion of the farm to his brother Roelof Johannes Minnaar. Roelof and his family constructed a large family home on their new farm, as well as a dam and irrigation furrows. They also laid out fields, orchards and vegetable and herb gardens. The dam was fed by the Wilge river and water was plentiful. As a result, the farm soon became a very productive enterprise.



Figure 2.3 - Cullinan Oak Street - (Lincoln: 2011)



Figure 2.4 - Workers compounds - (Lincoln: 2011)

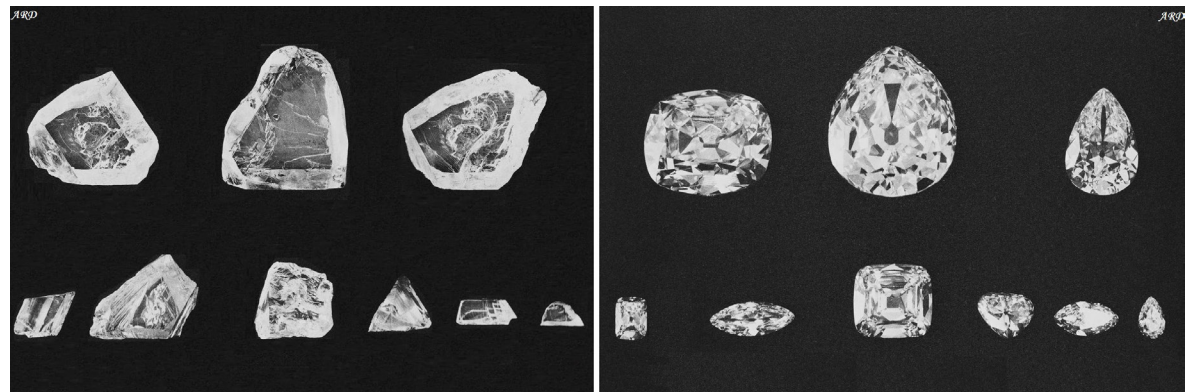


Figure 2.5 and 2.6- Major stones, uncut and cut - (Lincoln: 2011)

On the 7th of December 1896 Roelof's sons sold the northern portion of their farm to Willem Petrus Prinsloo. In 1898 Thomas Major Cullinan (Later Sir Thomas) was prospecting along the boundary fence of the Elandsfontein farm where he happened upon Percival White Tracey, who showed him with an alluvial 3 carat blue-white diamond. Cullinan stated that "there and then, I came to the conclusion that the whole of the country on which they were working was alluvial, and that its stones had to come from some higher level. I then tried to get under option, the farm on which the Premier was subsequently found" (Lincoln , 2011).

A couple years later the Second Boer War (1899-1902) forced the Prinsloo's and many other families to flee the area on ox wagon, in the face of the advancing British forces. When the British forces arrived on the farm they razed it to the ground. They were following the scorched-earth policy ordered by the British forces commander Lord Kitchener. (South African History Online, 2017) In 1902 at the end of the Second Boer War the Minnaar and Prinsloo families returned to their farms to find them burnt to the ground, with everything they had owned also, either burned or destroyed. They tried their best in the following years to return the farms to the previous state, but with the lack of resources they were not able to achieve this.

After initially being rebuffed, Cullinan managed to buy the farm in 1902 from Prinsloo's sons for a sum of £52 000. In 1903 Cullinan also convinced the Minnaar family to sell their farm to him. On the 1st of December 1902 Cullinan registered the Premier Min-

ing Company. On the 24th of April 1903 mining operations commenced, with the first steam plant, known as 'No. 2 Head Gear'. On the 25th of January 1905, Fred Wells, the then surface manager of the Premier Mine found what is still to this day, the biggest diamond ever discovered, the Cullinan Diamond. Therefore, by the definition of the Burra Charter the mine has significant heritage value because of the significant discovery made there.

The Cullinan diamond measured a staggering 3106 carats. It was purchased by the then Transvaal Government and presented to King Edward VII, on his 66th birthday as a gesture of their loyalty and gratitude to the King by the people of the Transvaal. (Lincoln , 2011) Joseph Asscher was selected to cut the stone into 9 major stones and 96 other smaller stones. It was agreed that the fee for cutting the stone would be all the other stones except the two largest (the Cullinan I or Great Star of Africa, and the Cullinan II or Lesser Star of Africa). These two massive polished stones weighing 530.2 carats and 317.4 carats respectively were used in the British Crown Jewels. (Scarratt & Shor, 2006, p. 124)

The mine continued to operate until the outbreak of the First World War (1914-1918). The mine remained closed until the conclusion of the war. In 1917 Ernest Oppenheimer founded the Anglo American Corporation, which focussed on the development of Gold mining in South Africa (The De Beers Group, 2018).

By 1920 De Beers had bought enough shares in the Premier mine to have a controlling interest. (Lincoln , 2011, p. 138).

Following the Transvaal gold rush, Anglo American became an industry leader and became the major shareholder in De Beers, and in 1929 Ernest Oppenheimer became Chairman of De Beers. By 1932 the Great Depression had worsened to such a degree that the demand for diamonds had completely dried up. De Beers took the decision to close all of its mines, including the Premier mine. (The De Beers Group, 2018). The town of Cullinan became almost completely abandoned, with the exception of a tiny caretaking staff left behind to safeguard the mine and its infrastructure.

In the early 1930's the South African Military had joined the allied forces in preparation for what was soon to become World War II. Because the mine was already closed and there was a plethora of vacant houses and other infrastructure, the army moves into Cullinan and set up a massive army base. In 1941 the army also built a huge Prisoner of War (POW) camp for Italian POW's captured in North Africa. (Lincoln , 2011, p. 89). At its peak the Zonderwater POW camp housed more than 86 000 Italian prisoners and was the largest concentration camp ever set up by the Allies (South African History Online, 2017)

1945 sees the end of World War II, and the Premier mine reopened. However, over the 13 years that the mine had been closed the open pit had been allowed to flood. It took 8 months for approximately 2.8 million litres of water to be pumped out, before mining operations could commence once again. (Lincoln , 2011, p. 99)

In the early 1950's mine management ordered explorative drilling to determine the quantity and quality of the material below the current mining level. These tests revealed that at 370m level the kimberlite

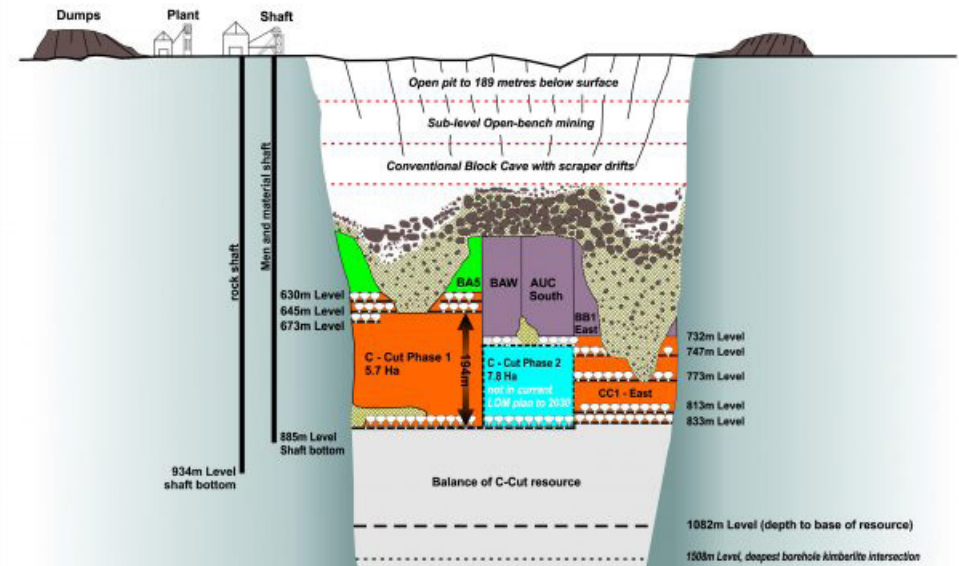


Figure 2.7 - Diagram showing the current Cullinan mine plan - (Petra Diamonds - www.petradiamonds.com)

pipe was cut off by a 75m thick Gabbro sill, which contained no kimberlite ore. However, below this the kimberlite pipe started again. After running the cost estimates of removing 75m of 'zero yield' rock, the mine decided that the most effective and efficient way to continue mining at the site was to sink a deep shaft directly adjacent to the pit, that ran to a level below the Gabbro sill and commence mining underground. (Lincoln , 2011, p. 110).



## TIMELINE OF CULLINAN

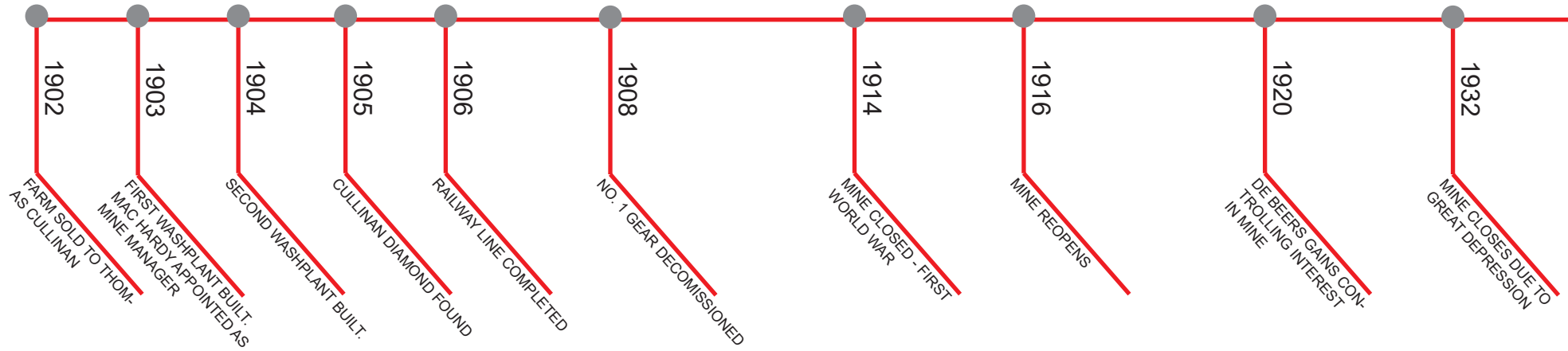


Figure 2.7 - Cullinan Mine looking west - (Lincoln: 2011)

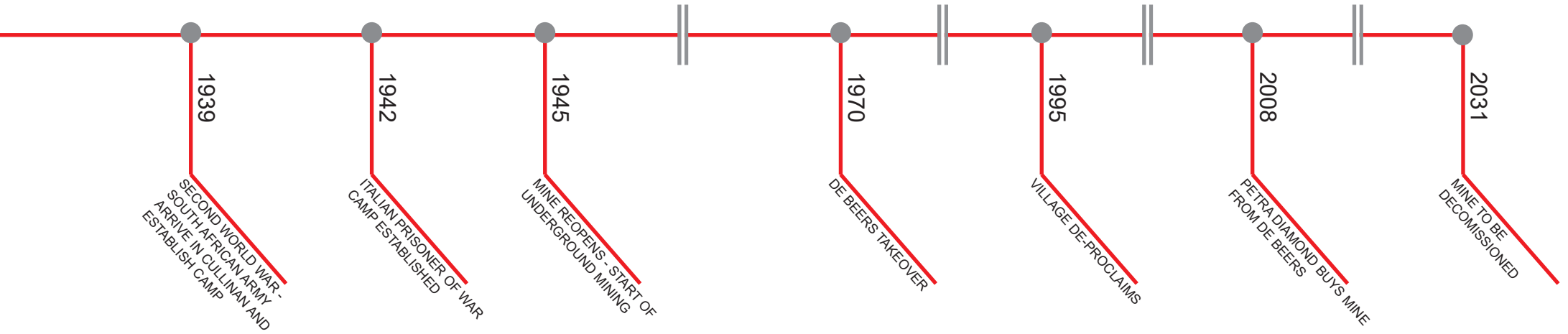


Figure 2.8 - Cullinan Village from the mine - (Lincoln: 2011)

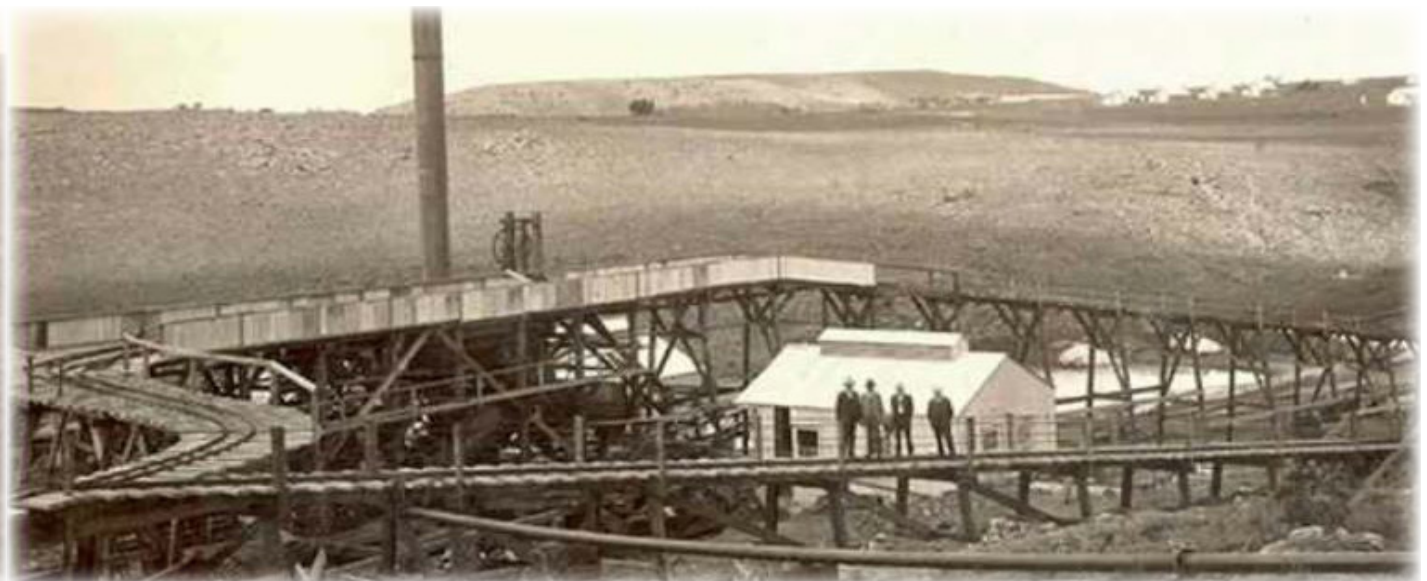


Figure 2.9 - Headgear No. 1 - (Lincoln: 2011)

## PETRA DIAMOND REHABILITATION STRATEGY



Figure 2.10 - Diagram showing existing infrastructure - (Author 2018)

### EXISTING SITE - VILLAGE AND MINE

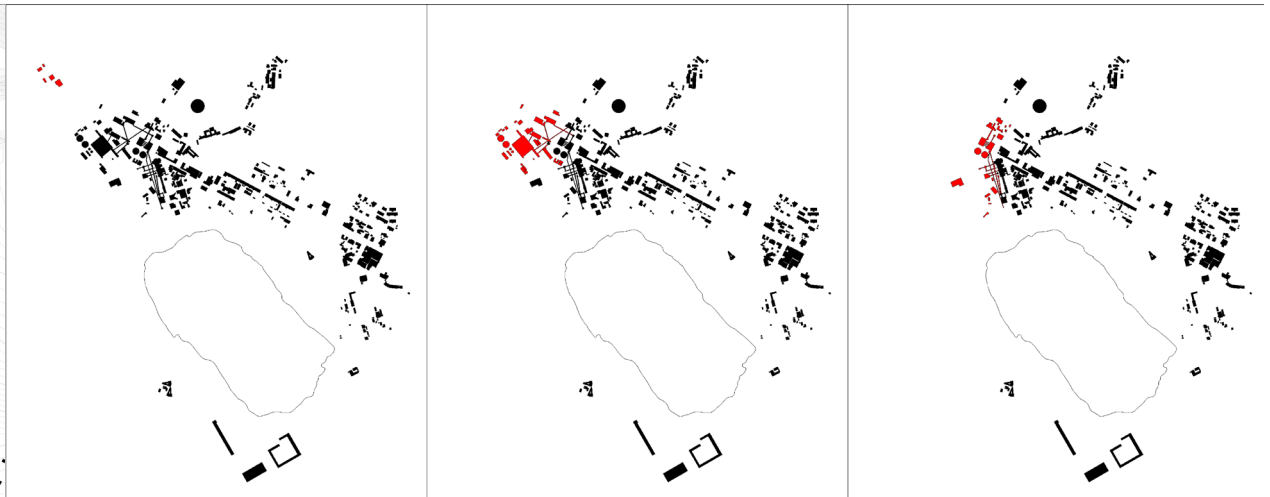


Figure 2.11, 2.12 and 2.13 - Diagrams showing Petra Diamonds existing rehabilitation strategy - (Author 2018)

### PHASE 1

### PHASE 2

### PHASE 3

## PETRA DIAMOND REHABILITATION STRATEGY

Petra Diamonds' current mine plan states that the mine has resources to continue with operations up until 2030. Meaning that the mine has a 12-year life span. (Petra Diamonds, 2018) As stated by Petra Diamonds "mining activities are not expected to last long after the cessation of operations" (Petra Diamonds, 2018). They further state that due to their strategic mine closure plans, that are already in place, the rehabilitation funding for 'latent impacts', post mine closure, have already been established.

### CULLINAN

Petra's general mine closure strategy, which is in line with the National Environmental Management Act No. 107 of 1998, states that the mined land shall be returned to its natural state and that the land shall become "de-industrialised" (Reyenecke, 2011).



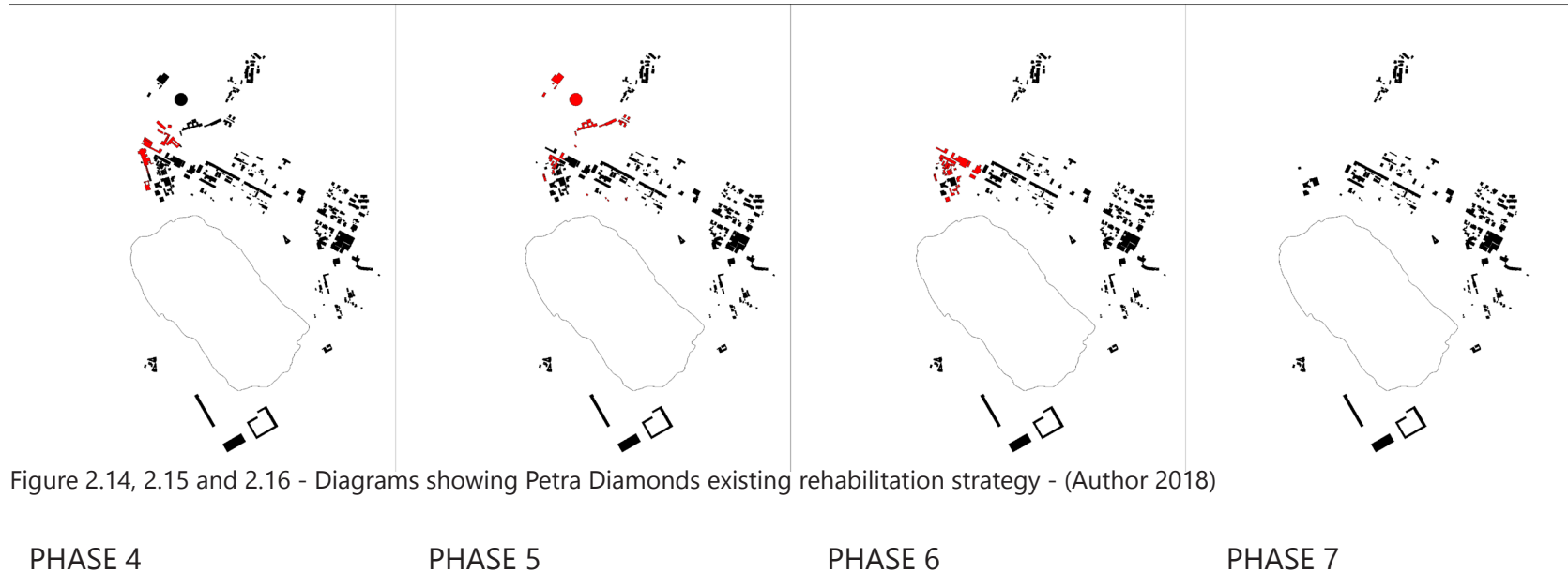


Figure 2.14, 2.15 and 2.16 - Diagrams showing Petra Diamonds existing rehabilitation strategy - (Author 2018)

PHASE 4

PHASE 5

PHASE 6

PHASE 7

However due to the significant heritage value of the Cullinan mine (Australia ICOMOS Incorporated, 2013), its mine closure plan differs slightly from Petra's other operations. The major portion of the mine will be decommissioned and 'de-industrialised' by means of demolition. Four buildings will remain in an attempt to retain the cultural heritage of the site, namely the winder building, Head Gear No. 1, the washer building and the crusher building. The rehabilitated land will then be absorbed into the adjacent Premier Game Park.

The major issue facing this strategy is that without the operational mine, and the proposed demolition of the majority of the mine, except for the above-mentioned buildings, the town will become yet another abandoned post-mining town. Because the industrial fabric holding the mine together will have been destroyed, the context in

which the mine holds significant cultural and historic value will be lost. Tourism, the second biggest industry in Cullinan, will be devastated by the demolition of the mine. The current, already tenuous relationship between the town and the mine will be completely destroyed. The retention of 4 buildings will not manage to serve as an accurate reflection of the mine that once existed, and was the site upon which the world's largest diamond was ever mined.

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This dissertation intends to put forward a different strategy for the future of the mine and in doing so, the future of the town.

## DEVELOPMENT OF CULLINAN TOWN



Figure 2.17 and 2.18 - Diagrams showing surface plan of mine and town 1910 - (Lincoln: 2011)

The development of Cullinan town is very similar to many other mining towns globally. The discovery of the mineral creates a 'mineral rush' and the site's population expands rapidly.

Initially the only formal buildings in Cullinan were the mining buildings and related infrastructure. But as the mine developed formal housing was erected for senior management (1904). Civic buildings such as the St Georges Church followed soon after (1905), as did formal workers compounds (1908), however, the compounds were separated from the main town.

As previously mentioned the mine shut during the two World Wars and only reopened at the cessation of hostilities in the Second World War.

By the 1950's very little development had happened in the town itself. But more had happened in the outlying areas.

## MACRO ANALYSIS

### MACRO ANALYSIS URBAN SCALE

### SITE LOCATION

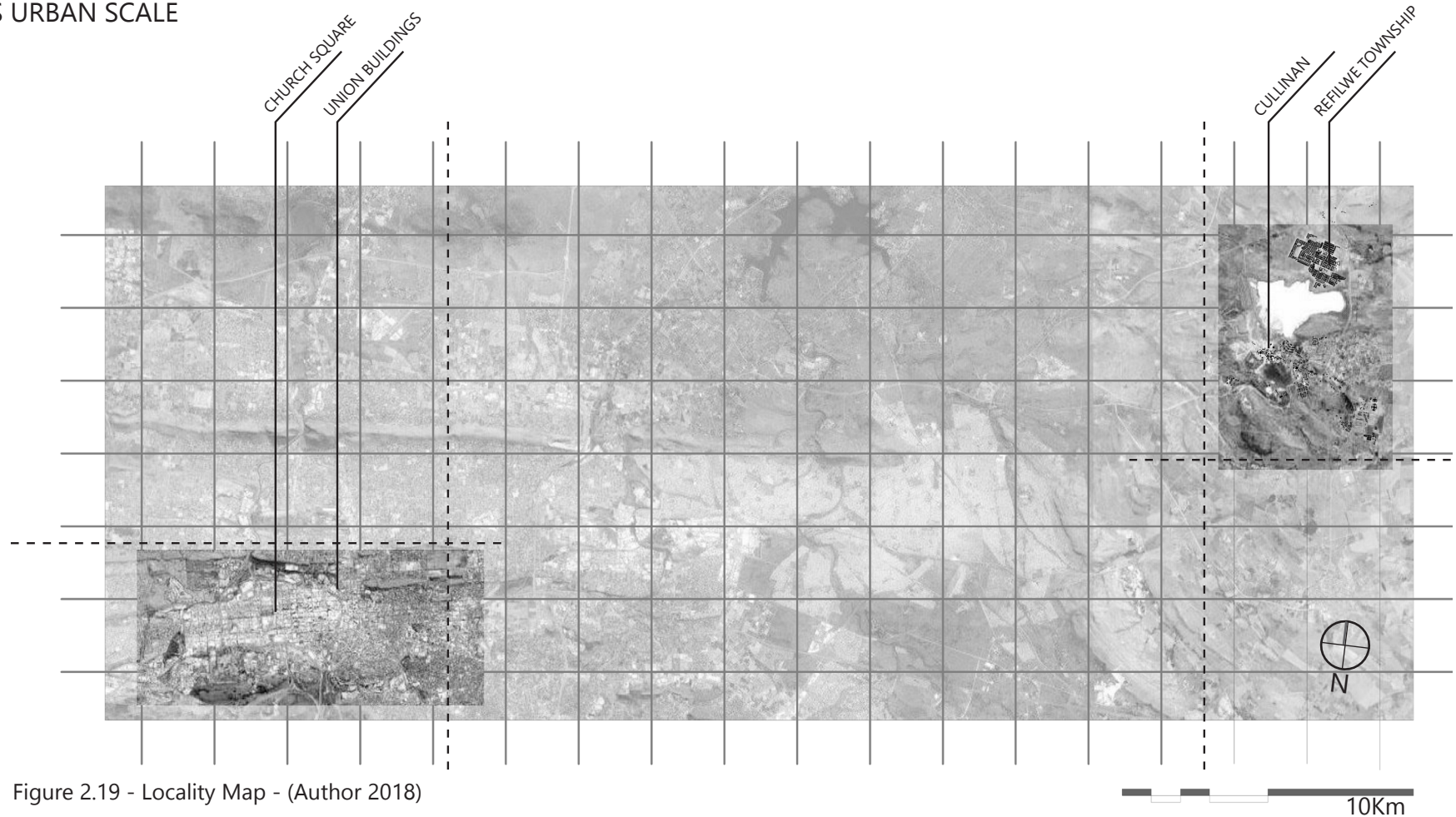
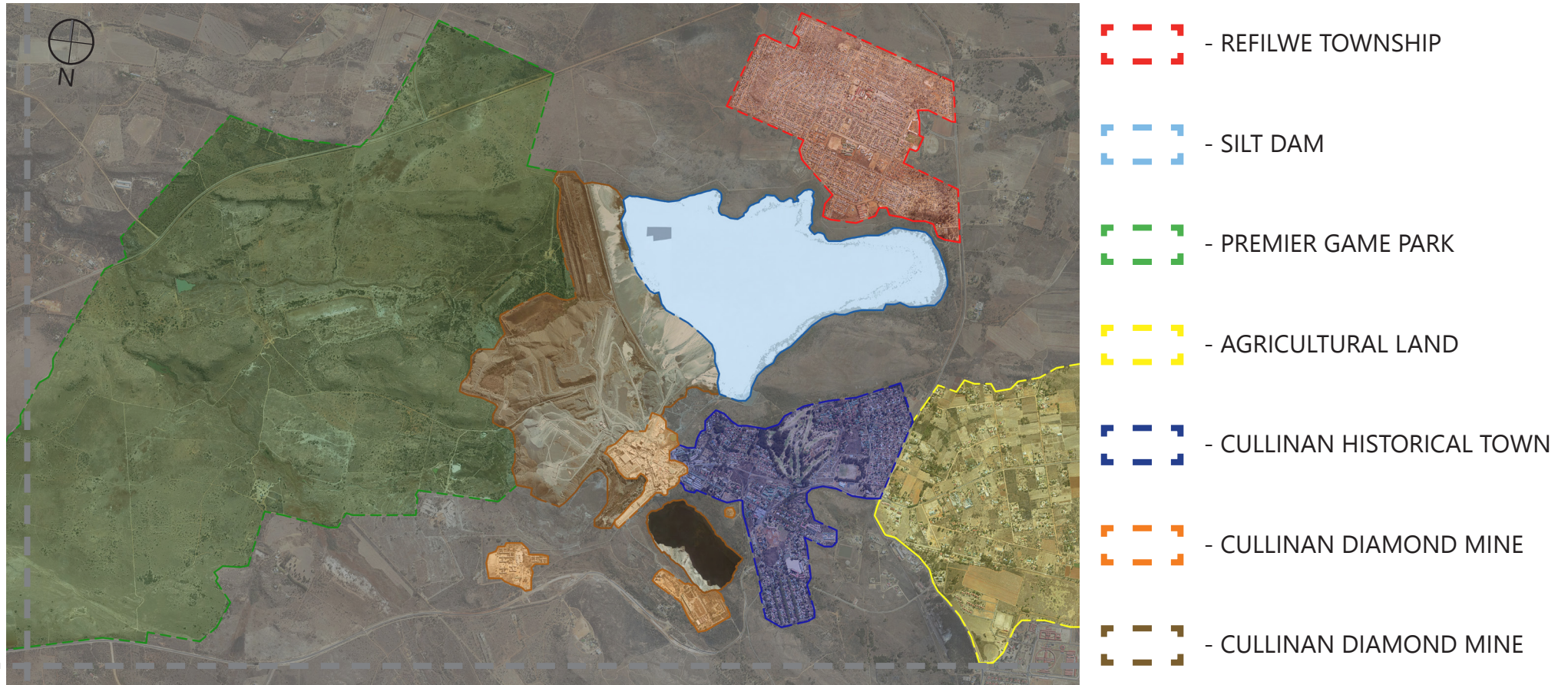


Figure 2.19 - Locality Map - (Author 2018)

Cullinan is a small-scale diamond mining town that is located approximately 40km northeast of Pretoria. It is the support town to the Cullinan Diamond Mine, owned by Petra Diamonds. Cullinan was one of the area's many boomtowns that began with the discovery of the world's biggest diamond. Apart from the mine Cullinan's second biggest industry is tourism. This tourism mostly related to the mine but there is also a very active culinary hub. Even so, when the mine closes in 2030 Cullinan will become yet another post-mining South African town with all the associated issues.

## MACRO ANALYSIS

### MACRO ANALYSIS ZONING



“One of the major issues in these towns is a lack of ‘appropriate’ infrastructure, and what infrastructure there is has often been incorrectly designed or scaled and is therefore either being used incorrectly or underutilised.” (Advisor, 2017)

## MACRO ANALYSIS // HISTORICAL BUILDINGS

ST GEORGES CHURCH - 1908

SHOPPING CENTRE

POST OFFICE - 1909

NEDBANK

McHARDY HOUSE MUSEUM - 1903

ST PETER'S CATHOLIC CHURCH - 1908

CHRISTIAN CHURCH

PRESBYTERIAN CHURCH - 1904

CULLINAN HOSPITAL - 1908

CULLINAN DIAMOND MINE - 1903

CULLINAN DIAMOND MINE OFFICES

OAK STREET - OLD CULLINAN TOWN

NO. 2 VENTILATION SHAFT

RAILWAY STATION - 1908

CULLINAN POLICE STATION

NO. 3 VENTILATION SHAFT

HISTORIC WORKERS COMPOUND - 1912

CULLINAN GOLF CLUB - 1920

CULLINAN COMBINED SCHOOL

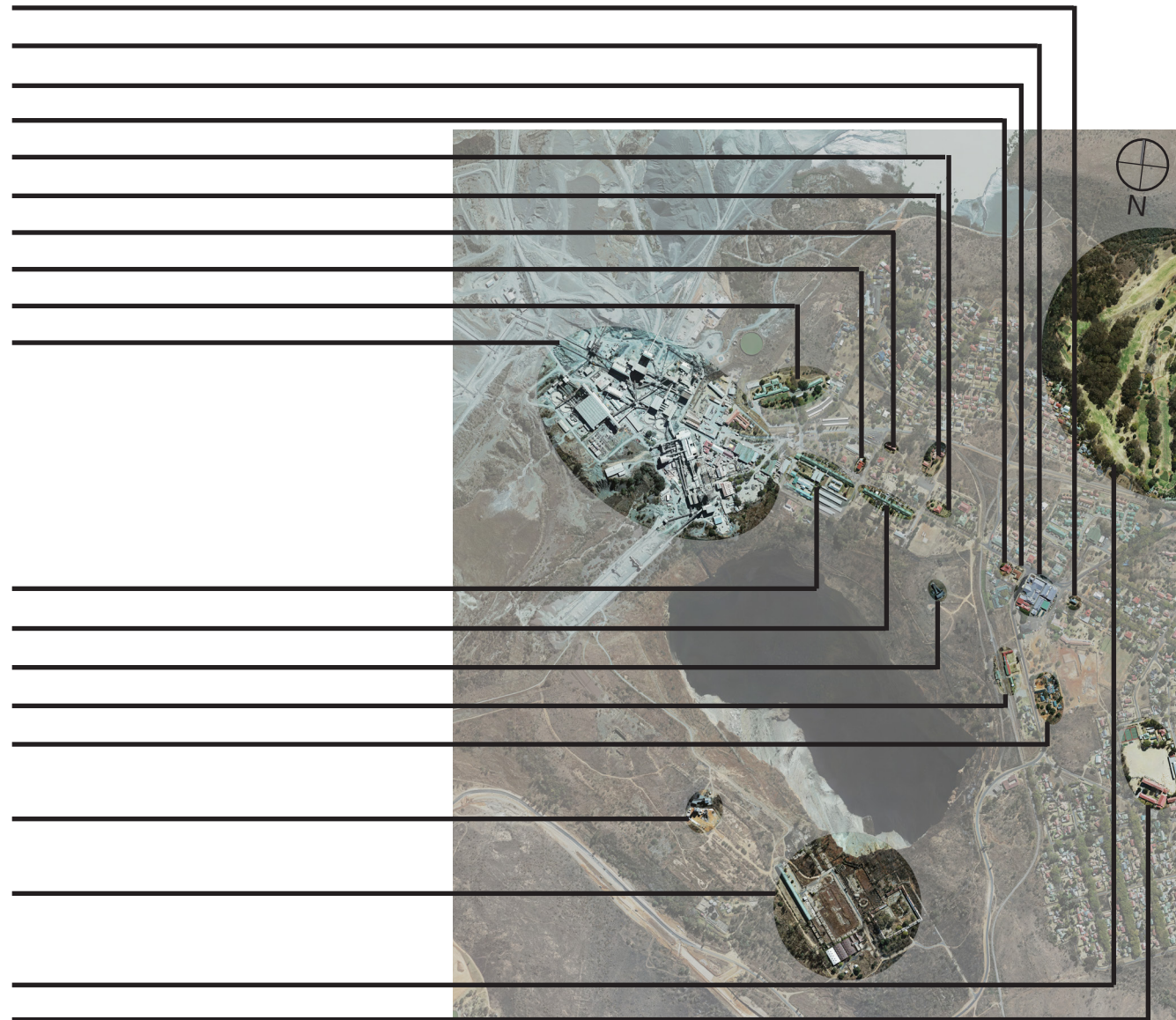


Figure 2.21 - Historical building mapping - (Author 2018)

## MACRO ANALYSIS // LAND USE MAPPING



Showing the different land uses in and around Cullinan and Refilwe










-  - HEALTH CARE
-  - SILT DAM
-  - RECREATIONAL
-  - AGRICULTURAL LAND
-  - COMMERCIAL
-  - INDUSTRIAL
-  - EDUCATIONAL
-  - DISUSED RUINS
-  - RESIDENTIAL

Figure 2.22 - Land use mapping - (Author 2018)

## MACRO ANALYSIS // ECOLOGICAL EXISTING - PIT



Figure 2.23 - Cullinan Mine pit - (Travel Ground - [www.travelground.com](http://www.travelground.com))



Figure 2.24 - Cullinan Mine pit - (Mining Technology - [www.mining-technology.com](http://www.mining-technology.com))

Due to the nature of the kimberlite pipe it was inevitable that large excavations would be required at the site. However, it is still incredible as to how large the pit is. The pit measures 32ha, roughly 1000m long by 400m wide and has a depth of 187m with an average gradient of 85 degrees. When the mine is no longer operational the open pit will remain. (Mining Technology, 2015)



Figure 2.25 - Cullinan Mine pit - (Mining Technology - [www.mining-technology.com](http://www.mining-technology.com))

## ECOLOGICAL EXISITING - TAILINGS



Figure 2.25 - Cullinan Kimberlite tailings - (Mining Technology - [www.mining-technology.com](http://www.mining-technology.com))

In the past 115 years over 165 mega tones of material has been removed from the site. This means that there are extensive tailing dumps at the site that form the major portion of the 'scarred' landscape. Due to the makeup of the tailings deposit very little grows on them and Vetiver grass has to be planted to help control the dust and erosion of the deposits. In 2017 Petra Diamonds commissioned a new plant on the site that specifically re-runs the kimberlite tailings to extract the very smallest diamonds that may still be in the kimberlite tailings. This new plant is part of Petra's development plant and is one of the major reasons why the mine will be able to remain economically viable for the coming years. (Petra Diamonds, 2018)

Petra has commissioned a new plant that reprocesses the kimberlite tailings to extract the smallest diamonds that will be used for industrial applications. Once this process has taken place the tailings will be used as building material, as aggregate in concrete and road building, as well as the fill for gabion walls on the new site.



Figure 2.26 - Cullinan Kimberlite tailings - ([www.ekalatours.com](http://www.ekalatours.com))



## ECOLOGICAL EXISITING - SILT DAM



Officially called Silt Dam No. 7, the large dam to the North of the mine is where the water that is used in the processes of diamond extraction is collected for the particles to settle. This settling of the particle matter in the water is what gives the dam its white colouration. The Cullinan mine uses ground water that is pumped from inside the mine to reservoirs where it is then fed into the mines closed water system. This closed water system allows them to recycle 99% of the water they use. The silt dam is vitally important in the process of recycling this water. (Petra Diamonds, 2018)

Figure 2.27 - Aerial images of Cullinan - (Geoinformatics Department, University of Pretoria)

## MICRO ANALYSIS - RESEARCH AREA

### RESEARCH SITE

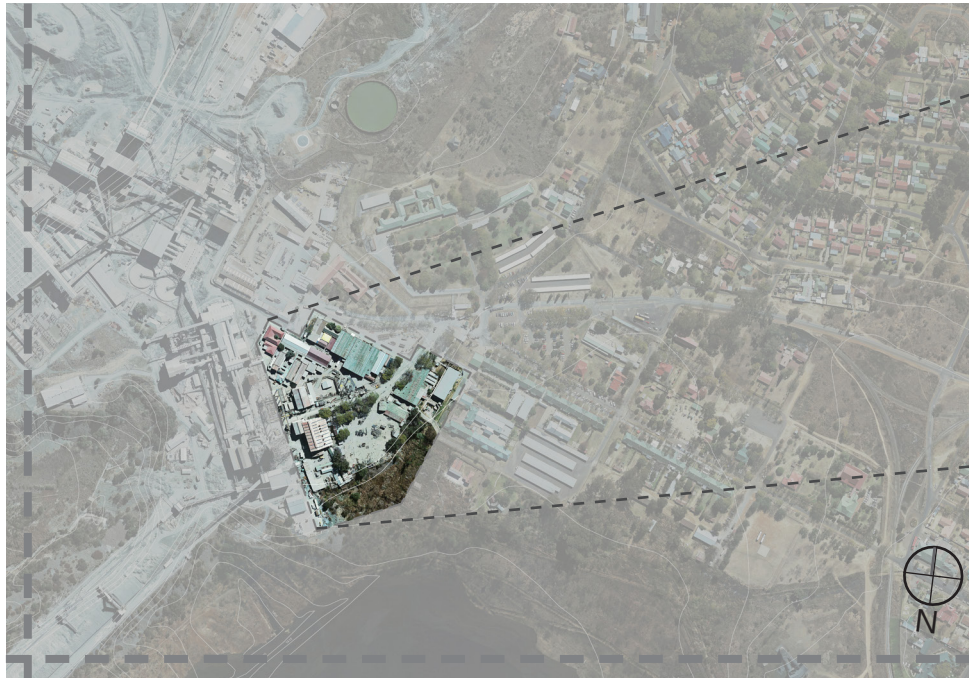


Figure 2.28 - Map showing research area - (Author 2018)

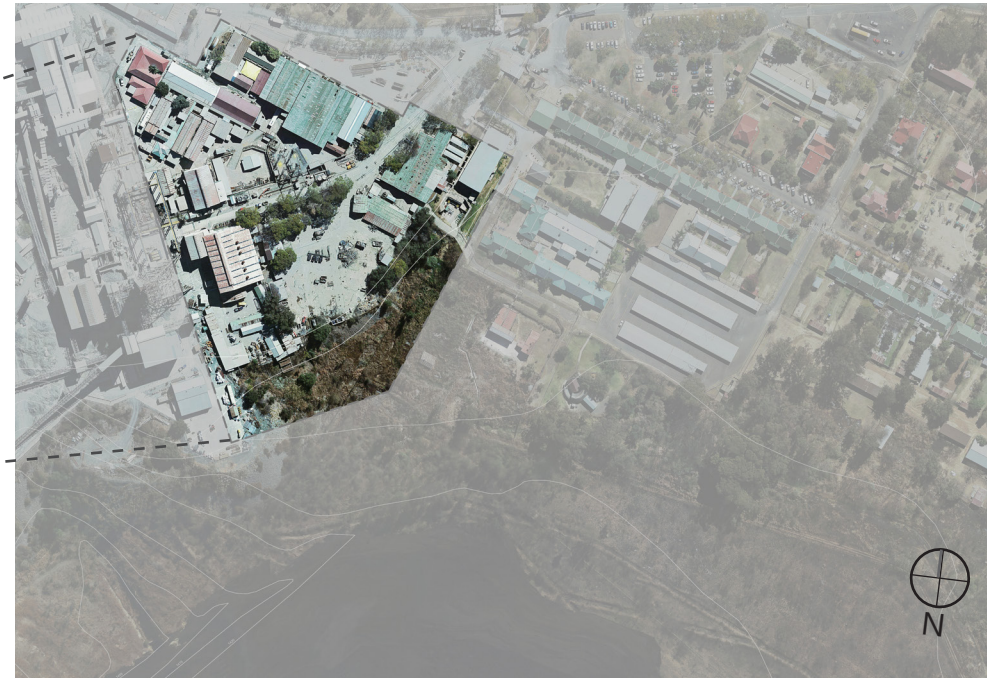


Figure 2.29 - Map showing research area - (Author 2018)

The research site is located directly to the east of the winder building, and south of the historic warehouses. In the site's existing condition, the selected site is an open-ended square that contains a few small buildings of differing ages. To the south of the site is the open pit, the site falls towards the open pit. The site was selected because it is an open site that is located between the major part of the mine and the town itself. Its location and development would serve to form a reconnection between the town and the mine.



Figure 2.30 - Image showing existing Cullinan mine - (Petra Diamonds - [www.petradiamonds.com](http://www.petradiamonds.com))

## EXISTING LANDSCAPE

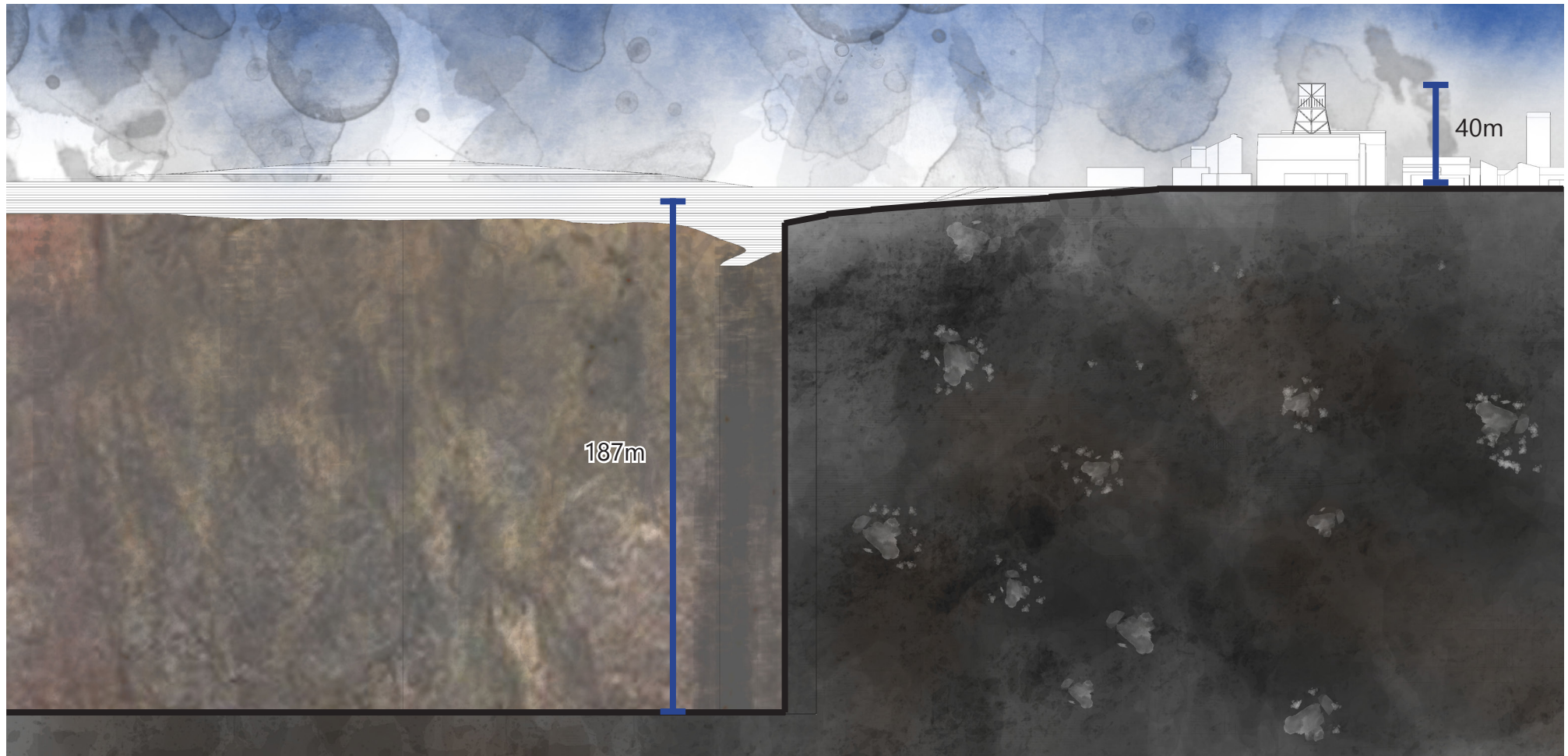


Figure 2.30 - Section showing relationship between the mine and the mining pit - (Author 2018)

The above section is to scale and only serves to express the relationship between the open pit and the existing mine. The open pit is 187m deep and can be seen in comparison to the 40m headgear No. 1. This section displays the vast effect of the mining process, prior to the adoption of underground mining at the Cullinan Mine.

## PHYSICAL CONDITION OF SITE

### RESEARCH SITE



Figure 2.31 - Image showing existing Cullinan mine - (Petra Diamonds - [www.petradiamonds.com](http://www.petradiamonds.com))

The research site is located directly to the east of the winder building, and south of the historic warehouses. In the site's existing condition, the selected site is an open-ended square that contains a few small buildings of differing ages. To the south of the site is the open pit, the site falls towards the open pit. The site was selected because it is an open site that is located between the major part of the mine and the town itself. Its location and development would serve to form a possible reconnection between the town and the mine.

MICRO ANALYSIS //

HERITAGE VALUE OF SITE

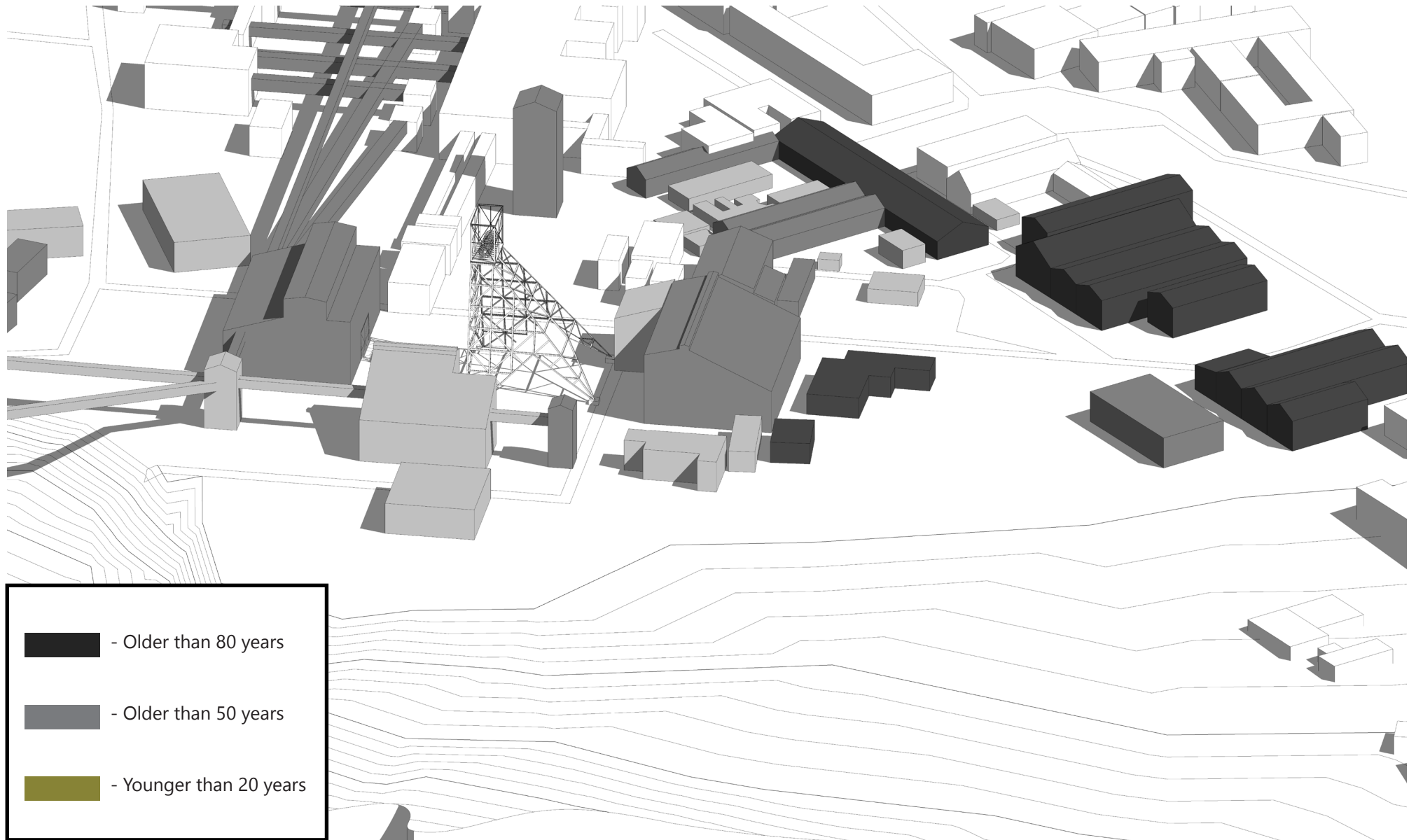


Figure 2.32 - Diagram showing the analysis of heritage value on the buildings on site - (Author 2018)

# MICRO ANALYSIS //

## CLIMATIC CONDITIONS

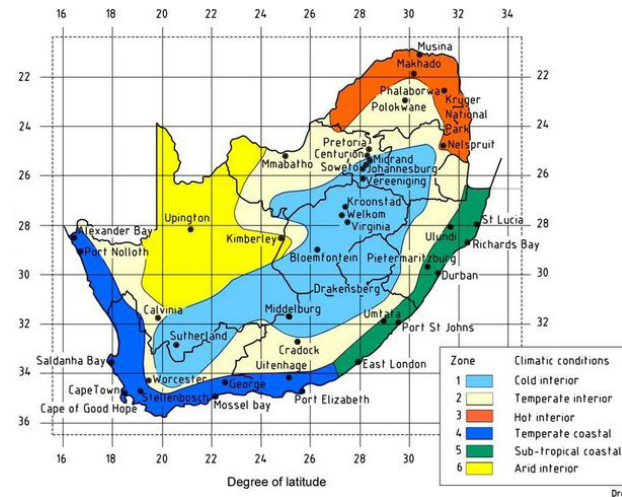


Figure 2.33 - Diagrams showing Climatic zone - (SANS 10400 XA)

According to SANS 10400 Part XA, Cullinan falls in the temperate interior climatic zone. The temperate interior is characterised by hot and rainy summers and cool dry winters. The overall average max temperature of Cullinan is 25 degrees Celsius and the average low is 12 degrees Celsius. Average yearly Rainfall for Cullinan is 675mm. Humidity is relatively low in Cullinan, which means that direct evaporative cooling is the most effective method of passive cooling. The summer cooling requirements are of greater concern than the winter heating requirements.

Exterior spaces will need to be shaded for the comfort of users. Similarly, the western and eastern facades will need to be protected from excessive amounts of direct sunlight so that interior spaces do not receive too much solar heat gain. Specific solar analysis will be conducted as an informant to the architectural solution.

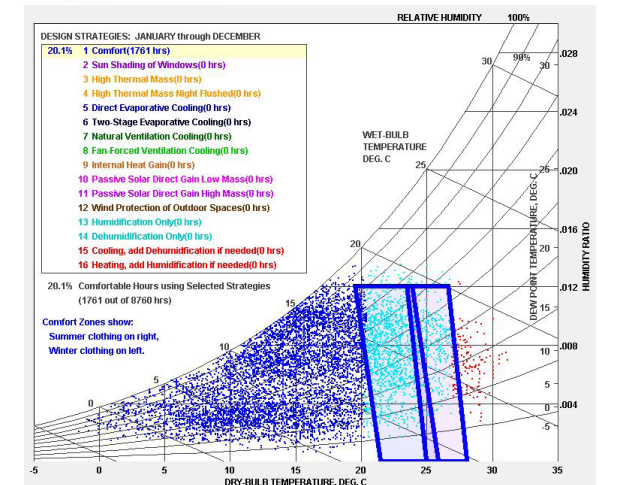
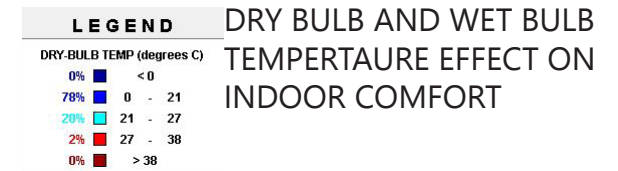
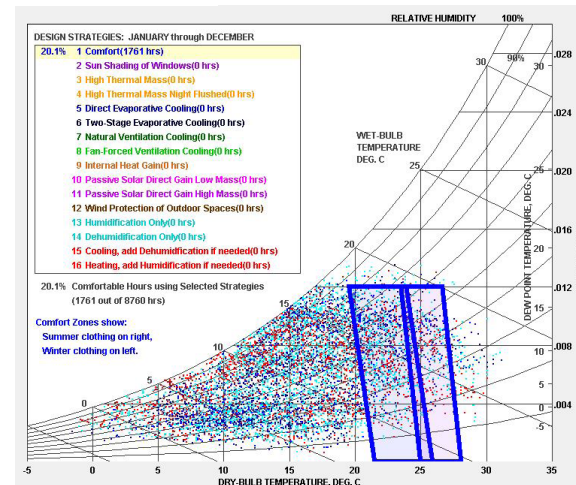
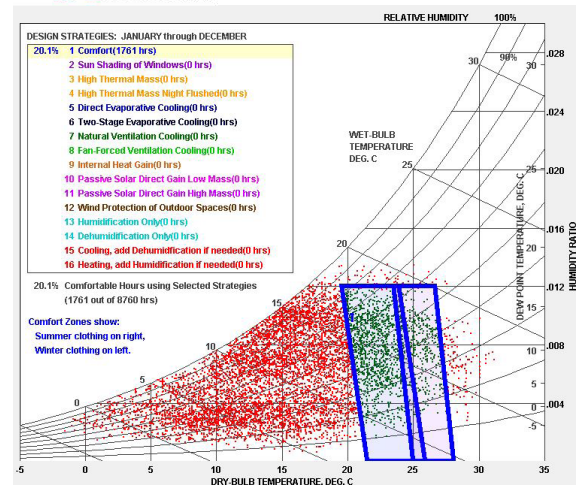


Figure 2.34, 2.35 and 2.36 - Psychrometric charter showing effects of dry bulb, wet bulb and wind speed comfort zones - (Author 2018)

### Annual Temperature Bins

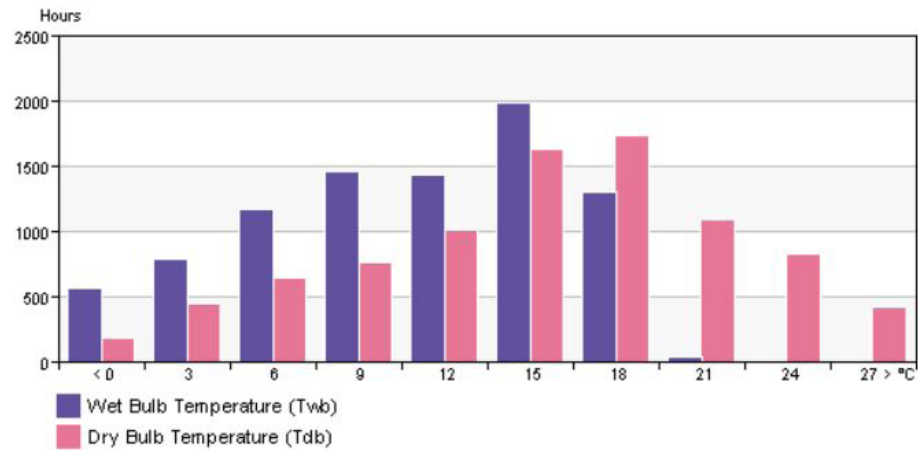


Figure 2.37 - Diagram showing Cullinan drybulb and wet bulb temperatures- (Author 2018)

### Annual Wind Rose (Frequency Distribution)

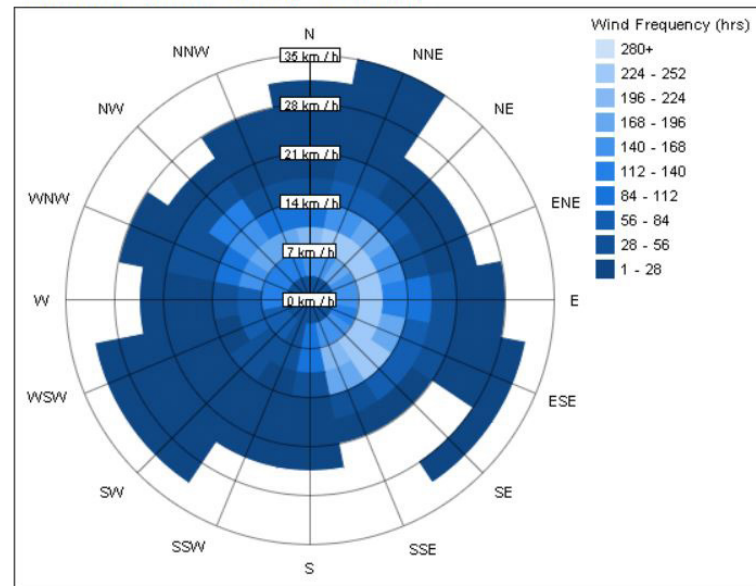
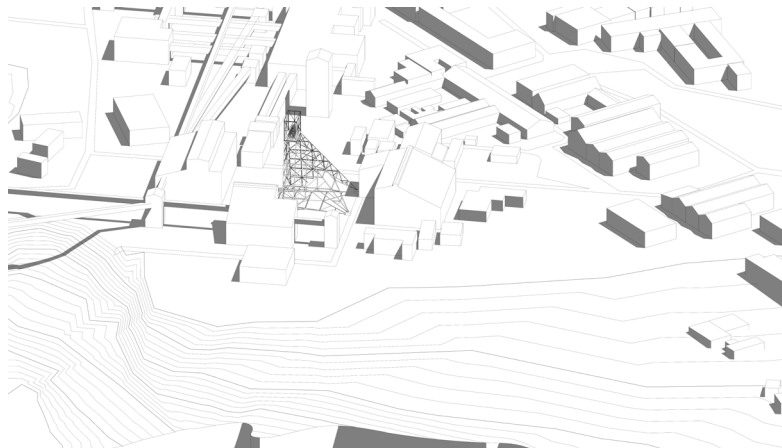
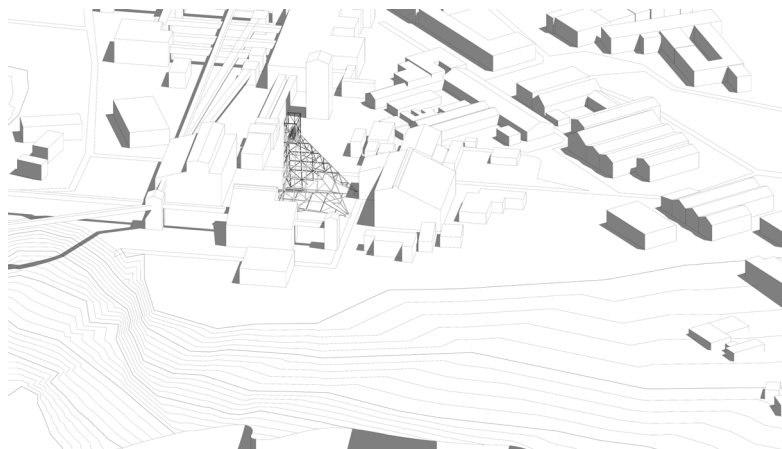


Figure 2.38 - Diagram showing Cullinan wind rose - (Author 2018)

## SHADOW ANALYSIS

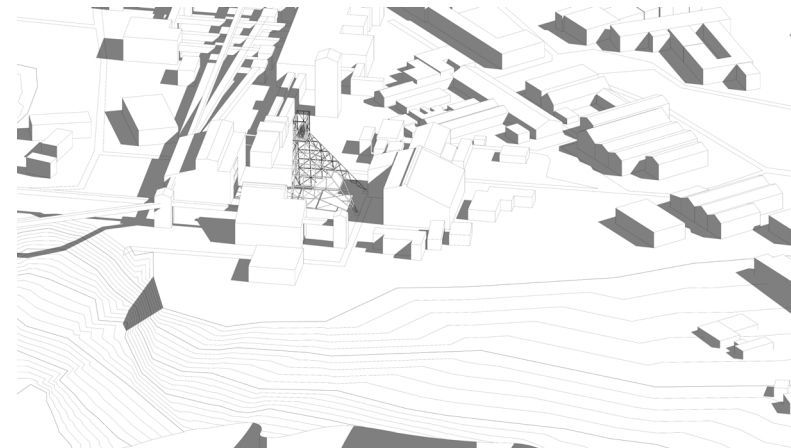


SPRING EQUINOX - 23 MARCH

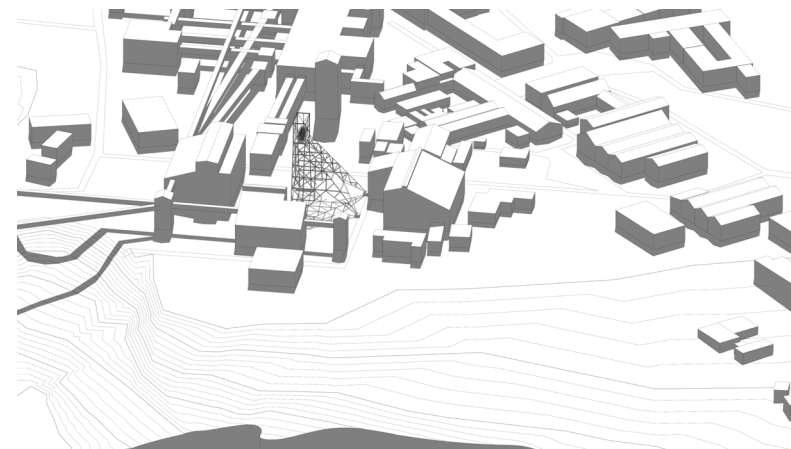


AUTUMN EQUINOX - 23 SEPTEMBER

The shadow analysis of the site shows that the open space to the right of the winder building does not receive any significant shading. this means that the public square that is proposed here will need extra shading.



WINTER SOLSTICE - 21 JULY



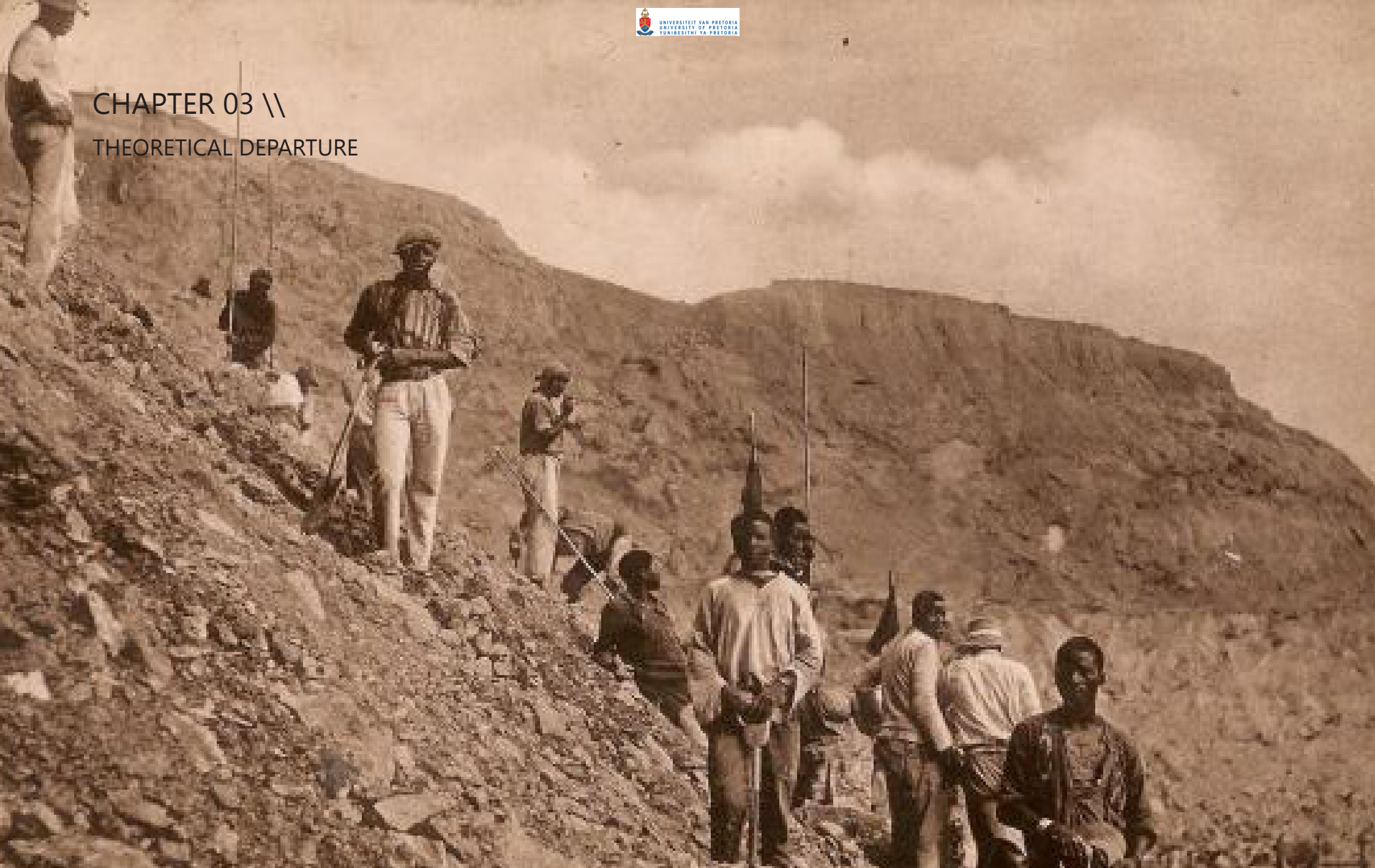
SUMMER SOLSTICE - 21 DECEMBER

Figure 2.39, 2.40, 2.41 and 2.42 - Shadow analysis diagrams - (Author 2018)

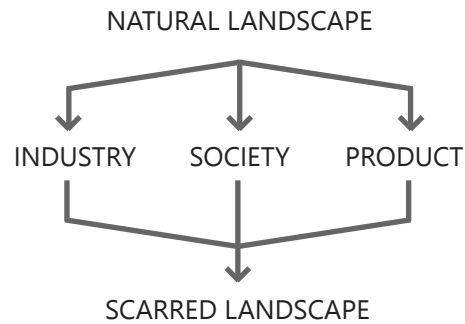




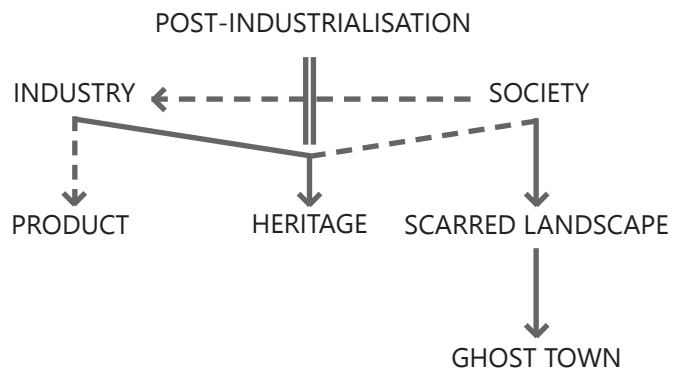
CHAPTER 03 \\  
THEORETICAL DEPARTURE



## INDUSTRIALISATION



## POST-INDUSTRIALISATION



## DE-INDUSTRIALISATION

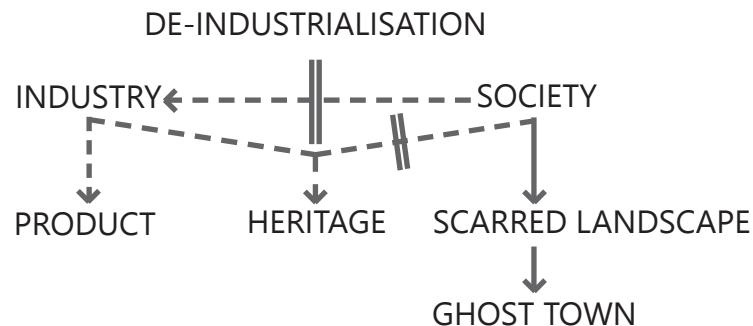


Figure 3.1, 3.2 AND 3.3 - Diagram showing Industrialisation, Post-Industrialisation and De-Industrialisation - (Author 2018)

## THEORETICAL DEPARTURE

### INTRODUCTION

This chapter outlines the theories that form the basis for this dissertation. These theories serve as the informants that form the departure point for the development of architectural solutions to the significant issues facing post-mining towns in South Africa. In order to create viable solutions, the aforementioned theories need to be understood in their purest academic form, in relation to post mining towns and specifically in relation to the Cullinan scenario that is being presented in this dissertation.

The ultimate goal for the Cullinan scenario is to demonstrate how resilience can be created through the application of, resilience theory, sustainability theory, regenerative theory, urban renewal, adaptive reuse, preservation and conservation theories (Burra Charter). The understanding of these theories will allow for the development of a framework and then an architectural response to that framework.

There are three distinct stages through which Cullinan has and is will to experience. The first was the process of industrialisation, which is characterised by the discovery of a mineral in the natural landscape, the development of industry, society and a product, resulting in a depleted of scarred landscape.

The second stage is the post-industrial stage. This stage is characterised by the disconnection between the society and industry and the product and the beginning of a disconnection from the industrial heritage that was created by the industrialisation process.

The third process is de-industrialisation. This process is characterised by the dismantling of the industrial infrastructure and thereby completely disconnecting society from the industrial heritage. Because the industry would no longer exist there would be no source of income for the society and the result is an abandoned mining town.

## RELEVANT THEORIES

### RESILIENCE AND SUSTAINABILITY THEORIES

Sustainability – “Sustainable development is development that meets our own needs without compromising the ability of future generations to meet their needs.” (Brundtland Commission, 1987)

Resilience - City resilience describes the capacity of cities to function so that people living and working in cities – especially the poor and vulnerable – survive and thrive no matter what shocks and stresses they encounter (Rockerfeller Foundation & ARUP, 2014)

### UNDERSTANDING SUSTAINABILITY AND RESILIENCE

The theory of sustainability is by no means a new concept; it has been around for many decades and in itself is quite complex due to its many facets and the fact that there are so many different types of sustainability. However, the theory of resilience is a fairly new concept. Nevertheless it is integrally linked to the concept of sustainability - resilience is a precondition that must be met before sustainability can be achieved. Urban resilience can be defined as “the capacity of cities to function so that people living and working in cities – especially the poor and vulnerable – survive and thrive no matter what shocks and stresses they encounter” (Rockerfeller Foundation & ARUP, 2014). Resilience in relation to cities speaks to that city’s ability to adapt to change, “bounce back from major shocks” (Harrison, et al., 2014, p. 26).

As with sustainability, resilience is inherently complex and multi-faceted. Resilience can speak to; economic resilience, ecological resilience, the resilience of governance, resil-

ience of the urban form, as well as fabric and resilience of the infrastructure (Harrison, et al., 2014) . Key principles of resilience are the capacity to learn, diversity, self-sufficiency and connectedness and redundancy. These relate to all the aforementioned types of resilience.

For anything to be resilient it needs to have the capacity to learn to understand what is the situation. There must be an ability of the entity to identify and acquire information and knowledge. Resilience requires that there be an interconnectedness that allows for knowledge to be shared between the different levels of governance, or whatever other structure is in question (Harrison, et al., 2014). The capacity to learn includes the ability to adapt to shocks.

Redundancy entails that there need to be several components, which can perform the same function. Should one component fail, there must be another, which can replace the first and perform the necessary task. In this way it ensures that a system has a greater reliability and is therefore less susceptible to overall failure. This is essentially resilience.

Diversity in resilience is linked to the idea of redundancy, however unlike redundancy diversity speaks to the notion that a variety of components must be able to perform the same functions differently, or must be able to perform a different function. Again, this means that a system is still able to perform when one of its components fail. Therefore, redundancy and diversity make up a big part of resilience.

The final principle is that of self-sufficiency and connectedness. This principle speaks to the entity's ability to self-regulate and selfheal, to use a network to support itself. Simonsen et al. (as cited in (Harrison, et al., 2014) states that a "well-connected systems can overcome and recover from disturbances more quickly, but overly connected systems may lead to the rapid spread of disturbances across the entire system so that all components of the system are impacted".

## LIMITATIONS OF SUSTAINABILITY THEORY

Limitations to sustainability theory often form around the fact that communities are unwilling to accept change, especially when it comes to socio-political and socio-economic change. This can be due to political views and beliefs or simply that people are not willing to change their lives to accommodate strategies that will serve them better in the long run. Whilst communities may be willing to support governance, or formal systems, they may be unwilling to support or adhere to informal systems of change (Harrison, et al., 2014). It is here where the definition of sustainability needs to be understood. “That meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations, 2017).

Another limitation of sustainability theory is that developing countries may not want to use sustainable methods to develop because the ‘developed’ world did not have to use more expensive sustainable methods. In some cases, it is not economically feasible for countries to develop by means of sustainable energy, for example. This again speaks to the definition of sustainability.

This is particularly true when it relates to countries with extremely fast population growth rates and or urbanization rates. As we know more than 50% of the world population live in urban areas, and that number is set to increase to 70% by the year 2050 (United Nations, Department of Economic and Social Affairs, 2014). With these levels of rapid urbanization, it is all but impossible for cities to respond with sustainable development of housing, infrastructure, access to water, electricity and production of food (Walker & Salt, 2006). It becomes very difficult for these countries, or cities to develop sustainably. As a result of cities being unable to cope with rapid urbanization, by unsustainable or sustainable methods, the vast majority of people who move to the city form part of the urban poor. These urban poor are further marginalized by restriction to land-use, for them the city becomes an exclusionary and unjust environment (Pieterse, 2015).

## HOW DOES URBAN RESILIENCE ADDRESS THE LIMITATIONS OF SUSTAINABILITY THEORY?

“One way of understanding the relationship between the two terms is to consider sustainability as an essential goal for development, and resilience as a way of thinking and acting that would lead us towards achieving sustainability.” (Harrison, et al., 2014, p. 15)

As previously stated urban resilience can be viewed as a precondition of sustainability. Where sustainability is the goal and resilience is a method for attaining that goal. If a city is not resilient i.e., has the ability to survive shocks and continue to function, then it cannot be sustainable. Sustainability speaks to a certain programme that needs to be followed to attain a sustainable status. However, resilience speaks to an ability to adapt. Adaption is a key principle of resilience, as is redundancy.

## SUSTAINABILITY AND RESILIENCE – CULLINAN

Cullinan, being a mining town with a limited lifespan is by its very definition unsustainable, due to the fact that they are mining a non-renewable resource. It is even more unsustainable due to the fact that towns like Cullinan are almost always mono-industrial and rely heavily on the mine for its economic success.

The biggest reason for the decline of mining towns is mine closure, which is an international phenomenon. Mine closure is specifically prevalent in South Africa due to the country's vast mineral deposits. In the past 20 years over 6000 mines have been closed and there are many more mines that will be closed in the next 10 years. (Venter, et al., 2018)

Mine closure in South Africa is catastrophic for the South African economy. In 2017 the mining sector made up for just 6.8% of South Africa's GDP, this is down from the mid 1970's when mining made up 21% of the country's GDP. Mine closure is even more devastating for the communities that are left behind. Mine closure essentially creates an economic vacuum. And the people that suffer the most are the actual miners. Since 2014 over 30,000 miners have lost their jobs. (Venter, et al., 2018)

Mine closures occur for various reasons, namely; the fall of global commodity prices, domestic cost pressures that have risen too quickly (electricity prices and wages), uncertainty over the government's mining policy and a fall in productivity of mines (viability) (Baxter , 2016). Due to the fact that most, if not all 'mining/support' town's revenue is created or linked to the mine, if the mine closed it essentially spells the end of the mining town.

Because mining towns and the mines they support have, up until this stage have been very lucrative, there has been no need for residents to diversify, or develop alternative streams of income. The mining companies see no reason to invest in infrastructure that



doesn't directly benefit the mine or meet minimum legislative requirements. Mining towns exist under the natural monopoly of the mining company. This is most often due to the remote location of the mine, meaning that the majority of residents of the mining town were drawn to the site because they would have jobs on the mine. Some mine workers dependents relocate with mine workers; however, this mostly happens with mine managers and upper levels of employees. The lower levels of employees are migratory, living in the towns for most of the year and travelling home once a year over the holiday period.

This situation suits the mining companies, because they do not have a competition for the labour force of the town. They are able to have a certain degree of autonomous control over the community. Similarly, due to the fact that the community trusts rely solely on the mining companies for funding, and often have mine company staff sitting on the relevant governing structure, they have control of how money is spent. This is especially true when local community members of the governing structure can be swayed or influenced.

As discussed above Cullinan and Rifilwe are not sustainable due to their mono-industrial nature, this in turn means that they are not resilient. When the diamond mine closes the economic backbone of the community (Cullinan and Refilwe) will die. There is no alternative industry that is not directly linked to mining operations that can, either absorb the workforce, or provide an income for the majority of the population.

The only way to create sustainability and resilience is to develop new industry and inclusivity for the community. Du Plessis (2013) highlights the fact that resilience in a man-made system can only be developed by dividing mono-functional components into smaller components that can provide the same functions. By doing this it means that if one of the functions is compromised that the other functions will be able to continue to work and serve the community. In short changing the community's reliance on a single source of income, the mine, and diversifying industry so that there are varied industries

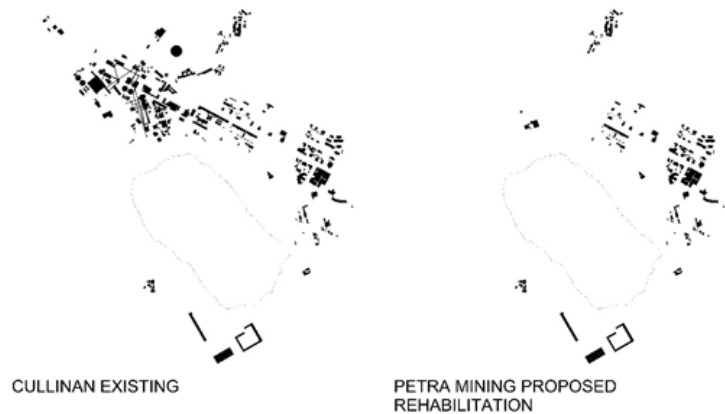


Figure 3.4 Diagram showing Petra Diamonds rehabilitation strategy - (Author 2018)

that can create income for the community.

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It is the intention of this research project to explore how the build environment can facilitate this diversification.

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## REGENERATIVE DESIGN THEORY

Regenerative Design Theory - "A system of technologies and strategies, based on an understanding of the inner workings of the ecosystems that generates designs to regenerate rather than depleting underlying life support systems and recourses within socio-ecological wholes" (Mang & Reed, 2012, p. 2).

## UNDERSTANDING REGENERATIVE THEORY

The concept of regenerative design has been around since Vitruvius and Leon Battista Alberti, who both formed concepts of the 'ideal city' and set about rebuilding parts of their respective cities. (Dreyfuss, et al., 2013, p. 3896)

Regeneration then continued through the ages, being used whenever either a war zone or a natural disaster destroyed infrastructure. In Europe massive regeneration of cities happened after many cities were completely devastated during World War II. Similarly, at the end of the Post-Industrial era (mid 1970's) many regeneration schemes were developed (Dreyfuss, et al., 2013, p. 3896). Whilst sustainability and Regenerative theories are essentially the same thing there is one crucial difference. In sustainability, ecological systems that have been destroyed are not restored, they are lost forever. Whereas in regenerative systems the destroyed ecological systems are repaired to the point where they can start to regenerate by themselves.

## REGENERATIVE THEORY IN THE CONTEXT OF CULLINAN

Cullinan was once a thriving mining town and before mining operations commenced there was an undisturbed ecological system surround the area that would become Cullinan. Now that the lifespan of the mine is drawing to its close the town faces an imminent catastrophe. Whereby the industry that supports the vast majority of the community will cease to exist. The mine site will become disused, the majority of the site will be dismantled and the site left for nature to grow back into the site. Several specific buildings will be left in place to try and keep the sites tourism value. Figure 2 shows the existing mine site and town contrasted to how Petra Diamonds intend to 'rehabilitate' the site post mining.

By simply dismantling the mining site the heritage value of the mine and in turn of the town will be completely lost. By leaving only a handful of buildings, namely the crusher building, No.1 and No. 3 headgears, winder building and the washer building, the essence of the space and its heritage value will be destroyed and in turn the tourism value of the site will also be lost. This will further disconnect the mine site from the town.

The intention of this research project is to use the mine site as the point of connection for the community. The connection point between Cullinan town, Rifilwe township, the mine and the outside world (Pretoria, Johannesburg). This is the site where knowledge, skills, products, produce and money can exchange. Figure 3 shows a basic diagram showing the path of connection between the above-mentioned places, where these exchanges can take place.

The specific site that has been selected is an open-ended courtyard on the southern side of the mine, which is framed by the winder building, No. 1 headgear and various warehouses.

## URBAN RENEWAL

### URBAN RENEWAL - THE PROCESS OF REDEVELOPING DILAPIDATED OR NO LONGER FUNCTIONAL URBAN AREAS.

Urban renewal is essentially land redevelopment of areas that no longer function the way they should or possibly whose purpose has changed. For instance, if an industrial area is no longer operational, as happened across the globe in the post-industrial era (Couch, 1990). Most often these sites were redeveloped into social housing projects. Urban Renewal also attempted to clean up city 'slums' and redevelop the sites into sites that make the city more attractive to the global market. This means that the poor people who were living in the 'slums' are removed or relocated to the outer edges of the city.

Very often these projects become exclusionary and deny people their 'right to the city' (Lefebvre, 1996) by making it too expensive for them to stay in the same area. Along with this any heritage value and social heritage gets completely destroyed.

### CREATING SUSTAINABILITY AND RESILIENCE THROUGH URBAN RENEWAL

Urban Renewal in its purest form is not sustainable because the inference is that when the site can no longer perform the function for which it was originally designated. If the site is then dismantled and redeveloped, there would be the increased cost of new building materials and embodied energy.

"City resilience describes the capacity of cities to function so that people living and working in cities – especially the poor and vulnerable – survive and thrive no matter what shocks and stresses they encounter" (Rockerfeller Foundation & ARUP, 2014)

Similarly, it is not resilient if you use the Rockefeller Foundation definition of resilience. The reason for urban renewal is that the sites are no longer functioning as they were intended. This is where adaptive re-use theory needs to be combined with urban renewal to create sustainable and resilient solutions.

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## CREATING SUSTAINABILITY AND RESILIENCE THROUGH RENEWAL OF THE EXISTING – CULLINAN

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The Cullinan Diamond mine has a massive infrastructure that will become defunct in the near future. The intention of this project is to use elements of urban renewal principles, together with adaptive re-use theory to create sustainability and resilience in the context of a post-mining town.

## ADAPTIVE RE-USE, PRESERVATION AND CONSERVATION THEORIES

Adaptive Re-use – “Implies the recycling of an older structure often for a new function. Extensive restoration or rehabilitation of both the interior and exterior is usually involved” (The Heritage of Canada, 1983)

“The function is the most obvious change, but other alterations may be made to the building itself such as the circulation route, the orientation, and the relationships between spac-

es; additions may be built and other areas may be demolished” (Brooker & Stone, 2004).

Preservation – “Preservation means maintaining the fabric of a place in its existing state and retarding deterioration” (Australia ICOMOS Incorporated, 2013).

Conservation – “Conservation means all the processes of looking after a place so as to retain its cultural significance” (Australia ICOMOS Incorporated, 2013).

## UNDERSTANDING ADAPTIVE RE-USE, PRESERVATION AND CONSERVATION THEORIES

As stated in The Burra Charter, “Conservation means all the processes of looking after a place to retain its cultural significance. It includes maintenance and may according to circumstances include preservation, restoration, reconstruction and adaption and will be commonly a combination of more than one of these” (Australia ICOMOS Incorporated, 2013).

## DE-INDUSTRIALISATION

De-Industrialisation – The process of social and economic change which is due to the reduction in industrial capacity or activities of a country or regions manufacturing and heavy-duty industry. (Collins English Dictionary, 2018)

The process of De-Industrialisation is essentially the opposite of Industrialisation. It is a reduction of a region’s industrial capacity. This reduction can be due to differing causes. One of the most obvious causes is that the industry is no longer economically viable. This is itself can be caused by various issues, namely: rising production costs (including labour costs), lower demand for the product and therefore lower commodity prices and depletion of raw material. Other factors include, the policies set forward by the government that might be unfavourable to the industry, environmental concerns and factors, political unrest etc.

De-Industrialisation does not just mean the halt or reduction of a particular industry but very

often it also means the destruction of the industrial infrastructure, so that the land can be re-developed for alternative uses. In some instances, this may be the most effective way of redeveloping the site, but in most instances the opportunity exists to adaptively reuse the existing infrastructure to suit the new purpose. Industrial infrastructure normally has high-embodied energy materials such as concrete and steel. Destroying this infrastructure only to replace it with slightly lower-embodied energy materials does not serve as a sustainable method of building or planning.

## CONCLUSIONS – THEORIES

It is very evident from all the theories above that in order to create a successful intervention one cannot rely on only one theory, but rather that to attain the best results one needs to combine many of the above theories.

In combination the theories set out in this chapter, namely: resilience and sustainability theory, regenerative design theory, adaptive reuse will lead to urban renewal resulting in preservation and conservation of the industrial heritage of the site. This for the benefit of those who would remain as residents of Cullinan and Refilwe, thus avoiding de-industrialisation.

These concepts will further be highlighted below by the precedents selected which will illustrate diverse approaches to the post-industrial challenges faced by cities the world over.

## DECODING THE INDUSTRIAL HERITAGE VALUE

*“Heritage is our legacy from the past, what we live with today, and what we pass on to future generations. Our cultural and natural heritages are both irreplaceable sources of life and inspiration.” - (UNESCO, 2018)*

### GLOBAL HERITAGE VALUE

The question of heritage is a global issue, that on some level has been dealt with very well by several different agencies and organisations. For example, the restoration of the Parthenon and the Acropolis site in Athens has been a great success, and has actually increased its heritage value to the general populus. However, the process of deciding if a specific site has heritage value, or when it should be designated as a heritage site is a more complex issue. Whilst UNESCO (United Nations Educational, Scientific and Cultural Organisation) is seen as the most important heritage organisation, almost every country has their own agency that deals with the issues of heritage within their sovereign state. Whilst these national agencies tend to follow the lead of the UNESCO principles and definitions, they have the right to adjust and implement rules and regulations relating to heritage as they see fit. This may mean that in one country a building or site is considered of heritage value if it is older than 60 years. In other countries it might be 80 years. Similarly, just because a building or site is over a certain age does not necessarily mean that it holds any significant heritage value. Therefore, each case has to be dealt with individually by the respective agency.

If a site has extreme significant heritage value it can be designated by UNESCO as a World Heritage Site, this site then falls under the protection of UNESCO rather than of that country’s heritage authority. UNESCO designates the title of World Heritage Site with two different sets of criteria, the first being Cultural World Heritage Site and the second being a Natural World Heritage Site. (UNESCO, 2018)

It is possible for a site to be designated a Cultural World Heritage Site and a Natural



World Heritage site at the same time if the criteria are met for both. For example, Mount Athos in Greece. (UNESCO World Heritage, 2018). See Appendix a for full UNESCO Cultural and Natural World Heritage Sites.

The UNESCO criteria for Cultural or Natural World Heritage Sites does not make specific provision for industrial heritage and therefore do not specifically apply to Cullinan. It could be argued that Cullinan holds significant heritage value because it is the site where the world's largest diamond was mined.

## INDUSTRIAL HERITAGE VALUE

*"Industrial heritage consists of the remains of industrial culture which are of historical, technological, social, architectural or scientific value. These remains consist of buildings and machinery, workshops, mills and factories, mines and sites for processing and refining, warehouses and stores, places where energy is generated, transmitted and used, transport and all its infrastructure, as well as places used for social activities related to industry such as housing, religious worship or education."*

- (TICCIH, 2018)

Whilst most of the sites that are designated World Heritage Sites are hundreds if not thousands of years old, industrial heritage is normally not older than 250 years old. Many people do not recognise industrial heritage or its significance. The vast majority of the population view industrial landscapes as scars on the environment and believe that once they are no longer necessary that the land should be returned to its natural state and that the industrial infrastructure should be removed from the site. Essentially this is the definition of de-industrialisation. However, what is not understood is that these industrial sites hold significant heritage value in the sense that they have value to the general population as a reminder of what happened on that site, the people that worked on that site, the processes that were used on that site and the discoveries that may have taken place on that site. (TICCIH, 2018) According to the NTCIH (The Nizhny Tagil Charter for The Industrial Heritage) there are different categories of values that make up industrial heritage.

#### HISTORICAL VALUE:

As stated in the NTCIH (TICCIH, 2018) historical value is based on “the evidence of activities which had and continue to have profound historical consequences. The motives for protecting the industrial heritage are based on the universal value of this evidence, rather than on the singularity of unique sites.” This means that if something significant was found, made or produced at a certain site that it has historical value.

#### SOCIAL VALUE:

As defined by the NTCIH (TICCIH, 2018), a site “is of social value as part of the record of the lives of ordinary men and women, and as such it provides an important sense of identity.” The site may have particular importance if a specific type of class, person, type of worker or community lived or worked at a specific site.

#### FUNCTIONAL VALUE:

Functional value is defined by the NTCIH as having “rarity, in terms of the survival of particular processes, site typologies or landscapes, adds particular value and should be carefully assessed. Early or pioneering examples are of especial value.” (TICCIH, 2018).

#### TECHNICAL VALUE:

A site may have technical heritage value if “it is of technological and scientific value in the history of manufacturing, engineering, construction.” (TICCIH, 2018)

#### ARCHITECTURAL VALUE:

NTCIH (TICCIH, 2018) denotes that a site may be nominated to have architectural value if it has “considerable aesthetic value for the quality of its architecture, design or planning.”

## CONCLUSION OF CULLINAN'S HERITAGE VALUE

Whilst Cullinan has not been declared an official heritage site by either the provincial or national governments, it has been nominated by several heritage authorities. There is significant heritage value in Cullinan, both from a cultural and an industrial heritage context.





CHAPTER 04 \\  
PRECEDENT STUDIES



## PRECEDENT STUDY - CONCEPTUAL

### STARA KOPALNIA CENTRUM NAUKI I SZTUKI

Building Name: Stara Kopalnia Centrum Nauki i Sztuki

Building Location: Walbrzych, Lower Silesia region, Poland

Project Size: 40,000 m<sup>2</sup>

Building Type(s): Mixed-use Cultural Centre

Project Type: Adaptive Re-use

Building Architect/Project Team: Nizio Design International

Project Year: 2004

#### DESCRIPTION

Stara Kopalnia Centrum Nauki i Sztuki is cultural and scientific centre located on the site of the old Julia coal mine (1770-1996) in Walbrzych, Lower Silesia region, Poland. Much like South Africa, Poland is heavily reliant on coal for its electricity production. As of 2012 Poland was generating 88% of its electricity by means of coal-powered power stations (Polish Information and Foreign Investment Agency, 2013, p. 3).

The old mine consisted of 16 building that were decommissioned in 1996. It was at this stage that plans were drawn up to create a cultural and science centre. The site contains several workshop/meeting spaces situated next to a large conference centre. There



Figure 4.1 - Stara Kopalnia Centrum Nauki i Sztuki - (Stara Kopalnia - [www.starakopalnia.pl](http://www.starakopalnia.pl))



Figure 4.2 - Stara Kopalnia Centrum Nauki i Sztuki - (Stara Kopalnia - [www.starakopalnia.pl](http://www.starakopalnia.pl))

is also a unique ceramic centre and several ceramics workshops, which is what the Lower Silesia region is known for, where artist can teach and display ceramics. The site also houses a café and a restaurant that can also be used as a function venue with cater-

ing, as well as a large exhibition hall, 9 guest rooms, a large outdoor event space, a indoor concert/performance space and an art gallery. The site also houses the Industry and Technology Museum.

### PROJECT INTENTIONS

According to the architects, Nizio Design International, the intention of the project was to mix the industrial past of the site with the future of science, art and culture. Central to this intention was the idea that the project should transcend the carbon era without completely eradicating the history of the Lower Silesia region (southwest Poland). The grain of the space should be retained, and at the same time enriched with modern solutions, thus the new mine should represent the best of the old and the new (Nizio Design International, 2017).

### PROJECT SUCCESSES

The heritage value of the buildings has been retained, and the modern interventions are clean and precise. They add to the existing rather than detract from it. It is very clear what is new and what is old. The project manages to include a didactic element to the site, through the museum, which documents the regions carbon era. It also allows for the site to be self-sufficient in terms of running cost, as the accommodations, workshop spaces and conference facilities then subsidize the cost of the museum. A lot of the old machinery has been left in its original position so as to show visitors how the mine used to operate. By doing this the designers have retained not only the architectural integrity of the site but also its historical and functional heritage value.



## PRECEDENT STUDY - FORMAL

### MALMO SALUHALL

Building Name: Malmo Saluhall

Building Location: Gibraltargatan 6, 211, 18 Malmo, Sweden

Project Size: 1,500 m<sup>2</sup>

Building Type(s): Market Hall

Project Type: Adaptive Re-use

Building Architect/Project Team: Wingardhs Architects

Project Year: 2016

### DESCRIPTION

The existing shed was a culturally protected disused freight shed that is located just west of the Malmo Central Station. It dates from the 1800's. The shed had been abandoned for many years and did not have a roof structure anymore. The designer extended the under-roof space so as to enlarge the hall to make space for about 20 food vendors and restaurants. There is also an outside seating area and a courtyard that has been designed to allow for the market to spill out in the outdoors when necessary.

### PROJECT INTENTIONS

The initial design thought was to add a similar shaped and sized ele-



Figure 4.3 - Malmo Saluhall - (Archdaily - [www.archdaily.com](http://www.archdaily.com))

ment to the side of the existing so as to mirror it. However, due to site restrictions this was not possible. The designer then decided to mimic the original shed in its profile on the gable end, but not to allow the far side of the structure to touch the ground, so as to avoid the existing services. (Wingardhs Architects, 2018)

### PROJECT SUCCESSES

The projects designers have successfully managed to expand the space while keeping true to the building typology and therefore not detracting from the heritage of the existing building. The connection between the two structures is designed to feel light and unobtru-

sive, it clearly highlights the difference between the old and the new. Whilst the materials of the new structure are very different to the old brickwork that is weathered and aged, the pallettee of materials (weathering corrugated steel and recycled bricks) echoes the industrial character of the existing structure. On the interior of the building the original elements are highlighted and the new elements are hidden away, again trying not to rival the existing heritage but rather expand on it softly. The overhang draws people into the space because it is not solid and it also leads people away from the street edge to the open courtyard. There is also space for seating under the overhang, so customers who have bought food or drinks inside can sit outside and enjoy them. This gives the customers the choice of being indoors or outdoors but still feeling connected to the space.

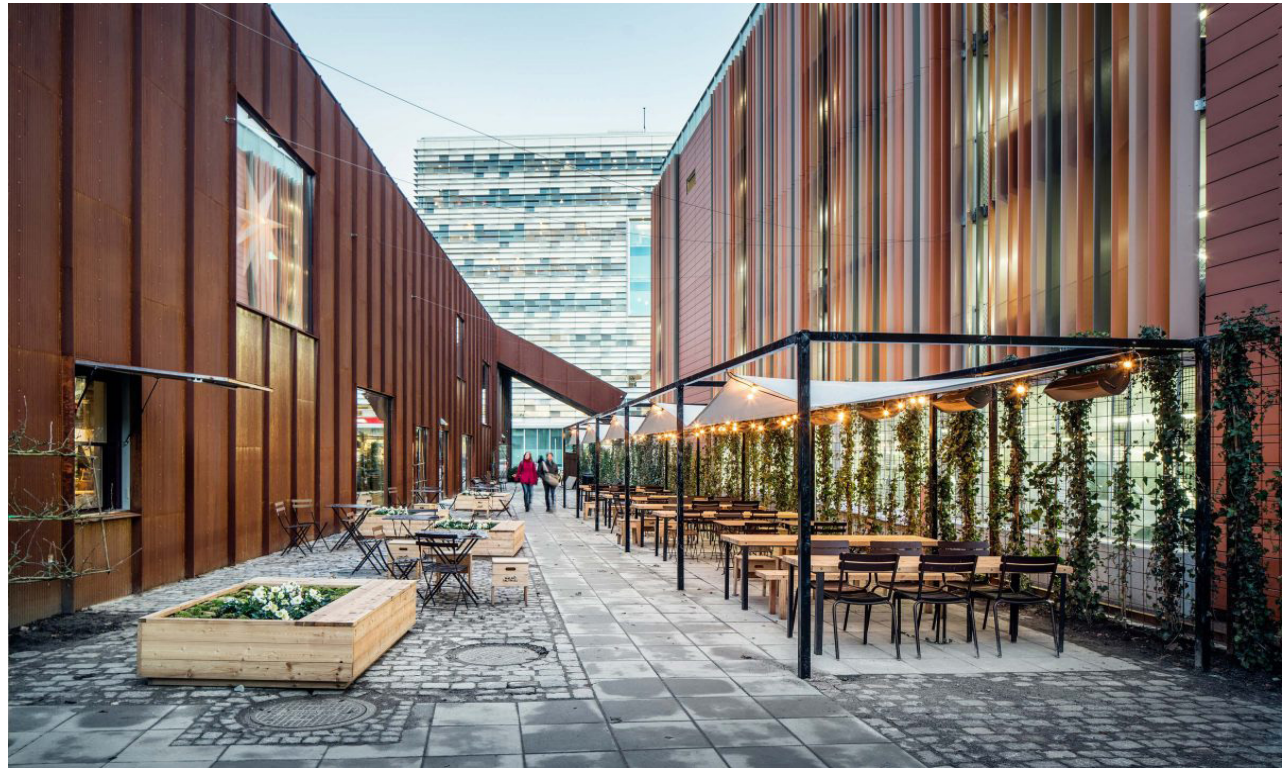


Figure 4.4 - Malmo Saluhall - (Kjellander Sjöberg- <http://www.kjellandersjoberg.se>)

## PRECEDENT STUDY - FUNCTIONAL

### THE UNIVERSITY OF TASMANIA'S SCHOOL OF ARCHITECTURE AND DESIGN

Building Name: Tasmania's School of Architecture and Design

Building Location: 8 Invermay Rd, Launceston TAS 7250, Australia

Building Type(s): University Building

Project Type: Adaptive Re-use

Building Architect/Project Team: Six Degrees Architects

Project Year: 2009

## DESCRIPTION

The University of Tasmania's School of Architecture and Design is housed in the old Inveresk Railway Workshops. The original site was built in the mid 1860's and was used to maintain steam locomotives. In 1950 the diesel workshops were built when the railways changed from steam locomotives to diesel locomotives. The buildings were then refurbished in 1995 as part of the exhibition for the Launceston Show.

When the University bought the property the structures had been re-roofed, cleaned and all the machinery had been removed, except for



Figure 4.5 - Tasmania's School of Architecture and Design - (University of Tasmania- [www.utas.edu.au](http://www.utas.edu.au))



Figure 4.6- Tasmania's School of Architecture and Design - (Six Degrees Architects- [www.sixdegrees.com.au](http://www.sixdegrees.com.au))

the overhead cranes. The buildings had a 12metre high volume with very little else in the way of interior apart from the structural framing that supported the roof.

## PROJECT INTENTIONS

There were 3 main intentions for the project. Firstly, to maintain the industrial heritage of the buildings, site and precinct. Secondly the new intervention had to follow the Environmentally Sustainable Design (ESD) principles that the school teaches. And thirdly it had to embody the schools 'workshop' teaching approach.

## PROJECT SUCCESSES

By placing a 3-story enclosed block on the western side of the block it allowed the designers to house all the service and administration needs in a single area, thereby allowing for the main volumes to stay open to serve as flexible studio and exhibition spaces. The original sawtooth roof structure, window framing, concrete structure and timber beams were all retained so as to keep the heritage value of the structure as well as the industrial typology. The exterior of the building could only be partially restored due to its heritage status. Again, the new work is clearly distinguishable from the old, and despite being new, still maintains the industrial typology of the site. Because of the nature of the project it was also very important for the designers to incorporate the ESD principles. These included reducing power consumption, water recycling and rainwater capture.

## PRECEDENT STUDY - TECHNOLOGICAL

### CNR – I.S.M.A.R. HEADQUARTERS, VENICE

Building Name: CNR – I.S.M.A.R. Headquarters

Building Location: Arsenale, Venice, Italy

Building Type(s): Office space, conference

spaces and Laboratories

Project Size: 2,961m<sup>2</sup>

Project Type: Adaptive Re-use

Building Architect/Project Team: Cecchetto & Associati

Project Year: 2012

#### DESCRIPTION

The Arsenale area is a very old part of the city and it was the site where the ancient Venetians built their Tires. These Tires were built in warehouses that were roughly 18m wide, 30m long and 12m in height. It is in several of these warehouses that the Italian National Research Centre decided to build their new headquarters. These warehouses sit alongside one another and the shared walls have arches in them. It was very important to the designers to retain these as part of the historical heritage of the site.

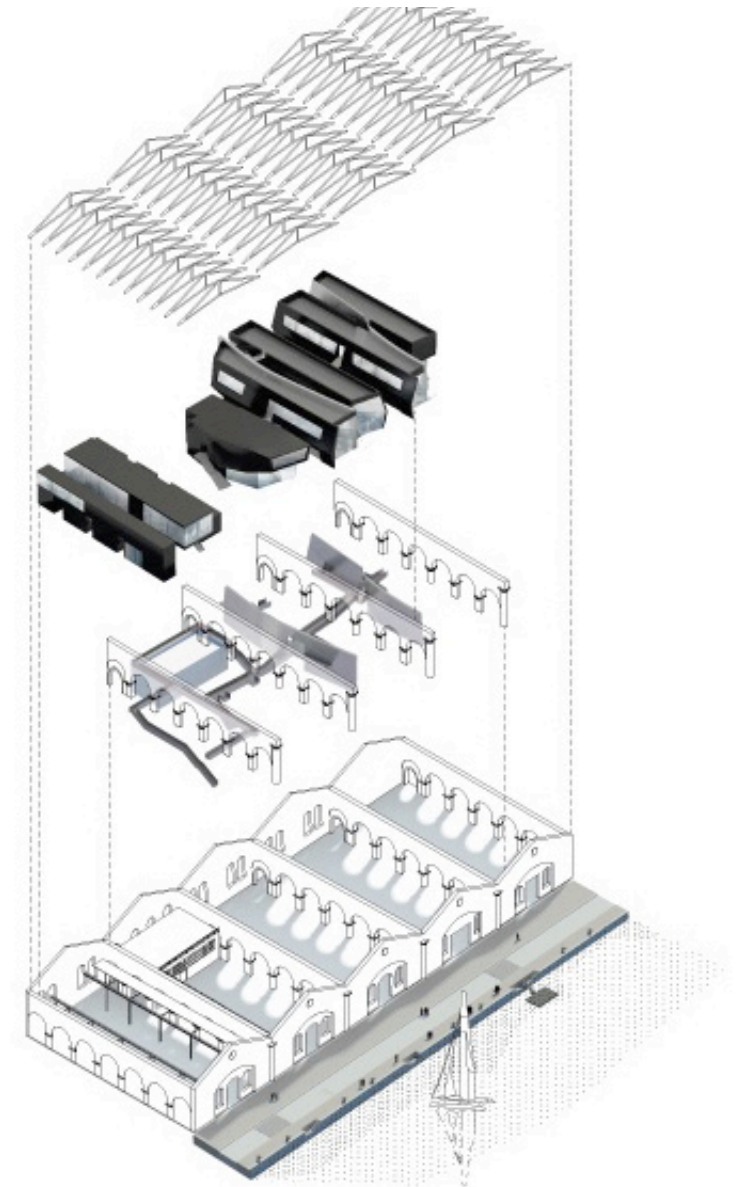


Figure 4.7 - Exploded diagram of CNR – I.S.M.A.R. Headquarters - (Studio Cecchetto- [www.studiocecchetto.com](http://www.studiocecchetto.com))

## PROJECT INTENTIONS

The intentions of this project were to maintain the historical heritage of the structures whilst incorporating the new. The warehouses used to be the site where the most technologically advanced warships of the age were built, and they now house the labs where new technology is tested before being released to the market. The designers want to highlight this contrast.

## PROJECT SUCCESSES

The contrasting of the old and the new in this building is extreme. Once again there is no doubt about which parts of the building are new and which are old. This is a classic example of the 'building with-in'. The new pods that house the offices, labs and meeting spaces sit away from any of the walls and also touch the ground lightly. This project is a masterpiece is adaptive re-use of very old structures.

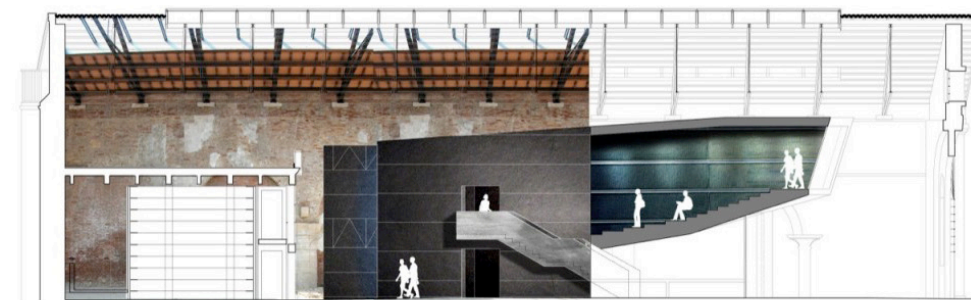


Figure 4.8 - Section - CNR – I.S.M.A.R. Headquarters - (Studio Cecchetto- [www.studiocecchetto.com](http://www.studiocecchetto.com))



Figure 4.9 - Image- CNR – I.S.M.A.R. Headquarters - (Studio Cecchetto- [www.studiocecchetto.com](http://www.studiocecchetto.com))

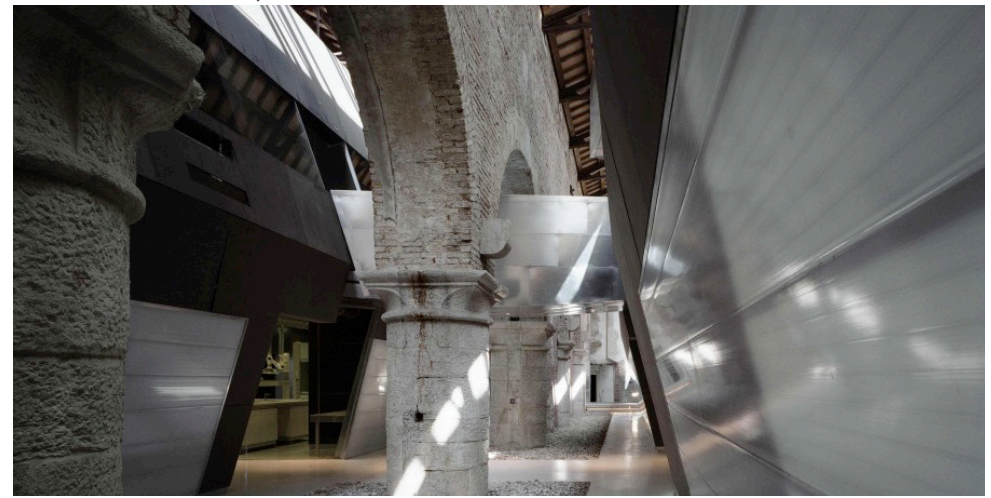


Figure 4.10 - Image - CNR – I.S.M.A.R. Headquarters - (Studio Cecchetto- [www.studiocecchetto.com](http://www.studiocecchetto.com))







# CHAPTER 05 \\ PROPOSED FRAMEWORK



## EXISTING SPATIAL DEVELOPMENT FRAMEWORKS

### GAUTENG SPATIAL DEVELOPMENT FRAMEWORK (GSDF)

The GSDF was developed by the Gauteng Provincial Government, in accordance with the National Development Framework. It is aligned to other national and provincial programmes, such as “Gauteng’s 10-Pillar Programme of Transformation, Modernisation and Re-Industrialisation Programme” (Gauteng Provincial Government, 2001, p. viii). The framework seeks to enable the municipalities of Gauteng to be able to provide services to the predicted future population of the province and develop opportunities for that population to prosper.

### DINOKENG DEVELOPMENT FRAMEWORK WITHIN THE GSPF

Within the GSDF the Dinokeng region (which is located to the North and Northeast of Pretoria including Cullinan, Rayton and Bronkhorstspuit) forms part of the province’s hinterland, has been designated for specific development in eco-tourism (nature reserves), agriculture and industrial zones. (Gauteng Provincial Government, 2001, p. 110)

This existing framework will serve as an informant to the proposed Cullinan urban framework.

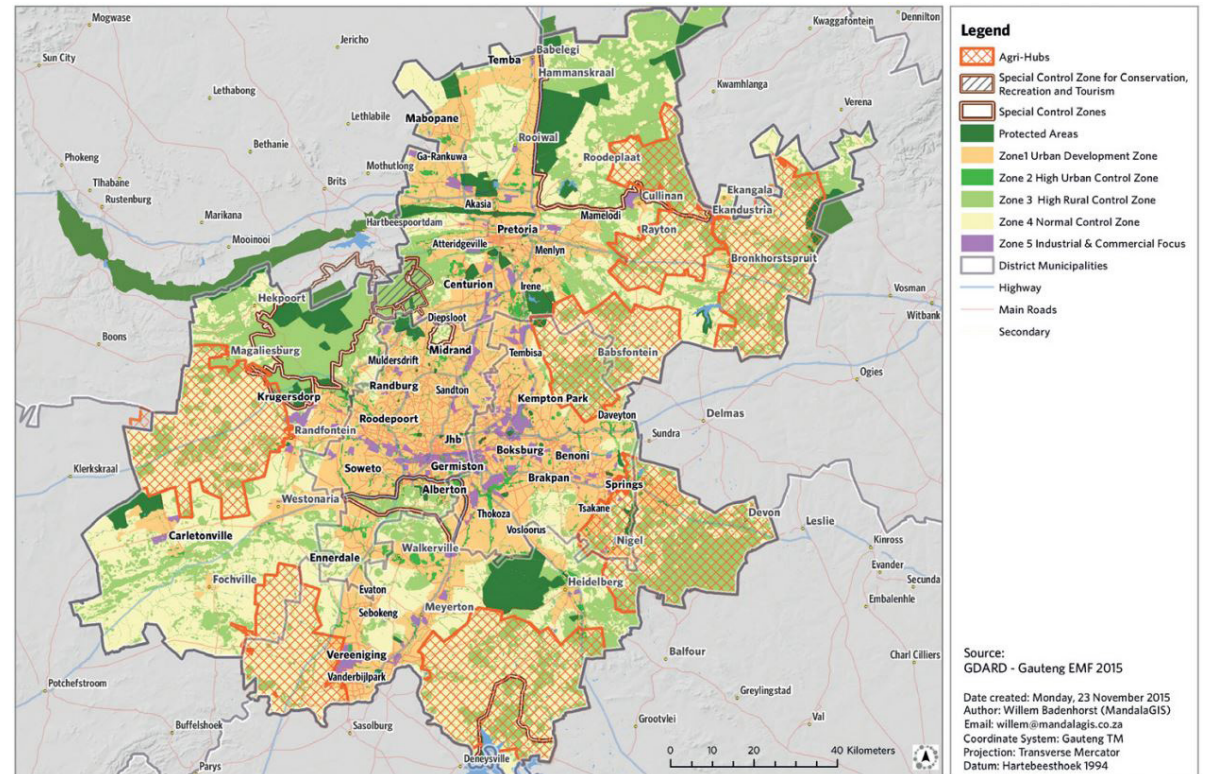


Figure 5.1 - Map showing Agri-hubs in Gauteng Region (GSDF 2011)

## URBAN FRAMEWORK

### URBAN FRAMEWORK INTENTIONS:

The intentions of the framework are to facilitate the reconnection between Refilwe, Cullinan and the mine itself. That relationship has been degraded over the past 50 years and is now very tenuous. The development of the urban framework will explore how the connection between these elements can be linked back together. The elements that need to be reconnected are:

- The historical town,
- The railway station
- The existing mine, in between the winder building and the historical warehouses
- Refilwe township

The framework will achieve this by creating a centralised node between Refilwe and Cullinan town, in the existing mine site. This node will bring together the two separated communities, where knowledge and products can be shared and the communities can reintegrate themselves. The framework will incorporate a new route for residents to travel from Refilwe to the centralised node, instead of having to move through Cullinan to get to the site.

The area between Refilwe and the mine site will be rehabilitated into agricultural and farming belt. And the central node will contain cleaning and packaging facilities for the produce from the proposed farms. The central node will also serve as a site from which the produce can be sold and transported.

Currently there is a train service that brings tourists from Pretoria station to the Cullinan station on two weekends a month. The framework proposes that the train service becomes more frequent and that it is also used to transport goods to and from the mine site. The existing railway line already runs directly into the mine.

The pathway that runs alongside Oak Avenue will be extended to the entrance of the central node and parking will be provided in close proximity to the entrance.

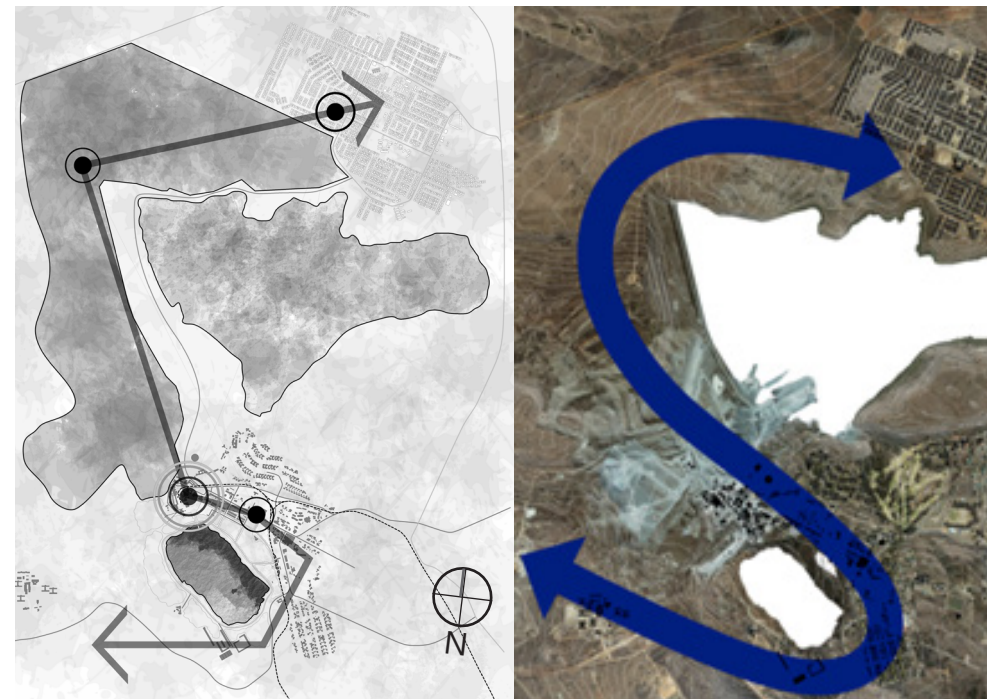
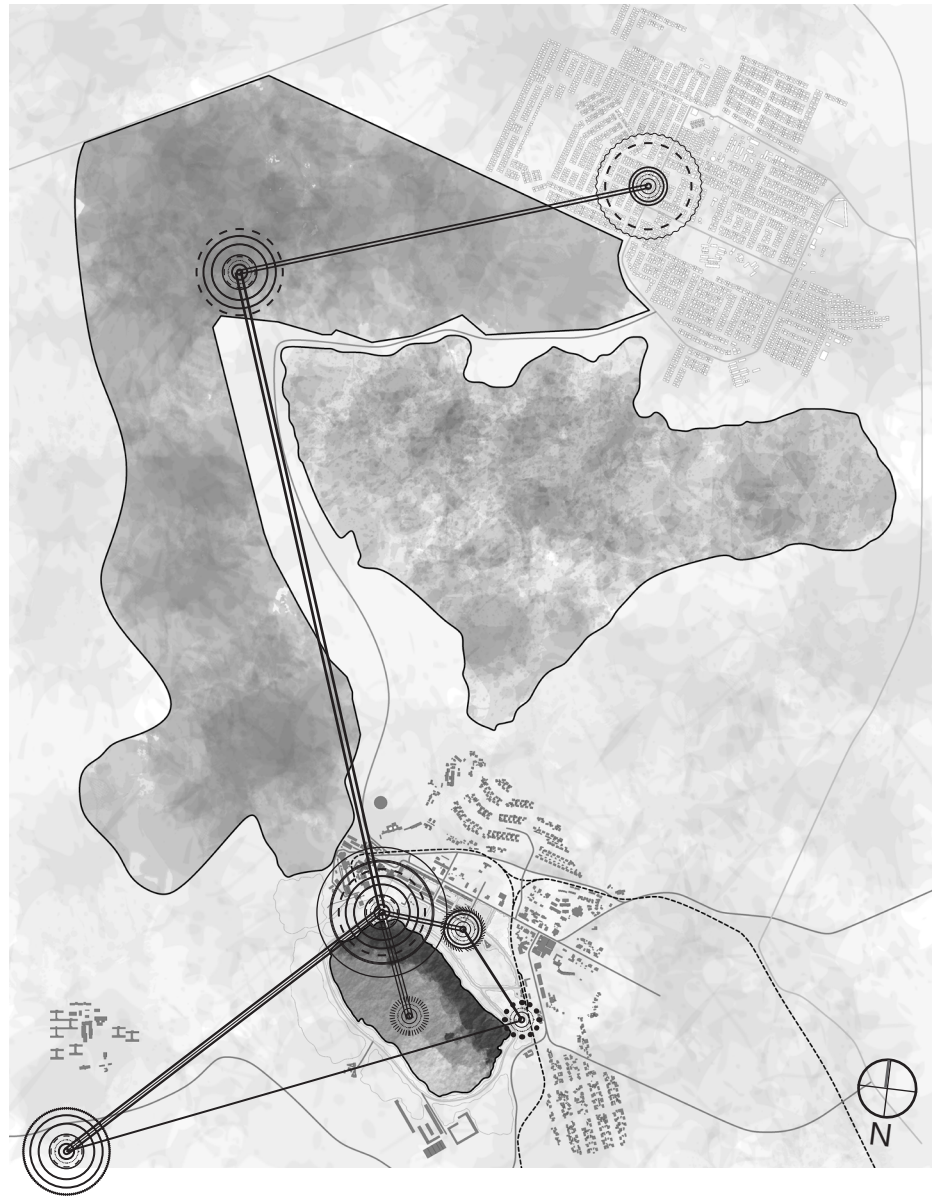

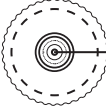



Figure 5.2 and 5.3- Diagram showing relationship between Cullinan, farm lands, the mine site and Refilwe (Author 2018)


# URBAN FRAMEWORK





- 


**CULLINAN INDUSTRIAL CENTRE**  
HERITAGE - CRAFT DEVELOPMENT - CULLINARY NODE - INDUSTRY -
- 

**REFILWE TOWNSHIP**  
TOURISM - CRAFT DEVELOPMENT
- 

**REGIONAL MARKET**
- 

**PROPOSED NEW AGRICULTURAL LANDSCAPE**  
INDUSTRY - PRODUCTION
- 

**HISTORICAL TOWN**  
TOURISM - CULLINARY NODE - HERITAGE - VISITOR ACCOMMODATION
- 

**EXISTING MINING PIT**  
HERITAGE
- 

**PUBLIC TRANSPORTATION HUB**  
TOURISM

Figure 5.4 - Diagram showing relationship between Cullinan, farm lands the mine site and Refilwe (Author 2018)

## URBAN FRAMEWORK

### SPATIAL RELATIONSHIP






-  MINING PIT
-  NATURAL LANDSCAPE
-  AGRICULTURAL LAND
-  SILT DAM
-  EXISTING RAILWAY LINE
-  ROADS

The diagram shows the relationship between the four major elements of the area and the proposed new land use. The town of Cullinan can be seen in relation to the open mining pit, as well as Refilwe township and the silt dam.

### MOVEMENT THROUGH AND AROUND CULLINAN

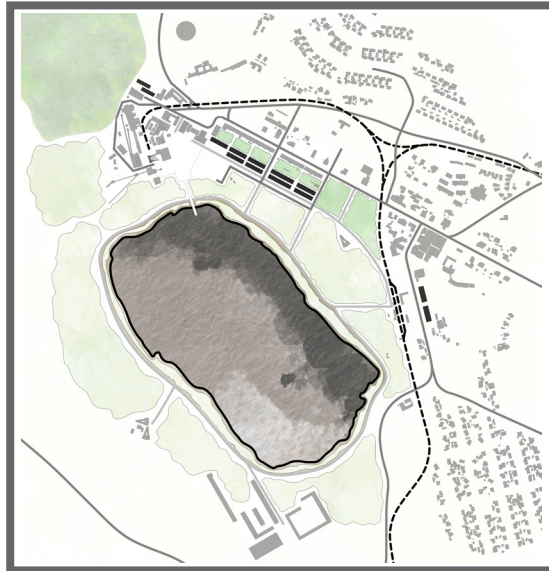


-  PRIMARY ROUTES
-  SECONDARY ROUTES
-  EXISTING RAILWAY LINE



The primary routes are used for vehicular and pedestrian traffic. These routes connect the town and the decommissioned mine to the outside world. The secondary routes are only for pedestrians and allow for both residents and visitors to connect with the mine and the open pit. Visitors are also able to walk from the train station into town and then on towards the mine. There is a secondary route that runs around the open pit and connects the old mine site to the ventilation shafts and the historical workers compounds, this route will form part of historical tours.

Figure 5.5 and 5.6 - Diagram showing urban framework elements (Author 2018)

## URBAN FRAMEWORK



### NEW DEVELOPMENT OF ACCOMMODATION

-  EXISTING BUILDINGS
-  PROPOSED NEW ACCOMMODATIONS

Proposed new accommodation will allow more people to live in Cullinan town closer to the new industrial complex. There will also be accommodation for students attending the skills centre.



### GREEN SPACE LAND USE

-  MINING PIT
-  AGRICULTURAL LANDSCAPE
-  NATURAL LANDSCAPE
-  RECREATIONAL AREAS

There are four distinct land types surrounding Cullinan. To the North-East agricultural land has been developed as part of the alternative industrial development. The natural landscape has been rehabilitated. Recreational spaces within Cullinan have been developed and there is a stronger relationship between the town and the mines open pit.

Figure 5.7 and 5.8 - Diagram showing urban framework elements (Author 2018)

## URBAN FRAMEWORK



Figure 5.9 - Urban Framework Plan (Author 2018)

# PRECINCT FRAMEWORK CONCEPTUAL DEVELOPMENT

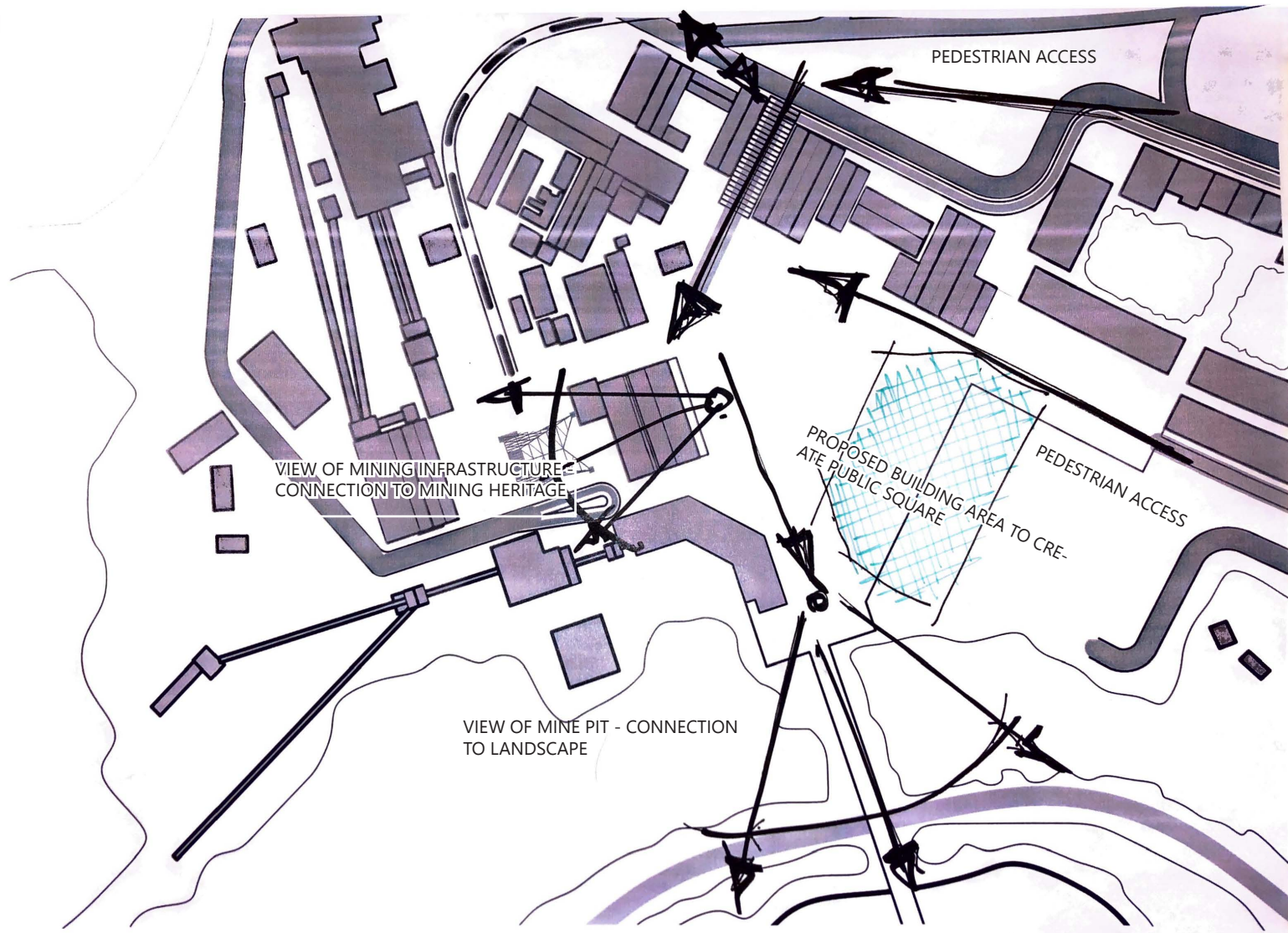


Figure 5.10 - Precinct Framework (Author 2018)



## CONCEPTUAL DEVELOPMENT

### PRECINCT FRAMEWORK

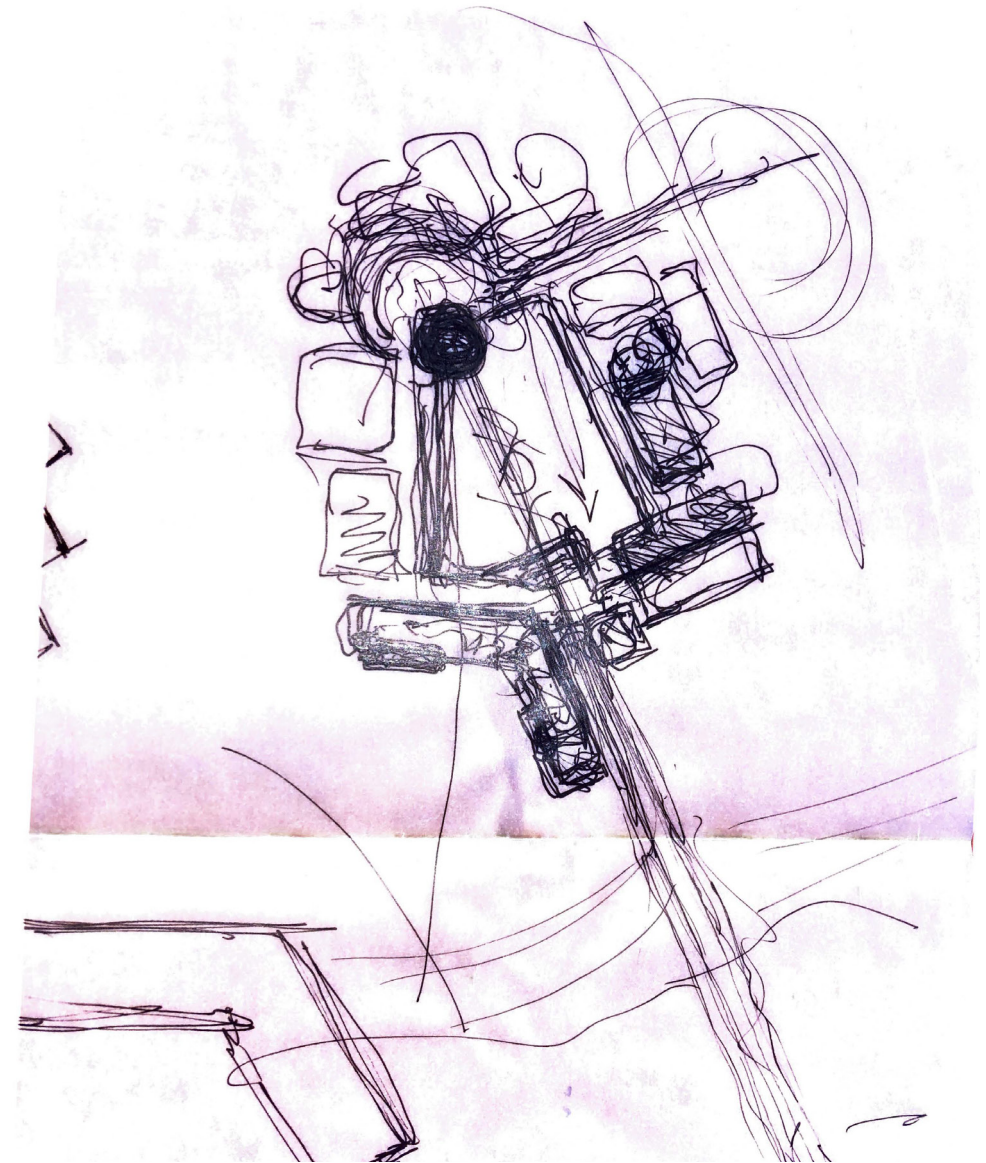


Figure 5.11, 5.12 and 5.13 - Precinct Framework Development (Author 2018)

# PRECINCT FRAMEWORK

## PRECINCT FRAMEWORK - EXPLANATORY DIAGRAMS

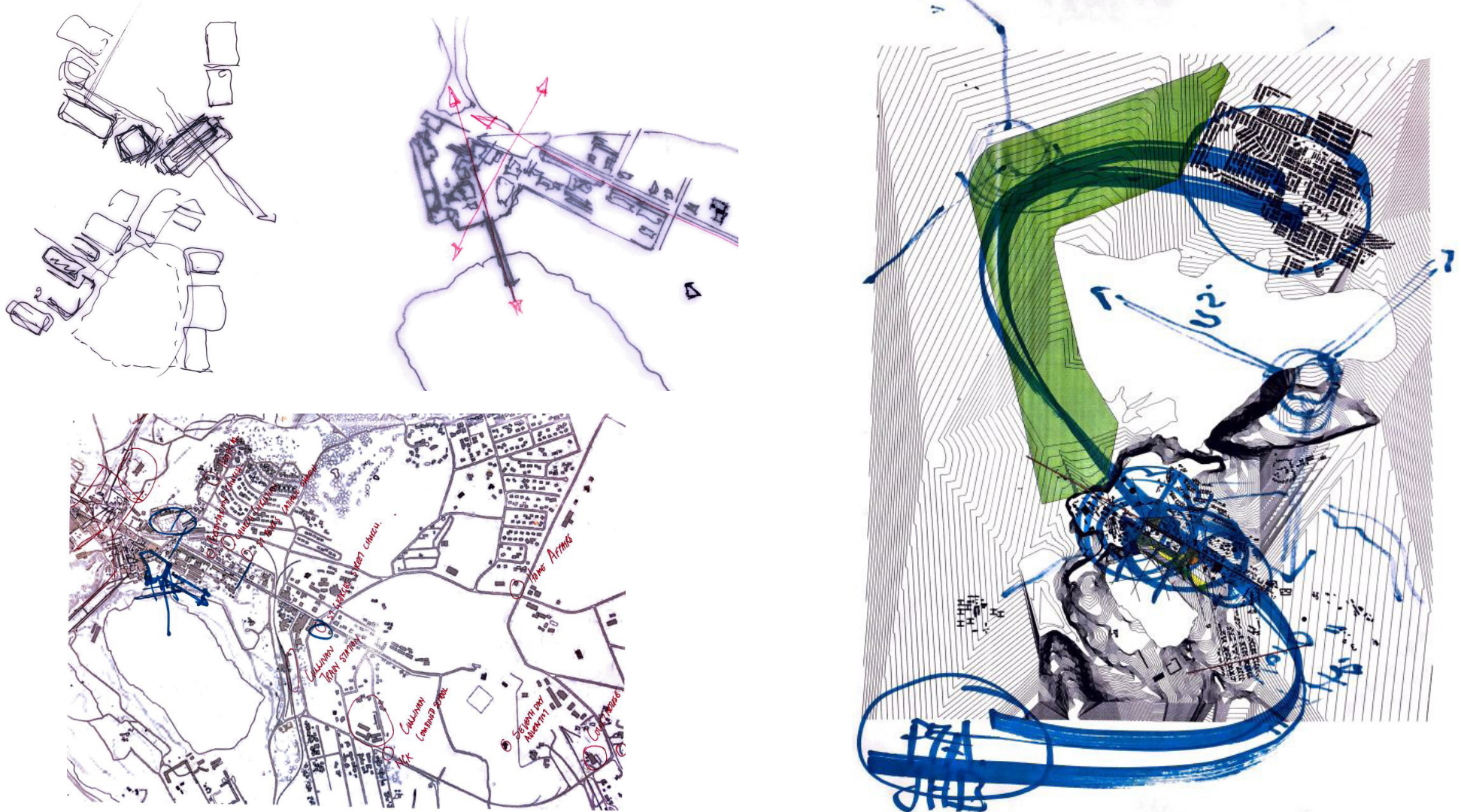


Figure 5.14, 5.15 and 5.16 - Precinct Framework Development (Author 2018)

# PRECINCT FRAMEWORK

## PRECINCT MASTER PLAN

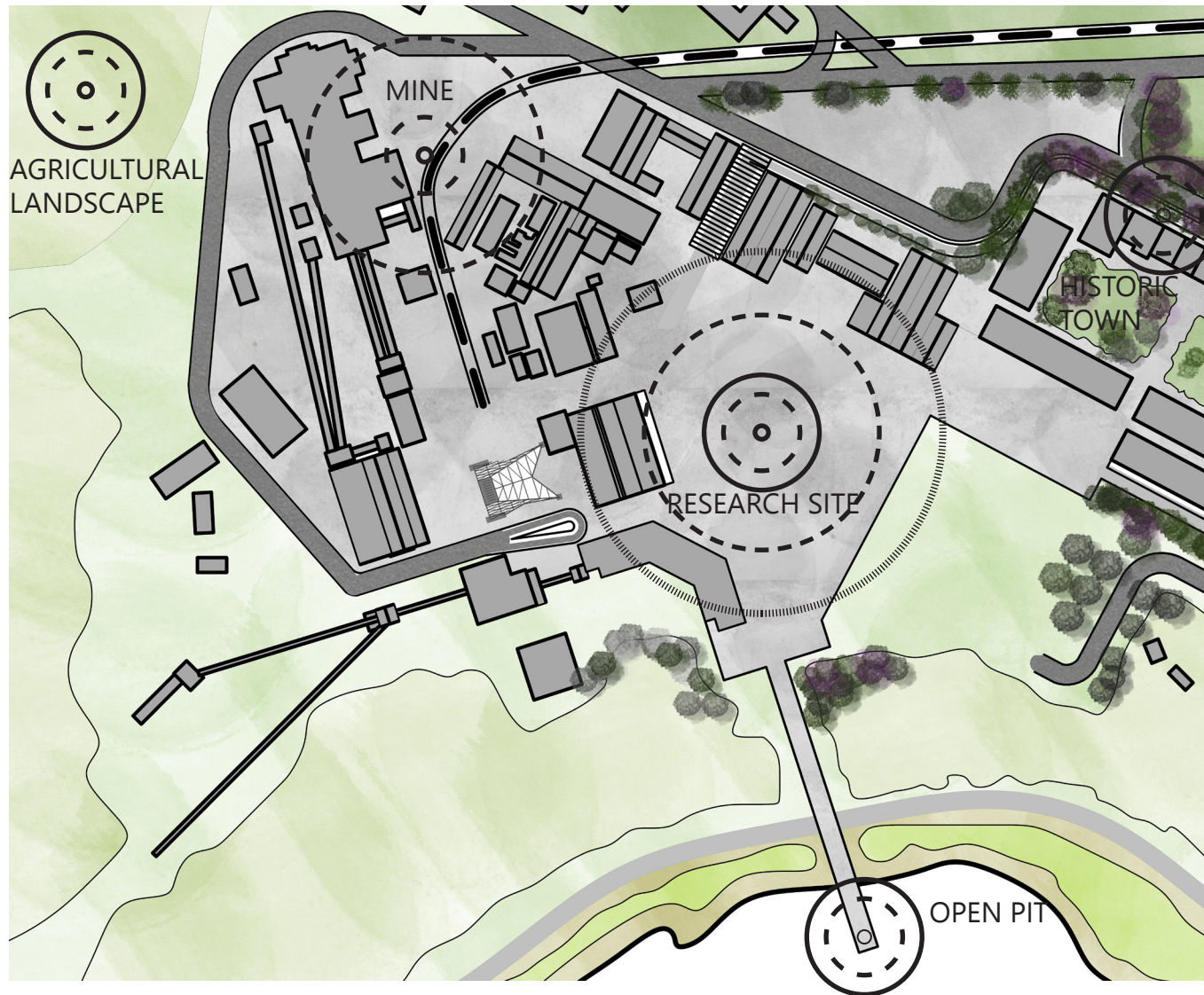


Figure 5.17 - Precinct Framework - Precinct Master Plan (Author 2018)



CHAPTER 06 \\  
PROGRAMME



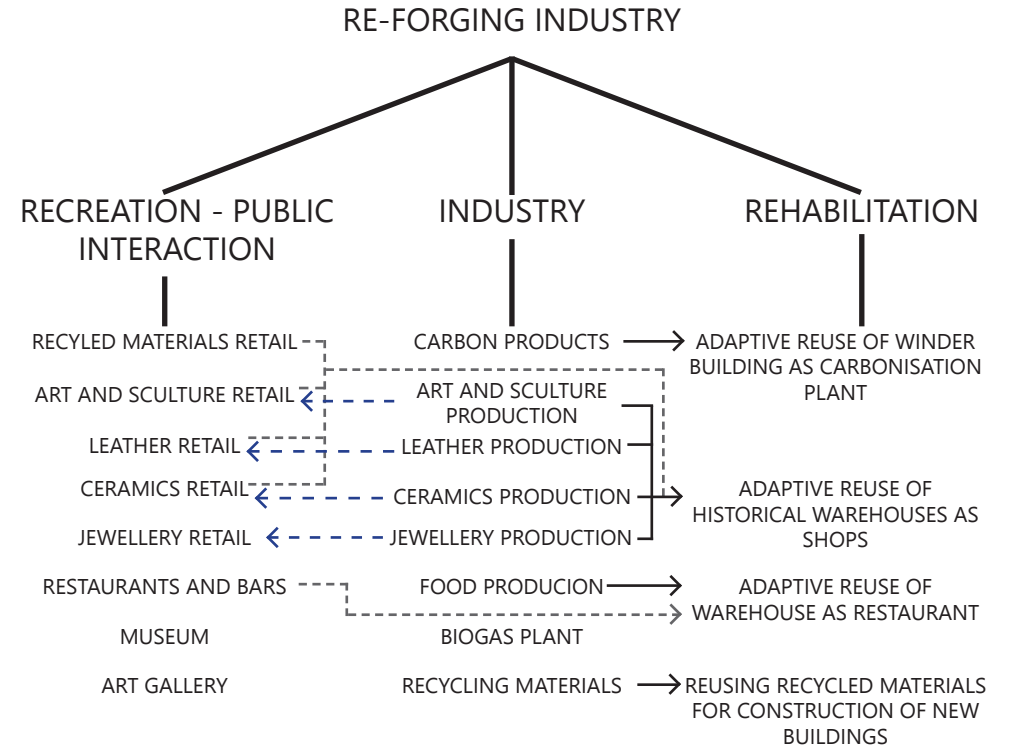
## PROGRAMME

### INTRODUCTION

The major issue surrounding mining towns in a South African discourse is that they are often in very remote locations. Apart from the material that is being mined on site, there is very little in the way of natural materials. This along with the fact that mining companies, through their governance of the mining locations tend to limit any development of alternative industry in the area. All of this means that when mining operations cease that the population of these mining towns struggle to find and develop alternative income sources.

Cullinan is somewhat more fortunate in the sense that it is not located in an area of extreme remoteness, and also due to it being the place of the discovery of the worlds largest diamond, it has a fairly successful tourism industry. It is a popular weekend destination, and boasts a healthy culinary industry. This being said there are no obvious alternate industries that can be developed that will take over when the mine closes.

The area surrounding Cullinan has an agricultural heritage, and is still a relatively productive area. The inhabitants of Refilwe practice subsistence farming to help subsidise their food needs. This means that the skills exist to further develop a working agricultural industry that can be linked into the greater Cullinan scenario. The small percentage of the Refilwe population that still work at the mine are medium to high skilled workers.



A relationship exists between the alternative industry production and the public element of the new industry. The alternative industry produces products which are then sold to the public. This direct relationship is in contrast to the normal disconnected production and retail relationship where the two do not happen in the same location.

There also exists a relationship between the new alternative industry and the site. A new approach to existing industrial infrastructure allows the new alternative industry to be housed in that infrastructure. This relationship is thus symbiotic because the industry can exist because it can be housed in the existing infrastructure and the infrastructure can be retained because of the alternative industry.

Figure 6.1 - Diagram showing the relationship between public interaction, industry and rehabilitation (Author 2018)

## PROGRAMME

### PROGRAMMATIC INFORMANTS

#### INDUSTRY

Cullinan obviously has a highly developed Diamond industry, and the mine is famous the world over. The mine and tours thereof are a significant tourism draw card. Along with the tourism value of the mine itself once the operation ceases to produce there are a host of industrial infrastructure that not only hold significant heritage value, but also provide a large opportunity for alternative industries to be set up in the vacated infrastructure.

#### AGRICULTURE

As previously stated the communities surrounding Cullinan have an agricultural heritage and the original farm that the mine was located on was once a flourishing farm. The soils in the area are nutritious and fertile. The opportunity exists for the land between the mine and Refilwe to be converted into farmland and land that can hold livestock. There are also chicken farms in the area.

Cullinan already has a thriving culinary industry, with many of the local restaurants actually farming their own produce to use in the kitchens. There is also a fresh produce industry where restaurants from Johannesburg and Pretoria purchase organically grown produce.

## PROGRAMME

#### TOURISM

Once the mine closes, if Petra Diamonds is allowed to continue with their rehabilitation strategy for the mine, the town will lose a major part of its tourism value. When tourists come to Cullinan they want to see the mine where the largest diamond in the world was mined. Petra's rehabilitation strategy would mean that only the No. 1 Head Gear and a few other buildings would be left on the edge of the vast pit. This image is not synonymous with the significant industry that exists at the Cullinan Diamond mine. There is already a disconnect between the mine and the town and this type of strategy would only serve to completely disconnect the town from its mining heritage.

#### EDUCATION

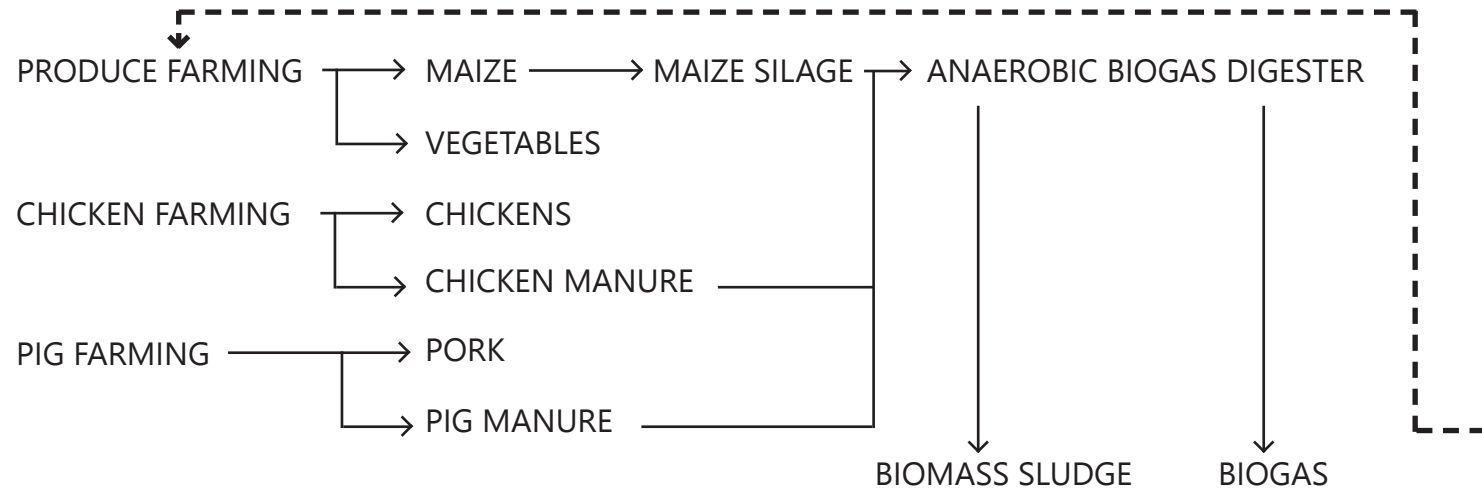
The educational component of this project is vitally important because it is directly linked to the SED of Refilwe community. Education and skills development will allow both (retrenched) miners and their family members to develop new skills and trades which will allow them to find new jobs or start their own businesses in a post mining scenario.

The alternative industry's that are proposed for the site will allow for students to gain practical experience and work as apprentices in whichever field they wish to study.

## BIOGAS PLANT

Biogas production is when a biomass is decomposed by bacteria in a closed tank. One of the bi-products of this decomposition is biogas. The other bi-product is biomass sludge, which can be used as a fertiliser or it can be dried and burnt as a biofuel.

## AGRICULTURE PROCESS



## AGRICULTURE

Agriculture is a key informant for this dissertation. It is the most obvious alternative industry for the communities surrounding Cullinan, specially because there is a heritage of farming and a working knowledge of the industry. The agriculture industry will also be able to supply the existing culinary industry existing in Cullinan.

The bi-products of the agricultural industry will be further used to create biogas which in turn will be used to fire the furnaces of the carbonisation plant. The biomass sludge can also be dried and burnt as a fuel in the carbonisation plant. Products from the carbonisation plant will then be used as feed and fertilisers in the agricultural industry, creating a closed system with no waste.

Figure 6.2 - Diagram showing the symbiotic relationship between agriculture, biogas industry and the carbonisation industry (Author 2018)

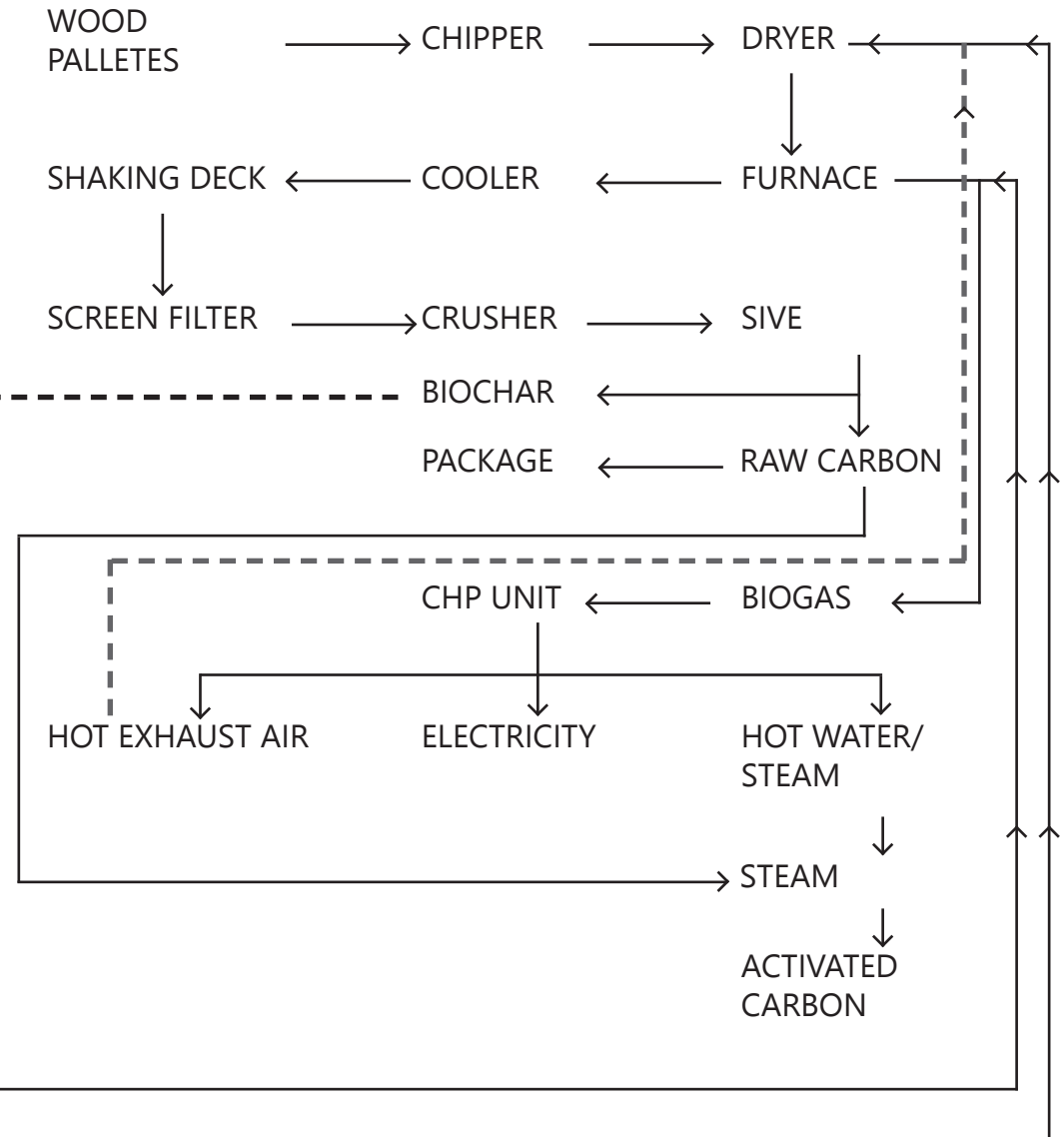


## CARBONISATION

The process of carbonisation is simply the burning of a biomass in the absence of oxygen, thereby reducing the carbon base biomass to its purest carbon form.

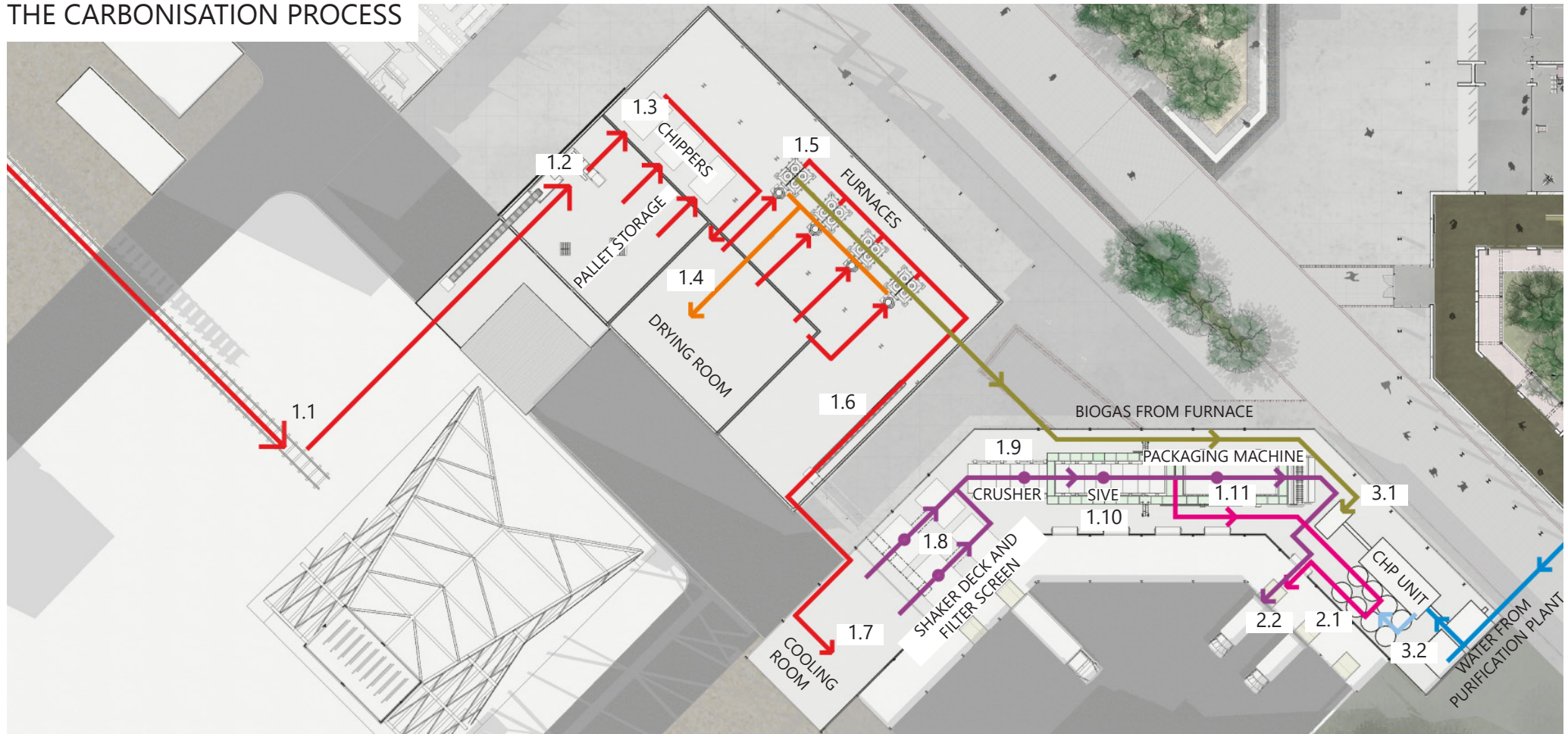
Carbon is a very useful material and can be used in maybe different ways. Commercially carbon is used in the agricultural industry as a fertiliser or as an additive to animal feed. Activated carbon is used in water purification plants. Carbon also has applications in the medical industry, cosmetics industry and in the alcohol production industry.

## CARBONISATION PROCESS



BIOCHAR FERTILISER - CARBON ANIMAL FEED

# THE CARBONISATION PROCESS



## // PROCESS 1

1-1 // WOOD PALLETS ARRIVE FROM CHEP BY TRAIN FROM JHB PRETORIA AND ROSSLYN

1-2 // WOOD PALLETS STORED INDOORS

1-3 // PALLETES CHIPPED INTO SMALL PIECES

1-4 // WOOD CHIPS STORED IN DRYING ROOM, EXHAUST HEAT FROM FURNACES USED TO DRY

1-5 // DRY WOOD CHIPS SENT TO FURNACE.

1-6 // CHARCOAL QUALITY CHECKED

1-7 // CHARMOAL STORED TO COOL

1-8 // CHARCOAL SENT THROUGH SHAKER DECK, FILTER SCREEN

1-9 // CHARCOAL CRUSHED INTO CARBON POWDER

1-10 // CARBON POWDER SIVED

1-11 // RAW CARBON PACKAGED AND SHIPPED

## // PROCESS 2

2-1 // RAW CARBON AND USED CARBON ACTIATED BY STEAM FROM CHP UNIT

2-2 // ACTIATED CARBON PACKAGED AND SHIPPED

## // PROCESS 3

3-1 // BIOGAS BYPRODUCT FROM FURNACES USED TO POWER CHP UNIT TO CREATE ELECTRICITY AND STEAM

3-2 // STEAM USED IN CARBON ACTIVATION





## CHAPTER 07 \\ ARCHITECTURAL INTENTION, CONCEPTUAL APPROACH AND DESIGN DEVELOPMENT



## FORGING A NEW APPROACH TO INDUSTRIAL ARCHITECTURE

### INTRODUCTION

Industrial architecture is an architectural style that developed as part of the industrial revolution, which was characterised by the mechanisation of production. This was the first time that large scale factories were needed to house machinery. Initially these structures were built from the same materials as previous buildings, but the industrial revolution then provided the answer to its own problem, Iron. The introduction of iron as a material, was in its own right revolutionary. The new material allowed for much larger spans, large factory halls, with relatively very little vertical support structure (iron columns). (Wilkinson, 2010, p. 35)

The structural iron-frame became synonymous with industrial architecture. The permutations are almost endless. From a strong frame it is possible to hang, place or attach almost anything to it, and the possibilities for cladding are almost endless. It is also a very economical way to build.

The current approach to industrial architecture differs from place to place, but in a seemingly current period of de-industrialisation most designers are reluctant to use old industrial infrastructure, and are more inclined to push for new developments. However, the economic climate and rising cost of materials is favors adaptive reuse of industrial infrastructure which is the most economically feasible way to redevelop industrial sites.

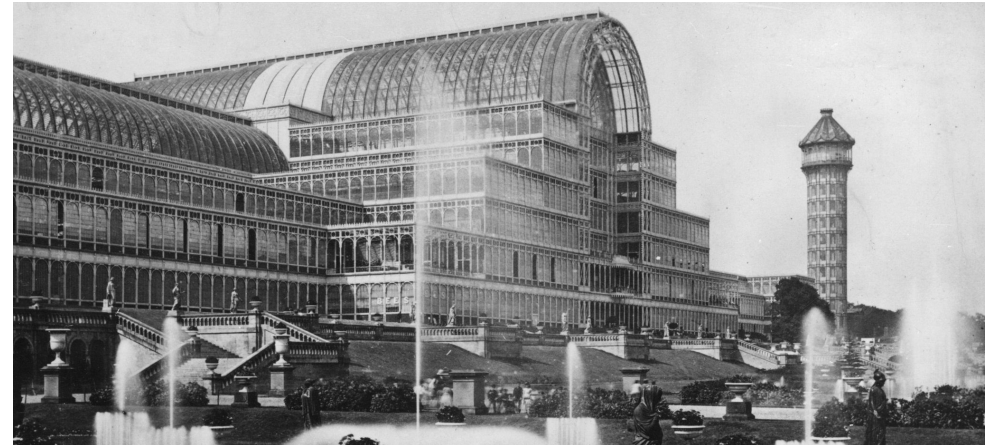


Figure 7.1 - Urban Framework Plan (Author 2018)

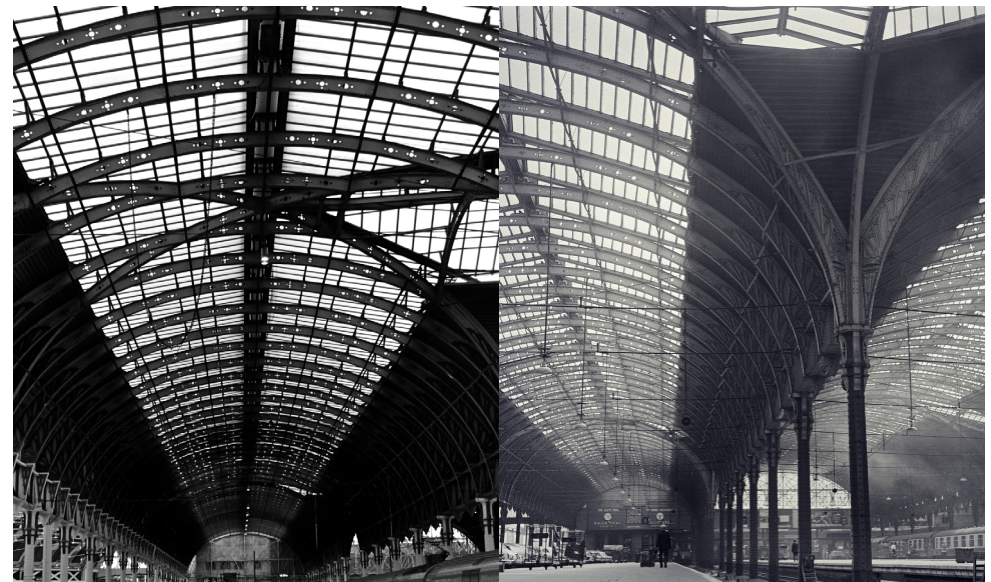


Figure 7.2 and 7.3 - Urban Framework Plan (Author 2018)

## ARCHITECTURAL INTENTIONS

Several main architectural intentions were identified as a reaction to the problems that were outlined in Chapter 001. The following will serve as an explanation as to how these intentions developed the architectural solution.

### ARCHITECTURAL INTENTION 001

#### FACILITATING THE DEVELOPMENT OF ALTERNATIVE INDUSTRY

The mine site has developed over the space of 110 years into its current layout. The entire site is designed in such a way to maximise efficiency for the diamond extraction process. The buildings are laid out in a very pragmatic way however, it is clear that there was no form of spatial planning involved in the layouts design. This is particularly evident when one looks at all the separate axes that the buildings are laid out.

The current layout of the site does not lend itself to alternative industries because of its mono-programmatic setup. For this reason, the infrastructure and its layout will have to be adapted to suit the new proposed programmes. The requirements of each on the proposed programmes in terms of sizing and services will need to be understood and the situated appropriately within the existing infrastructure. Where necessary new infrastructure will be developed using recycled materials.

## ARCHITECTURAL INTENTION 002

### CREATING A PUBLIC INTERACTION WITH INDUSTRIAL PRODUCTION.

“The social life in public spaces contributes fundamentally to the quality of the life of individuals and society as a whole” – W. H. Whyte

“As designers we have a moral responsibility to create physical places that facilitate civic engagement and community interaction.” - W. H. Whyte

Whilst the industrial buildings are fairly adaptable, in terms of function, their layout on the site limits the uses they can support. It is for this reason that the current mine site is difficult to navigate and even when the mine is decommissioned the site remains unfriendly to public interaction. It is therefore important that the site that has been selected will be made into a public friendly site that facilitates an interaction with the industry/industries that surround it.

The development of a public square will be used to facilitate this interaction. Frederick Law Olmsted's (1822-1903), a visionary landscape architect's, concept of the 'inner park' and the 'outer park' (Project for Public Spaces, 2005) is not only relevant to urban parks, but is also relevant to the design of public squares/piazza's and can be seen in the

design of public squares that predate his concept. The concept can be extrapolated to the 'outer square' and the 'inner square'. Two of the best examples of this are the Piazza del Campo in Siena, Italy and the Piazza Bra in Verona, Italy. See Figures 7.4 and 7.5.



Figure 7.4 - Piazza Del Campo (Project for Public Spaces, 2005 - [www.pps.org](http://www.pps.org))



Figure 7.5 - Piazza Bra in Verona (Project for Public Spaces, 2005 - [www.pps.org](http://www.pps.org))



## ARCHITECTURAL INTENTION 003

### A RECYCLED INDUSTRY

The intention is not only to adaptively reuse the existing industrial infrastructure but also to reuse materials from the infrastructure that is no longer needed. The existing material palette and the proposed new palette have many common components. The new buildings and the buildings that are being adapted will use the same materials. There will be a far lesser need to import new materials for the proposed new structures. The existing site currently has a high-embodied energy due to the types of materials that are used in industrial architecture. Therefore, by reusing some of existing structural components and other materials will mean that the cost of the new development will be greatly reduced in terms of embodied energy and carbon footprint.

The manpower needed to dismantle some of the infrastructure and then adapt and reassemble it will also provide a host of jobs for the local community and also allow from the development of skills for the community.

## CONCEPTUAL APPROACH

The present mining industry is by nature very mono-dimensional; it only serves the purpose of extracting a non-renewable resource from a site. The mining industry is by definition unsustainable and does not hold any real resilience (ability to adapt) potential. The infrastructure used to achieve this is designed for the sole purpose of production. When the raw material is exhausted the existing industrial infrastructure is no longer needed. This results in the site and related infrastructure being decommissioned and abandoned or decommissioned and demolished. The contrasting approach is to reuse the site and its infrastructure, by repopulating the site with alternative industries and creating a symbiotic relationship between the industry, the public and the industrial heritage.

### (RE)INDUSTRIALISATION

In a post mining context, the industry that the infrastructure supported no longer exists. Therefore, the reason for the infrastructure to exist is also redundant. However, the infrastructure still holds value from a heritage and from a latent potential perspective.

The potential exists for alternative industry to reoccupy the infrastructure and once again give the infrastructure a purpose. Care needs to be taken to ensure the integrity of the industrial infrastructure from a heritage standpoint. Each industrial element needs to be evaluated on its merit as a heritage component and then the appropriate theoretical principle needs to be applied so as to enhance the usefulness and potential of each industrial element.

## INITIAL CONCEPTUAL DESIGN DEVELOPMENT

The initial design concept was to create a public square by developing a building on the south east edge of the site. The building was partially submerged in the landscape, and had a green roof.

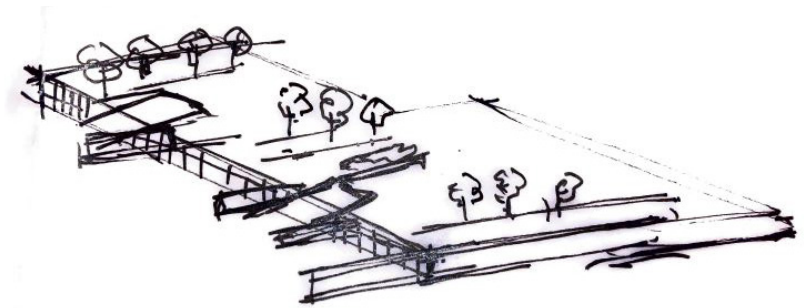


Figure 7.6 - Early conceptual sketch (Author 2018)

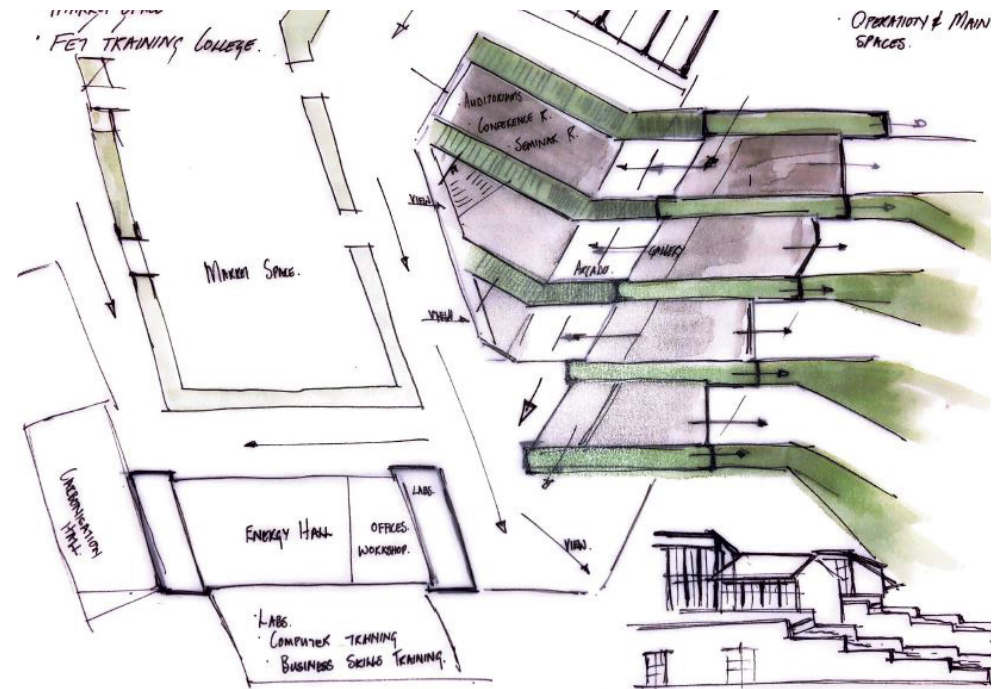


Figure 7.7 - Early conceptual sketch (Author 2018)

# DESIGN INTERTAION 001

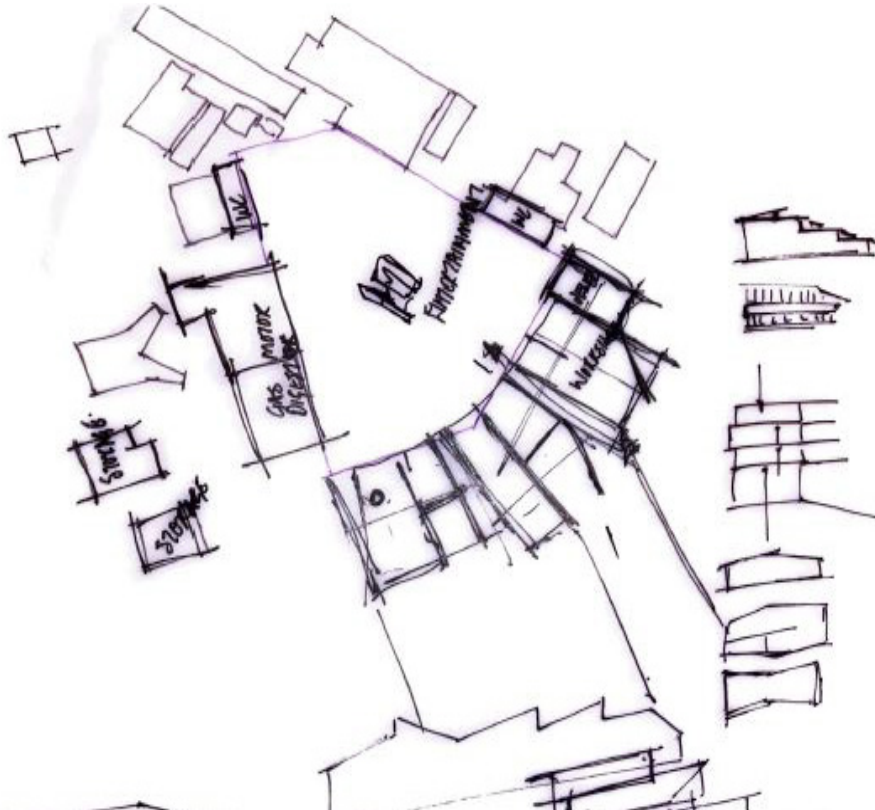


Figure 7.8 - Early conceptual sketch (Author 2018)

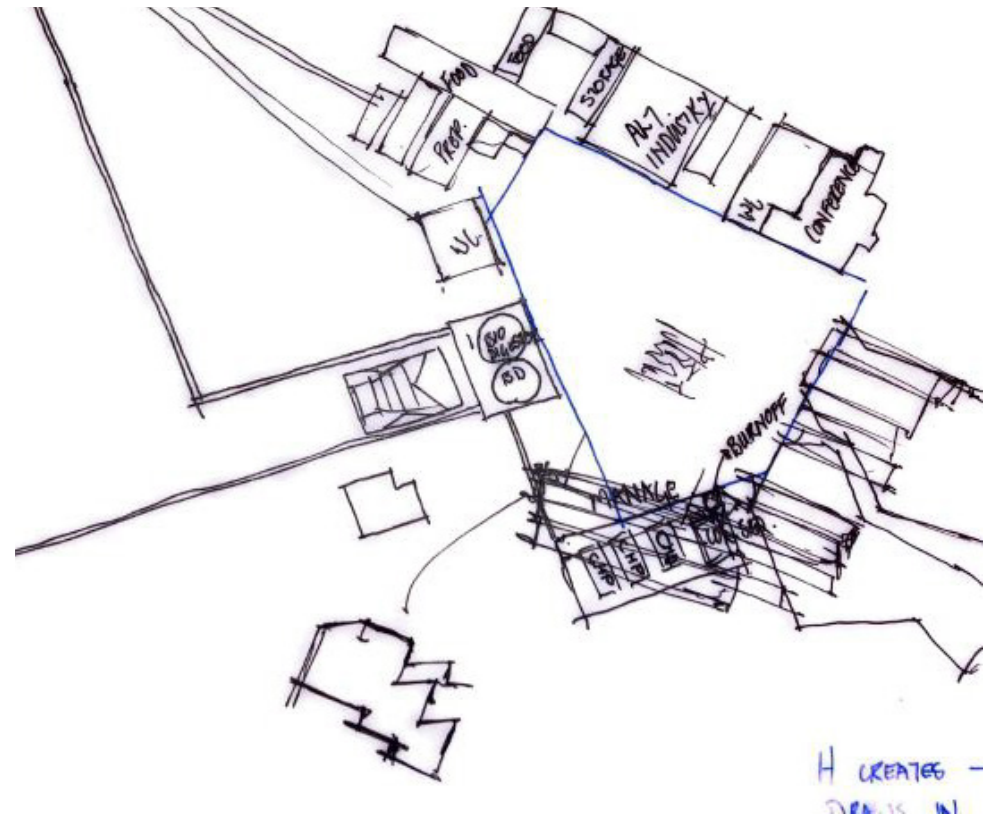


Figure 7.9 - Early conceptual sketch (Author 2018)

## DESIGN INTERTAION 001

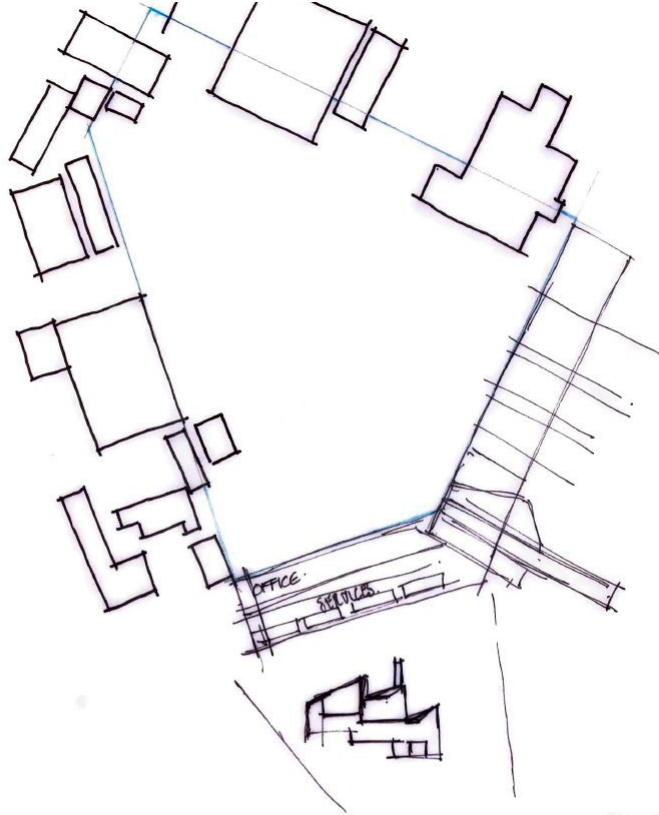


Figure 7.10 - Sketch showing development of public square (Author 2018)

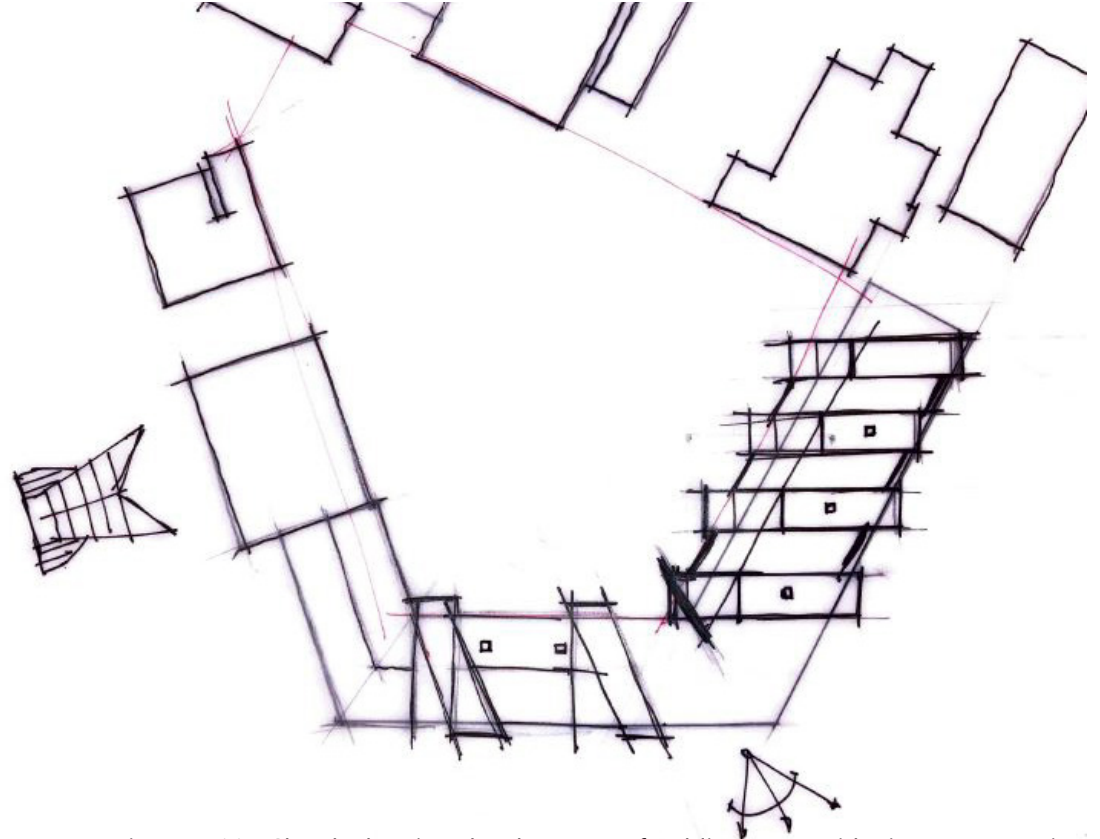


Figure 7.11 - Sketch showing development of public square with view to open pit (Author 2018)

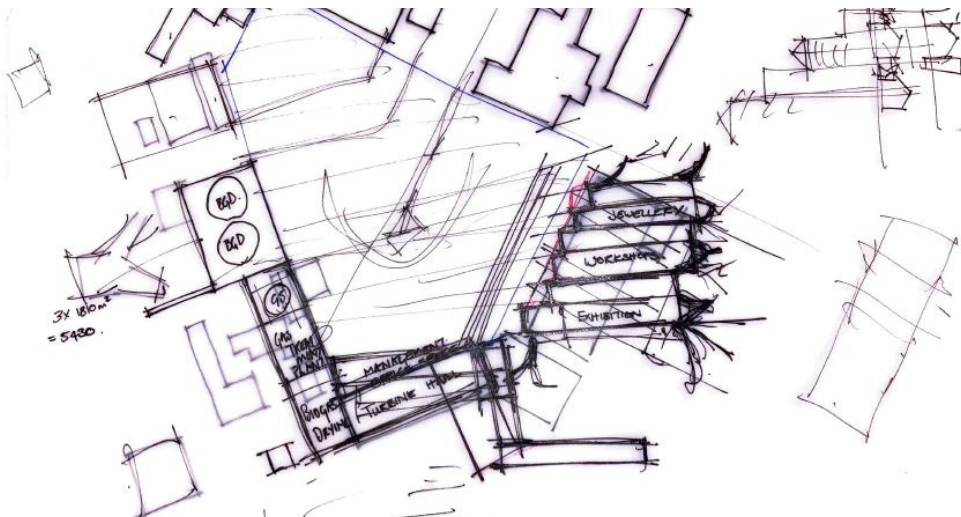


Figure 7.12 - Sketch showing the development of public square - staggered building (Author 2018)

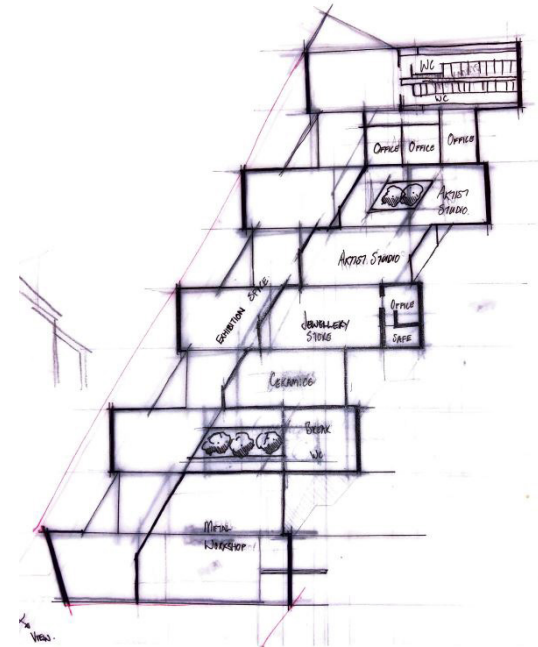


Figure 7.14 - Sketch showing the of the interior spaces of the staggered building (Author 2018)

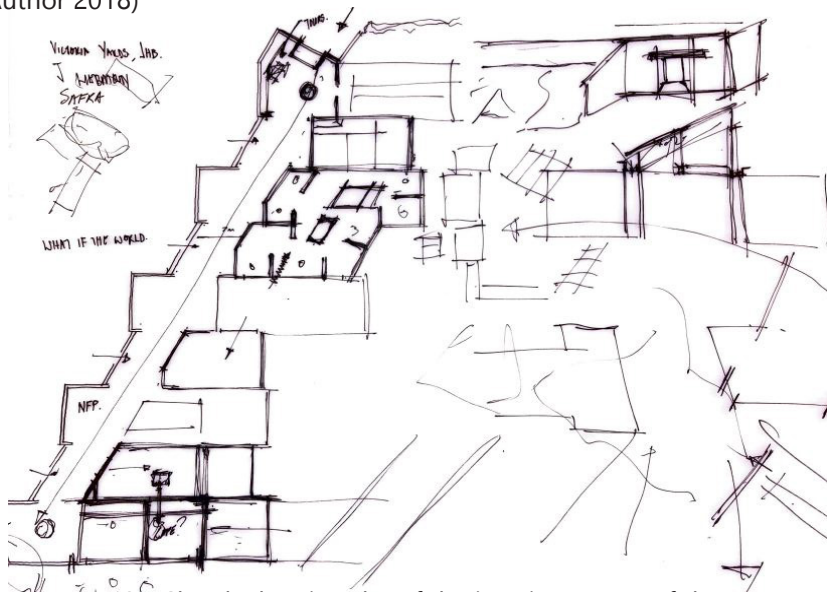


Figure 7.13 - Sketch showing the of the interior spaces of the staggered building (Author 2018)

## DESIGN INTERTAION 002

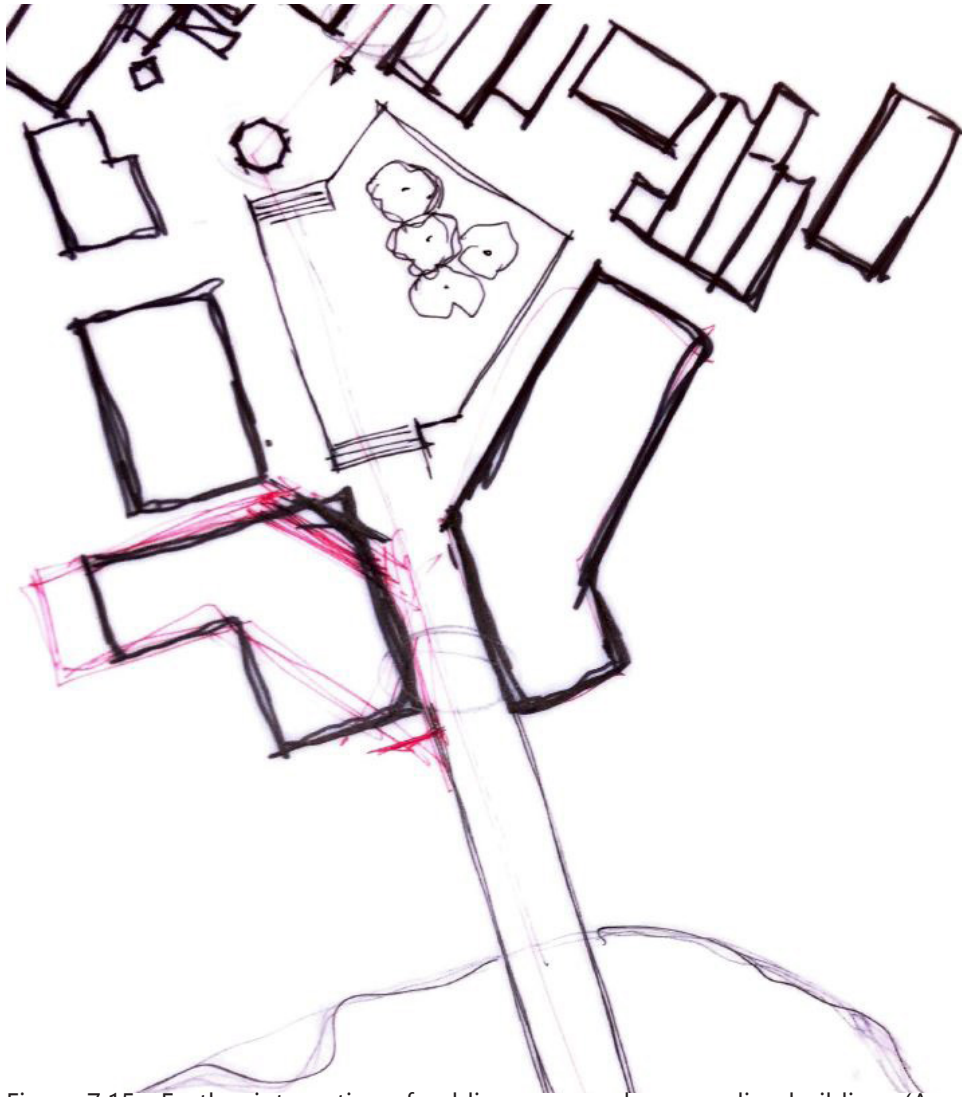


Figure 7.15 - Further integration of public square and surrounding buildings (Author 2018)

## DESIGN INTERAION 002

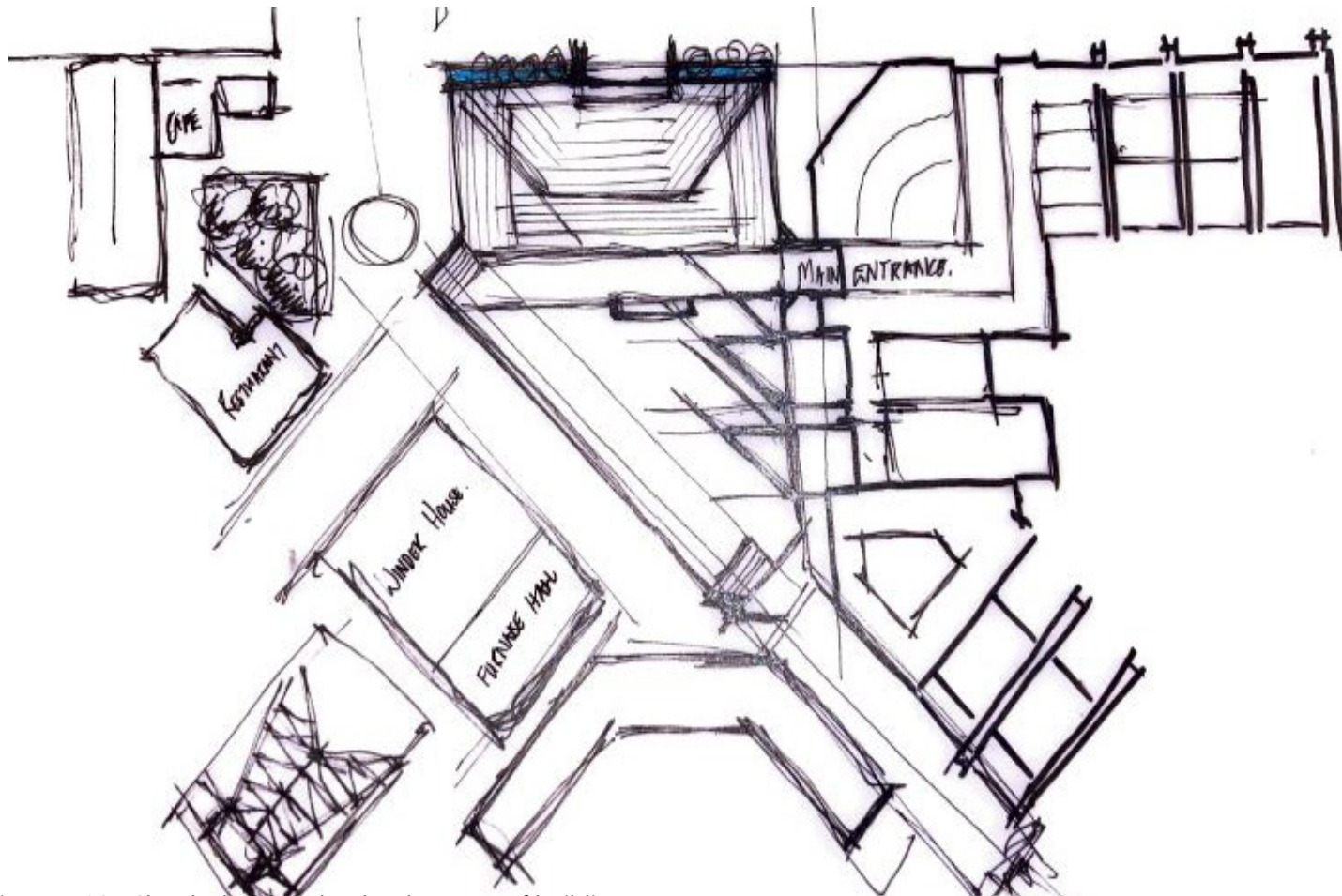


Figure 7.16 - Sketch showing the development of buildings  
(Author 2018)



# FINAL DESIGN - SITE PLAN

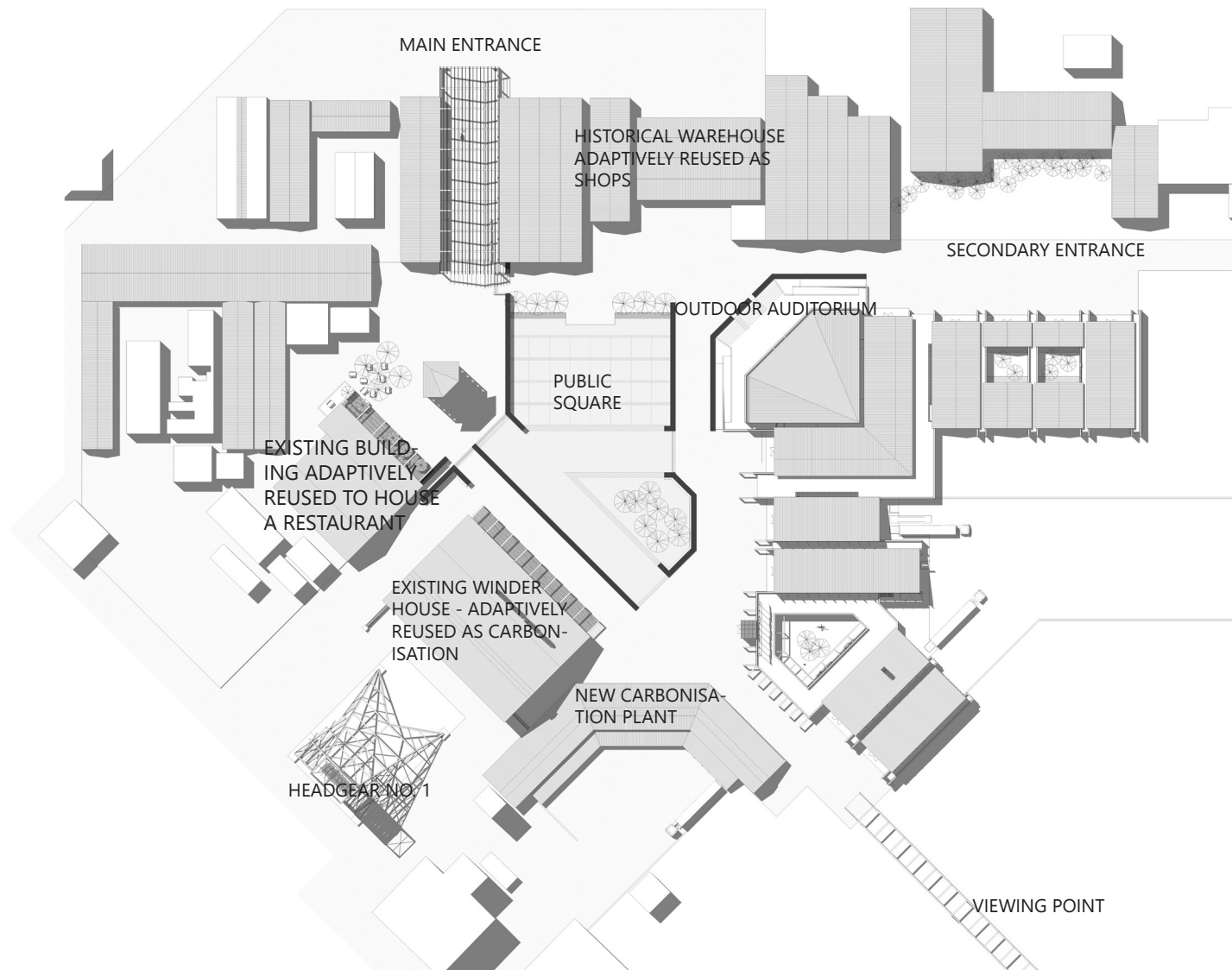


Figure 7.17 - Final Design Site Plan (Author 2018)



# CHAPTER 08 \\

## DESIGN AND TECHNICAL RESOLUTION



# DESIGN

## PLANS - SITE PLAN

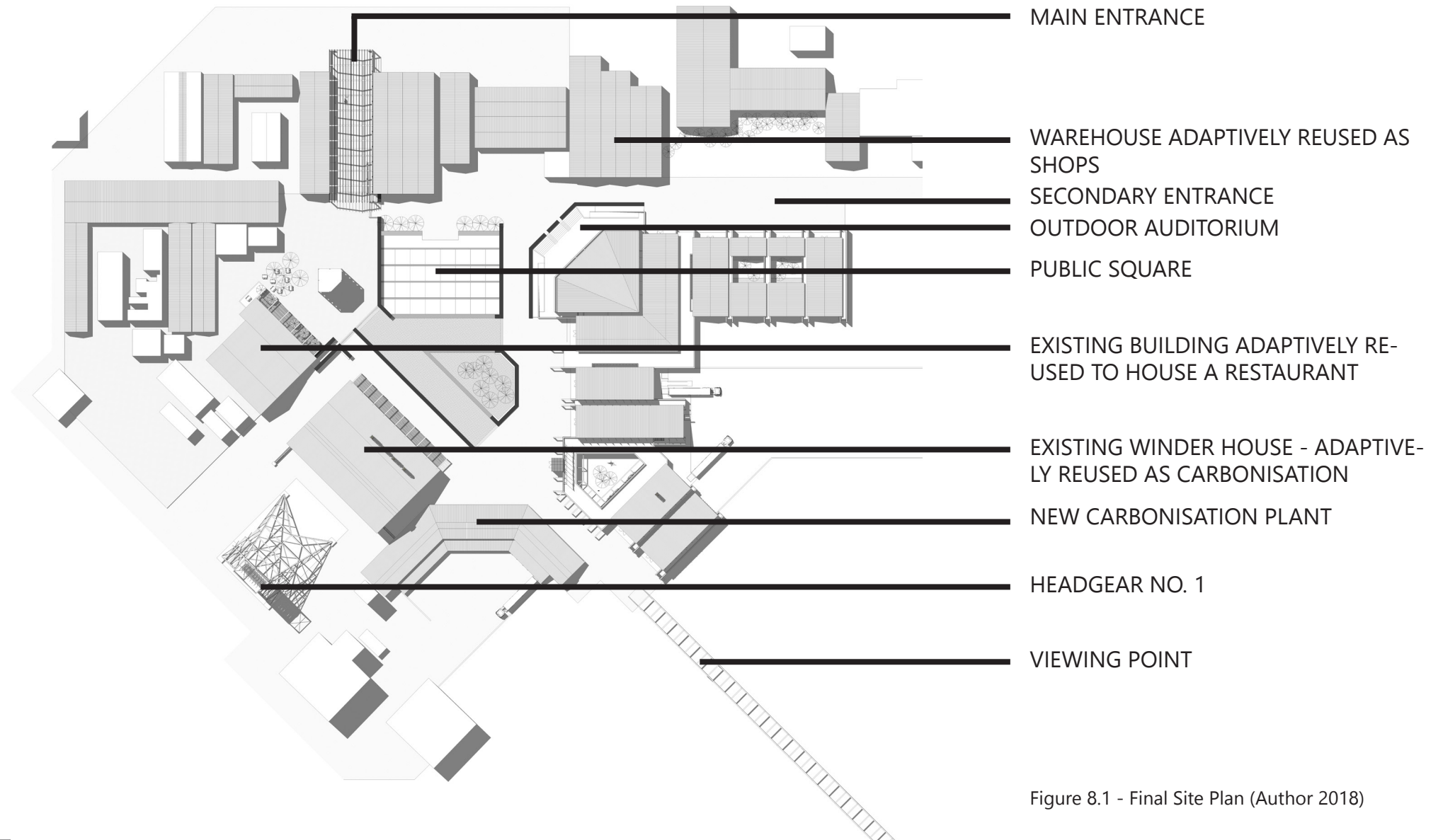


Figure 8.1 - Final Site Plan (Author 2018)

DESIGN  
PLANS

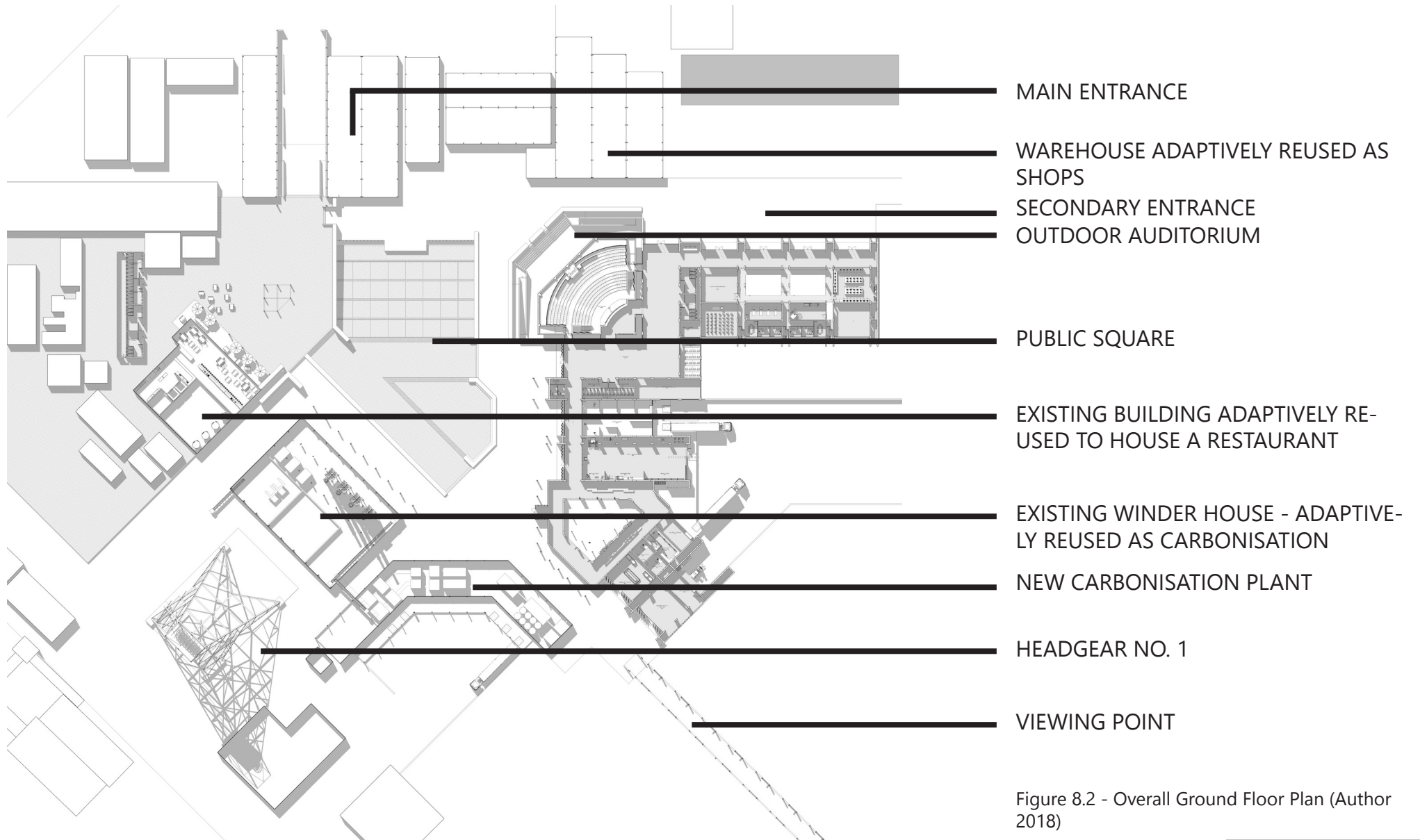
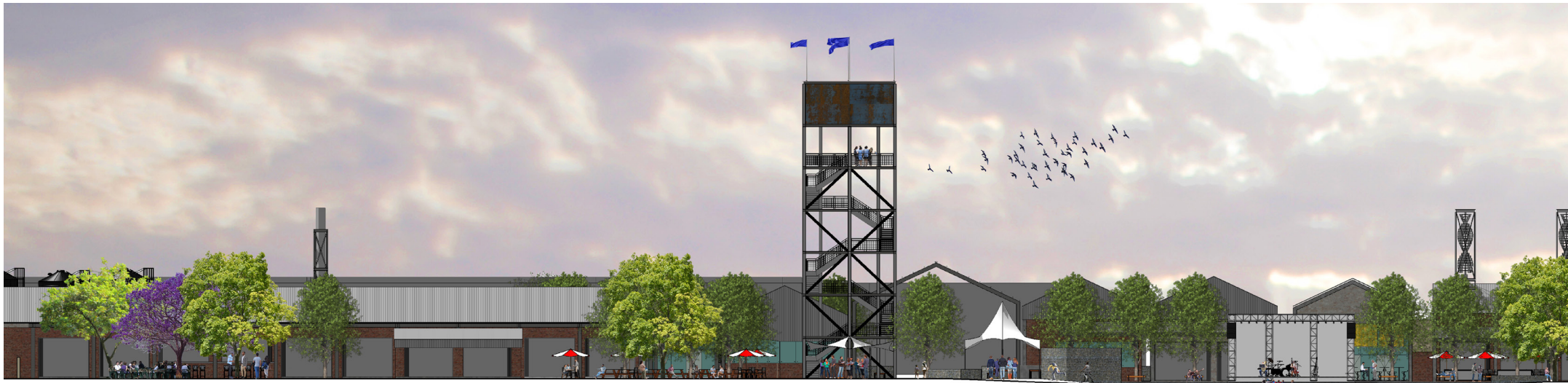
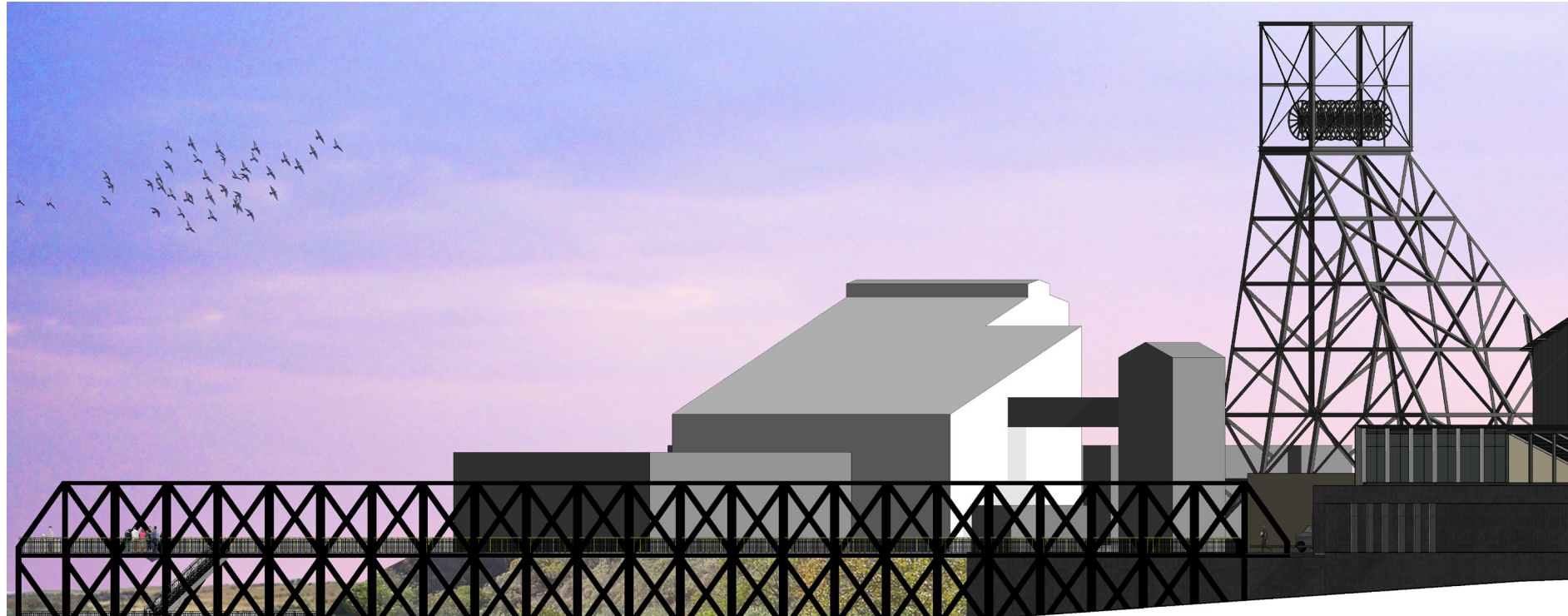


Figure 8.2 - Overall Ground Floor Plan (Author 2018)

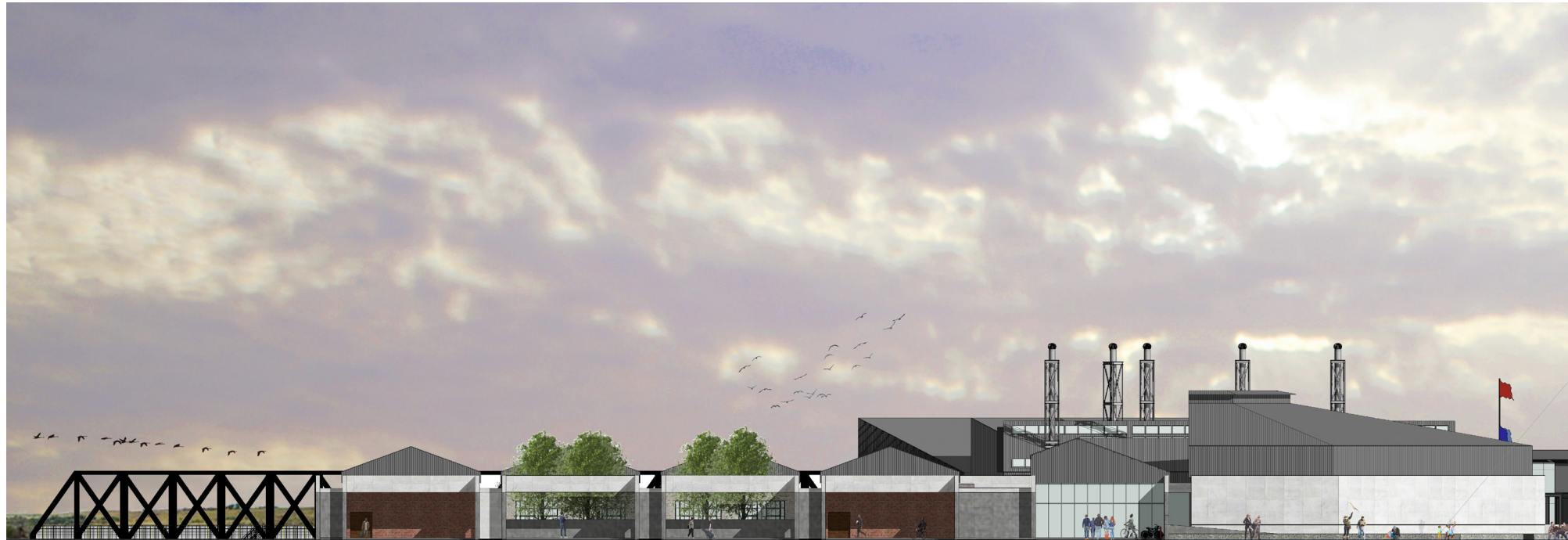


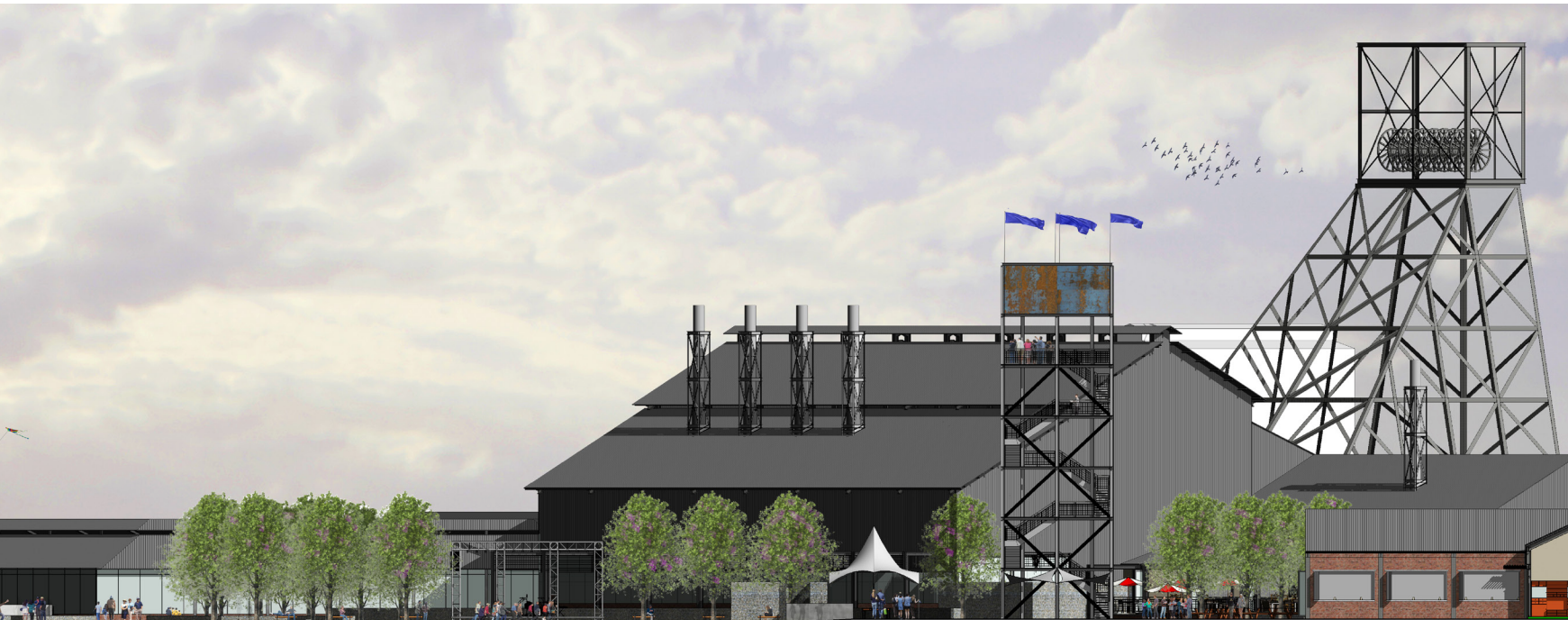












# DESIGN

## PLANS - GROUND FLOOR PLAN

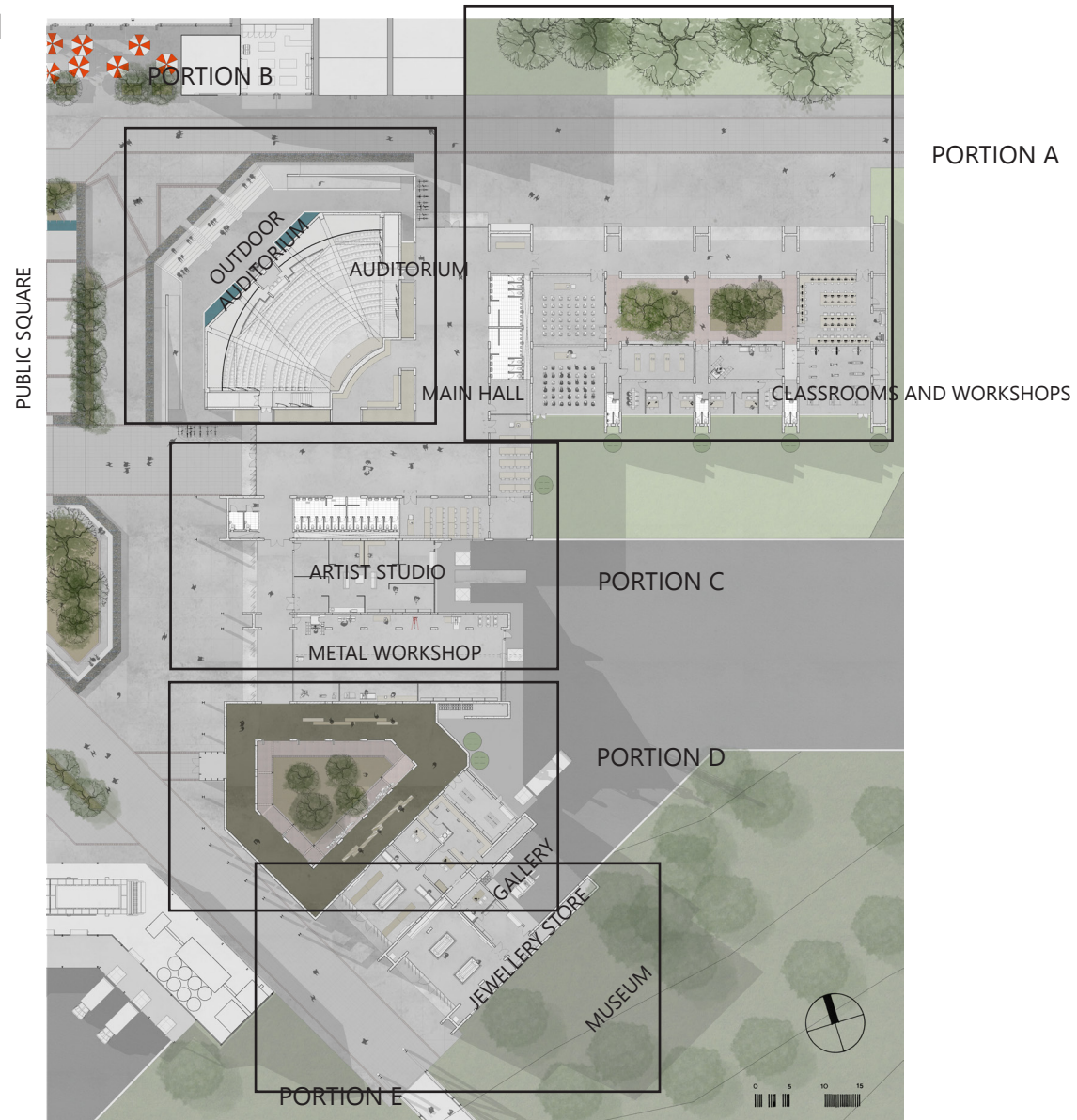


Figure 8.3 - Ground Floor Plan (Author 2018)

# DESIGN

## PLANS - GROUND FLOOR PLAN - PORTION A



Figure 8.4 - Portion of Ground Floor Plan - Portion A (Author 2018)

# DESIGN

## PLANS - GROUND FLOOR PLAN - PORTION B

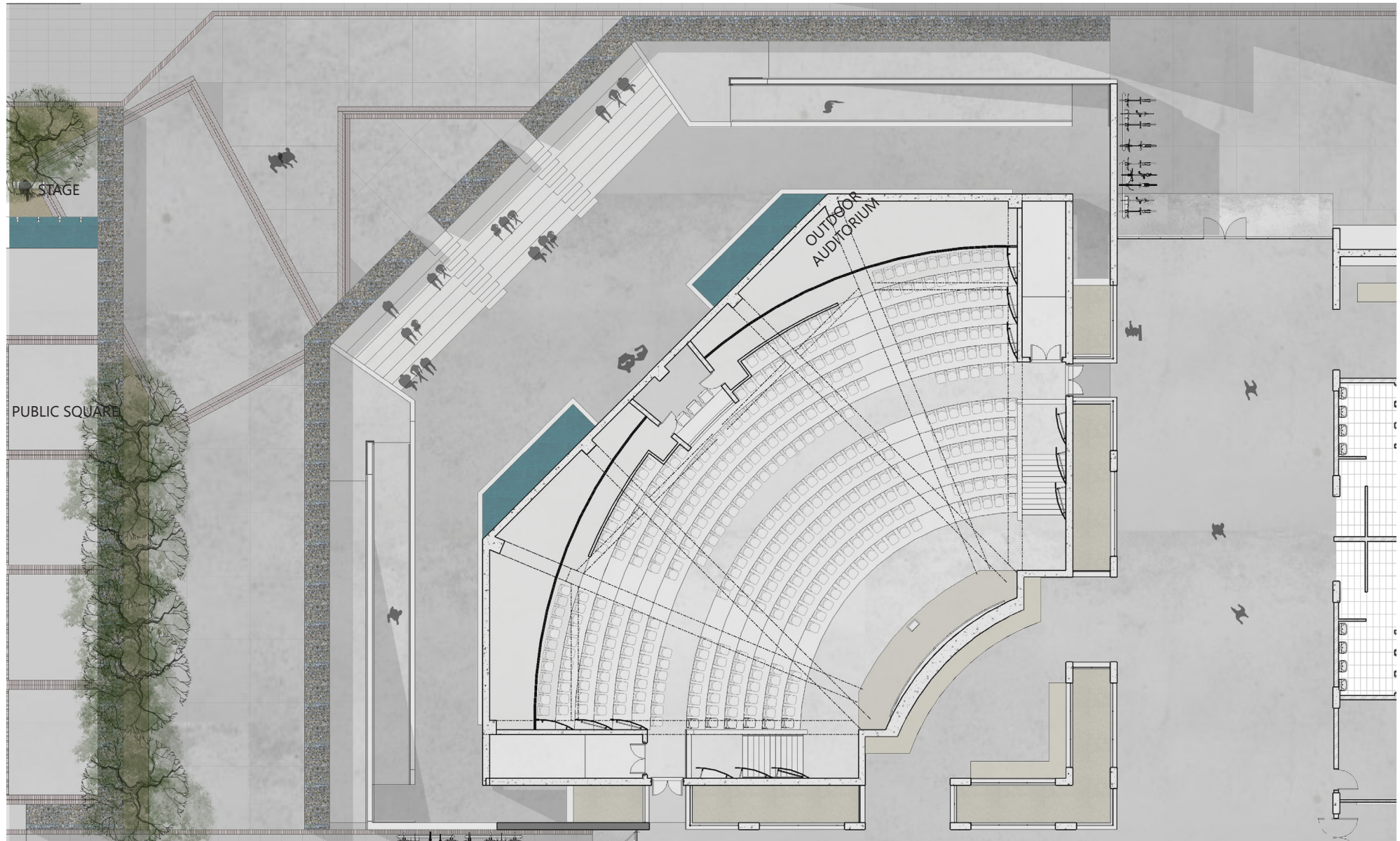


Figure 8.5 - Portion of Ground Floor Plan - Portion B (Author 2018)

10m

# DESIGN

## PLANS - GROUND FLOOR PLAN - PORTION C

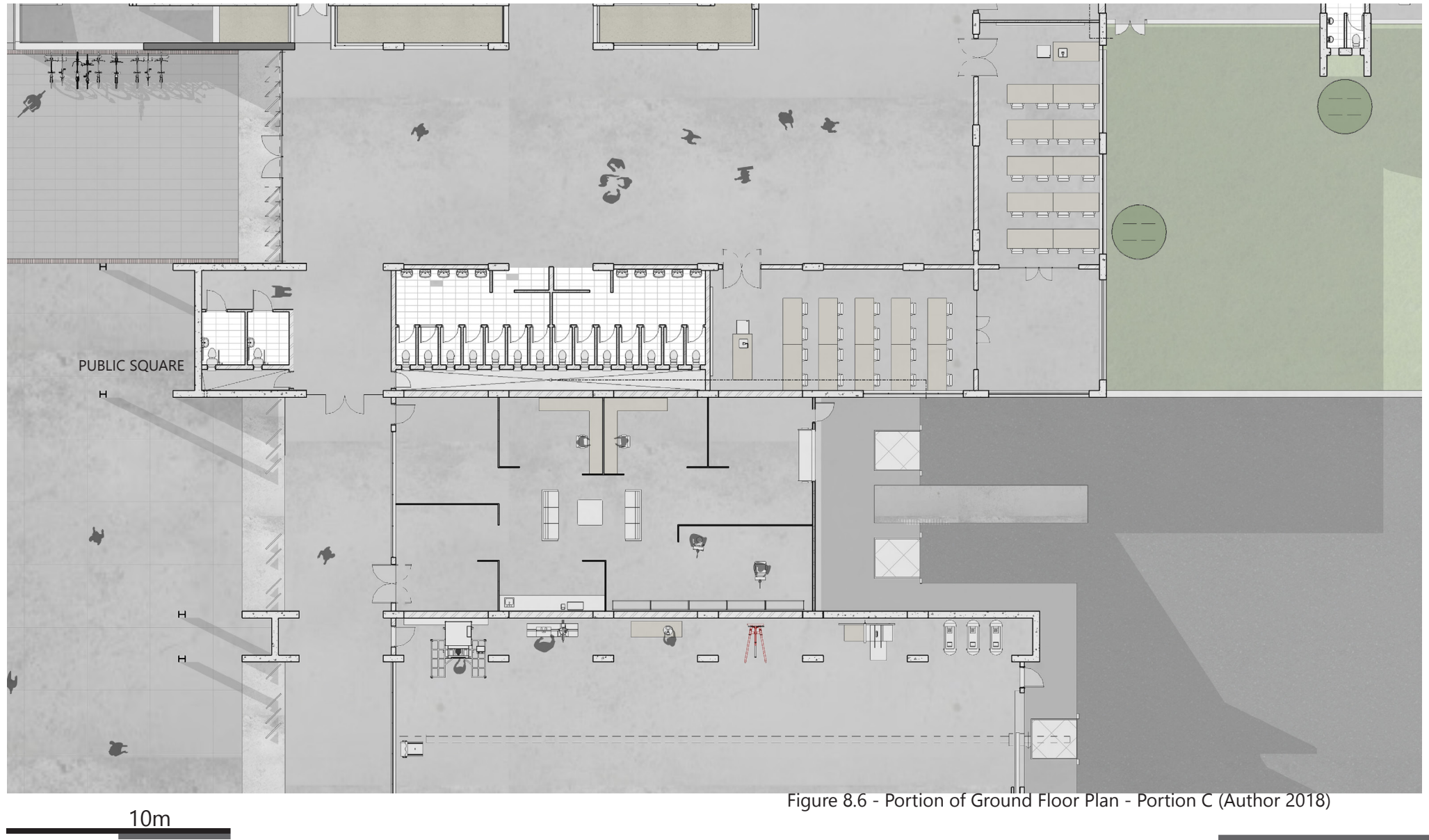


Figure 8.6 - Portion of Ground Floor Plan - Portion C (Author 2018)



DESIGN

PLANS - GROUND FLOOR PLAN - PORTION D

10m

Figure 8.7 - Portion of Ground Floor Plan - Portion D (Author 2018)





DESIGN

PLANS - GROUND FLOOR PLAN - PORTION E

10m

## TECHNICAL RESOLUTION

### INTRODUCTION

The post-industrial fabric of Cullinan consists of the industrial heritage structures and the landscape. There is a disconnection between these structures and the resultant state of the natural landscape. The technology that is used in industrial architecture is simple and precise, it is not overly complicated and is easy and fast to construct. As was the necessity of the industrial revolution. The technical resolution of the proposed development will follow the same principles albeit with modern variations.

### TECTONIC CONCEPT

The tectonic concept that has developed as a result of the architectural intentions and programmatic informants is uncomplicated and relies heavily on the existing tectonics of the surrounding infrastructure. The key element of industrial architecture is the portal frame. The intention of the tectonic concept is to replicate the simplicity of the structure whilst adapting it to best suit the programmes of the proposed new industry. Because the majority of the materials utilised, in the construction of the new and adaption of the existing buildings, are recycled, disassembled and reassembled in a different configuration, the tectonics of the existing and the tectonics of the new remain similar. The bolted connections of the steel structural elements remain a central theme of the construction, as does the way in which steel is connected to concrete. The concrete structure however has been modified to form a conduit for the building's services.

## DETAIL DEVELOPMENT

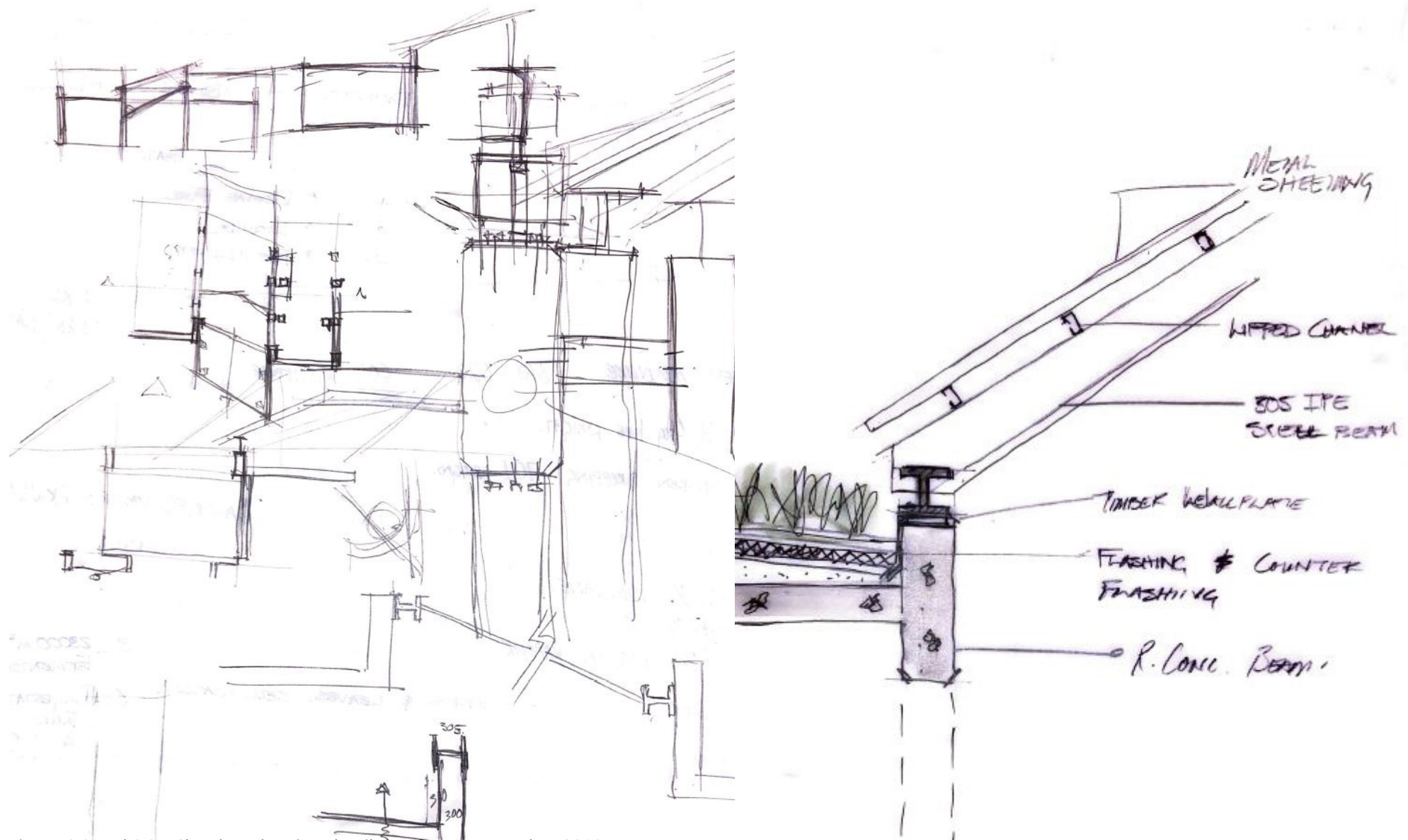


Figure 8.8 and 8.9 - Sketches showing detail development (Author 2018)

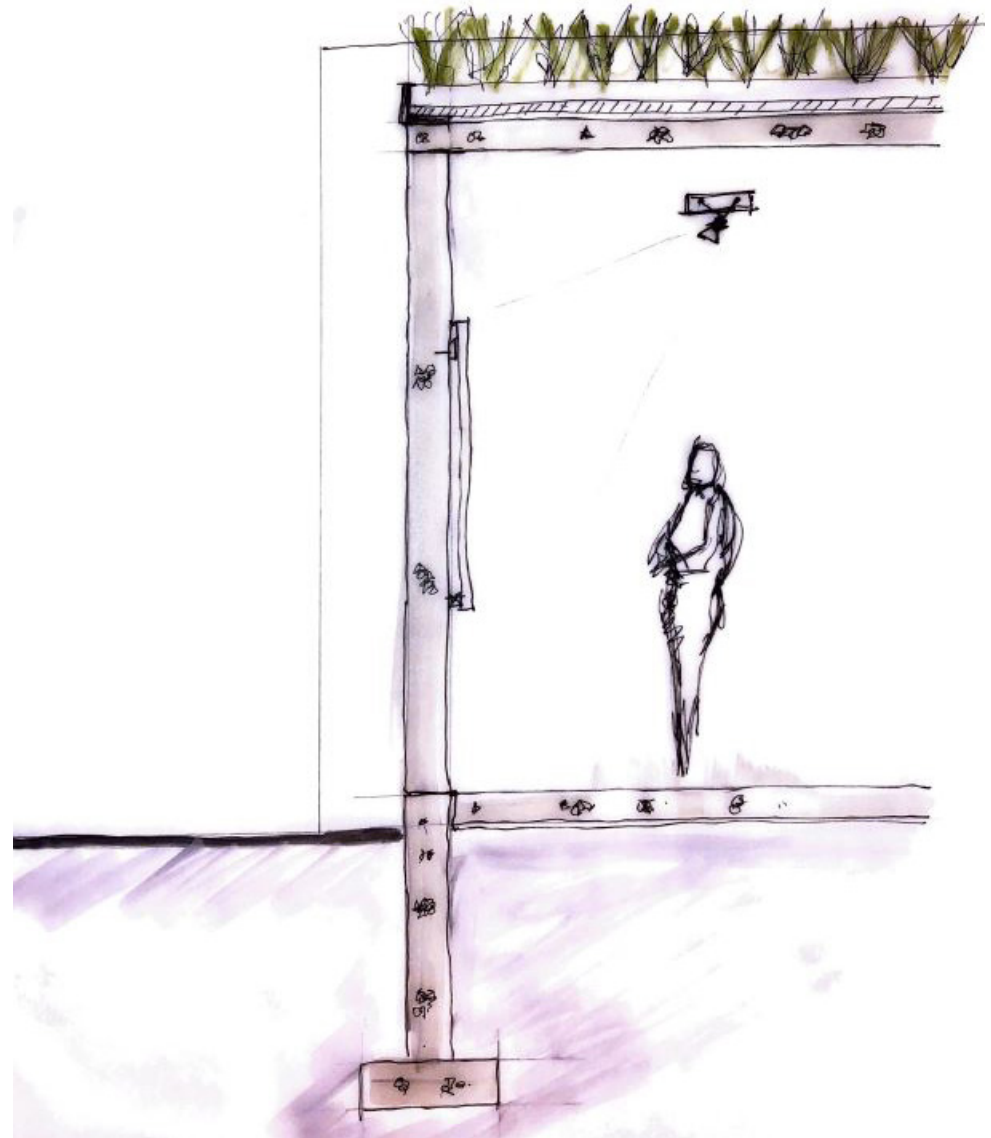
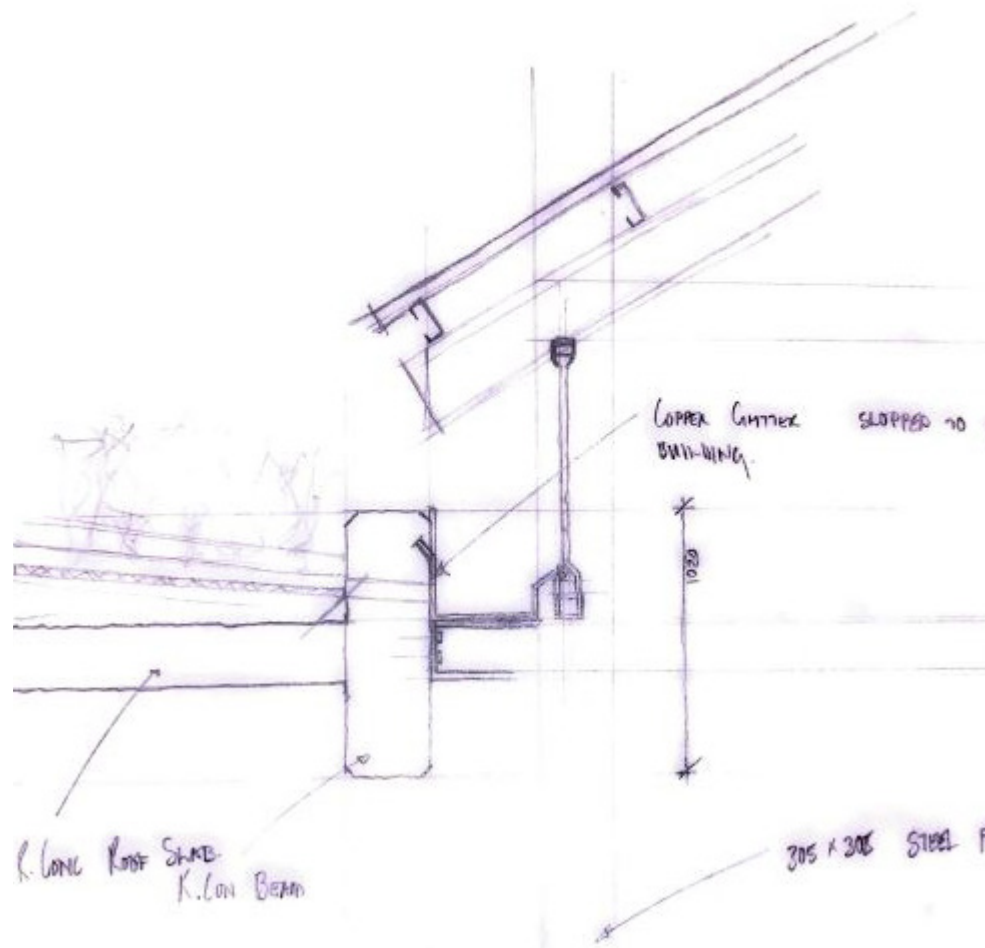


Figure 8.10 and 8.11 - Sketches showing detail development (Author 2018)

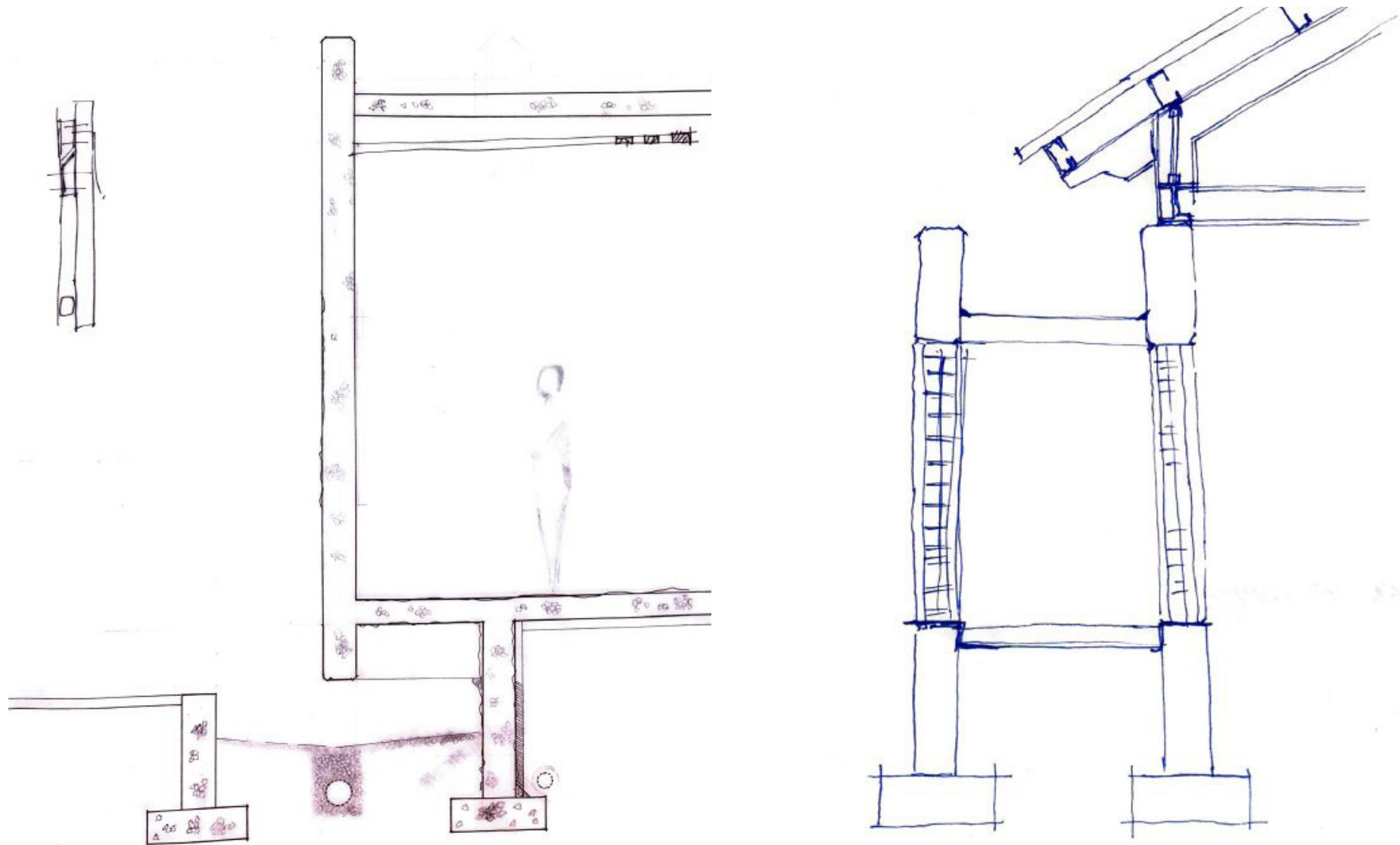


Figure 8.12 and 8.13 - Sketches showing detail development (Author 2018)

# SECTION A-A

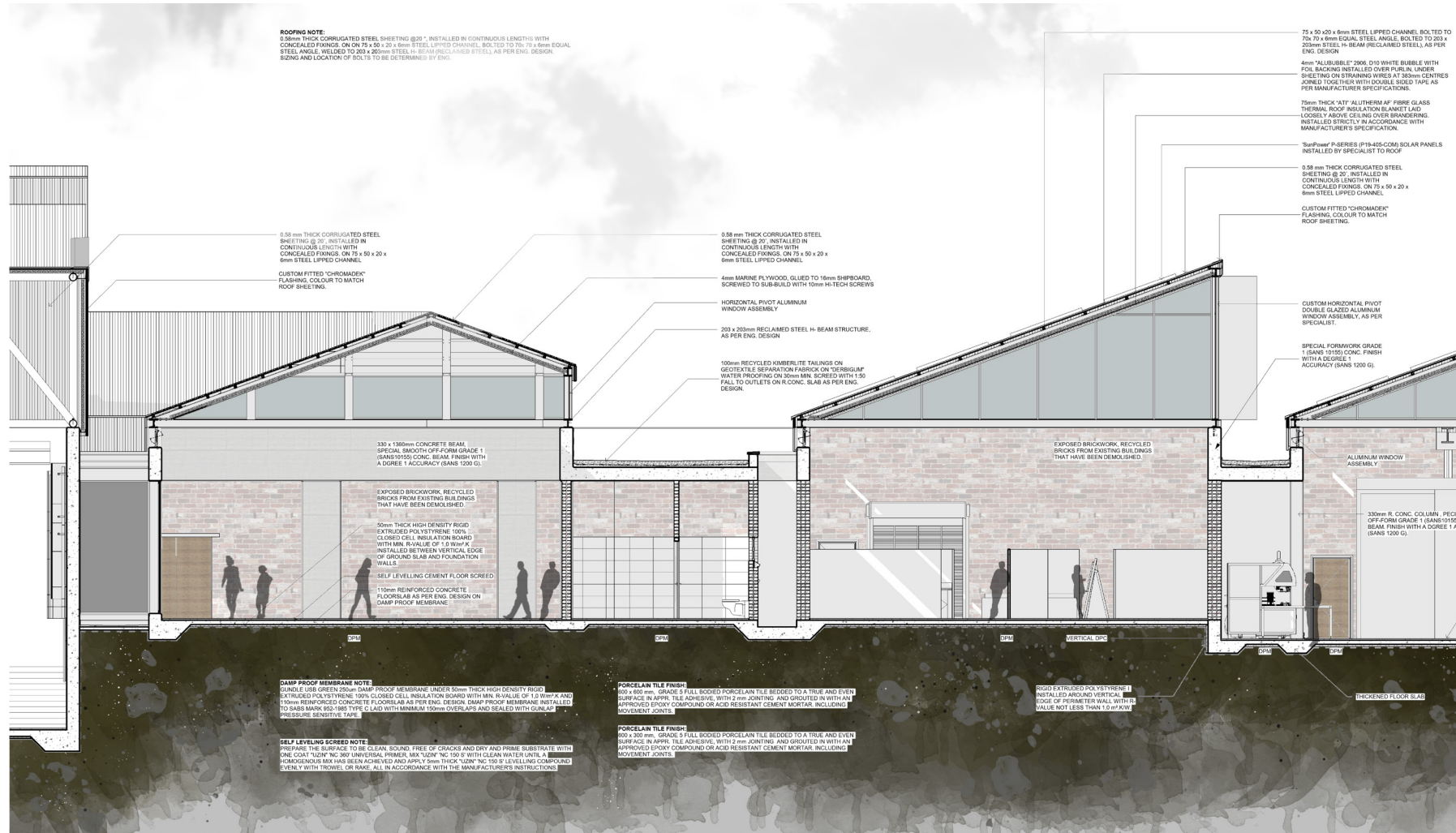
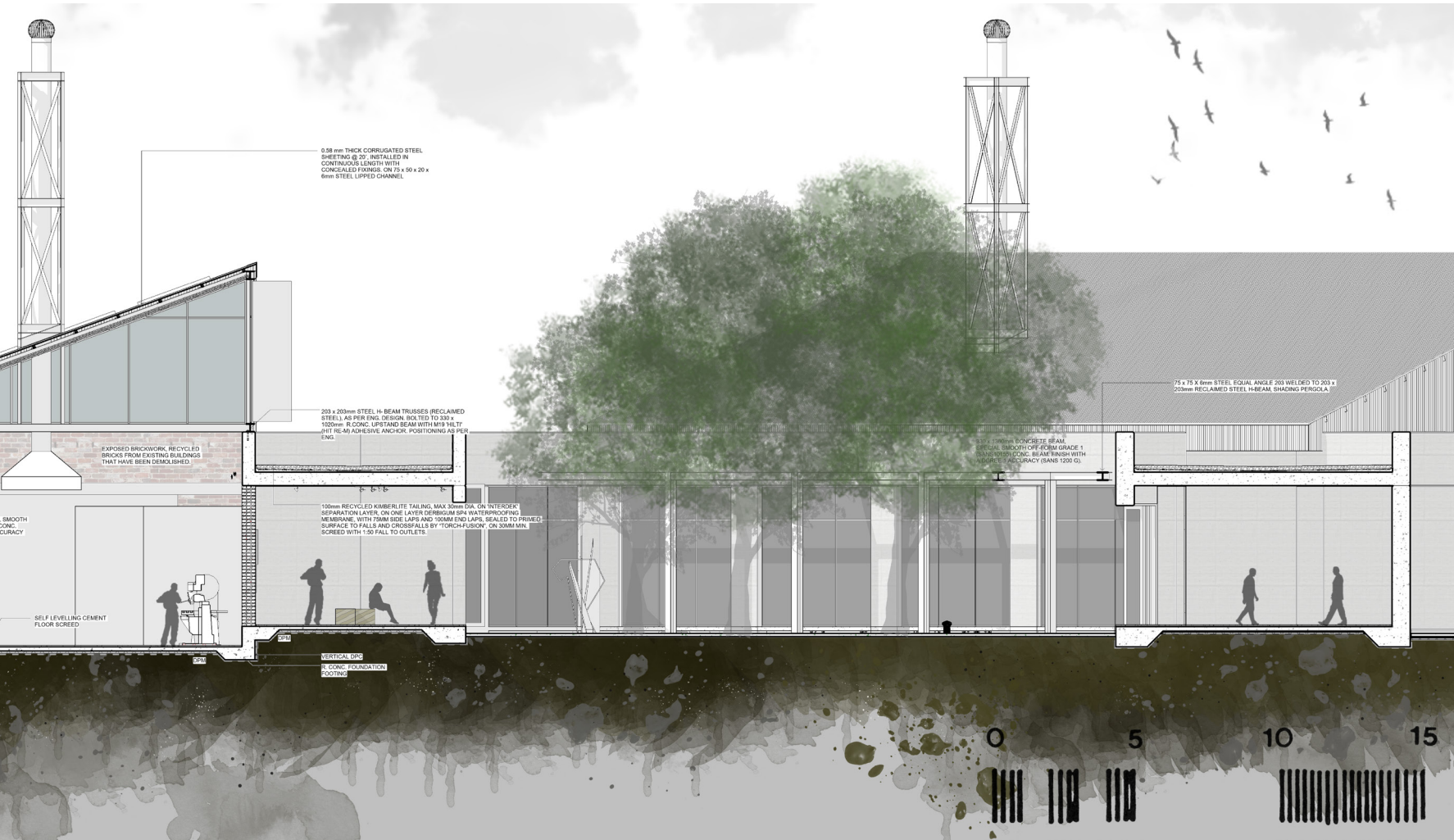


Figure 8.14 - Section A-A (Author 2018)



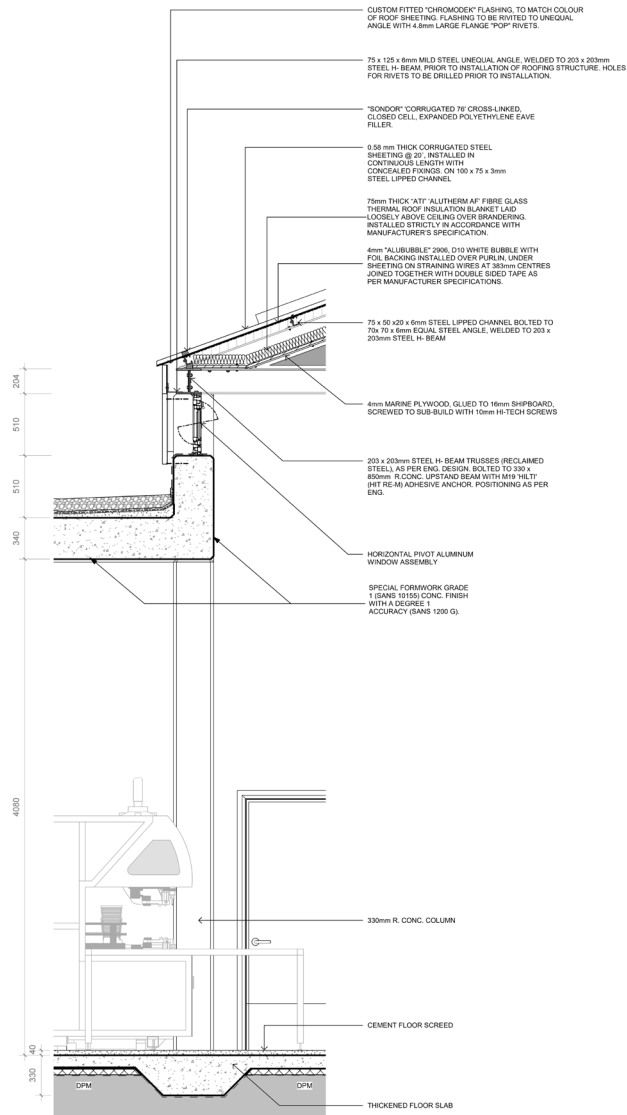


Figure 8.15 - Section A-A - Detail 1 (Author 2018)

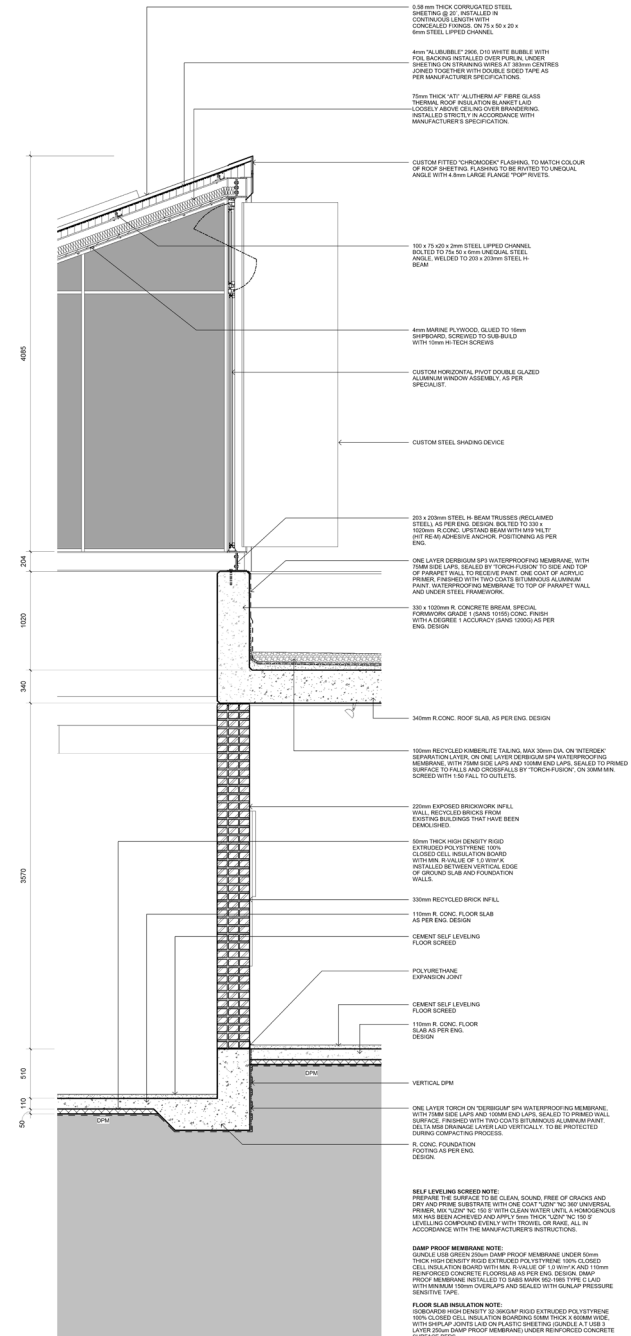


Figure 8.16 - Section A-A - Detail 2 (Author 2018)



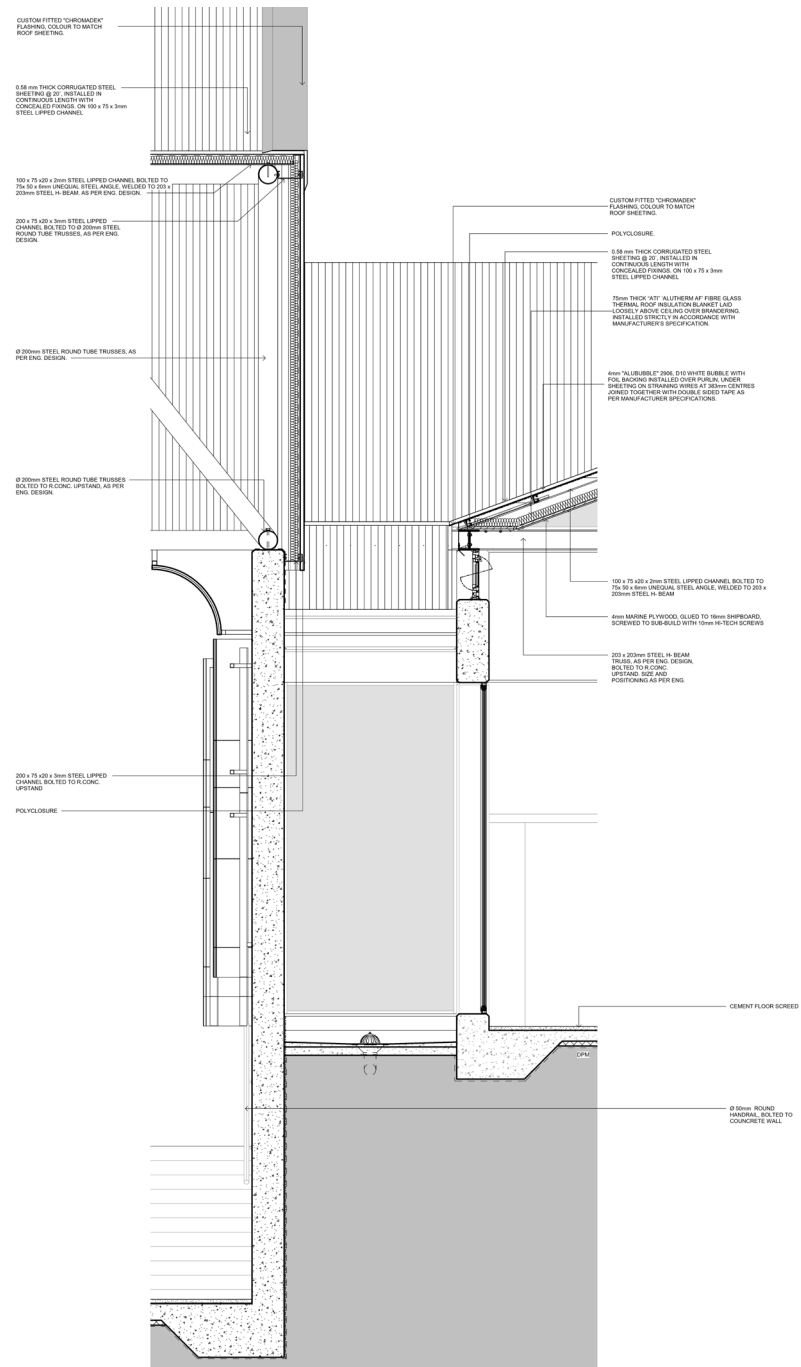


Figure 8.17 - Section A-A - Detail 3 (Author 2018)

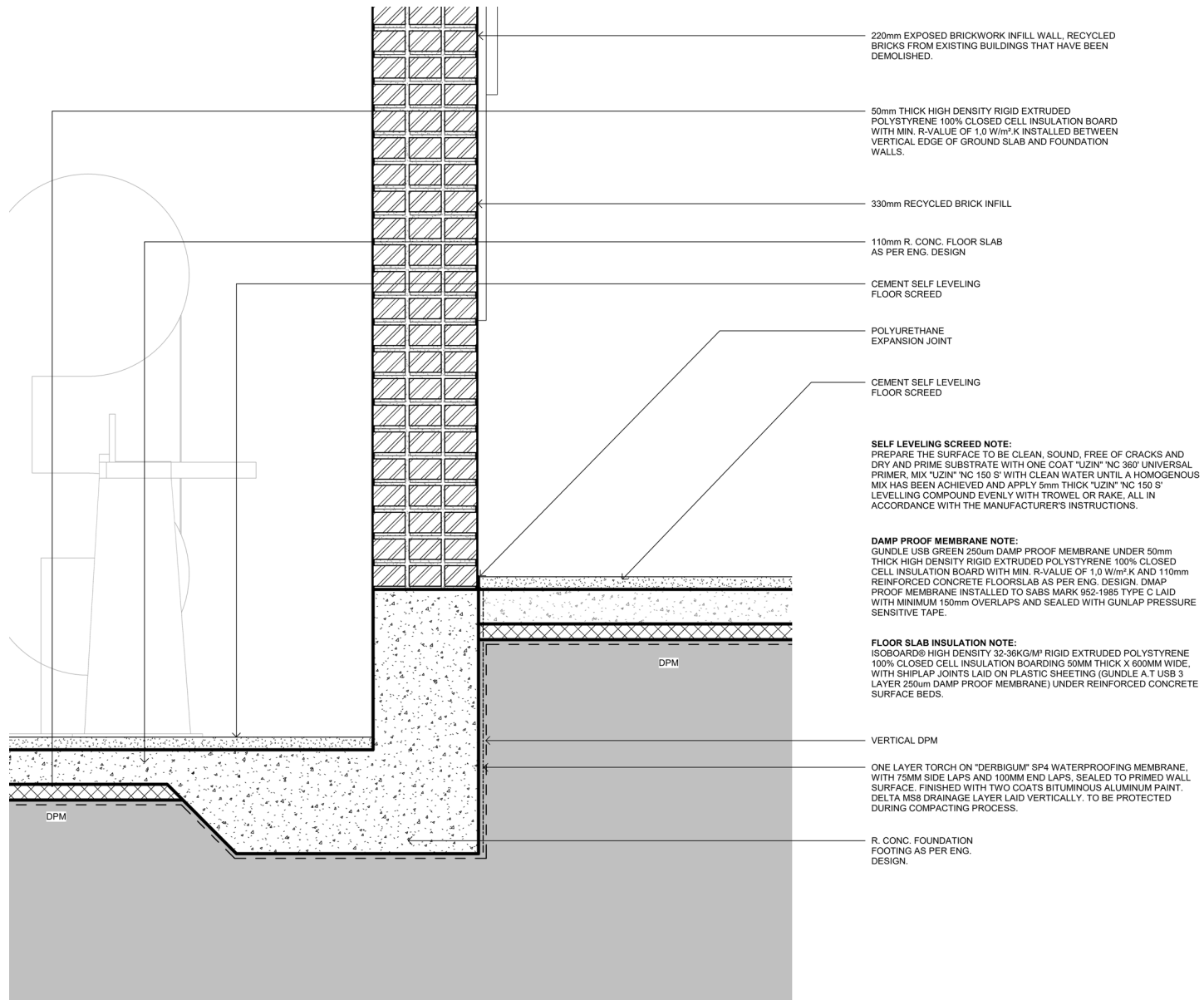


Figure 8.15 - Section A-A - Detail 1-3 (Author 2018)

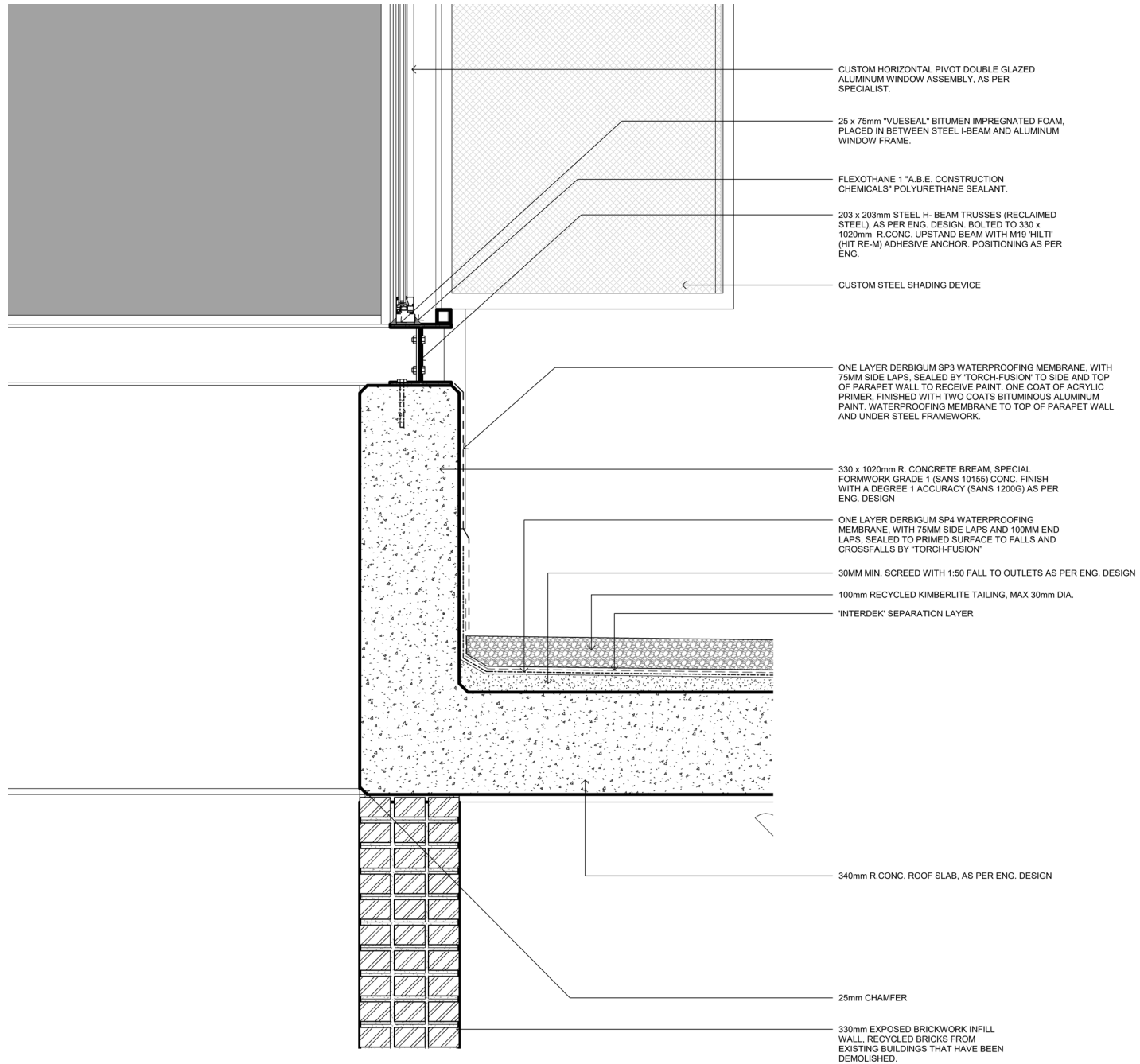


Figure 8.16 - Section A-A - Detail 1-2 (Author 2018)



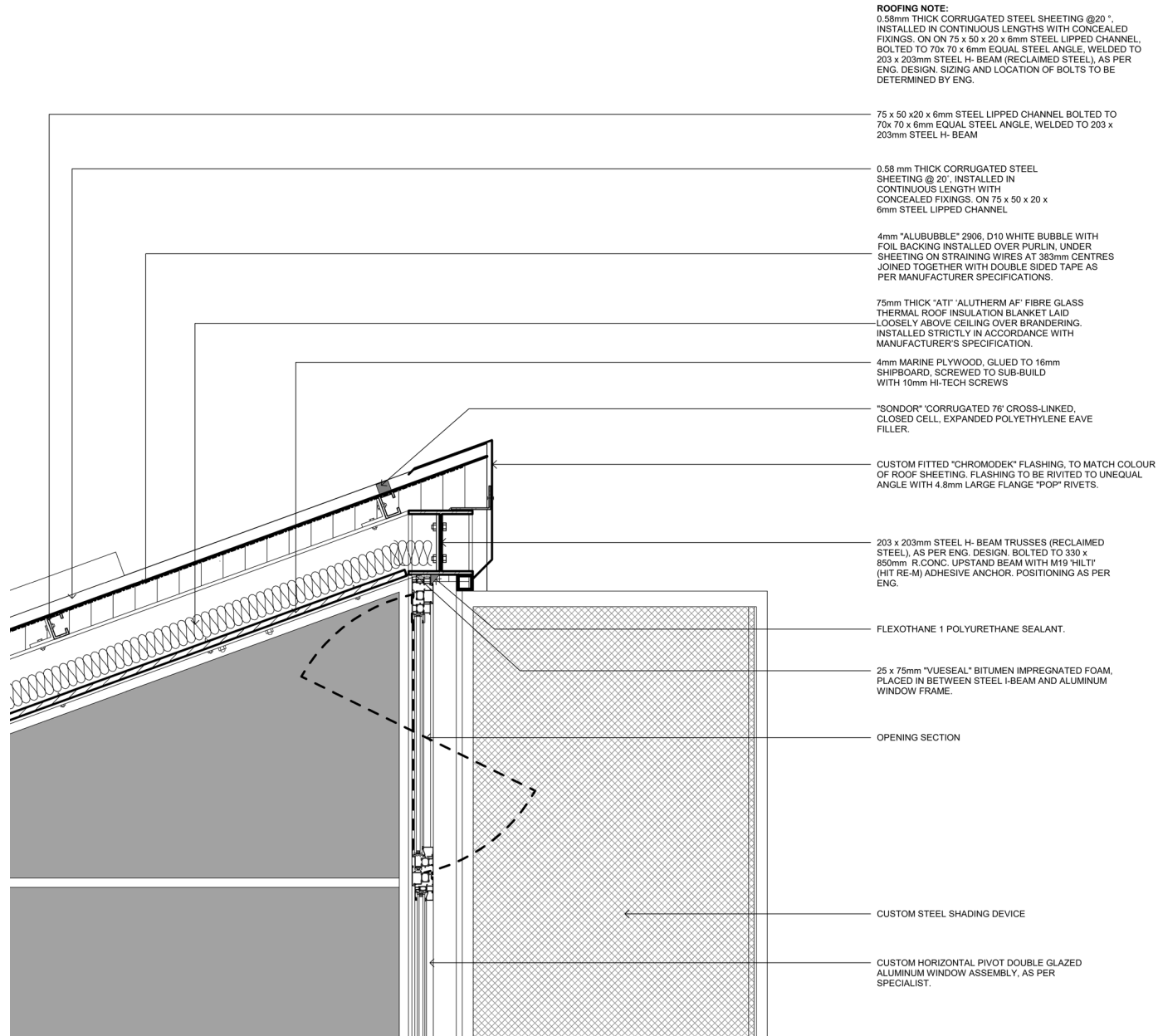


Figure 8.17 - Section A-A - Detail 1-1 (Author 2018)

# SECTION B-B

**ROOFING NOTE:**  
0.58mm THICK CORRUGATED STEEL SHEETING @20°, INSTALLED IN CONTINUOUS LENGTHS WITH CONCEALED FIXINGS, ON 75 x 50 x 20 x 6mm STEEL LIPPED CHANNEL BOLTED TO 70 x 70 x 6mm EQUAL STEEL ANGLE, WELDED TO 203 x 203mm STEEL H-BEAM (RECLAIMED STEEL), AS PER ENG. DESIGN. SIZING AND LOCATION OF BOLTS TO BE DETERMINED BY ENG.

0.58mm M.S. FLASHING 'CHROMADEK' FINISH COLOUR TO MATCH ROOF SHEETING

CUSTOM FITTED STEEL RIDGE FLASHING, COLOUR TO MATCH ROOF SHEETING, TO BE FITTED BY SPECIALIST.

100mm RECYCLED KIMBERLITE TAILINGS ON GEOTEXTILE SEPARATION FABRIC ON 'DERBIGUM' WATER PROOFING ON 30mm MIN. SCREED WITH 1:50 FALL TO OUTLETS ON R.CONC. SLAB AS PER ENG. DESIGN.

100mm RECYCLED KIMBERLITE TAILINGS ON GEOTEXTILE SEPARATION FABRIC ON 'DERBIGUM' WATER PROOFING ON 30mm MIN. SCREED WITH 1:50 FALL TO OUTLETS ON R.CONC. SLAB AS PER ENG. DESIGN.

0.58 mm THICK CORRUGATED STEEL SHEETING @ 20° INSTALLED IN CONTINUOUS LENGTH WITH CONCEALED FIXINGS, ON 100 x 75 x 3mm STEEL LIPPED CHANNEL.

100mm RECYCLED KIMBERLITE TAILINGS ON GEOTEXTILE SEPARATION FABRIC ON 'DERBIGUM' WATER PROOFING ON 30mm MIN. SCREED WITH 1:50 FALL TO OUTLETS ON R.CONC. SLAB AS PER ENG. DESIGN.

220mm EXPOSED BRICKWORK INFILL WALL, RECYCLED BRICKS FROM EXISTING BUILDINGS THAT HAVE BEEN DEMOLISHED.

EXPOSED BRICKWORK WALL, RECYCLED BRICKS FROM EXISTING BUILDINGS THAT HAVE BEEN DEMOLISHED. BAGWASHED FINISH

330mm R. CONC. COLUMN AS PER ENG. DESIGN.

330mm R. CONC. WALL AS PER ENG. DESIGN.

SOIL BACKFILL, COMPACTED IN LAYERS OF 150 MM LAYERS (MECHANICAL COMPACTION), TO A DENSITY OF AT LEAST 95% MDD (ASHFITO), AS PER ENG. DESIGN.

KIMBERLITE TAILING BACKFILL

ONE LAYER TORCH ON 'DERBIGUM' SPM WATERPROOFING MEMBRANE, WITH 75MM SIDE LAPs AND 100MM END LAPs. SEALED TO PRIMED WALL SURFACE, FINISHED WITH TWO COATS BITUMINOUS ALUMINUM PAINT. DELTA M88 DRAINAGE LAYER LAID VERTICALLY, TO BE PROTECTED DURING COMPACTING PROCESS.

150mm Ø POROUS GEOPPE LAID INTO SMOOTH PEBBLE BED WITH MAX 25mm Ø PEBBLES WRAPPED IN 2 LAYERS OF POLYESTER GEOTEXTILE TO PREVENT CLOGGING BY KIMBERLITE TAILINGS

WEEP HOLE TO OUTSIDE

**SELF LEVELING SCREED NOTE:**  
PREPARE THE SURFACE TO BE CLEAN, SOUND, FREE OF CRACKS AND DRY AND PRIME SUBSTRATE WITH ONE COAT 'UZIN' NC 389 UNIVERSAL PRIMER, MIX 'UZIN' NC 150 S' WITH CLEAN WATER UNTIL A HOMOGENEOUS MIX HAS BEEN ACHIEVED AND APPLY 5mm THICK 'UZIN' NC 150 S' LEVELING COMPOUND EVENLY WITH TROWEL OR RAKE, ALL IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.

**DAMP PROOF MEMBRANE NOTE:**  
GUNLIE USE GREEN 250mm DAMP PROOF MEMBRANE UNDER 50mm THICK HIGH DENSITY RIGID EXTRUDED POLYSTYRENE 100% CLOSED CELL INSULATION BOARD WITH MIN. R-VALUE OF 1.0 W/m²K AND 10mm REINFORCED CONCRETE FLOOR SLAB AS PER ENG. DESIGN. DAMP PROOF MEMBRANE INSTALLED TO SABS MARK 962/1985 TYPE CLASS WITH MINIMUM 150mm OVERLAPS AND SEALED WITH GUNLAP PRESSURE SENSITIVE TAPE.

RIGID EXTRUDED POLYSTYRENE INSTALLED AROUND VERTICAL EDGE OF PERIMETER WALL WITH ITS VALUE NOT LESS THAN 1.0m²/WK

RECYCLED BRICK PAVERS: SIZE 220 x 110 x 65mm THICK LAID WITH A MINIMUM LONGITUDINAL FALL OF 1% ON A TRANSVERSE FALL OF AT LEAST 2% ON 50mm COMPACTED SAND BED WITH FINE JOINTING SAND SWEEP AND VIBRATED INTO JOINTS. END BRICK TO BE LAID IN CONCRETE FOOTING.

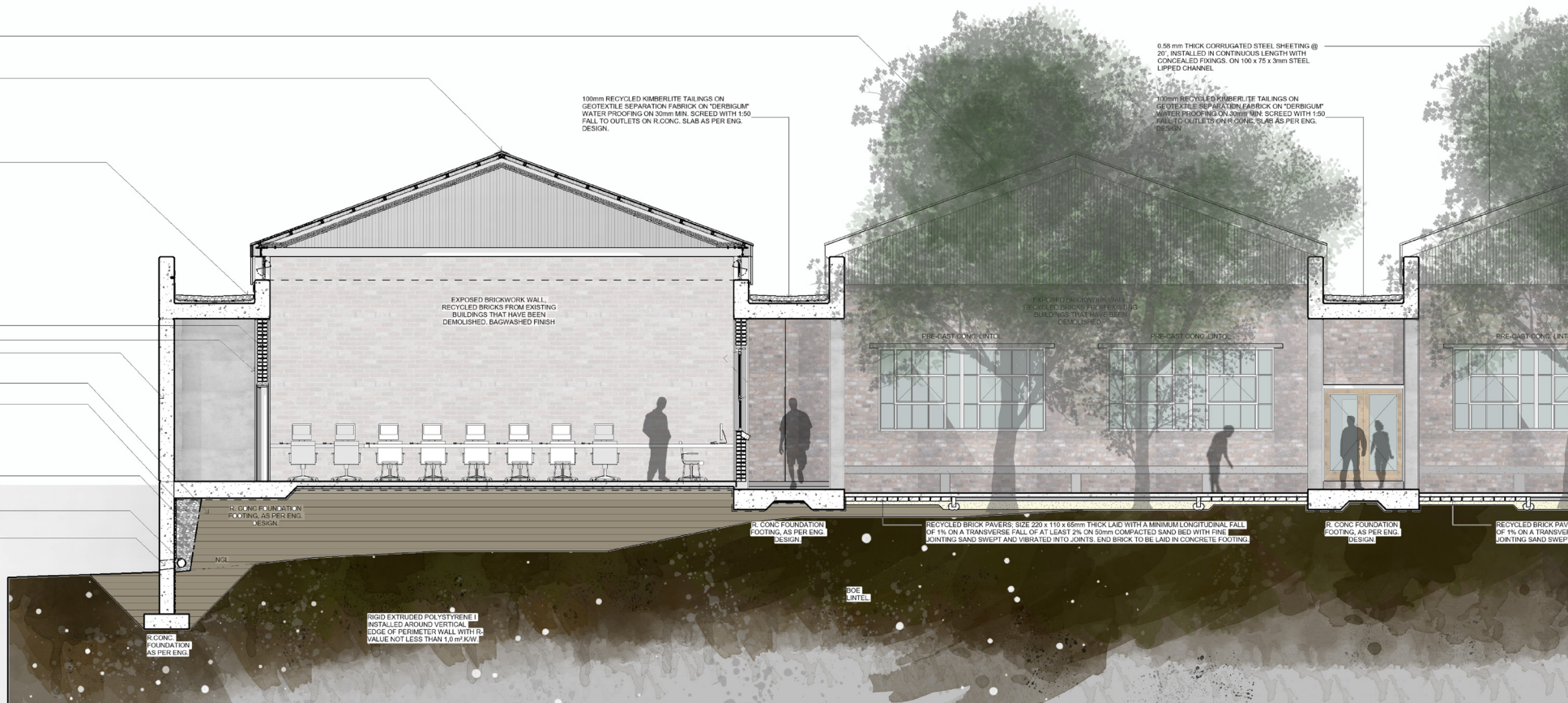
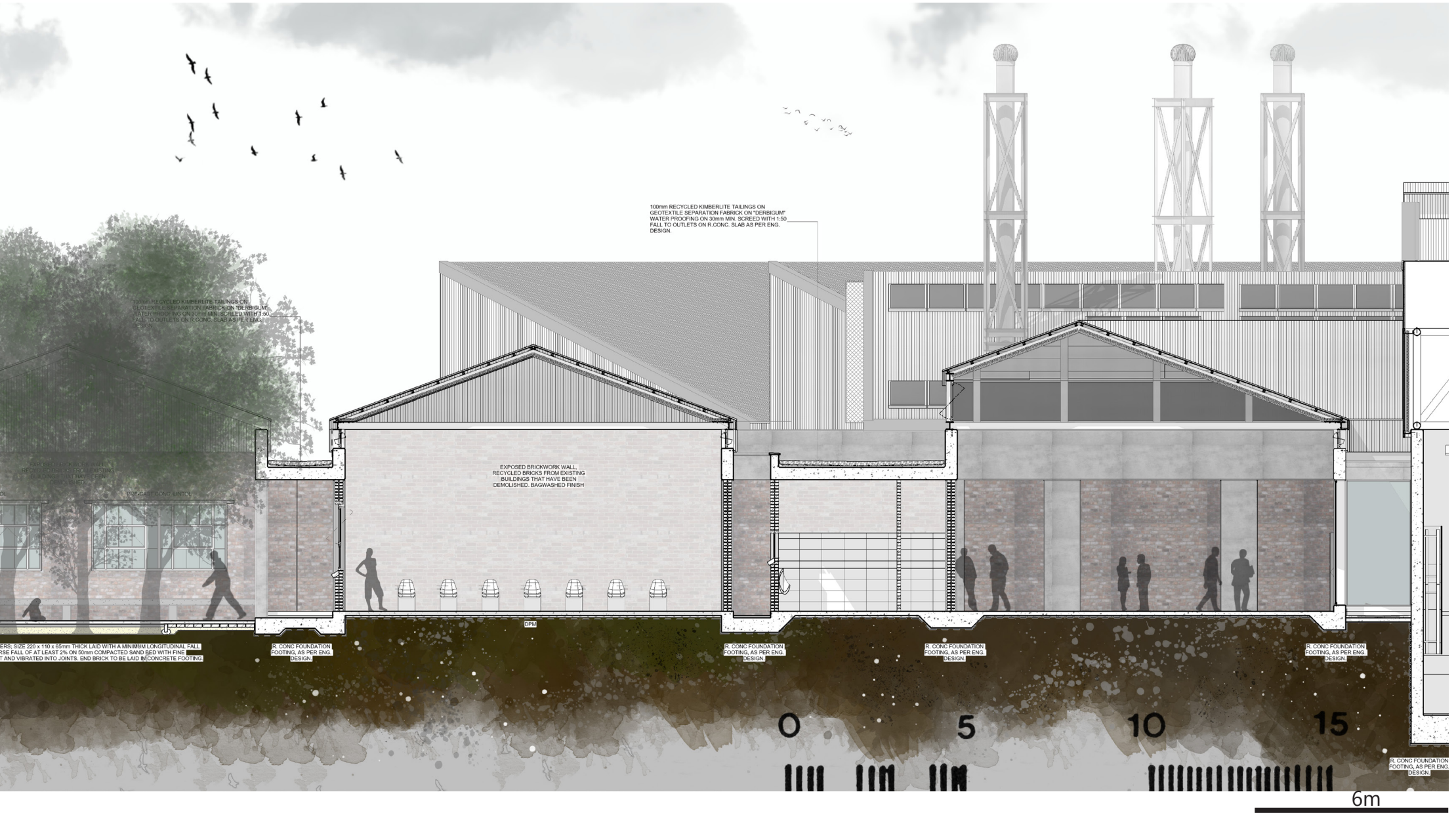


Figure 8.18 - Section B-B (Author 2018)



**ROOFING NOTE:**  
0.58mm THICK CORRUGATED STEEL SHEETING @2° - INSTALLED IN CONTINUOUS LENGTHS WITH 0.58mm THICK CORRUGATED STEEL SHEETING FROM EXISTING BUILDING. EQUAL SIZING AND LOCATION OF BOLTS TO BE DETERMINED BY ENG.

0.58mm THICK CORRUGATED STEEL SHEETING TO BE INSTALLED IN CONTINUOUS LENGTHS WITH CONCEALED FIXINGS ON 100 x 75 x 3mm STEEL LIPPED CHANNEL

50 x 50 x 2.5mm SQUARE HOLLOW SECTION R/C CHASE, BOLTED TO CONCRETE UPSTAND. 0.58mm THICK CORRUGATED STEEL SHEETING TO BE RIVETED TO HOLLOW TUBING WITH 4.8mm LARGE FLANGE "POP" RIVETS. HOLES FOR RIVETS TO BE DRILLED PRIOR TO INSTALLATION.

100mm RECYCLED KIMBERLITE TAILINGS ON 100mm R. CONC. SLAB AS PER ENG. DESIGN. WATER PROOFING ON 300mm MIN. SCREED WITH 150 FALL TO OUTLETS ON R. CONC. SLAB AS PER ENG. DESIGN.

340mm R. CONC. ROOF SLAB, AS PER ENG. DESIGN

25mm CHAMFER

10mm SAW CUT, WATERPROOFING MEMBRANE FITTED TO SLAB AND 15mm WITH BACKER ROD AND SEALANT

330 x 1020mm R. CONC. UPSTAND, AS PER ENG. DESIGN

CONCRETE DAY JOINT

220mm EXPOSED BRICKWORK INFILL WALL. RECYCLED BRICKS FROM EXISTING BUILDINGS THAT HAVE BEEN DEMOLISHED.

330mm R. CONC. COLUMN AS PER ENG. DESIGN

330mm R. CONC. WALL AS PER ENG. DESIGN

SOIL BACKFILL COMPACTED IN LAYERS OF 150mm LAYERS (MECHANICAL COMPACTION), TO A DENSITY OF AT LEAST 95% MOD. AASHTO, AS PER ENG. DESIGN.

CONCRETE EXPANSION JOINT

CONCRETE DAY JOINT

KIMBERLITE TAILING BACKFILL

ONE LAYER TORCH ON "DERBIGUM" SP4 WATERPROOFING MEMBRANE, WITH 75mm SIDE LAPS AND 100mm END LAPS, SEALED TO PRIMED WALL SURFACE. FINISHED WITH TWO CLEAN WATER UNTIL A HOMOGENOUS MIX HAS BEEN ACHIEVED AND APPLY 5mm THICK "UZIN" PROTECTED DURING COMPACTING PROCESS.

150mm Ø POROUS GEOTEXTILE LAD INTO SMOOTH PEBBLE BED WITH MAX. 25mm Ø PEDDLES WARRIED IN 2 LAYERS OF POLYESTER GEOTEXTILE TO PREVENT CLOGGING BY KIMBERLITE TAILINGS.

WEEP HOLE TO OUTSIDE

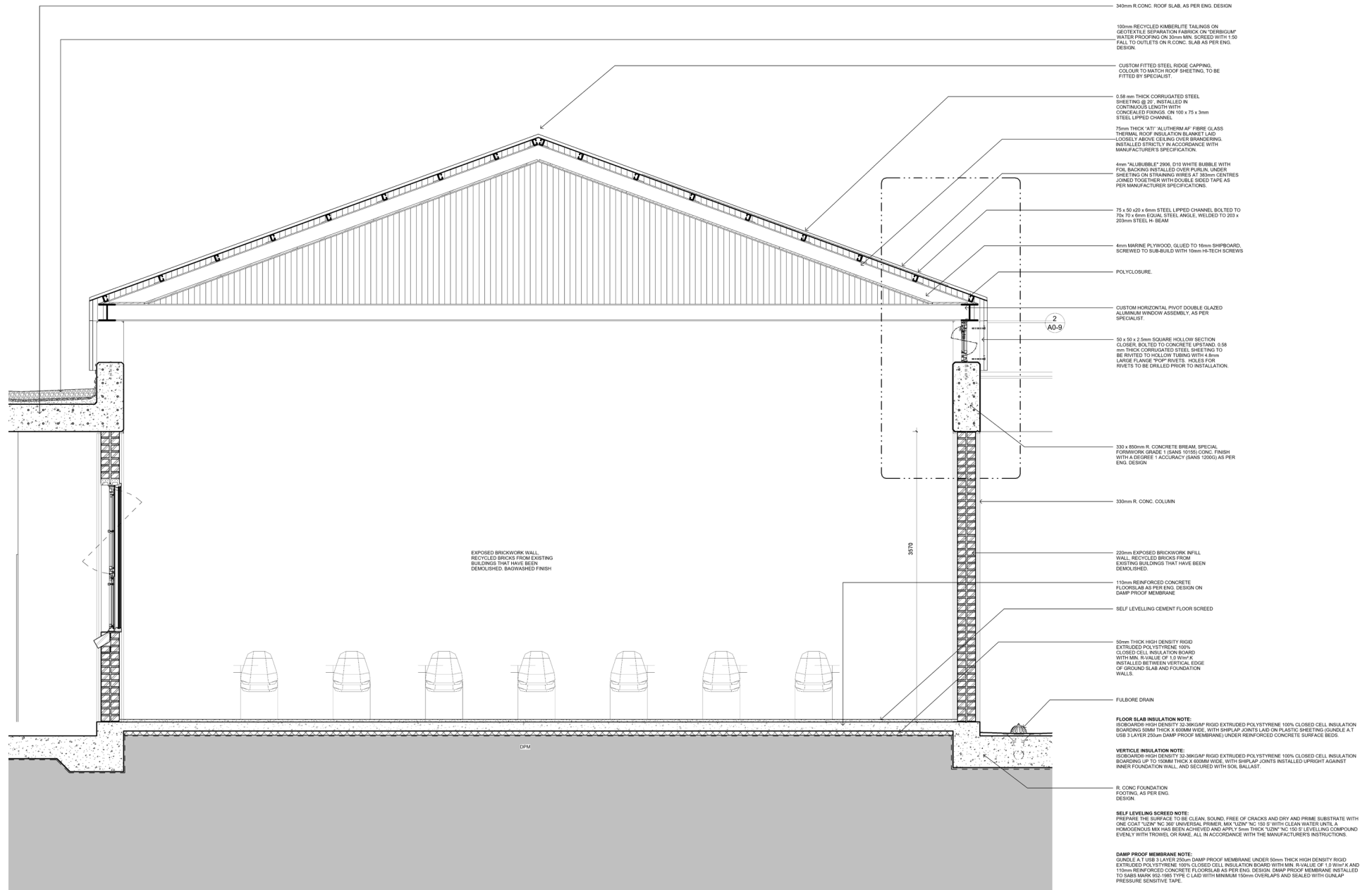
**SELF LEVELING SCREED NOTE:**  
PREPARED WITH CLEAN, SOUND, FREE OF CRACKS AND DRY AND PRIME SUBSTRATE WITH ONE COAT "UZIN" NC 380 UNIVERSAL PRIMER, MIX "UZIN" NC 150 S' WITH CLEAN WATER UNTIL A HOMOGENOUS MIX HAS BEEN ACHIEVED AND APPLY 5mm THICK "UZIN" SELF LEVELING SCREED TO THE ENTIRE SURFACE. ALL IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.

**DAMP PROOF MEMBRANE NOTE:**  
GUNDLE USB GREEN 250um DAMP PROOF MEMBRANE UNDER 50mm THICK HIGH DENSITY RIGID EXTRUDED POLYSTYRENE 100% CLOSED CELL INSULATION BOARD WITH MIN. R-VALUE OF 1.0 (R-VALUE OF 1.0 PER 25mm THICK). DAMP PROOF MEMBRANE INSTALLED TO SABS MARK 1682 TYPE C1 AND SEALED WITH GUNLAP PRESSURE SENSITIVE TAPE AND 100mm OVERLAPS

SECTION B-B // DETAIL 1

SCALE 1:20





SECTION B-B // DETAIL 2

SCALE 1:20

**ROOFING NOTE:**  
CORRUGATED STEEL SHEETING @20° INSTALLED IN CONTINUOUS LENGTHS WITH CONCEALED FIXINGS ON 75 x 50 x 20 x 6mm STEEL LIPPED CHANNEL BOLTED TO 70x 70 x 6mm EQUAL STEEL ANGLE. WELDED TO 203 x 203mm STEEL H-BEAM (RECLAIMED STEEL) AS PER ENG. DESIGN. SIZING AND LOCATION OF BOLTS TO BE DETERMINED BY ENG.

0,59 mm THICK CORRUGATED STEEL SHEETING @20° INSTALLED IN CONTINUOUS LENGTH WITH CONCEALED FIXINGS ON 100 x 75 x 3mm STEEL LIPPED CHANNEL

4mm "ALLUBUBBLE" 200% D10 WHITE BUBBLE WITH 10% BACKING GRANULES FIBRE FILLING. UNDER SHEETING STEEL ANGLE WELDED TO CENTRES JOINED TOGETHER WITH DOUBLE SIDED TAPE AS PER MANUFACTURER SPECIFICATIONS.

75 x 50 x 20 x 6mm STEEL LIPPED CHANNEL BOLTED TO 70x 70 x 6mm EQUAL STEEL ANGLE. WELDED TO 203 x 203mm STEEL H-BEAM

75mm THICK "ATI" ALLUTHERM AF FIBRE GLASS THERMAL ROOF INSULATION BLANKET LAID OVER STEEL ANGLE. WELDED TO CENTRES. INSTALLED STRICTLY IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION.

45mm MASONRY PLASTER, GURED TO 16mm SUBBOARD. SCREWED TO SUB-BUILD WITH 16mm HI-TECH SCREWS

"SONDOR" CORRUGATED 76 CROSS-LINKED, CLOSED CELL, EXPANDED POLYETHYLENE EAVE FILLER.

POLYURETHANE POLYCLOSURE.

CUSTOM HORIZONTAL PIVOT DOUBLE GLAZED ALUMINIUM WINDOW ASSEMBLY AS PER SPECIALIST.

203 x 203mm STEEL H-BEAM TRUSSES (RECLAIMED STEEL) WITH 16mm HI-TECH SCREWS TO 80x 80 CONCRETE UPSTAND BEAM WITH M19 HI-TI (HI RE-M) ADHESIVE ANCHOR. POSITIONING AS PER ENG.

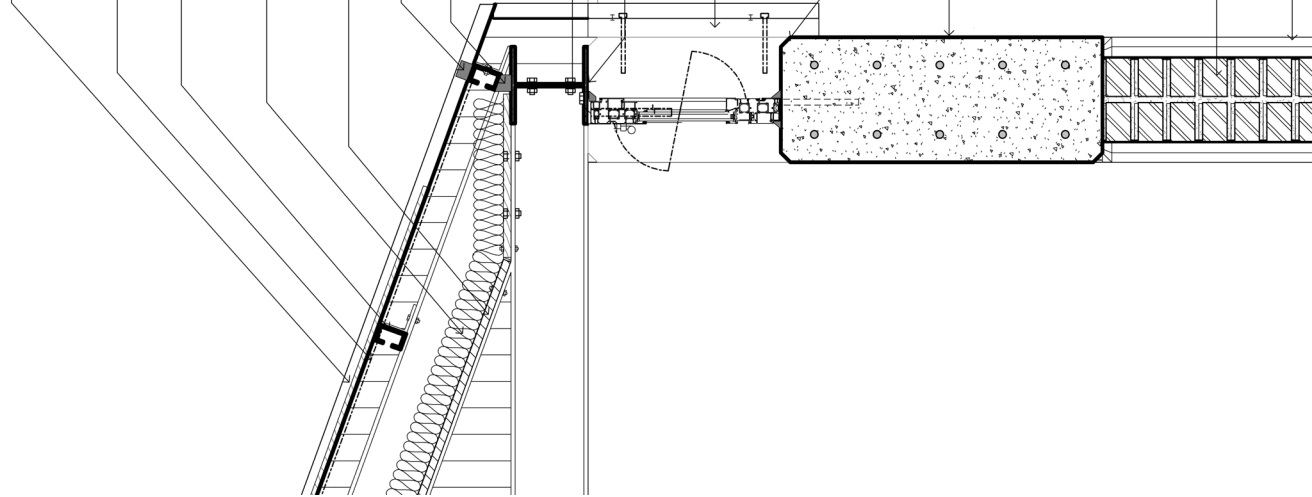
50 x 50 x 2,5mm SQUARE HOLLOW SECTION CLOSER, BOLTED TO CONCRETE UPSTAND. 0,59 mm THICK CORRUGATED STEEL SHEETING TO BE RIVETED TO HOLLOW TUBING WITH 4.8mm LARGE FLANGE "POP" RIVETS FOR RIVETS TO BE DRILLED PRIOR TO INSTALLATION.

25mm CHAMFER

330 x 850mm R. CONCRETE BEAM. SPECIAL FORMWORK GRADE 1 (SANS 10155) CONC. FINISH WITH 1% AIR ENTRAINMENT (SANS 12005) AS PER ENG. DESIGN

220mm EXPOSED BRICKWORK INFILL TO EXISTING BUILDINGS THAT HAVE BEEN DEMOLISHED.

330mm R. CONC. COLUMN



SECTION B-B // DETAIL 3

SCALE 1:20

# SECTION C-C

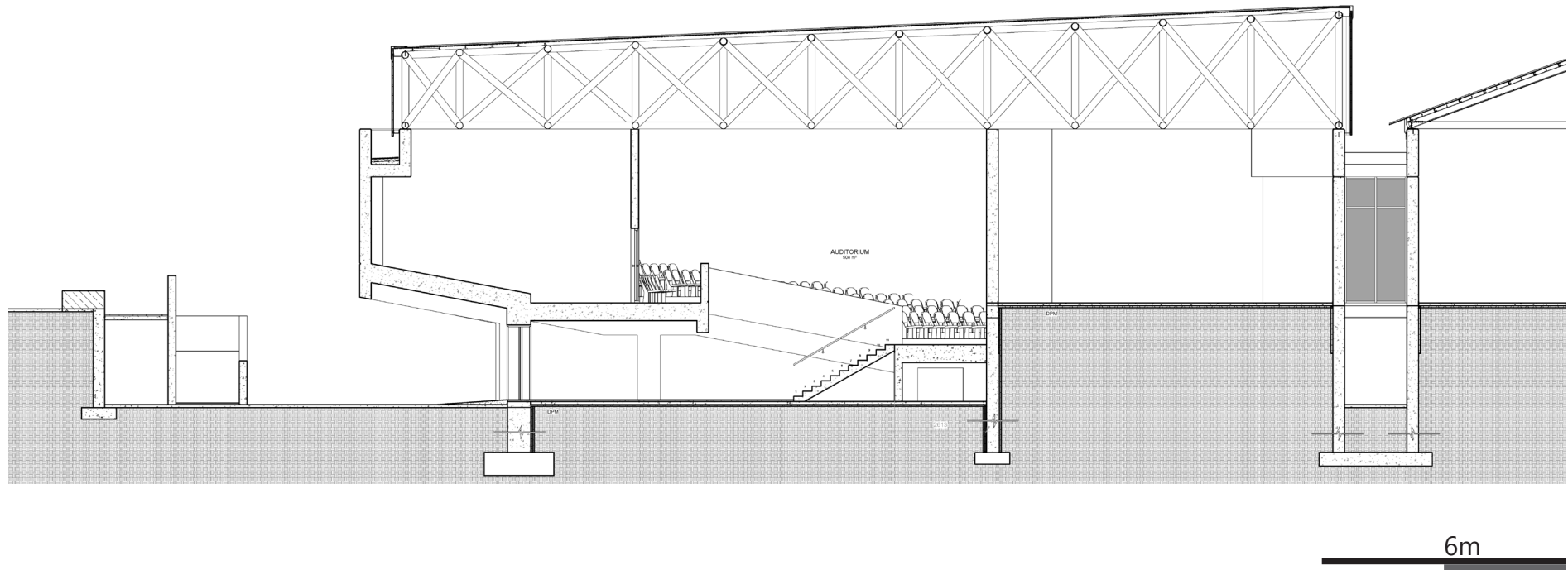


Figure 8.19 - Section C-C (Author 2018)

# SECTION C-C

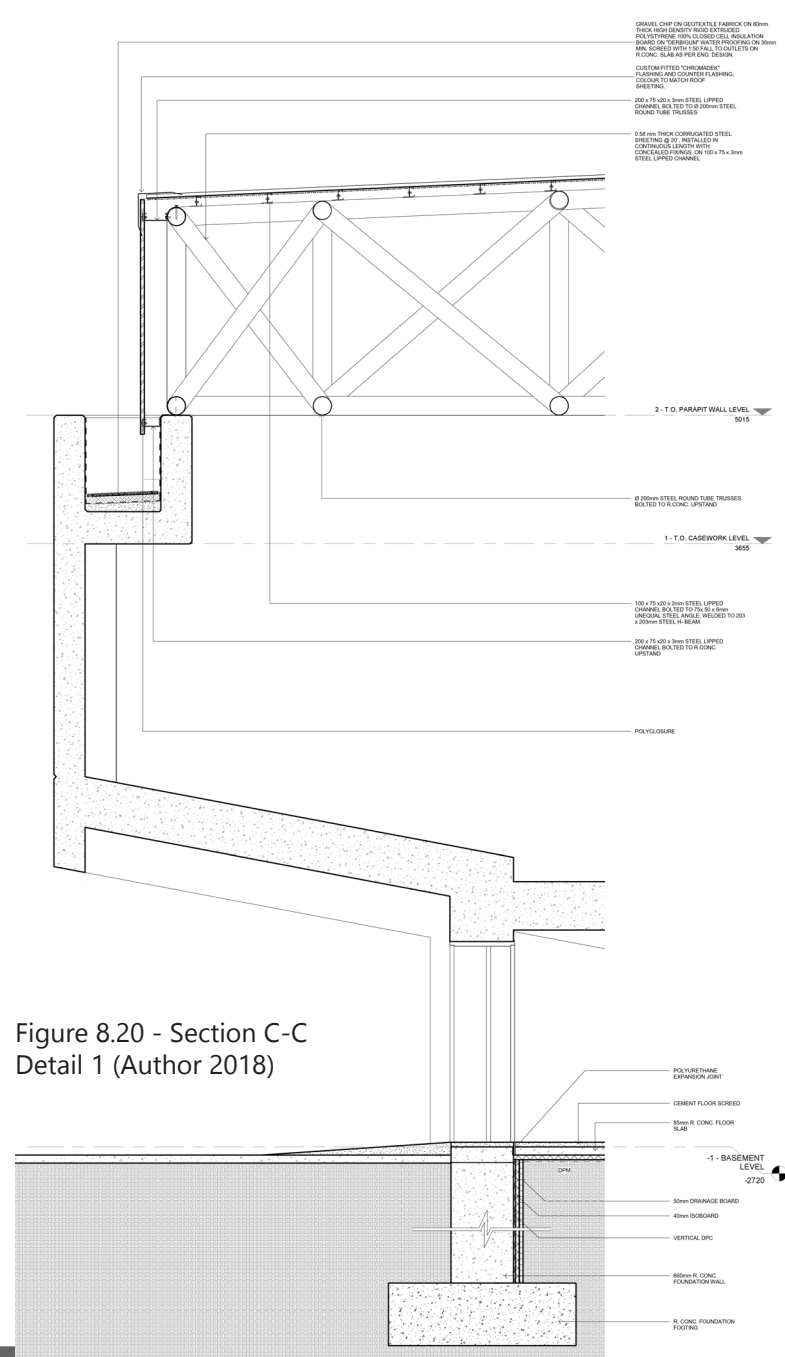


Figure 8.20 - Section C-C Detail 1 (Author 2018)

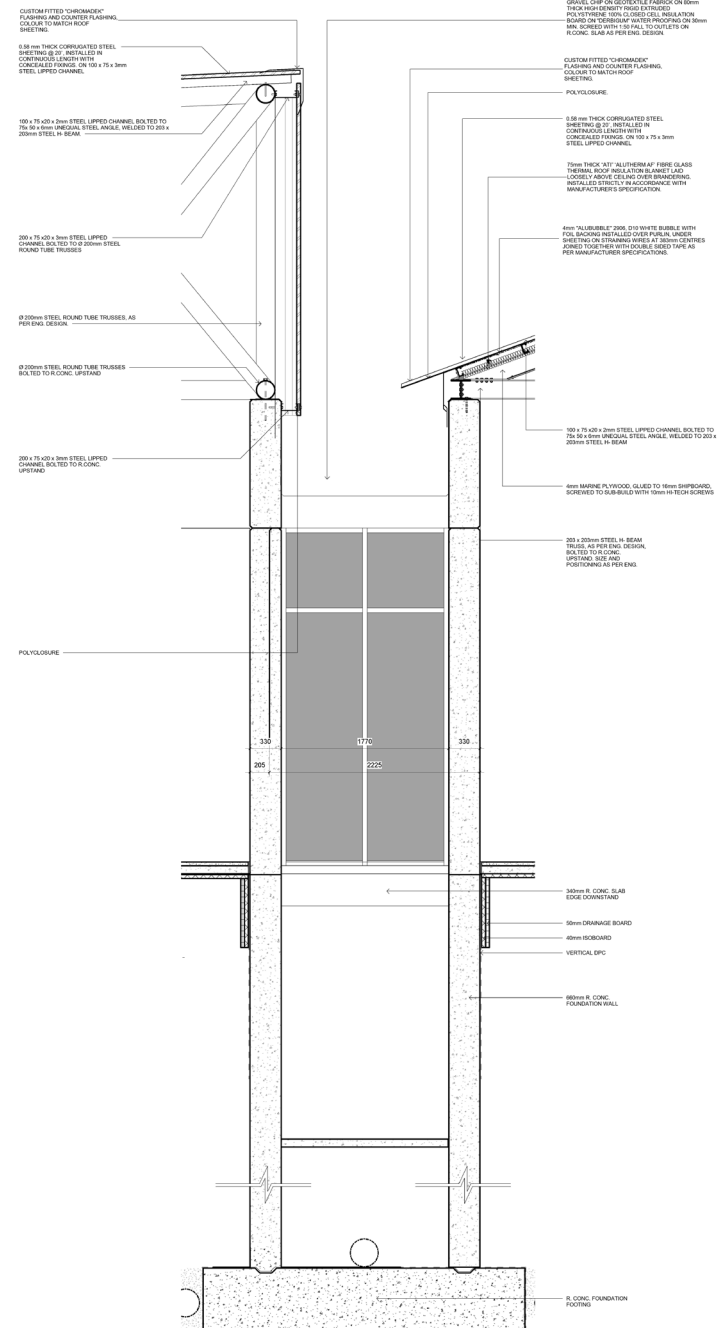


Figure 8.21 - Section C-C Detail 2 (Author 2018)

# WATER MANAGEMENT STRATEGY

## WATER COLLECTION

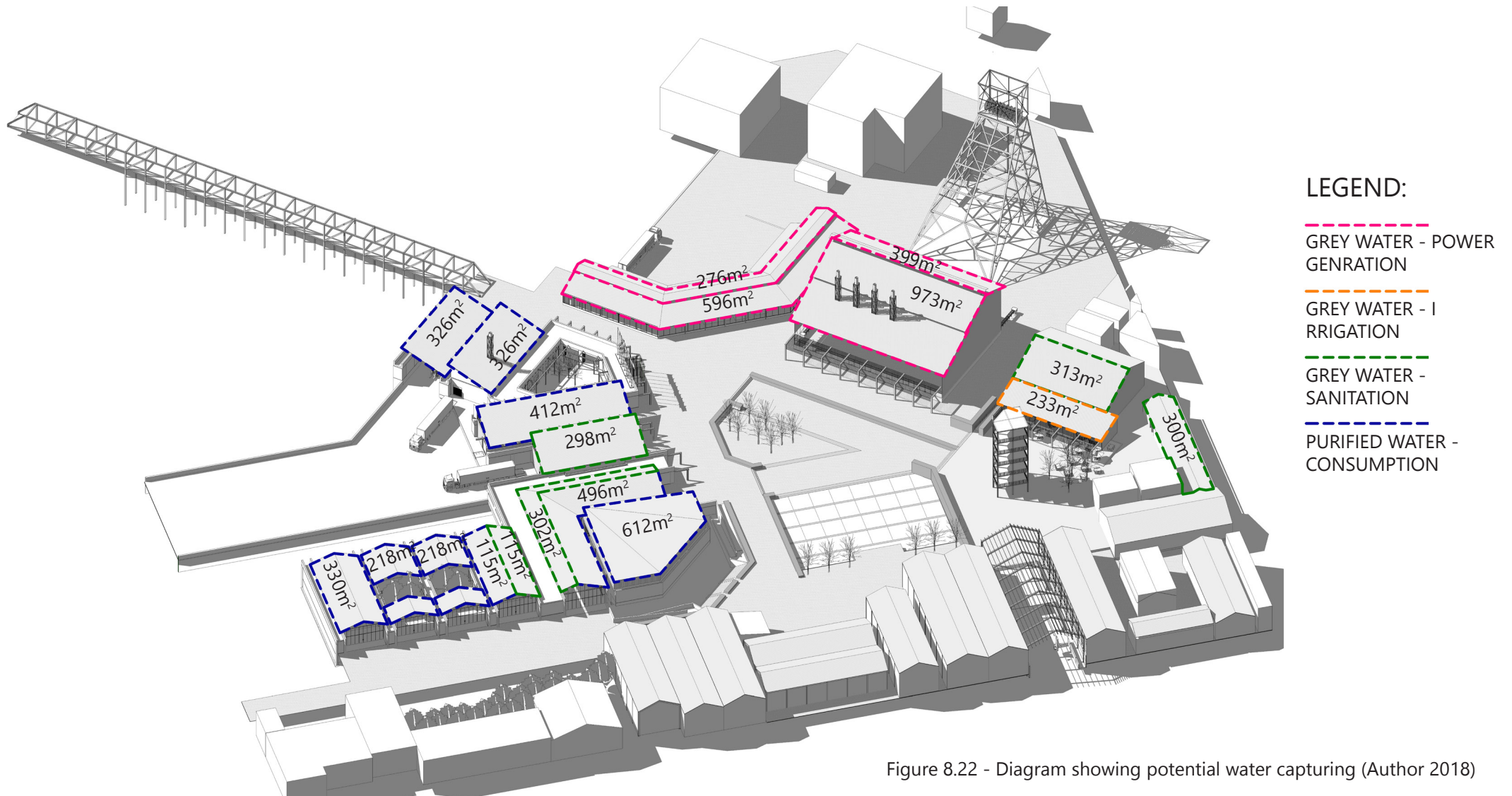


Figure 8.22 - Diagram showing potential water capturing (Author 2018)

## WATER MANAGEMENT STRATEGY

### RAIN WATER HARVESTING CALCULATIONS

MONTH:	RAINFALL (mm):	POWER GENERATION (L) AREA (m <sup>2</sup> ): 2244	IRRIGATION (L) AREA (m <sup>2</sup> ): 233	SANITATION (L) AREA (m <sup>2</sup> ): 1015	CONSUMPTION (L) AREA (m <sup>2</sup> ): 3053
JANUARY	136	274665.6	28519.2	124236	373687.2
FEBUARY	75	151470	15727.5	68512.5	206077.5
MARCH	82	165607.2	17195.4	74907	225311.4
APRIL	51	102999.6	10694.7	46588.5	140132.7
MAY	13	26254.8	2726.1	11875.5	35720.1
JUNE	7	14137.2	1467.9	6394.5	19233.9
JULY	3	6058.8	629.1	2740.5	8243.1
AUGUST	6	12117.6	1258.2	5481	16486.2
SEPTEMBER	22	44431.2	4613.4	20097	60449.4
OCTOBER	71	143391.6	14888.7	64858.5	195086.7
NOVEMBER	98	197920.8	20550.6	89523	269274.6
DECEMBER	110	222156	23067	100485	302247
ANNUAL TOTAL (mm <sup>2</sup> ):	674	1361210.4	141337.8	615699	1851949.8

\*Calculated with a 0.9 Runoff Coefficient

Figure 8.23 - Table showing rain water harvesting calculations (Author 2018)

The is a significant amount of water that can be captured from the rooves on a yearly basis. This water will be used to service different parts of the development. See Figure 8.22. Water from the winder house building and the new carbonisation plant will be used in the production of electricity through a turbine. The water will be transformed into steam by the residual heat from the carbonisation furnaces. This electricity will then be used by the buildings on the site, thus further reducing the site's carbon footprint and operational costs of the site.

sanitary fixtures. Water captured from the restaurant roof (indicated in orange) will be stored and used for irrigation purposes. Water that is captured from the main building's roof (indicated in blue) will flow into storage tanks that will then be filtered to provide potable water to the site. The amount of rainwater captured will be adequate to supply the site's needs. If there is a shortage of water, underground water can be pumped from the mine and used on site. This underground water is currently the major source of water for the mine operations.

Water that is captured (indicated in green) is to be used to supply

## DAYLIGHTING AND SOLAR SHADING ANALYSIS

As previously noted the western and eastern facades need to be protected from direct sunlight and solar heat gain. The roof structures have been designed to provide the correct amount of light into each space.

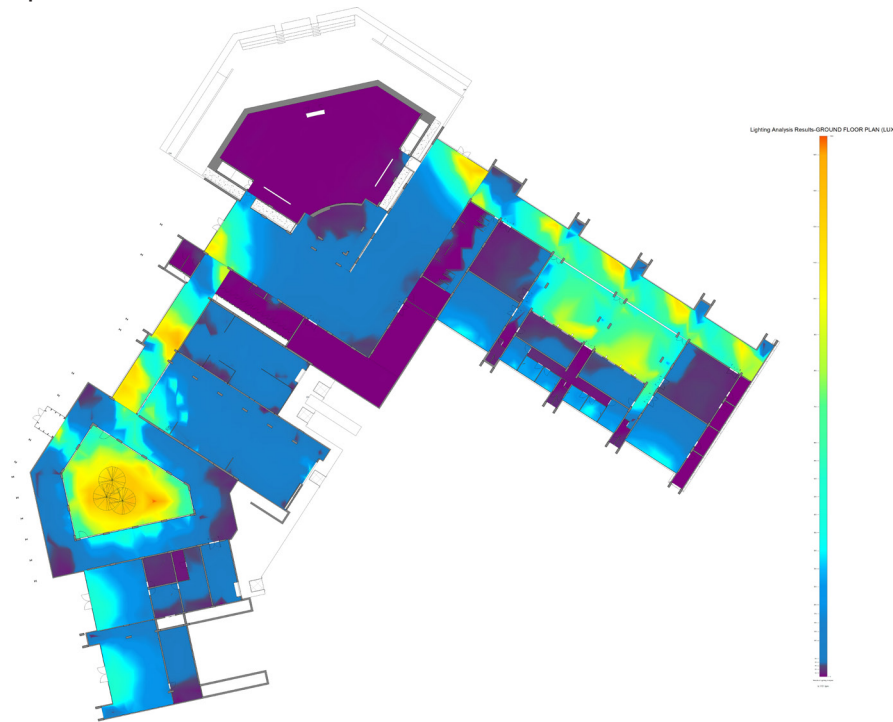


Figure 8.24 - Solar analysis showing the lighting (21 July) levels for the building without any solar shading devices. In the northern walkway the lighting levels are too high and therefore there will be significant solar heat gain.

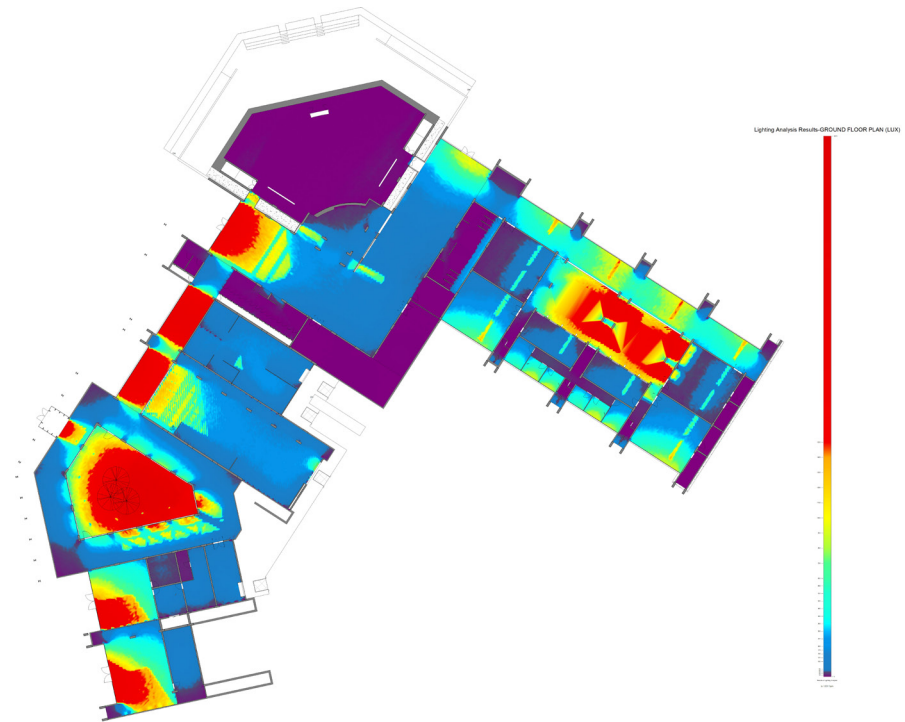


Figure 8.25 - Solar analysis showing the lighting (21 December) levels for the building without any solar shading devices. In this scenario the eastern portion of the building experiences very high levels of solar heat gain. It is evident from this analysis that shading devices are extremely important for the thermal comfort of the building.

## DAYLIGHTING AND SOLAR SHADING ANALYSIS

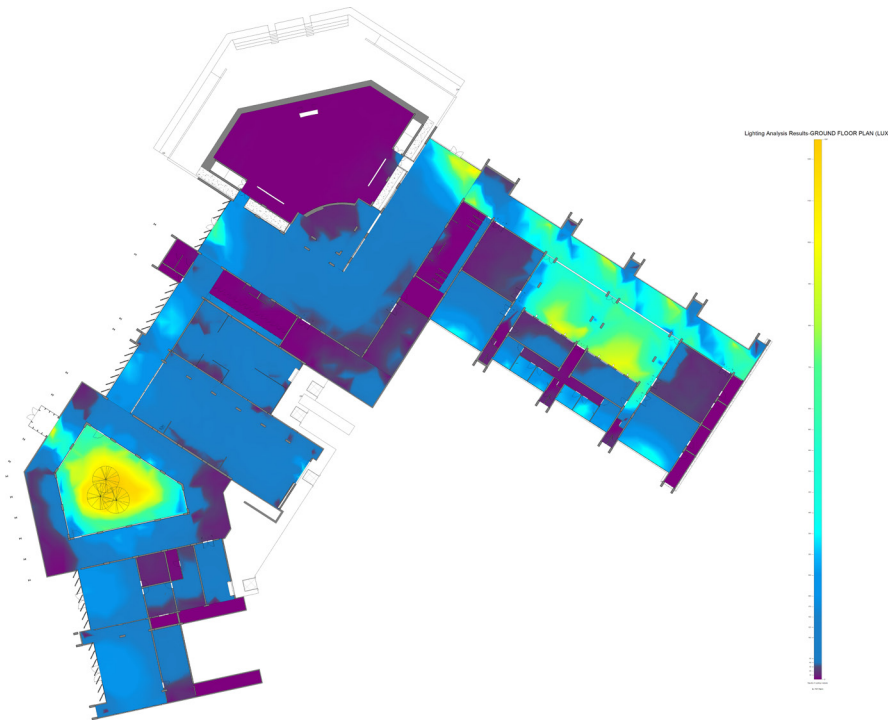


Figure 8.26 - Solar analysis showing the lighting (21 July) levels for the building with solar shading devices. The analysis shows that solar shading devices greatly reduce lighting overexposure and solar heat gain.

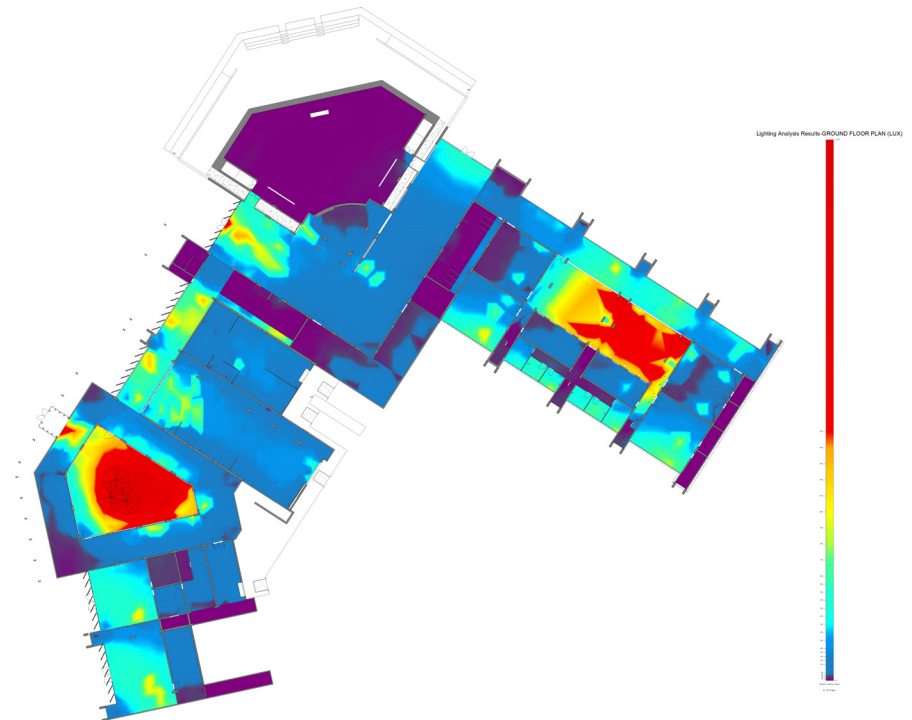


Figure 8.27 - Solar analysis showing the lighting (21 December) levels for the building with solar shading devices. The analysis shows that solar shading devices greatly reduce lighting overexposure and solar heat gain. This reduction will enhance the thermal comfort of the building.



## SBAT ANALYSIS - COMPLETED SITE

### SB SBAT REPORT

4.2

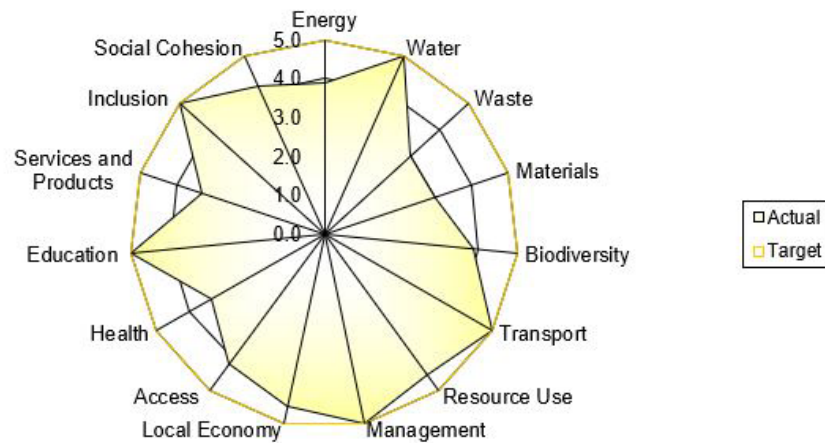
#### SB1 Project

CULLINAN - CRAFT CENTRE

#### SB2 Address

101 OAK STREET, CULLINAN, SOUTH AFRICA

#### SB3 SBAT Graph



The Sustainable Building Assessment Tool (SBAT) system has been designed to help evaluate the sustainability of buildings in their planned or existing state. The tool can be used by designers to understand the shortcoming of a design or existing building in relation to several poignant criteria, namely economic, social and environmental.

The tool has been designed to be especially helpful for buildings in developing countries, where larger economic and local economic issues are most often one of the key priorities.

The SBAT tool can also be used as part of a design iteration process to evaluate how specific designs functions in terms of sustainability and then enhance the areas where the design is lacking.

#### SB4 Environmental, Social and Economic Performance

Score

Environmental	3.7
Economic	4.6
Social	4.2
SBAT Rating	4.2

#### SB5 EF and HDI Factors

Score

EF Factor	3.8
HDI Factor	4.5

#### SB6 Targets

Percentage

Environmental	75
Economic	93
Social	83

## PERSPECTIVES OF FINAL DESIGN



Figure 8.28 - View from main square towards brewery and ceramics courtyard (Author 2018)



Figure 8.29 - Internal view of ceramics courtyard (Author 2018)



Figure 8.30 - Internal view of education courtyard (Author 2018)



Figure 8.31 - View from pit towards observation tower (Author 2018)



Figure 8.32 - Northern side of new building towards windmill building, showing headgear No. 1 in background (Author 2018)



Figure 8.33 - Western side of public square towards new building (Author 2018)



Figure 8.34 - Internal view of metal working studio (Author 2018)

## CHAPTER 09 \\ CONCLUSION

The intention of this dissertation was to develop an alternative to the rehabilitation and closure strategies currently planned for the Cullinan mine.

In the not too distant future South Africa faces an overwhelming challenge, which will result from the exhaustion of mineral resources in the mining sector. Mines are reaching a point where the gold and diamonds are either running out, or are too deep to mine safely. This coupled with ever increasing demands for salary and benefit raises for workers and the massive escalation of cost of electricity will force redundancy and job loses on an unprecedented scale.

The development of this alternative strategy means that the people of Cullinan and the people of Rifilwe can have a future in a post-mining scenario. Alternative industry will allow them to continue to exist in their current lives albeit with a new skills set, and a renewed outlook on their community.

There has been a considerable investment in providing both infrastructure and housing for workers and staff in mining towns, which, as I have said, are often in very remote locations.

In my dissertation I have a possible solution for Cullinan. It does not represent a blanket solution to the overall problem but because of its historical and its geographic proximity to major centres in Gauteng it proposed a means whereby the town can in a way 're-invent' itself for

the benefit of at least some of the people who have made Cullinan and Refilwe home.

The overall problem in this country is vast when one considers the livelihood and well being of the labour force.

Mines have been forced through legislation to make considerable financial provision for the restitution of mining sites, but unless a global that encompasses the future of employees and their dependants is created, it is likely that there will be a crisis not only on humanitarian, but also a political level, which will impact heavily on the future of South Africa.

In a small way i have addressed this future scenario, but there needs to be a widely based an futuristic plan evolved in which architecture necessarily will play a major part.

Although this is a conclusion to my master's dissertation I remain aware of the great impact that the exhaustion of mineral resources will have on our population in years to come.



# FINAL PRESENTAION AND MODEL



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## APPENDICES

### APPENDIX A - CRITERIA FOR CULTURAL WORLD HERITAGE SITES - UNESCO

THE CRITERIA FOR CULTURAL WORLD HERITAGE SITES ARE:

- i. "Represents a masterpiece of human creative genius and cultural significance"
- ii. "Exhibits an important interchange of human values, over a span of time, or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning, or landscape design"
- iii. "To bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared"
- iv. "Is an outstanding example of a type of building, architectural, or technological ensemble or landscape which illustrates a significant stage in human history"
- v. "Is an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture, or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change"
- vi. "Is directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of

outstanding universal significance"

THE CRITERIA FOR NATURAL WORLD HERITAGE SITES ARE:

- vii. "Contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance"
- viii. "Is an outstanding example representing major stages of Earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features"
- ix. "Is an outstanding example representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems, and communities of plants and animals"
- x. "Contains the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation"

(UNESCO World Heritage, 2018)