

Waste Metal Repository for Adaptive Reuse

Historical (Erasure) and the Toxic Mining Landscape of Johannesburg's Central Basin

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***“How do the conceptual agendas of designed
landscapes engage, ignore or contradict the violent
and problematic aspects of their material
production”***

- Jane Hutton, *Reciprocal Landscapes*



Figure 0.2

Abstract

The city of Johannesburg is defined by the commodity of gold. Upon finding its rock embedded presence along the Witwatersrand reef line, the city began to grow accordingly generating the historical formation of a city around the mining industry. This in turn accredits the city that exists today on the basis of these gold pockets; however, a history of the rich landscapes is commonly unacknowledged in the process of identifying the final metallic product. In order to obtain the precious metal from the earth, a previously vigorous landscape was wounded and carved in order to extract the gold particles. In the wake of this landscape stripping, the carved-out earth was displaced from its origins and placed above ground as mountainous landfills known as the gold mine dumps that scatter along the Johannesburg skyline from east to west.

These compacted mounds create the memory of the scarred earth but further represent a toxicity that is deeply embedded in the mining industry. The soil upon its removal and exposure to air becomes toxic, contaminating soil, water, and dust. This creates an environment of toxicity that is caused by human landscape destruction that today requires chemical rehabilitation in order to detoxify the expansive physical contamination.

While physical contamination acts a marker of the environmental damage this industry has inflicted, a further toxicity exists in the form of social wounds. The marginalization, inequality and treatment historically imposed by the mining force is a toxicity that is more difficult to visualize than the physical extraction mounds of the landscape.

Today the production of gold has decreased, and the city of Johannesburg has become more dependent on a series of other industries. The call for mine dump removal is essential to the expulsion of physical contamination; however the query arises around the removal of a historical marker and monument of social, environmental and historical ruination. The design proposal objective of this research is to identify how these toxic wounds can be mended, while simultaneously creating a memory of historical erasure.



Figure 0.3

Declaration

I, Danielle Mensky (student number 1456518) of Architecture [Professional] in the year 2022.

I hereby declare the following:

I am aware that plagiarism [i.e. the use of someone else's work without permission and/or without acknowledging the original sources] is wrong. I confirm that the work submitted for assessment for the above course is my own unaided work except where I have stated explicitly otherwise. I have followed the required conventions in referencing thoughts, ideas, and visual materials of others. I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my unaided work or that I have failed to acknowledge the source of the ideas or words in my own work.

Danielle Mensky

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To my parents: Morris and Aviva, and siblings: Gilad and Galia. Thank you for your unconditional support and entertaining every architectural notion. You have all played such a vital part to my architectural studies, and I am incredibly thankful for you all.



Figure 0.4

Terminology

a glossary list of fundamental terms and definitions that are crucial to the study

Acid Mine Drainage [AMD]

“Acid mine drainage (AMD) is a major water quality problem as it reduces the pH of water resource, making dissolved metals readily available for uptake by benthic organisms and fish, which becomes a major pathway of their introduction into the human food chain.”

Diversion:

“The action of turning something aside from its course.”

Erasure:

“The removal of all traces of something; obliteration.”

Mine Dump:

“A large mound or hill of mining waste at the surface of a mine.”

Metallurgy:

“The branch of science and technology concerned with the properties of metals and their production and purification.”

Mineral Leaching:

“A chemical process in mining for extracting valuable minerals from ore. Leaching also takes place in nature, where the rocks are dissolved by water. Post leaching, the rocks are left with a smaller proportion of minerals than they originally contained.”

Monument:

“A building, structure, or site that is of historical importance or interest.”

Ore:

“A naturally occurring solid material from which a metal or valuable mineral can be extracted profitably.”

Pyrite:

“A shiny yellow mineral consisting of iron disulphide and typically occurring as intersecting cubic crystals.”

Resource:

“A country’s collective means of supporting itself or becoming wealthier, as represented by its reserves of minerals, land, and other natural assets.”

Repository:

“A place where something, especially a natural resource, is found in significant quantities.”

Refinery:

“The place where gold is separated from other metals or residues.”

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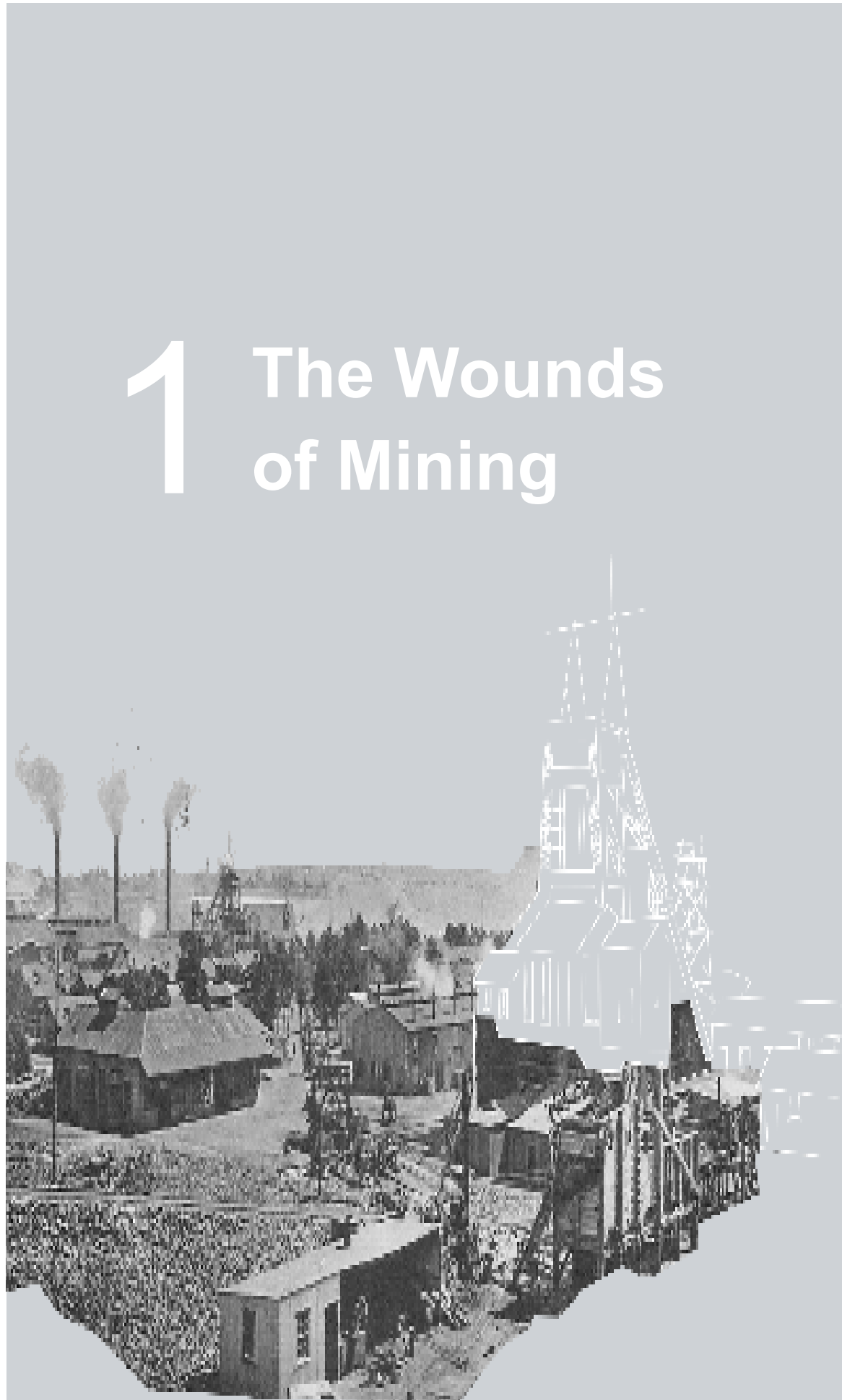
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1 The Wounds of Mining



Introduction to the research analysis of toxicity inflicted on Johannesburg by the mining industry

The state of being consists of a series of three fundamental stages: the past, the present and the future. These stages while seemingly time stamped and defined by their occurrence are interwoven into an intricate network that defines the other. In essence the past will be diametrically linked to the future and the present will mediate the effect that one has on the other. These interrelated time lapses form the basis on the proposed architectural intervention. Past examination identifies memories that have created the ruination that require architectural intervention today, while simultaneously highlights the significance of memories as a form of documentation and time capturing (McLeod, 2021). Memories offer the ability to compare past and present states of toxicity to assess future architectural remediation.

Psychologists Richard Atkinson and Richard Shiffrin proposed a model in 1968 titled the: Multistore Model, which describes the transition of information into three different memory formats (Atkinson et al., 1968, p.92; Malmberg et al., 2019).

The first format being short-term memory, which is directly related to a sense of currency and recent occurrence. The second memory format is: long term memory, being the ability to recall more distant events. The third memory system is the sensory store that; is a result of the reaction one's olfactory (sensory) system responds to events (Atkinson et al., 1968, p.94). These various memory stores are interrelated. For a long-term memory to be created, the sensory store and

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short-term memory need to correlate in order to produce a significant response for the individual allowing the engravement of a long-term memory (Atkinson et al., 1968, p.103).

The skyline of Johannesburg encompasses these memories, with yellow-hued mounds of earth that define the city as ‘the city of gold’ amid the modernization and multifaceted growth that disguises Johannesburg’s history today (Ball, 2017; Latilla, 2018, p.).

The mine dumps act as a remembrance of the toxicity that gold mining has inflicted, but also as a historical memory of the formation of Johannesburg as a city, inevitably creating a past reflection for the development of Johannesburg (Latilla, 2012). The resulting city of Johannesburg has stemmed from this environment of industrial promise and thus the spatial formations today, and planning scheme

are indicative of a placemaking system defined by the commodity of gold (Latilla, 2018).

While this physical demarcation left on the landscape acts a form of wound



Figure 1.1 A Landscape of Mine Dumps (Spelterini, 1904)
An aerial photograph of the mining progression along the reef line taken from a hot air balloon

remembrance – the significance of mine dump removal in a post-mining urban landscape poses the issue of erasure amid a history that has defined the city economically, socially, politically, and environmentally. The impact these mine dumps hold, therefore requires an in-depth analysis ranging from: mining origins in Johannesburg, to the value of metal historically (Baldwin, 2012; Ball, 2017).

The state of ruination that requires this detailed analysis further highlights the concern of its current decomposition. The research is aimed to analyse the concerns of dual toxicity and mining wastage to ultimately identify an architectural solution that aims to redress the current state. The theory of power and difference through architecture - forms a primary viewpoint to the research of toxicity caused at the hands of the consumerist demand for gold, and thus its social and environmental ramifications of decay (Blaga *et al.*, 2019 ; Burger *et al.*, 2015; Leach,

1996, p.336).

The exploration through the perspective of memory and wastage therefore acts as the fundamental lens that this analysis will be conducted, thus defining the resulting proposal of an architectural intervention.

The primary aim is to identify the evolution of this toxicity in all of its states (Baldwin, 2012; Ball, 2017). The forced acceptance of the toxicity and wastage of industry forms the fundamental rationale for the proposal of architectural reformation, in which the memory of mining has caused a permanent scar on the landscape despite the efforts to remove traces of toxic architectural formation.

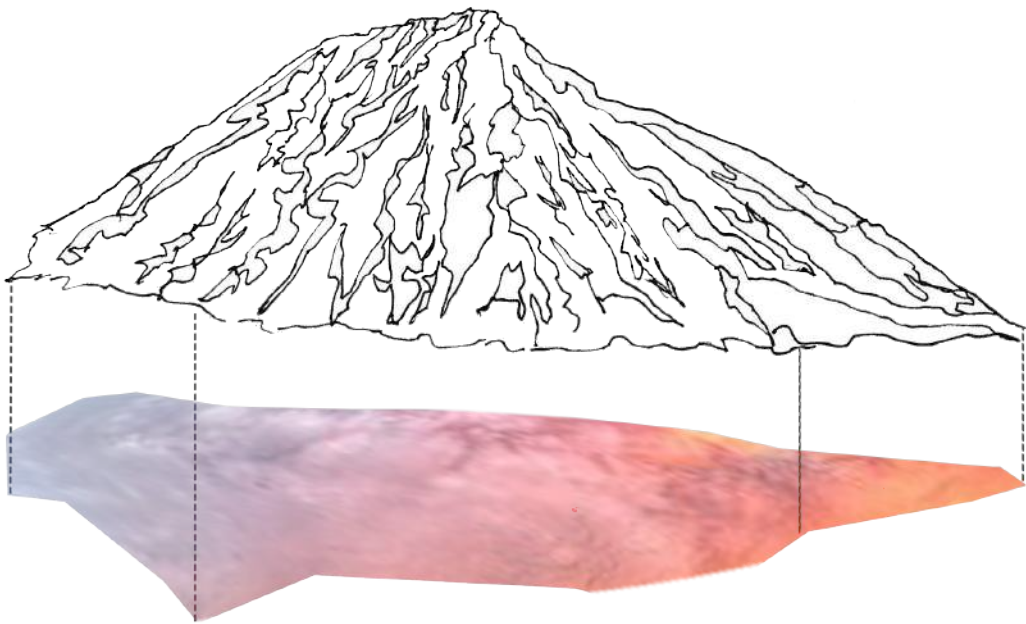


Figure 1.2 Mine Dump Removal (Author, 2022)
When mine dumps are removed a stain in the soil remains despite toxic rehabilitation. This creates a permanent scar within the landscape.

1.1 Historical development of mining industry, and impact on state of decay through the lens of spatial formation.

The memory of toxic mining is a result of the discovery of gold within the Witwatersrand reef in 1886 which created the catalyst start of the formation of the city. The gold findings along the reef line allowed for a superficial surface finding; however, the need to dig deeper and sink down vertical shafts required a more extensive amount of infrastructure in order to extract the gold particles. This would ultimately lead towards placemaking, in which the notion of temporary structures began to take on a more permanent nature (Chipkin, 1993, p.11). The initial haphazard settling around the reef line can be seen to have created a reverberation in which the city relied on a series of three rebuilds (Latilla, 2018, p.7-9; Unknown, 1986, p.115). The first build resulting in the temporary iron shacks and tents aimed at temporary habitation (Chipkin, 1993, p8-11). The second build as a result of the anticipation of the depth of gold creating a sense of permanence seen in the establishment

of four-story brick and mortar buildings. The third build being the transition to the skyscraper, ultimately reflecting the success of the mining industry within Johannesburg and thus the advancement of placemaking, occupation and the evolution of building technologies (Moeti, 1986). The prospect of gold as a commodity was a direct source of the city's growth, within the first five years the city had expanded to a population of approximately thirty thousand, progressing to one hundred thousand over the succeeding next five years (Latilla, 2012).



Figure 1.3 Johannesburg Progression around the Mining Landscape (Author, 2022)

The city extended around the line; with a more formalised town planning scheme north of the line as people began to settle and permanently inhabit the initially proposed temporary landscape.

1.2 Mine dump as monumental ruin

While the gold reef line can be seen to be the city’s outset, as the mining industry began to dig deeper, and more individuals began a more permanent settlement – the development north of the line grew more prominent. Mining by nature is an industrial process and thus the desire for permanent habitation away from industrial noise, dust and toxicity started to direct city planning further north (Latilla, 2018, p.9; Unknown, 1986, p.117). This resulted in a degradation of desirability to live next to operational mines or alongside the radioactive and polluted dumps forming a wasteland of oxidized mining particles. When identifying the planning layout that exists today there is cluster of factories and warehouses that surround these mining spaces with the exception of some of the informal settlements that live on the previously unoccupied and abandoned sites as a result of pollution (Lieberink). The price of residential zoned land is lower than those further north as a result of the mining industry. This raises the first issues of toxicity, that the solution to the contaminated land is industrial zoning, mild remediation and placing warehouses

and industrial parks in place of mine dumps (Blaga et al., 2019).

The deployment of warehouses and industrial parks on extracted mine dumps poses a twofold problem. The first concern deals with the depth of soil remediation from the mine dumps; while the second deals with the abandonment of landscapes and memory (Daniel, 2018). The landscape pre mining featured an unscathed environment of bleached limestone and veld landscape. The gold was embedded deep into the rock below the soil and removed via forced separation from the rock walls. This process disturbs meters to kilometres of substrata and soil from the natural environment resulting in resource depletion and drainage; the previously rich and resource abundant landscape is labelled undesirable and stamped with the label of perpetual industry in the form of a warehouse (Daniel, 2018).

Mining landscapes therefore showcases the primary principles of resource exhaustion. The book Reciprocal Landscape: Stories of Material Movement by Jane Hut-

ton (2020) most effectively describes this process of drainage as an “appropriation” of “nature”, in which we have physically emptied the natural landscape of its liberty for the sake of commodity trading and demand.

This by essence positions the mine dump as the ruination of a landscape in its medial form. The mine dump is now the symbol of exhaustion and separation while simultaneously holds the contrasting ideology of the possibility of waste (Hutton, 2020. P.37). The mine dump is essentially formed from the tailing particles of a mine, notably highlighting the wasted metal value that is embedded in the wastage. The process of the tailings occurs when the inside of mine shaft is excavated, and the residual tailings are deposited to form the large mounds (Daniel, 2018; Kardas, 2010). The particles of these dumps therefore vary- containing soil and sand particles, to rock as well as metallic minerals. It is estimated that the mining industry produces one hundred billion tons of mining waste per annum globally (Khorami).

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While these mounds are categorized as waste, they often still contain various metal content, ranging from common metals to precious metals such as: gold, silver, and platinum (Humphries et al., 2016). The particles are often much smaller than what is examined for within the mine. The metal content of the dump can be sifted through the retrieve any abandoned commodities; however, the value of the metal is often inconsequential to the major mine conglomerate to expend resources and infrastructure to extract the minerals. This negligible perspective often results in abandonment of the dumps (Michaud, 2016).

Two other scenarios often arise from the detachment of the major mining company to the dumps. The first involves additional companies coming in and removing the dump in hopes of extracting the metal content (Humphries *et al.*, 2016). This scenario is closely linked to mine remediation policies, where legislation specifies the required licenses and processes required under the National Environmental Management: Waste Act 59 of 2008. The second scenario is a series of informal artisanal mining – in which individuals come and manually pan through the

dumps for metals. These informal miners are locally known as ‘Zama Zama’ Miners and they are often vulnerable owing to the toxicity exposure of manual extraction processes, as well as the lack of formalized legality to mine the dumps (Mugai, 2020). The Zulu term ‘Zama Zama’ encapsulates the notion of this process of panning through waste – translating directly to the words ‘try try’; however, the phrase roughly means: “those who try to get something from nothing.” This artisanal and legally labelled mining contributes towards 20% of total metal production from Africa (Mugai, 2020; Reuters, 2014).



Figure 1.4 Zama Zama Mining (Smith, 2019)

The photographic nature puts the miners at risk by exposing their identity; therefore most photographic activities conceals the faces of the individuals who mine.

1 The Wounds of Mining

The physical toxicity of these mine dumps poses an extremely pressing concern. The metals and minerals embedded in the dust and soil are now entangled in a poisonous toxicity as a result of iron disulphide oxidation (Coetzee et al., 2010). Pyrite is a form of iron disulphide with a high arsenic content (Kardas, 2010). This mineral exists underground alongside the other metals and poses a toxic threat once it has been extracted. The mineral gains its arsenic properties upon exposure to oxygen and thus begins to contaminate the soil, water, dust, and air that surrounds the mine dump (Coetzee *et al.*, 2010; Mwenda, 2018).

While re- mining of landscapes both formally and informally deals with the first stages of toxicity in terms of miner health – the seepage of the toxicity creates pollution that can travel on urban scales – affecting expansive water networks, air breathability and the state of soil (Burger *et al.*, 2015; Mwenda, 2018).

This mining of landscapes highlights the extraction of value and the result of leaving behind the mine dump as this entity that is in between waste. It is rich in metal

yet poses a toxic threat creating an anecdote of what has happened to the landscape. This memory stands for how the city has developed and evolved, but also symbolic for the ruination that the industry has caused (Fitz *et al.*, 2019, p.10-13; Mwenda, 2018).



Figure 1.5 Mine Dump as a Monument (Larkin, 2010)
Photograph by artist Jason Larkin, captures the landscape of transportation and roads was built around the mining environment. This in turn creates a diametric link between the mine dump and the experience of movement throughout the city.

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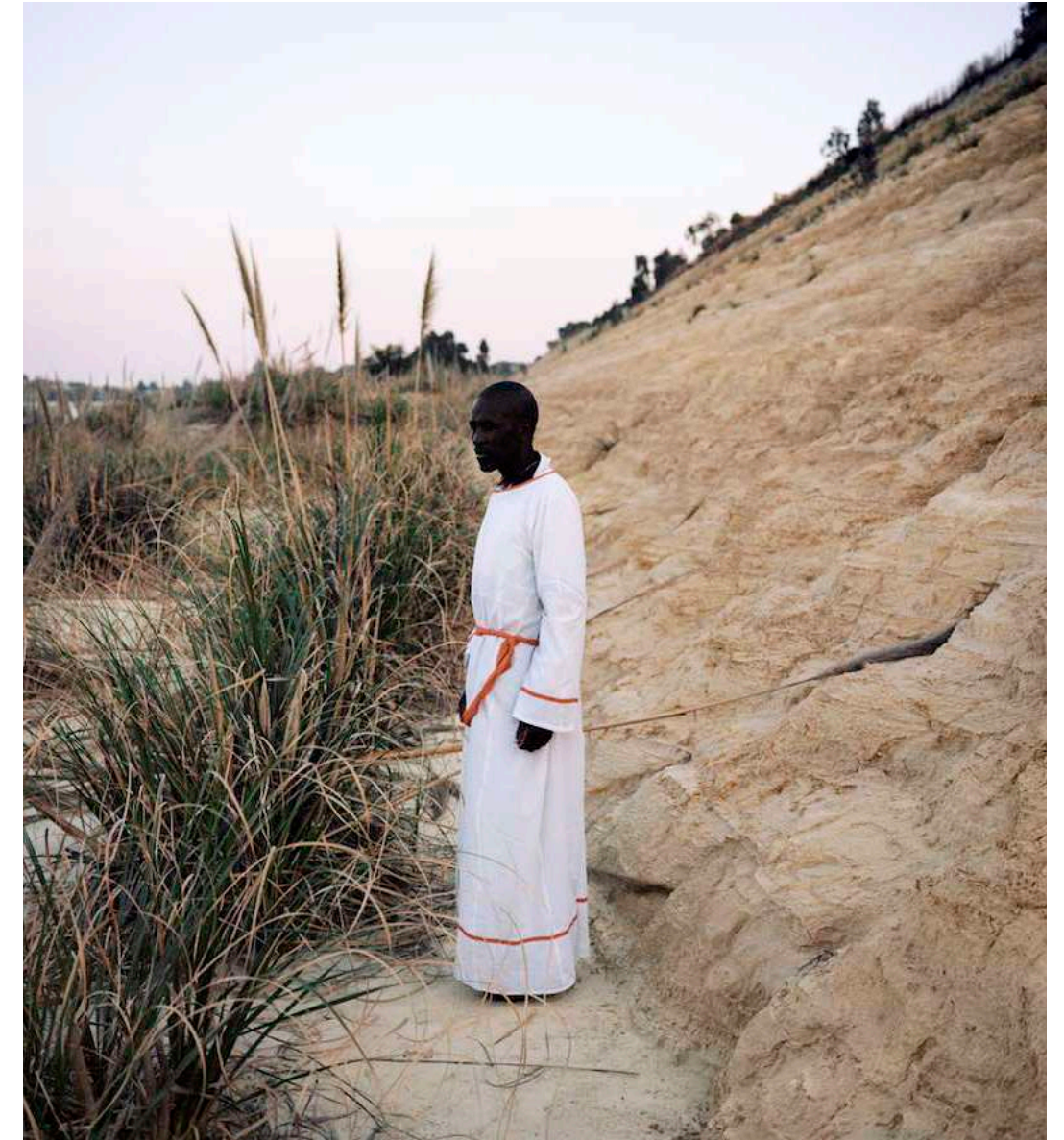
The notion of memory narrates the history of the mine dump as monumental symbol nature there is also a sense of ritual that occurs within these places of valuable discard. The positioning of some of the mine dumps as seen adjacent to Klip River, and the water channels within Olifantsvlei, Boysens and Zwartkoppies highlights the relationship between water bodies and these large ephemeral – abandoned mounds of the mine dumps (Burger *et al.*, 2015). This spatial relationship between the two create a link to the placemaking potential for spirituality and ritual amongst the mine dumps. Baptism and prayer are closely associated with water bodies and purification. The process of physical, spiritual, and emotional cleansing is tied to the physicality of free-flowing water bodies. This draws attention to the significance of these water sources as an opportunity for these rituals to occur. The proximity to the mine dumps offers an isolated, emphatic location adorned with the expansiveness of its site. This often leads to these mine dumps becoming a place of ritual (Harrisberg, 2019). The concern arises as a result of the tailings toxicity. The potential seepage and contamination of the adjacent water bodies from the mine tailing raises the concern for the effect bathing and drinking these waters will have

on the user. The toxicity of mine tailing and particularly the contamination of water – known as acid mine drainage is harmful physically and can lead to carcinogenic implications (Harrisberg, 2019; Mwenda, 2018).

The emphatic principle that arises from this form of ritual is paradoxical in its approach to purification. While the ritual is embodied in a process of cleansing, the water source itself is contaminated; polluting the experience of purification.

Figure 1.6 Prayer Ritual at the Mine Dump (Larkin, 2010)

Photograph captured by Jason Larkin explores the notion of prayer rituals being a linked construct to time and water source, resulting in prayer rituals occurring at sunrise and sunset.



1.3 Historical impact of ruination embedded socially into mining and metallic industry

While documenting the physical effects of mining, the question arises around the effects the industry has caused both socially and emotionally. This raises a further layer of embedded historical contamination and poses a fundamental discussion to the toxic symbolism these mine dumps reflect upon, and thus the significance of the call for social reformation (Mwenda, 2018). Kathryn Yussof’s book ‘A Billion Black Anthropocenes or None’ (2018) explores the individual and human toxicity that the mining industry has inflicted. Yussof captions the industry as a visualisation of “the historic regime of metallic power.” (Yusoff, 2018, p.15) This highlights the corruption and enslavement attached to mining, in which lives have been exploited and equated to a monetary gain. Mine workers in the earlier instalments of the mining industry in Johannesburg can be analysed through a lens of racial profiling and inequality. The start of the mining industry in Johannesburg resulted in the demand for labourers (Mwareya, 2014). This brings to attention the employment of a form

of slavery within the Johannesburg mining industry, in which taxes and rights created the working force that could be deployed beneath the ground. This in essence begins to discuss the toxicity of racial division that is attached to the history of the mining industry. The taxes and regulations imposed under the Apartheid regime created a sense of pressure and lack of rights generating a venomous system of forced labour (SAHA). Mine and Workers Acts from 1911 created opportunity for ‘the white man’ and a servitude ‘for the coloured man.’ This system would result in a lack of rights, unequal wages, longer working hours and precarious environments for the black miner as opposed to benefacting conditions of the white miner (Mwareya, 2014; Mwenda,2018; SAHA). The African labour recruited for the industry represented ten times the amount to the white miner (Mwareya, 2014; SAHA).

Mining conditions by nature are harsh and carry a high degree of danger. The gold

reef line of the Witwatersrand radiated the possibilities for deep embedment of gold that would require long underground mining shafts and extensive equipment to extract gold from rock veining (Mwareya, 2014). These conditions pose endless hours of laboursome work and underground activity in an environment identified as virulent. The mineralogical demand however overweighs the effect these processes can wreak on one’s physical being, as well as mental and emotional state. The experience of underground confinement is explored through various prison architectures and designs (Leach, 1996, p.339). The power and oppression these architectural archetypes possess is directly related to the experience of forced la-

bour underground (SAHA).

1.4 Resulting states of ruination as amalgamation of physical, social, and environmental wounds of metallic extraction

Together the mining environment, forced recruitment and labour rights and benefits are indicative of the historical contamination of the mining industry in Johannesburg. African men were entrapped into an unequal system of forced settlement and mining labour at the hands of mining conglomerates who equated human life to a monetary and commodity value. Individuals were forced to abandon their homes and families to create a livelihood against the imposed taxes from a colonialist system. This entangles a deep history of ruination that has affected both the miner and those they were forced to leave behind. This ruination is left in the monuments that scatter across Johannesburg. Throughout the developed skyscrapers and city CBD – the mine dump mounds act as a form of memory of the toxicity caused to build the city that exists today (Latilla, 2012).

The dumps left in the path of resource depletion showcases the effect we have thrust upon the natural environment. The by-products of this industry have exploited people, animals and nature causing an originally stable landscape to be subject to ground movement in our wake for mineral extraction. Through the architectural theory of power and difference the perspective of the mining landscape can be analysed. The theories lens showcases the Johannesburg layout as result of the power of colonial mining rule and the effect this in turn has inflicted historically. The mine dumps essentially act as the ruins left by the mining industry; a physical demarcation of wounds from the history of mining; politically, economically, socially, and physically (Leach, 1996, p.342). An estimate by the Chamber of Mines states

that extractable gold resources will have depleted by 2033. This statement highlights the finite nature of these resources and emphasises the mine dump as the final memorial sentiment for the resulting “future [we have] built on the annihilation

2 The Metallic Inducement



2.1 Historical significance of metal and gold

While the mining industry in Johannesburg can be analysed by its respective ruination as the premise for this research; the significance of the metal industry as whole is a direct source of ongoing contamination. The prevalent questions that arise is: why these mined commodities are so valuable?

The metals that have been found along the fifty-six kilometres of the expansive Witwatersrand, reef range from precious metal: gold, silver, and platinum to base metals of aluminium, copper, iron, nickel, and uranium. The vast resources are all mined along the reef, Gold; however, has always been the primary driver in mining owing to its ongoing demand and high value (Browd, 2016; Letourneau, 2014).

Metals historically have been used for ornamentation, as jewellery and in construction technologies to feeding the demand for excavation as the mining industry grew in Johannesburg. Gold specifically as a metal can be delineated into its various chemical properties and attributes (Fisher, 2021). Gold has a good level of electri-

cal and thermal conductivity, making it an important element in electronic and aeronautical industries. The precious metal is noncorrosive and has a high boiling and melting temperatures at 1065 degrees centigrade - yet this is easily achieved in a controlled environment (Bullivant, 2019). The material is both ductile and malleable with the flexibility and moldability as required by various industries including jewellery, furniture, and art. The metals appearance is matte-like but can be polished to a high glossed finish (Bullivant, 2019; Fisher, 2021).

The value of precious metals today is intrinsically tied to a market demand. These metals form tradable commodities to which a monetary value can be attached. Universally these metals have long been perceived as valuable due to their finite nature. There is a fixed amount of embedded metal that can be mined creating speculative demand, related to the scarcity of the resource (Truswell, 1978).

The link between gold specifically as a metallic value has been a socio-psychologi-

2 The Metallic Inducement

cal phenomenon that goes back to the roots of some of the oldest religions and cultures. The Jewish Torah, Christian bible and Islamic Quran, all contain imagery that links the metal to power, value, and opulence (Kesselman, 2017; The Editors of The Encyclopaedia, 2008). Religious ideas of ‘the golden calf’ as a powerful symbol of idolatry similarly apply to the adornment of mosques or religious texts (Kesselman, 2017). These religious perspectives see metal adornment as a creation of opulent facades and envelopes that can detract from the connection of spirituality by adding the object of the metal as a physical barrier often identified in religions as ‘idol worship.’ This in synopsis is the negative relationship that the opulence of the material can create. Contrastingly in Greek, and Egyptian mythology gold is perceived as a symbol of beauty and strength (Schorsch, 2017). Its gold lustre is tied to the notion of ‘The Gods’ giving a sense a divine strength to those who have access to it. These various historical and belief orientated perspectives creates the view of extravagance and fancify that is attached to the nature of the metal.



Figure 2.1 Use of Gold in Ancient Egypt (Greco, 2022)
Engraved panel on Tuttenkhamen's tomb in order to explain his story of death in the afterlife.

2.2 Metallic Appropriation

While the ownership of metal can be debated to its natural placement within a landscape, a further argument arises around the regional and cultural possession of the metal. This notion refers to the findings of a significantly rare, mined commodity that is extracted, declared, and then removed by a more powerful state or entity. This showcases the underlying power and scarcity associated with these finite resources (Girdlestone, 2019).

The 'golden rhino' is an instance of this question of appropriation in which an eight-hundred-year-old artefact discovered in the Mapungubwe region in South Africa is being transported to the British Museum. While this narrative is publicised as an educational experience “for new audiences” the other hand refers to the removal of a cultural symbol that signifies a historical understanding of a civilisation that occurred eight centuries ago (Brown 2016; Tiley-Nel, 2016). The sculpture was found in 1930 by an archaeologist in the grave of a Mapungubwe leader on the top of the

hill. This finding generated an archaeological dig below – uncovering remains indicating an entire civilisation and ancient technologies (Brown, 2016; Girdlestone, 2019).The statue therefore creates a significance to understanding the mining environment, and cultures implored in South Africa that are substantially older than the reef line discovery in Johannesburg. This creates a timestamp of value predating metals current worth. The ability to create these sculptures indicates the technology of mining, smelting, and casting prior to universal mining technologies. This would suggest that the rhino is as a physical attestation of a cultural history of gold and its use (Girdlestone, 2019).

The physical property of metal for engraving has a similar poetic comparison to its historical movement and findings. The process of the metal’s lifecycle indicates an entire history that is embedded into the metal. The question of metallic power is therefore deeply etched into the use, findings, and movement of metal globally.

This in turn forms one of the primary notions of historical and social toxicity that governs the demand for the metal (Tiley-Nel, 2016).



Figure 2.2 The Golden Rhino (Tiley -Nel, 2016)
Wooden infill with gold encasement foil.

2.3 Symbiotic relationship of metal to monetary value, analysis of fundamental demand that stimulates mining

While gold has always held a detailed connection to sculpture and ornamentation. The metal has further been a denotation of monetary value throughout history, acting as an exchangeable currency that is non tarnishable and non-corrosive (Beattie, 2022; Fisher, 2021). This enhances the notion of gold as a commodity; being a tradable resource. The tangibility and scarce nature of the metal allows the resource to hold a value that is associated with its production constraints (Beattie, 2022). The creation of gold coins or precious metal coins such as silver is a process that undergoes ‘minting’ ensuring the metal is produced into even sized discs and stamped. This minting process occurs under governmental authority –previously under rulership and kingship - to ensure the legitimacy of a standardised, portable, and durable currency (Extra History, 2016; Whipps, 2017). The historical stamping adornments that are inscribed on the metals identifies the country of origin and ties

the metal back to a sense of power by showcasing the current reigning ruler as the emblematic stamped symbol (The Editors of the Encyclopaedia; Whipps, 2017). The finite nature of the gold is a direct relation to its demand as a commodity. In turn this will affect the possessed value of a gold coin. The use of a coin creates a medium for trade that is acceptable between both parties (Clayton, 2020; The Editors of the Encyclopaedia).

Monetary exchanges today have evolved to the use of paper money and even digital reserves and values. A rationale for this trading shift of legitimate gold coins is a result of the metals limitations. While the price of goods over time goes up the use of money as a currency forced the need for an increase of coins per each purchase. This would be heavy and non-transportable, as well as positioning econom-

ic growth to the equivalence of available gold. A further concern that arose from the primary placement of gold as a monetary value system was the opportunity for base metal application to the gold structure. This term of alloying is a fundamental process to gold production as it makes the metal harder to ensure the metal keeps its shape. However, the process of alloying also allows the metals gold value to fluctuate by changing the purity. This achieved through the introduction of base metals such as zinc or copper. This would suggest that coin could be valued for more than its intrinsic value (Clayton, 2020; Extra History, 2016; The Editors of The Encyclopedia).

One of the most fundamental uses of gold through the lens of economic use, is its security against economic inflation. This was greatly expressed through the Gold

2 The Metallic Inducement

Standard that was implemented in 1870 till 1920 and focused on a global standardisation of international currency in which paper money would act as a physical representation and security for a quantity of gold held in the reserve bank (Funds Europe, 2021; Learn Liberty, 2013). From the initiation of this system onwards it has been illegal for unwrought gold commodities to be held by the public or any persons without a permit specifying they may hold raw forms of gold (unwrought). Gold commodities can only be held by the public in the form of manufactured products, in particular - jewellery or sculpture - as well as in the form of gold coins and commemorative medals.

The gold standard epitomised the restraints on economic capabilities as a result of the finite commodity. The standard while creating stability in relation to paper value was also subject to fluctuations according to gold production. Gold’s increased findings create more accessibility and thus a decrease in value, whereas the scarcity heightens the metals attached value (Beattie, 2022; Funds Europe, 2021).

Metal value can still be seen in the use of coins today. Krugerrands are minted coins that are accessible to public purchase through means of banks and financial brokers – this allows individuals to purchase and own gold (Ash, 2007). The coin is a notoriously and globally used coin that is minted in South Africa which holds one ounce of pure gold. The coin is purchased at the gold price at the time of purchase with an estimated 8% mark up for the minting labour that went into the manufacturing of the coin (Allen et al., 2020). This fee is significantly lower than the labour fees that would accompany jewellery manufacturing but offer the opportunity for individuals to own gold. The value of the coin is tied to the gold price. This means individuals can hold the metal for reasons of economic value (Allen et al., 2020; Ash, 2007).



Figure 2.3 Kruggerand (Direct Bullion, 2020)
A full krugerrand coin minted in casings
equivalent to ounce of gold

Mineral Commodities (Metal)		2010 South Africa Production (Metric Tons)	2010 Global Production (Metric Tons)		2020-2021 South Africa Production (Metric Tons)	2020-2021 Global Production (Metric Tons)
Gold		189	2500		100	3000
Copper		96600	16000000		48100	21000000
Silver		79	22679		56	24000
Platinum		127	170		113	170
Palladium		82	202		80	200
Nickel		3239	1700000		34900	2700000
Iron Ore		58000000	1800000000		62000000	2200000000
Aluminium		800000	135000000		717000	65300000
Rhodium		19	21		18	21
Chromite		10871095	24000000		18000000	41000000

Figure 2.4 An analysis of South Africa’s mineral production in 2010 in comparison to 2021-2022, in relation to global production (Author, 2022)

The graph indicates a significant drop in gold production. In 2010 the production of gold within South Africa had dropped to 0.35%, this indicates the reality behind metal production in South Africa, and thus the production within the city of gold is largely placed on PGM (platinum group metals: rhodium, platinum and palladium).

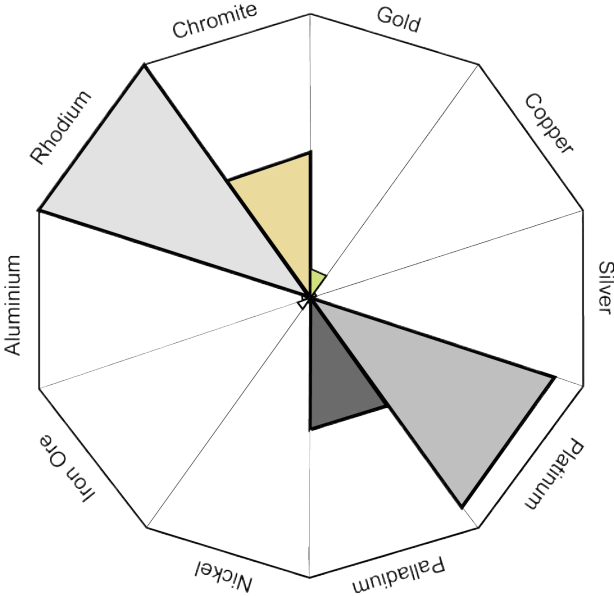


Figure 2.5 2010 South Africa Contribution to Global Metal Production (Author, 2022)

Gold: 7.56%
Silver: 0.35%
Rhodium: 90.4%
Palladium: 40.5%
Platinum: 74.7%

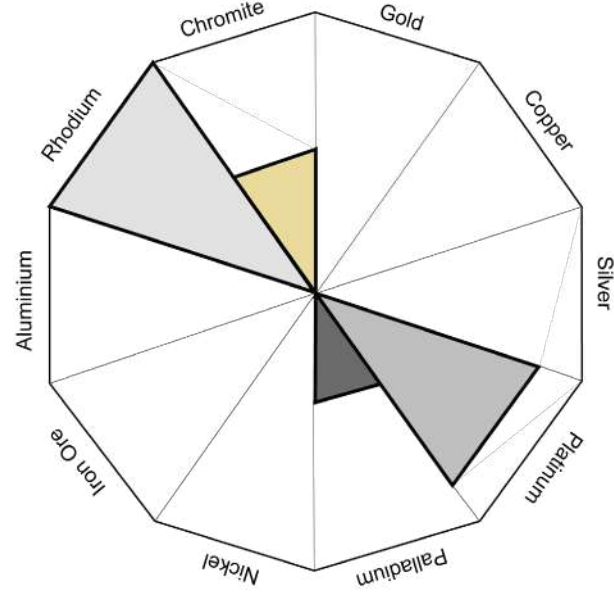


Figure 2.6 2021 South Africa Contribution to Global Metal Production (Author, 2022)

Gold: 3%
Silver: 0.2%
Rhodium: 85%
Palladium: 40%
Platinum: 66%

Value drop in metal production from 2010- 2020/2021. PGM materials such as Rhodium, Palladium and Platinum are still dominant in the South African production market. The price of these metals is indicative of the demand with rhodium being the most expensive metal in the world at an average of R 7500/ gram (statistic taken on 17/09/2022).

2.4 Process of landscape stripping and metallic extraction- though legislation

While Johannesburg historically has been a vital contributor to the global production; producing 67% of global gold production till 1970 (Letourneau, 2014; Truswell, 1978). Today South Africa’s contribution to global production has lowered to 4.2% (Harrison et al., 2012; Letourneau, 2014). South Deep Mine located along the Witwatersrand today is still the largest gold mine in the world, despite the depleting production (Creamer, 2021; Ellis, 2022). This statistic highlights the resource depletion we have inflicted in our wake to keep up with global economies, demands and standards. The natural deposits along the reef have been drained – quantifying the metals value above that of the landscape (Creamer, 2021; Harrison *et al.*, 2012). With an estimate of forty-four active gold mines in Johannesburg, the gold mines are still a fundamental part of the cityscape. The mining environment in South Africa owing to its previous history of dominant gold production is notorious for its mining technologies and mine sizes (Hollands, 2022). Out of the top ten deepest

mines in the world, Johannesburg houses fours of them, being: Maponeng Gold Mine, Driefontein Mine, South Deep Gold Mine, and Kusasaletu Gold Mine (Faku, 2022). This statistic is further enhanced with Maponeng mine being the deepest current mine in the world at minus 3.8 kilometres sub surface (Faku, 2022). The list of ten deepest mines then further includes two more mines in South Africa located in the Vaal dam region. This approximates six of the ten deepest mines housed alone within in South Africa (Analysis, 2019; Hollands,2022).



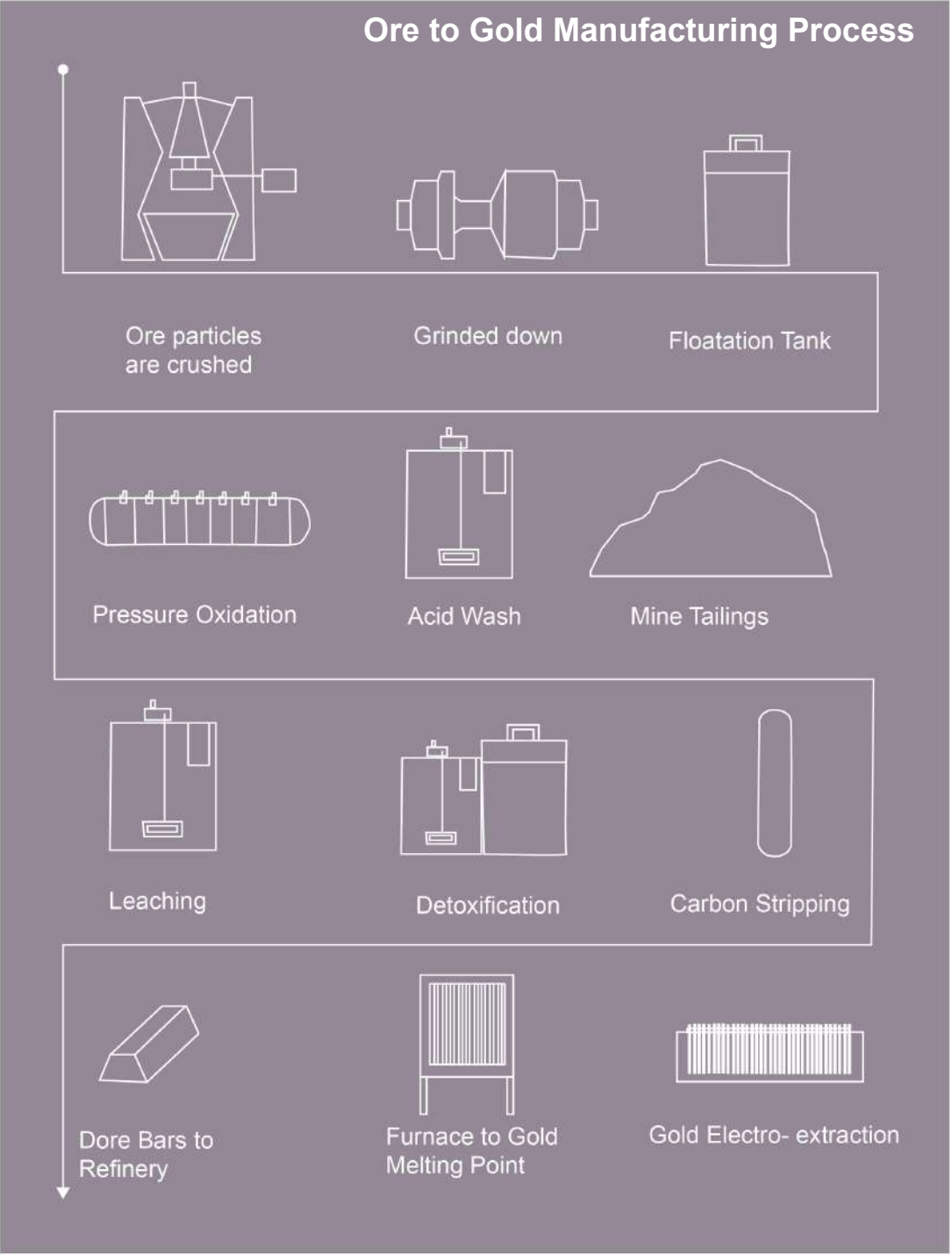
Figure 2.7 Mponeng Gold Mine (Graccon)
The current deepest mine in the world, located in Johannesburg transports approximately 4000 mine works down the elevator shafts.

2 The Metallic Inducement

The mining process for gold can be analysed via formal and informal processes. These two methodologies highlight the contamination and toxicity they inflict, undergo, and suffer (Lieberink). The process between the formal and informal is also a direct result of economic capabilities and government allowance and regulations. The formalised processes as proceeded by mining companies starts by sinking shafts underground and blasting or drilling ore particles from rock walls where gold is presumed (Haldar *et al.*, 2018). These ore particles are then removed from the mine and processed through crushing equipment to break down the large rock particles. The crushed ore is processed through large scale milling equipment to grind down the ore further to fine particles that are easier for transportation as well as making the extraction of valuable materials an easier method (Haldar *et al.*, 2018). The next process involves leaching the gold from the ore; the fine particles are treated with arsenic –achieved in a liquid form that chemically pries the gold away from the ore (Haldar *et al.*, 2018). The leaching process is achieved over twelve to thirty hours while maintaining a constant temperature (Altinkaya *et al.*, 2020). The leached liquid solution is then filtered through a system called: the clarification

leaf processor. The clarification leaf filters any solid substrate particles. The filtered solution goes through a system of ‘vacuum de-aeration’ which removes gases from the solution. This essentially will remove oxygen and carbon dioxide from the gold solution (Ball, 2017; Haldar *et al.*, 2018). The solution will then be treated with Zinc powder which will precipitate gold out of the solution – essentially allowing the gold to be ‘recovered’ from the solution into a solid state (Ball, 2017; Haldar *et al.*, 2018). The total solution will go through a filter press to remove the liquid solution from the solid gold particles. The gold is then washed to remove any excess solution. To ensure all other substances are removed the metal is put through a high heating system of smelting – which will burn off substances. The gold can then be poured into a specified form that can be transported to a refinery for processing (Auerswald *et al.*, 2005).

Figure 2.8 Ore to Gold Manufacturing Process (Author, 2022)
The ore pieces go through a series of manufacturing before reaching the consumer. The main requirement is to extract the gold as the ore contains other minerals and acids.



2 The Metallic Inducement

Contrarily artisanal and non-formal mining extracts the ore from existing veins that have already been mapped out through mines that have been abandoned. The ore is manually drilled from the rock surface and crushed via available tools or via a crusher. The milling process turns the rock chunks to dust via a ball mill drill attachment that is found at most hardware stores (Mugai, 2020). The gold then needs to be separated from the ore as seen in the leaching process – this however is achieved using a box that allows water to run through it relying on gravity to separate the heavier metal from the lighter sands and soil components (Mugai, 2020). The box is known as a ‘sluice box’ and can be made by the artisanal miner (Brock, 2015). The leaching process if further carried out using mercury solutions to extract the metal further forcing the gold to amalgamate with the mercury to form a softer solid. The substance is then melted to evaporate the remaining mercury leaving behind the metal composition in the form of solid metal mix (Mugai, 2020; Reuters, 2014). This in essence will expose the artisanal miner to high levels of poisonous contact from mercury as well as the toxicity from the pyrite particles they will breathe in through the process of extraction and crushing (Reuters, 2014).



Figure 2.9 Zama Zama Mining (Mohlala, 2017)

The creation of a ‘Phenduka’ (sluice box) from an upcycled gas canister to create the gravity system to replace the formalised process of metallic sorting.

2 The Metallic Inducement

The two processes - despite their formality or lack of - highlights the significance of chemical positioning that is essential to the extraction of the gold. The process is entangled in a contamination in order to produce a product that is labelled pure (Reuters, 2014). This in essence will affect those who exposed to the pollution but also a resulting by-product of pollution that can seem into the air, the water, and the landscape (Clark, 2019; Mwenda, 2018).

The dangerous nature of mining as previously discusses results in toxic exposure but also the hazardous environment of the vertical shafts. This threat affects both formal mining process and informal (Reuters, 2022). While artisanal mining is a form of economic generation that is stimulated from the abandoned waste, it still poses the threat of a dangerous working environment. The abandonment of a mine often leads to the removal of infrastructural systems that aided in mining safety. Without safety systems in place, the miners are exposed to a larger risk that has resulted in numerous fatalities as a result of shaft instability and acid mine drainage water levels (Sullivan, 2021).

A further danger that persists around the informal process is the lack of physical security that is highly installed in formalised operations. The shift from a mining conglomerate to individual artisanal miners showcases the notion of ‘each to their own,’ where each can earn on the basis of their findings (Jamasmie, 2015). This can lead to internal fighting and danger that threatens the miner (Mugai, 2020).

While the physical result of mining is demonstrated in the monuments of a mine dump, there are further effects that are not as visually apparent. Mining originally to the cityscape causes ecosystem degradation and in some instances series of deforestation to remove vegetation (Betournay, 2011). The soil further is subject to instability and erosion. The exposure of these excavation sites to water and wind can cause soil to become displaced and to move away from origins. A further concern is the effect of excavation on the creation of sinkholes (Papas, 2017). These cavities can be detrimental and life threatening to the region they are in. The sink-hole can collapse spontaneously and rapidly (Papas, 2017).



Figure 2.10 Ecological Effects of Excavation (World Atlas)

The deforestation caused by mining. The natural landscape can be stripped in order to accommodate the industry; however outskirts trees are necessary to soil stabilisation and in turn the trees are cut back to create perimeter edges. This creates a juxtaposition between ruin and necessity between landscape and destruction.

2.5 Resulting devastation inflicted by the monetary perspective

In essence metallic value has been an in-demand commodity throughout time.

A quote by Nils Bubandt et al - in the essay collection: ‘Arts of Living on a Damage Planet’ phrases this demand as an “era of human destruction [that] has trained our eyes only on the immediate promises of power and profits.” (Bubandt *et al*,.2017, p.15) Its ever-changing desired rationale for extraction -while ranging - has always had a connection to power and perceived value. The construct of wealth and significance encompasses the deposits acting as a motivator to strip landscapes and appropriate the existing natural environment (Bubandt *et al*,.2017, p.15). The metals embedded value from the social constructs we have created – stimulates a moral rationale for those in power to create this toxicity that extends from social, political, economic to environmental devastation (Olalde, 2016). This justification of toxicity leaves high levels of waste – Six thousand mines lie abandoned upon the Witwatersrand Reef with mine dump wastelands left to pollute the environment because

of conglomerates removing as much minerals as economically beneficial and declaring unprofitability to not exhaust efforts (Clark, 2019; Olalde, 2016). This means that the mining waste is abandoned. The promised duty of environmental obligation is second to profitability. The mines create open wounds within the landscape that can be polluted from the now exposed pyrite particles. While mining regulations aim to prohibit this abandonment of waste, these regulations did not regulate the industry during mining peaks allowing for landscapes to be drained and abandoned (Harrison *et al*., 2012; Olalde, 2016).



Figure 2.11 Soil Instability (Tama, 2012)
Soil collapse and toxic water leaching in Virginia, America

3 The Toxic Result

3.1. Toxic by-products caused by mining waste

Kathryn Yussof raises the notion of society's perception of commodities in her book '*A Billion Black Anthropocenes or None*,' as she phrases the metal extraction industry as "the language of exchange [where], it might be assumed that something was given rather than just taken" (2018, p.40).

This notion accentuates the concept of the post-production and marketed product.

This positions a perception of metal production as a systematic process that starts with cause and leads with a produced good. Through the lens of the consumerist this instant gratification of the resource is seen through its commercial acquisition. Commercial retail stores of the metal showcase the final product in its polished and purified form.

This creates an absence in the consumers realisation of the true nature of the product. They see the final abundance of material in a store and yet the memory of the

toxic process is unaccompanied in the final form. The advertisement of the mining industry showcases the abundance of materiality and fortune to be found to benefit us as a global society. This serves as a form of promotion that ties to Yussof's statement: in which there is the understanding that this material is somehow owed to us rather than a natural element that has been disturbed and forcibly removed.

This enhances the significance of documenting the state of toxic liminality that exists between the possibility of gold findings to the production of goods, the state the most do not see (Fitz *et al.*, 2019. p.12; Yussof, 2018, p.40). The occurrence that poses the most enduring threat - socially, environmentally, and economically, is overwhelmingly: pollution.

The mine dumps are the monuments that symbolise the toxic waste created by the mining industry. They visually highlight their existence as their purpose is

solely related to mining wastelands. This highlights their importance to the notion of memory, however; there is an extensive amount of pollution that exists that is not as easily landmarked.

There are three forms of pollution that the pyritic particles inhabit. Dust, Soil and Water. These three forms of ruination in nature occur on various scales in the Johannesburg region, which ultimately affects their degree of toxicity and therefore their degree of ruination (Balch, 2015; Schrader *et al.*, 2015).

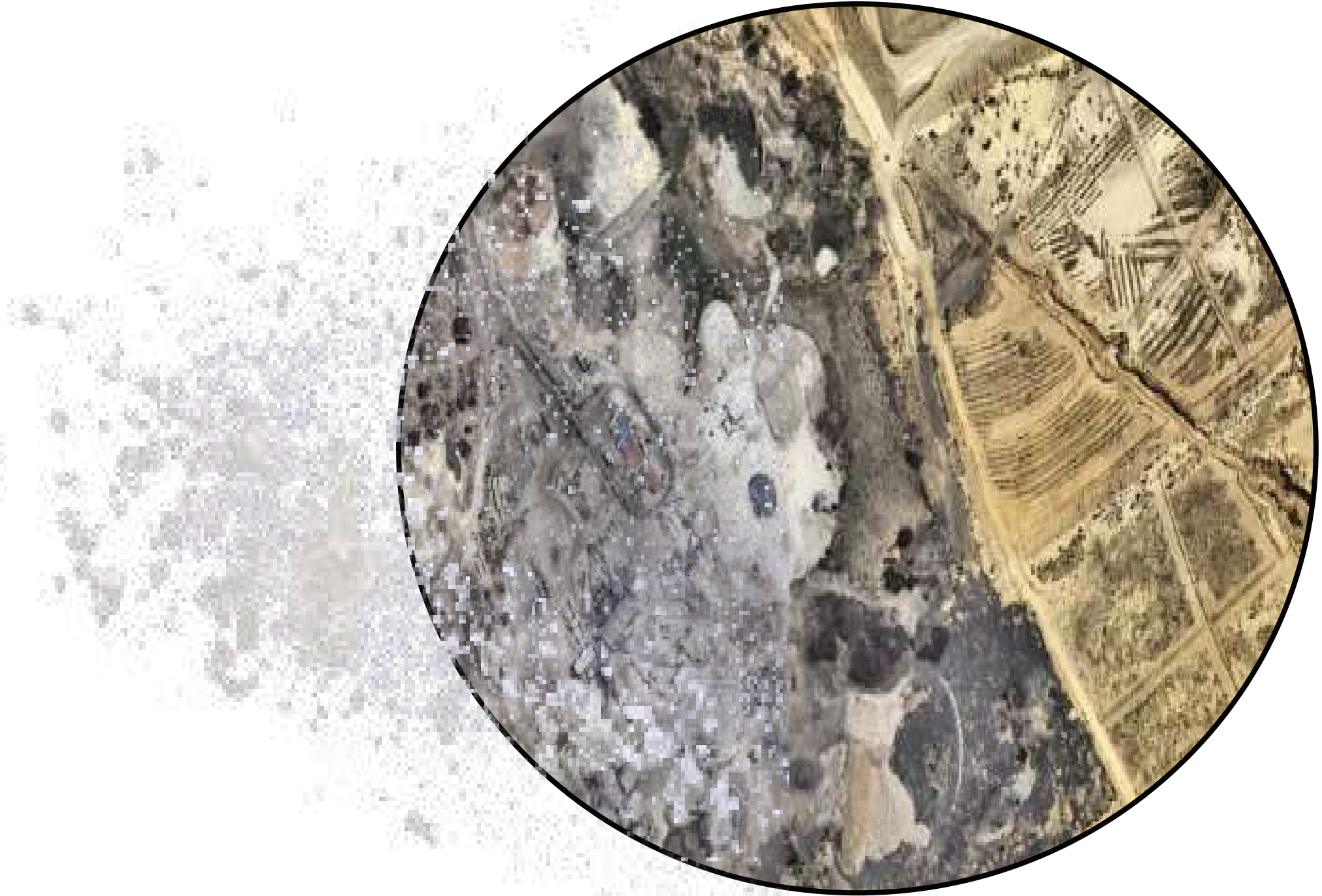


Figure 3.1 Natural Mineral Repository Collage (Author, 2022)
Collage exploration of the dust, soil and water toxicity from the mining industry.

3.1.1 Dust

The dust particles that contain this sulfuric contamination are mixed into the existing dust of the Johannesburg landscape. This creates a toxicity that is undistinguishable and easily hidden into the malignant history that accompanies the materials production (Smallhorne, 2012). The small particles are therefore able to travel expansive distances via wind direction and inhabit the surrounding cities, informal settlements and factories that line the surrounding mines and mine dumps. This movement allows the toxic dust to enter inhabitants' respiratory systems; suggesting that the inhabitant will be breathing in this toxic dust that has been associated with the creation of carcinogenic conditions, neurological concerns, and respiratory ailments (Balch, 2015; Nkosi, 2018). The height of the mine dumps also creates the opportunity for these particles to travel larger distances because of a higher wind velocity at the mine dumps peak (Nkosi, 2018; Grange, 1973).

Figure 3.2 Habitation on the Mine Dump (Google Earth, 2013)
Featured is a house built on part of the mine dump - the concern arises around the dust proximity and potential respiratory concerns that arise from the spatial relationship between the two.



3.1.2 Soil

The second pollution that occurs is the contamination of soil. The sulphuric acid content seeps into the ground soil below penetrating below the surface. This creates the concern that when a mine dump is removed, the space below still holds the contaminated earth in its wake. The result will affect the habitancy of the natural landscape (Blaga *et al.*, 2019). This concept of toxic soil is most indicative of ruination of the landscape we have stolen from. Its original resources are depleted and what is left is poisonous, replacing abundance with radiation and carcinogen. The use of the land post mining therefore requires extensive remediation in which the soil requires cleansing through chemical neutralisation to balance the sulphuric levels of the soil (Sinkala *et al.*, 2011. P5-7). While the soil can be neutralised over time and through expensive infrastructural processing the apprehension arises around the quality of the soil (Blaga *et al.*, 2019). This in essence reflects on the potential stripping of nutrients from the soil in which the soil is potentially socially usable but not environmentally habitable. This raises the notion of our irreparable

pollution in which; “the planet we live on and live with is exhausted, drained, depleted, damaged [and], broken” (Fitz, *et al*, 2019).



Figure 3.3 Sinkhole in Chile (Unknown, 2022)

Formation of a 50m sinkhole caused by metal mining.

3.1.3. Water

The third contamination that poses the most extensive threat is pollution of water known as Acid Mine Drainage. While the previous two pollutions are vitally critical their extent of contamination is region based. Acid Mine Drainage contamination however begins to toxify hundreds of kilometres worth of water bodies that are essential to our drinking water supply (Burgess *et al.*, 2010).

Acid mine drainage is the result of the pyrite oxidation, which creates a chemical reaction resulting in the previously mentioned iron disulphide. When the contaminated particle counters water from existing dams or rainwater runoff, the resulting reaction forms toxic sulphuric acid sludge known as Acid Mine Drainage. The heavily rich metal water is now toxic and transfers a red-orange property to the originally clean water. The effect small rivers and streams inflict on major water sources is a result of the city layout. Johannesburg’s development as a city as a result of gold deposits is an enigma in terms of city planning (Humphries *et al.*, 2016, p.95-98;

McCarthy, 2012). The traditional rationale for city formation is the location of major water bodies or religious activity such as churches. Johannesburg however is uniquely positioned around the extents of the gold reef line of the Witwatersrand. In turn this results in a city that lies between water basins using “tributary” smaller streams and rivers to connect the city to the larger water supplies of the Vaal Dam, and primarily to the Lesotho High Lands catchment (Burgess *et al.*, 2010; Humphries *et al.*, 2016, p.95-98; Schrader *et al.*, 2015).

This creates a scenario of water veining that connects the water catchments between the mining town- resulting in the allowance for the acid mine drainage to run into flowing streams and dilute within the connecting water, mixing toxicity into a fundamental water supply (Burgess *et al.*, 2010).

This creates the ability to ascertain the expansiveness of contamination and ruin-

ation. The mines have spread the toxicity along the reef line; however natural and fundamental elements such as wind and water have aided the toxicity to move and spread, creating a spreading horizontal plane effect to the vertical tainting that industry has inflicted. (Cukrowska *et al.*, 2002; McCarthy, 2012).



Figure 3.4 AMD Water (Musingafi, 2013)
Contaminated water source, depicting the saturated discolouration that affects the water.

3.2 Impact of Acid Mine Drainage on habitation

A major concern arises around the nature of informal settlement placement to the mine dumps. This proximity brings up the emotional toxicity of marginalisation that is directly associated with the mining industry but also the toxicity that occurs from the close nature of occupation. According public and mine health specialist: Vusumuzi Nkosi, “[a] estimated 1.6 million people live in informal and formal settlements on – or directly next to – mine dumps in South Africa” (Nkosi, 2018).

While the dust particles play a large factor in respiratory concerns in these areas, affecting these areas most prominently, the water supply or more significantly, the lack of, plays a vital role in the imminence of this pollution (Balch, 2015; Burgess *et al.*, 2010). Water and sanitation access are fundamental resources that are commonly inaccessible to informal settlements that surround the mine dumps (Schrader *et al.*, 2015). This fundamental right and access to basic needs that has

been unattended, results in inhabitants using the surrounding rivers and streams as water sources. The toxicity concern therefore arises as inhabitants are bathing, cooking, and drinking from the sulphuric water (Cukrowska *et al.*, 2002; Kotze, 2011). A key takeaway from this notion: regards the point of intervention that occurs for toxic water treatment.

A major concern is that generates this toxicity is abandonment. While this toxicity is almost a second-hand repercussion – further fatal repercussions exist upon the physical existence of the mining landscape. Mining alone is a dangerous activity; however, the abandonment of mining landscapes is dangerous to the occupants in surrounding areas (Clark, 2019). This is of both for the originally operational mine and the mine dumps. Leaving access to the mining unattended can be life threatening. Mines fill with water which have led to drownings and landslides (Hendriks,

2022). A further concern is falling within the confined spaces (Clark, 2019). Today’s mining regulations and legislation prescribes the removal of waste from acid mine drainage to be chemically treated to neutralise the contamination for the water to be fed back to nation water supply systems (Trans- Caledon Tunnel Authority, 2011). This is achieved through treatment plants on active existing mines, as well as through a government implemented treatment program in collaboration with the TCTA (Trans-Caledon Tunnel Authority).

While the operational mines today indicate the immediate removal of toxic water, the need for the major plant system showcases the toxicity inflicted by one hundred and thirty-six years of mining ruination (Balch, 2015).

3 The Toxic Result

The impact this has on informal settlements is a direct result of pre-regulatory actions. The contamination of water from older mines that were abandoned, and unimpeded mine dumps results in a dormant situation of untreated water that is used by individuals who inhabit the spaces between the mines. This heightens the need for intervention.

The toxic water of Acid Mine Drainage is indicative of wastage in its most harmful formation. The waste piles that form the mine dumps are the first stage of waste that has been carved out of the ground and transferred to mounds that allow the runoff to occur for the second stage of contamination. This history and memory of pollution is embedded into the notion of wastage which has been deemed to this point as hazardous and toxic (Fitz *et al.*, 2019. p.12). The reality of the waste however is also opportunistic. The waste is contaminated and dangerous, yet rich in metal and mineral content, containing small pockets of precious metals that were not worth the mining facilities to extract (Cukrowska *et al.*, 2002).



Figure 3.5 Natural mineral repository collage (Author, 2022)
Collage exploring the toxicity of underground mining through the exposure of shaft access openings to water build up causing acid mine drainage. Mine operations historically continued during these conditions until the declaration of the safety concerns surrounding acid mine drainage.

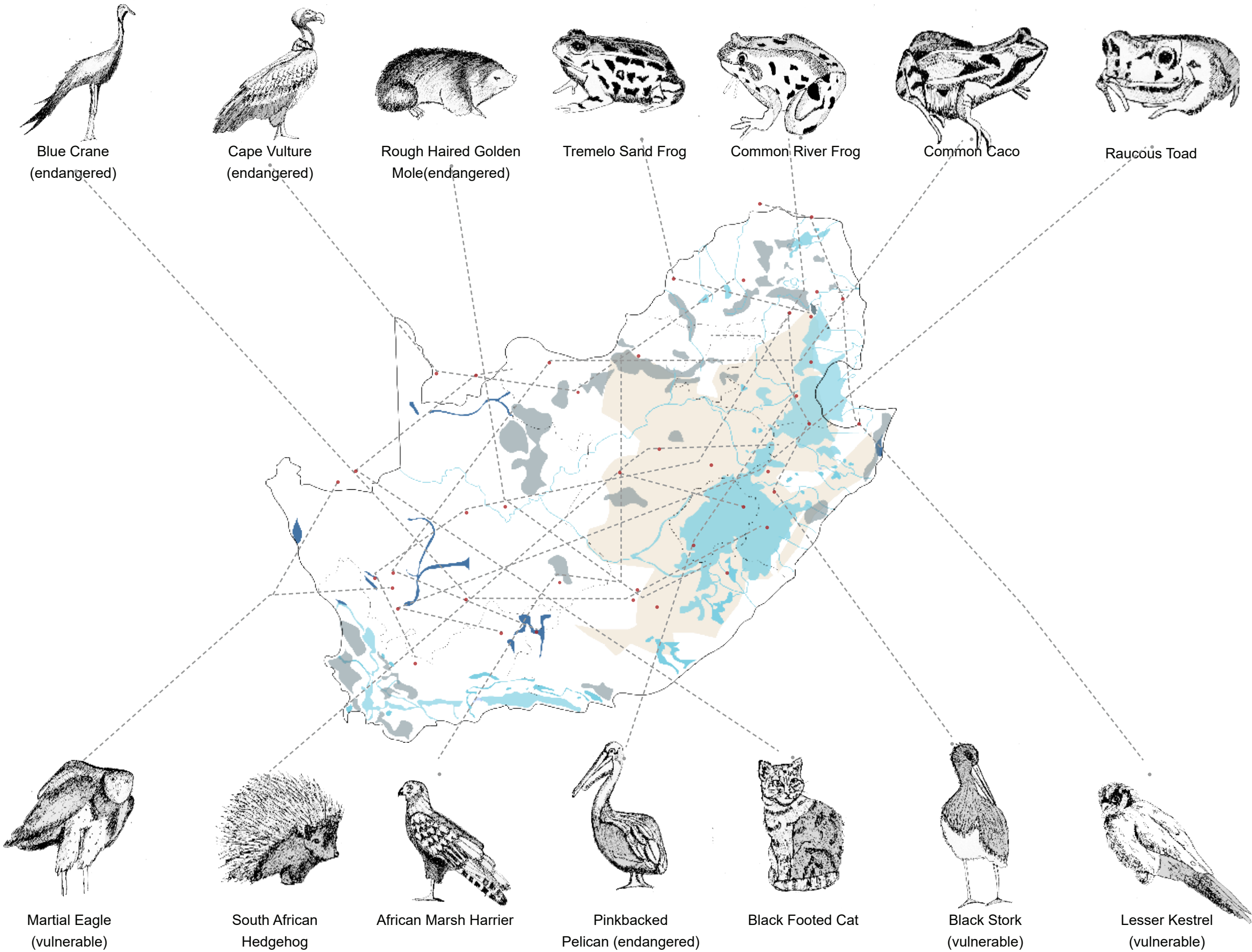
3 The Toxic Result

The toxicity from dust, soil and water has a further effect on further habitation affecting fauna and wildlife. The major toxic concern in this instance is the water and its relative effects on ecology. Aquatic animals such as amphibians may be exposed to an intense volume of acid mine drainage. Contaminated streams may result in fatality, respiratory concerns, and reproductive anomalies (Bega, 2022).

The water sources are fundamental to the survival of various fauna species, and therefore contaminated water sources become an increasing concern.

Soil instability poses a threat to animal habitation and their relative spatial occupation, and thus regions with ground water and wetlands conditions may be more at risk to soil collapse and sinkholes.

Figure 3.6 Fauna Mapping (Author, 2022)
Fauna and Amphibians affected by the toxicity of the mining industry



3.3. Shift in perspective; opportunities from toxic waste and metallic waste recycling

The previous discussion on metallic value heightens this notion of wastage. These metals have been deemed of extreme value to the level of landscape appropriation and devastation with an estimate over one hundred billion tons of metallic wastage in South Africa per year- a large quantity of mining efforts in this form of waste are deemed ‘scrap’ (Cukrowska et al., 2002).

This raises the questions around the possibility for metal extraction and recovery as a process of wastage reuse. This queries the methodologies and the possibility of metal precipitation from the toxic wastewater of acid mine drainage. Similarly, to the notions explored through metal refinery, a notion of chemical treatment can be applied to coax the metal out of liquid form to a precipitated solid formation. This essentially creates the opportunity for waste recycling, retrieving back small

particles from the toxic solution (Bryson *et al.*, 1997, p.169-170). The significance of this exploration is based on the amount of toxic waste production but also on the finiteness of underground gold.

Experimenting with waste metal retrieval on a home scale differs to that of the techniques of a metal refinery; however, the possibilities of this waste retrieval on both scales is ultimately achievable. This highlights the access and availability to the skills and resources needed to perform such a task on both the industrial formalised scale, as well as the smaller artisanal opportunity.

The chemical term ‘precipitation’ in the context of liquid metal solutions - such as acid mine drainage - refers to the process of extracting the solid metal from its current liquid state from the toxic sludge (Fleming, 2011). This allows the liquid to un-

dergo a chemical treatment to remove the wasted metals. The formalised process within metal refineries is a more chemically controlled process ensuring the fumes from the chemicals used to treat the various metal solutions. According to Michaud, metal solutions such as: nitric acid, sulphide and hydroxide do not contaminate spaces and are able to be reused (Michaud, 2018). The formalised process will also reduce the wastage significantly, using exact chemical compound formulas to monitor the process. The chemicals used to treat the solution are dependent on the metal they aim to extract outwards. The reactions occur dependently and thus will result in various approaches to the chemicals used for different metals (Michaud, 2016).



Figure 3.7 Chemical Metal Precipitation (Science Photo Library)
Metal salt state.

Acid Mine Drainage Treatment and Equipment

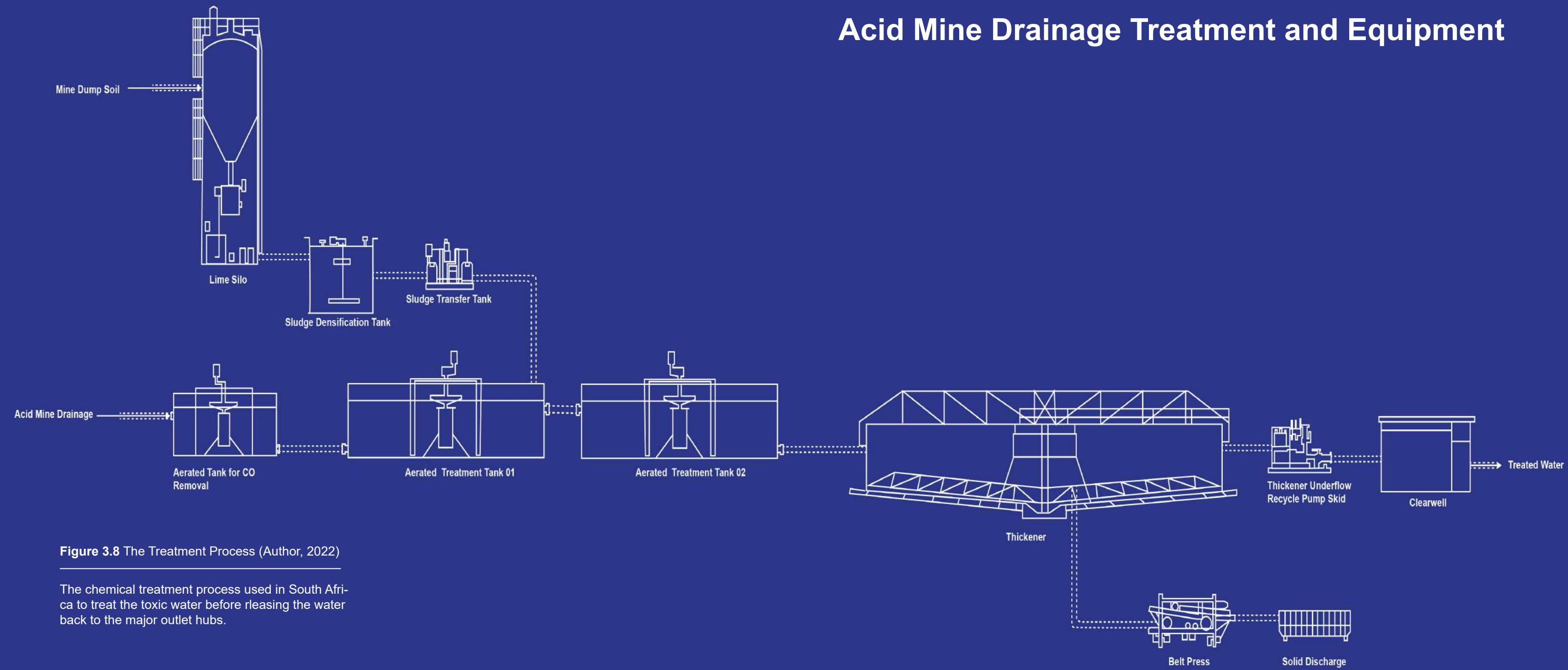


Figure 3.8 The Treatment Process (Author, 2022)

The chemical treatment process used in South Africa to treat the toxic water before releasing the water back to the major outlet hubs.

3 The Toxic Result
Nitric Acid Sketch Charette

From the more artisanal approach, the author conducted a controlled charette experiment under the supervision of a jeweller manufacturer. The experiment conducted was around copper metal precipitation from nitric acid solution. The process relies on a chemical reaction between the copper and the nitric acid. The copper was in a completely dissolved liquid state when in the presence of the concentrated nitric acid and small portion of distilled water, transferring a blue colourant to the originally transparent chemical (Fleming, 2011; Red, 2018). The scientific terminology for the reaction that occurs is the creation of Copper Nitrate ($\text{Cu}(\text{NO}_3)_2$). During the process of burning between the nitric acid and copper – the solution let off a dark orange smoke which is the ‘nitrogen dioxide.’ This is traditionally controlled using equipment in a metal refinery to ensure the fumes are contained; however, on the artisanal scale the experiment required to be performed outside to avoid fume inhalation (Sullivan. 2012). Once the fumes had begun to die down – indicating that the solution had either expended itself or the copper had been completely dissolved – the substance of urea was used to neutralise the acidity. This left a deep blue liquid of the dissolved copper. To get the copper into solid formation a further reaction was required (Fleming, 2011; Sullivan, 2012).

The copper was required to undergo an electrical process using positive and negative charges (cathodes and anodes) to coerce the metal out of the liquid and into solid form- this in essence is a reaction using the principles of scientific attraction (Red, 2018). The placement of a steel rod into the solution allowed this process to occur. The copper particles became attracted to the rod and started forming filing type layers around the steel rod. Over the course of a few hours or overnight in terms of the experiment, the copper fully encased the rod (Sullivan, 2012).

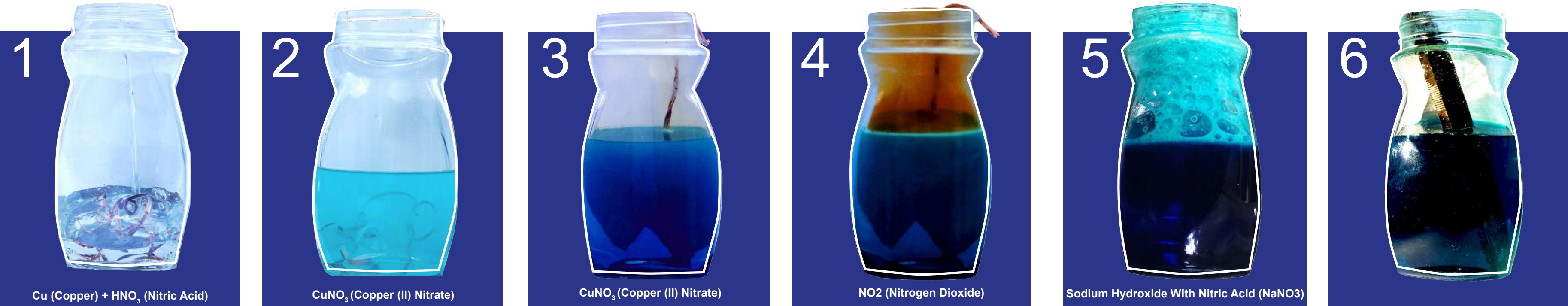
The steel rod was then be removed from the solution, and the copper scraped off the rod and rinsed in preparation for melting down into solid copper product- ready for use.



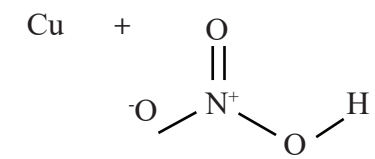
Figure 3.9 Sketch Charette Cleansing (Author, 2022)
Draining and cleaning off any excess solution with distilled water and muslin cloth.

3 The Toxic Result
Nitric Acid Sketch Charette

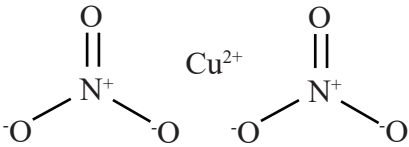
Figure 3.10 Sketch Charette - Chemical Processes (Author, 2022)



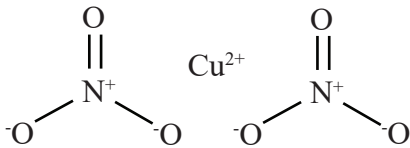
Stripped copper wire is flattened using a hammer and then placed in a glass container with pure nitric acid solution.



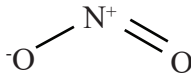
The previously clear solution begins to turn a light blue as it begins to ‘eat’ the copper wire. This occurs when the nitric begins to dissolve the solid wire.



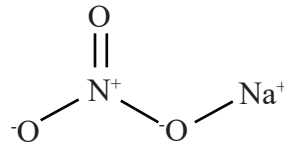
The solution begins to take on a darker blue colour on the basis of how much copper is dissolved. Adding additional copper will darken the colour.



A brown smoke will begin to billow from the solution releasing nitrogen dioxide as a result of the exposure to oxygen. Using appropriate apparatus can prevent this from escaping.



Once the brown smoke has ceased to billow and any additional copper does not dissolve - the solution is at a state in which the nitric acid has expelled its energy and the solution can be neutralised with sodium hydroxide.



A steel rod is then placed into the solution causing the dissolved - liquid copper to attract to the steel rod. This chemical reaction is a result of positive- negative particle attraction between the protons and the electrons. This will draw the copper onto the rod in the form of solid copper coloured particles.



Figure 3.11 Sketch Charette Outcomes (Author, 2022)

The particles precipitated out of the nitric acid solution are soft and filing-like. The filings created their own organic form and would break upon touch. Placing the filings in a crucible and heating the element will allow the copper to form a solid shape- gaining its harder form.

Primarily the experiment was indicative of the possibility of extracting minerals out of acid mine drainage; through the particle change between solid, liquid and gaseous states. There was however a further understanding that the experiment highlighted, being: the organic formations of metal. The recti-linear formations showcase straight and sharp edges that have moulded around the steel filing. The metal will in liquid form began to mould and form around the recti-linear shape of the steel file. While these soft particles broke off upon scraping - the inherent shapes remained.



3 The Toxic Result

This experiment highlighted the possibility for waste to be re-examined through the lens of toxic treatment as well as the prevention of refuse (Corder, 2019).

The metallic industry apart from the mining waste – is a system that relies heavily on reuse. The jewellery industry alone is responsible for 78 percent of gold production (Minerals Council South Africa). While they form the primary demand for the capitalism that drives the mining industry – the process of reuse is a principle that is heavily adopted within the practice. Jewellery by nature is a form of processed and sculpted metal – in which the original product undergoes a series of heating, casting, pouring, moulding, and shaping to produce the finished article. The process follows a form shift of the metal where it has passed through several chemical states to achieve the final design; however, those changes are processes that can be repeated constantly (Alexander *et al.*, 2018; Edden, 2016). The nature of metal allows for these pieces to be melted down to form a new function. This creates the sense of lifecycle behind the material. Its waste and production effects are too large to be unacknowledged however the nature of the continuous reproduction of the

metal is a fundamental principle to its nature. The finite supply of gold findings within the earth may have repercussions to the mining industries success. However, gold and metals are categorised by a strong possibility for adaptability and potential (Alexander *et al.*, 2018).

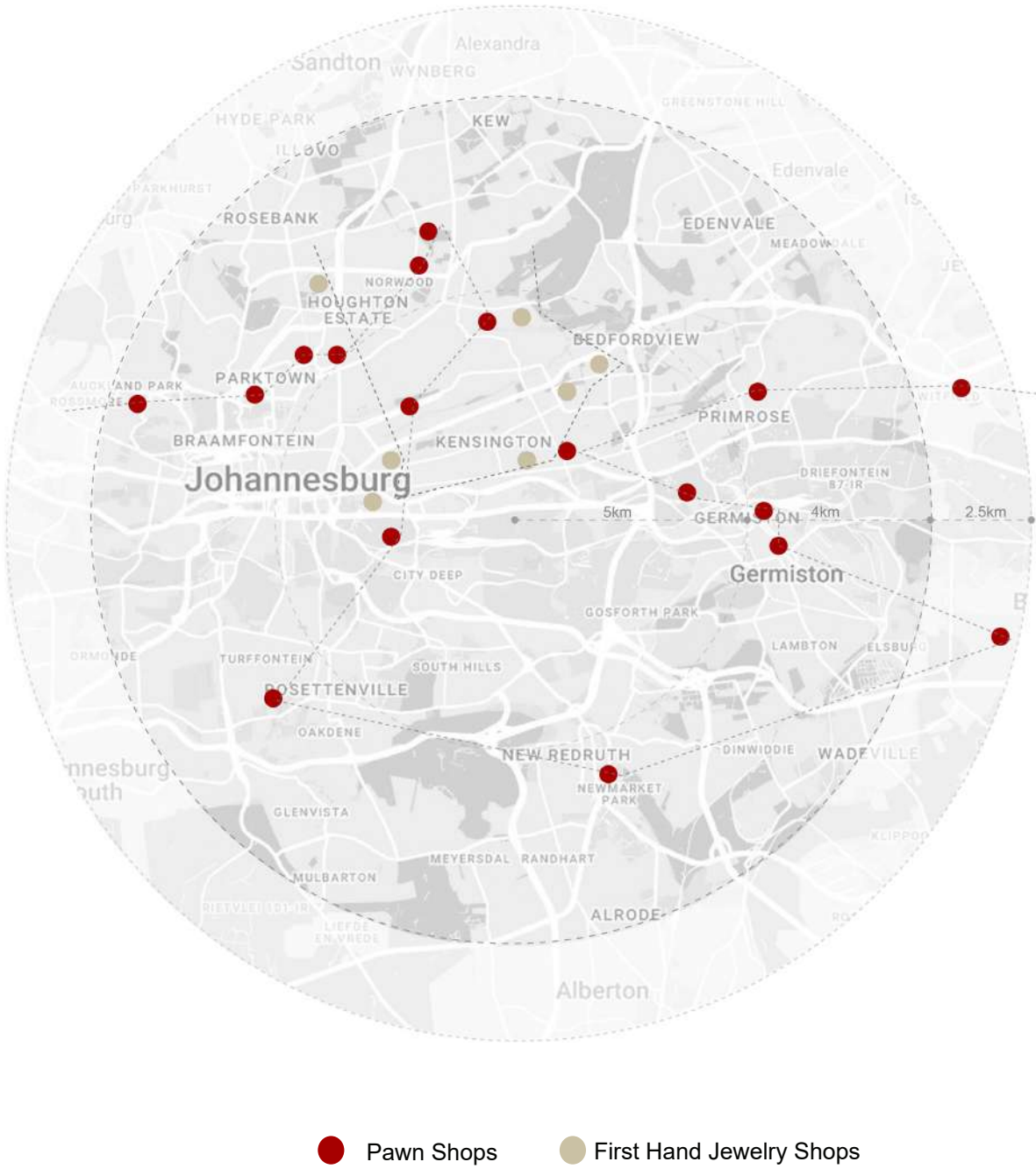
This notion highlights the jewellery industry as a twofold factor in gold production-one as a perpetuator of the need for mining but also as the possibility for waste and reuse to drive the industry and thus the future of gold in a world of post mining. Gold throughout history has been an economic investment but also one in social and fashion industries. Methods of first-hand reuse of gold is evident in most jewellery manufacturing factories. Old clients bring in pieces of jewellery that have grown outdated or unnecessary and regenerated into new forms to tie the metal to fashion and economic changes (Alexander *et al.*, 2018).



Figure 3.12 Copper Filings that Broke During Precipitation (Author, 2022)
The lightweight nature of the filings resulted in an accumulation of particles in the bottom of the glass jar after precipitation procured. These particles had broken off and did not reabsorb as the nitric acid had been expent and neutralised.

3 The Toxic Result

While direct contact with jewellery manufacturers forms the first stage of metal recycling. One of the most common architectural formations of this exchange is the use of pawn shops (Pawnbroking Industry Data & Statistics). The pawn shop aims at either buying old goods for a monetary value or making a profit for selling old goods on the owners’ behalf. The first-hand form of metal recycling occurs through the process of second-hand consumerism – in which jewellery can be resold to a new owner (Pawnbroking Industry Data & Statistics). The second form of metal recycling acts a form of mediation between jewellery manufacturers, wholesalers, and the consumer. The architectural instance allows for a series of exchange to occur preventing wastage and aiding a finite production system.



A second architectural formation that allows the exchange and recycling process to occur is the metal refinery (Auerswald *et al.*, 2005, p.1-6). While the function of metal refineries is closely integrated with first hand gold production; a secondary program is performed of recycling old equipment and articles, particularly pertaining to the jewellery industry. The refinery will look for wastage, taking in items that may contain any form of metal from: old carpets in jewellery factories, burnt and discarded melting crucibles (graphite containers to melt metal), and sandpaper. The refinery in essence acts as a waste plant. The collected materials will be incinerated accordingly, and the resulting metal found will be bought by the refinery, and process to form pure forms of metal that can be sold back to jewellers and manufactures (Auerswald *et al.*, 2005, p.1-6). The overall process will continuously cycle between the industry with brief pauses from consumer purchase. This results in waste and reuse on an ongoing scale – ensuring the metals lifespan supersedes its initial function.

Figure 3.13 Pawn shop cartography in relation to the Germiston region (Author, 2022)
The ratio of pawn shops to Jewelry stores is 18:7

3 The Toxic Result

While jewellery governs the bulk of gold production - metal use itself extremely vast – ranging from digital equipment, to construction, to even aeronautical components (Browd, 2016). The endless uses suggest a large supply of potential wastage, and thus a large possibility for recycling. Old IBR roof sheeting, and E metals such as phones and computer monitors all contain metallic content that is undesired at some point during its lifespan (Corder, 2019). The possibility of reuse allows this timespan to extend passed its initial life stamp and became a possibility for new resources from an existing supply without stripping the landscape.

These fundamental principles of recycling the old and undesirable are imperative to the possibility of thwarting the environmental degradation as a result of mining pollution. The possibility of value has been a driving force in gold production throughout time, this notion is embedded into the social and economic constructs that govern its demand (Browd, 2016). Thus, the possibility of the wastage value could aid the drive for environmental reformation and restoration – creating an opportunity from toxic leftovers. The need for architectural intervention to highlight the opportunities implanted in the waste is in diametric conversation with restoring a historically depleted landscape (Yusoff, 2017, p.48).

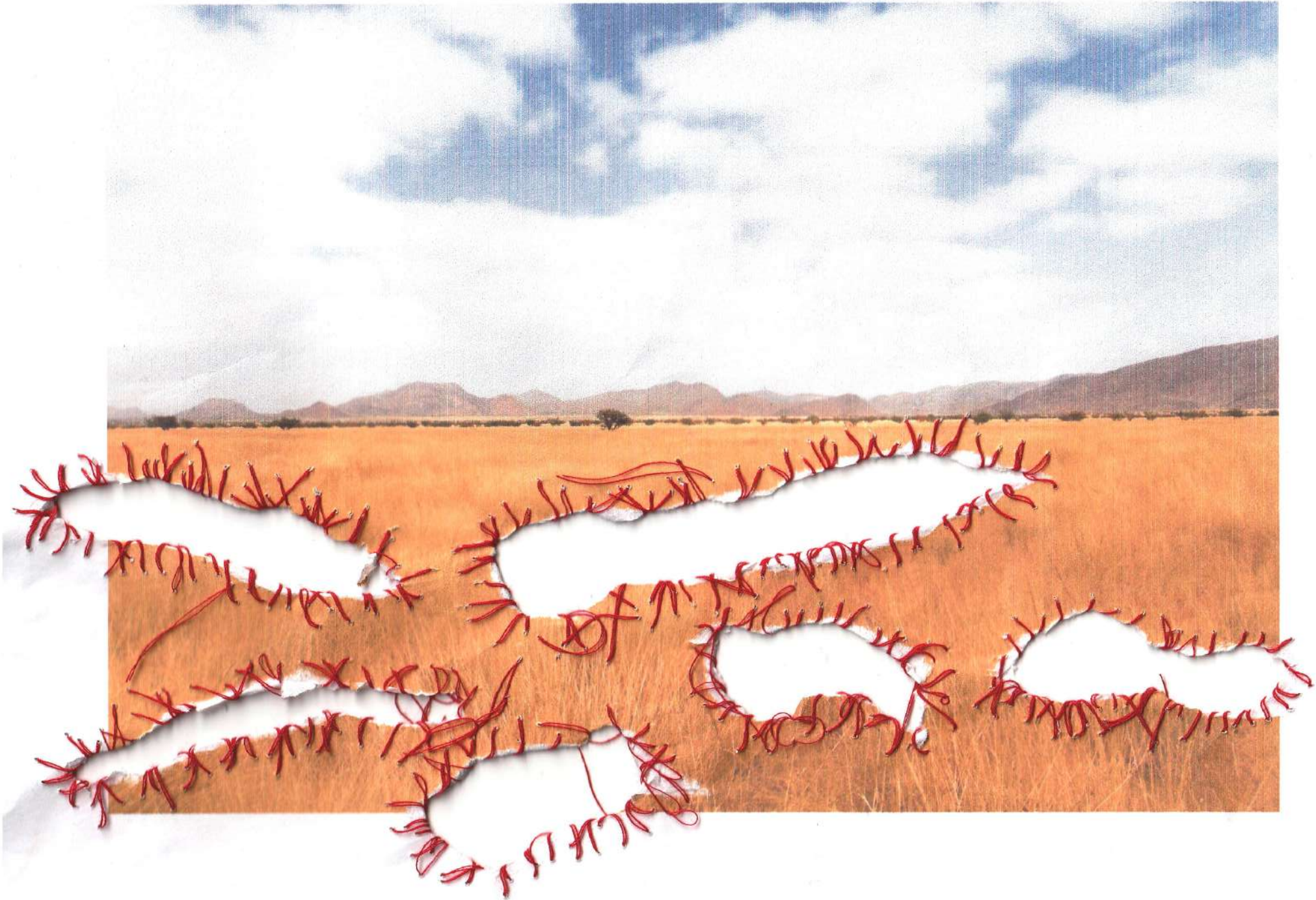
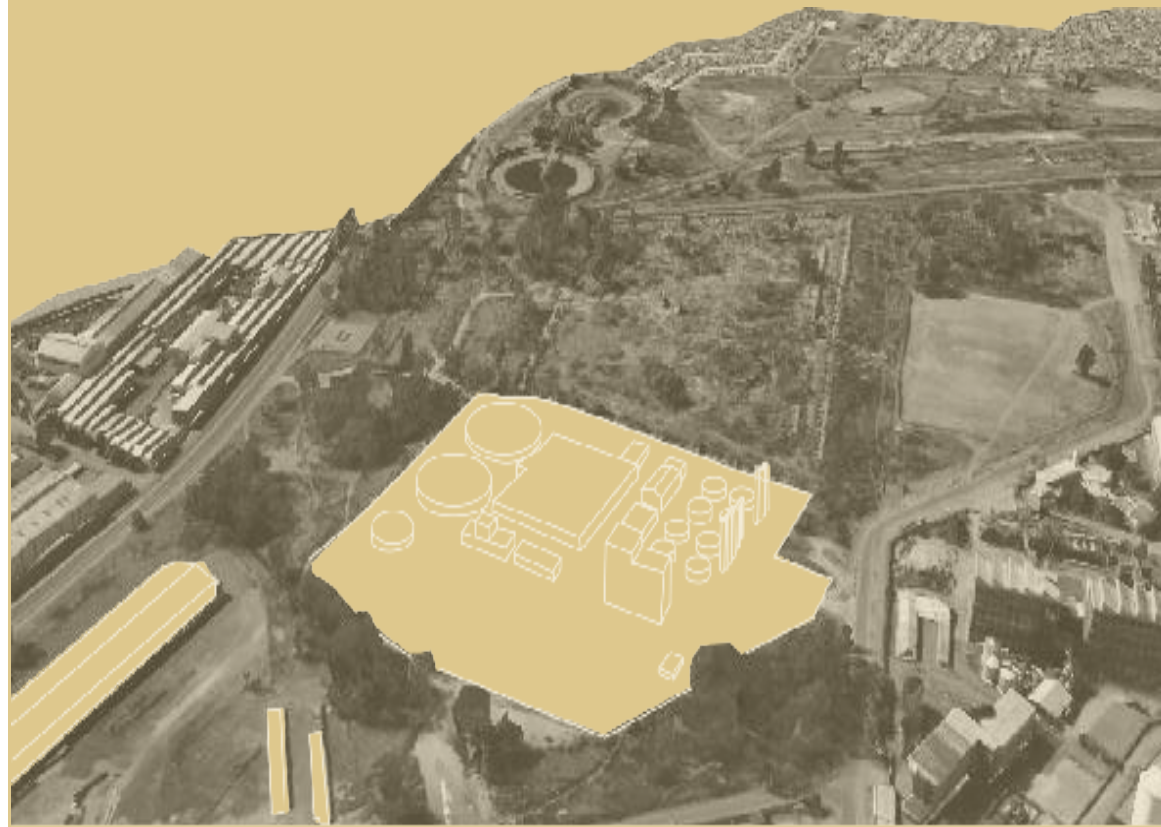


Figure 3.14 Holding the Wounds of the Landscape (Author, 2022)

Sewn stitches supporting the boundaries of the torn paper to prevent further fraying. This acts in a two-fold manner but mending any further damage but also highlighting the torn elements.

4 The Metallic Inducement



4.1 Primary architectural concept: exploration of repository to remediation and memorialization of various forms of mining toxicity

The call for mine dump removal is an essential action. As previously discussed, these sites generate large amounts of pollution, and their inertness allows the toxicity to continuously grow. This can easily create a rationale need for their destruction; however, the process of removal also acts a form of erasure and deletion that takes away a part of mining history that is so imperative to the city and the lives it has impacted (Ball, 2017; Fitz *et al.*, 2019, p.12; Sinkala, 2011). This emphasizes the primary driving force behind the proposed architectural intervention as a sense of reflection. This forms the notion of holding the wound in which architectural form can be generated and designed in order to physically demarcate spatially the wounds and toxicity caused by these mine dumps and the mining industry.

The exploration of memory forms in architectural terminology and methodologies links directly to the state of past through the process of the experiential. This is

done through architectural typologies of memorials, museums, mausoleums, and galleries all creating archetypes of spaces for past reflection (Collins English Dictionary, 2014). The concern is that this mine dump deletion is not simply a past memory but an erasure of impact (Fitz *et al.*, 2019, p.12; Yusoff, 2018, p.15). The space must not just generate a historical guide to the past but rather an exposure of its all-encompassing by-products. This piloted a search of terminology that could facilitate a display of impact, leading towards the word ‘repository.’

The rudimentary definitions of the word repository place it as a form of storage to a variety of things placed in different formats: from containers to spaces. However, a deeper investigation of the word revealed the definition as: “a place where something, especially a natural resource, is found in significant quantities” (Collins

4 The Metallic Inducement

English Dictionary, 2014; Cambridge Dictionary; Oxford Languages). The notion of this type of space explores the natural landscape prior to gold mining as its original repository – the first space of exhibition in its most abundant and most natural container.

The book Reciprocal Landscapes by Jane Hutton (2020, p.44) raises the question: “what if we looked at materials not simply as single- purpose commodities, but instead as continually changing matter that takes on different forms, and is shaped by - but also shapes – others?”

The quote in the context of the text describes materials as a physical demarcation of space tied to a sense of historical landscape. Hutton further describes this notion as the possibility of connection between an existing material, its place of origin and its ultimate destination of human placement. This essentially creates an embedded link that can be completely unbeknown to the spatial user- as a “thin thread, two sites are pulled together and a tangle of relations appears” (Hutton, 2020, p.25).

This suggests the potential role of architecture as a medium to link this sense of history through placemaking under the guise of a phenomenological approach.

Similarly, the notion of documenting materiality- origins lies in the sentiment left by the sheer size of a mine dump. The mounds are comprised of the contents dug out from the inside of the mine shafts, showcasing the movement of materials from its original place of settlement to its topsoil transference. The material almost expresses a metaphorical desolation in its forced removal; from a promising rich soil to one that becomes poisonous upon oxidisation (Fitz, *et al.*, 2019; Hutton, 2020, p.25).

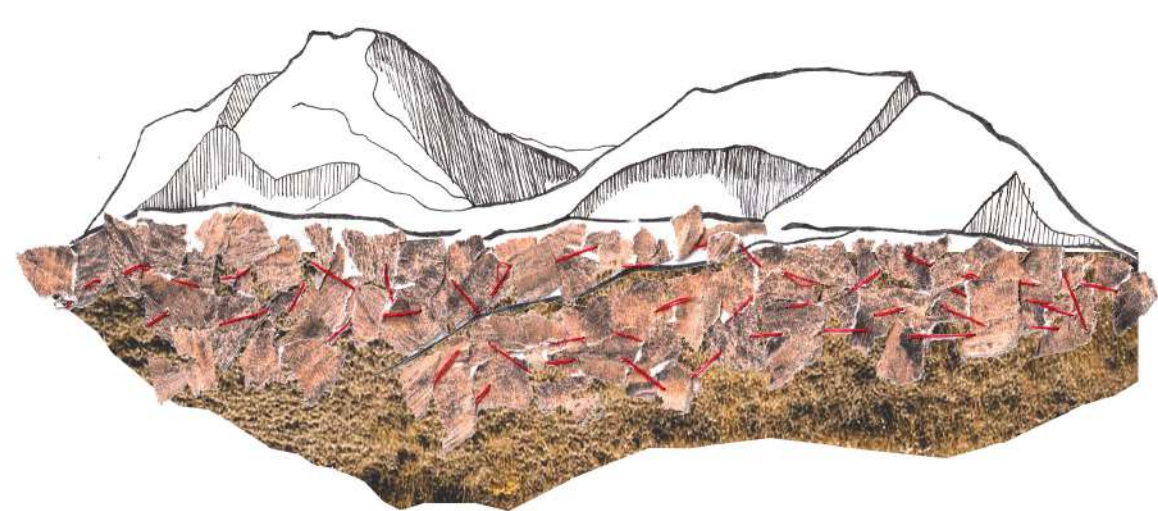


Figure 4.1 The Reverse Condition (Author, 2022)
The ‘mirror’ landscape of what mining has inflicted. The stitched veld landscape as held together as a memory of what was

4.2. Architectural building typologies: exploration of potential for wastage reuse as architectural program for intervention

Through a further lens of the mined material – the gold products themselves exude the most extensive forms of change from its initial state, and the concept of placing the ore submerged gold particle against a finished jewellery article displayed in a glass case - creates an almost paradox of landscape belonging (Chamber of Mines, 2017). There is however the significance of potential that is entangled in this paradox – where the material can be something else in comparison to its origin. While this has resulted in an industry of toxic ruin it also applies to the wastage – suggesting that the history of ruination and abandonment can still shift to a future form of potential change (Hutton, 2020, p.26). The tie between material and landscape therefore plays a fundamental role in the implementation of an architectural intervention that can address parts of the ruination inflicted by the mining industry (Schrader, 2015). This is a physical notion of extraction, depletion, and contami-

nation, but also the fundamental design component of the intervention as a form of activity mapping of past, present and future in the sense of the repository (Ball, 2017; Oxford Languages).

The focus of the toxicity highlights the wastage crisis among a finite resource, as well as the need to remediate the acid mine drainage wastage through means of chemical treatment and metallic extraction (Bobbins, 2015; Lyaloo, 2020). This offers a threefold opportunity: where contamination can be treated, waste can be reduced, and the opportunity for job creation can be heightened.



Figure 4.2 Input Vs Output (Author, 2022)

Comparison between form - the solid metal can be extracted from the find grains of the mine dump.

4.3. Site selection for repository and waste reuse intervention; through examination of environmental, historical, and social impact

The creation of a building that focuses on metal reuse and recovery from toxic water creates the opportunity for the industry to be softened through methods of reformation and upliftment. Instead of landscape appropriation and stripping, a perspective of possibility arises from the toxic sludge treatment and reuse to generate a reformed industry of growth and repurpose (Bobbins, 2015; Hutton, 2020).

The historic life of the metal particle experiences a series of different states- chemically shifting from liquid, molten, gas and finally back to solid formation. This is indicative of the flexible properties the material possesses but also of the actual implemented processes of transition required to change state (Michaud, 2016). The changing of state and evolution from one to another creates the notion that this chemical change can extend to landscape (Barnard, 2018). This form of

evolutionary transition applies to the appropriation of the mining landscapes that has resulted. These spaces similarly to the ore, have experienced a series of change that has taken the natural veld landscape, and superimposed an industrial framework that has made the land uninhabitable. The suggestion that is proposed relates to the concept of material and landscape reuse, in the fabric of an environment of history, recollection and memory (Atkinson *et al.*, 1968, p.92).

Legislatively in 2011 a plan was implemented under the authorisation of the South African government in order to treat the toxic water of the contaminated rivers and streams before they enter the major water resource regions such as the Vaal dam and Limpopo Basin (Digsby Wells Environmental, 2012). The plan involved the establishment of three acid mine drainage treatment plants that would intercept the

water connection points, acting as a divergent system to clean the water before allowing the water to be pumped to its location for use. The three treatment plants were proposed to span across the reef line from east to west intercepting all major streams (Digsby Wells Environmental, 2012). The infrastructural systems to clean the water are extensive with operational costs of R 209,719,285 and capital costs of R 697,727,075 (Digsby Wells Environmental, 2012).

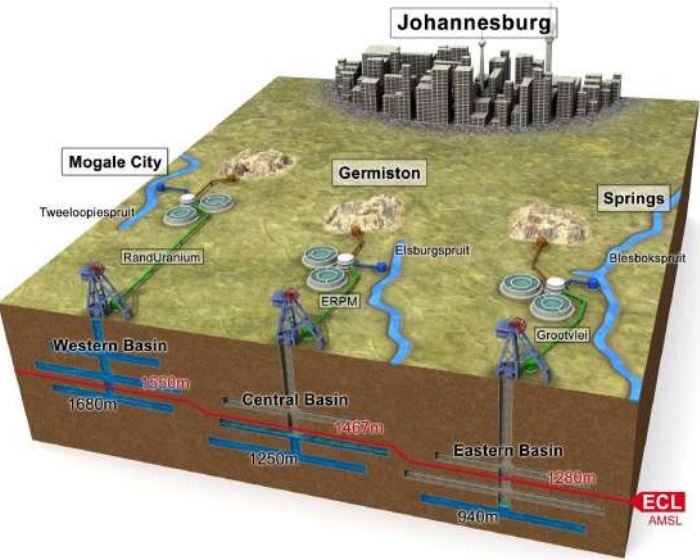
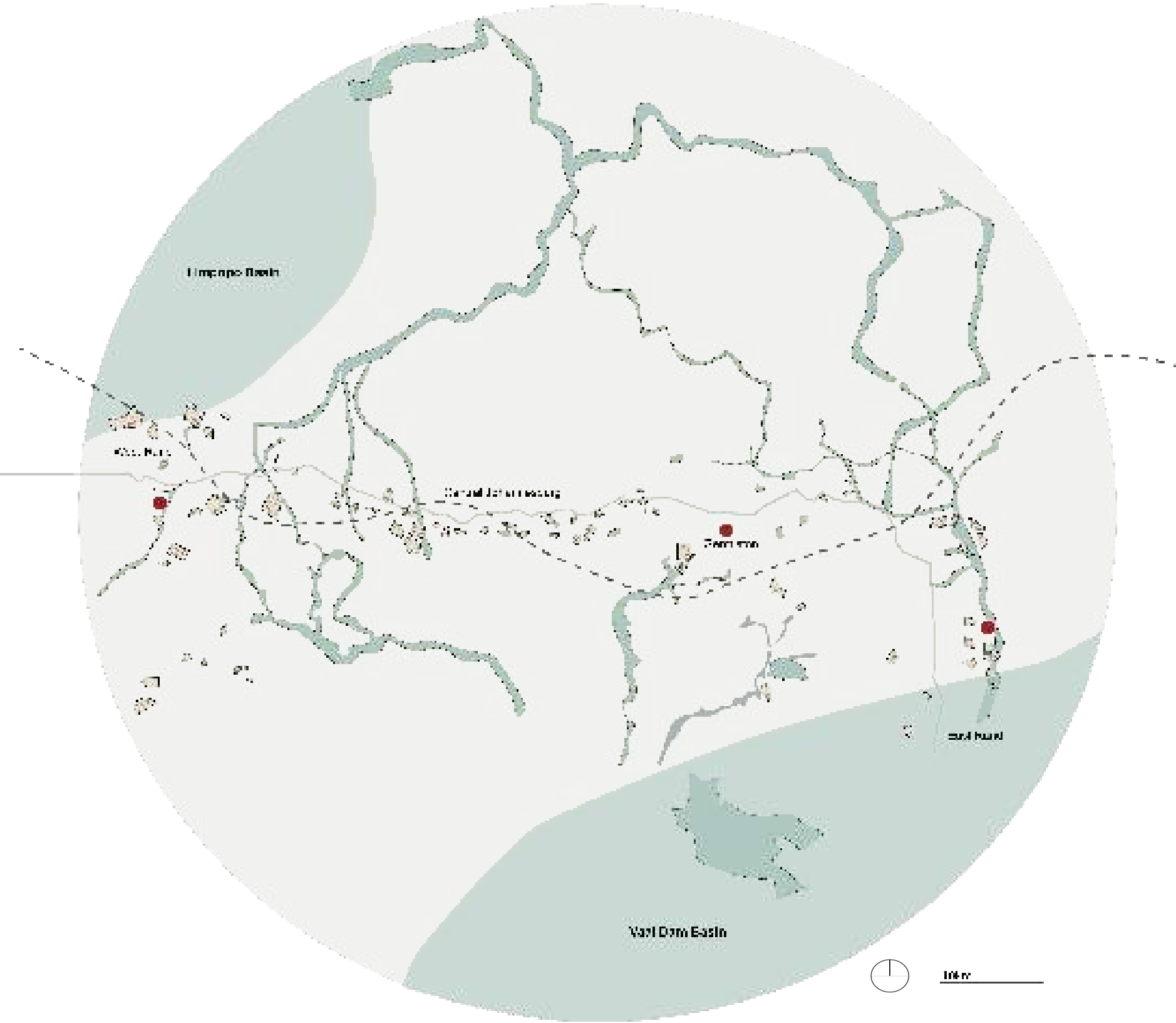
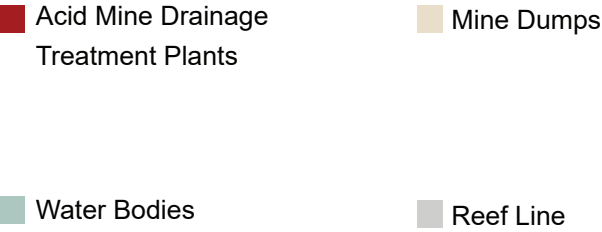


Figure 4.3 Treatment Plant (Digsby Wells Enviornmental, 2012)
Proposal by the Trans-Cal-edon Tunnel Authority for acidic water treatment.



This places a large focus on the site that is chosen for the building proposal, offering the adjacent industrial and abandoned land parcels to the sites as opportunities for the building intervention. The most prominent site of the three is the Central Basin Acid Mine Drainage Treatment Plant in Germiston as the site functions as the central plant in the most diverse location being industrial, residential, informally occupied, and small holding. The site further holds an immense mining history making it the most suitable for the application of a wound holding and detoxifying intervention.

Figure 4.4 AMD Treatment Plants (Author, 2022)
The position of the treatment plants across the east to west rand, in comparison to the mine dump and mine locations and their impact on the water streams and connections



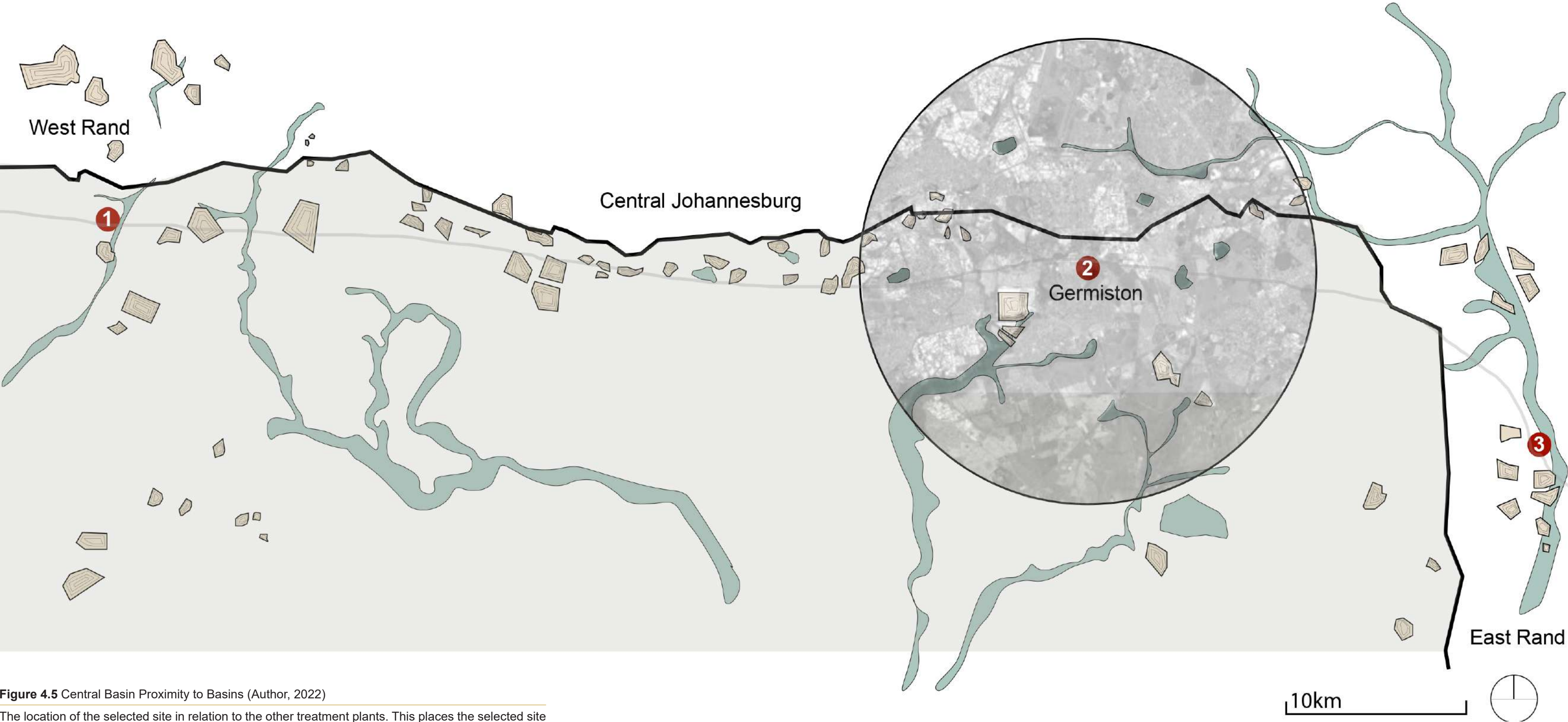


Figure 4.5 Central Basin Proximity to Basins (Author, 2022)

The location of the selected site in relation to the other treatment plants. This places the selected site as located in the densified portion of Joahnnesburg.

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The site historically is a landscape that was shaped entirely by the mining industry from its first proclamation to its current uses (Digsby Wells Environmental, 2012). The site has always been defined by the industry and the resulting mushroom of city planning that encircles the city is a result of this nature.

The site functioned as one of the shaft entrance locations for the gold mine known as the ‘East Rand Mine’ established in 1893 amid the expansion of gold diggings within the Germiston region (The Editors of Encyclopedia, 2012; Wood, 2016). Germiston’s foundation is further a direct result of gold mining. The city developed around the basis of deposits found along the reef line – creating a consequential result of the set-up of a mining town (Ball, 2017; Barnard, 2015).

Germiston itself epitomises the impact of the mining industry from the transition of farmland into industrial landscape and further one of the fundamental aspects of development being a transportation hub. Two of the largest infrastructural systems that governed the growth of the mining industry were set up in Germiston, being:

the largest railway transport junction in the country, and Rand Refinery - as the largest refinery in South Africa - producing an approximation of one third of the gold mined globally from 1921 to 2012 – during the gold mining peak. The refinery was established in 1920 – and took on the processing of all raw gold that was excavated. The mined metals were chemically treated and cast into ingots for global disruption.



Figure 4.6 AMD Treatment Plants (Gorter, 1963)
[Left] Lift shaft at the EPMG mine that was originally poitioned at the location of the current central basin acid mine drainage treatment plant. The shaft has been removed in order to treat the cite for acid mine drainage levels and pipe connections were placed in that location to prevent any further build up.

Figure 4.7 AMD Treatment Plants (East Rand Proprietary Mines Ltd, 1928)
[Right] Certificate of share rights in the EPMG mining company for gold extraction.



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The significance of the placement transportation hubs and routes through Germiston showcases its direct significance to the movement of gold (Woodgate, 2017). The need for transportation technology and infrastructure is vital to the capitalism of gold on a global scale, and thus its relationship to Rand Refinery is directly associated to the possibility for the transportation of approximately fifty thousand tons of gold per annum (Mackay, 2021). The relation of Germiston to the expanse of the reef line from east to west allows a central point of industry to be created adjacent to the growth of the Johannesburg CBD (Ball, 2017; Woodgate, 2017). This notion of Germiston’s role as a transportation hub grew – from railway lines to the installation of Rand Airport in 1931, acting as the major international transport route until 1948 where the developed infrastructure could not keep up with the developing aeronautical infrastructure and demand (Ball, 2017; SAA Museum). The gold findings within Germiston were abundant and large mines were established along the intersecting reef line, such as: ‘Simmer and Jack Gold Mine,’ ‘Rose Deep Gold Mine’ and ‘Knights Deep Gold Mine.’ While these mines offered gold promise their operations were more finite in nature; with two of the three mines lying aban-

doned today – Knights Deep Gold Mine as the last to function to date (South African Mining and Engineering Journal, 1922). This by nature impacted the formation of Germiston dramatically – as a place of initial gold promise, to one of industrial placemaking to its current state of liminality as today it houses the mash up of industrial, retail, and residential programs (Burger *et al* ; Wood, 2017).

The apprehension attached to the area is linked to the habitation that occurred between the industry – the architectural layout positions informal townships between the industry and formalized residential. This highlights a concern of the effect mining pollution and industry has on the surrounding occupants. A further concern is the appropriation of landscape that this area has generated. While the Johannesburg CBD showcases a metamorphosis of industrial change – the area of Germiston is still heavily defined by its mining heritage (Munro, 2017; South African Mining and Engineering Journal, 1922).



Figure 4.8 Good Hope Informal Settlement (De Wee, 2017)

The ironic devastation between the proximity of the treatment plant and the informal settlement raises the comparison between a site with abundant water supply, and the other without sanitation or water infrastructure. The proximity between these sites is less than 500m. Pictured above is a resident of the settlement transporting water from the Elsburg-spruit river to her house.

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While the mine dumps monuments and mine shaft infrastructure in Germiston is less abundant today that its initiation – most commerce and trade is centered around the metallic industry (Burger, 2015; The Editors of Encyclopedia, 2012). Today Rand Refinery still functions as the largest refinery within South Africa. The programmatic change has shifted to the processing of waste reprocessing as previously discussed (Mackay, 2021). The rationale for this change is the shift in gold findings that has occurred. The notion over- mining and exhaust is an impression that is engraved within the region of Germiston – the shift in programmatic role of Rand Refinery to one of waste collect is indicative of this change and the need for mining redress (Mackay, 2021). From scrap yards to SA Metal Groups – majority of mining resources and trade still lives within the area of Germiston. The notion highlights Germiston’s tie to the metal industry, showcasing an embedment of mining history, and thus its significance as an architectural landscape in need of metallic rejuvenation and toxic reformation.

The comparison between the development of Johannesburg in relation to Germiston further creates an interest into the urban landscape, as it draws a sense of stagnation due to mining that has comparatively evolved and adapted in Johannesburg. This creates a fascination in to how the site could be remiagined post mineral extraction.

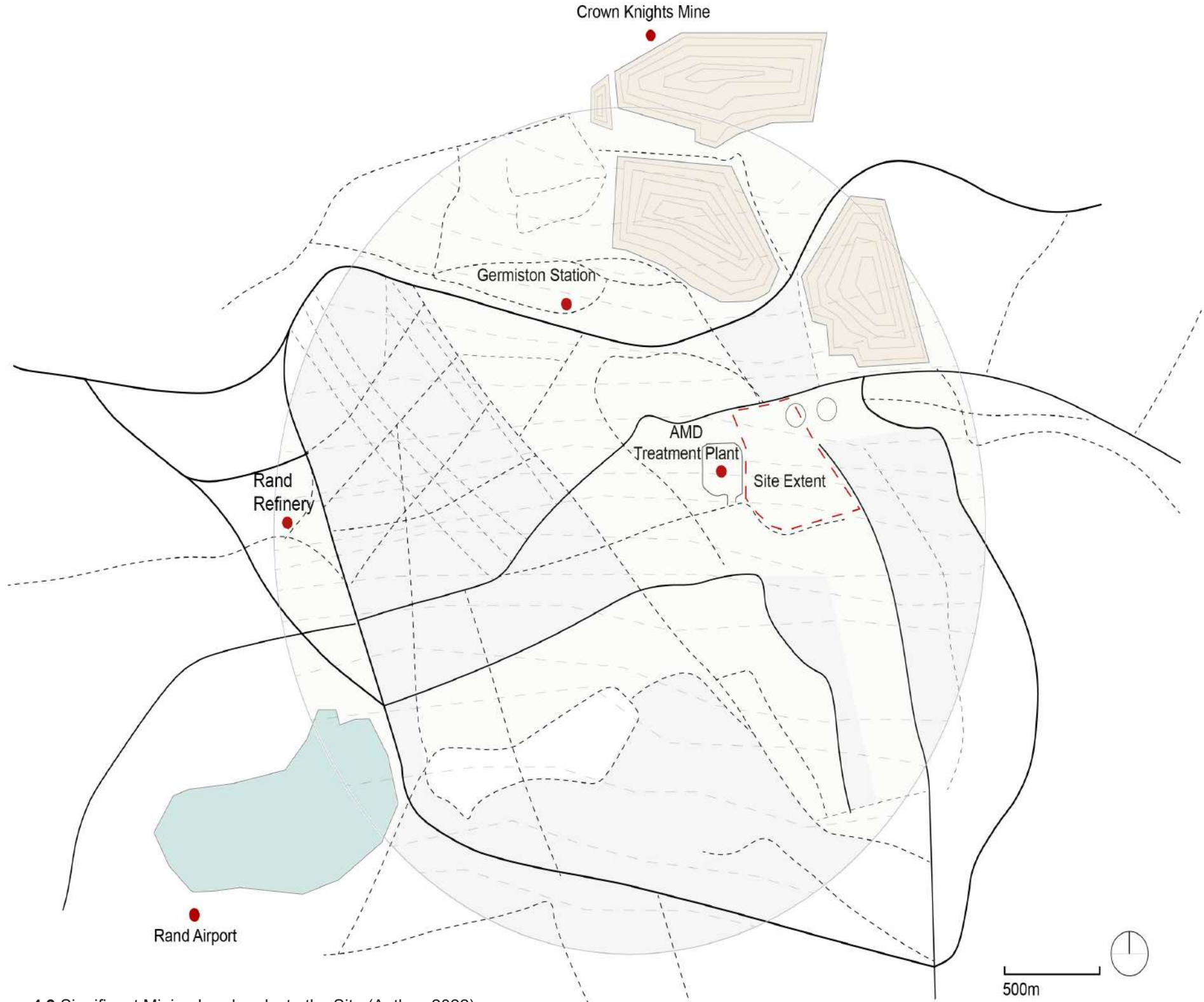


Figure 4.9 Significant Mining Landmarks to the Site (Author, 2022)
Historical mining landmarks such as rand refinery , the old railway station, rand airport and Crown Knights Mine form the greater context of the site.

4 The Metallic Inducement

The Central Basin Acid Mine Drainage Treatment Plant is located in the Germiston South region of the overall area- under three kilometers south of the reef line. The mining function of the site was eradicated in 2008 (Digsby Wells Environmental, 2012; Trans- Caledon Tunnel Authority, 2012). The concern arose around the lack of functioning of the mine, as it was then accumulating a high level of water content – with unprofitable gold findings. The resulting mining activities in Germiston has caused water pans – in which the water has begun to pool and collect within disrupted earth crevices and openings. The mine shafts became filled with water run off – diluting the toxic pyrite particles and producing acid mine drainage. The most pressing concern arises from this by the position of the ground water table levels and the level of contaminated water produced by the acid mine drainage. The instance of the environmental critical level (ECL) in the case of the site - sat at 1467m which is a critically concerning level – and a contaminant to the water basin (Digsby Wells Environmental, 2012; Trans- Caledon Tunnel Authority, 2012). This created the need for a treatment plant that could firstly deal with existing mine toxicity but also the area of the ‘central basin.’ The TCTA (Trans-Caledon Tunnel

Authority) along with the Department of Mining and Water Treatment proposed a three-stage approach in which three treatment plants could be installed along the basin. The function of the plants is to act as a diversion system, in which the acidic water can be collected via the toxic sludge streams, treated, and then returned to natural, clean water supplies, and in turn back to the central basins systems (Digsby Wells Environmental, 2012; Trans- Caledon Tunnel Authority, 2012).



Figure 4.10 Central Basin Treatment Plants (Digsby Wells Environmental, 2012)
Caricature drawing explaining the connectivity approaches implored by the treatment plant.



Figure 4.11 Treatment Plant Site Photographs, (TCTA, 2008)

The site construction photos showcase the thick concrete construction used to contain the basins. The major materials used are reinforced concrete and steel structures. The steel is primarily used to create walkways above the basins.



4 The Metallic Inducement

The surrounding area of the chosen site is defined by an industrial park- where the expansive and demarcated boundaries of the site act as a central point to an en-
circling environment of industry. Through a contextual analysis and study into the demographics of the site; Germiston holistically can be seen to have undergone a transition of settlement with the notion of an evolved landscape that has changed from a veld farmland to one of “grasslands of colonially introduced species (Firth, 2011)”

Figure 4.12 Flora Species on Site

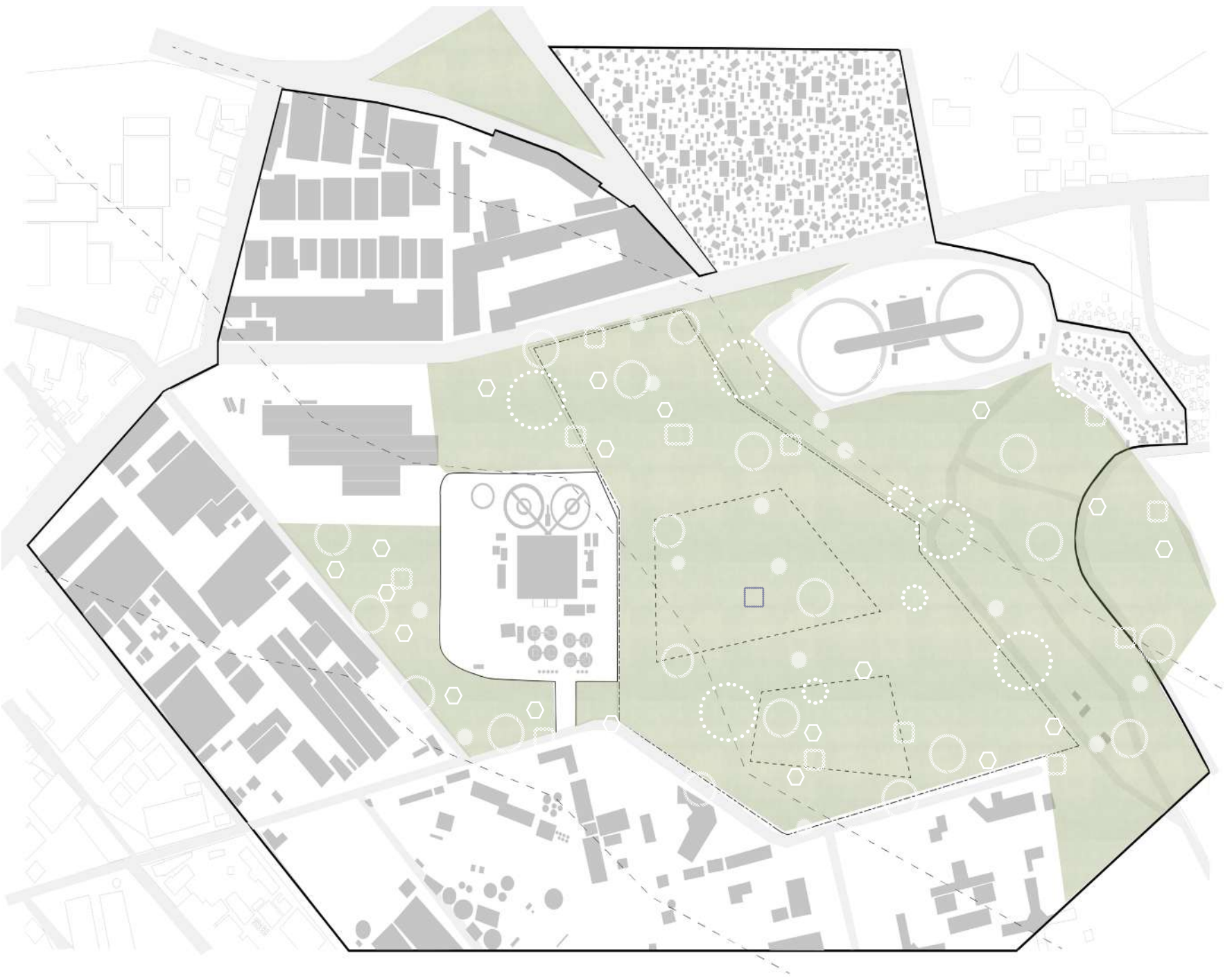


Figure 4.13 Flora Mapping (Author, 2022)
The various flora grown on the site is sparsely spread throughout the landscape

4 The Metallic Inducement

The contextual region of Germiston overall is divided into various proportions of habitation – with 35% dedication to agriculture in its various forms, 15% in industrial and 50% in residential with the majority of residential (35% of the total) being informal settlement (Firth, 2011; Statistics South Africa, 2007). The direct site; however, focuses on smallholding farming, industrial, and informal residence – equating to a proportional 10%, 55% and 35% analysis (Statistics South Africa, 2007). This showcases the proportion of industry to informal settlement because of the historically abandoned, and toxic environment (Daniel *et al.*, 2018; Firth, 2011). The residential component that sits in proximity to the site, is the: Good Hope Informal Settlement situated Northeast of the site with the mere separation of the main road. The settlement houses approximately 4000 people, without connections to water and sanitation services (Hlatshaneni, 2018; Nyoka, 2018). The settlement through the lens of the impact of the mining industry epitomizes this sense of industrialization and the virulent social history that encompasses the site. The notion of impact the mining industry has created is magnified in the instance of the creation of industrial wastelands that are occupied by marginalized persons as a result of the sites stigmatized renunciation (Hlatshaneni, 2018; Nyoka, 2018).

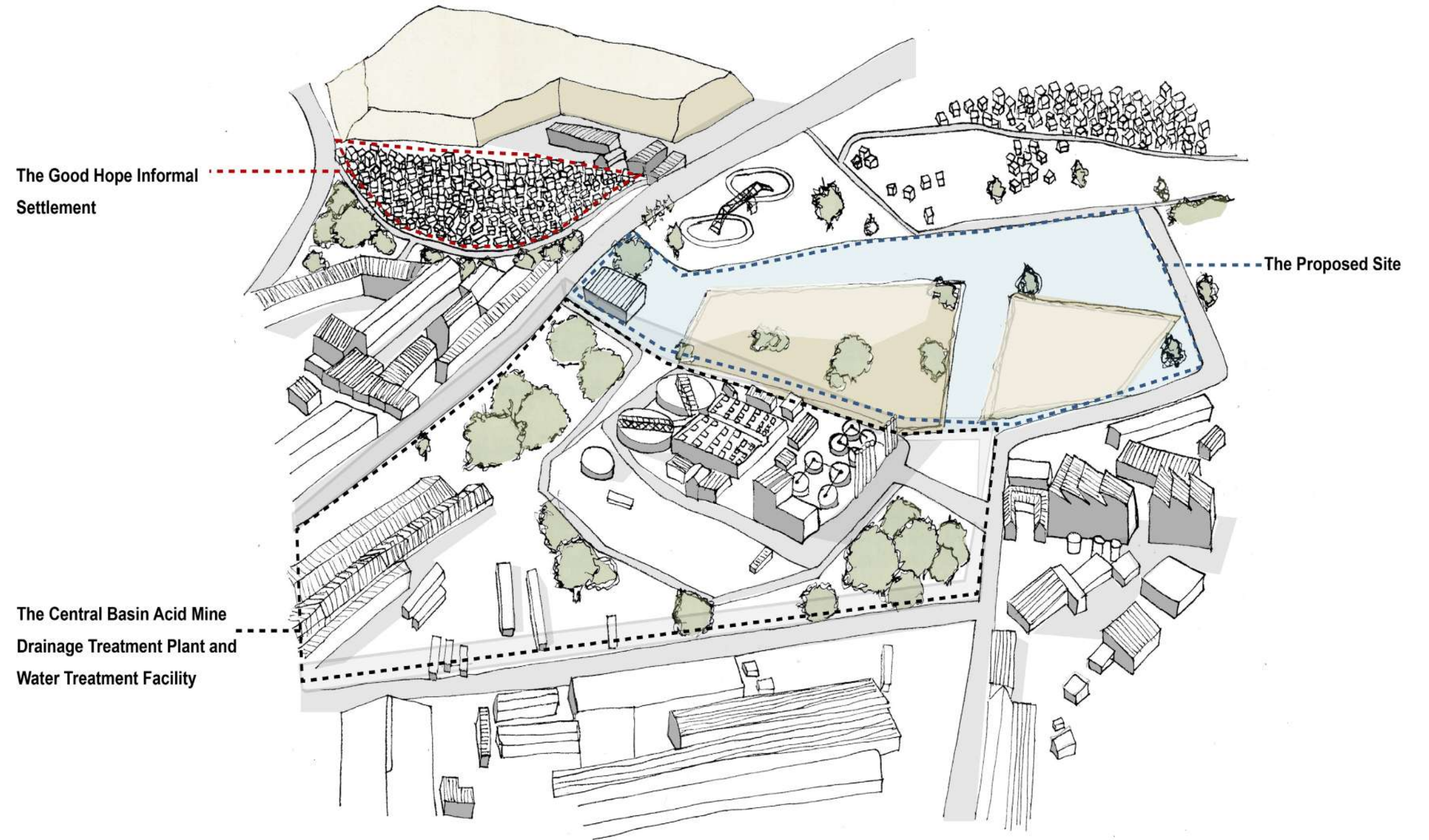


Figure 4.14 AMD Treatment Plant Context (Author, 2022)

The larger context of the site showcases a combination of program ranging :

15% Industrial	35% Informal Residential
20% Smallholding	15% Formal Residential
5% Commercial Agriculture	10% Subsistence Agriculture

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The development of the contextual area was predominately around metal growth and thus the surrounding buildings house the locations of programs pertaining to metal, being SA Metal Group, Fabricated Steel Manufacturing, MD Steel Services, Scaw Metals Group Wire and Stand.

The further generation of program in the surrounding context - aimed to create commerce as a subsidiary to metal production by offering machinery, equipment, skills, and chemicals to the first – hand production industry. This is supplied by: Rolfes Chemicals, CIM Chemicals, PTF Manufacturers, LSG Machine Tools, and ISEGEN Chemicals.

This creates an environment that is driven by a primary and subsidiary form of industry and commerce of a good – amongst a displacement of the sense of home that is created by the placement of housing in between the mine dumps and the commerce. The Acid Mine Drainage Treatment Plant itself physically acts as the separation zone of these two opposite programs; while its aim is to treat the indus-

trial waste - the architectural tropes that have defined its structure and program create the air of industrialization and privatization (Digsby Wells Environmental, 2012). The centrality of the site possesses the opportunity to diffuse the juxtaposition between residence and heavy mining industrial – finding an ability to create the proposed architectural intervention through form and design as a method to create an effective coexistence of its current context. “As humans reshape the landscape, we forget what was there before” (Bubandt *et al*., 2018, p.20), the nature of the high boundary walls of the site was a result of the need to keep individuals away from chemicals and hazards – the power and effect this has, however, can also create a sense of separation (Leach, 1996, p.336; Trans- Caledon Tunnel Authority, 2012).

The need to create transparency to the ongoing activity of toxicity offers the opportunity to transform these ideologies into architectural form. This concept of transparency deals with the current contextual concerns, but also the conceptual proposal of the building to create a sense of awareness of the ongoing toxicity. The achievement of this toxicity exposure through architectural methodologies needs to

consider how to achieve this goal amid a toxic environment (Trans- Caledon Tunnel Authority, 2012).



Figure 4.15 AMD Contamination (Google Earth, 2018)
Contaminated pools of acid mine drainage.

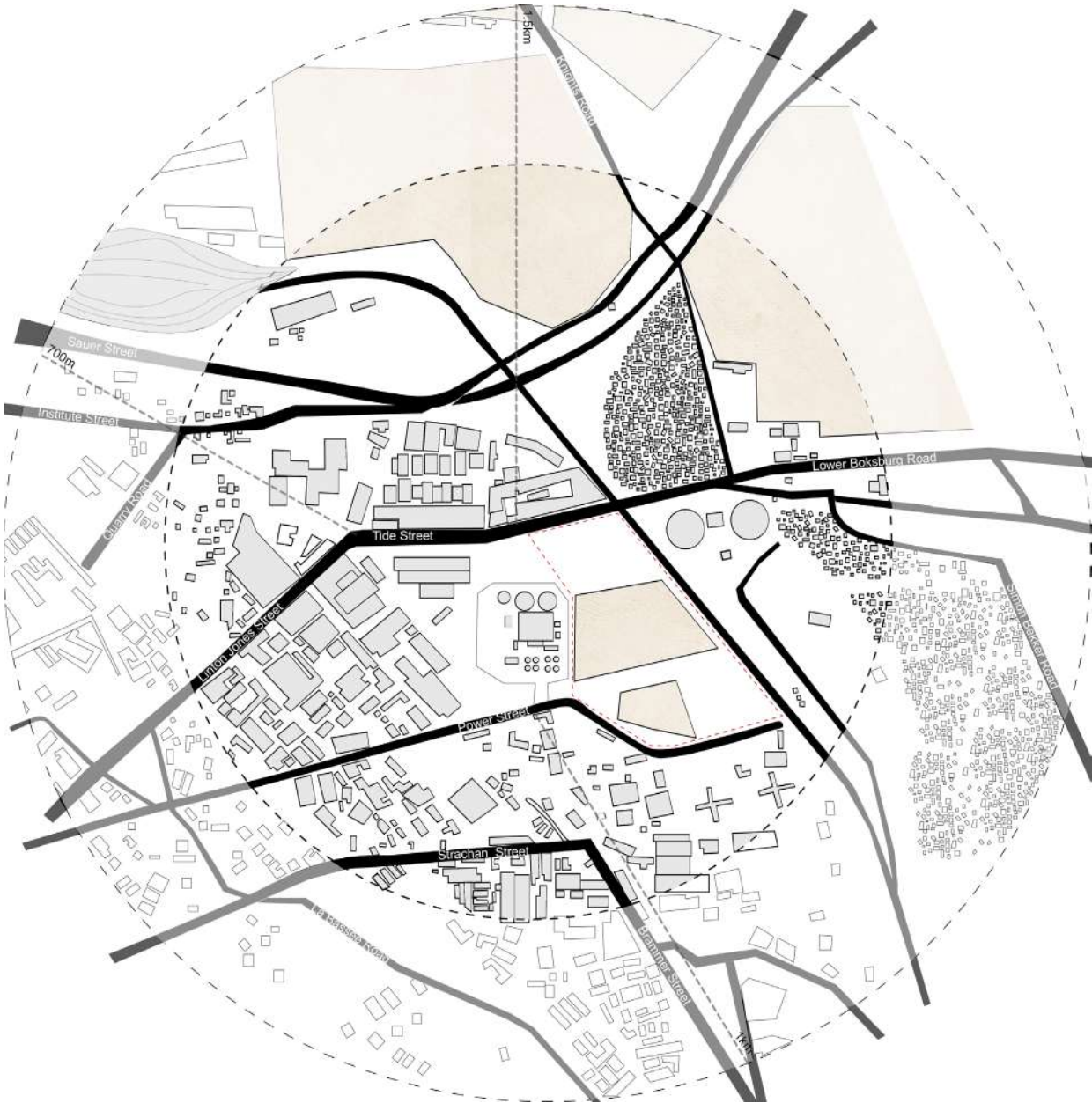
4.4. Programmatic possibilities embedded in site because of linear process of waste removal and neutralization

The chosen site deals directly with Germiston, but also the groundwater toxicity of Johannesburg CBD and central areas (Trans- Caledon Tunnel Authority, 2012). Two mine dumps were housed on the site – and the first line of remediation was their removal. The mining infrastructure was removed, and the plant was erected in its demolition. The soil was remediated to allow individuals to work within the site, containing the toxicity within a conduit of chemical piping vessels and systems as a form of toxic enclosure (Trans- Caledon Tunnel Authority, 2012; Wood, 2015).

The document for the proposal of the project compiled by Digsby and Wells Environmental on behalf of the TCTA, describes the plant implementation as an “endemic” process to the toxic crisis of acid mine drainage contamination (Digsby Wells Environmental, 2012). The intervention aims to treat, purify, and give back.

This endemic notion however still harbors a potential of recycling ‘recycled waste.’ The potential of attaching an architectural intervention to the existing treatment plant allows for this process of purification and remediation to extend passed its expected potential. Perhaps this intervention can extend from one category of environmental remedy to an additional one of social, economic, and historical amelioration (Digsby Wells Environmental, 2012).

Figure 4.16 Selected Site (Author, 2022)
The 1.5km radius highlights the span of industry that encircles the site.



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This leads to the conceptual drive of an architectural project that aims to use the existing treatment plant – and expand upon its function on the otherwise uninhabited expanse of the site to recycle the wasted metal content from the acid that is being treated. The positioning of this intervention of the central basin site enhances the notion of the repository; in which the buildings will be the next form of remediation to reflect upon a natural landscape that has undergone so many various forms of change at the hand of the mining industry. The site allows the metallic collection of waste to occur at the source through a costly system that is already in place, and thus allows the proposed building to exist to consume unnecessary waste (Hutton, 2020, p.26).

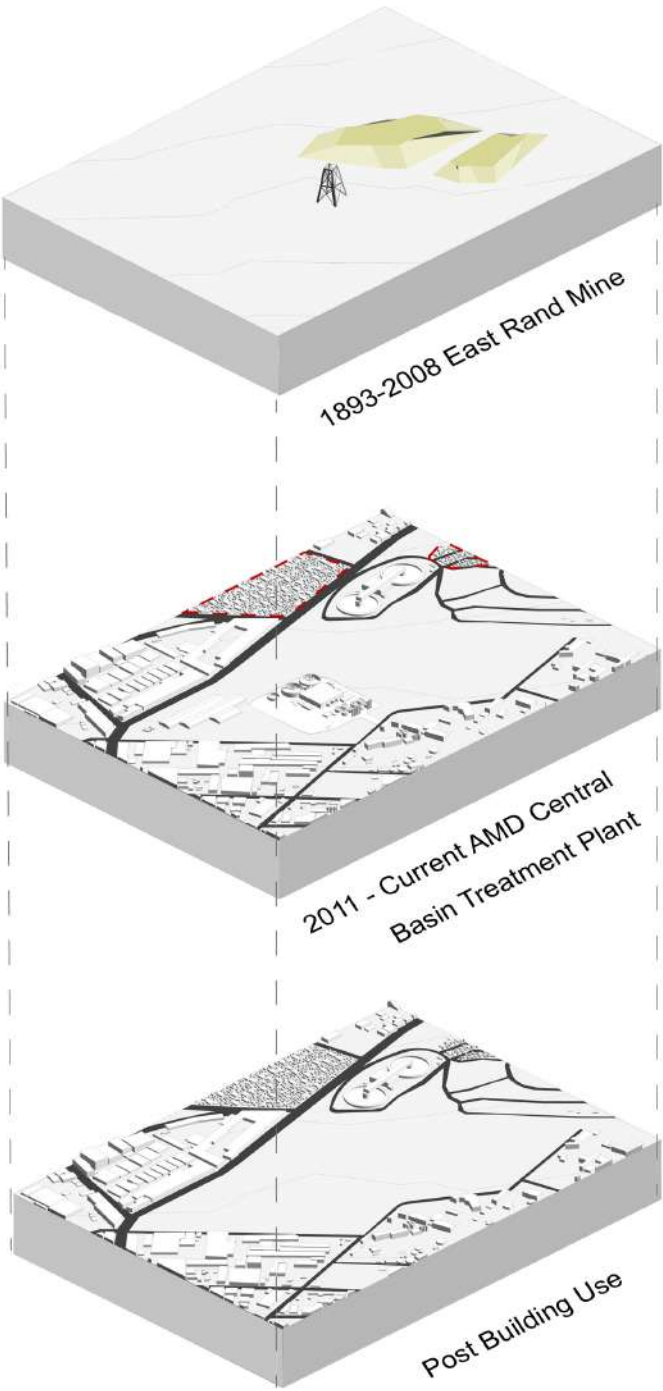
A further integral concept that arises from the use and connection to the existing infrastructure of the treatment plant is the notion of temporality. According to the Digby and Wells Environmental assessment the lifespan of the plant is directly proportional to the treatment of the water. The eradication of toxic water will ultimately lead to the ‘endemic’ phase in which the intervention is complete. The plant is de-

signed to work on short term and long-term plans; however, these are inevitably time stamped upon their success (Digsby Wells Environmental, 2012). This raises the questions of what happens after?

The aftermath redress raises the need to picture an architectural landscape of documentation and memory that can map history and toxicity even when the eradication off mining infrastructure and toxic water occurs. “As life enhancing entanglements disappear from our landscape’s ghosts take their place (Bubandt *et al.*, 2018, p.17).

Figure 4.17 AMD Life cycle of the Site (Author, 2022)

Exploring the site’s history suggests potential future abandonment. The nature of the site has demarcated the previously rich land as industrial and uninhabitable. A question of what will occur after the treatment plant succeeds in its treatment plan (estimate of 30 years) rises, suggesting an architectural intervention could be implemented to prevent this historical labelling system.



4 The Metallic Inducement

The temporal nature of the sites current habitation suggests the importance of this translation into an architectural program. The conceptual drive must respect this impermanence of program on the site, using this as an opportunity to restore the equilibrium of the landscape that was disrupted by the industry. The removal of the natural integrity from landscape and social toxicity is a repository that can create the architectural formations that remind us of and teach us about the infliction we have caused. This responds to the removal of the mine dump – taking away toxic form but discovering an architectural one that can serve in its purpose (Ball, 2017; Hutton, 2020, p.26; Munro, 2017).

The proposed intervention thus aims to produce a building that can function beyond its lifespan. This showcases a fundamental program of a repository in which mining history and toxicity can be exposed. The building will create memory as its primary objective and as method of outliving the current sites AMD rehabilitation. The secondary program interventions will aim at keeping up with the current sites intervention by recycling the waste to be used by a jewelry manufacturing plant, and

the creation of a skills center in which the jewelry trade from waste produce can be acquired with a focused proposal of job creation and skill development within the local community. As the resources eventually fade the scale of these programs will decrease to smaller scale programs with an increase in the repository experience to allow the site to act as form of monument.

The ultimate creation of this intervention within the Central Basin Acid Mine Drainage Treatment Plant site, will create a landscape for rehabilitation in the state of aftermath of the mining industry. The fundamental significance of the building is its ability to address both the historical toxicity, present state of land decay, and social constraints within a functioning industrial environment. The ability of the project to see beyond its use plays a crucial role in creating an intervention that challenges the notion of wastage and stagnation that is inherent in the demand for gold. It is a state too long accepted and inflicted upon the urban landscape of Johannesburg. This proposed architectural intervention responds phenomenologically, environmentally, and socially to a landscape of multifaceted decay and ruination through

methods of waste repurposing, documentation and environmental construction.



Figure 4.18 The Treatment Plant (SAME Water, 2014)
The current state of the proposed site is primarily abandoned with unconstrained vegetation.

4.5. Conclusion

Gold mining will forever be embedded into the formation of Johannesburg as a city. While this has brought a series of infrastructure and growth to the city, the perspective of gold infamy will always be attached to its history, culture, and potential for future growth. This creates an environment where architecture and the built form propose the opportunity to mend, highlight and respond to a landscape and society that has been encompassed within such an extensive history of metallic decay. The effects of the mining industry have left behind a trail of toxicity that extends far beyond the physical cleaning water.

The fundamental significance however is the notion of remembrance or rather re-phrasing as the notion of ‘not forgetting.’ This heightens the need for the landscape and the environment to be mended and remediated, but fundamentally for the notion of acknowledgement and culpability for the toxicity that requires such extensive reparations. The architectural proposal of the repository program in this sense aims

to achieve this goal in the sense of a hybrid typology. The sense of museum and memorial are terms that do not fully achieve the goal of the repository but become architectural precedents in which this form of ruination holding begins to generate. The notion of the two programs of repository and creation from waste symbiotically create a harmony in the sense of rehabilitation and acknowledgement, thus allowing the architectural mending process to leave behind the trace of repair it utilizes.

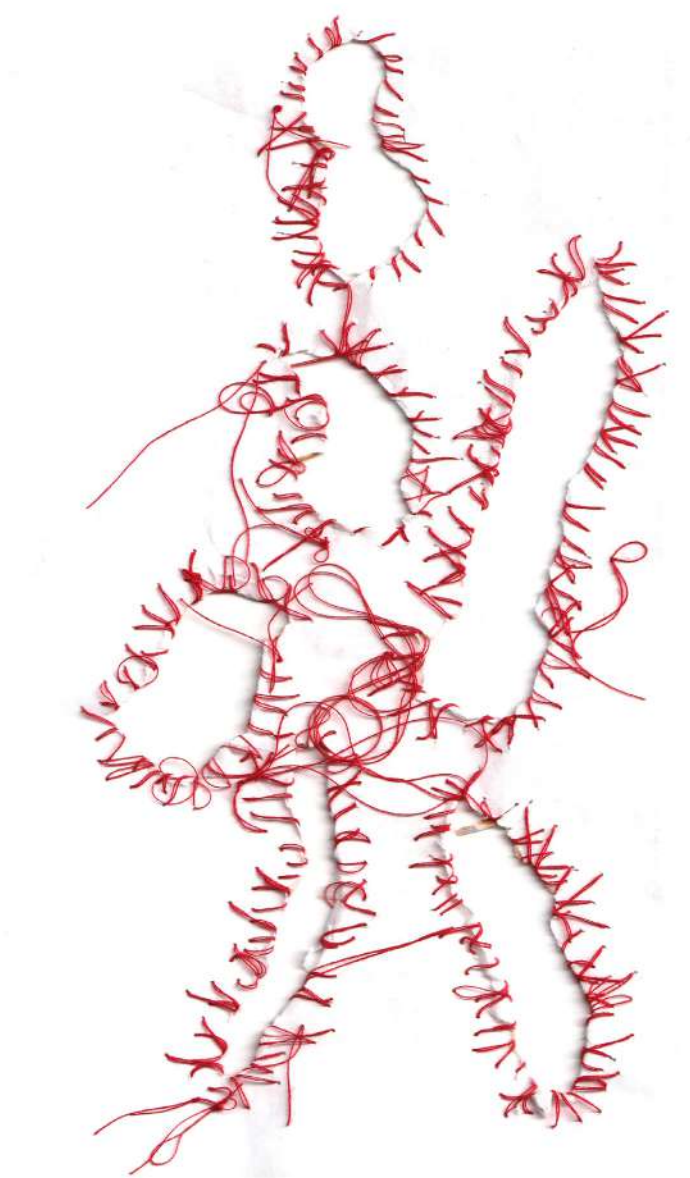


Figure 4.19 Inverse Landscape Stitching (Author, 2022)
The reverse mending stitches of the landscape reveal open wounds with an even more convoluted and messy stitch that holds the from the ‘underside’

4 The Metallic Inducement

Site Analysis

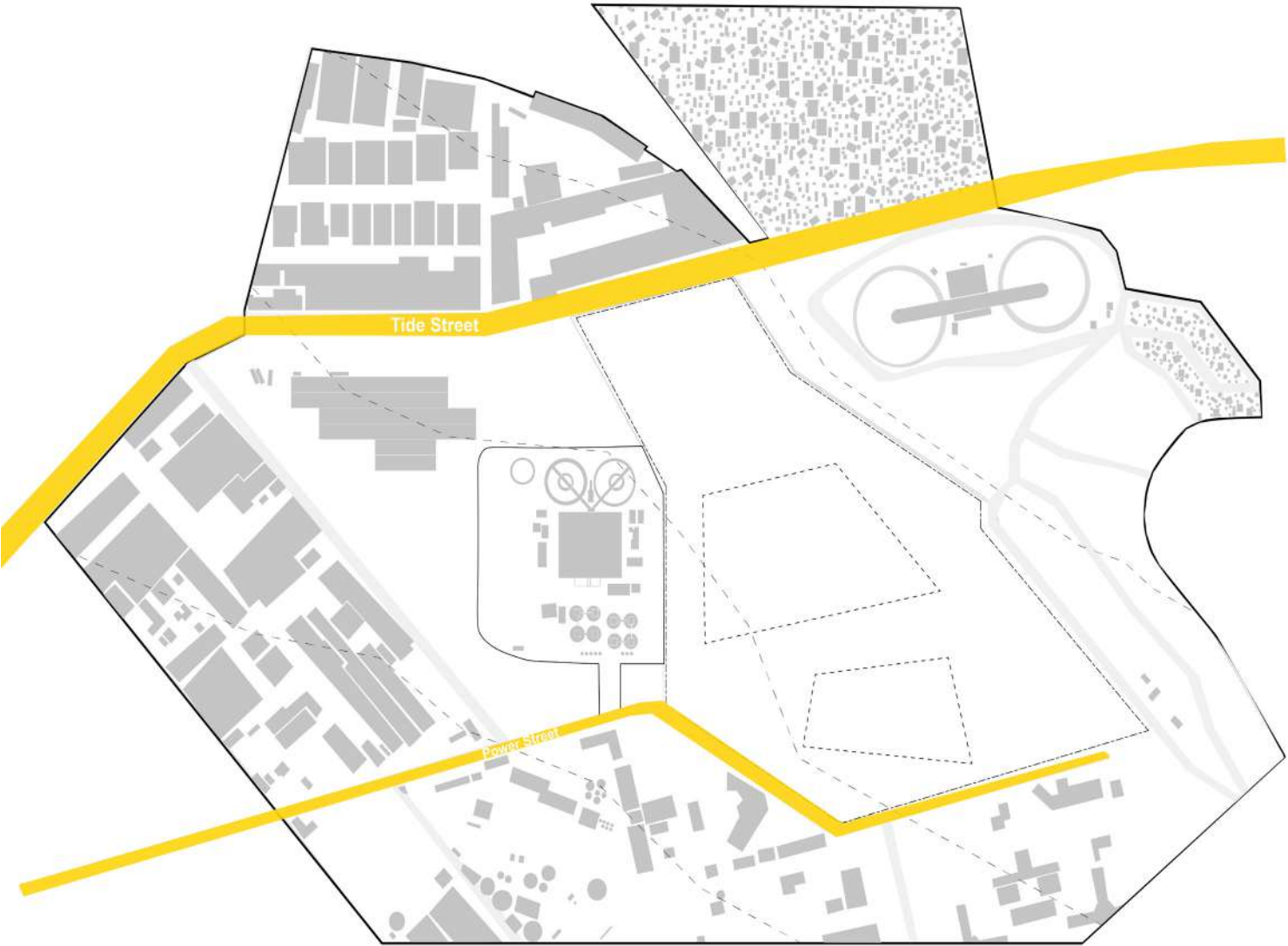


Figure 4.20 Access to the Site (Author,2022)

Primary access to the site occurs on the subsidiary road (Power Street) this deviates traffic away from the main road (Tide Street).



Figure 4.21 AMD Street Level Analysis of Accessibility (Author,2022)

Landscaping approaches on Tide Street accommodate pedestrian circulation. The pavements are broad and road is maintained whereas the subsidiary road of Power Street is more industrial and service based covered in a thick dust.

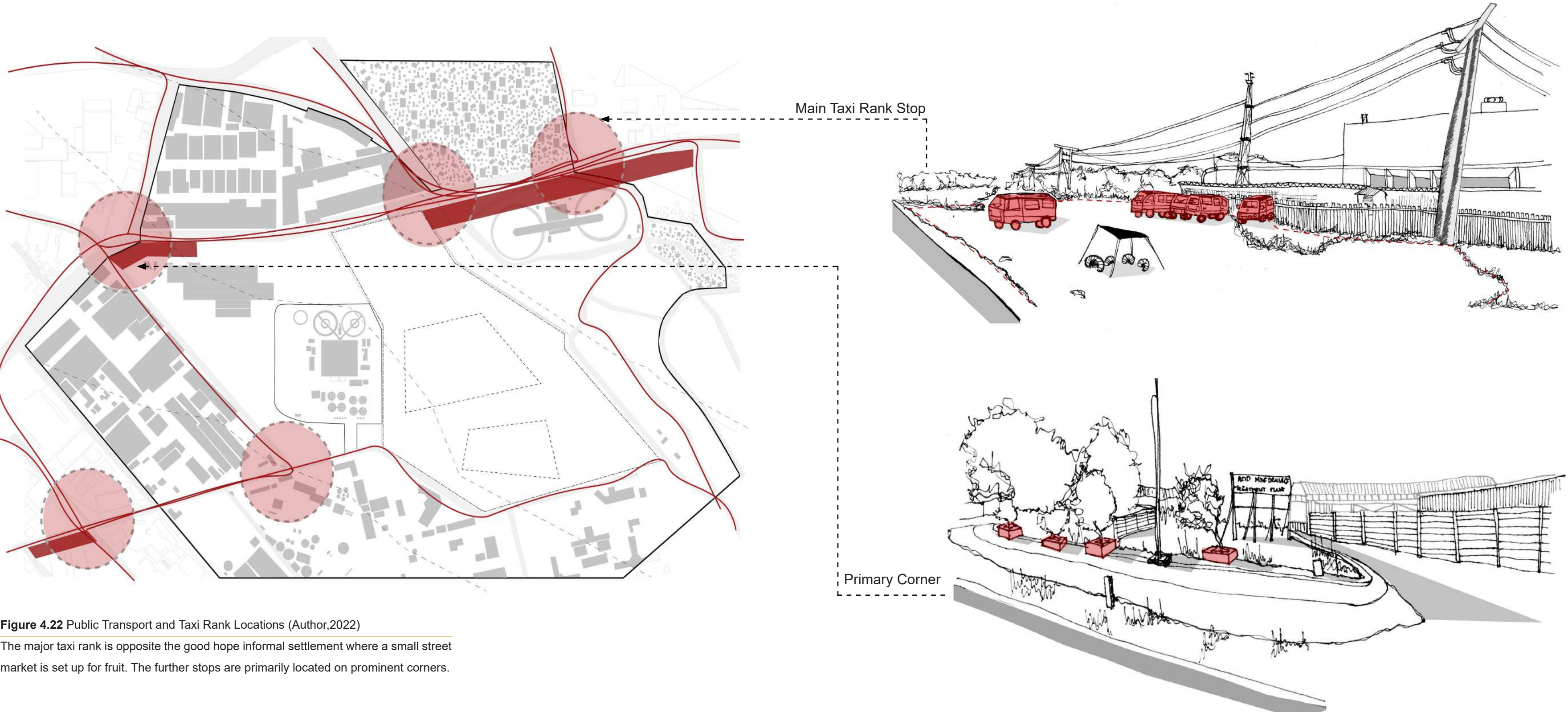


Figure 4.22 Public Transport and Taxi Rank Locations (Author,2022)

The major taxi rank is opposite the good hope informal settlement where a small street market is set up for fruit. The further stops are primarily located on prominent corners.



Figure 4.23 Examining Potential Future Activation(Author,2022)

Potentially creating a road between the two roads of Power street and Tide street creates a direct connection between the proposed building and equal access from both routes. The proposal allows a further connection between the public and the existing treatment plant in which a sense of transparency can be achieved between the building processes and public viewing.

5 Design Development

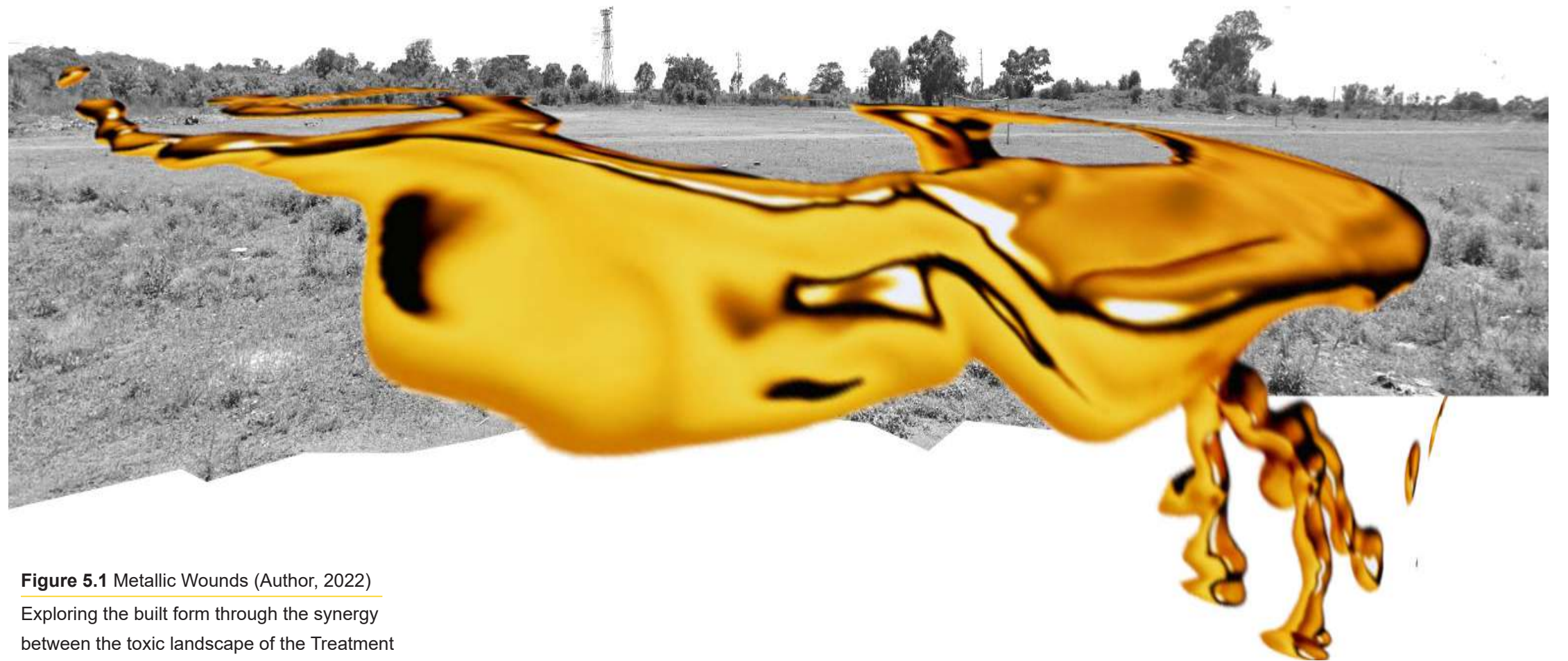


Figure 5.1 Metallic Wounds (Author, 2022)

Exploring the built form through the synergy between the toxic landscape of the Treatment Plant, and the proposal of a building that stores, uses and remembers the metallic wastage accumulation.



Figure 5.2 Holding the Wound (Author, 2022)

The mining landscape today is entwined with rehabilitation techniques for remediation which remove levels of toxicity- acting as a form of erasure. Architectural form therefore poses the opportunity to take this place by providing a positive opportunity for program while simultaneously holding the wound.

5 Design Development

Sketch Charette 2 - Melted Pewter Metal

Figure 5.3 Pewter Sketch Charette (Author, 2022)



Pewter skirting was broken up into smaller pieces in order to fit into a melting crucible.



The crucible and pewter was placed in a melting kettle to a temperature of 800 degrees Celsius. This took approximately 1 hour



Once temperature had been reached the crucible is removed from the kettle using furnace grade gloves and crucible tongs.



A glass vase was filled with distilled water and the liquid metal was poured into the vase.



The liquid pewter began to sink to the bottom of the vase releasing large amounts of heat evident in the bubble size. The metal was liquid red at the beginning of the pour and began to turn silver upon solidification (approx 2 minutes).



The last elements poured were now in liquid form and the pooling of pewter on the bottom of the vase in relation to the heat caused the vase to shatter from the bottom.



The resulting form was haphazard with softer foil like elements on the outskirts were the pewter had lightly settled in relation to the thick middle of the form. Glass pieces are embedded into the form creating sharp shards.



The top of the form was the inverse of the vase from where it had cracked at the bottom. This is largely indicative of the wax process used by jewellers to create the inverse of the required piece.

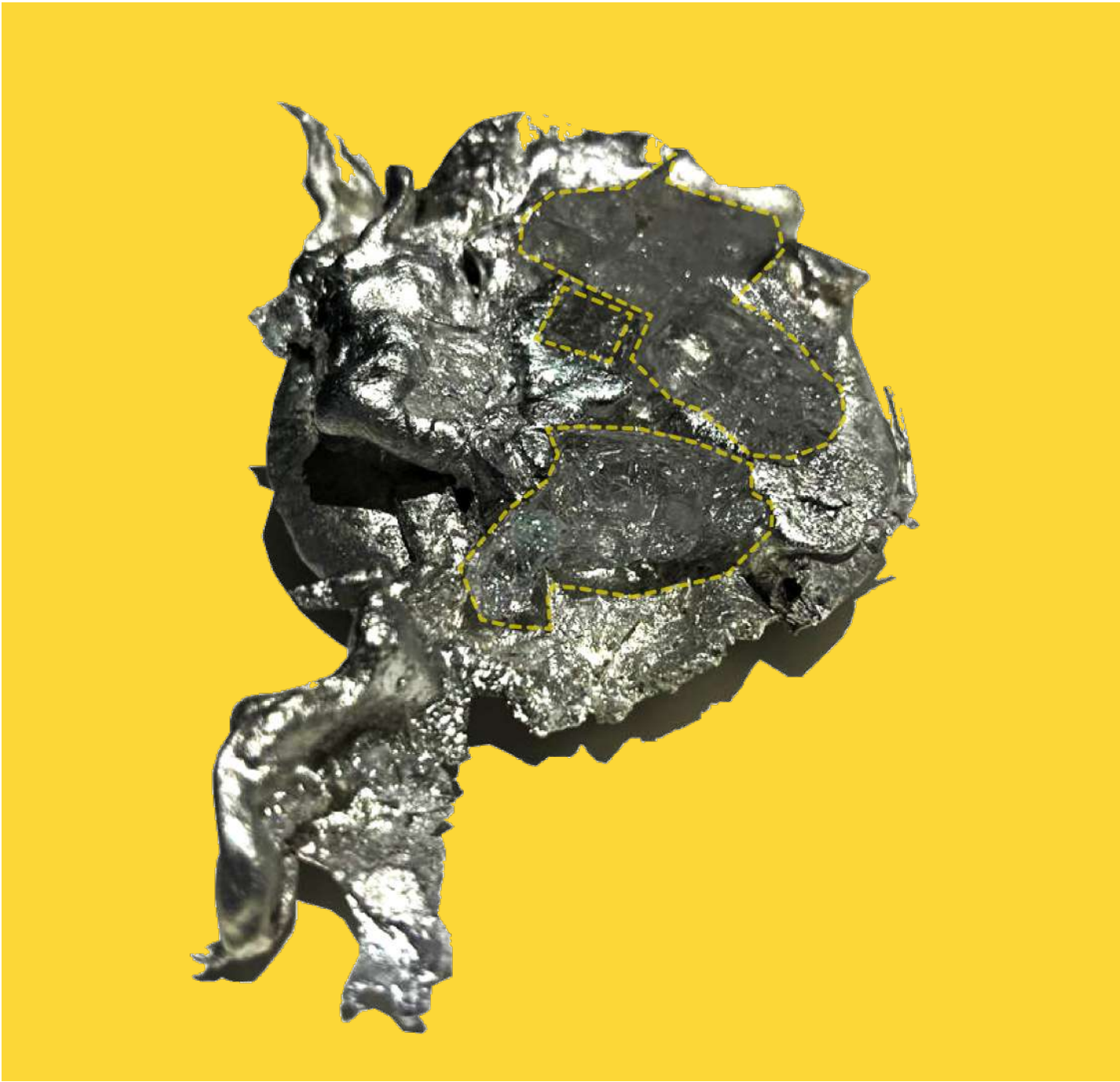


Figure 5.4 Sketch Charette Outcome (Author, 2022)

The sketch charette experiment embeds the glass within the metal work indicating the possibility of form acting as a wound. This notion of highlighting the wound and holding open the damage acts as the primary driving force to the buildings design development. While the building filters and reuses the wasted metal, it further proposes the use of architectural form to act as a historical repository and physical store of the impact the mining industry has inflicted hisstotrically but also currently.

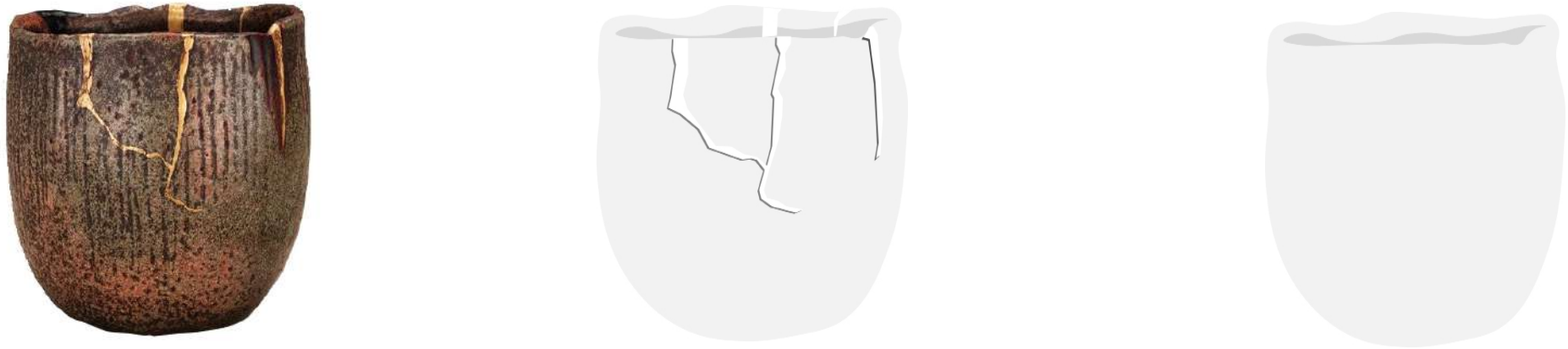


Figure 5.5 Kintsugi Repair (Author, 2022; Unknown, 2016)

A Japanese technique for damage repair; in which broken ceramic elements can be mended using gold infill. While this showcases an organic use for gold it further stimulates the notion of holding open the wound and emphasising the loss.

repository

/rɪˈpɒzɪt(ə)ri/ *noun*

- 1. a place where or receptacle in which things are or may be stored.
- 2. a place where something, especially a natural resource, is found in significant quantities.



Figure 5.6 Natural mineral repository collage (Author, 2022)
Collage exploring the natural state of pyrite underground and the undistrubed veld landscape

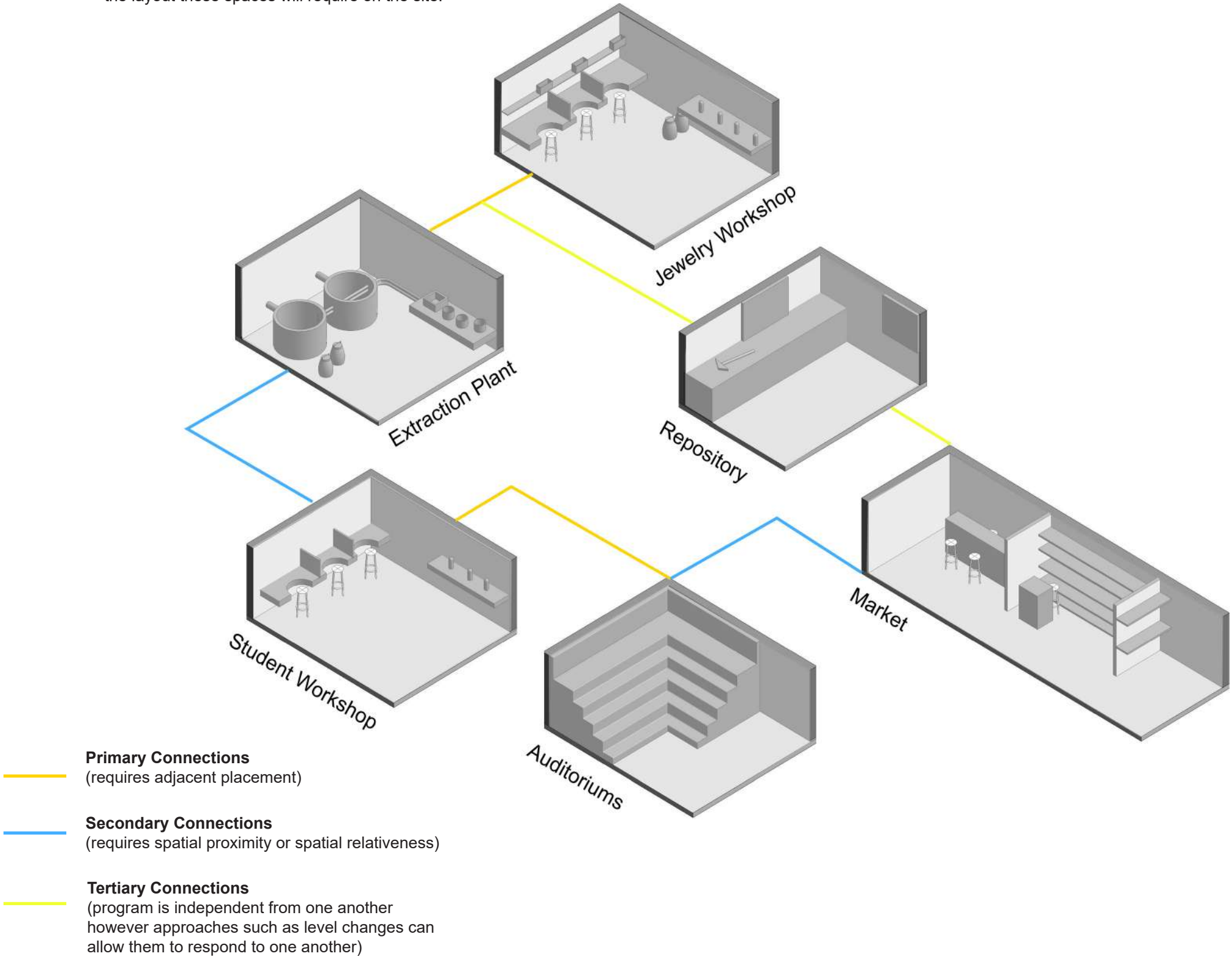
5 Design Development

Program & Accomodtion Schedule

Program	Occupancy	Square Meterage (m²)	Accessibility	Spatial Requirements
Metal Extraction Plant	D1: High Risk Industrial J1: High Risk Storage	430m²	Semi Private Access for staff however; certain activities can be seen by public via a raised viewing deck external to the program.	• Extraction Room • Storage Facility (Chemicals) • Storage Facility (Metals) • Sanitary Change Room • Ablutions • Break Room • Offices
Jewellery Production Centre and Workshops	D2: Moderate Risk Industrial J2: Moderate Risk Storage	1000m²	Semi Private Access to metal and jewellery staff as per bench rent approximately. Workshop available for hotspot opportunities.	• Workshop • 3D Printing Station and Laser Cutting • Melting and Casting Facility • Polishing Room • Melting Facility • Studio Space • Ablutions • Break Room • Storage Facility • Access to Metal from Extraction Plant
Jewellery Metal Works School and Workshops	A3: Places of Institution D2: Moderate Risk Industrial	1185m²	Semi Public Auditorium venues to be used as a multipurpose space for public lectures. The studio spaces and workshops to be used by the students and apprentices.	• Workshop • 3D Printing and Laser Cutting Station • Melting and Casting Facility • Polishing Room • Studio Space • Auditorium • Lobby • Lecture Class Rooms • Ablutions • Break Room • Storage Facility • Teaching Offices
Repository	C2: Museum	2800m²	Public The repository is for open – public access which highlights the significance of creating this access while respecting the work spaces privacy as well as maintaining safety protocols for the extraction plant and chemical use.	• Viewing Deck • Multipurpose Room • Exhibition • Archives • Sensory Rooms • Metal Exhibition • Storage • Ablutions • Fire Escape • Lobby • Offices
Market	F1: Large Shop A1: Entertainment and Public Assembly	744m²	Public Open – public access	• Enclosed Market Spaces • Cafeteria • Ablutions • Storage Facility
[Total Program Approximation : 6160m²]				

Figure 5.7 Spatial Proximity (Author, 2022)

Programmatic proximity layout determining the inter-relationships between the spaces and therefore the layout these spaces will require on the site.



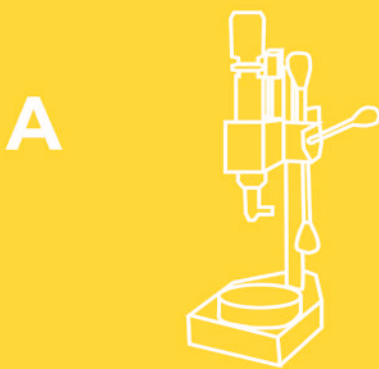
Jewelry Manufacturing Process and Equipment Specifications

Step 1. Melting & Alloying



Oxygen Propane Torch

Step 2. Form making



Stamper



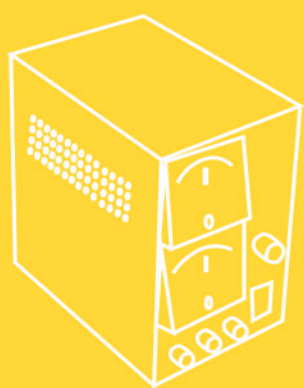
Extruder/ Roller

Step 3. Cleaning & Polishing



Tumbler

Step 4. Plating



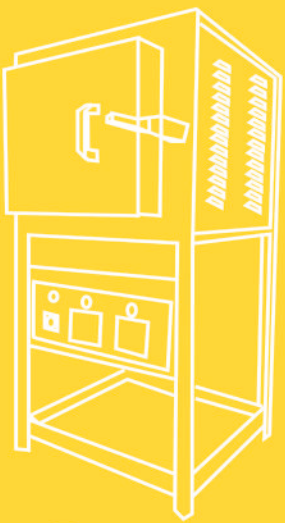
Electronic Plating Machine



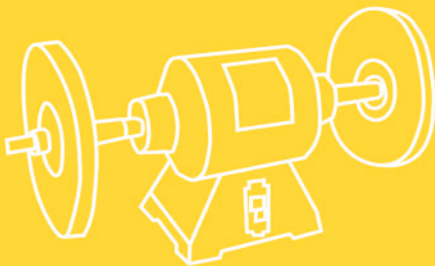
Melting Kettle



Casting Machine



Furnace



Polishing Machine

Figure 5.8 The Manufacturing Process (Author, 2022)

The jewelry manufacturing process is relative to the style, skills and type of product that is desired by both the client and the jeweller. This results in a extensive possibility for manufacturing; however a set of jewellery equipment exists that in turn affects the programmatic set up and requirements of the production and manufacturing spaces.

Precedent Study: Metallic Museums

Allmannajuvet Zinc Mine Museum, 2016

Peter Zumthor

Sauda, Norway



Figure 5.9 Perspective photograph of Allmannajuvet Mining Gallery (Bernsten, 2016)

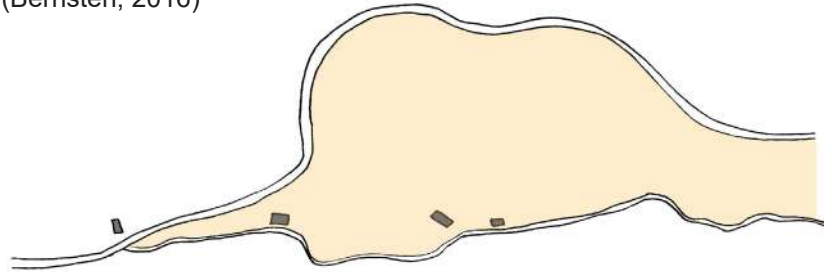
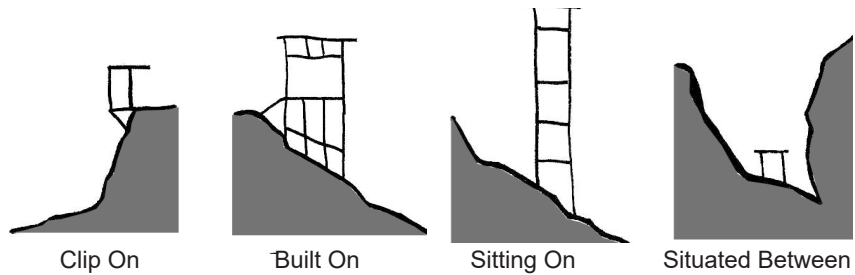


Figure 5.10 Precedent Analysis (Author, 2022)

[Top] The museum functions are spread alongside a large linear route of an old zinc mine - allowing the transitory experience to replicate that of the mine.

[Bottom] The museum functions are spread alongside a large linear route of an old zinc mine - allowing the transitory experience to replicate that of the mine.



Precedent Study: Metallic Museums

Museum of Modern Aluminium, 2022

Has Design and Research

Nonthaburi, Thailand

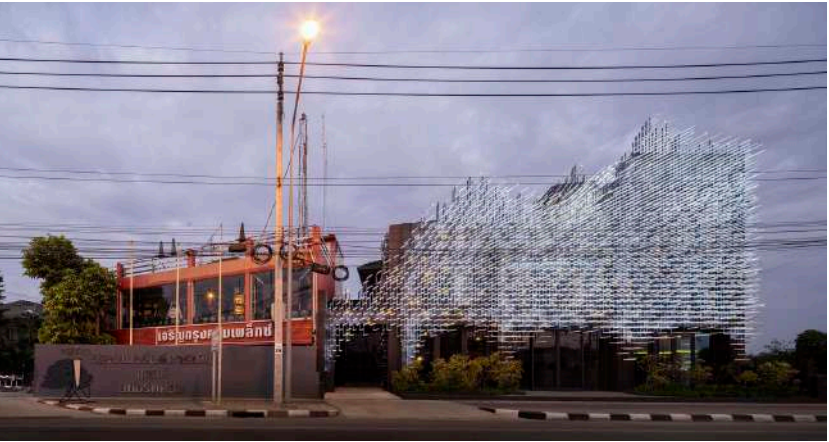


Figure 5.11 Photograph of the Museum of Modern Aluminium facade (W Workspace, 2022)



Figure 5.12 Precedent Analysis (Author, 2022)

The building attached to an existing aluminium mining plant; however the programmatic approach of the building was to showcase the abundant and modern use of aluminium today. This created a juxtaposition between the existing building on the site and a creation of a modern structure. The building inherently consists of four rectilinear masses that accommodate the ranging program and height requirements of the museum. The use of the aluminium cladding begins to diffuse the facade - softening and morphing the form paradoxically. This allows the metal to be perceived from one facade as a soft formation while from a different perspective the angular and sharp formations are more evident and striking.

Precedent Study: Museums

Jewish Museum, 1999

Daniel Libeskind

Berlin, Germany



Figure 5.13 Aerial perspective photograph of the Jewish Museum (Schneider, 2001)

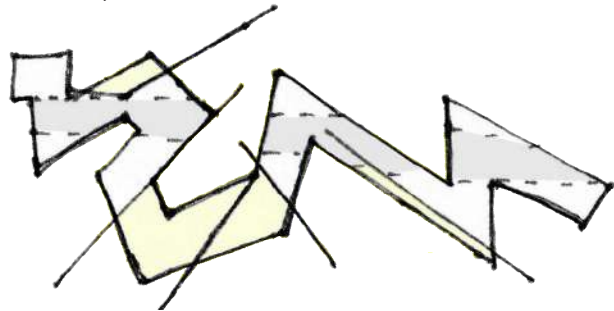


Figure 5.14 Precedent Analysis (Author, 2022)

The museum focuses on a long thin floor plan that starts from one end to the other. The program therefore is largely dependent on the movement between these spaces. The design therefore utilises the edges for enclosed program allowing the circulation to flow consistently.

Precedent Study: Metallic & Concrete Structures

Barcelona Olympic Archery Range, 1991

Enric Miralles & Carme Pinos

Barcelona, Spain

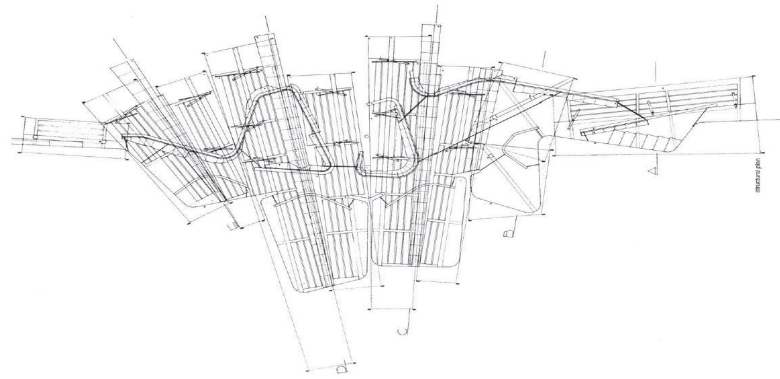


Figure 5.15 Olympic archery range floor plan diagram (Miralles and Pinos, 1991)

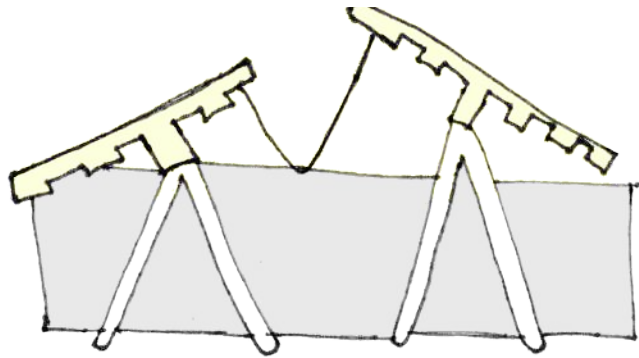


Figure 5.16 Precedent Analysis (Author, 2022)

The linear programmatic plan is broken up through the use of the roof scape. This creates a synergy between the effect of the plan while creating independent moments through the individual spaces. The roofing further allows for effective stack ventilation to occur, as well as the potential to vary in height to relate to various program.

Precedent Study: Industrial Museums

Zeitz Mocca, 2017

Heatherwick Studio

Cape Town, South Africa

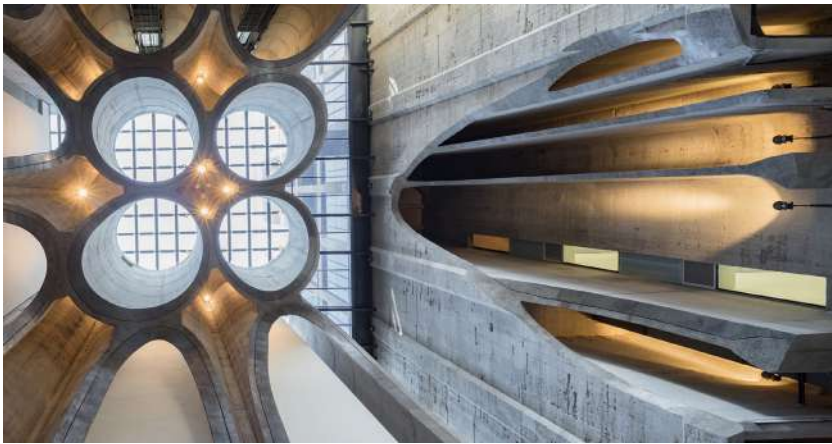


Figure 5.17 Perspective photograph of interior silo of the Zeitz Mocca (Baan, 2017)

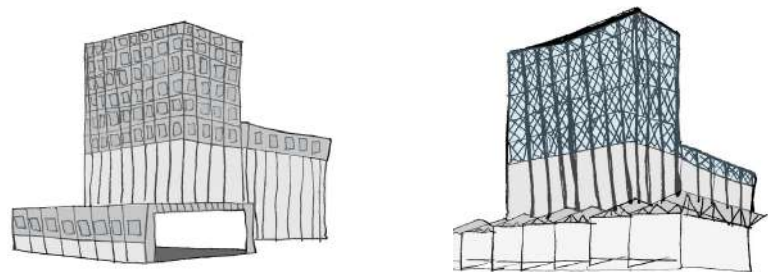


Figure 5.18 Precedent Analysis

[Top] The transition of the original grain silo building into the art museum and hotel focused on a more internal approach of carving. This allows the historical nature of the building to remain industrial - demarcating what existed before.

[Bottom] The approach to carving re-purposes the silos into an art formation. The notion keeps the silos intact while carving them to accommodate new program and use.



Precedent Study: Metal Use

Riyadh Metro Station, Under Construction

Zaha Hadid Architects

Riyadh, Saudi Arabia

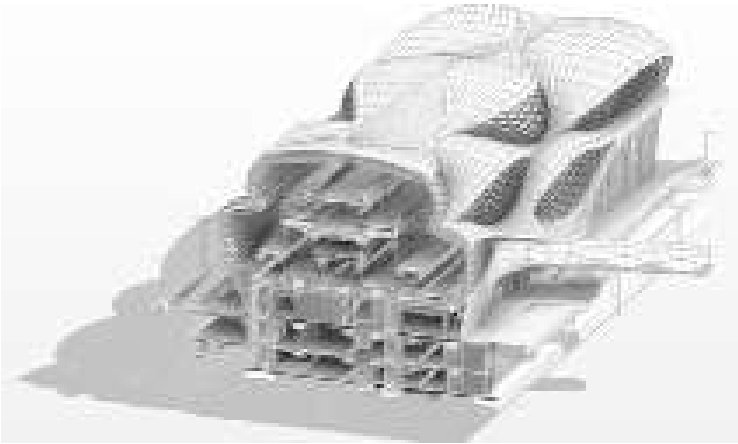


Figure 5.19 Sectional Perspective Through the Metro Station (Zaha Hadid Architects, 2013)

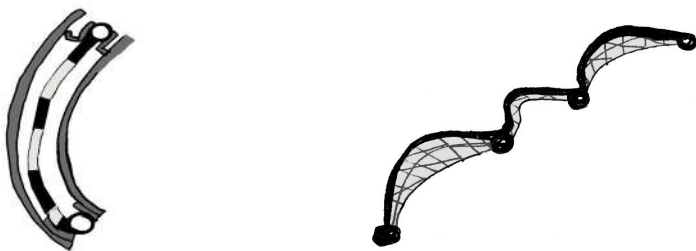


Figure 5.20 Precedent Analysis

The metro station - while not yet complete -creates the opportunity to assess the current raw structural state of the building in relation to its proposed and rendered form. The cladding of the building strives to create a smooth metallic facade, however; the metallic support system alone (that is later covered) offers the opportunity to engage with metallic formations - showcasing the more industrial approach to the building.

Adressing the Expanse of the Site



Figure 5.21 Mine Dump Stains

Two mine dumps have been removed from the site and rehabilitated, however a pigment stain remains demarcating them from the aerial perspective. Fauna and vegetation make the stains less noticeable while occupying the site therefore the notion of generating form keeps the essence of holding the wound of the mine dumps from erasure.

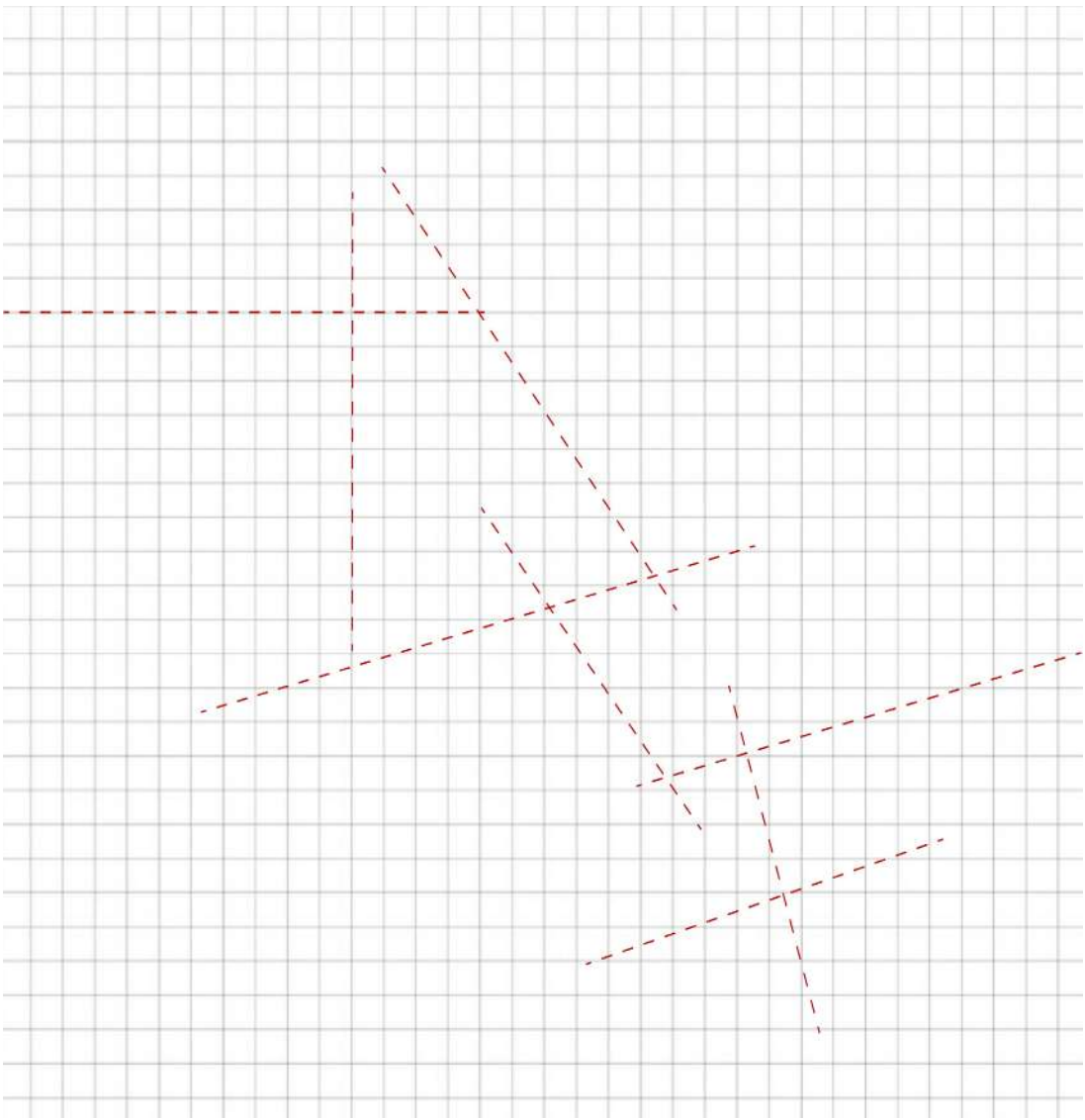


Figure 5.22 Mine Dump Grid Lines

The translated formations of the mine dumps form a spatial grid in which the building form can begin to generate from.

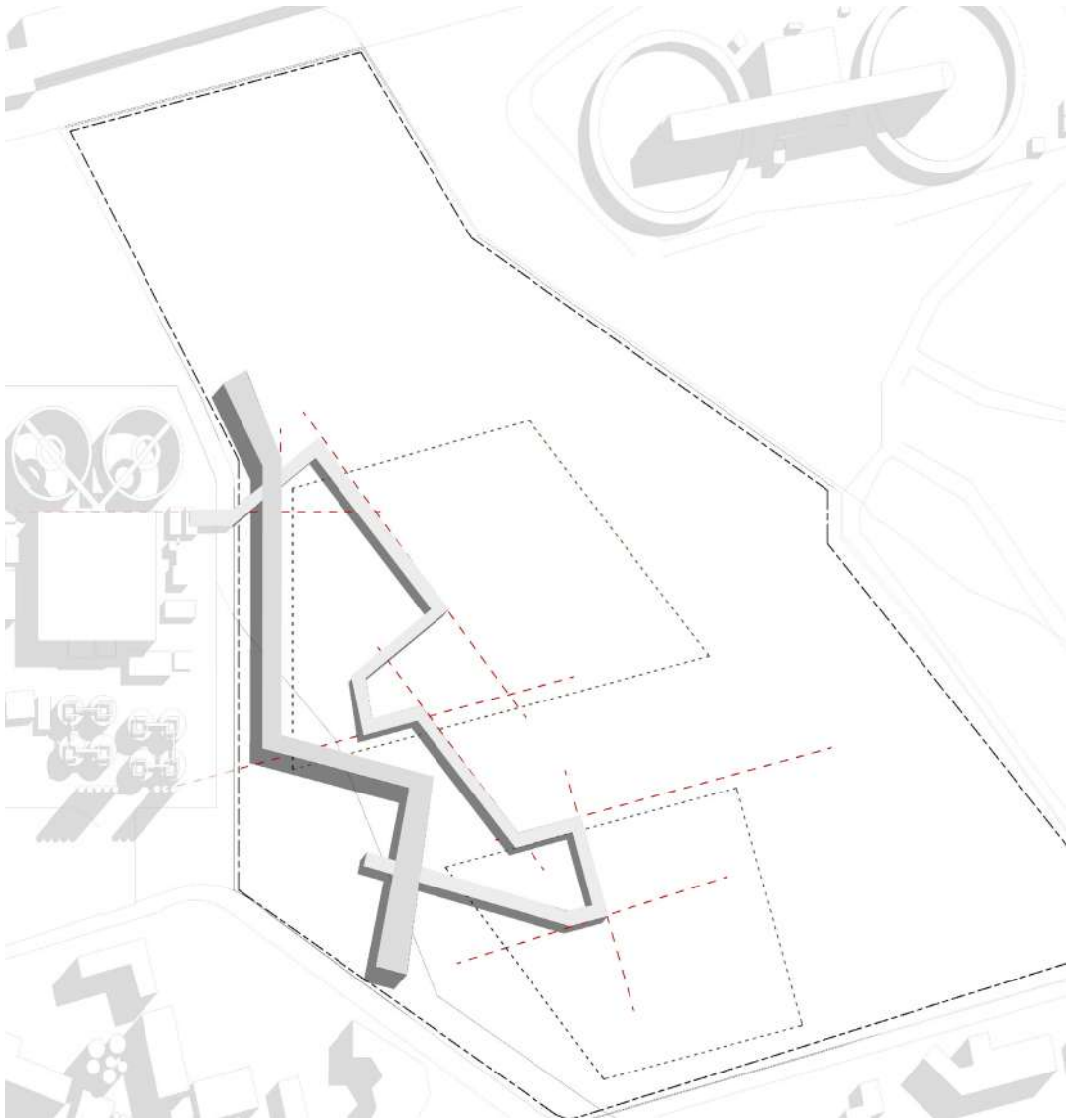


Figure 5.23 Translating the Grid

The grid lines when placed along the left boundary of the site create two long linear paths. The need to edge close to the boundary connects the existing treatment plant to the proposed extraction plant and repository; while using the appropriate portion of the site to its relatively large extents. The separation of the line based grid allows the generation of two forms to exist: one that forms the repository element and the other the metal works; however they intersect and two pivotal points.

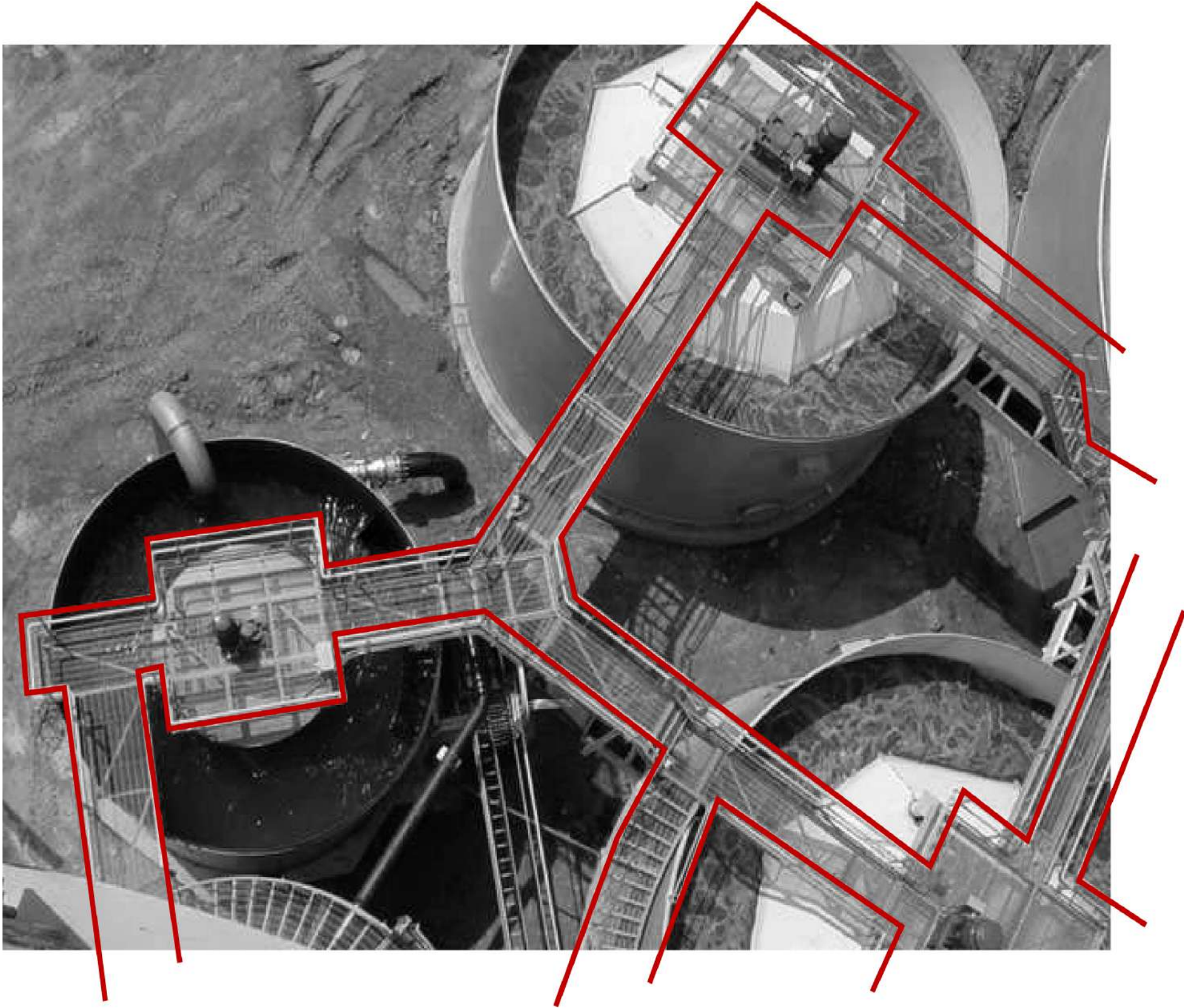


Figure 5.24 Treatment Plant Circulation Typology

Steel walkways connect the treatment basins together - allowing the large expansive bins to be monitored and controlled from a raised circulation. This creates accessibility but also a safety barrier from a toxic environment.

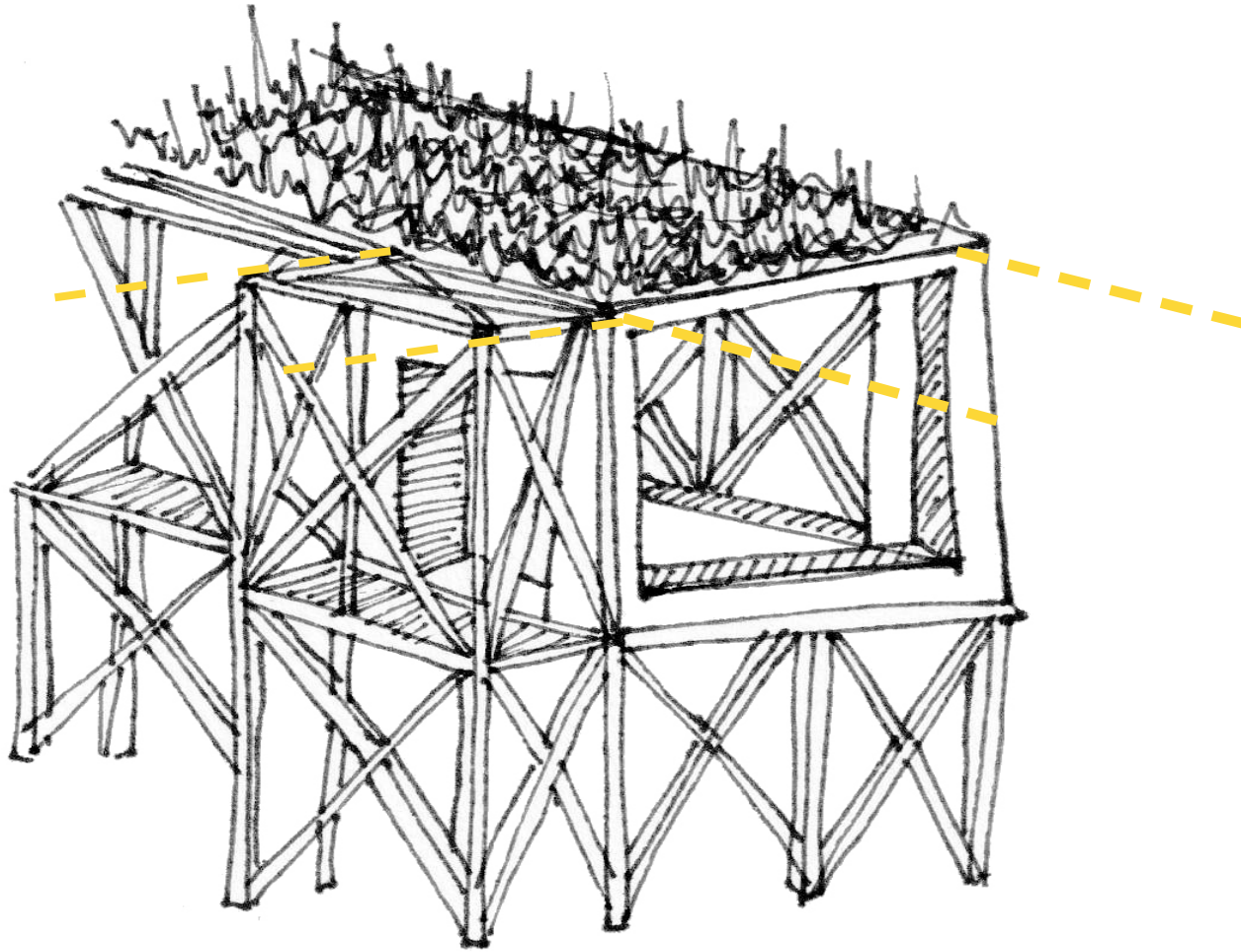


Figure 5.25 Viewing Deck

Exploring architectural walkways to view the treatment plant adjacent to the site. This is currently barricaded to create safety control; however a raised platform that views in allows this process to be viewed by the public and the actuality of the toxic water treatment in Johannesburg to become realised. This creates an enclosed safe platform.

Circulation

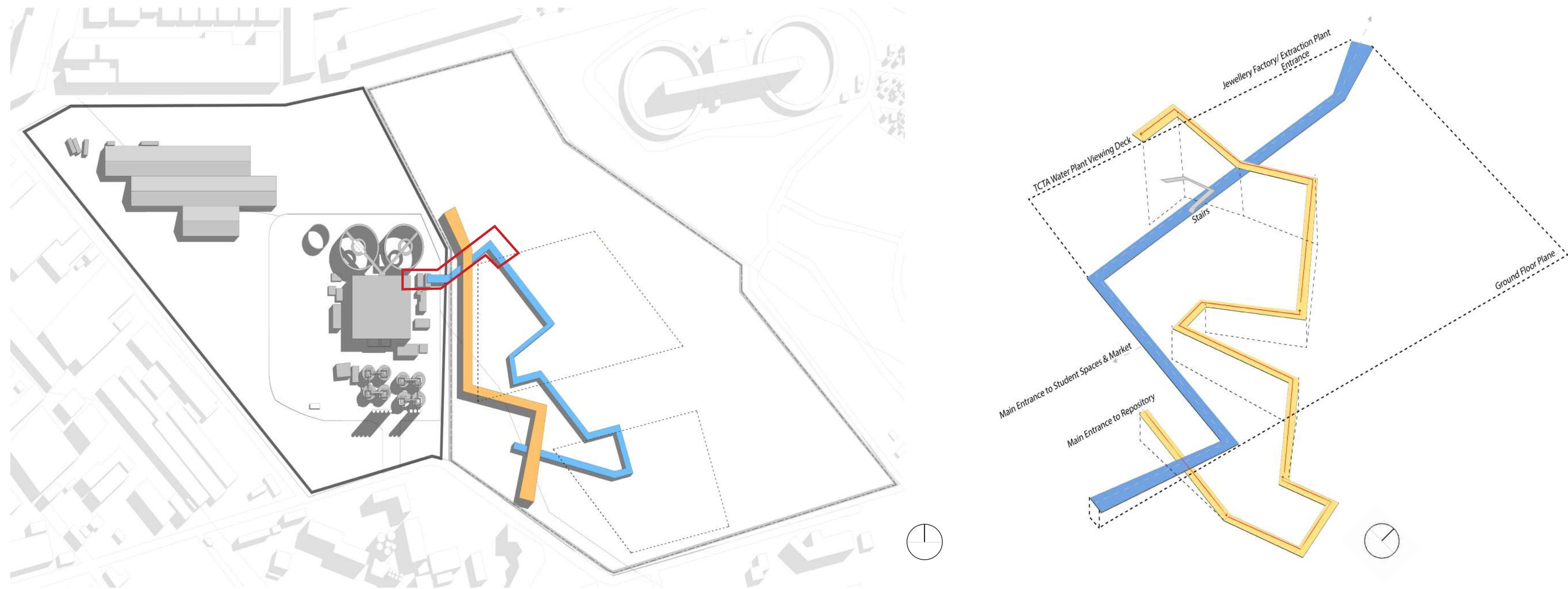


Figure 5.26 Building Circulation

The circulation design aimed to create two different movement experiences. The first experience is the repository which aims to simulate an experience of the current state of the site: this includes moving under the ground and branching out similarly to the route of mine shaft. Contrastingly the route in orange is aimed to remain purely above ground to ensure no workers are forced to move underground as seen in mining environments. This is based on a social motivator in order to create synergy between the two routes but to ensure that the repository remains experiential. The two routes overlap at two intersection; however this is aimed at viewing from a distance. The rationale is for hazard and safety protocols as well as respecting the work environment for individual users of the manufacturing and extraction spaces.

Adressing the Stains of the Removed Mine Dumps

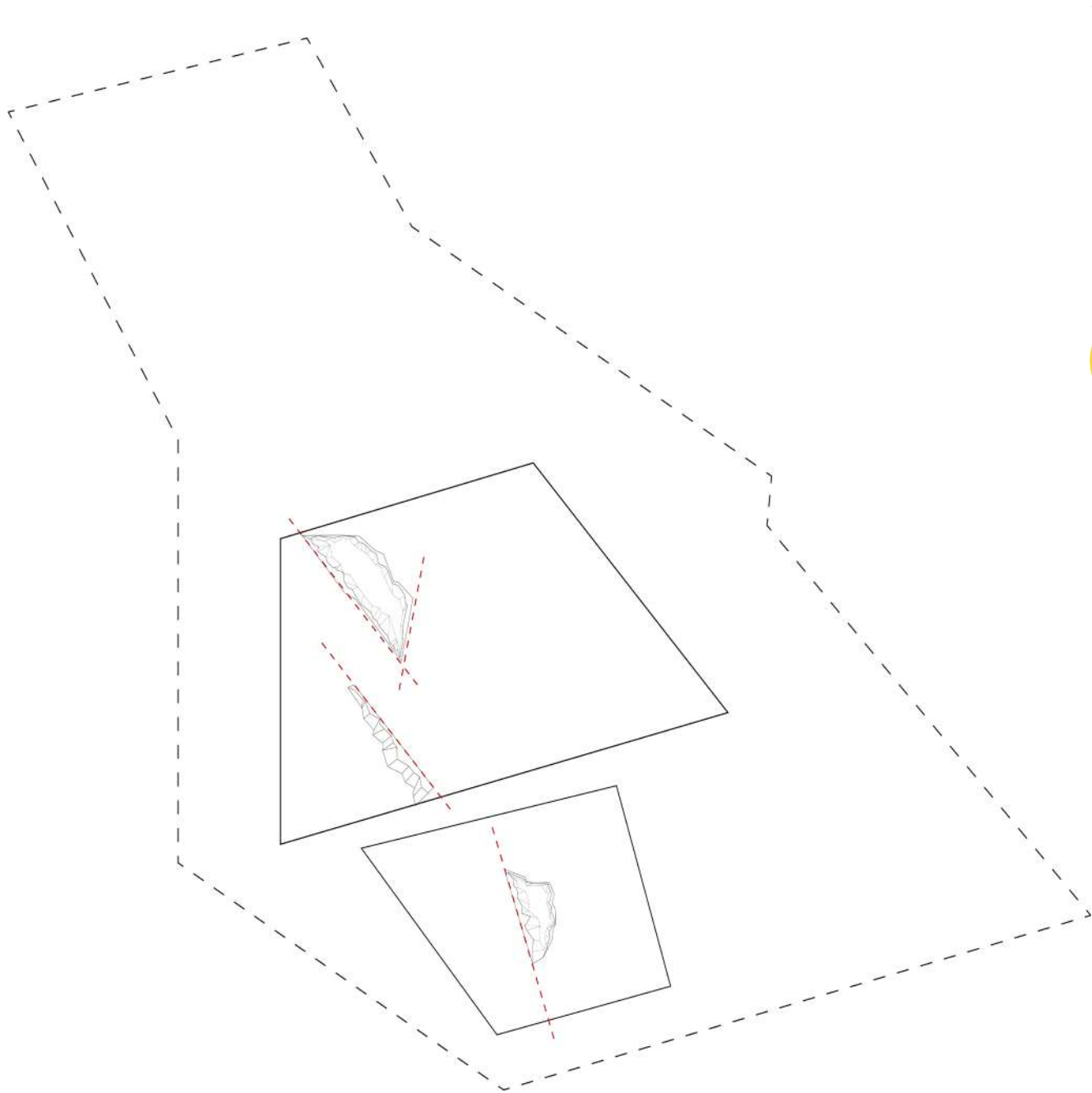


Figure 5.27 Carving Berms from the Mine Dump Stains

The stains of the mine dumps are the only remaining element of their monumental existence, and the stain is only emphatic and evident from an aerial perspective. Proposing the possibility of cutting portions of the mine dump into the ground showcasing their effect on the soil.

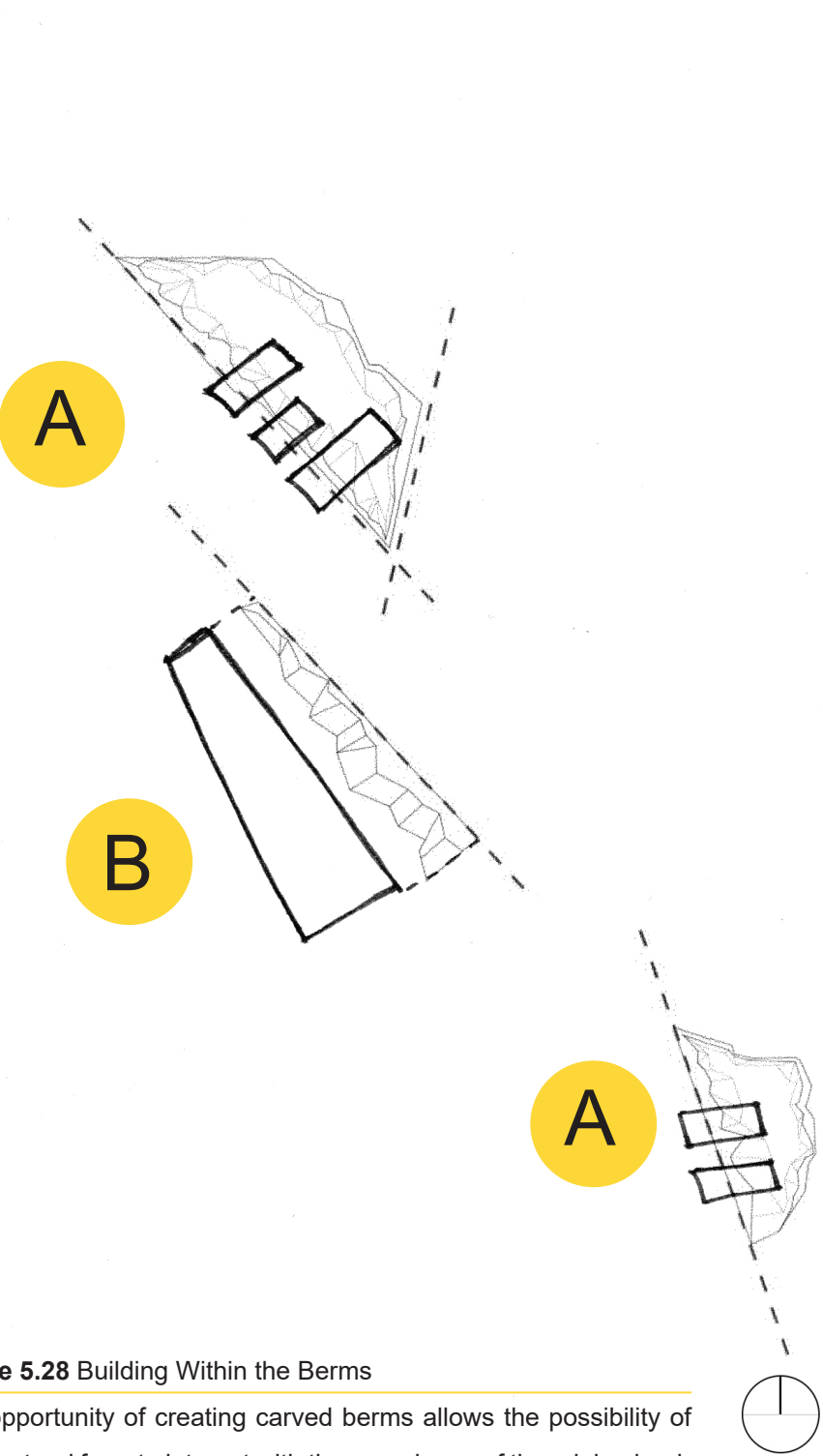
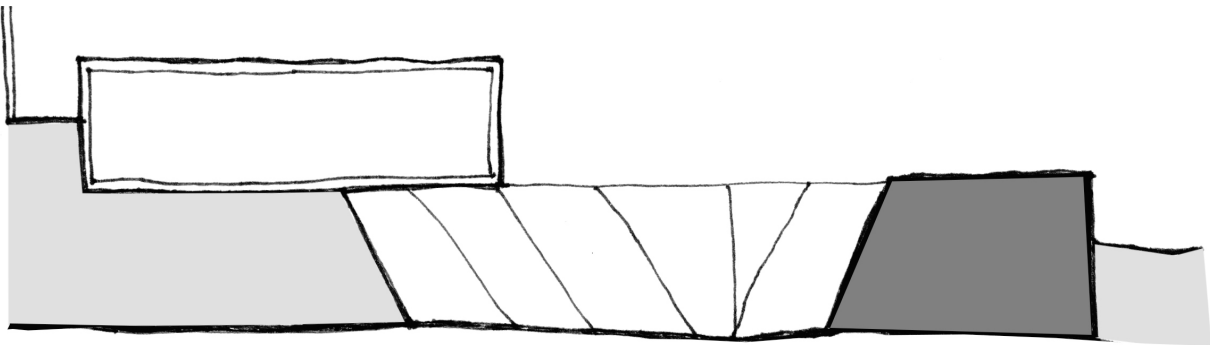


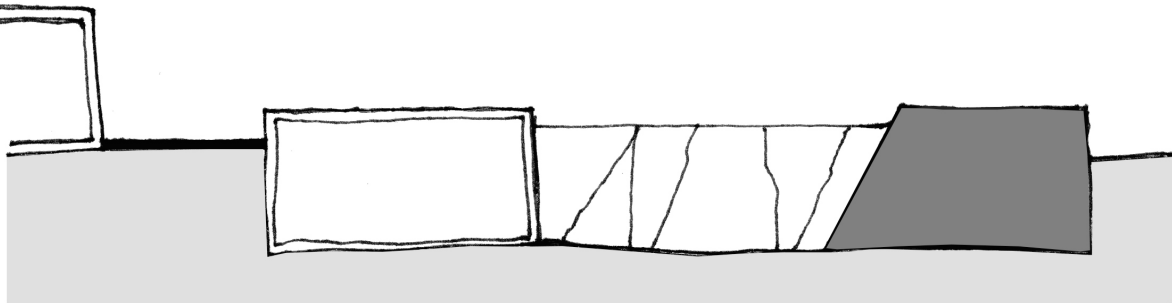
Figure 5.28 Building Within the Berms

The opportunity of creating carved berms allows the possibility of architectural form to interact with the experience of the mining landscape. This allows users to inhabit the rough carved edges of the excavated rock. This program proposal interacts as part of the repository.



A **Figure 5.29.1** Repository to Berm Condition A

The first architectural form typology is raising the protruding form over the excavated section to overhang over the space. The raised experience creates a suspended view of the rock below, allowing the program to physical jut over the berm.



B **Figure 5.29.2** Repository to Berm Condition B

The sunken form allows the space to be level with the bottom of the berm. In this instance the viewer is able to enter the berm level and experience the roughness of the rock below.

Massing Progression



Figure 5.30 Massing and Form Exploration 1
Massing sketch: exploration sketch 22/04/2022



Placing the program requirements on the site ascertain the response to connect the two primary roads- north and south. This allows the building to remain on the western extents of the site in close proximity to the treatment plant - therefore setting up a smaller site extent.

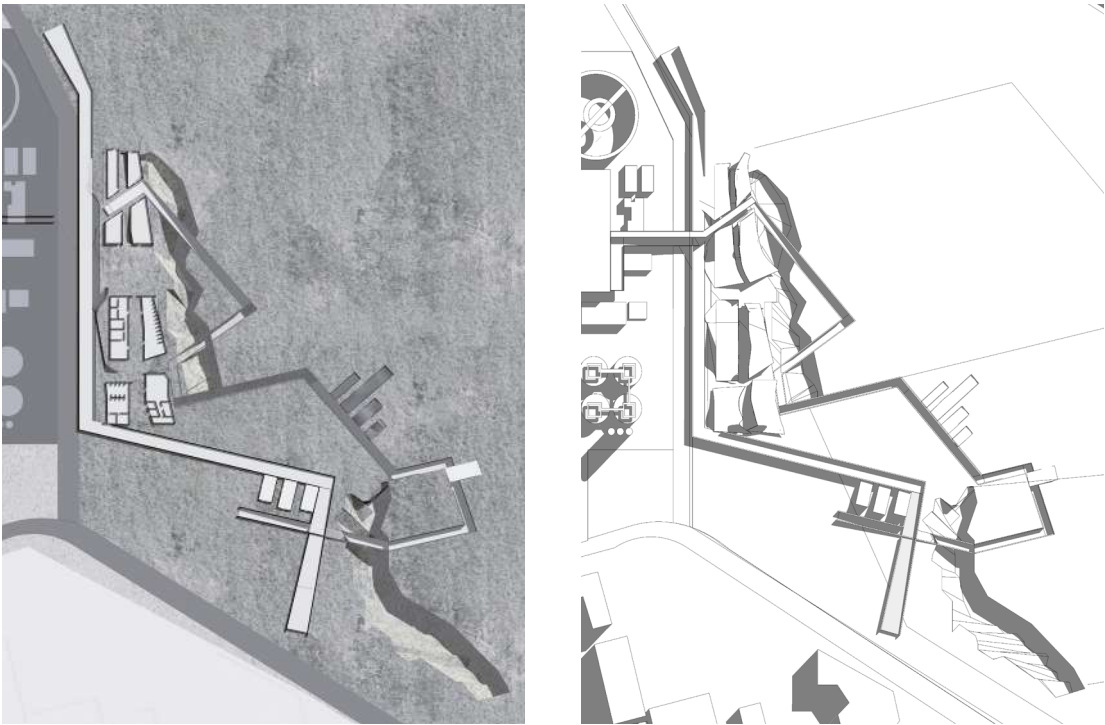


Figure 5.31 Massing and Form Exploration 2
Massing sketch: June Review 30/06/2022



[Top] The building programmatic sectors extrude outwards from the long circulation - this allows the public versus private program to occur, however a divide between the building form occurs that does not accentuate the linear experience of connecting the site.
[Bottom] The roofscape further becomes broken which if united could emphasise the thin-ness of the building.



Figure 5.32 Massing and Form Exploration 3
Massing sketch: 07/07/2022



Exploring the use of the 'circulation' routes as part of the building program. Similarly to the June review the building is still fragmented and the approach to maximise sunlight and northern light is still limited in this fragmented design. The circulation spaces are still too prominent in relation to the programmatic sizes.



Figure 5.33 Massing and Form Exploration 4
Massing sketch: 09/07/2022



Thickening the proposed linear circulation to include the building form creates a more natural flow and enhances the notion of the continuous roof. The building however is becoming too cellular and regulated which needs to be resolved, as well as dealing with the changes in program. The repository further needs to thicken and thin to enhance the experience of the long linear circulation. A further focus is the relationship between the repository and the metal works building footprint which has now created in between courtyard spaces.



Figure 5.34 Massing and Form Exploration 5
Massing sketch: June Review 09/07/2022



The refinement of the previous diagram begins to thicken and thin the cellular grid. This also begins to create public versus privacy differences between the programs - while allowing the long continuous plan to remain.



Figure 5.35 Massing and Form Exploration 6
Massing sketch: 16/07/2022



Introduction between the treatment plant forms and the proposed building. The circular forms begin to introduce an ideal workshop-scape in which the the full perimeter of the room can be maximised for bench use as well as the internal radius while keeping an appropriate walking distance between the two.

Massing Progression and Integration of Massing Developments 4- 6

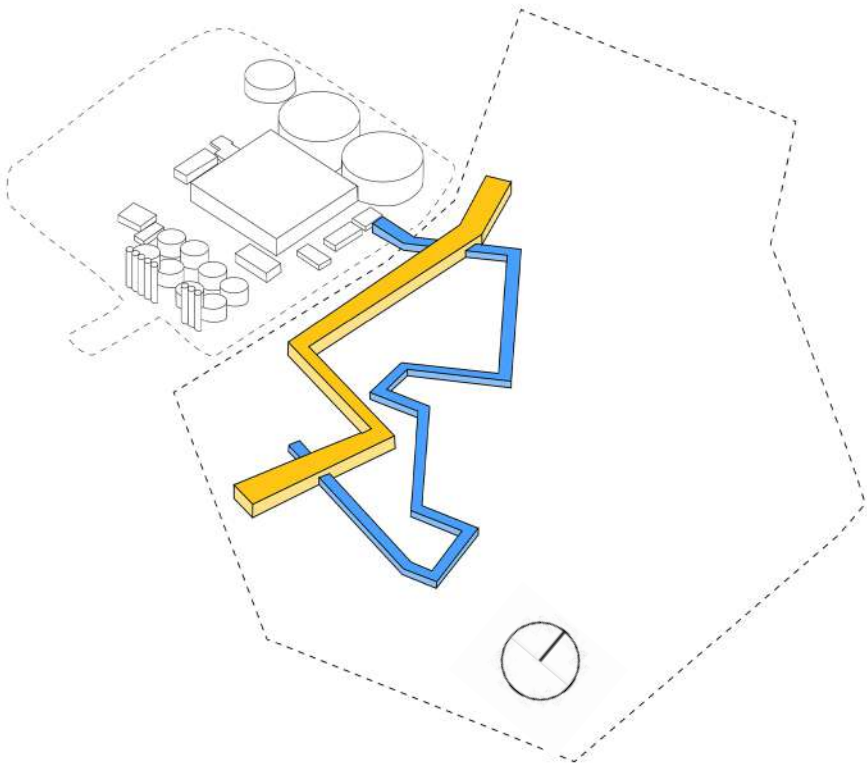


Figure 5.36 The Relationship Between the Two Buildings

The first outcome of exploring the site was distinguishing two different circulation routes - which resulted in the separation of two distinct buildings. While two overlaps occur on the southern and northern façades the programs are designed to only view the other in those areas and not overlap in order to maintain the safety protocols and privacy .

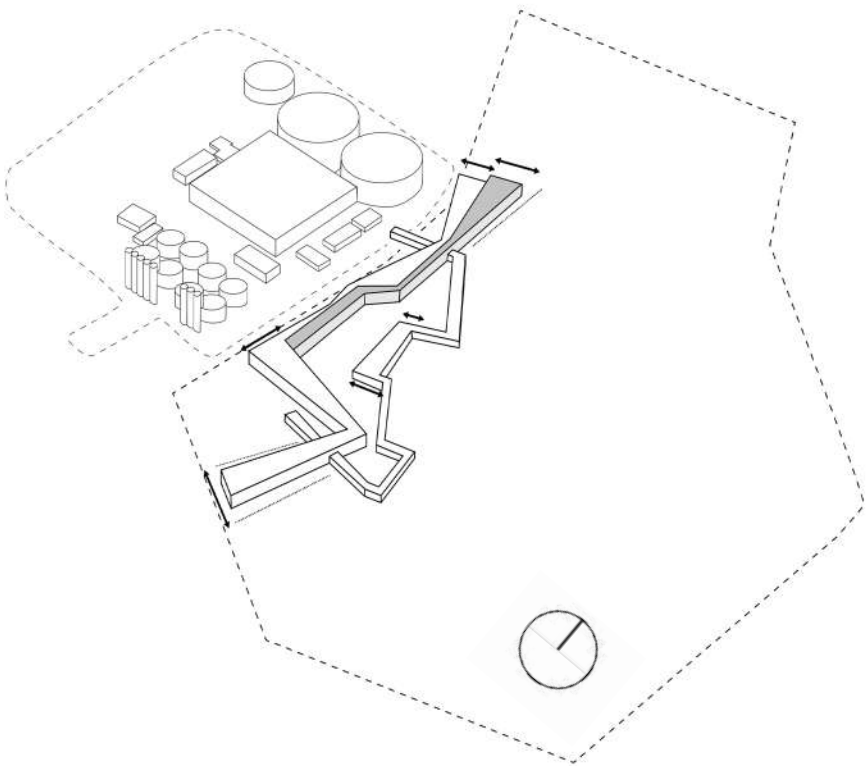


Figure 5.37 Edge Thickening

The narrowness of the circulation was resulting in cellular and replicated spaces- creating edge thickening allows for more northern light, increased corner prominence and the opportunity to create more unique spaces.

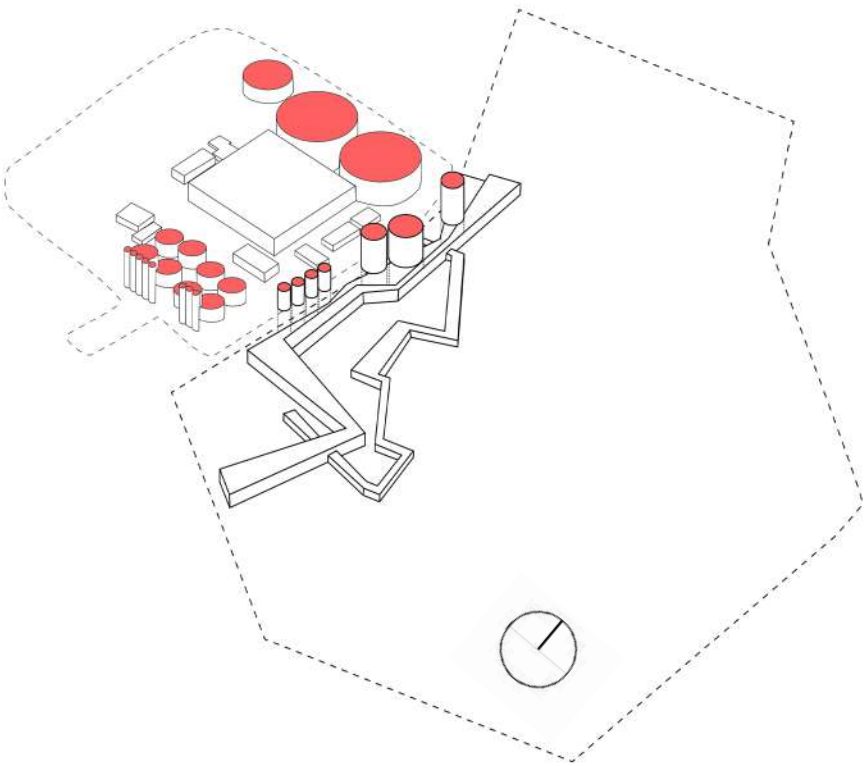


Figure 5.38 The Influence of the Silo and Basin

The rectilinear nature of the building through the aerial and axonometric perspective was indicative of the juxtaposition between the two building and thus the introduction of circular forms begins to create a synergy between the two while using material and edges to create more distinct boundaries.

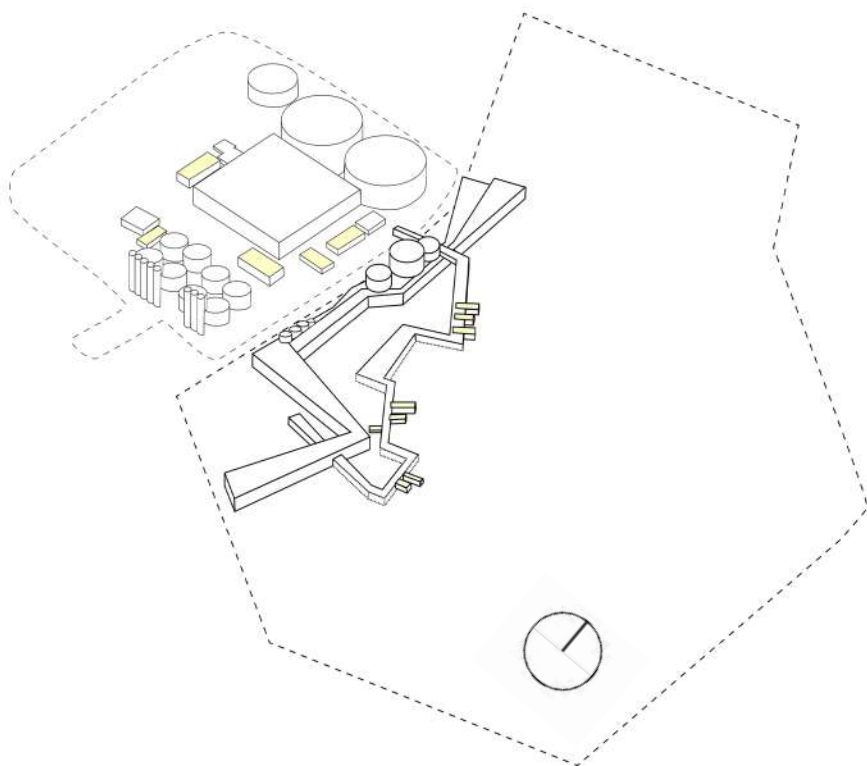


Figure 5.39 The Repository Extrusions

Similarly the broken up and small buildings on the treatment plant site create small diversions along the route between extraction to treatment which forms a parallel narrative to the stops along the repository. Incorporating the proportions of the small structures allows this divergent experience to occur within the expanse of the

Spatial Relations

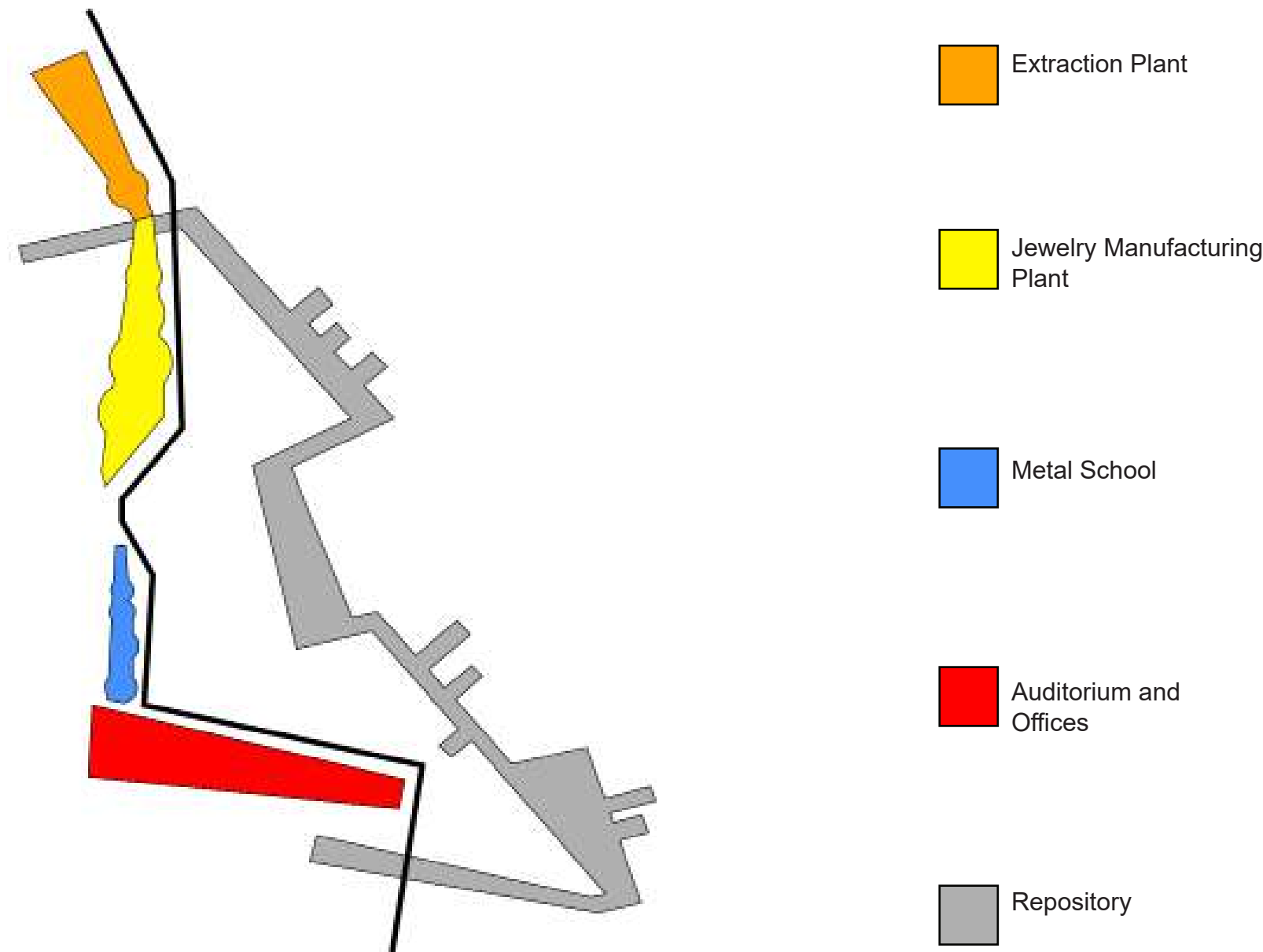


Figure 5.40 Program Placement

While integrating the program into the massing - the placement resulted in the more public functions such as the: market, repository, school and auditorium being placed towards the southern extent of the site towards the subsidiary road; while the more private program is placed further up and north of the site being: the extraction plant and jewelry workshop. This is in relation to the surrounding context of the site and the prominence of the taxi rank location for staff circulation and movement to work,



Figure 5.41 Plan Design Development

The plan at design development phase is beginning to develop the program within the massing further- allocating spaces to the various requirements of the program from polishing rooms and furnance spaces to general ablutions and break rooms.



Repository

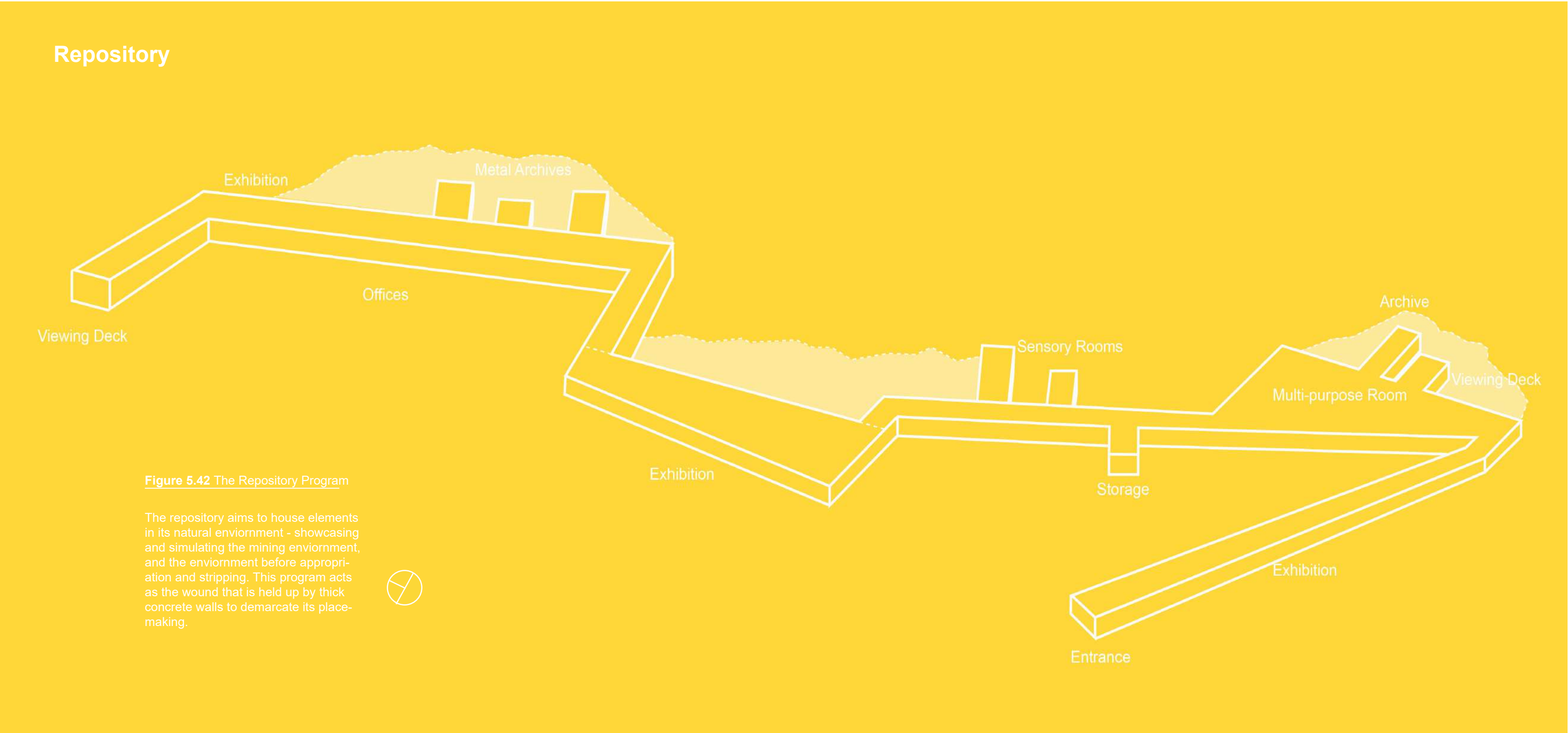


Figure 5.42 The Repository Program

The repository aims to house elements in its natural environment - showcasing and simulating the mining environment, and the environment before appropriation and stripping. This program acts as the wound that is held up by thick concrete walls to demarcate its place-making.



Metal Works Building

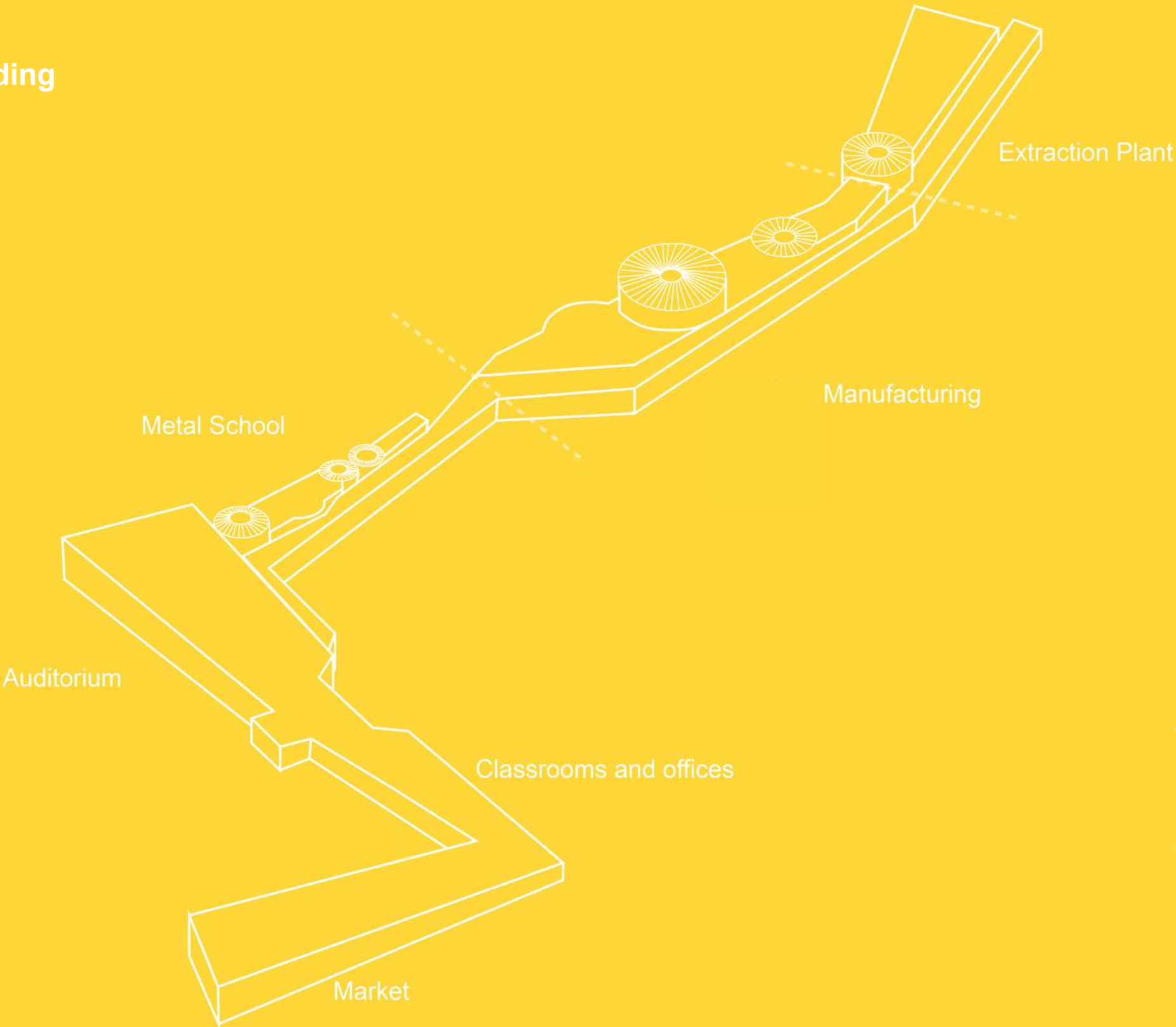


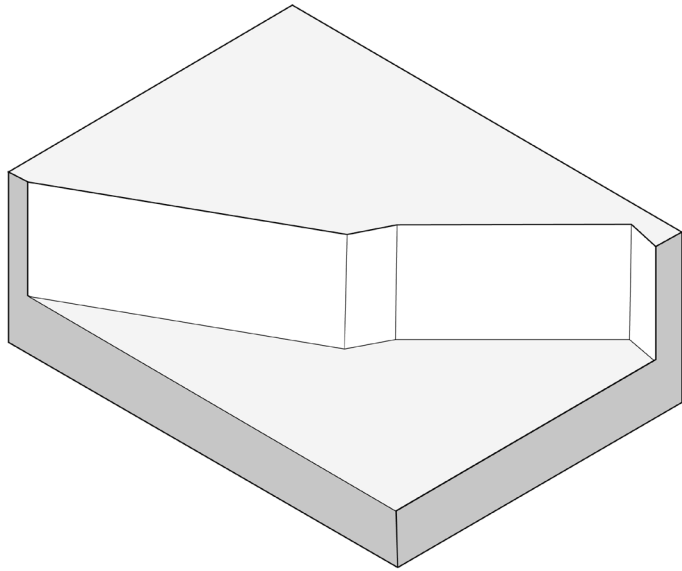
Figure 5.43 The Metal Works Program

The metal works building mass is essentially broken into the 5 primary programs however the linear experience aims to remain continuous and seamless to stretch the building against the existing treatment plant.



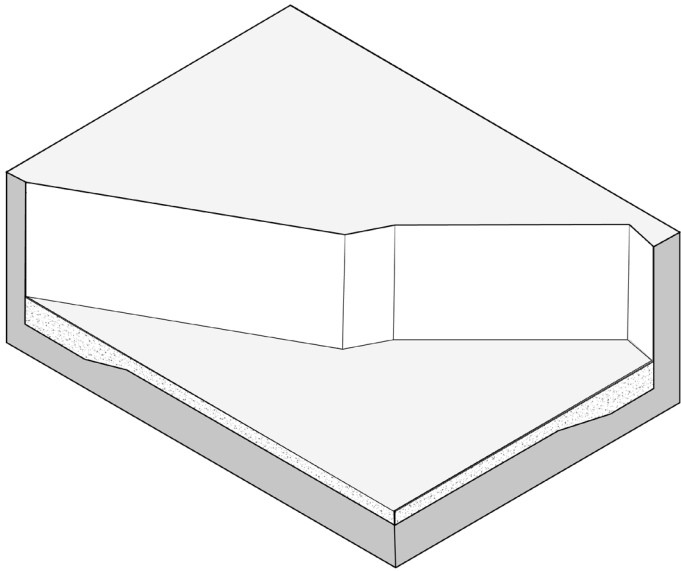
Figure 5.44 Concrete Berm Construction

1



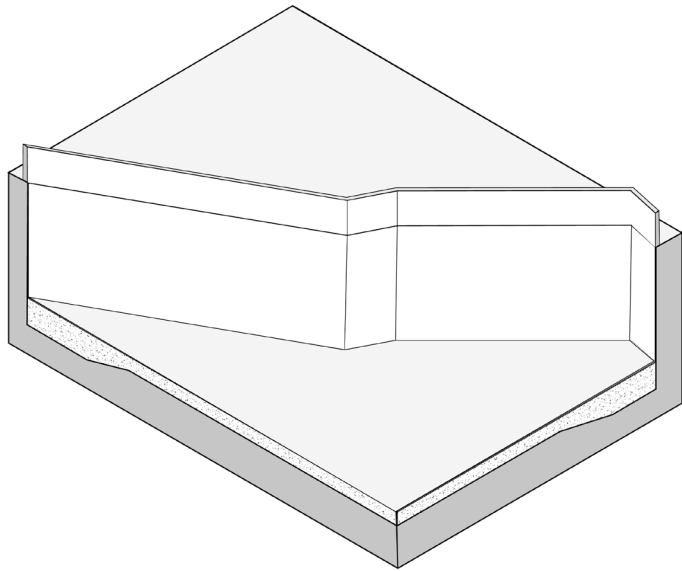
The soil is excavated and cut back to the desired level of the berm (-4500mm) and prepared for foundations.

2



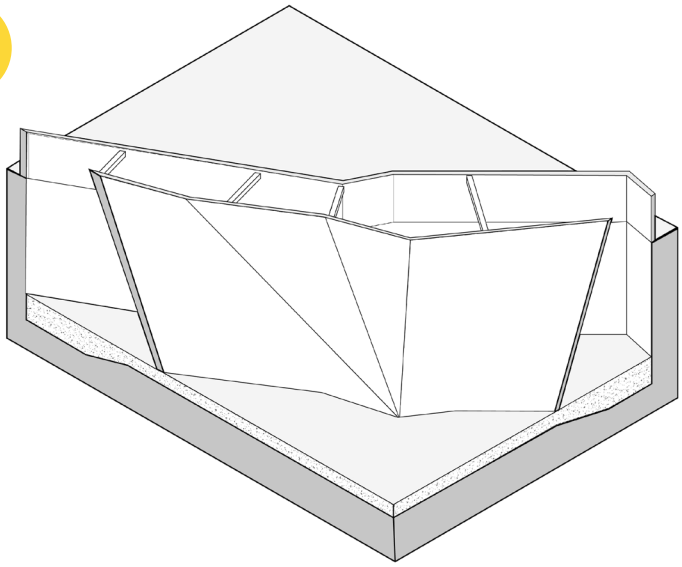
Raft foundations are cast in place which edge thickening requirements around the designated footprint of the concrete wall placement

3



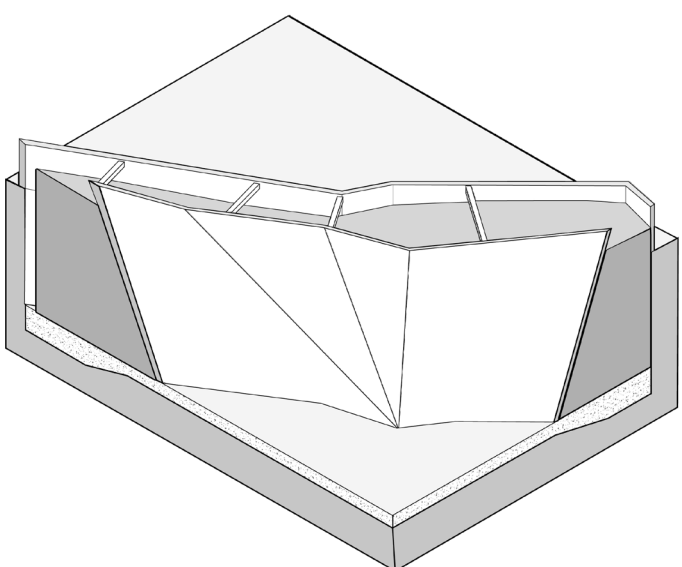
Form work lines the edge of the wall exceeding +1500mm to create a natural balustrade . This form work must exceed that designated height to allow for compacting machinery to be used.

4



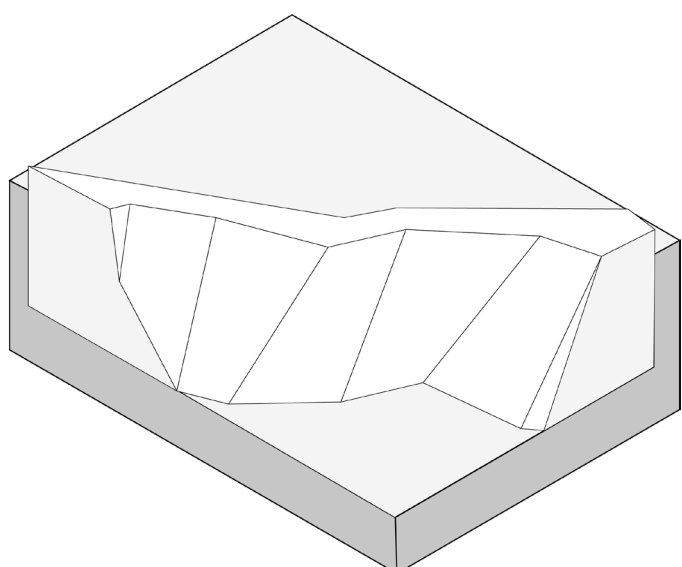
The front form work and support frame to then be put in place. This form work is to drawing specifications to ensure the correct angular form is achieved.

5



The flyash concrete mixed with site aggregate is then placed within the formwork and compacted in levels to achieve the required height.

6



Once the concrete has reached structural mpa and has dried out - the formwork may be removed to reveal the berm walls.

Concrete Construction

The rationale for the use of concrete within this proposal is two-fold. The use of a permanent material like concrete creates the essence of the repository as a wound holding device, and as a sense the immortalisation of the memory of the mine dump. The material while controversial in its ecological effects, creates a visual description of how natural resources can be stripped and repurposed into a toxic-non environmentally friendly formation.

The second factor is the concrete weathering ability can create an rough- destroyed earthlike appearance. The repository program largely uses the two concepts of natural placement and juxtaposition to create its architectural form.

In this instance the removal of the natural yet toxic soil creates a juxtaposition;where this one natural material creates a juxtaposed belonging within the ground that the program prescribes.



Exploring Architectural Wounds



Figure 5.45 Wounded Formations (Mascheroni, 2013)

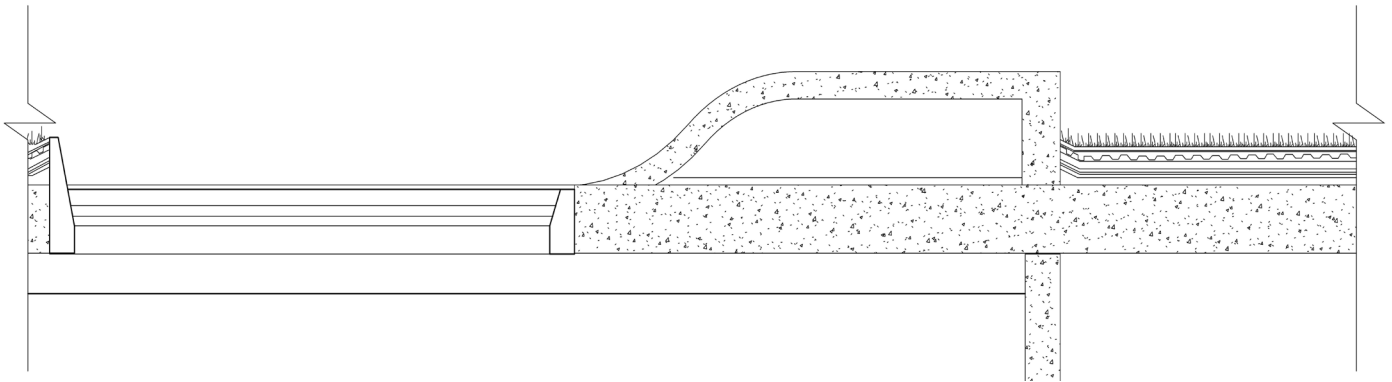
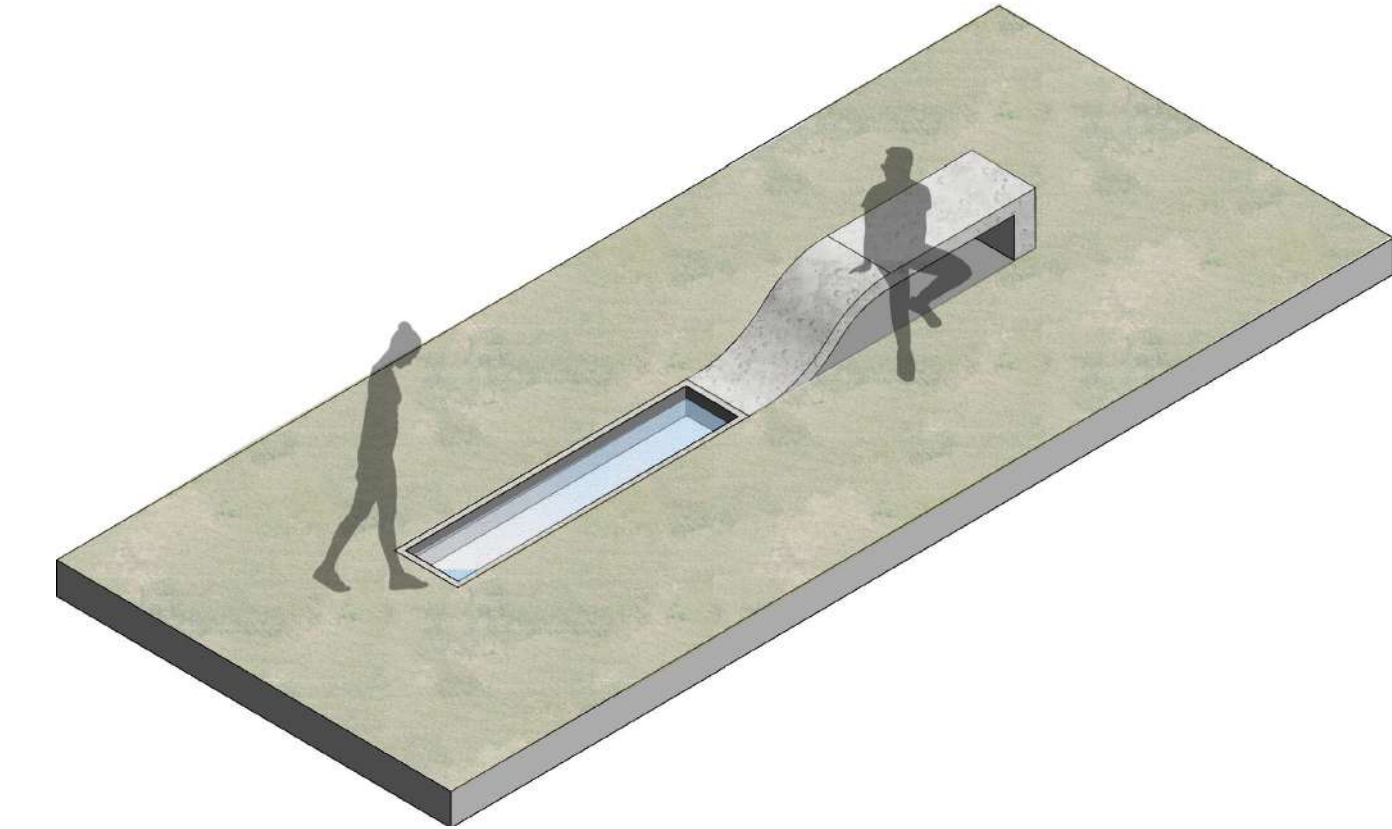
[Left]

The use of concrete to create seating forms are used in a sculptural and phenomenological manner in order to lift the concrete from ‘where it would naturally have been placed.’ This irony showcases what occurs below which translates to the idea of the upliftment of the artificial element of concrete and revealing the below as a seemingly unnatural occurrence. The view of the underneath appears almost wound-like.

Figure 5.46 Wound Translations

[Right]

The proposal of this type of landscape design within the site to reveal elements of the repository. The ability to translate this wounded lifting as an opportunity to carve out skylights and viewing portals into the repository below.



Connection Between Materials

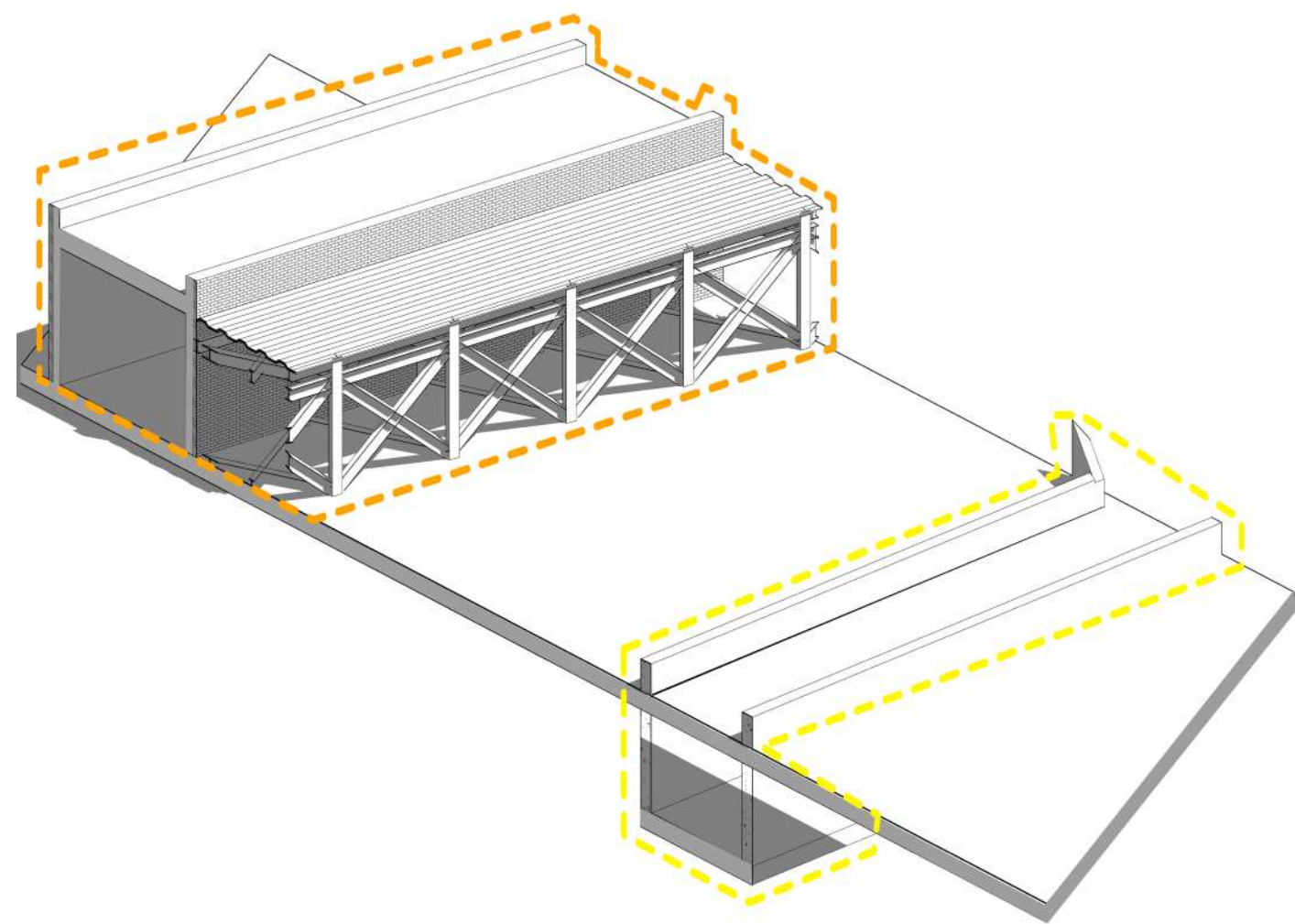
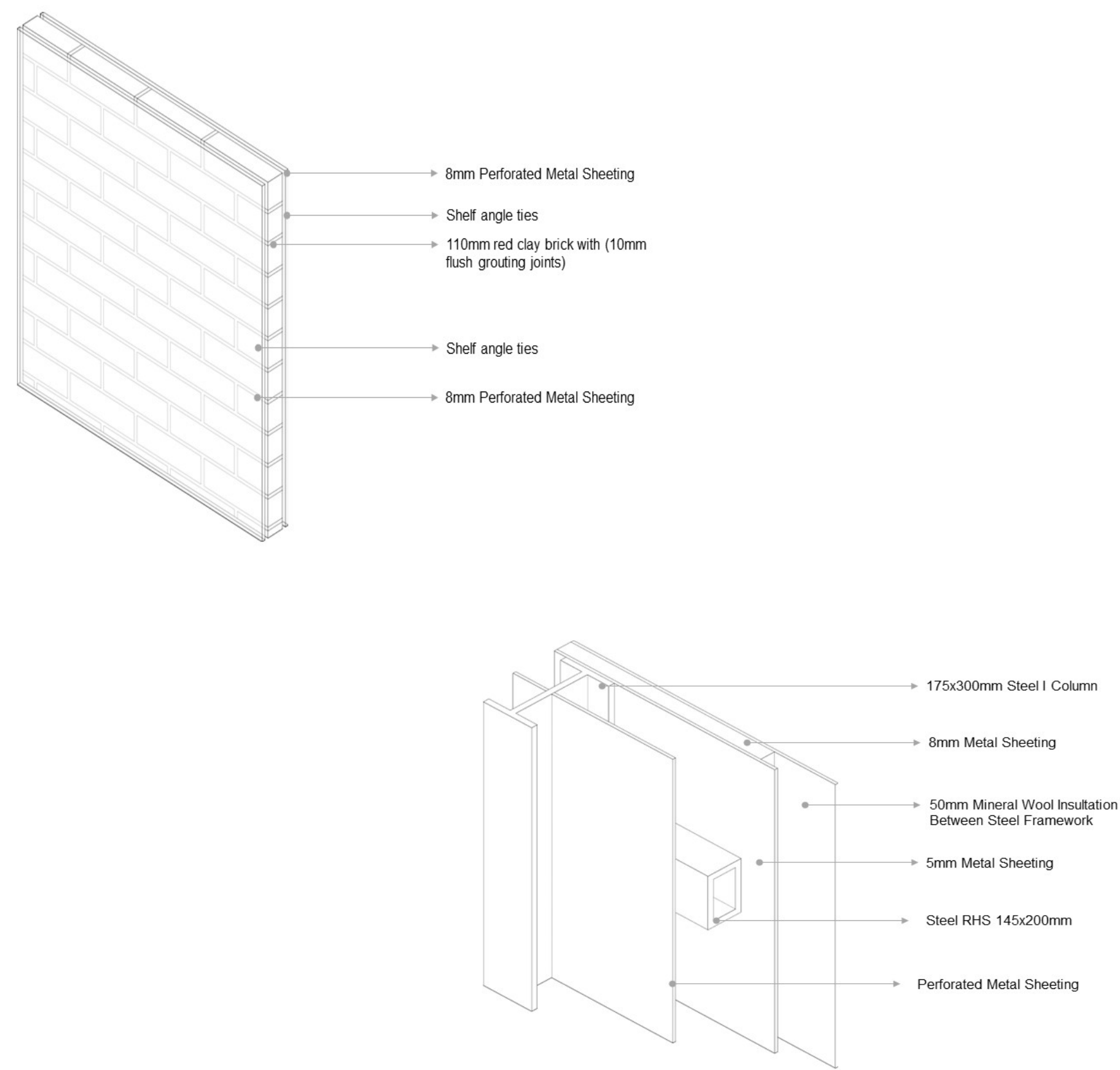


Figure 5.47 Material Relationships

The experimentation with three different materials aims to create the effect of permanence versus temporary architecture while maintaining the appearance of the industrial environment - which is largely steel. The element proposed in yellow indicates the sunken repository which is proposed to be primarily a concrete structure housed with a green roof. This directly relates to the idea of permanence of holding open the earth as a form of scar. The metal works building highlighted in orange is brickwork and steel in order to create a lightweight - more temporary - industrial environment that highlights the finite nature of mineral extraction and that in turn even this building will have a limited lifespan on productive outcomes.



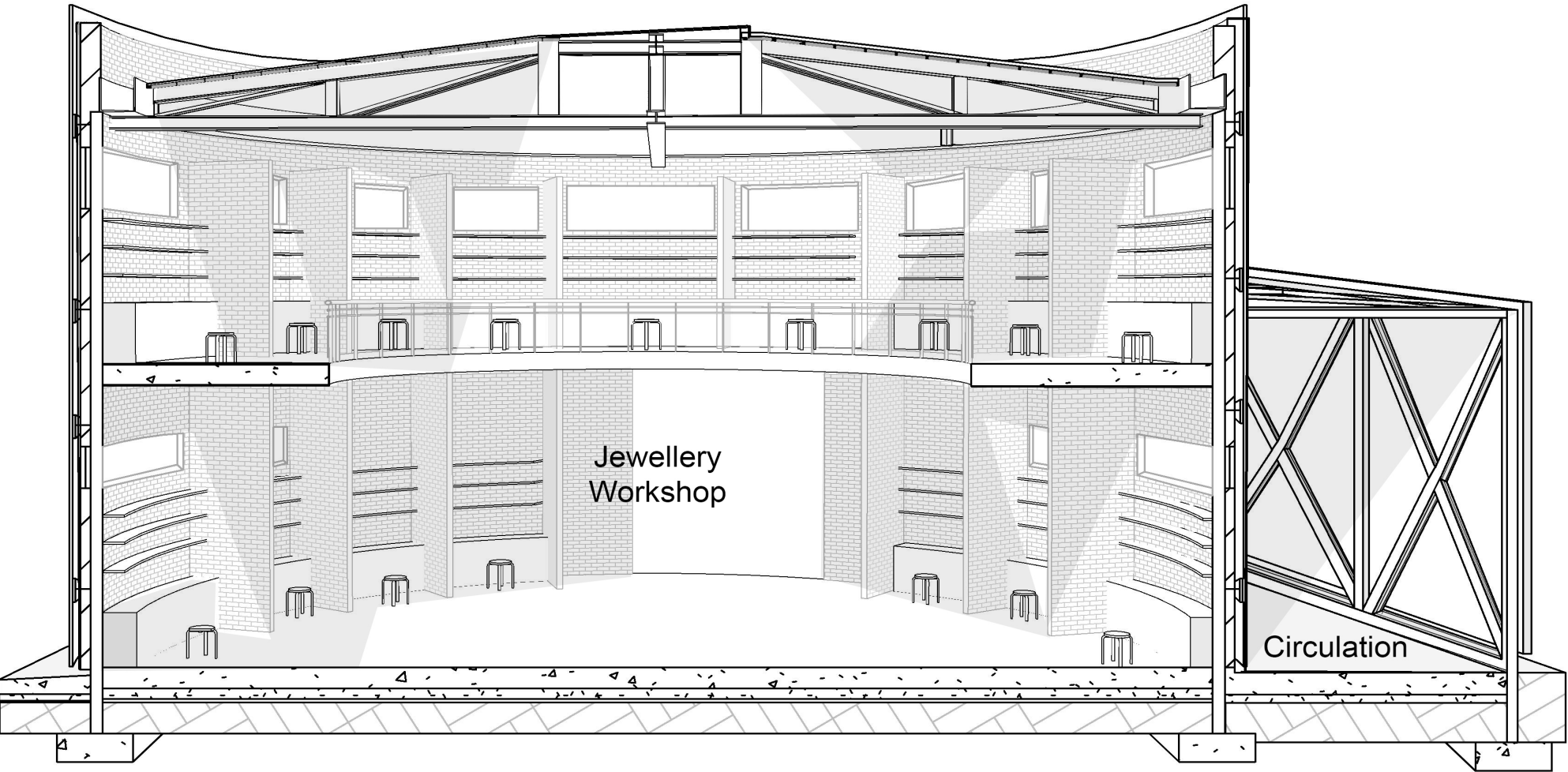


Figure 5.48 Sectional Perspective Development

The cut occurs through the main jewellery workshop. The aim of the spatial design is to be one of the few double storey volumes in the buildings that houses the work benches and spaces for the jewellers and artisans. The design is aimed to incorporate the circular formations of the treatment plant basins into the architectural form - creating large parapet walls to create that effect externally while creating a lightweight steel appearance internally. The use of skylights and lighting techniques needs to be one of the primary focuses going forward in the design to maximise the natural light and ventilation within the space.

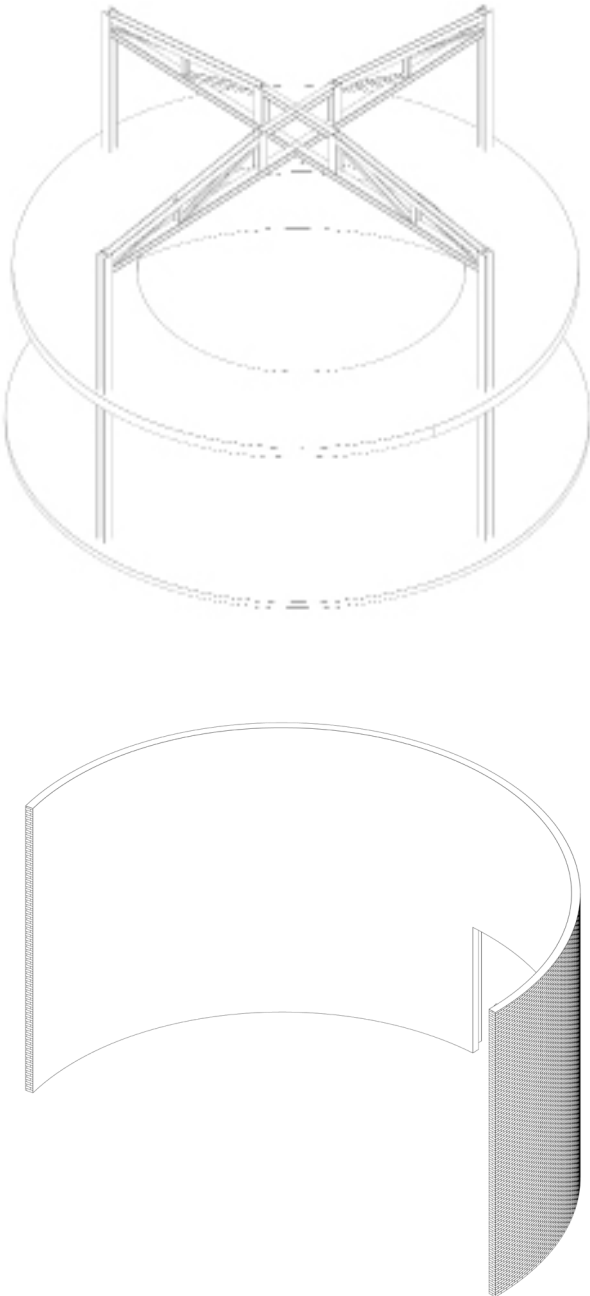
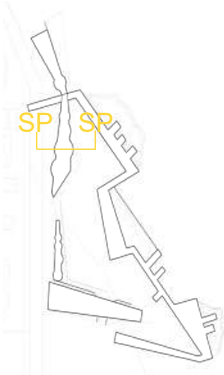


Figure 5.49 Material Typologies

The lightweight nature of the steel is infilled by crick and metal sheeting to create porosity, privacy and access to deal with the transition between the more public spaces to the more private.

Section AA

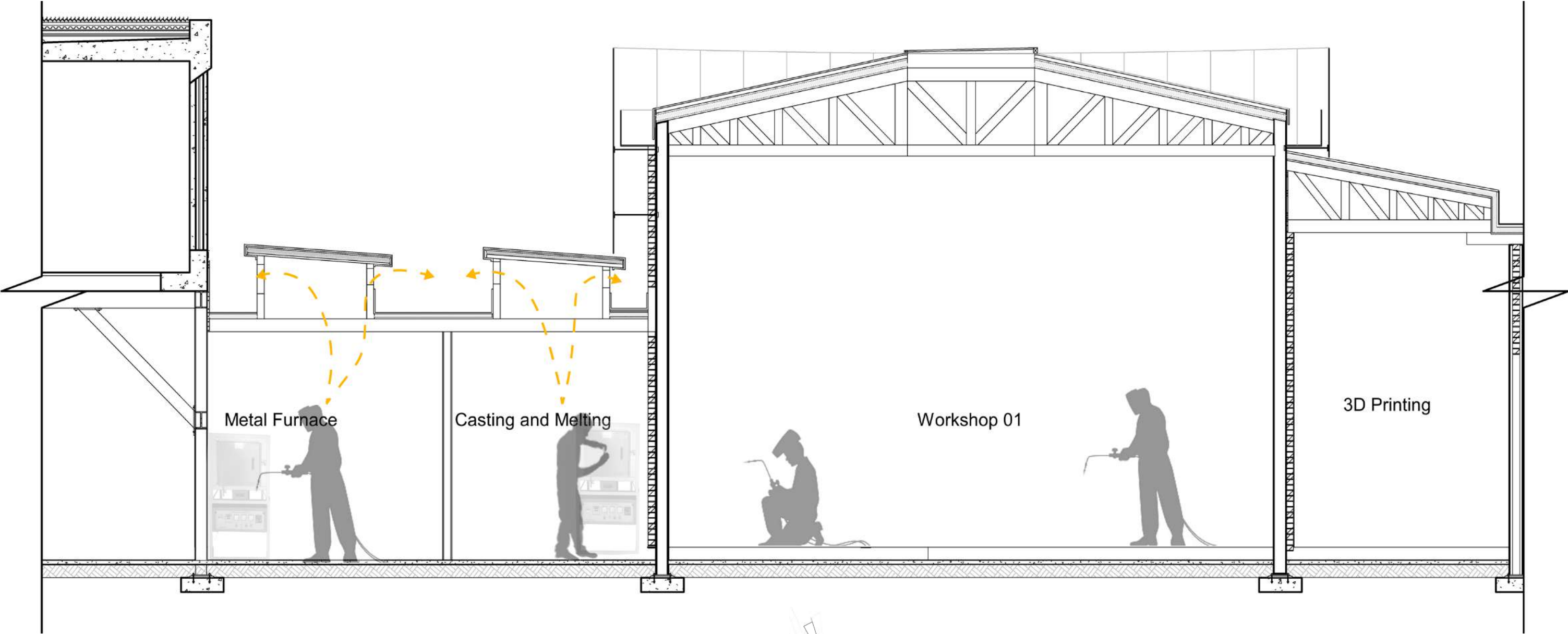
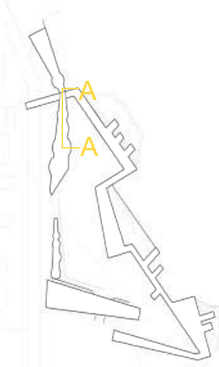


Figure 5.50 Section AA

The cut occurs through a long section of the Jewellery Manufacturing program - This is primarily through two fundamental programs of heat gain being the furnace melting room, and the casting and melting. Fan extractors will be essential as well as artificial light; however through architectural formation- stack ventilation raised roofing structures can be introduced to enhance the effect of these mechanical requirements and thus reduce the amount of intervention required.



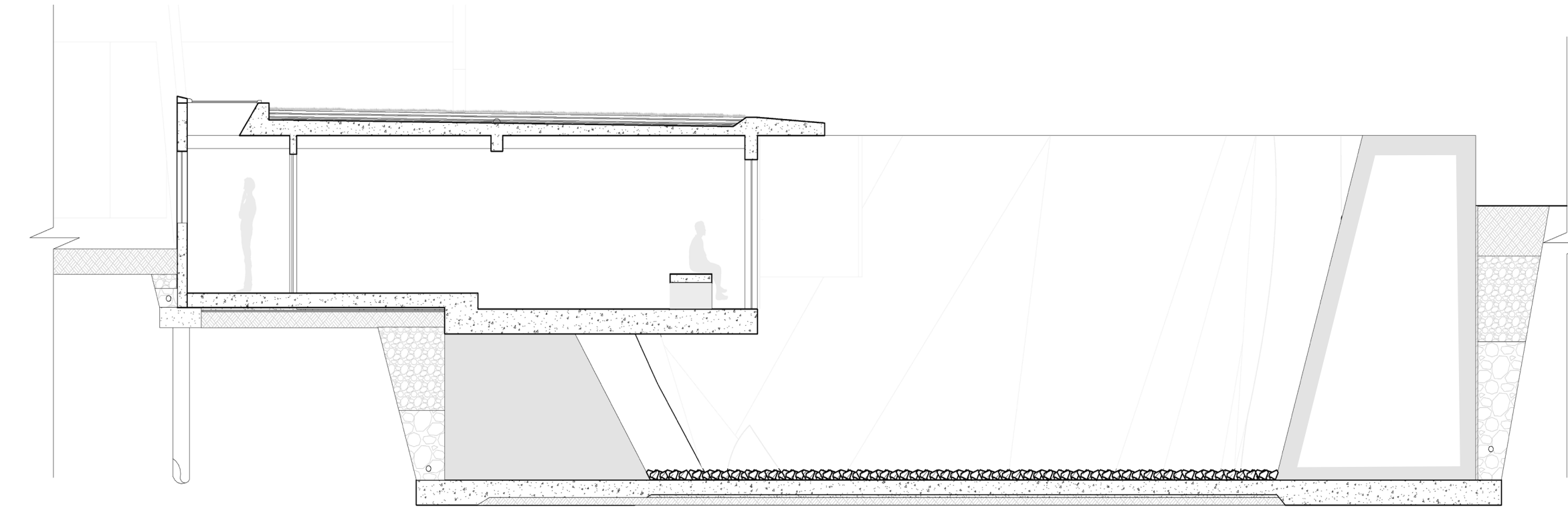


Figure 5.51 Section BB

Cuts through condition A of the berm in which an archival room juts out over the berm landscape and actually used part of the berm to support the cantilever. The tapered concrete edge slab allows water to filter out and into the void.

The 'concrete wounded' seating is used to create a viewing deck into the expanse of cut out earth. The rocks below offer a design opportunity to be further explored.

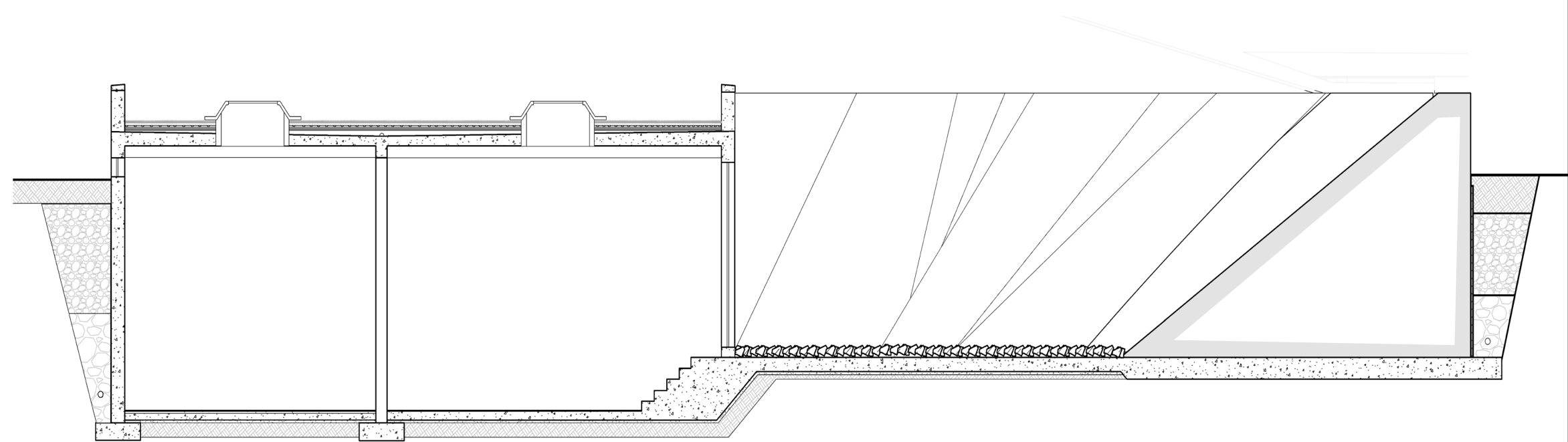


Figure 5.52 Section CC

Cuts through condition B of the berm in which the building sits inside the bermed landscape. In this condition the building is further sunken to allow seating level to be lower than the external berm - this replicates coming out of a space - which was the fundamental mining circulation approach. The berms offer a large amount of light to enter through the glazing however skylights offer a controlled sliver of light to enter and illuminate some of the gallery spaces.

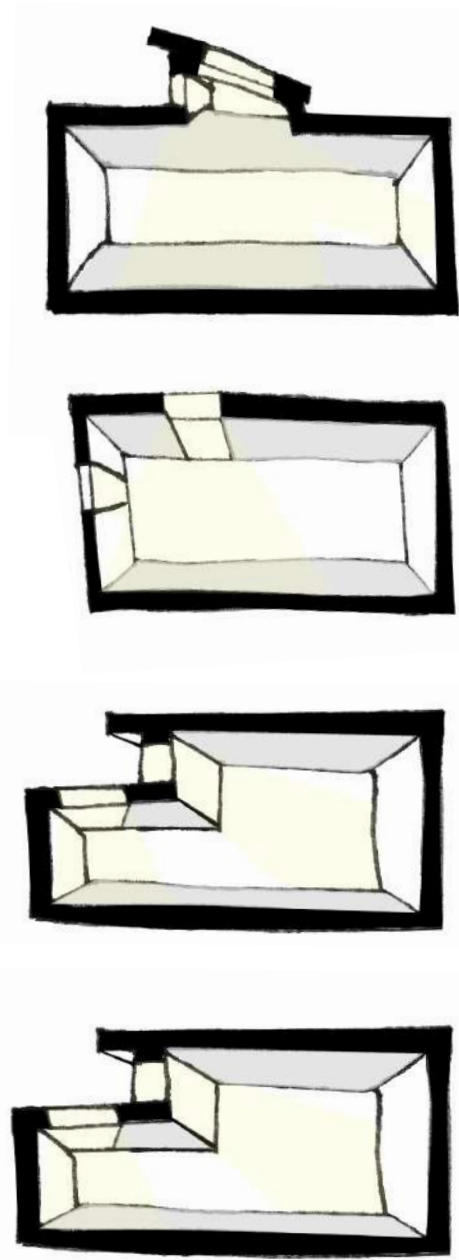
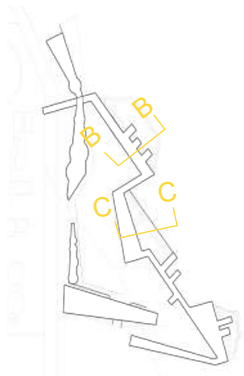


Figure 5.53 Lighting

Exploring different skylight conditions in order to play with illuminating various walls and portions of the repository to create a more sensory experience.

6 Final Design

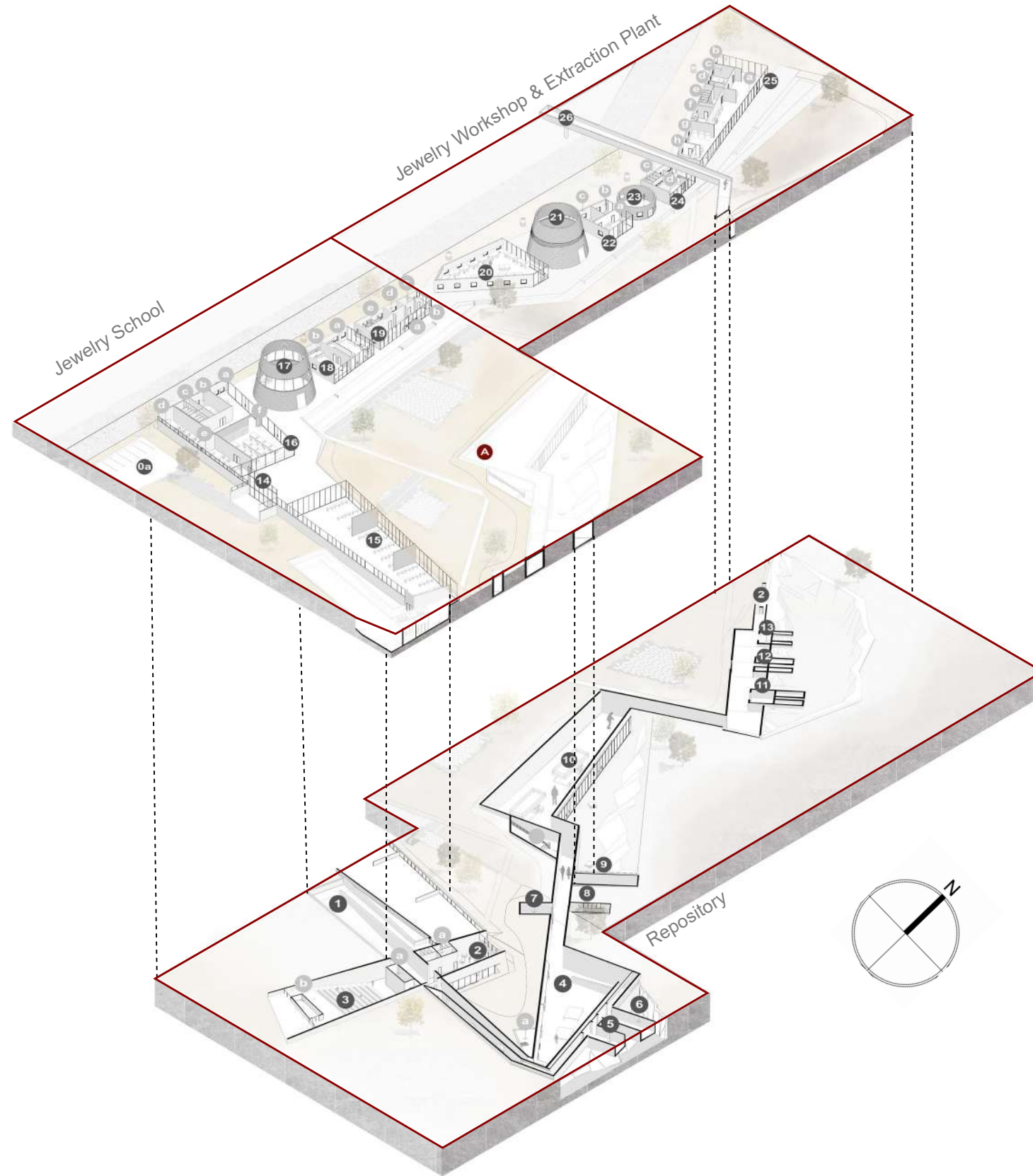
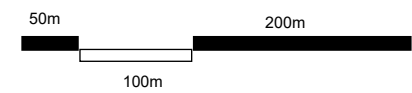


Figure 6.1 Axonometric

The relationship between the two buildings proposed, as their positioning proposes the building as a landscape project in which the structure cuts in and sits above the ground.



Site Plan



- | | |
|--|-----------------------------------|
| 1. The Site | 11. Churston Engineering |
| 2. The Central Basin AMD Treatment Plant | 12. LSG machine tools |
| 3. Water Treatment Facility | 13. Beyond perfection fabrication |
| 4. Fabricated Steel Manufacturing | 14. MD Steel services (pty) |
| 5. Wireforce | A. Mine dump stains |
| 6. CIM Chemicals | B. Mine dump (current) |
| 7. Aveng manufacturing house | |
| 8. ISEGEN Germiston | |
| 9. GMR Scrap | |
| 10. Good Hope informal settlement | |

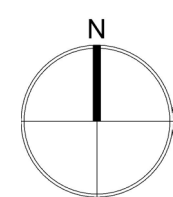
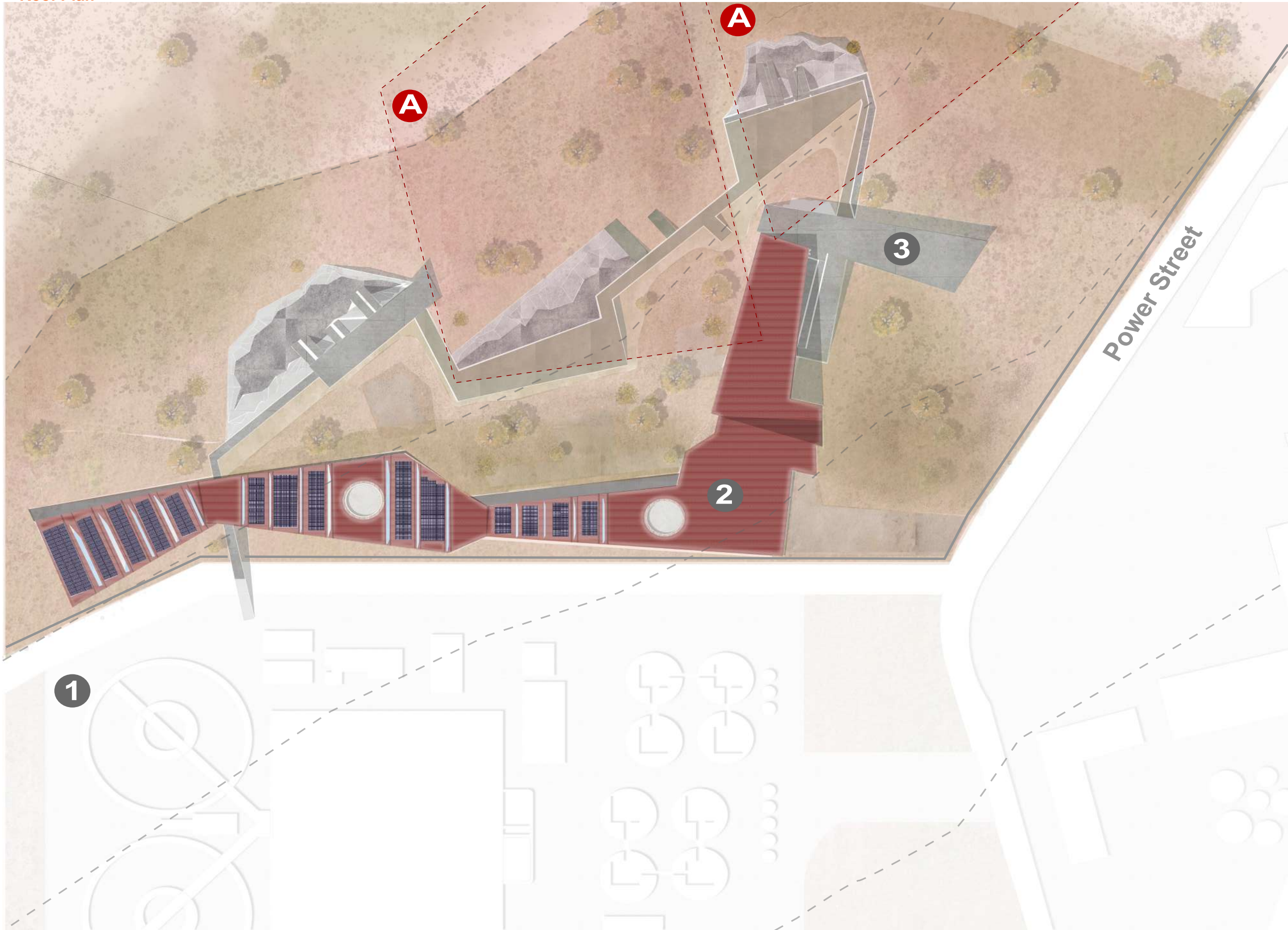


Figure 6.2 Site Context

The surrounding context of the site is largely industrial and remnants of its previous mining landscape.



Roof Plan



- 1. The Site
- 2. The Central Basin Acid Mine
- Drainage Treatment Plant
- 3. Repository
- A. Mine Dump Stains

Figure 6.3 Roof Plan

The proposed building splits into two primary structures being the metal works building and the repository. While these building intersect at two points, they house different programs and utilize different materials.

The metal works building connects to the existing treatment plant in order to reuse metallic waste from acid mine drainage that can be used to teach waste metal jewelry production.

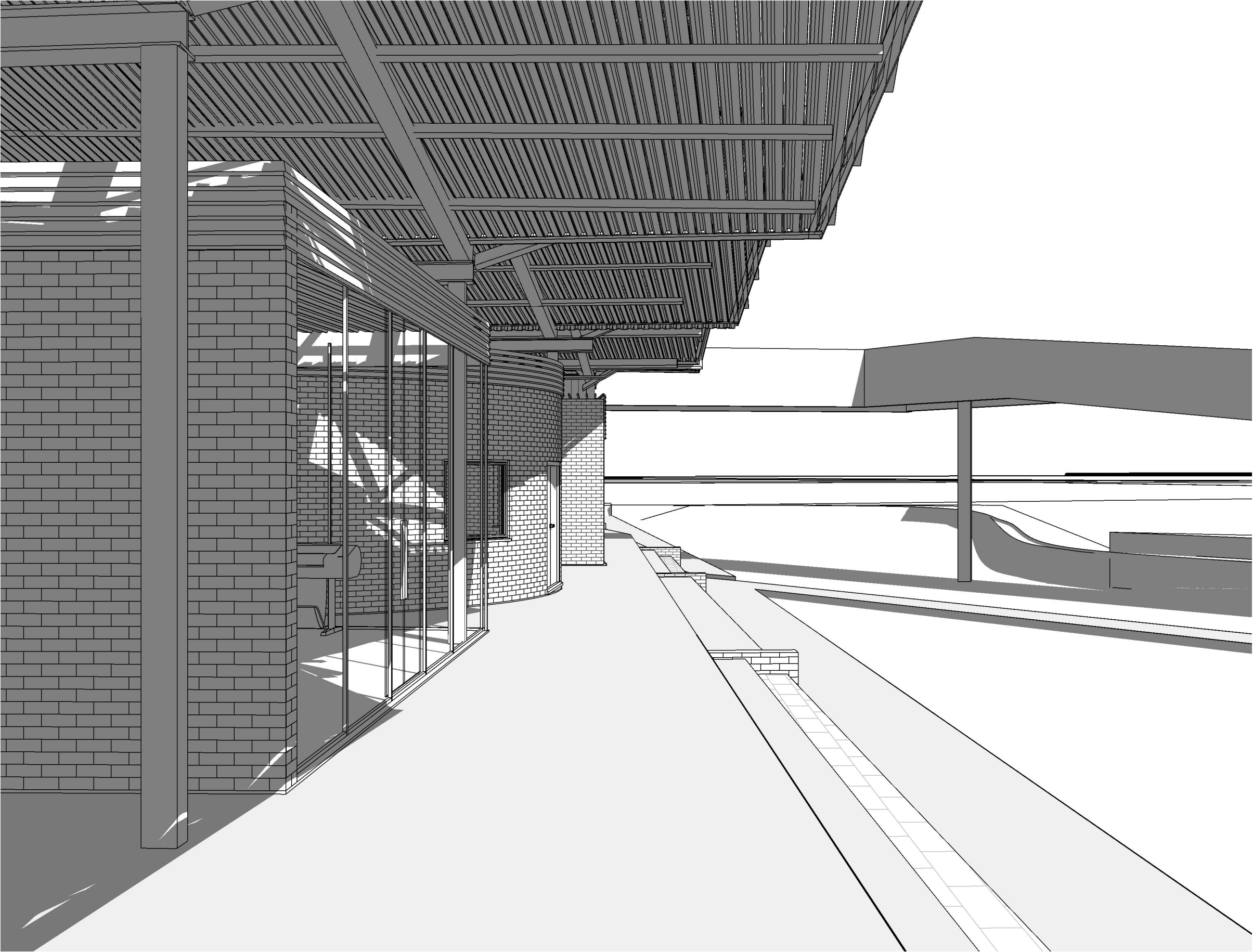
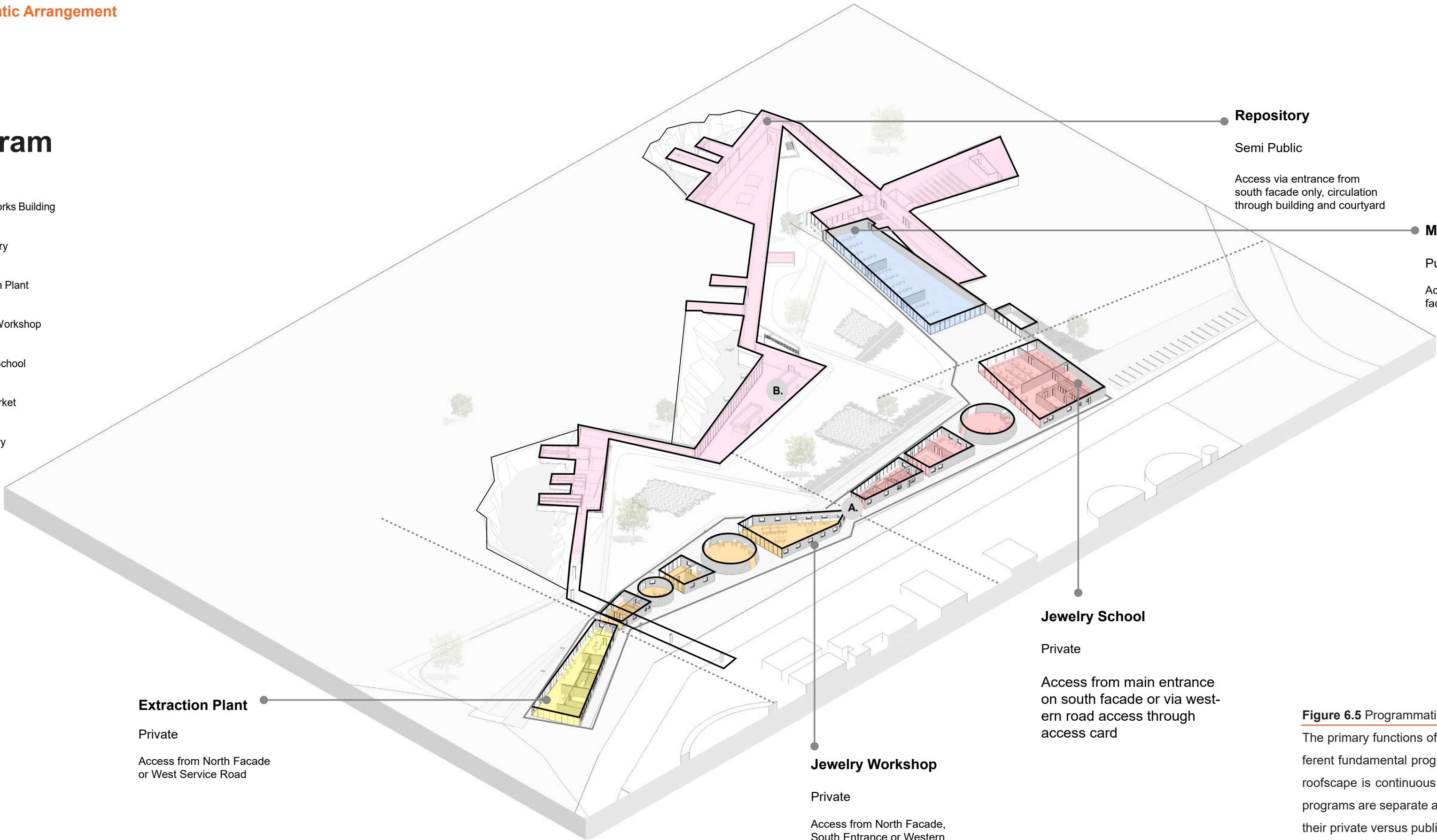


Figure 6.4 Metal Works Perspective

View towards North boundary overlooking the Jewelry printing rooms and the repository viewing deck.

Program

- A. Metal Works Building
- B. Repository
- 1. Extraction Plant
- 2. Jewelry Workshop
- 3. Jewelry School
- 4. Metal Market
- 5. Repository



Extraction Plant

Private

Access from North Facade or West Service Road

Jewelry Workshop

Private

Access from North Facade, South Entrance or Western Road Access via gate

Jewelry School

Private

Access from main entrance on south facade or via west-ern road access through access card

Repository

Semi Public

Access via entrance from south facade only, circulation through building and courtyard

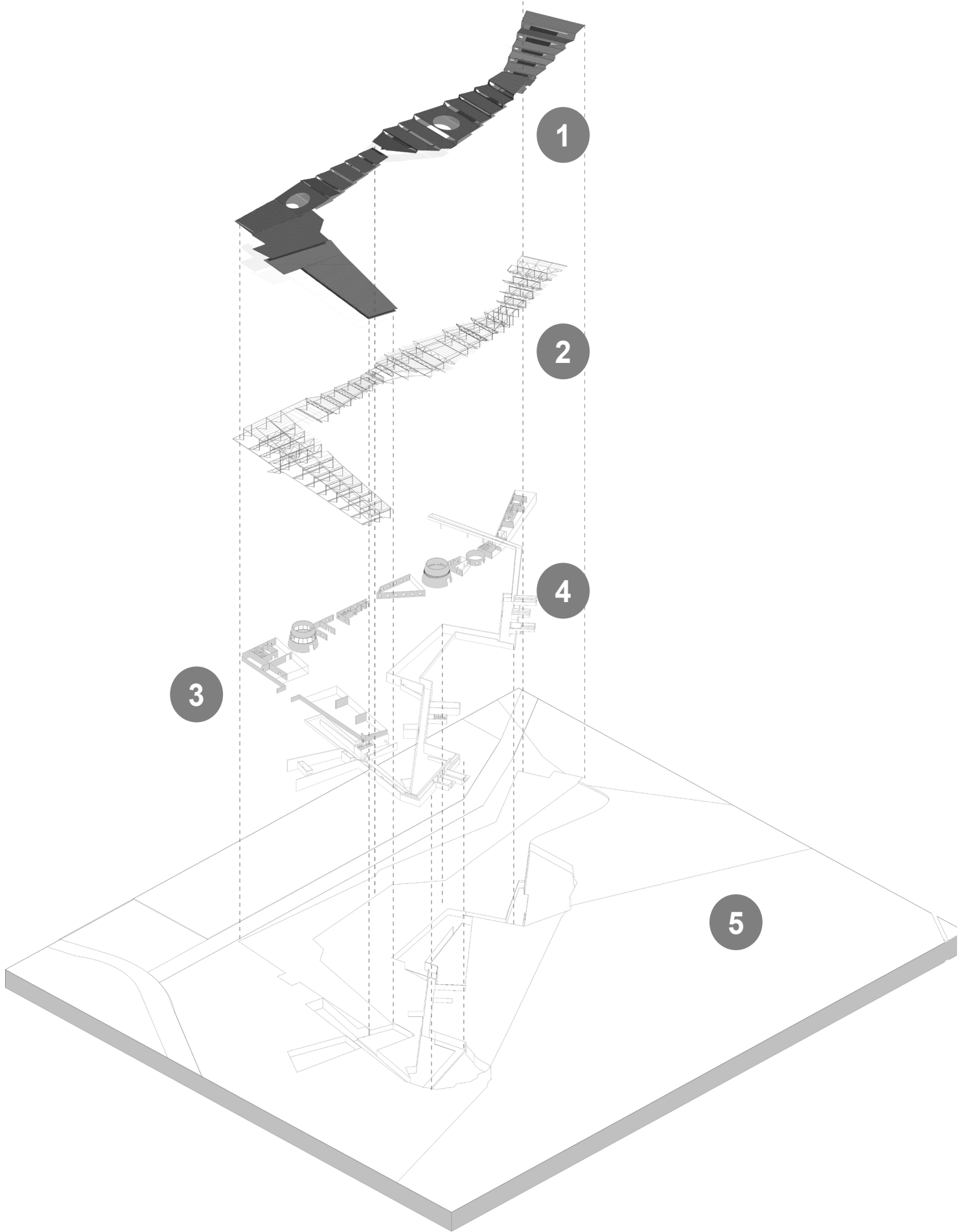
Metal Market

Public

Access via south facade entrance

Figure 6.5 Programmatic Arrangement

The primary functions of the buildings are split into five different fundamental programs. While the metallic building's roofscape is continuous and acts as one building – these programs are separate and positioned on the site based on their private versus public nature, their accessibility and relationship to the central basin acid mine drainage treatment plant adjacent.



Materiality

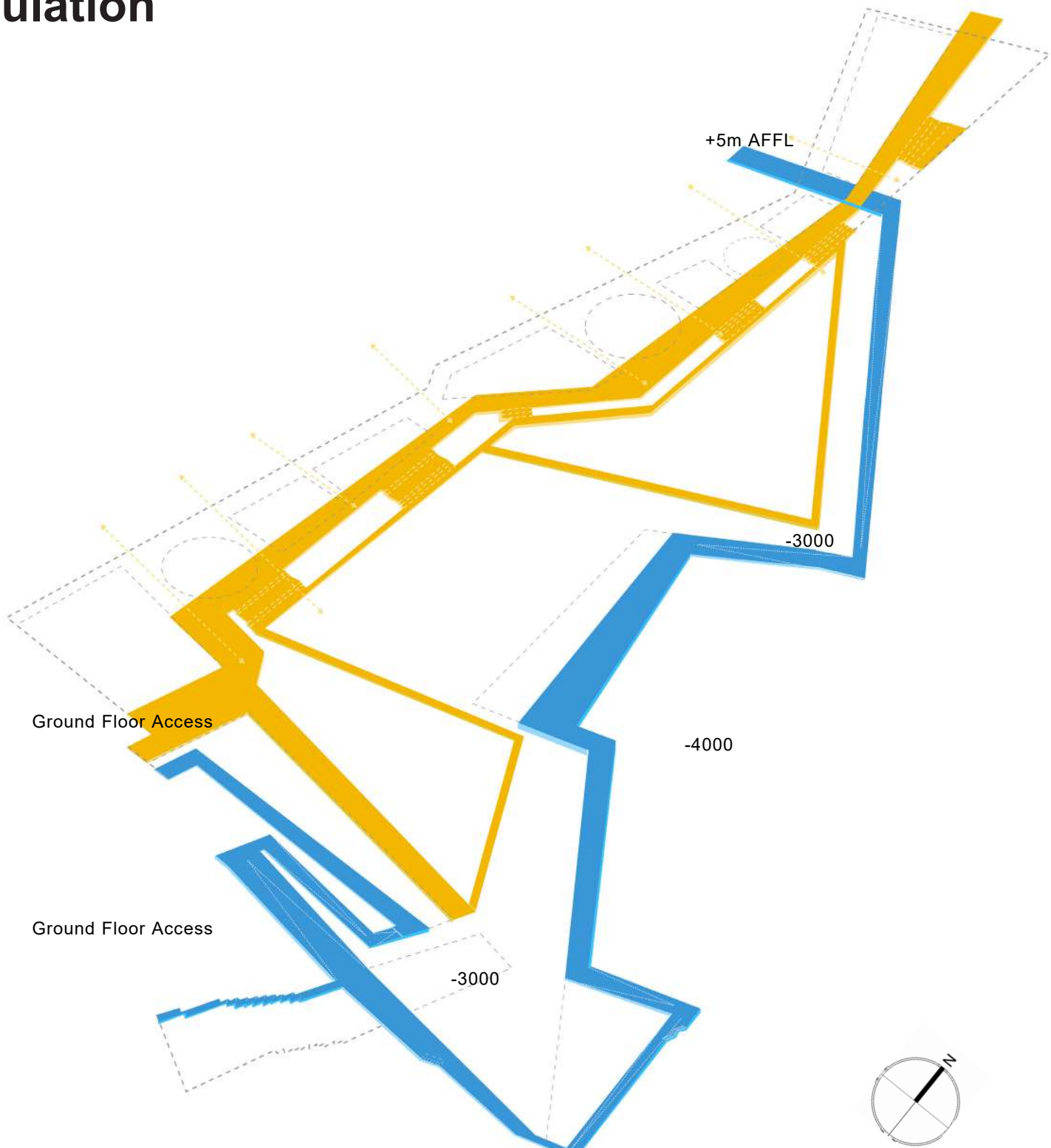
- 1. Lightweight saw tooth IBR roof sheeting
- 2. Steel structural system – beam, truss and column
- 3. Brick infill and conical kilns (sitting on the site)
- 4. Concrete retaining walls (cutting into the site)
- 5. The site.

Figure 6.6 Building Materiality

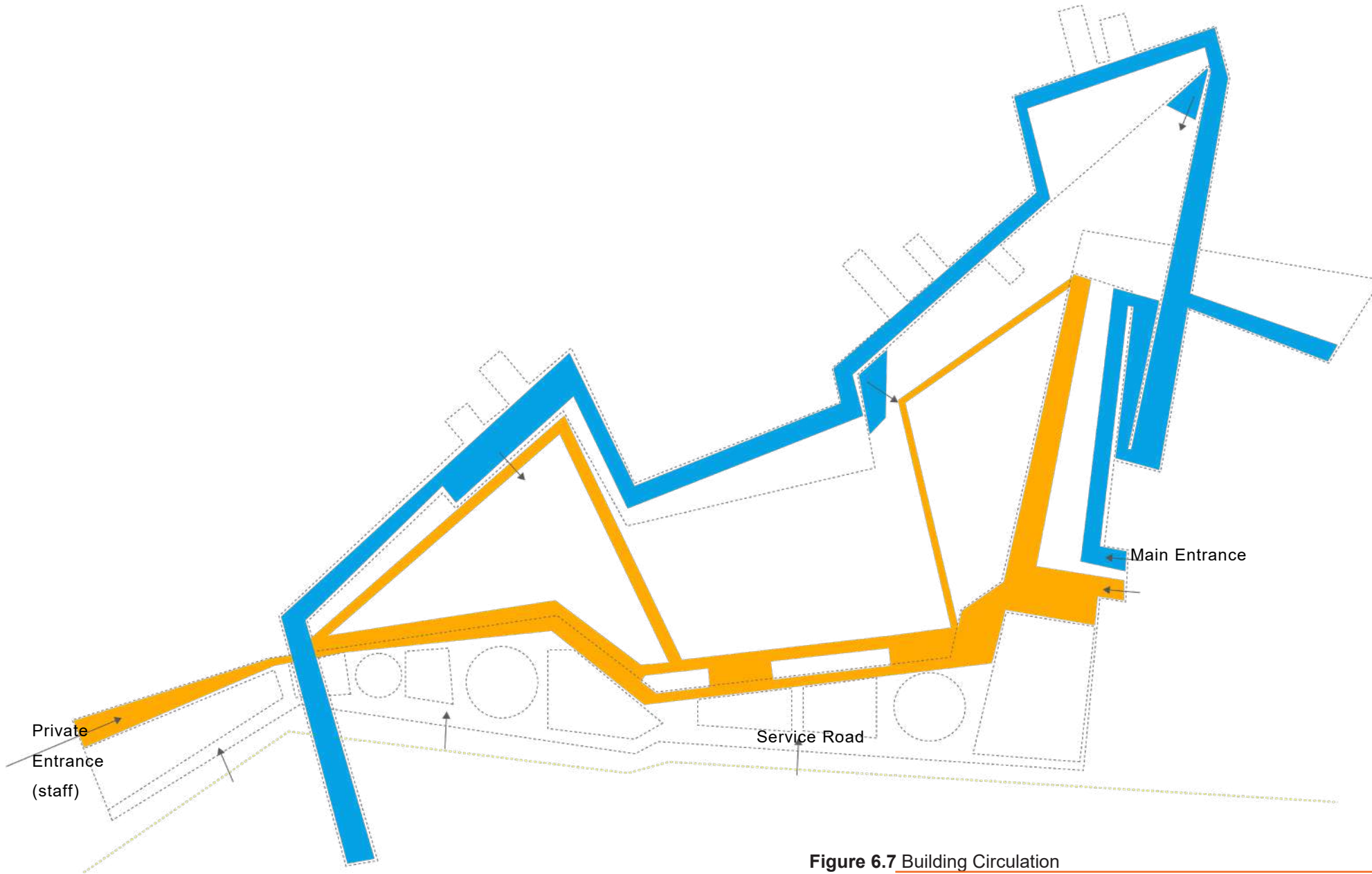
Creating the distinction between the two proposed buildings of the repository and the metal works building,

The metal works is designed to be lightweight and more temporary in its nature being a steel and brick building while the repository cuts and embeds into the earth with a sense of permanence achieved using fly-ash concrete to create the retention walls that hold open the wounds of mining that are fading.

Circulation



Axonometric of circulation path

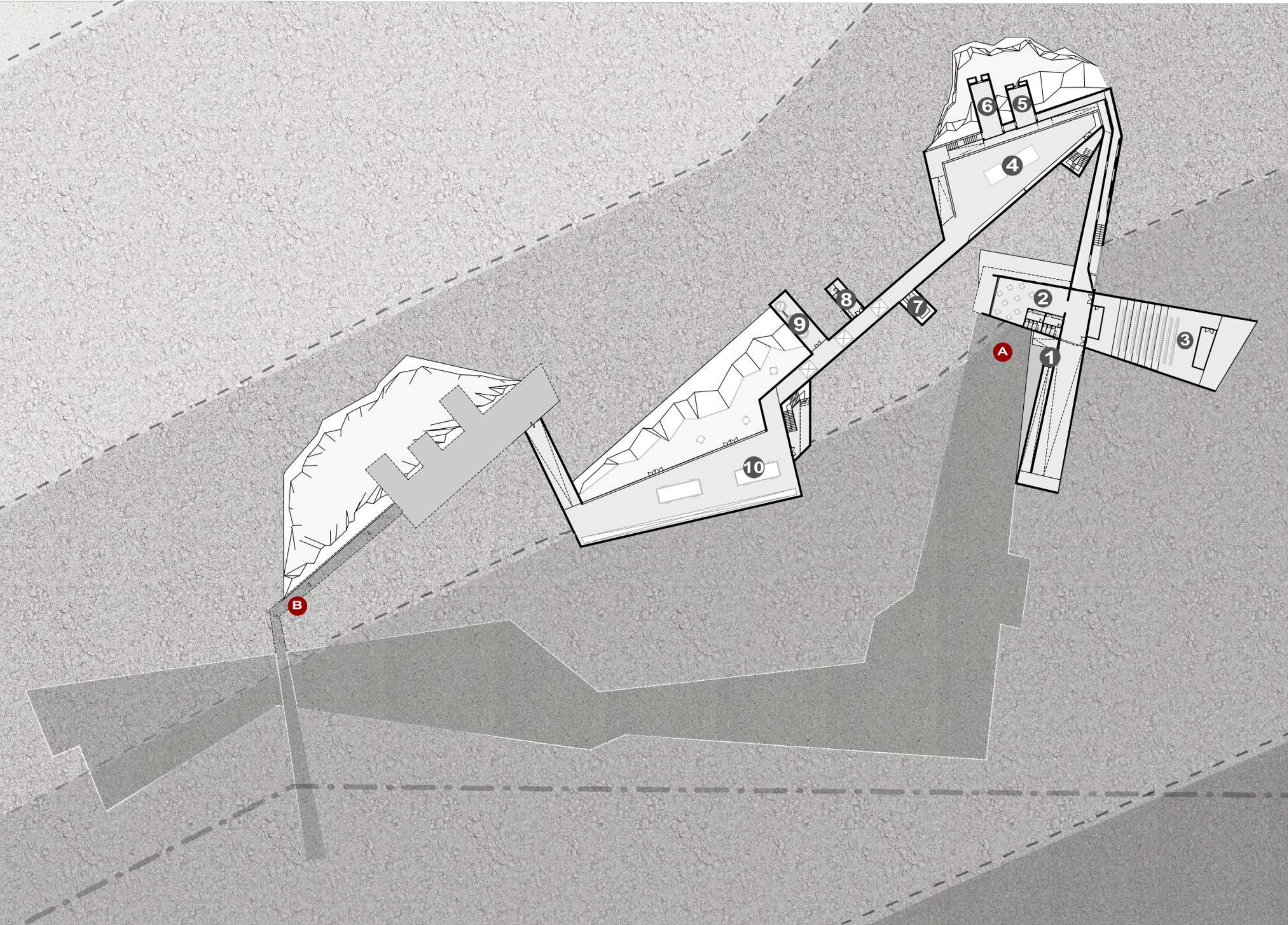


Plan of circulation path

Figure 6.7 Building Circulation

Circulation within the metal works building is contained within the ground floor – allowing the programs to stretch alongside the site while simultaneously ensuring accessibility to the programs. The internal courtyards are lower allowing the vertical circulation from the ground plane to offer seating opportunities alongside the courtyard.

The repository circulation is ramp based – using the floor plane to cut in and out of the earth.



Repository Floor Plan

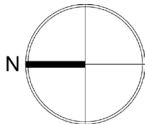
Level -1

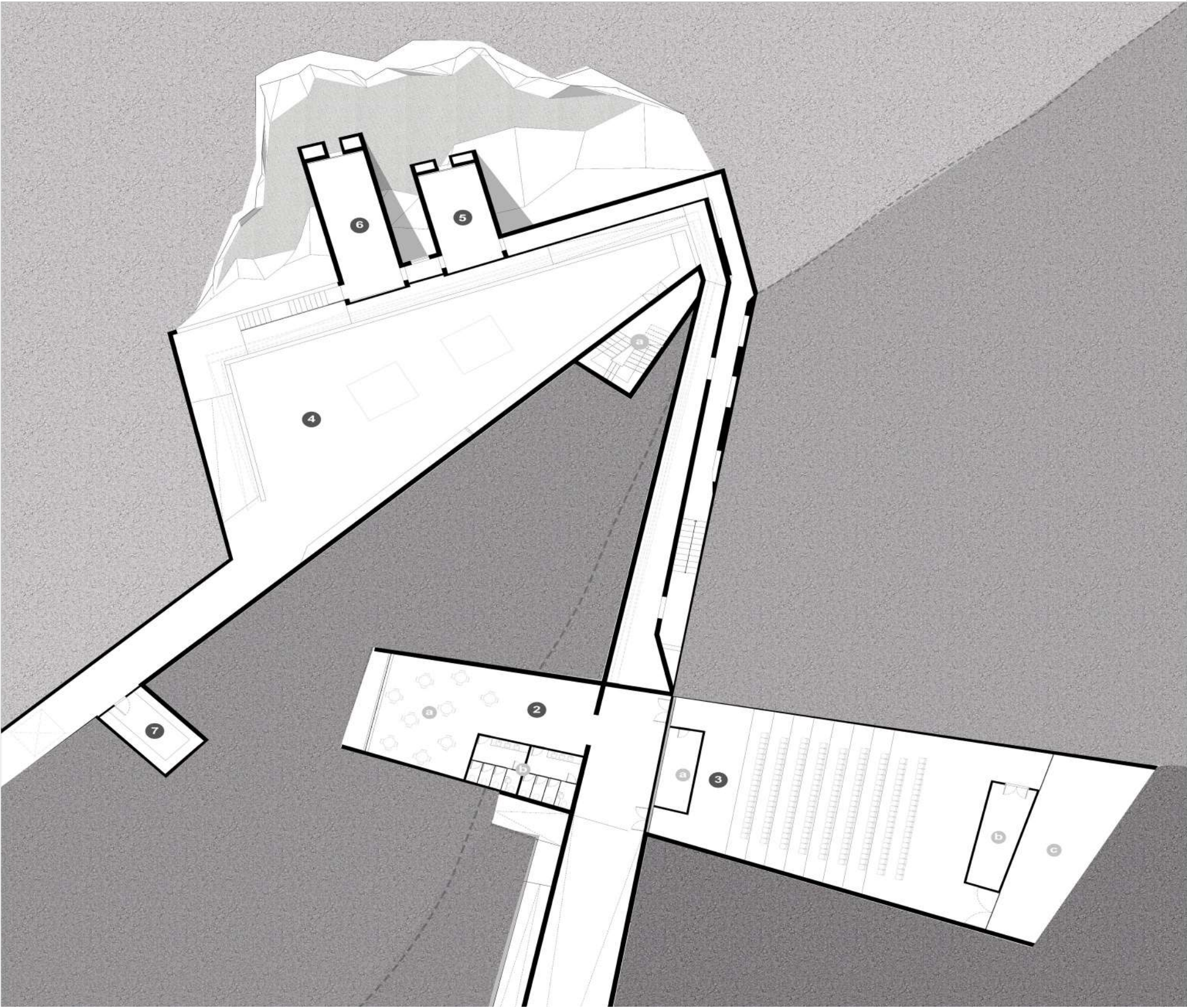


- | | |
|----------------------|--------------------------------------|
| 1. Entrance | 9. Sensory Room |
| 2. Lobby | 10. Exhibition |
| 3. Auditorium | A. Building Adjacent at Higher Level |
| 4. Multipurpose Room | B. Treatment Plant Viewing Deck |
| 5. Archive | above |
| 6. Archive | |
| 7. Office | |
| 8. Ablutions | |

Figure 6.8 Repsoitory Floor Plan

The ‘repository’ refers to the storage and archive of elements in their natural environment. This translates into an experiential storage of the history and effects of landscape mining. The building cuts into the ground inserting itself into the landscape.





Detail Plan 1: Repository

Level -1



1. Entrance (Ramp Down)

2. Lobby
 - a Cafeteria
 - b Ablutions

3. Auditorium
 - a Storage and equipment
 - b AV Room

4. Multurpose Room
 - a Exit to courtyard 1/ Fire Escape

5. Archive

6. Archive

7. Office and storage

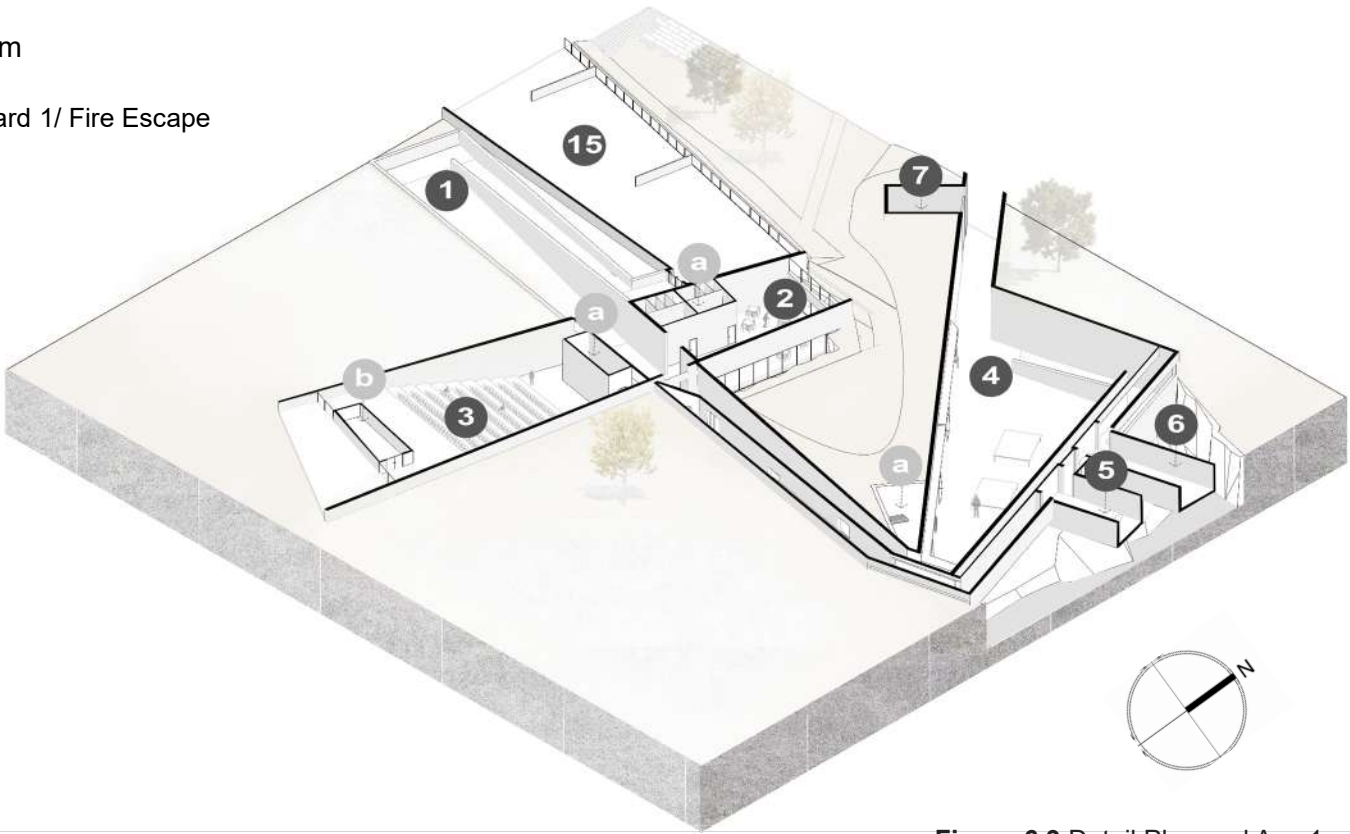
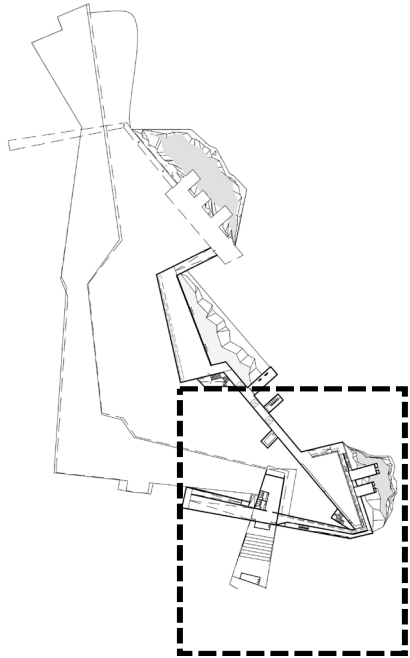
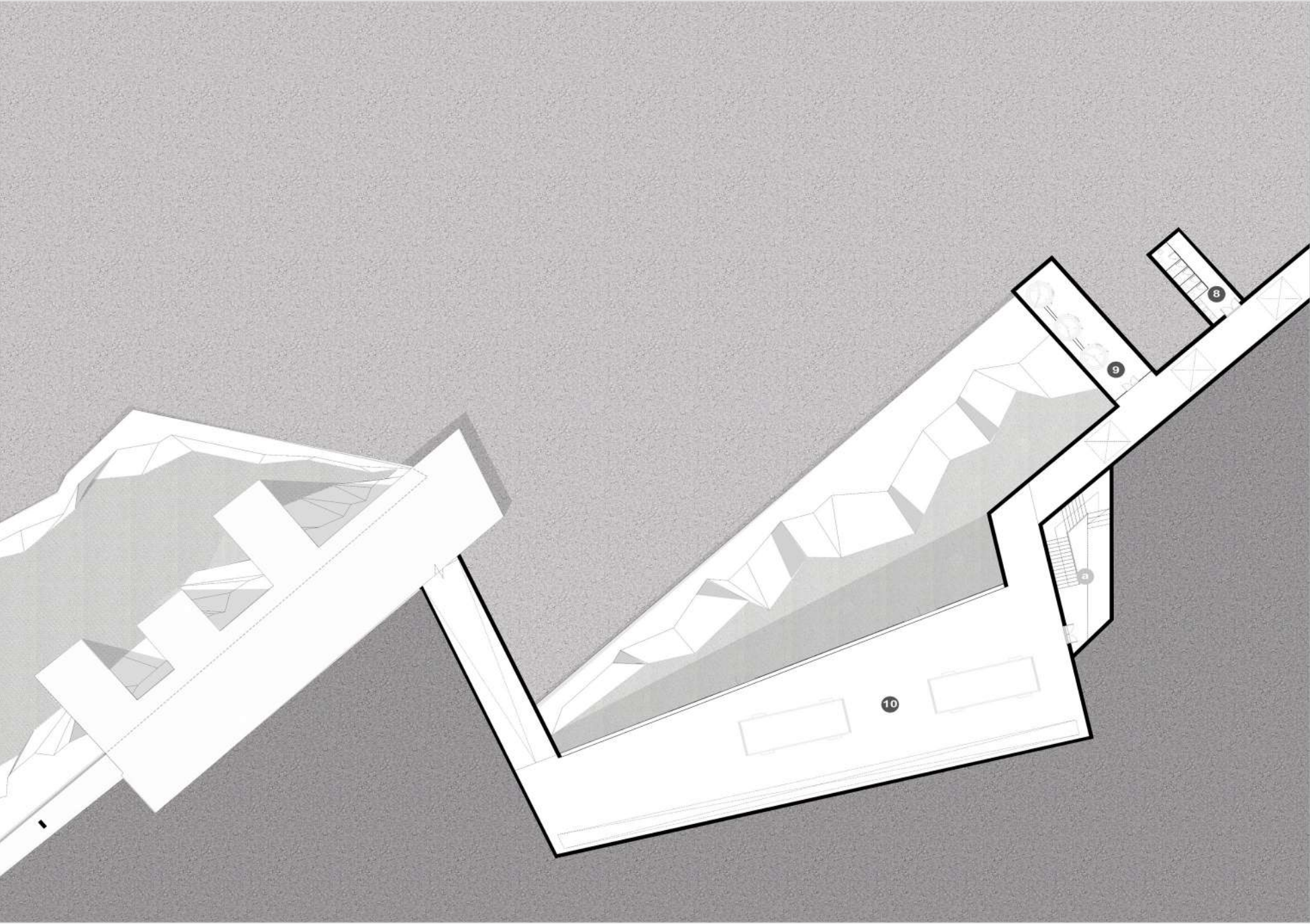


Figure 6.9 Detail Plan and Axo 1



Detail Plan 2: Repository

Level -1



- a Exit to courtyard 2/ Fire Escape
- b Outdoor seating area

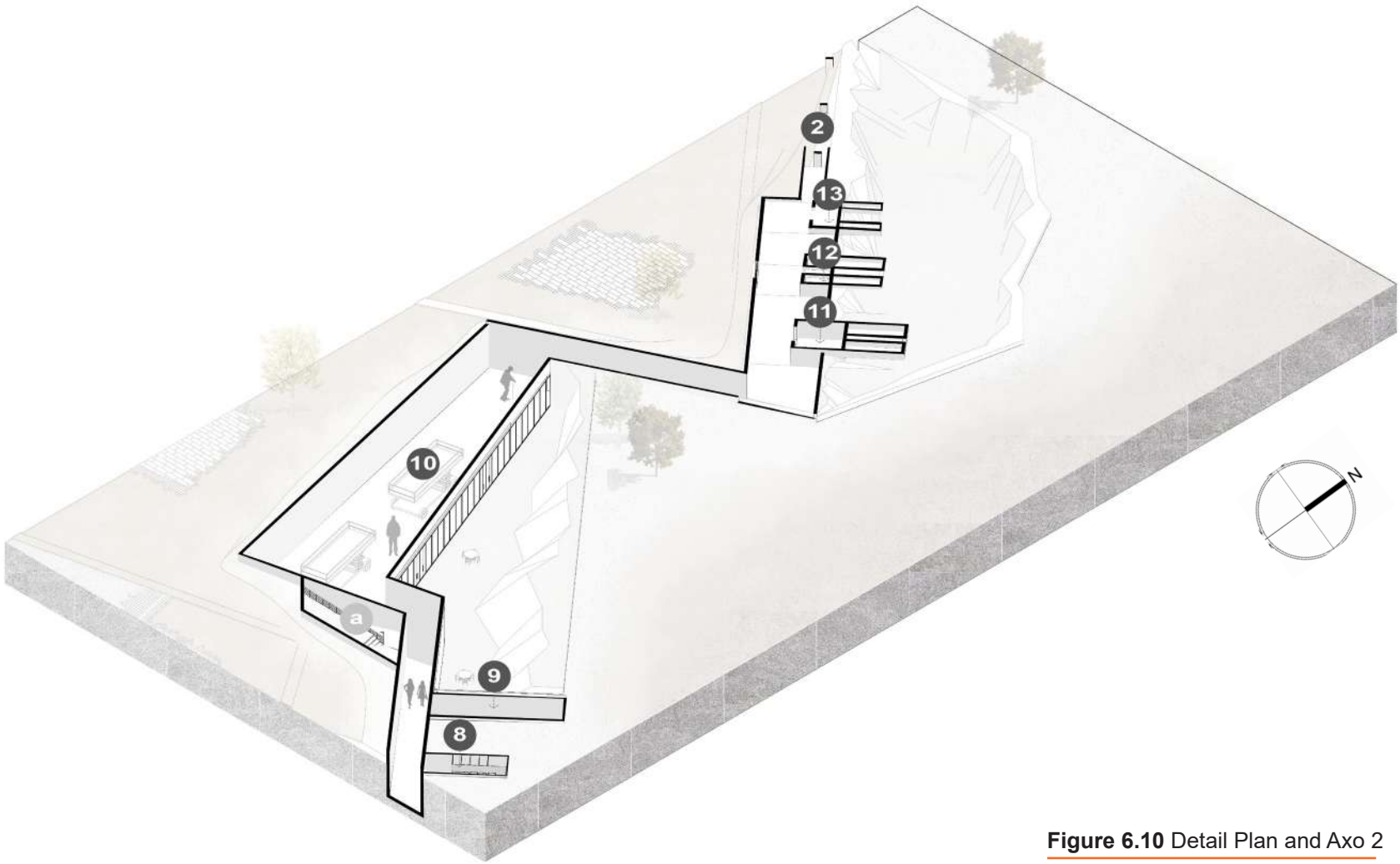
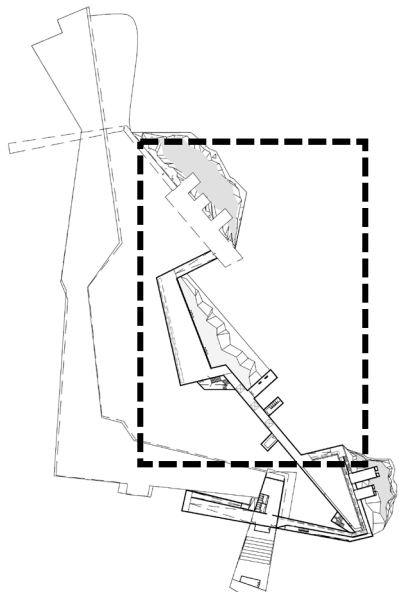


Figure 6.10 Detail Plan and Axo 2

Figure 6.11 South View of Repository
View looking towards north boundary from the Southeast corner, overlooking the repository.



Figure 6.12 Internal View of Repository
Exhibition space within the repository – housing old mining equipment and showcasing the rough environment in its contained state.



Figure 6.13 Entrance to the Repository
Cutting into the ground - creating the experience of movement descending into the earth.





Ground Floor Plan

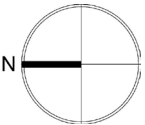
Metal Works Building

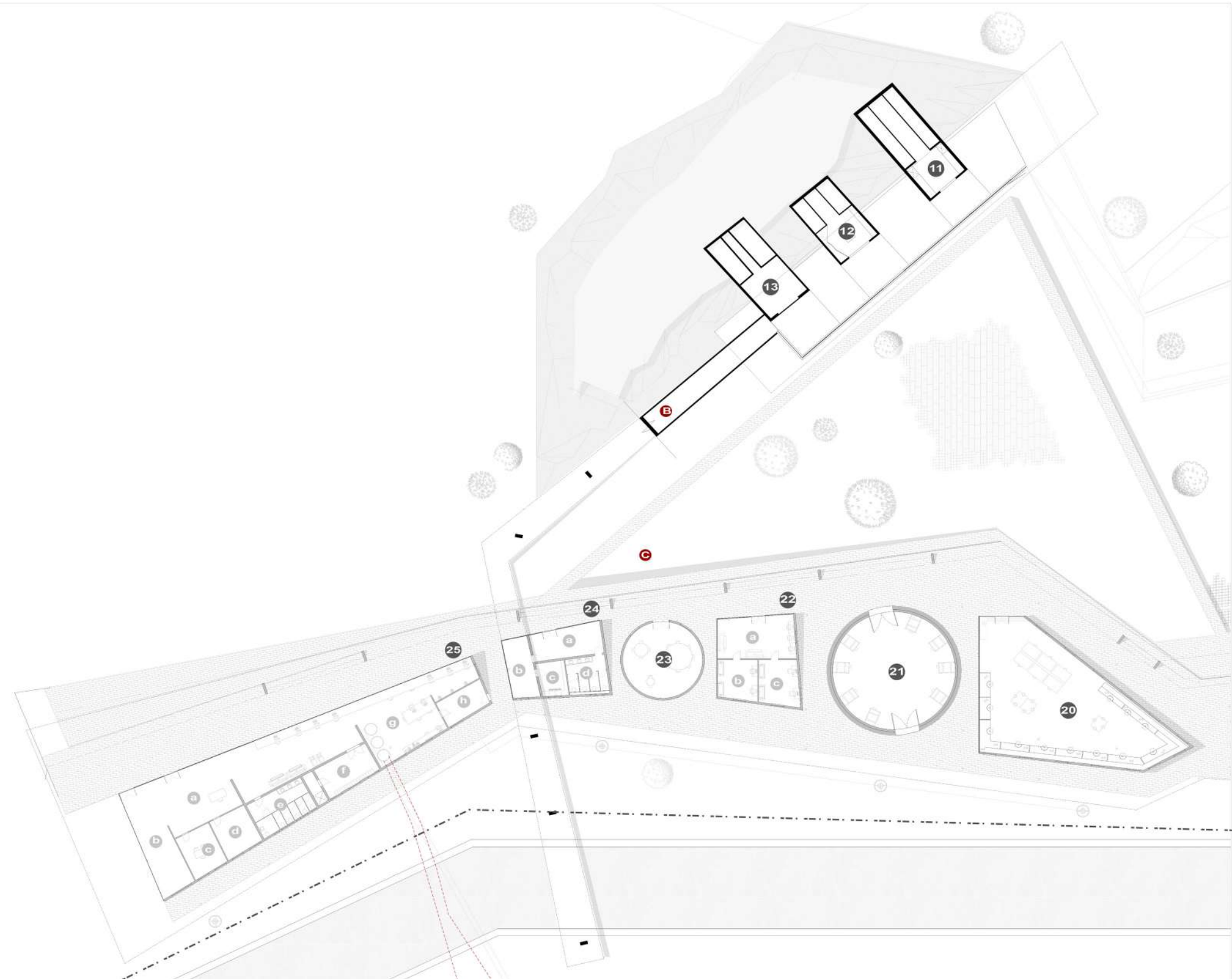


- | | |
|----------------------------------|----------------------------------|
| Public Entrance | 21. Furnace & Melting |
| 14. Entrance & Lobby | 22. 3d Printing |
| 15. Metal Works Market | 23. Meeting Room |
| Jewelry School | 24. Break Room and |
| 16. Classrooms | storage |
| 17. Furnace & Melting | Extraction Plant (25) |
| 18. Metal Workshop | B. Viewing Deck |
| 19. 3D Printing | C. Courtyard |
| Jewelry Workshop (20-24) | D. Connection to |
| 20. Workshop | Treatment Plant |

Figure 6.15 Ground Floor Plan

The ‘metal building’ is divided into 4 sectors. The first being the public entrance. The second being the jewelry school. The third being the jewelry workshop for professional individuals. The fourth being the extraction plant that processes the metal waste from the acid mine drainage treatment plant adjacent.





Detail Plan 3: Ground Floor Plan



- Public Entrance**
- 14. Entrance & Lobby
 - 15. Metal Works Market
- Jewelry School**
- 16. Classrooms
 - 17. Furnace & Melting
 - 18. Metal Workshop
 - 19. 3D Printing
- Jewelry Workshop (20-24)**
- 20. Workshop
 - 21. Furnace & Melting
 - 22. 3d Printing
 - 23. Meeting Room
 - 24. Break Room and storage
- Extraction Plant (25)**
- 25. Extraction Plant
- Other Features:**
- B. Viewing Deck
 - C. Courtyard
 - D. Connection to Treatment Plant

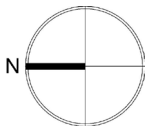
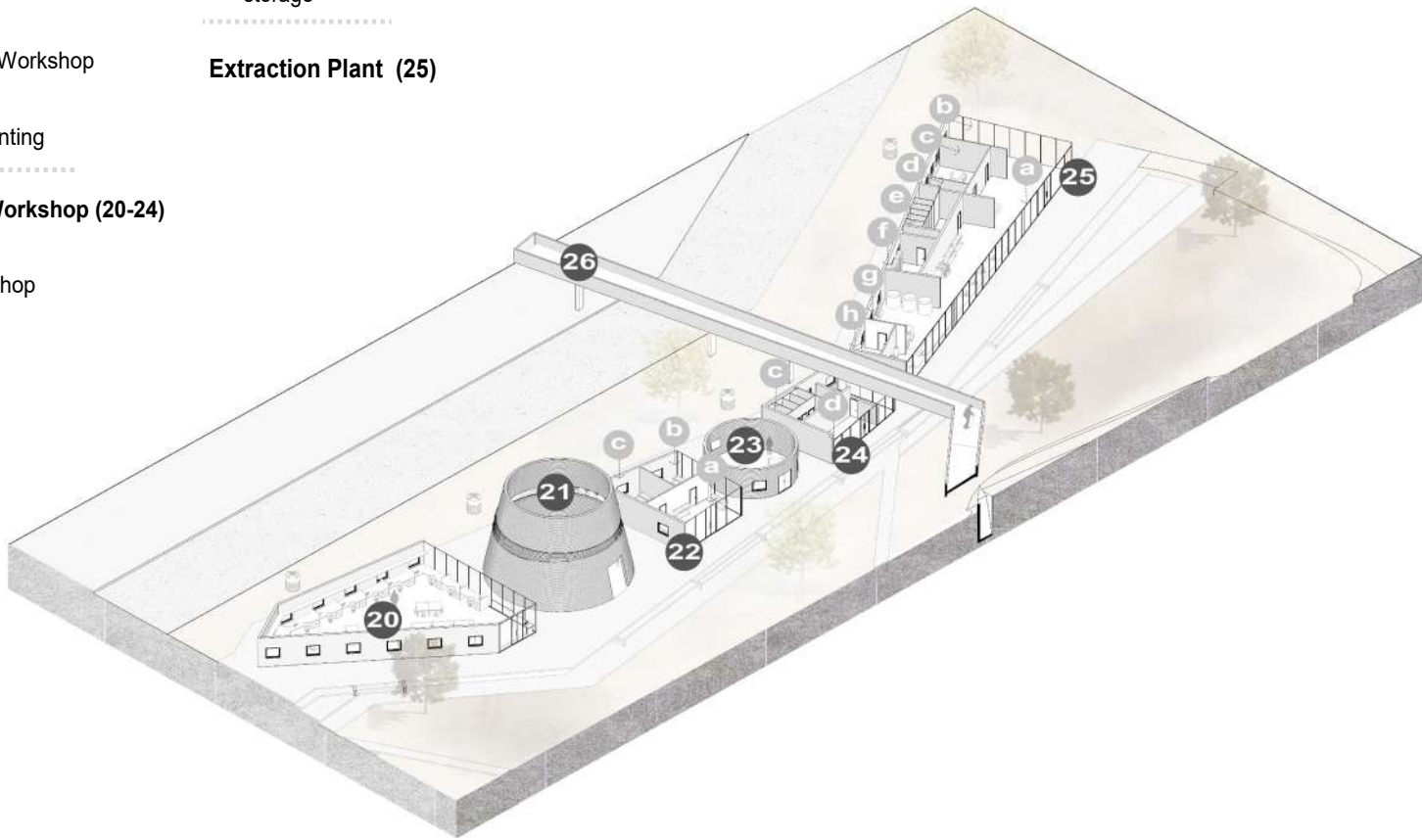
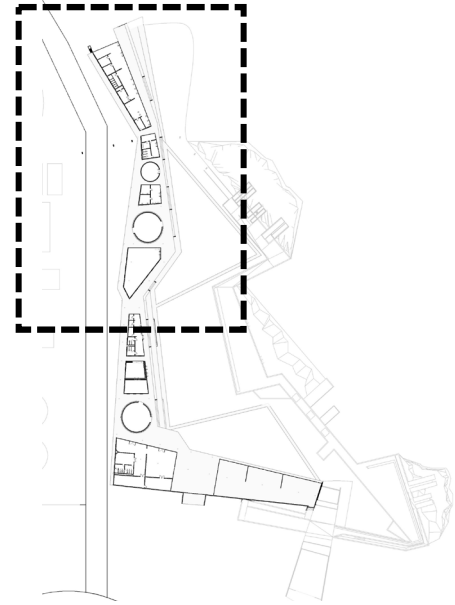


Figure 6.16 Detail Plan and Axo 3
Semiprivate – public program. The metal market (13) is public program whereas the school becomes more private as its spans towards the north.

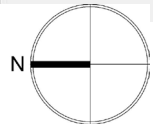
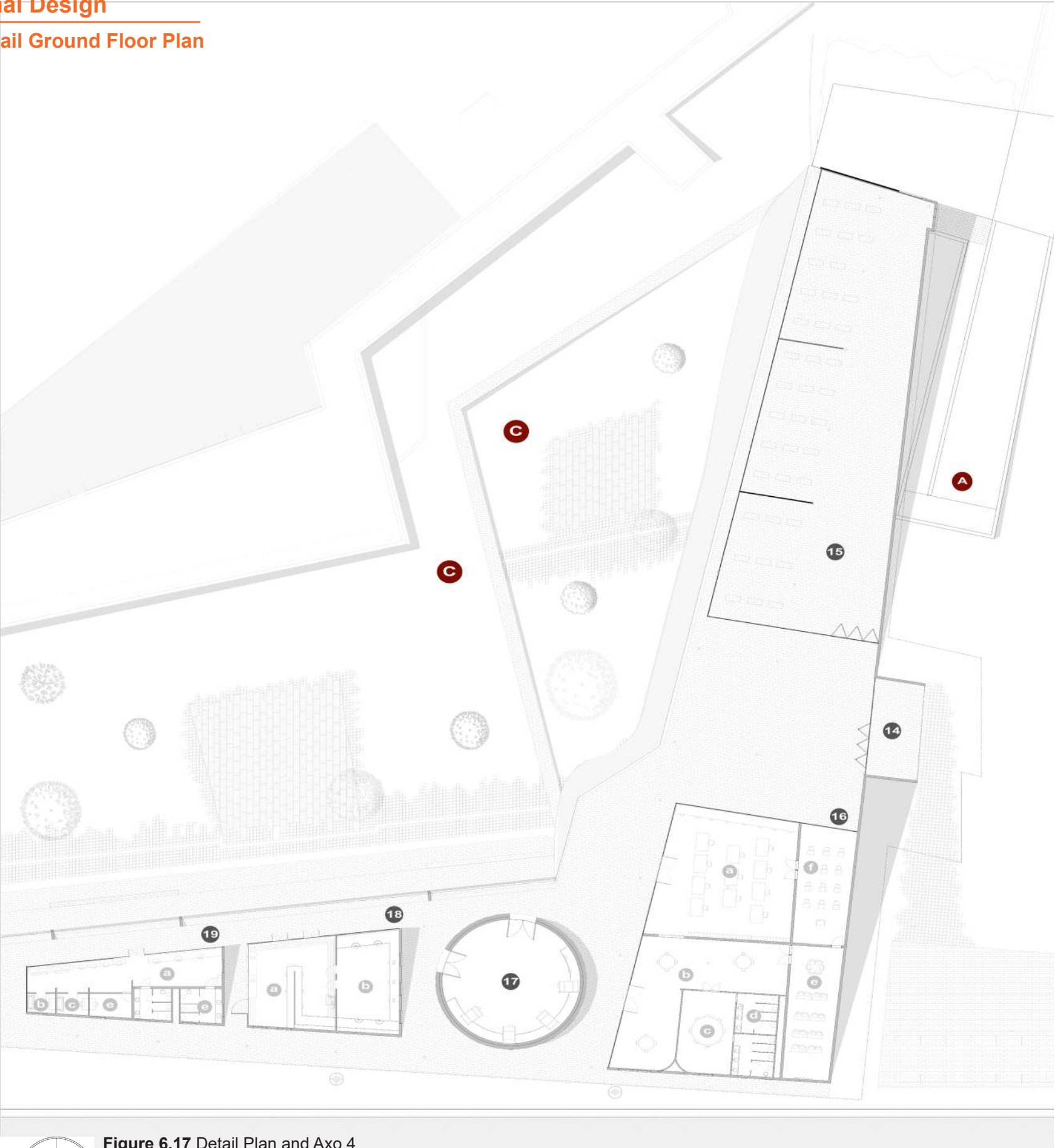


Figure 6.17 Detail Plan and Axo 4

The program is more private by nature and the two programs while separate are interdependent on one another. The Extraction plant (25) feeds back the collected waste metal to the jewelry workshop (20-24) allowing professional artisans the use of the recovered metals.

Detail Plan 3: Ground Floor Plan



Jewelry Workshop (20-24)

20. Workshop

21. Furnace & Melting

22. 3d Printing and Cutting Studio

- a Printing and drafting studio
- b Laser Cutting Room
- c 3D Printing

23. Meeting Room

24. Staff Room

- a Break Room

b Equipment storage and Collection

c Laundry Room (for metal dust collection from work clothes)

d Ablutions

Extraction Plant (25)

- a Administration
- b Break Room
- c Office
- d Pump Room

e Ablutions

f Change Room

g Extraction and processing

h Metal and chemical storage

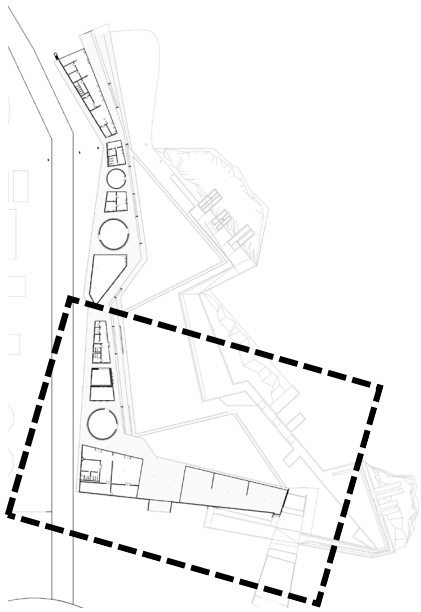
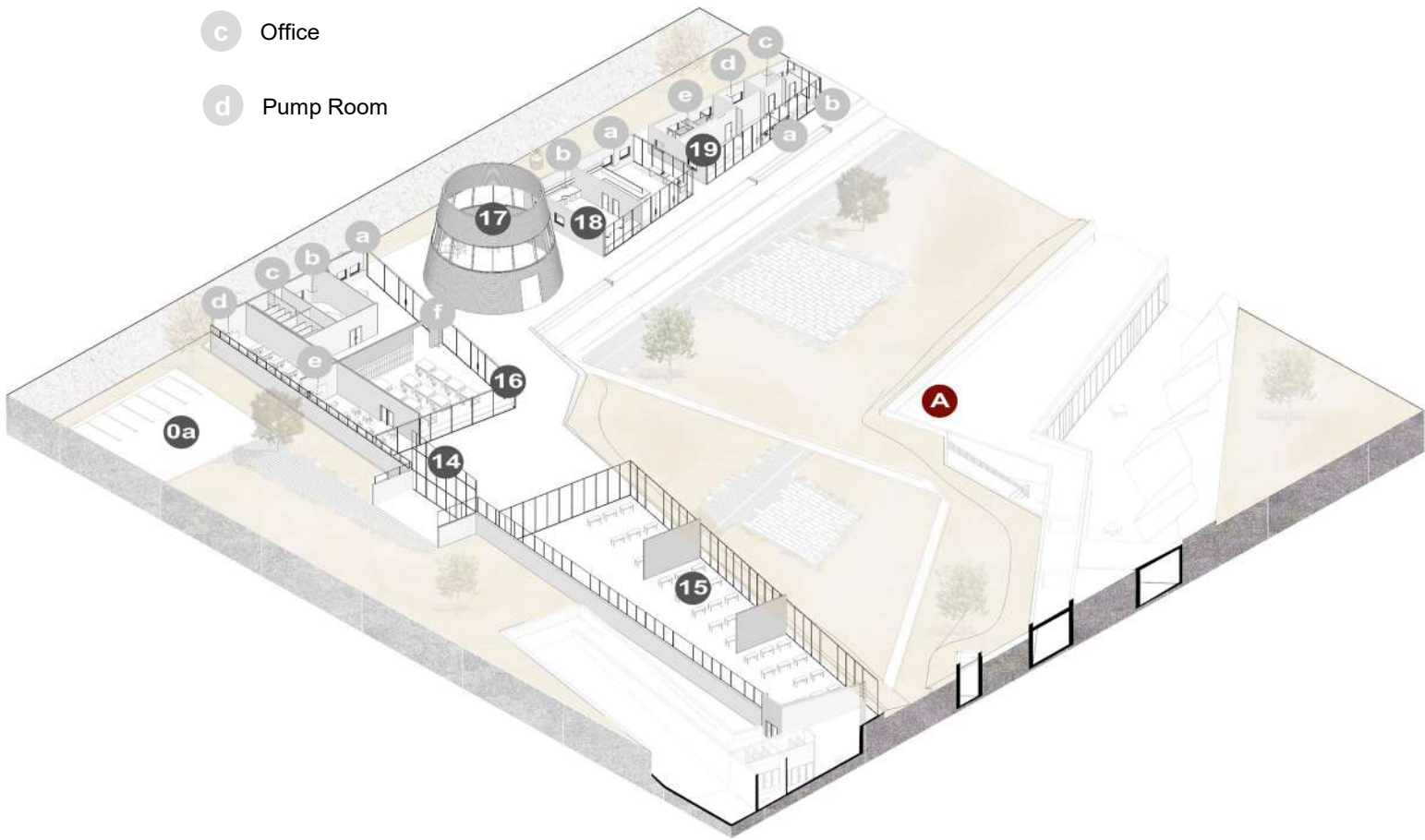


Figure 6.18 Metal Works Building
View towards North boundary overlooking the Jewelry printing rooms and the repository viewing deck.





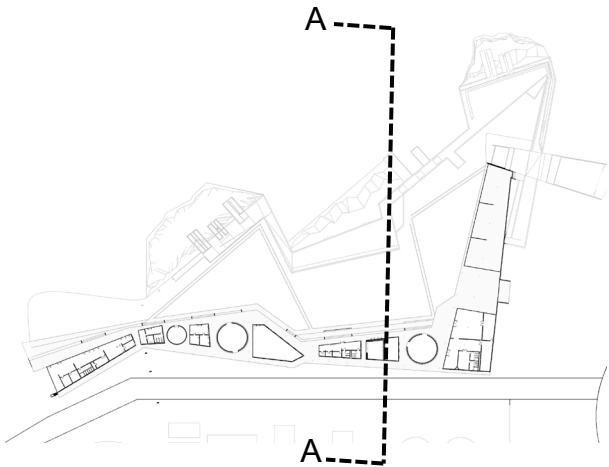
Figure 6.20 Metal Works Building Internal
View of the jewellery work stations, and out towards repository overlooking the courtyard.





Figure 6.21 Sectional Perspective AA

- 18 Metal Workshop
- 10 Exhibition
- B Repository Viewing Deck
- C Courtyard



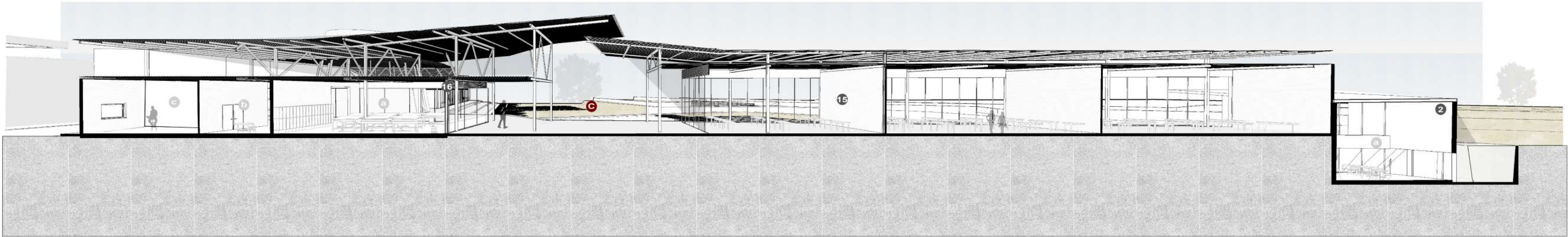
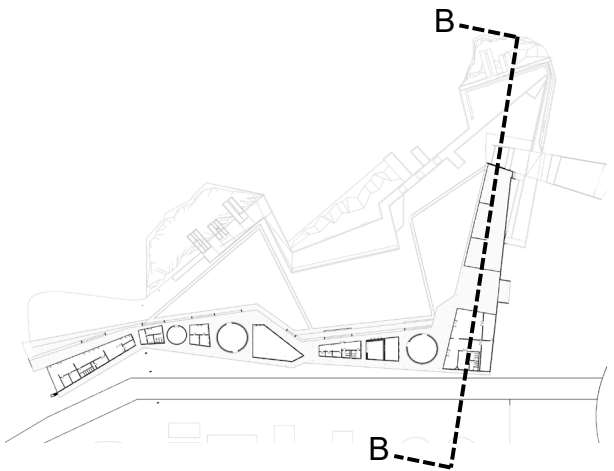


Figure 6.22 Sectional Perspective BB

16 Jewelry School a Drawing Studio b Meeting Room c Private Seminar Room 15 Metal Works Market 2 Lobby C Courtyard



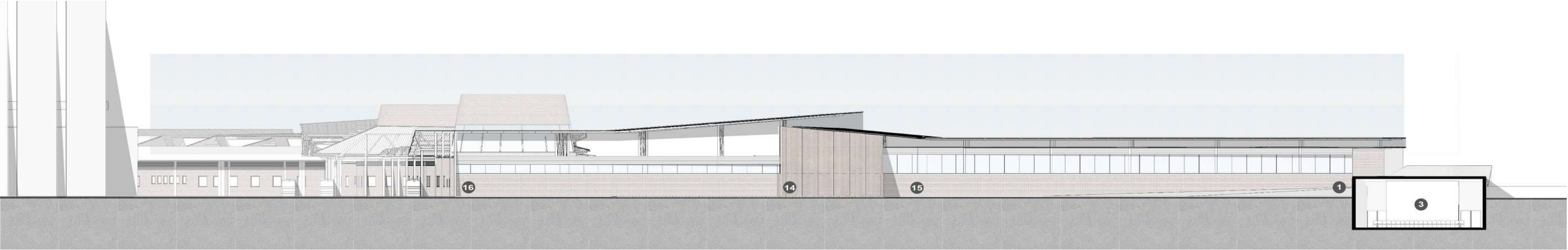


Figure 6.23 South Elevation

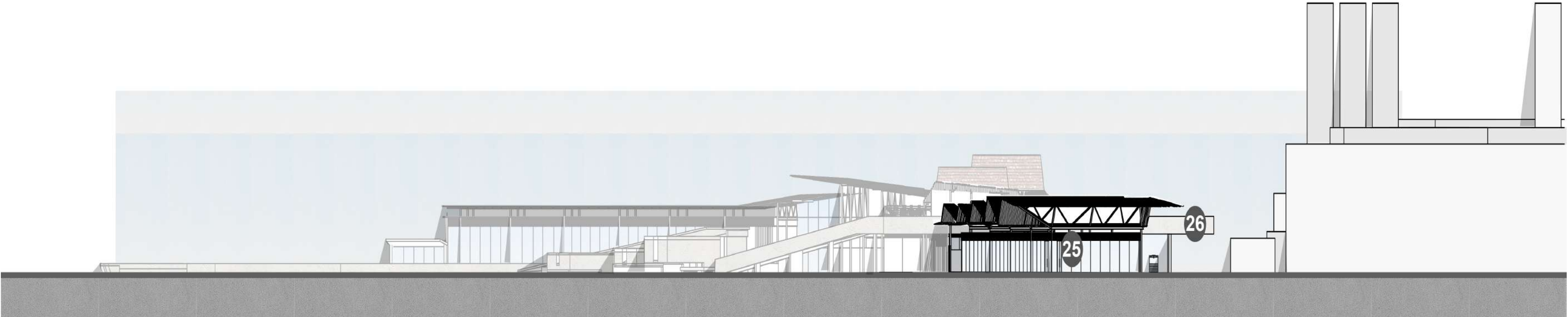


Figure 6.24 North Elevation

6 Final Design

Sections and Elevations



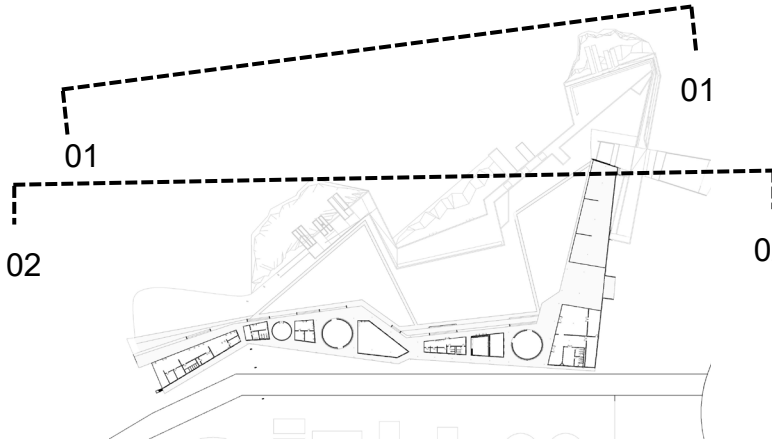
Figure 6.25 Section AA

4 Multipurpose Room



Figure 6.26 Section BB

3 Auditorium a Storage and Equipment b AV Room c Ground Floor Access 1 Repository Entrance 2 Lobby 4 Multipurpose Room



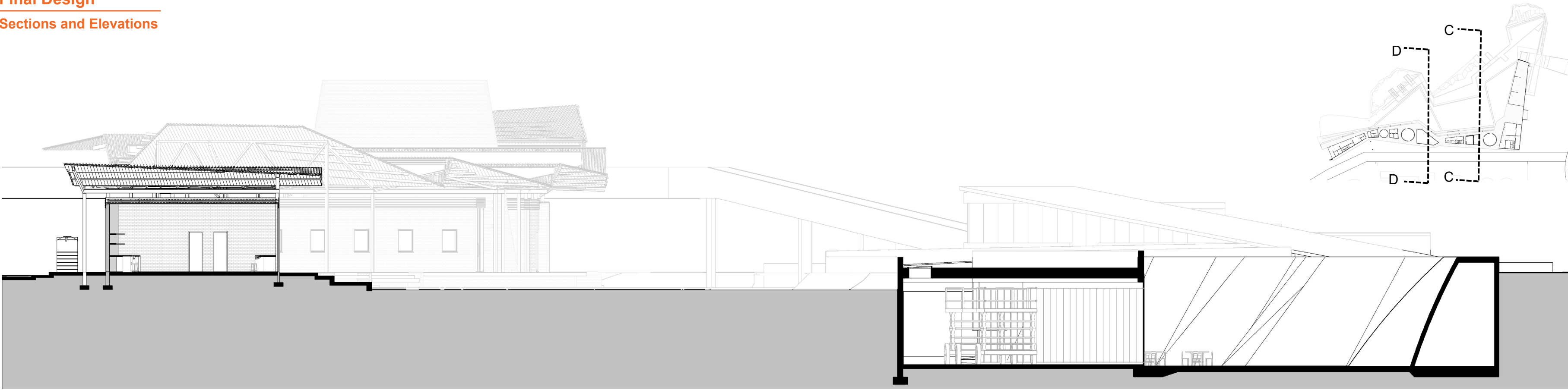


Figure 6.27 Section CC

18 Metal Workshop 10 Exhibition B Repository Viewing Deck C Courtyard

1m 5m 10m

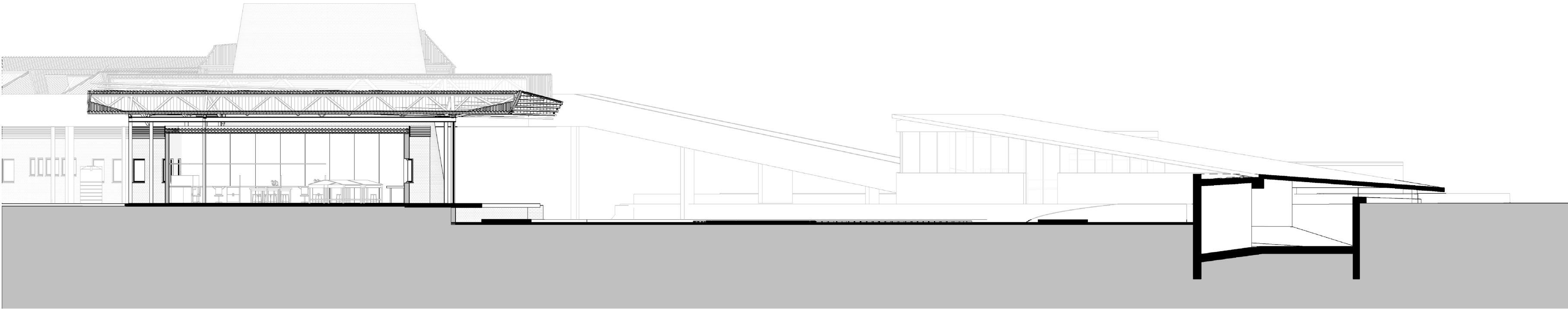


Figure 6.28 Section DD

20 Workshop 10 Exhibition B Repository Viewing Deck C Courtyard

1m 5m 10m



Figure 6.30 Metal Works Building- Laboratory
Internal perspective from the laboratory - chemical processing in secured environment while maintaining view of courtyard.



Figure 6.31 Viewing deck
View from the repository viewing deck overlooking the metal works building, the inserted repository, the industrial landscape and the treatment plant.



Ventilation & Heat Gain

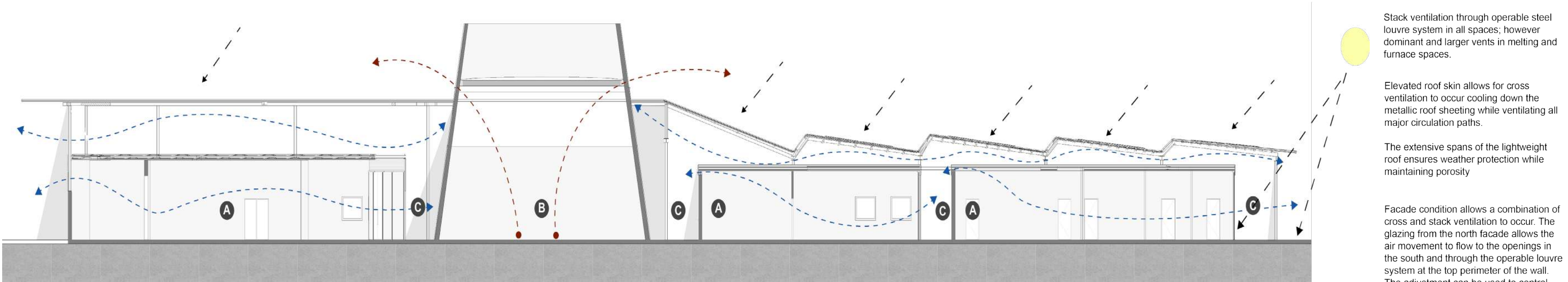
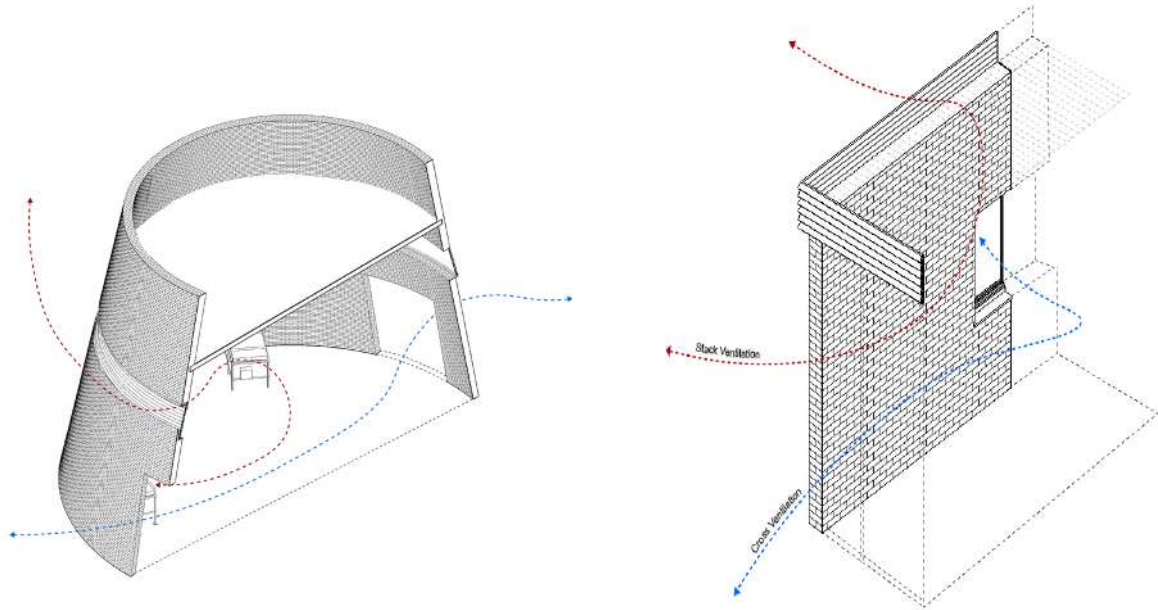


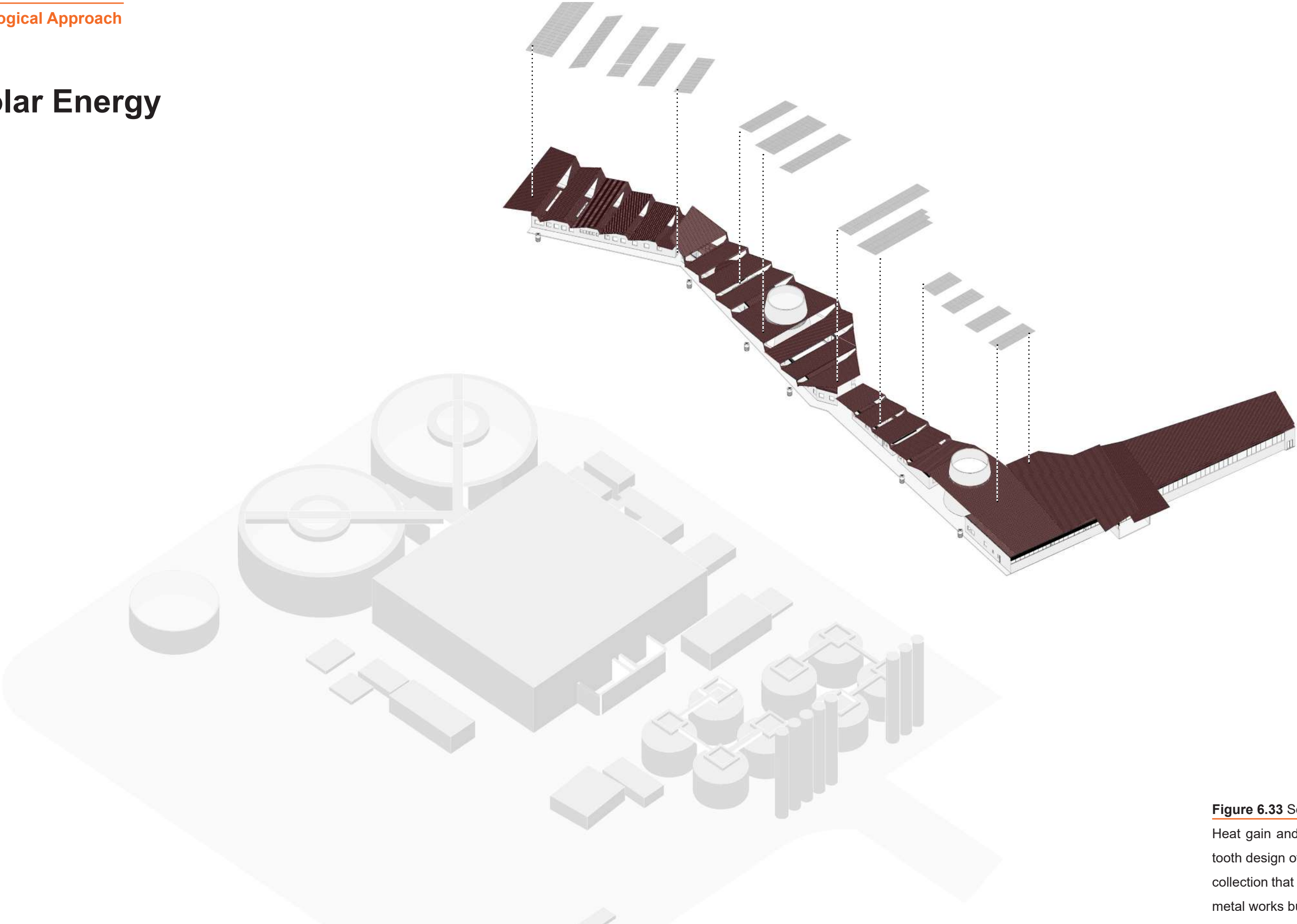
Figure 6.32 Ventilation & Heat Gain

Prioritizing passive design strategies relate to the notion of the building reevaluating how we perceive and use waste. from using it to hold open the earth, to recycling the material to create a renewable resource. This notion is further inherent in the roof design of the building in which a monolithic ‘floating’ roof spans over the housed programs below. This in essence creates two roof skins allowing air flow and natural ventilation to occur throughout the building.

- A . Workspaces
- B . Melting Room and Furnace
- C . Circulation



Solar Energy



Solar panels on saw tooth roof. Angles range from 26- 35 degrees.
Total Approximate Number 425 solar panels

@450 Watt solar panels:
Approximately 717 187.5 Kilowatt hours total

South facing skylights aligned with inner skin to allow passive natural light into both buildings. Saw tooth prevents harsh summer sun but accommodates for the winter sun angle.

Louvre system allows for the heat gain within the roof skin to be released or trapped. In winter the operable system can be closed to allow the spaces below to warm while in summer the system can remain open to expel out the hot air.

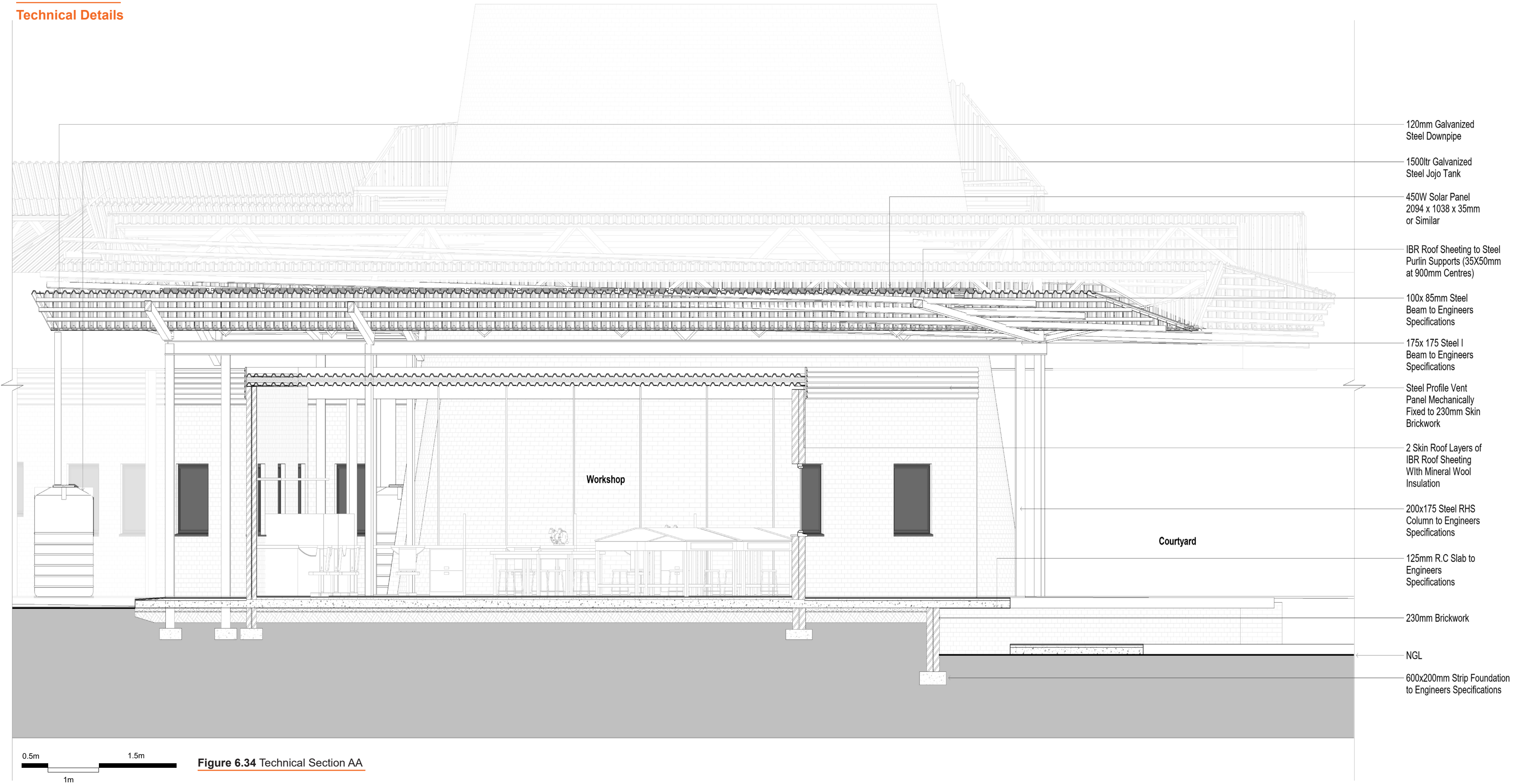
Large steel gutters at every pitch intersection for water collection to jojo tanks. Water to then be pumped to treatment room and used throughout building. Any remaining water is fed back to treatment plant adjacent.

Figure 6.33 Solar Energy

Heat gain and control further benefits from the systematic use of the double roof skin. The saw tooth design of the first skin helps maximize solar panel angles, sky light openings and wastewater collection that can be pumped back to the extraction plant water treatment program of the proposed metal works building.

6 Final Design

Technical Details



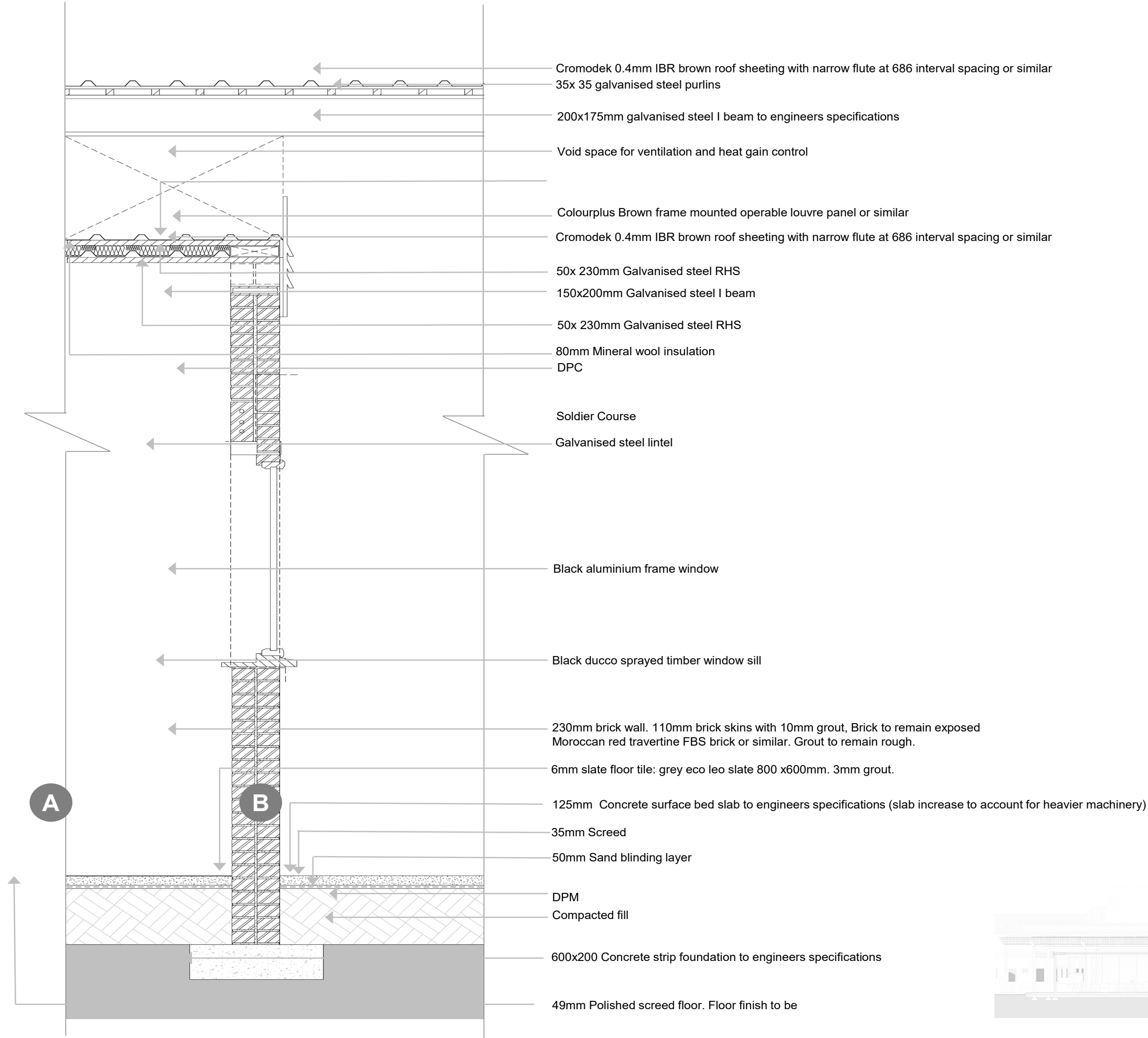
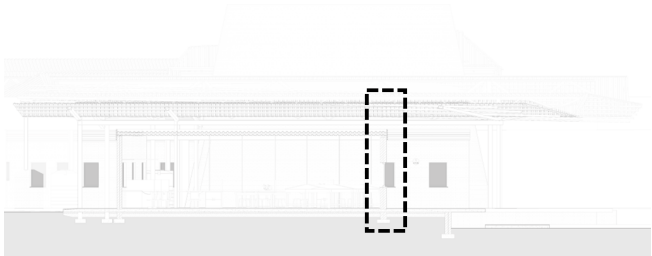


Figure 6.35 Technical Section Detail AA



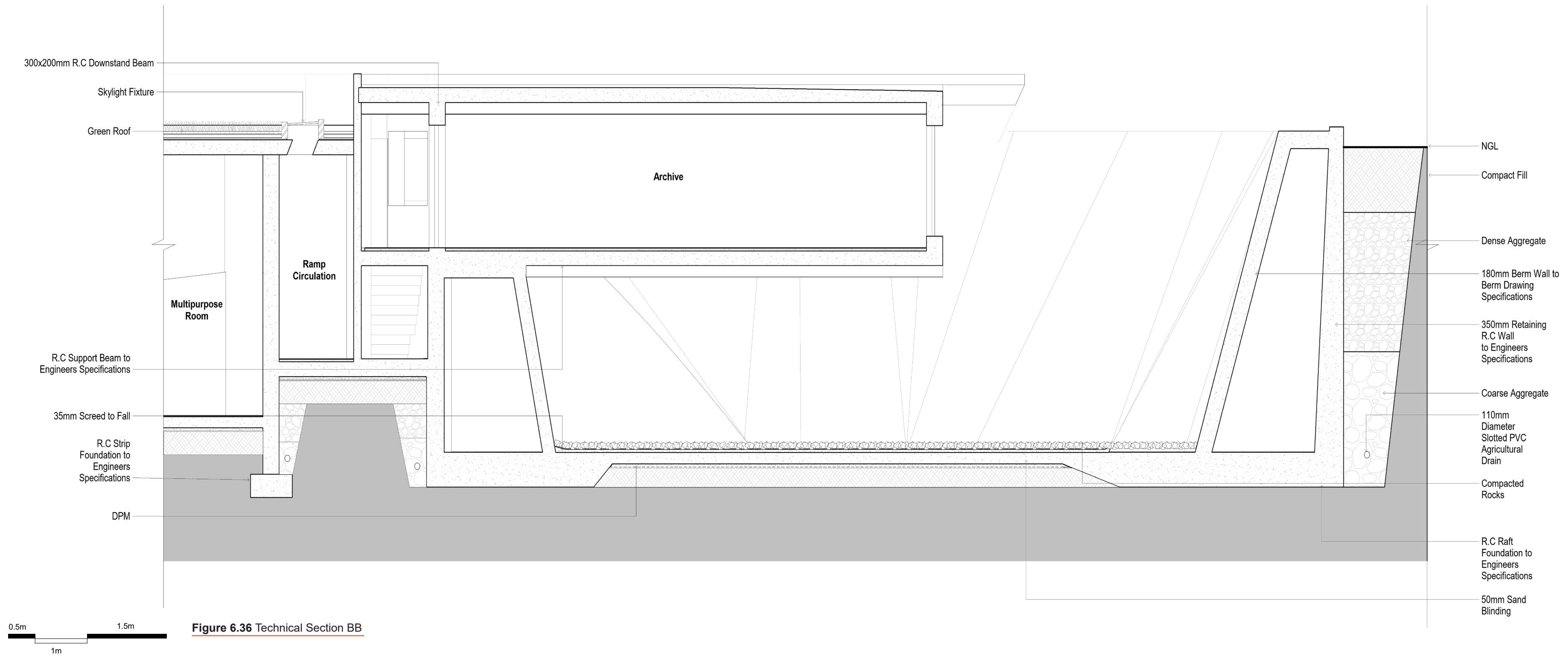


Figure 6.36 Technical Section BB

Executive Summary of Project Proposal

The project proposals aim is the construction of a waste treatment plant that recycles metallic waste from an existing water treatment plant on the existing Central Basing Acid Mine Drainage Treatment Plant in Germiston South. The project aims to sit adjacent to the existing infrastructural treatment facility to redirect the metallic waste into the proposed building where it can be reused as opposed to discarded. The metallic waste will programmatically be extracted where further programs of jewellery manufacturing, waste metal jewellery skill centres, retail stores and museum can be implemented. These programs will in essence generate an operational income to cover the capital costs while focusing primarily on the social benefit of the building.

The general aim of the proposed building includes waste reduction, historical marginalization redress, local community economic growth, and primarily: job and skill development.

This projects viability can be ascertained through the report which showcases the significance of this proposed building as a potential income generation in a site that is currently utilizing large operational costs. The proposed building is aimed to create a public and social benefit as its main source of income; however its nature in terms of waste reuse, post building lifecycle reuse, and skill creation facilities allows the project to be a viable project in isolation, but also to the existing on profit treatment plant on the site.

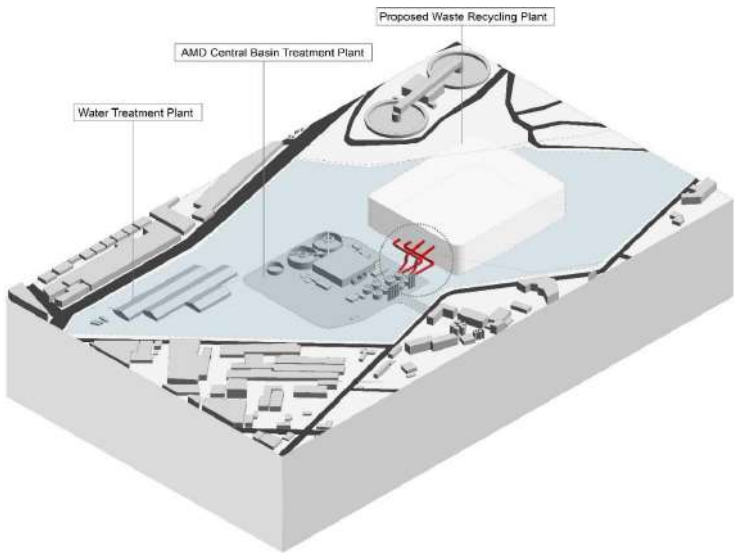


Figure 1.1: by Author

Authoritative Agent (Role of The Authoritative Involvement of the Proposed Project)

Authoritative Commissioning of the Project

The authorization and initiation of the project is commissioned by the: South African Government under the departments of: The Department of Mineral Resources, and the Department of Water and Sanitation.

Under these generalized departments – specialized departments and groups would act as representatives for the project proposal, this would be the: TCTA (Trans Caledon Tunnel Authority) Under the Department of Water and Sanitation, and the Department of Mineral Resources.

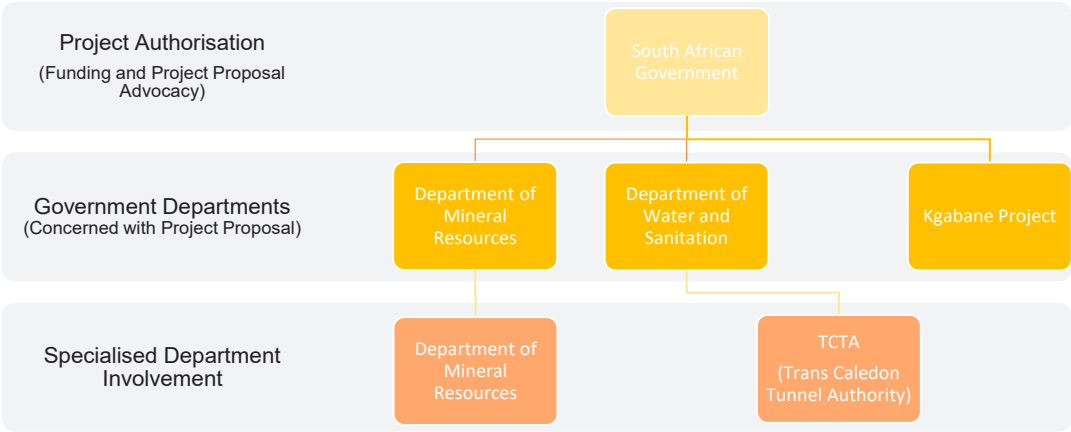
The existing building on the site (the acid mine drainage treatment plant) is currently under the authorization of the TCTA under the Department of Water and Sanitation. The proposal will in essence be an extension of the project with the addition of the Department of Mineral Resources.

An NGO involvement occurs through Kgabane Project which aims to teach unemployed persons jewellery manufacturing skills. The Ngo’s involvement is aimed at the marketing to the use of spaces in the academic metallic skills development centres and workshops.

Legislative Acts that Govern The Implementation of the Project as Per Authoritative Commission

- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEMWA).
- The National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)
- National Water Act, 1998 (Act No. 36 of 1998)
- National Heritage Resources Act, 1999 (Act No. 25 of 1999)
- Minerals and Petroleum Resources Development Act (No 28 of 2002)

Organogram for Authoritative NPC (Non-Profit Company) Involvement



5 Appendices

Viability Report

The project authorization is carried out from the Specialized Department: under the Department of Mineral Resources and the TCTA (Trans Caledon Tunnel Authority).

Project Funding and Incentive to NPC:

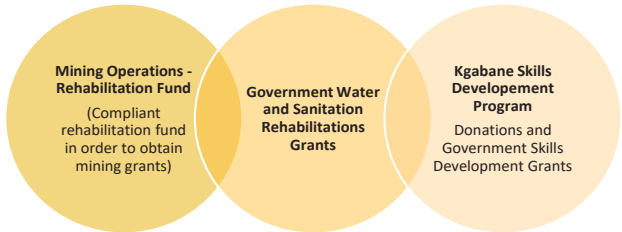
1.Funding:

The funding occurs primarily from public funding and secondarily from project funding

Public funding (social benefit as primary proposal justification) Project Funding (investment by the local authorities will result in the income covering the operating expenditure of the proposed building and the servicing of capital costs)

The capital and Project funding is predominately curated from the mining rehabilitation funds provided by the government, because of payments from current mines in order to rehabilitate their waste, and the toxic water contamination. This fund is already in place for the water treatment plant.

Donations and Skills Development grant funding comes from the A further funding comes from skills development funds from Kgabane Project and the government provision for skill development and waste recycling. The aim of building income generation from the programmatic output aims to create an investment into the non-profit nature of the project as a primary necessity for environmental rehabilitation.



2. NPC Nature of the Proposal Commissioning & The Possibility of the Building Proposal as a Method to Pay Off the Investment of the Existing Treatment Plant:

The project proposal is primarily for public benefit and environmental safety and sustainability – this is the nature as well of the existing treatment plant. All project funding and assets go towards the objectives of waste recycling and water treatment for public benefit. The proposal of additional programs: jewelry manufacturing workshops, jewellery retail stores and the museum offer an operational cost cover for the building.

Marketing Strategies:

The marketing of the project is aimed to generate donations and investment within the building operations of the proposed skills development centres and museums. These spaces encourage tourism and education systems that can be advertised through magazines, social media, and news forums to encourage investment into those fields.

The Site Proposal for the Building

Site:

Central Basin Acid Mine Drainage Treatment Plant, Germiston South



Development Purpose:

The site currently houses a water treatment facility that generates a metallic waste that can be recycled and extracted to produce metal commodities. These commodities can be used to create industry and metallic skills development which will stimulate growth and economic generation in a stagnating and abandoned landscape.

Total Site Area (Including Existing Building):

329 350m²

(Existing Site Occupation: 135 937m²)

Proposed Site Area (for building proposal):

175 669m²



Proposed Built Area:

15000m² (Including Landscaping – program and usable/ habitable/ rentable space 6000m²)

FAR:

0.08 (With Landscaping) 0,03 (Habitable Space)

Zoning:

Industrial (Application for Commercial Zoning Addition)

Primary Rights of the Site:

Site is officially owned by the: Witwatersrand Gold Mining Realisation Trust (Government Tenure)

There is permissible development under Government Authority – the site is to be constructed according to chemical treatment safety regulations and legislation – this will implicate material, construction, and design decisions. Users of the site will not be permitted into the existing treatment plant without authority this will result in the design prescription of the proposed building.

Site Accessibility:

- Taxi Rank proximity 300m from site boundary
- Access via main road (Tide Street) and subsidiary road (Power Street)
- Currently limited parking for treatment plant employees and transportation vehicles, an additional parking for staff and visitors for the proposed building must be added and separated from access to the existing wastewater treatment plant.

Demographics

Medium to High Density Residential and Industrial Sector

Growth potential

Stable

Competition

Low

Site Preparation

High (Earthworks, Land Surveying, Servicing all prepared)

Service Availability

High

Land cost

Land is currently owned by government. The project is an addition to an existing infrastructural system, thus reducing land acquisition costs or holding concerns.

Information concerning the initial land costs is unknown at this time, however an estimate is assumed based on current industrial mining land property rates. The land size in relation to its position in Germiston South and in comparison, to other industrial properties is estimated at: R 411 473 750 (this value however is an estimate)

Site Technicalities and Accessibility for Construction (An analysis of current site conditions):

Technicality	Good	Likely	Bad
Access to Site	X (Site is in industrial sector just off main road, construction disruption is negligible)		
Storage of Material Facilities	X (Existing Treatment Plant provides large warehouse storage facilities)		
Delivery Times	X (Industrial Area, Negligible Concern)		
Noise and Dust		X (Industrial Area; however, dust must be controlled in specific portions of the site as a result of potential toxic contamination)	
Construction Hours	X (The site has a residential sector that is informally on the outskirts this should be considered to limit works. Further working hours must be observed)		
Safety Measures on Site		X (The toxic rehabilitation on the site is contained within the existing treatment plant however safety precautions are essential	

The Construction process overall aims to be implemented as undisruptive as possible, considering the safety measures on the site in terms of toxicity. The site has already been rehabilitated to ensure a safe

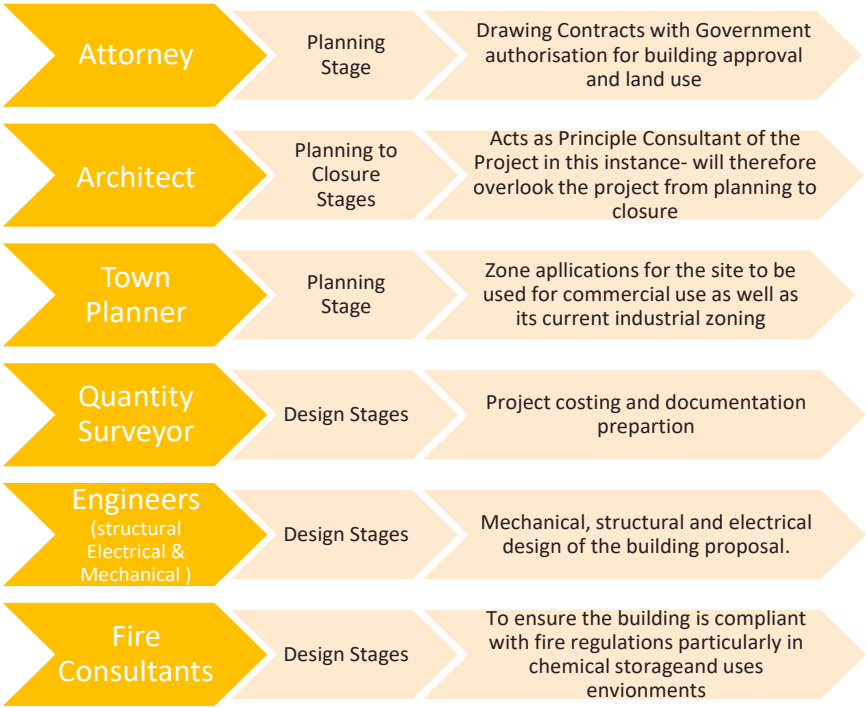
The Professional Team Involved in the Proposed Project

The professional team involved within the project is a result of the construction and design proposals of the building, and a response to the existing work carried out by the existing treatment plant on the building.

- o

The existing treatment plant has contributed the following information which has ultimately reduced certain professional involvement and, thus professional fees:
- Land Surveying Information
- Town Planning Drawings and Specifications (the appeal will only be made to add the commercial zoning rights to the property which are otherwise industrial)
- Geotechnical Engineer

The primary professional team as per the project proposal and their duration involvement is as follows:



The figure above shows the appointed professional team by the authority (in this instance the Government appointment of the TCTA and Department of Mineral Resources). Their main objective is the project design and construction. The appointment is by the Authority of the Government; however, engagement with each professional consultant is done through the architect acting on behalf of the authority as the principal agent.

The estimated time for construction (without delays) is 2.5- 3 years. This time frame is used as an estimate to ascertain professional fee costs for the various professionals to ascertain the viability through the perspective of the cost feasibility of the professionals required.

The Specialist Consultants Required for Design Input (Design Stage):

- o

Chemical Engineer
- o

Mining Specialist
- o

Jewelry Manufacturer
- o

Water Treatment Specialist

The Specialist Consultants Required for Construction Input (Construction Stage):

- o

Chemical Engineer
- o

Water Treatment Specialist
- (These specialists are required at construction phase to ensure the works are per chemical safety requirements, as well as water pressure, and supply requirements for the discharged metallic water to be transported between buildings.)

The Professional Fees of the Architect Involved (Student Architect 1456518)

Project categorized at high complex project.

Project cost bracket 10. Of: 260 000 001 – 520 000 000

Value of works estimated at R300 000 000

Professional Fee Calculation:

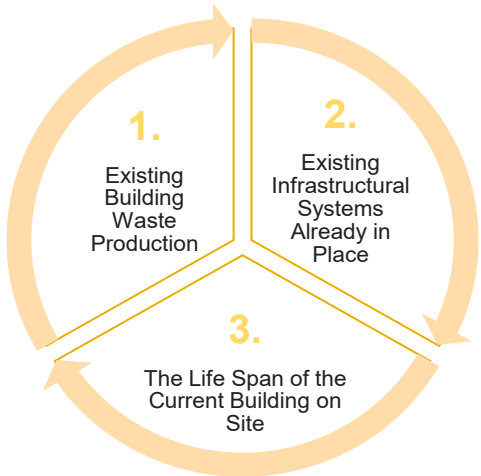
R300 000 000 – R260 000 001= R39 999 999

R26 581 498,86 + 9,60% x (R39 999 999) = R30 421 498,7

Total agreed upon professional fee between client and architect: R30 421 498.7

Financial Viability of the Proposed Project

Financial Incentive and Rationale for The Project Proposal:



1. Existing Building Waste Production

The significance of this proposal financially aims to reduce wastage material from an existing infrastructural system. The current existing treatment plant aims to treat toxic water by neutralizing acid mine drainage for it to be fed back into the domestic water supply system. The proposal of the new building financially will use the metallic waste of the treated water to create operational costs in the form of a commodity that can be used in jewellery manufacturing and metallic skills development workshops. The ultimate proposal aims to take the capital costs of a non-profitable existing facility and use that infrastructure to generate operational costs to make the new building and old building economically contribute.

2. Existing Infrastructural Systems Already in Place

There are currently existing servitudes and utilities from the existing buildings construction – the proposal of an additional structure on the site will therefore reduce new capital costs through connecting to existing systems and earthworks.

3. The Life Span of the Current Building on Site

There is a financial view of the redundancy of the existing treatment plant on the site. The lifecycle of the building is temporary suggesting a large capital cost could potential be reused by a new proposed building.

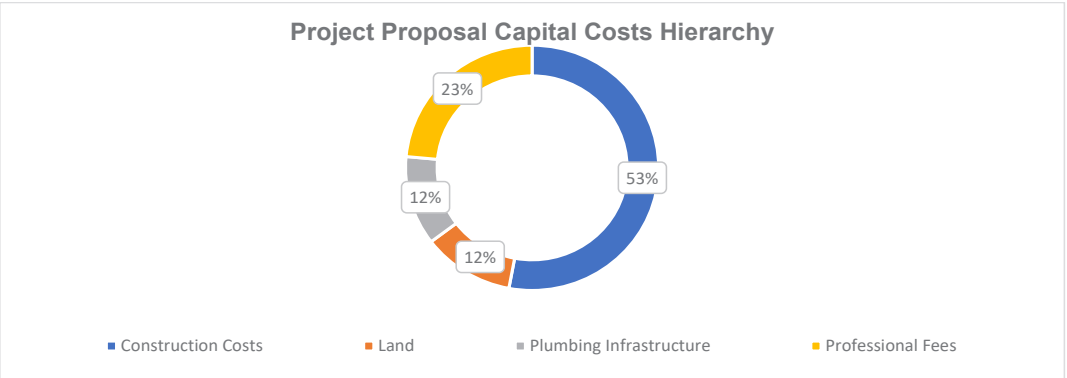
Therefore, the analysis of financial viability van be assessed in two parts. Part 1: capital, operational and professional fees of the proposed project. Part 2: The existing site's: capital, and operational costs. This can lead to a comparison that can ascertain if the building ultimately can reduce costs based on connecting to existing systems and recycling material waste.

Part 1 (Building Proposal):

The capital costs for the proposed metal recycling plant will therefore mainly include:

- Materiality (proposed brick, aluminium, and steel structure)
- Construction fixtures, equipment Costs
- Labour (construction costs (Professional fee increase for water specialist as a subcontractor)
- Plumbing infrastructure (To connect existing water treatment plant to new waste recycling plant)
- Land Acquisition (Government owned land for water treatment – building will act as extension onto the already purchased land under the TCTA) Current depreciation in land value because of area industrialization

Hierarchy of Capital Costs:



Building Cost Rates

Program	Rate per metre squared (As per AECOM Documentation)	Total Cost of Building per Program (using higher estimation value)
Metal Exchange Facility (Industrial)	R 4,800 – R 6,900 per m²	(800m² structure) =R 5 520 000
Jewelry Manufacturing Facility (Industrial)	R 4,800 – R 6,900 per m²	(1300m² structure) =R 8 970 000
Metal Skills Development Facility (Educational)	R 8,300 – R 8,800per m²	(1000m² structure) =R 8 800 000

Retail Store (Commercial)	R8,300 – R 10,900 per m²	(400m² structure) =R 4 360 000
Museum (Commercial)	R 14,600 – R 20,800 per m²	(2500m² structure) =R 52 000 000

Total Proposed building costs for relative facilities: R119 831 000

(Note: Additional costs application influenced by material selection for cladding structure and specialized equipment) [Corten steel approximates R11511 per ton]

Additional estimated cost of 50 000 000 for project landscaping

Operational Costs of the proposed building:

- Maintenance and Repairs of the Building
- Utilities
- Metal Extraction (chemical and water pricing)
- Rent of Jewellery Store and Workshop Spaces (Average in Johannesburg is 32m² for R1696. Total square meterage proposed: 2205m² - generating 50% of the building as generative income- estimation of R124 656 per month generation)
- Sales commissions from Jewellery Store
- Museum Revenue (Average Museum ticket in Johannesburg is R60 per person)

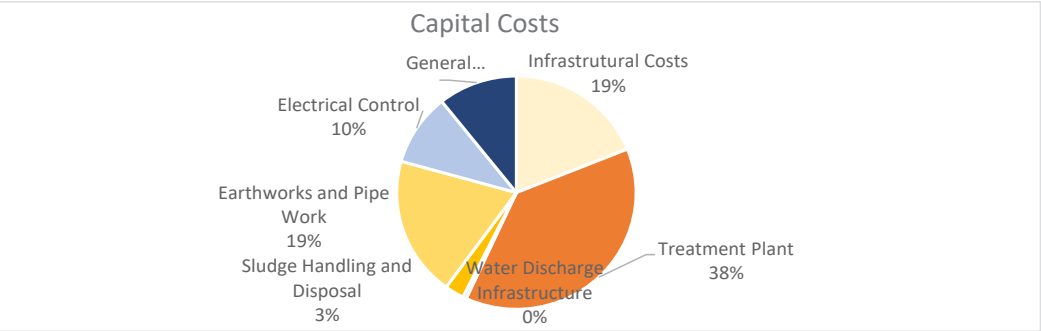
Program Proposed	Income Generation
Metal Exchange Facility	Non rentable (government funded facility)
Jewellery Manufacturing Workshops	Rentable
Metal Skill Development Facilities	Rentable – teaching facility
Retail Store	Rentable
Museum	Rentable – exhibition, educational facility. Income from visiting user
Common Areas (Storage, cafeteria, recreational spaces)	Non – Rentable. Non income generative
Circulation Spaces	Circulatory spaces between major programs: Non – Rentable. Non income generative. Circulatory spaces within the museum: generative – acts as museum exhibition space,

The deduction from the above figure showcases the significance of common areas and circulation as non-generative income- this emphasizes the design construction on the fundamental programs of the manufacturing facility, skill development facility, retail store and museum as they provide an operational income to support the buildings viability.

Part 2 (Existing Treatment Plant):

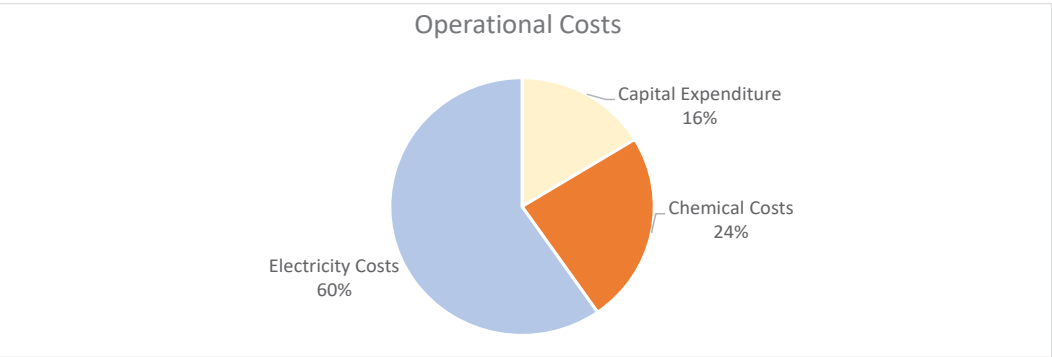
Capital Costs for the current treatment plant on site:

Total: R238 631 500



Operational costs for current treatment plant on site:

Total: R161 852 083 per annum



Conclusion Between Part 1 and Part 2: The impact of the existing building on the building proposal

The resulting impact of the part 2 on part 1: will result in the deduction of costs in the proposal from the already available:

1.Treatment Plant 2. Infrastructure 3. Earthworks.

The total reduction results in the reuse of capital cost -infrastructural systems amounting to:

R 181 955 628

Social Viability and Implications of the Proposed Project

The proposed project looks at neutralizing the acidity of toxic infected water caused by the mining industry which overall acts as a social and environmental incentive for the project conception.



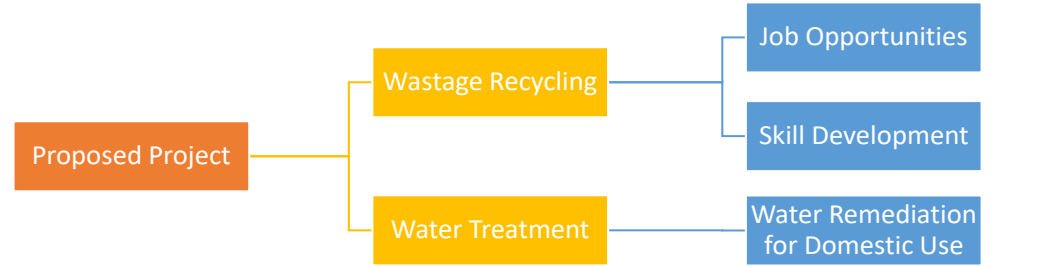
Figure 2.0: By Last Real Indians, 07 December 2016.
URL: <https://lastrealindians.com/news/2016/12/7/dec-7-2016-navajo-nation-files-lawsuit-against-epa-over-toxic-mine-spill>. Date Accessed: 01/06/2022

This is further translated into the waste collection and extraction which allows an economic revenue of metal production and craft to be created from waste product. This will inevitably create job opportunities and skills development.

The Kagbane project aims to work in conjunction with the proposed building in order to create facilities where individuals can use the recycled waste to create jewelry. This allows the building to act as an infrastructural system to create the instruments for skill development and learning.

The immediate area of the site is an industrial park with an adjacent informal settlement as a result of the previously abandoned mine dump remediated site. The project will aim to create job opportunities within the immediate context.

Project Social Impact:



Job Opportunities:

The proposal creates an employment sector through the operational use and program of the building. The site is a large extent housing a small-scale building with a large industrial surrounding district, and densely occupied informal settlement. The program implementation will allow further economic growth for the industrial sector while stimulating job positions within the local context.

The following job opportunities are proposed:

- Building Maintenance
- Metal Extraction
- Jewellery Manufacturing
- Museum Curation and Maintenance
- Retail Store

The estimated job creation is: 400jobs between the various programs (this figure is purely an estimate on operational job creation of the building post construction and excludes the labour involved in construction and professionals involved in the building design)

Skill Development:

The building proposal aims to create an educational facility which will teach local unemployed persons the processes of metal works from waste extraction to jewellery manufacturing from recycled waste metal.

The jewellery skills facility aims to teach individuals from the local community metal works skills. These skills will extend from jewellery production, melting, casting, pouring, and polishing, to metal shaping techniques of rolling, stamping, and pressing. The metal works will extend to teaching artisanal skills as well as digital applications of software to metallic design.

Materials & Sustainability:

The material choices primarily focus on the materials ability to contain chemicals and toxic substance- this will result to robust construction materials for the primary structure: brick, steel and concrete where applicable with suitable servicing infrastructure to be as per the chemical engineering and water treatment consultant specifications.

The façade design is targeted at the suitability of the program to its design in the landscape- the building materials proposed for cladding and façade design are to be recycled Corten steel sheets that are able to corrode over time. This will reduce façade maintenance and allow the building to age with the building.

The Proposed Project Brief

The Rationale for the Brief:

The proposed ultimately proposed a large-scale complex building construction to be used as a metal extraction plant that can feed into subsidiary programs such as a metal jewellery manufacturing facility, a skills development plant, a jewellery retail store, and a museum.

The proposed building is aimed to act to create viability for an already existing infrastructural system on the Central Basin Acid Mine Drainage. The existing building neutralizes the acidity of acid mine drainage water – to allow the water levels to return to a PH level that is drinkable. The processes and systems already in place will be treating the water; however, a social benefit and economic opportunity arise from the wasted metal solutions that are neutralized. The proposed building will thus aim to generate an operational income to an otherwise public benefit project that is purely driven by legislative action and warrants no physical monetary income.

The proposed building will offer its own form of waste reuse, obligations to memorializing the mining industry implications socially, environmentally, and politically, as well as creating a metal skill development opportunity within a context highly affected by the mining industry.

The viability of the project will aim to address the temporal and finite nature of the existing building on site – generating program that can exist after the existing treatment plant has depleted acid mine drainage resources.

Procurement:

Materials and supply:



General material procurement will occur through local material suppliers and equipment. The Industrial sector of the site provides a 500m – 6km of 80% of building materials

Contracting Methods:

The project is a public project through government inception therefore the nature of contracting methods is largely based on government tenders. The nature of tender grants will further be in line with the construction companies involved in the previous construction of the existing treatment plant on site by: Digsby and Wells as the construction company.

Construction Methods:

In order to maximized efficiency in both time, labour, transport, and erection on site – an emphasis will be placed on precast elements where applicable. A further emphasis on brick as a construction material will be placed.

Research Proposal Certificate



Private Bag 3 Wits, 2050
Fax:
Tel:

Reference: Mr Yaseen Stoffberg
E-mail: facultyregistrar.ebe@wits.ac.za

06 September 2022
Person No: 1456518
PAA

Miss D Mensky
5
Hannaben Street
Linksfeld Ridge
2198
South Africa

Dear Miss Danielle Mensky

Master of Architecture (Professional): Acknowledgement of receipt of research proposal

I am pleased to acknowledge receipt of your research proposal entitled *Waste Metal Repository for Adaptive Reuse: Historical (Erasure) and the toxic mining landscape of Johannesburg's central basin*. under the supervision of Hilton Judin (Principal Supervisor).

You will hear from us in due course.

Yours sincerely

Mr Yaseen Stoffberg
Faculty Registrar
Faculty of Engineering and the Built Environment

Title Change Certificate



Private Bag 3 Wits, 2050
Fax:
Tel:

Reference: Mr Yaseen Stoffberg
E-mail: facultyregistrar.ebe@wits.ac.za

06 September 2022
Person No: 1456518
TAA

Miss D Mensky
5
Hannaben Street
Linksfeld Ridge
2198
South Africa

Dear Miss Danielle Mensky

Master of Architecture (Professional): Change of title of research

I am pleased to inform you that the following change in the title of your Research Report for the degree of **Master of Architecture (Professional)** has been approved:

From: **Ameliorative Pigment Plant: Re-envisioning toxic mining waste as a resource on the East Rand.**

To: **Waste Metal Repository for Adaptive Reuse: Historical (Erasure) and the toxic mining landscape of Johannesburg's central basin**

Yours sincerely

Mr Yaseen Stoffberg
Faculty Registrar
Faculty of Engineering and the Built Environment

Ethics Clearance Certificate



13 June 2022

Faculty of Engineering and the Built Environment:

Ethics clearance letter:

Dear Danielle Mensky

Student number (1456518), this letter confirms that your ethics application has been cleared. Your clearance/protocol number: SOAP021/03/2022

Yours sincerely

Lerato Nkosi

Books:

Allen, M. and Naismith, R. (2020) *Early Medieval Monetary History*. 1st edn. Routledge (Studies in Early Medieval Britain and Ireland).

Bobbins, K. (2015) *Acid Mine Drainage and its Governance in the Gauteng City-Region*. (GRCO Occasional Paper, 10).

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Unknown (1986) *Johannesburg One Hundred Years*. Chris Van Rensburg Publications (PTY) Limited.

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