SMALL SCALE RIVERS, LARGE SCALE IMPACT

THE RECONNECTION OF MAN AND NATURE THROUGH THE PURIFICATION OF NATURAL RESOURCES

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ABSTRACT

The increasing demand and pollution of natural water systems caused by the constant growth in population has placed maximum strain on the resources upon which people depend. The presence of water sources has ensured the establishment, development and progression of the urban environment since settlements first originated, however, these environments have grown beyond the resources capabilities to sustain them. The preservation, purification and sustainable use of water have quickly become the most important strategies ensuring the survival of the urbanized world and its inhabitants.

The loss of water as a resource as well as their ecological systems and processes is not limited to larger water sources but is evident in the smaller scale river systems that are exposed to the urban environment on a daily basis. The demands by the surrounding urban environments exceed the capability of these smaller river systems which in turn has led to their neglect and steady destruction.

This study investigates the potential of small scale urban river systems to be able to provide for the surrounding urban environment as a resource through the process of purification. The reintroduction of the river as a resource will instil a sense of stewardship in man over the natural environment on which they rely, focusing on the connection between man and nature. The transformation of the riverfront into an interactive public space will promote the use and interaction of people with a previously neglected environment. The strengthening of the connection between man and environment is achieved through the incorporation of the resource into the economic sector of the urban environment, using the river as a means of income and production will add considerable value to the natural environment.

A broad approach was investigated that took the entire river system into consideration, while the main design intervention took place at one specific point along the river which had potential in all social, ecological and economic aspects. A decommissioned, post-industrial site was selected into which the purification of the river system could be integrated. The purification of the river would allow for various degrees of use, interaction, education and production centred around the resource. The proposal creates opportunities for the creation of public space and economic activities which benefit the surrounding communities through the rehabilitation of a polluted urban river. The incorporation of the river system into the post-industrial site is responsible for the rehabilitation and reclamation of a wasted landscape into one of provision and connectivity between various aspects of the urban environment.

The purpose of the intervention is the re-introduction of an existing urban river system into the built environment through the creation of social, economic and ecological connections, re-capturing the significance, importance and potential they hold as a resource as well as the ability to inform urban spatial design.

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PART 1: THE POWER OF RESTORATION AND REHABILITATION

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CHAPTER 1: THE REAL WORLD PROBLEM

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INTRODUCTION

There is a constant struggle between the artificial environment of the city and that of the untouched natural environment.

The demand of the natural environment to consistently meet the needs of the populace is seen to eventually deplete and destroy the very resources which were responsible for its initial existence.

As urbanization increases so the rural lands decrease, it is the blind forces of urbanization which develop along the lines of least resistance that are responsible for the depletion of resources on which it so harshly depends. There is a certain consciousness surrounding the depletion of resources by the urbanized world in the name of progression.

Through the continuous and increasing congestion and the widening expansion of urbanized environments, it is no longer only the natural landscape which suffers, areas of the urban environment which have run their course and are no longer of a beneficial nature will face the same neglect, defacement and degradation as that of the natural environment.

Focusing on the depletion of water in particular, there are various levels on which water has been responsible for moulding the existing world into place over centuries of discovery and development. As the source of all life, there is a certain degree of understanding and respect with which the developing world should incorporate the resource into a daily way of life. Through reassessing and re-evaluating the role water systems have played within the urban environment as well as the ever evolving relationship between user and resource, one will gain an understanding in the progression and significance of the use of urban river systems within the built environment.

There has been significant movement in the direction of environmentally sustainable design as well as an attitude of stewardship on a global scale, moving away from the previously human dominated uses of water which inherently had an effect on ecological properties.

There is however a necessity for the initiatives to be adopted not only in large scale river cities but in all freshwater resources which are negatively affected by the urban environment and have the ability to directly influence people's lives.

The future design of urban cities as well as human survival lies in the development of mutually beneficial relationships between urban environments and their water systems, where human interventions in such systems becomes a strength rather than a liability of the system.

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THE INFLUENCE OF URBANISATION ON URBAN RIVER SYSTEMS

The progression of urbanisation was directly responsible for the continuous decline and degradation of the natural environment, as urbanisation increased so the state of the natural environment steadily decreased.

There is a point reached where city development and the resultant population have outgrown their local water supply.

The natural resources which were responsible for their initial establishment are no longer able to sustain the needs and requirements of the surrounding environment. As a result, cities begin to rely on distant water bodies and systems as a resource while existing rivers are barely used as resources, ultimately serving the urban area as an element of disposal and management for negative products of the industrialised and developed environment.

As cities were establishing they were able to obtain substantial volumes of pure water to support the dependent population as well as able to dispose of the produced wastes with minimal impact and influence on the natural environment. It is essential that the development of waste management and infrastructure of the urban environment develop at the same speed as the rate of overpopulation and pollution increase. Failure to do so will result in the significant decrease in the quality of urban rivers, not only will they no longer be able to be used as a resource, but evolving into a hazard to their surrounding environment (Ellis 2011. para. 1-2).

Urban rivers bear the brunt of the cities industrial effluent, urban runoff and untreated sewage, stripping these resources of their aesthetic and ecological value and resulting in the transformation of large green areas into neglected, deserted areas with little, completely restricted or no access. The rivers, which were solely responsible for the city establishment, have become disassociated and disconnected from the urban environments.

When reassessing and re-evaluating the value of the river system within its current context, it is necessary to understand the historical background surrounding the use of and influence that river systems have had on the developing environment.

The river was strongly associated with urban development regarding its use as a a resource as well as urban design tool.

Photo1.1.1: Moreleta Spruit running through rural residential area (Author, 2015)

Photo 1.1.2: Moreleta Spruit pollution and litter. (Author, 2015)

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Rivers as a Resource

The presence of water played a significant role in the identification and eventual colonisation/habitation of an area, more permanent settlements were established through the systemic cultivation of plants and the domestication of animals, both of which were heavily reliant on the presence of water.

The more reliable the available water source was for irrigation and domestic use, the more stable the settlement was, resulting in a greater opportunity for development and progression. It took the production of surplus storable food, more complex social organization and technological advances to meet the requirements of the 'urban revolution'.

Ultimately, cities were established at the intersections of transportation routes or points where goods are required to shift from one mode of transportation to another, such as land to rivers and ocean ports. (Ellis, 2011. para. 1)

Cities serve as centres for manufacturing, storage and trade and it is the surplus produced from the outskirts of the cities which are distributed throughout the centre, developing around marketplaces and the exchange of produce between rural and locally produced goods.

Rivers as an Urban Design Tool

The locations of cities were determined through the presence of water as a resource, but the spatial organization of the city itself was further influenced on various levels by the river system. As cities grew and established themselves, the complex social organization of cities demanded segregation and separation. (Ellis, 2011. para. 4).

Urban Rivers served as a dividing line between settlements, used as a form of natural boundary or barrier between various races, population groups, farmlands and industrial properties. Later through increasing industrialisation, increased migration and social division, these rivers became an important line of separation, a natural boundary, between ambiguous territories marked by racial segregation, conflicting uses, contradictory conditions and constant change.

As the development of urban environments took place, urban rivers were further recognized in terms of protection of nature, fisheries, recreation as well as their considerable value in contribution to the landscape.

These rivers over time were continuously used and adapted for use beyond irrigation, domestic use, fishing and transportation but were slowly but surely incorporated into the industrial environment. (Gardiner 1997 cited in Cengiz 2013. p. 1).

The natural elements of the landscape on which cities were established were taken into consideration as a means of design and spatial configuration of the urban city layout.

The arrangement of networks, buildings and open space in various ways would give rise to the ultimate urban structure for the most functional city designs.

Photo 1.1.3: Restricted access to Moreleta Spruit (Author, 2015)

Photo 1.1.4: Security and restricted access surrounding Moreleta Spruit (Author, 2015)

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It is essential to understand the potential of urban river systems to act as a connection between landscapes and communities.

The open space surrounding urban river systems provides for the presence of natural river habitat. The future design of cities needs to incorporate urban rivers and urban river systems as a link between open spaces, throughout the urban environment, such as parks, gardens, lawns and nature reserves which provide for an essential break from the harsh urban environment.

The abundance of green space and exposure to such environments, increases the aesthetic value of the areas and renders them desirable areas to live in.

However, it is essential to understand the implications of the development of green areas, even though green spaces are responsible for the further depletion of the natural river habitat, these spaces are often designed with certain planting and activity implications, disrupting the natural ecological processes, which in turn decreases the biodiversity and species richness in these areas.

This, along with the increased development of industrial facilities, residential areas, freeways and commercial areas infringing on the flood lines of the river system, leaves little to no protection of the natural environment. (Davis and Jensen 2015)

Many of the world's greatest cities have been established along the banks of fragile river systems, requiring specific design interventions for the preservation and protection of the urban environment from the potential threats of the natural environment.

There is a level of initial connectivity designed between the cities and their respective riverfronts, indicating how the riverfronts were initially established and later designed and defined as public spaces.

The urban environment has however come to dominate the natural environment, and a shift in perspective in terms of hierarchy between nature and man is required to ensure sustainability.

Past uses of rivers and social tendencies have affected the present conditions of rivers, and the struggle is no longer between man and the natural environment, it is in the transition between the anthropocentric mind set and that of stewardship, the responsible planning and management of resources is the only option if man is to survive. (Smardon 1995 cited in Cengiz 2013. pg. 1-3).

Photo 1.1.5: Unrestricted access to Moreleta SPruit and green space in residential area. (Author, 2015)

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EXAMPLE OF INTERNATIONAL URBAN RIVER CITIES

The Thames River, Victorian London

There are various aspects of connectivity throughout a number of historical river cities of the world.

The Thames, before the great embankment was built, was responsible for supporting lives and livelihood in physical proximity to its water.

The construction of the embankment was responsible for the alteration in the relationship between the user and river system, with the great brick and granite walls sealing off all access to the river, thereby restricting access to people who had no legal or bureaucratic right to work on it. The river was no longer a working thoroughfare, but had become a subject of engineering reports and water quality surveys.

Due to the level of pollution, the river had become a main source of disease transmission, and the design of the embankment was aimed at the interruption of the ecological connectivity in order to prevent this transmission, resulting in the loss of traditional river occupations and utilisation.

After the complete exploitation and degradation of London's economic and natural life line, the solution was to hide the pollution through channelization and the construction of a wall around the river, thereby removing the pollution from site, but not resolving the base line problem.

The construction of the barrier between urban and natural environments completely limited the interaction between man and river, however there was the development of a public promenade along the river's edge, creating a vantage point from which the river could be enjoyed as a social amenity.

The lack of physical connectivity to the river system and limited understanding of the natural systems and processes was a inhibiting factor in terms of value of the river and understanding of the river system. (Porter 1998 cited in May 2006. pg. 480)

Picture 1.1.1: Thames River in London Urban Area - Modern Day (D, Harris, 2014)

Photo 1.1.6: Thames River in London Urban Area - Mid 1900's (D, Sim. 2014)

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EXAMPLES OF LOCAL URBAN RIVER CITIES

The Orange River, South Africa

Although not related to one specific establishment, the Orange River is responsible for the establishment of a number of cities, towns and settlements along its course, providing for a large section of South African rural and urban development. Its value as a resource is unmatched by any other river in the country.

The Orange River, is one of the longest rivers, not only on the continent of Africa, but South of the Tropic of Capricorn. It originates in the Lesotho highlands, draining into the Atlantic Ocean in a generally westerly direction. It transverses the veld region of South Africa and is responsible for defining the boundaries between provinces and countries.

The drainage basin of at least 855 000 square kilometers is unamenable to cultivation without irrigation in the western half. ('Orange River' 2015)

There are two large river projects, the Orange River Project and the Lesotho Highland Project, designed and in the process of construction, to meet the water demand for irrigation, increasing urbanization and economic development in the central industrial areas of South Africa.

The main tributary of the Orange River is the Vaal River, which flows through the major population and industrial core of the country later turning south to join the Orange River.

The high valleys of the Orange River headwaters are uninhabited by major populations and urbanization, however adjacent plateaus are used as rural grazing lands. Sections of the river further south are used for maize cultivation and grazing.

There are highly irrigated sections of the river used for agriculture and growth of cotton, lucerne, grapes and dates as well as the presence of a number of scattered farms within the reach of the rivers freshwater supply. There are no large towns situated along the riverbank, yet the river is still used for the provision of water to a number of large cities such as Johannesburg. (The Department of Water Affairs, South Africa n.d)

The unchanged natural state of the river has had an effect on the development of large irrigation and hydroelectric projects due to the high amounts of silt which clogs reservoirs and limits storage capacity.

The Orange River Project was developed as a result of the drastic increase in population and the associated development needs and demands. The porject aimed to utilize the water from the lower catchment of the Orange River for extensive irrigation schemes, generation of hydro-electric power and urban water supply, meeting the ever increasing demand for food and water.

The main aims of the project revolved around the use of the river system as a sustainable reource, making provision for new irrigation development along the river at various areas within reach of

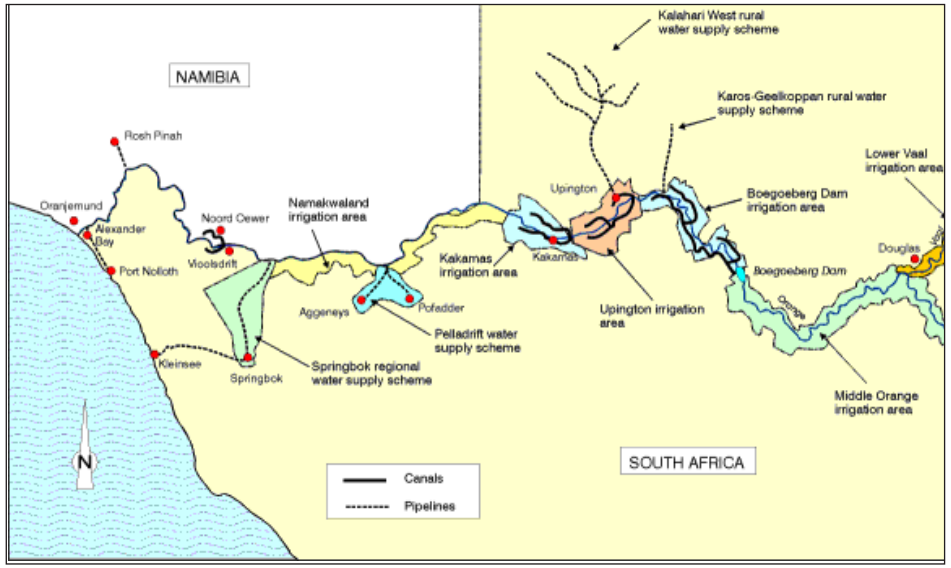

Image 1.1.1: Map of Orange River (The Department of water and sanitation, 2015)

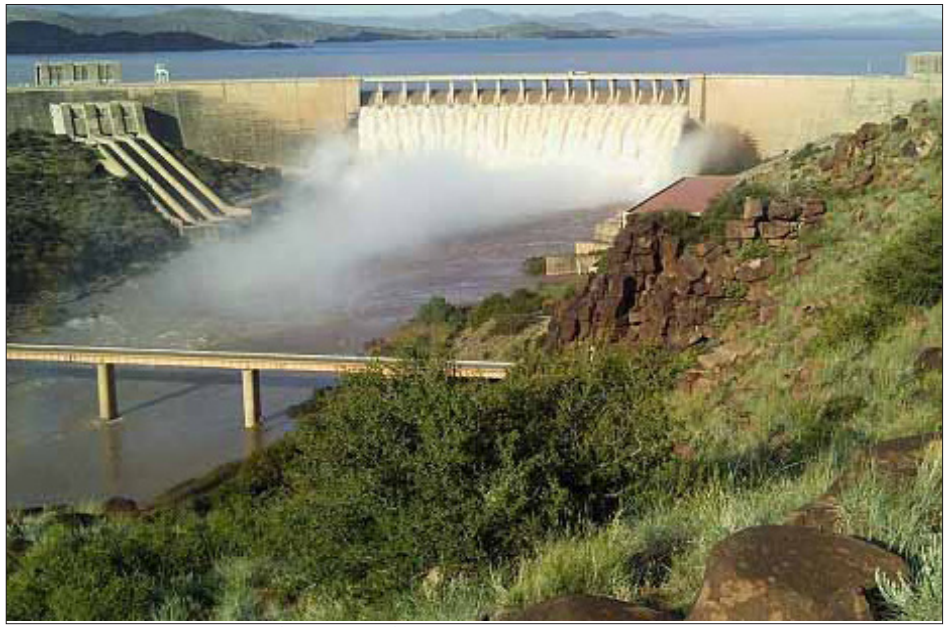

Photo 1.1.8: Gariep Dam Wall (Aliwal. 2011)

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Photo 1.1.9: Orange River Irrigation Scheme1.1.1 (J, Dippenaar, 2010)

the river, stabilizing the water supply to existing irrigation schemes, higher water quality to water deficient associated rivers, to supply water to various urban centers and the generation of hydro electricity.

The project would be responsible for a number of positive outcomes throughout South Africa such as:

1. Increase in agricultural production.
2. Making provision for a large number of irrigation farms.
3. Allowing for the production of meat and agricultural crops.
4. Promoting economic activity and development in the areas directly involved with the river.
5. Creation of stable farming communities, thereby counteracting the migration of the rural population to the cities.
6. Promotion of tourism and recreation.
7. Flood control and protection of riparian zones and irrigation streams.

Constant analysis and management of the Orange River is required in terms of the evaluation of efficient and sustainable use of the water resource, the quantity of water available for development and use, as well as the influences of further development on the hydrology and water quality of the river and surrounding environment.

The Gariep Dam is the main water storage dam in the Orange River system. This dam, along with the Vanderkloof Dam, support hydro electric schemes belonging to Eskom, and were responsible for the storage of water for irrigation schemes established in Buchuberg, Upington, Kakamas and Vioolsdrif.

The river is also available for rafting and canoeing in the summer months and holds great historical economic value in the South African diamond mining indudtry, with the first diamonds in the country being discovered in alluvial deposits on the Orange River.

In terms of water quality and the constant increase in urbanisation and population growth, it is impossible for the water resource to sustain the current pattern of consumption. Despite the looming water crisis, consumption by agriculture, industry, mining and household demand are increasing and placing further strain on the water supply through pollution and hydrological disturbances.

The main impacts of the urban environment on the river system are erosion, mining and mineral processing, industrial/agricultural/domestic effluent released into the river, poor and inappropriate waste disposal and indiscriminate dumping. ('Orange River' 2015)

The Orange River is responsible for the water provision along the length of South Africa, maintaining the economic sector and providing for the urban and rural environments. Therefore a drastic change in the impact of the urban environment on the river system is necessary to ensure sustainability and the increasing demand on the environment.

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PROBLEM IDENTIFICATION

The progressive decline in the urban river resources and freshwater ecosystems as a whole, has led to the focus on rehabilitation and preservation of natural resources.

With water systems surrounded by urban environments, there are certain social, ecological and economic implications which need to be taken into consideration when addressing urban river rehabilitation. The neglect, separation, degradation and pollution of urban rivers and their surrounding environments is not confined to a specific country, region, population or grouping, it is a problem faced on a global scale, common to all areas which are subject to urbanization.

Man is entirely reliant on the availability of usable fresh water, and the lack thereof will undeniably cause the unravelling of not only man, but all life on earth. The continuous irresponsible use of water systems is responsible for the gradual destruction of the resource as well as its ecological functioning.

Using urban rivers and streams as dumping sites and waste removal channels is the direct cause of the increased alienation and separation between urban dwellers and the now polluted natural resource. An alternative approach is required to the way in which water is treated, consumed and managed within the built environment, there is no possible future without the presence of water as a usable resource. (Davis and Jensen 2015) (RC: His & contemp)

HYPOTHESIS

Integration between the life of the city and its waterfront will aid in the promotion of human access to and interaction with the riverfront and water systems, through the use of conceptual, visual and physical connectivity between urban and natural environments. The interaction between user and system in a manner which will raise awareness in the complexity and importance of urban river ecosystems will increase interest in ecosystem integrity, ultimately providing clues for the appropriate use of those systems.

DESIGN STATEMENT

The investigation of polluted small scale urban river systems will establish how treatment and rehabilitation initiatives require a design response which will re-establish various levels of social, economic and ecological connectivity throughout the water system.

TECHNICAL QUESTION

How will the improvement of ecological functions within the river system be resolved while simultaneously increasing access and integration between the urban and ecological environment as well as minimizing the anthropogenic influence of the urban environment on the water resource?

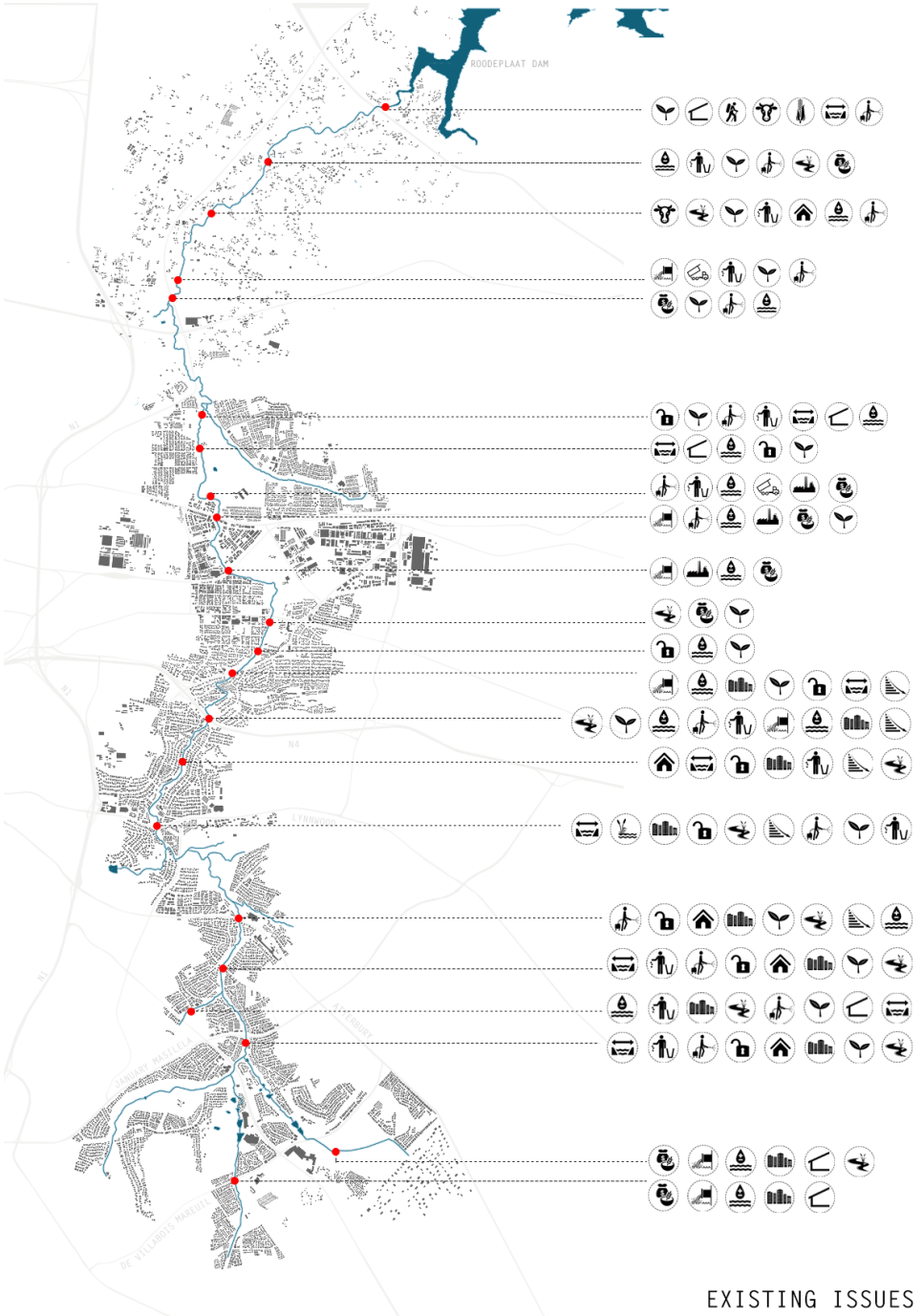

Figure 1.1.1: Mapping of issues encountered along the course of the Moreleta Spruit (Author, 2015)

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CHAPTER 2: APPROACH TO SMALL SCALE URBAN RIVER SYSTEMS

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INTRODUCTION

River Cities were established along the banks of major rivers which were, and are able to, provide for the development and sustainability of larger populations. However, cities such as Pretoria, which were established along the banks of smaller rivers, relied on the water resources in very much the same way as larger scale rivers, but in a more minimalistic manner. These smaller rivers were able to sustain the smaller initial settlement populace in terms of a water source for irrigation and domestic use. As the settlements developed and established into cities, the water sources were no longer of sufficient volume and alternative water sources were sought.

Through the loss of significance in terms of human survival, the urban rivers took on a more aesthetic role in the progressively urbanised environment.

The upkeep and maintenance of such river systems were not of as much importance as that of river systems which were responsible for the existence and sustainability of an entire city, resulting in the negligence and degradation of the natural corridor, compromising all ecological and aesthetic value still held by the small scale rivers.

Through the lack of activity and significance, the river systems are reduced to urban environment stormwater management outlets and a pollution channel removing waste from within the urban boundaries. Restricted access, lack of maintenance, little to no ecological, social and economic value and safety concerns have transformed these once pristine natural resources into scars running through the environment as a visual reminder of the dominance of the urban environment over the natural.

As the rate of urbanization and overpopulation puts strain on the limited resources at our disposal, the reality is that these resources will eventually run dry and it is the human race that will have caused their own demise. This reality triggered the movement in the direction of rehabilitation and restoration of city sustaining river systems, however it is no longer viable to only focus on selected river resources. Small scale urban rivers may not be responsible for the survival of greater populations however, managed and educated approaches to even a minimal amount of water could turn previously neglected corridors into self-sustaining resources with the potential to benefit millions.

The contemporary cultural and design approaches to urban river connectivity are almost diametrically opposed to the ecological and hydrological notions due to the fact that they promote human interaction with the riverfront, which is controlled and mediated by the built environment. This approach is solely focused on the interaction of man with the natural environment and it is this manner of interaction which is responsible for the disruption of the biophysical connectivity, not only along the river but between the river and the shore through the crossing of banks with bridges and roads. Rivers are channelled and shored up in order to prevent flooding as well as the incorporation of landscaping for recreational use, both interventions are responsible for the destruction of the natural environment, including the systems and processes on which the river relies.

From an ecological point of view, this is an extremely poor approach due to it being an artificially focused design which is responsible for the alteration of hydrology and ecology of the river in order to best suit the economic and aesthetic values of the city. (Otto, McCormick and Leccese 2004 cited in Hay 2006)

The approach to the small scale river systems will be focused first and foremost on planned rehabilitation and restoration of the urban river, the recovery of multiple lost or deteriorated ecosystem services, the improvement of water quality and ecological systems, and processes surrounding the natural river corridor.

The design importance lies within the manner in which these rehabilitation and restorative approaches to the river system are executed, intending to create a connection between the urban and natural environments. It is through exposure and understanding that people will recognise the importance, significance and value of the existing water systems.

Increasing accessibility and education of such resources will slowly but surely alter perceptions in the greater population for the preservation and protection of the dwindling resource. The apparent benefits of rehabilitation will aid in human well-being in ways such as, health, economic value, life quality and contribution to regional renewal.

The value that lies in the ecosystem services are in the handling of a wide variety of sustainability challenges such as the demands of land use planning, agriculture, carbon and microclimate management as well as the management of watersheds, biodiversity and tourism.

It is important not to lose the historical importance of water as a resource during the process of rehabilitation and restoration. The innovative design process will deal with the research, interpretation and creation of both alternative and contemporary ways in which the river is able to reclaim its value, through providing for the urban environment and population as a resource as well as its potential to shape the surrounding environment.

It is important to evaluate the urban open areas and green space systems regarding public benefit, such as protection from flood risk and flood plain management through specification of flooding area boundaries on river banks.

Meeting the increased demands for future population growth through the development of strategies which are responsible for the protection and preservation of landscape characteristics and alleviation in effects of rising populations and urbanisation pressure, will ensure the future presence of multifunctional river systems in the city landscape for future generations. (Cengiz, Smardon and Memluk 2011 cited in Cengiz 2013)

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The Establishment of Pretoia along the Apies River.

Photo 1.2.1: Church Square in the Early 1900's (Church Square, Pretoria, South Africa, 1905 WDL3016.png)

In terms of an urban river city, Pretoria would never be one of the first examples when competing with cities such as San Antonio, Boston or London, however, it was due to the presence a river system that the city of Pretoria was originally established.

The first inhabitants of Pretoria were settled in Church Square which is located approximately 4.8km from the Fountain springs which is the constant water source that Pretoria has been dependent on since the start of its existence and the only water source for Pretoria from 1855 until 1935.

The Fountains have yielded crystal clear, high quality water since their discovery, and continue to do so today. The Commandant-General of the Transvaal Republic, Marthinus Wessel Pretorius, considered the abundant water supply and natural contours of the area and declared the area ideal for the establishment of a new capital, his motivation for registration was that the area was well suited to build a city with large and unlimited available area and water.

The two springs were located in the Fountains Valley on the Groenkloof farm, in the same dolomitic area that provided water from seperate eastern and western fountain compartments and which were divided by the Fountains Dyke. The springs discharged their water supply into the Apies River that flowed continuously and strongly northwards.

The presence of the Apies river played a

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Photo 1.2.2: Apies River - Natural Environment. (L, van Vuuren, 2012)

Photo 1.2.3: Apies River - Urbanised (L, van Vuuren, 2012)

Photo 1.2.4: Apies River Original Reservoir (L, van Vuuren, 2012)

significant role in the choice of location for the establishment of the new city as an important trade and movement route to Delgoa Bay crossed the Apies River close by. The site had previously been a popular overnight stop for travellers and transportation wagons before the formal settlement of the town, due to its abundance in water and natural grazing areas for cattle. (Adams 2012)

The landscape drops approximately 50m in elevation between the fountain source and Church Square, providing a gravitational movement for water to Church Square. The water was directed into Church Square through the digging of a water furrow, which was the first municipal works of the new settlement.

The furrow was completed in 1855, followed by the construction of a holding dam at the springs. The construction was done hastily and required reconstruction a few years later, formalising both the dam and the channel. (450mm x 900mm).

Regulations were set in place protecting the water quality and maintaining equal distribution of water. No water was to be taken from the furrow before it entered the town and no pollution of the water was allowed through washing, dumping etc. As the settlement increased, so the maintenance needs on the water supply increased and a suprintendent was appointed and held responsible for water management.

The provision of water was the only service offered to the inhabitants, but due to the lack of stormwater management and the polluting of the water supply through waste water and sewerage dumping, private wells were dug on individual properties.

During the first British occupation in 1877, there was an increase in military and business opportunities, leading to an influx of the white population between 1877 and 1878. The sanitary conditions, which were already poor, were now no longer able to sustain the settlement and attempts were made to clean the furrows and water systems. Due to a lack of funding, conditions continued to deteriorate during the British military occupation.

The Transvaal Republic regained its inderpenedence in 1880 and resumed municipal management under the control of the magistrate and reporting to centraol government. There were continued complaints regarding the water supply and water furrows and attempts to improve the situation were minimal and relatively unsuccessful.

The discovery of gold in Johannesburg led to a sudden influx once again, which led to the mobilising of resources in the private sector through a concession policy. The concession for the supply of clean water for 50 years was awarded to Pretoria Water Works Company Limited in 1889. A new collection chamber was built in Fountains Valley, combining both water sources. From the collection chamber a steel pipeline was constructed to transport water and to feed the reticulation network. The town was occupied again in 1900 by British forces and the guiding principal was that only the minimum municipal improvements were to be made. Urgent alterations to the collection chambers were made and new steam pumps installed, supplying the military barracks with water. After peace was reached in 1902, a city council was appointed and held responsible for municipal development and improvements.

The steady increase in population and the expanding municipal area put strain on the water supply and distribution system. The springs were providing more water than required, but key components and infrastructure were lacking and the systems needed to be expanded once again, resulting in new storage reservoirs being built. The town exploited the constant water supply and at one stage, Pretoria was self proclaimed to be the most well watered town in the world. Water was running down each and every principal street and was used to irrigate the town, but the water demand was unrealistically high and needed to be significantly reduced.

In 1922 there was almost no restriction on domestic consumption and although the springs were coping with the water demand, the overexplotation of the resource would eventually result in the failure to meet the growing demand.

Water metering was introduced to manage the demand but the reduction in demand was minimal and as a result, the development of an additional water source to supply Pretoria was inevitable and urgent. The scheme implemented was the use of the Rietvlei dam and was commissioned in 1934. (Haarhoff, Juuti and Maki 2012)

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CHAPTER 3: SITE SELECTION - THE MORELETA SPRUIT

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INTRODUCTION

The establishment of the city of Pretoria originated just south of the Magaliesberg Mountain range along the banks of the Apies River in Church Square.

The Magaliesberg, which originated in the west, offered three main points of access to Pretoria through geological faults in the mountain range. The first being Hartebeespoort, the second Wonderboompoort, located directly above Church Square and through which the Apies River drains into the Bon Accord Dam, and lastly Derdepoort, which is the geological fault through which the Moreleta Spruit drains into the Roodeplaat Dam.

The presence of the Moreleta Spruit, east of the Apies, allowed for further development east of the original point of establishment of Pretoria. It was through Derdepoort that traders would gain access to the Soutpansberg trading route, as the Wonderboompoort was often flooded by the Apies River. (Swanepoel and Jensen cited in Taljaard 2013)

The development of the city of Pretoria towards the east was a process of merging the original established areas around Church Square along the Apies River and the farming and industrial development which took place at Silverton along the Moreleta Spruit. Through the understanding of the historical value surrounding the Moreleta Spruit, certain areas will have higher connection to the river from a social aspect, which will aid in the nature of design intervention taking place at various points.

The Moreleta Spruit was chosen as the river system of focus rather than the Apies River, as multiple interventions and strategies have been proposed for the Apies River due its high significance and importance concerning the history of the establishment of Pretoria.

The establishment of Pretoria may have initially been influenced by the Apies River as a water source, however the expansion and growth of the city was made possible by the presence of other smaller river systems such as the Moreleta Spruit. Each system held its own significance and value in terms of provision as a resource and establishment potential.

In terms of the overall project and intention of this thesis, the main aim is the discovery and unveiling of the potential of any river source, including small scale neglected rivers, as a resource and natural system of importance within the urban environment.

The Moreleta Spruit is exposed to a number of environments to which it can interact and benefit through appropriate design and ecological interventions, ultimately reintroducing the river system to its current environment as a resource and system of significance and importance.

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LOCATION:

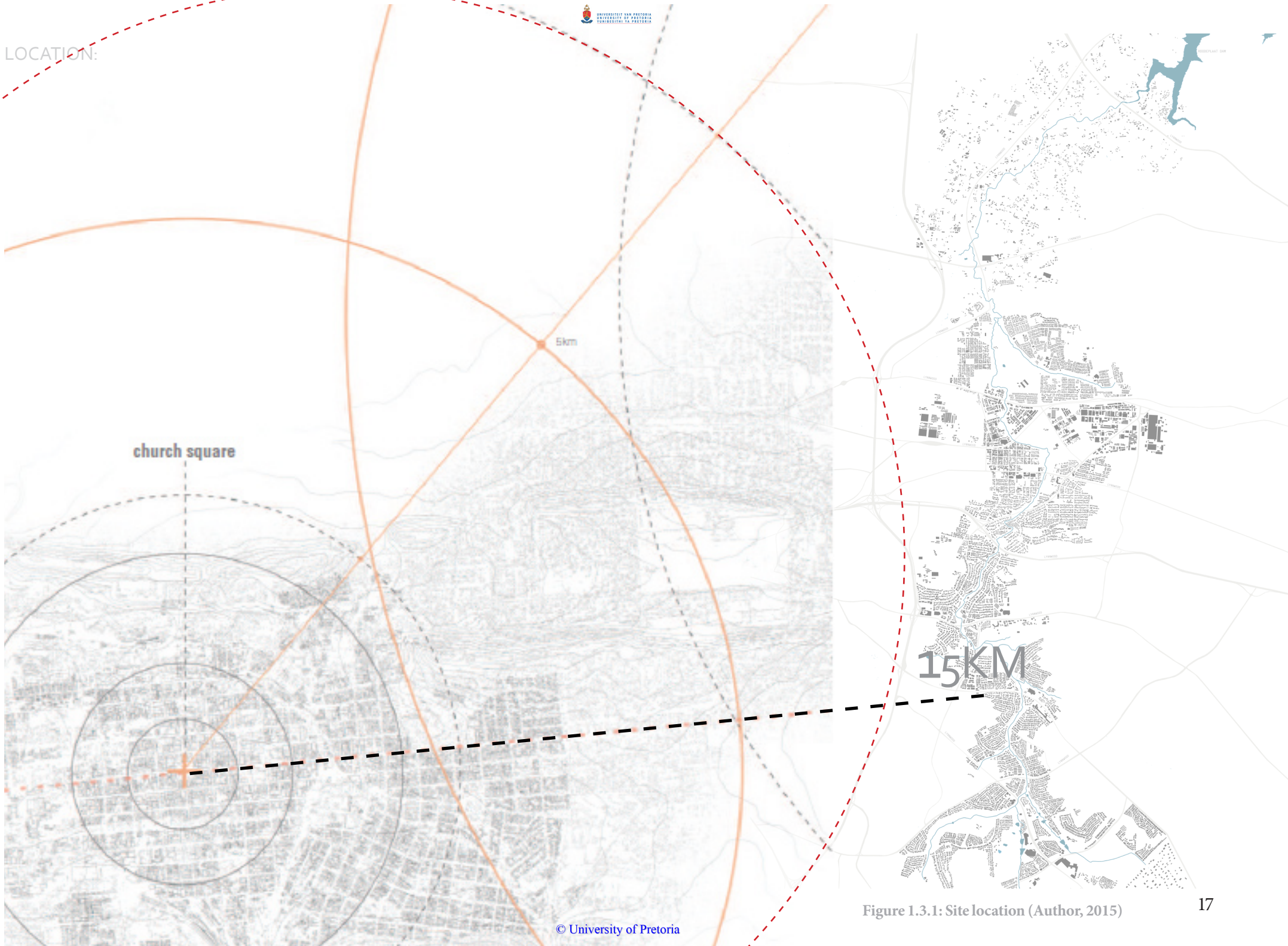

Figure 1.3.1: Site location (Author, 2015)

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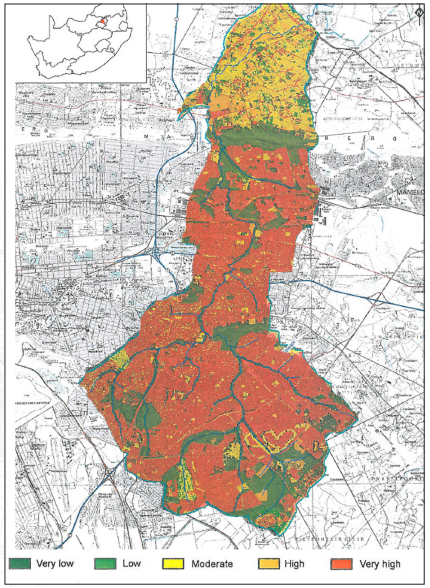
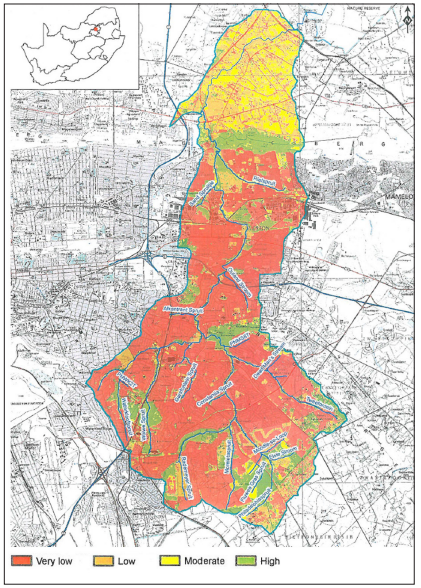
Figure 1.3.3: Moreleta Spruit Catchment Area (Author, 2015)

POLLUTION RISK



REHABILITATION POTENTIAL



RUNOFF RISK

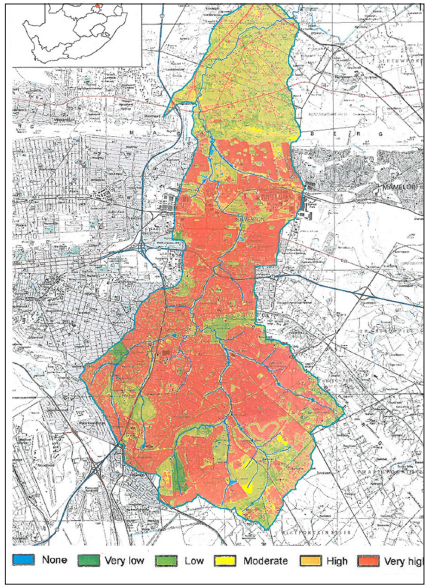


Figure 1.3.2: Catchment area analysis (The Department of Water Affairs, 2012)

The Moreleta Spruit, located within quaternary catchment A23A which forms part of the Limpopo Primary Catchment in Gauteng Province, flows from the south to the north and drains into the Roodeplaat Dam.

The Spruit and the catchment are found in the Tshwane municipal area where the catchment is mainly made up of dense urban settlement in the south and semi-urban settlement in the north. The catchment covers 68 238ha of which the Moreleta Spruit catchment makes up 19%.

There is still a rehabilitation potential within the catchment, but the human activities within the catchment will increase or decrease this potential. (The Department of Water Affairs 2012)

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AREAS OF HISTORICAL SIGNIFICANCE

Derdepoort

Previous human activity is evident through visual signs of ploughing that took place when Derdepoort was still farmland, which demonstrated a high degree of technical and creative development at a particular period. Early Iron Age ceramics were discovered along the edge of the river which held potential information contributing to the understanding of both cultural and natural heritage. An existing historical canal was found in the area which previously extended to meet the Moreleta Spruit for the transportation of water to the farm, evidence that the river was used for the establishment and existence of settlements along its banks. (The Department of Water Affairs 2012. p. 6-7)

Eersterust

Eersterust was the first formal coloured township and in 1905 the existing farm was subdivided in order to create plots for the township development. It was considered to be the gateway to the industrial areas as many of the industrial workers were of the coloured racial group which led to the development in such close proximity to the industrial area of Silverton. In the 1930's the living conditions were very poor and it was only in 1962 that the first housing schemes were completed.

The name Eersterust was the result of one of three possible reasons, firstly was that the idealistic farm owner who was responsible for the development of the township named it such as it was the creation of the first resting place of the descendants of slaves. Secondly, it was the first resting stop outside of Pretoria for the postmen and traders. Thirdly, it was a place of rest for the republican forces that came with the British war. (The Department of Water Affairs 2012. p. 6-7)

Silverton

In 1845 David Botha was the first to settle in the area on Koedoespoort farm, by 1874 the Gold Rush was at its peak and the farm was bought by Hans Mundt, who developed a half way station for travellers.

Silver was discovered on the farm in later years which was responsible for the naming of the settlement. The rush was short lived, as the amount of silver was insufficient to sustain a large settlement, however a small settlement had established itself and became known for its trade and industry. The settlements development as an industrial hub was possible due to land being relatively cheap, available labour forces and close proximity to existing trade routes and water resources. (The Department of Water Affairs 2012. p. 6-7)

Faerie Glen Nature Reserve

In 1800 the Ndebele had settled in the area, remains of walls and huts are still present on the Bronberg slopes. The Hartebeespoort 304 and 305 farmlands were a permanent white settlement by 1862, and the owner of the farm was Hendrik Willem Struben who named his homestead The Willows. The floodplains were used for agricultural crops and grazing of cattle.

The development of what is known today as Lynwood road was originally

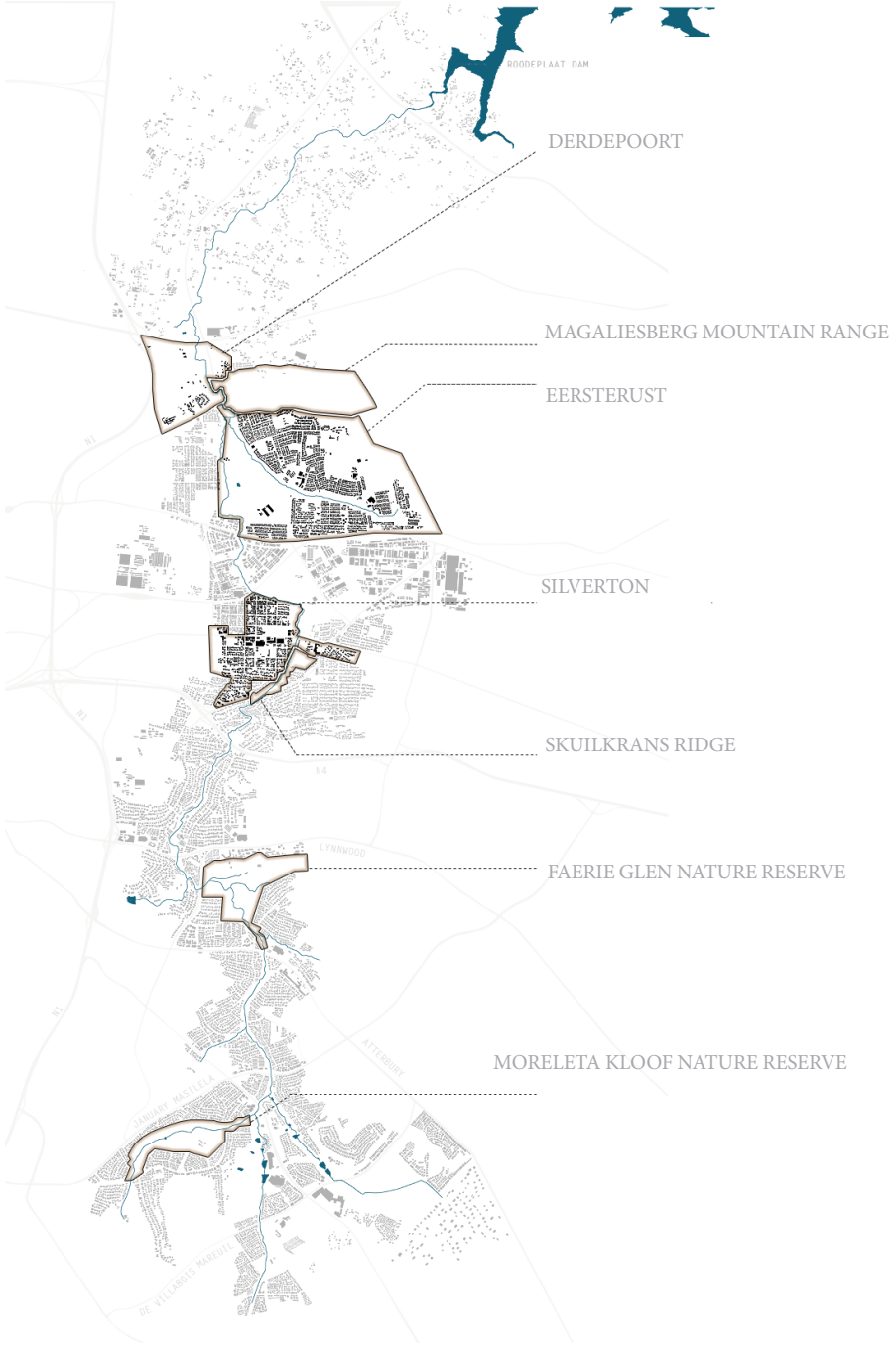

Figure 1.3.4: Moreleta Spruit Historical Significance (Author, 2015)

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constructed as the sole road leading to the Struben farm. In 1965 a bridge was built over the Moreleta Spruit along Struben road which had to be increased in 1988 in order to cope with the increased volume of water runoff as development increased. (The Department of Water Affairs 2012. p. 6-7)

Moreleta Kloof Nature Reserve

Historically, the Moreleta Kloof Nature Reserve was a part of the initial farm belonging to the Rademeyer family who were known for cattle farming.

After the death of the owner, the farm was subdivided and the original farmhouse, constructed in 1903, is currently being used as a restaurant within the nature reserve. When the farm and buildings were transferred to the Pretoria council from the estate of the last owner, it was handed over on the condition that the Kloof will always be kept as a green zone and that no residential developments are permitted on the Kloof.

The Moreleta Spruit acts as an ecological and spatial link between significant ecological systems. Understanding the green corridor and places of ecological significance, informs the nature and character of the river in terms of ecological value, which in turn informs the design interventions for the rehabilitation and restoration of the natural environment and the preservation of existing and limited green space. It further serves as a migration corridor for indigenous fauna and flora which has importance in rehabilitation of natural systems, processes and biodiversity.

The exposure of users to the natural environment will contribute to the relationship between man and nature and through the design interventions the intention would be to increase recognition, importance and preservation of green spaces, addressing their significant decrease for the purpose of development and urbanisation.

The river system increases aesthetic value of the surrounding environments and the green space offers an opportunity for hiking trails, cycling routes, bird watching, photography and other activities which will instil a connection between user and the environment. (The Department of Water Affairs 2012. p. 6-7)

Photo 1.3.1: Moreleta Spruit Natural Environment (Author, 2015)

Photo 1.3.2:Faerie Glen Nature Reserve (Author, 2015)

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AREAS OF ECOLOGICAL SIGNIFICANCE

Areas of Ecological Significance associated with the river system are: Magaliesberg Mountain Range Skuilkrans Ridge, Meyerspark Bird Sanctuary, Faerie Glen Nature Reserve, Struben Dam and the Moreleta Kloof Nature Reserve. The ecological condition of the Moreleta Spruit fluctuates between protected areas and the areas of the stream which are exposed to the natural environment.

As the Spruit flows through the residential areas towards the industrial area in the north, the poorer the quality of not only the water but the associated habitats and ecological functioning of the system, become. The design intervention will be required to rehabilitate and restore the damaged systems and processes as well as improving the water quality, which as a result will increase the levels of fauna and flora diversity and the aquatic ecology.

Magaliesberg Protected Natural Environment

Includes the eastern edge of the mountain range directly north of Eersterust and Mamelodi and their specific vegetation types.

Faerie Glen Nature Reserve

The 124 hectares are considered the jewel of the Moreleta system (Kantor 2010 cited in The Department of Water Affairs 2012) as the single largest area of minimally disturbed natural habitat. There is an abundance in vegetation and animal diversity found in the reserve, as well as the inclusion of the sensitive Bronberg ridge vegetation, extending along the mountain range towards the east, 10% of the ridge consists of mountain wetland.

Struben Dam Bird Sanctuary

Forms part of the flood control system of the Waterkloof Spruit, a tributary to the Moreleta Spruit system, with an abundance in bird and aquatic life and known for its Brakenveld vegetation type.

The CSIR Grounds

The close proximity of the CSIR grounds contributes to a runoff of higher quality water into that section of the Moreleta Spruit

Moreleta Kloof Nature Reserve

100 Hectares of natural habitat includes various hiking trails and human interaction with the natural environment, the high level of animal and bird life is an attraction for urban dwellers. (Kantor 2010 cited in The Department of Water Affairs 2012. p10)

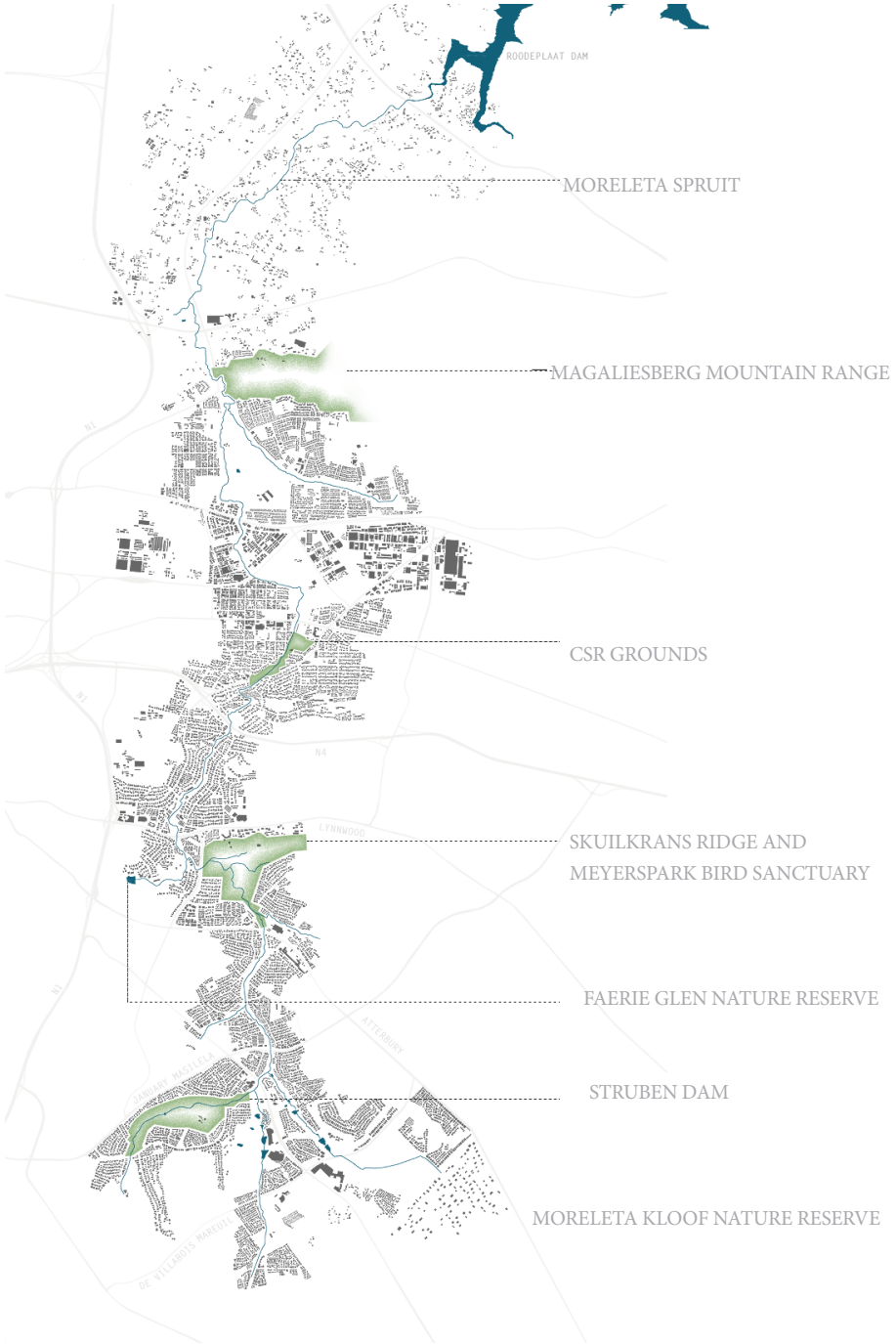

Figure 1.3.5: Areas of Ecological Significance (Author, 2015)

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VEGETATION ANALYSIS

Alien Invasive Vegetation

Although there are significant problems concerning the Moreleta Spruit environment, minimal invasive species are evident around the sources of the Spruit, but as urbanisation increases and the Spruit is exposed to degradation and habitat destruction the number of invasive species is on the increase.

The main vegetation type surrounding the river origins is grassland and the original tree species found were the Acacia Karroo and Combretum Erythrophyllum. Further downstream the invasive species include the Acacia Mearnsi, Eucalyptus, Solanum Mauritianum, Populus x Canescens, Privet species, Lantana and Willows. (The Department of Water Affairs 2012. p. 7)

Regional Habitats

The change in biomes taking place along the course of the river system is reflected in the distribution of trees from grassland in the south progressing towards savannah in the north. The change in geology, climate and topography along the river system are responsible for the change in vegetation distribution. The high lying areas in the south drain the Spruit to the low lying areas in the north. (The Department of Water Affairs 2012. p. 7)

Plants with Medicinal Value

In the Faerie Glen Nature Reserve both the Lippia Javanica as well and the Lippia Rehmanni are found. The Lippia Javanice grows in the open veld, in bush and forest margins, it is very aromatic and is well known in the African tribes for its medicinal value. (The Department of Water Affairs 2012. p. 8) (Maharaj 1995 cited in The Department of Water Affairs 2012) (Linde et al 1995 cited in The Department of Water Affairs 2012)

FAUNA ANALYSIS

There is a diversity of smaller mammals found along the course of the river system. Documented are hares, mongoose, dassie, common duiker, otter, bush baby, greater cane rat, hedgehog, porcupine, spotted genet and the larger mammals which have been introduced into the reserve areas. (The Department of Water Affairs 2012. p. 10) An extended avifauna report has been attached as an indication of the various bird species to be found along the Moreleta Spruit.

AQUATIC ANALYSIS

The aquatic ecological data was obtained from The Department of Water Affair's Resource Quality Services, the National Rivers Database and the River Health Programme.
Several fish species have been recorded in the Moreleta Spruit, Ghieliemientjies, Bass (near Roodeplaat dam), Barbus Paludinosus (Straight Fin Barb), Barbus Anoplus (Chubbyhead Barb), Tilapia Sparmanii (Vleikurper), Sarotherodon Mossambicus (Bloukurper) and the Pseudocrenilabrus Philander (Southern Mouthbrooder)

GEOLOGICAL STATUS

The Moreleta Spruit is a perennial stream with a high number of tributaries feeding it. The source of the water is the Malmani Dolomite which is found in the southern region of Pretoria. (The Department of Water Affairs 2012. p. 10)

Photo 1.3.3/4/5: Moreleta Spruit Natural Environment - Skuilkrans ridge and Magaliesberg Mountains (Author, 2015)

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The land use zoning within the developed environment will play an important role in determining the appropriate nature of intervention to take place within various zones. Through the evaluation of the characteristics, needs, requirements and issues within each, specific outcomes can be constructed for ways in which to address and resolve apparent issues, while ultimately rehabilitating and restoring the urban river and its environment. (The Department of Water Affairs 2012. p. 14-17)

Rural Residential

Small Holdings

The rural residential areas alternate between smallholdings and informal settlements. In areas dominated by smallholdings there is a low percentage of paved areas which means there is a low runoff and pollution risk due to high rates of infiltration as well as very high rehabilitation potential. Pollution in these areas is mainly due to agricultural activities and the accumulation of fertilizers and pesticides in runoff. There are large areas of open space surrounding the river system and private properties have direct and unrestricted interaction with the river, no fencing. The establishment of informal settlements along the banks of the river have a more negative impact than that of smallholdings, there is a high pollution risk due to the lack of sanitation and waste management services. The river, which is directly accessible, is used as a primary source for washing clothes and personal hygiene. The infringement on the flood lines and floodplains is a dangerous risk for individuals in cases of flash floods. (The Department of Water Affairs 2012. p.17-19)

Low Income Residential

Eersterust, Derdepoort, Mamelodi East, Jan Niemand Park

These areas have a moderate to high runoff and pollution risk as a result of the high percentage of paved areas and are mainly areas of mixed land use. With no restriction on access to the river system due to the lack of fencing and other forms of barriers, there are specific litter problems which are compounded by the challenges in waste collection management and services. There is a fair amount of open space surrounding the Spruit, resulting in minimal floodplain infringement which means there is a high rehabilitation potential in these areas. (The Department of Water Affairs 2012. p. 17-19)

High Income Residential

These areas make up the majority of the surrounding environment along the river system and is an area with high settlement density. The change in landscape was a direct result of the human development and activities in the area. Previously existing grasslands and seepage wetlands were replaced by impervious infrastructure with more than 60% of the landscape being transformed into built environment. The density increases towards the south, closer to the origin of the river, comprising mainly of residential areas interspersed with small pockets of commercial and industrial developments.

The majority of the Spruit has been fenced off to the public, with security controlled access. Due to the lack of management and maintenance the river system has become an unsafe place with a number of incidents of violence and theft being reported.

The high percentage of paved areas has resulted in a high runoff and pollution risk, with a fundamentally negative impact on the river ecosystems such as wetland functioning as well as sedimentation and erosion. There is limited open space surrounding the river, resulting in a low rehabilitation potential. The benefit of interventions in these areas would be the complete transformation and integration of the residential environments with the river fronts, drawing people to the river rather than barricading them from it. The increase in interest and understanding as well as the provision of activities and community based open areas will encourage the preservation and protection of green areas by the user. (The Department of Water Affairs 2012. p. 17-19)

Industrial

Silverton, Silvertondale, Waltloo, Koedoespoort

There are no wastewater treatment facilities within the catchment area or along the course of the Spruit. With the large number of industries evident on and around the river system, there is a significant negative impacts on the river system and it functioning due to the uncontrolled releases directly into the river system, which has now become a waste water stream through this area.
There is a high percentage of paved areas and a high runoff and pollution risk. The significant decrease in the water quality as it exits the industrial area flows directly into the agricultural and most natural surrounding environment.

There is no restricted access in the area and little to no interaction with the river system. (The Department of Water Affairs 2012. p. 17-19)

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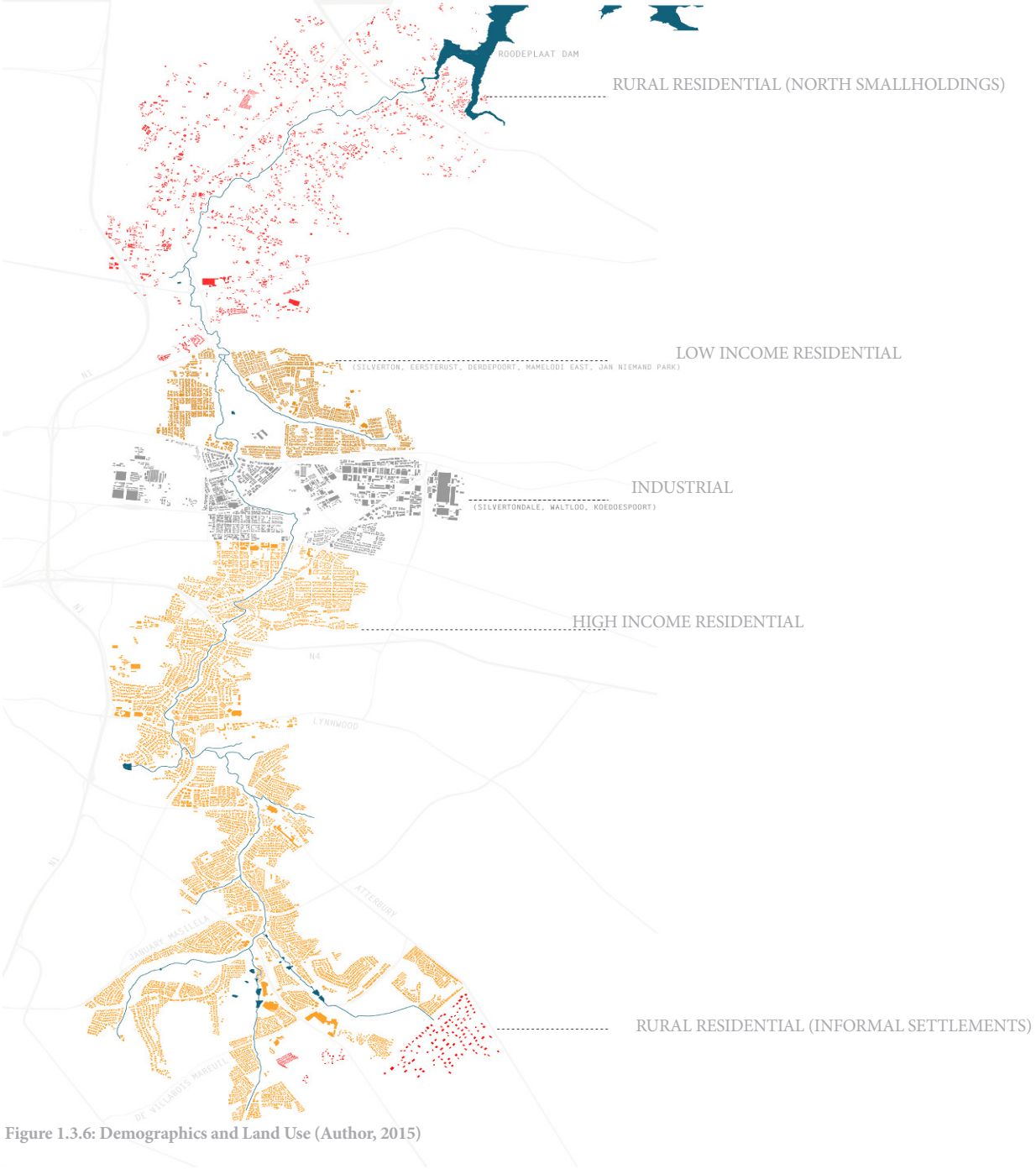

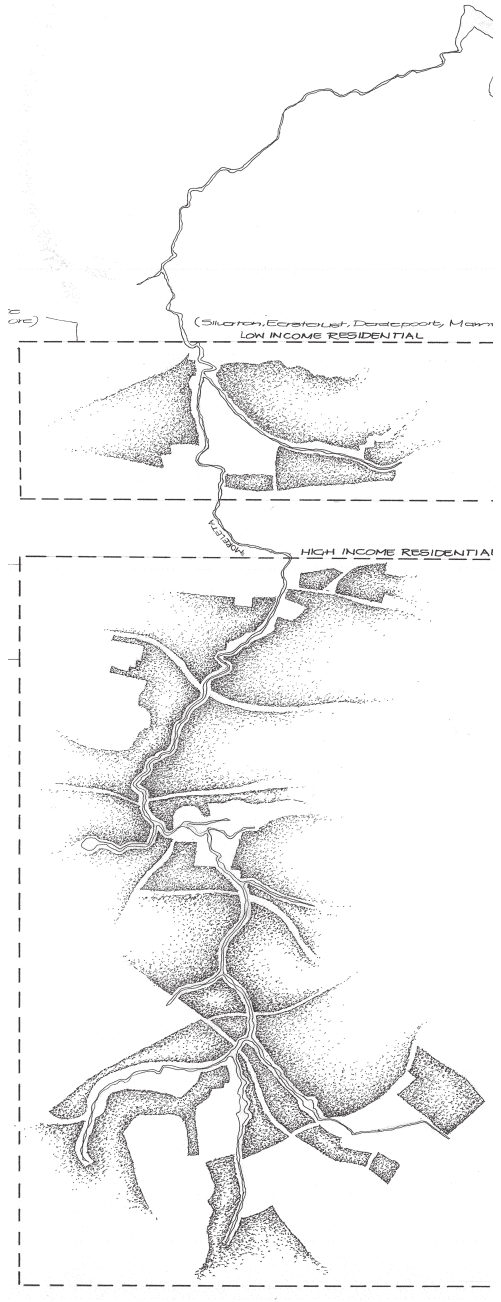

Figure 1.3.6: Demographics and Land Use (Author, 2015)

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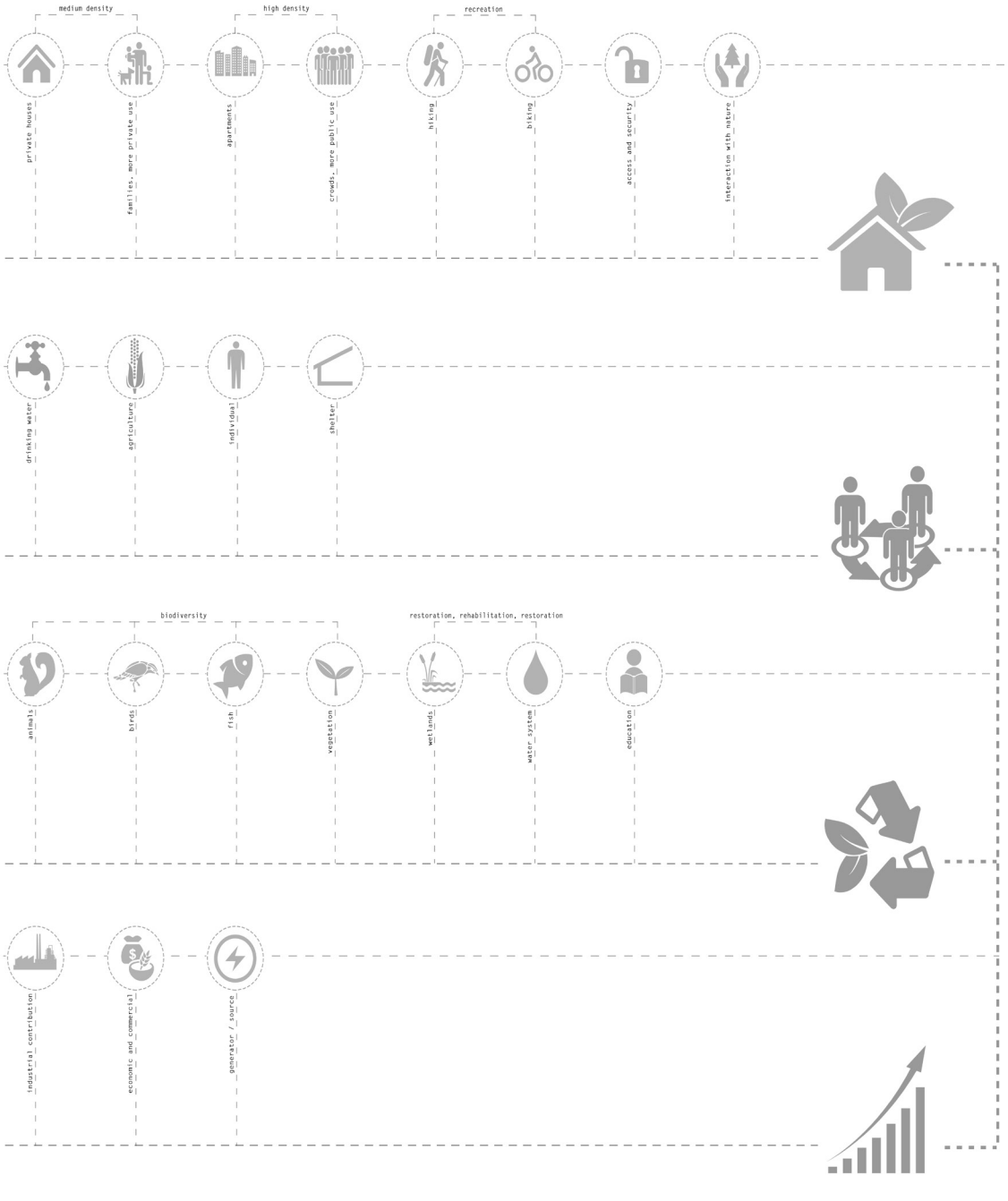
VISION AND INTENSION FOR VARIOUS DEMOGRAPHIC AREAS OF RIVER SYSTEM

HIGH INCOME RESIDENTIAL - VARYING DENSITIES - VARIOUS INTERACTION

LOW INCOME RESIDENTIAL - INFORMAL - DESIGNING FOR THE INDIVIDUAL

NATURAL ENVIRONMENT

INDUSTRIAL ENVIRONMENT



INDIVIDUAL POINTS OF INTERVENTION - RESPONSE OF RIVER TO THE SURROUNDING CONTEXT - VARIOUS CONTEXTS = CHANGE IN IMPORTANCE, FUNCTION, INFLUENCE, PURPOSE OF RIVER AND NATURAL ENVIRONMENT - DEVELOPMENT OF SELF SUFFICIENT ENVIRONMENTS FEEDING OFF THE NATURAL ENVIRONMENT - MUTUALISTIC RELATIONSHIP.

Figure 1.3.7: Demographic Vision and Intention (Author, 2015)

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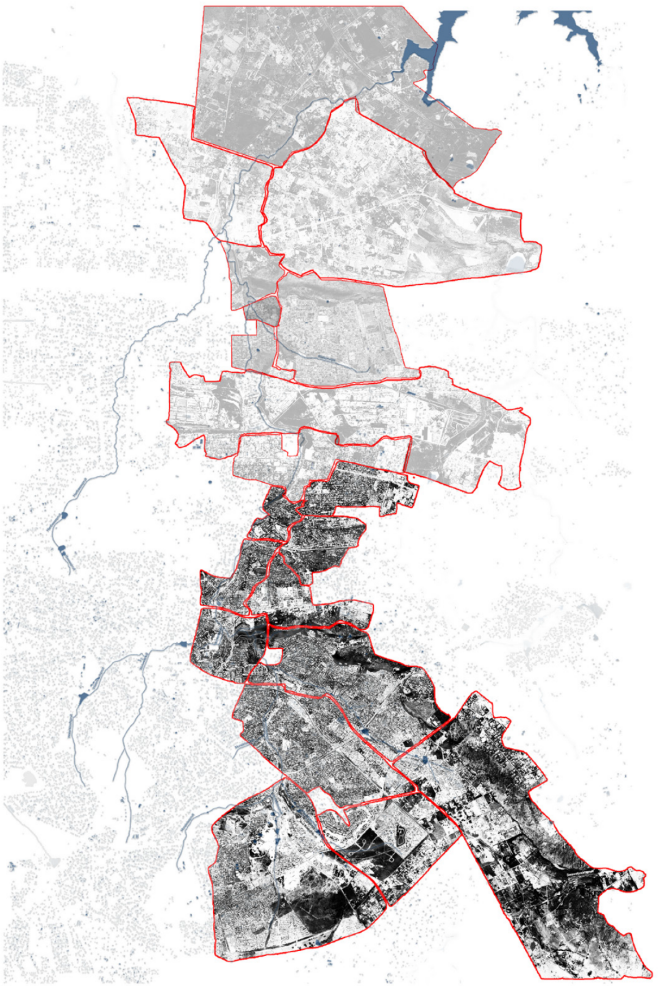

Limited Access

Increased access and designed riverfronts with public space will strengthen connection between urban and natural environment.

Cycling

Hiking

Recreation and Experience

Increase in safety and maintenance will allow for the bike and hiking trails to reopen. Encouragement of exercise through use of the natural environment.

High density housing, apartments

Larger population, public use

High Density

Larger urban parks and riverfront parks making use of urban open space for larger communities and higher densities.

Interaction with nature

Various activities which allow for the interaction with the natural environment, bird watching, photography, immersion in nature.

Families, more private use

Private houses

Medium Density

Smaller scale interventions for use by individuals and smaller communities with private access to river system.

HIGH INCOME RESIDENTIAL

Overall Intention:
The creation of space which allows for the integration of residential environments with the natural, taking safety and accessibility into consideration. Each space responding to the various demands and requirements of the different contexts of high and medium developments or neighborhoods.

Figure 1.3.8: High Income Residential Intention (Author, 2015)

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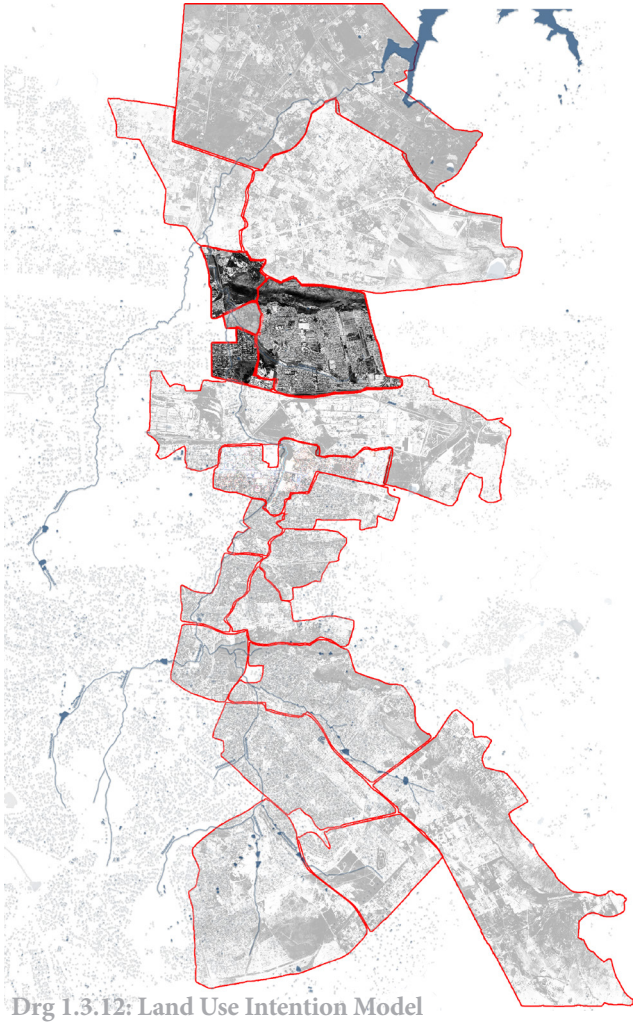

Drg 1.3.12: Land Use Intention Model

LOW INCOME RESIDENTIAL

Overall Intention

Designing for the low income informal settlements which establish themselves along the course of the river system, a place of enablement and provision where individuals are able to sustain themselves, relying almost solely on the natural environment for basic human needs. Development of micro self sufficient systems integrating the individual into the natural processes and systems.

Figure 1.3.9: Low Income Residential Intention (Author, 2015)

Informal housing

Concerned with informal settlement establishment on river banks. Provision of water purification, waste removal and sanitation for settlements to limit direct pollution of river.

Individual

On an individual scale. Providing individuals with basic human needs of water, focusing on water delivery systems to informal sector.

Agriculture

Purification and restriction of agricultural runoff into river system. Possible in river purification systems to prevent further downstream water pollution.

Use of water systems

Use of natural systems as a resource for lower income areas, involves purification, distribution and access. Strengthens connection between man and natural environment.

PROCESS & SOLUTIONS

DESIRED OUTCOME & INTENTION

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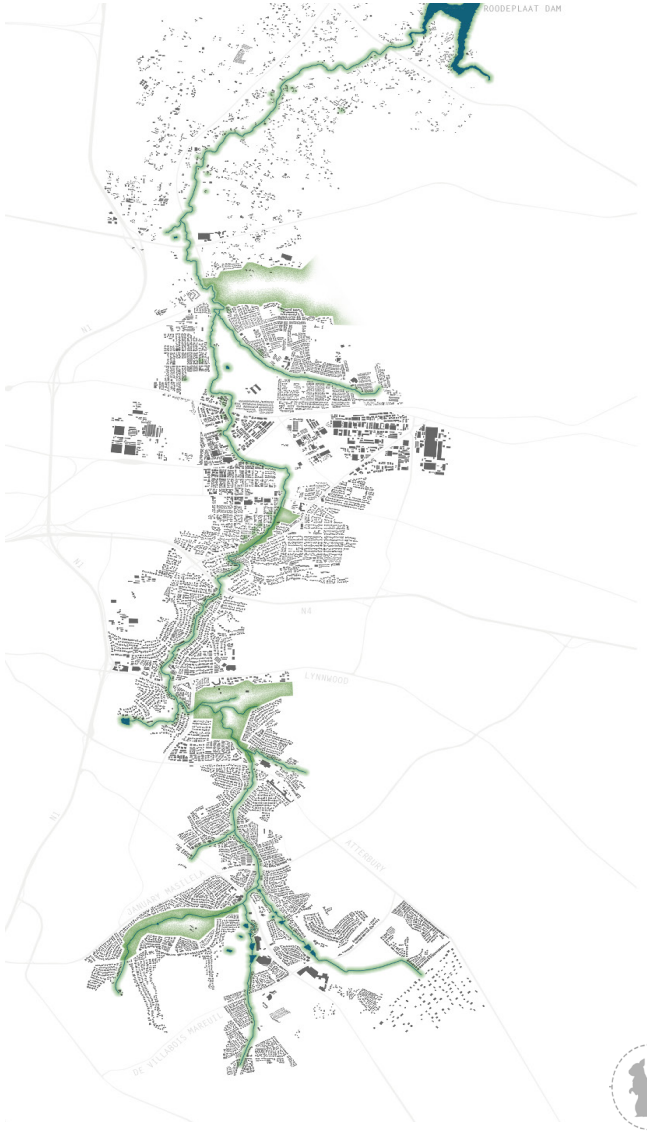
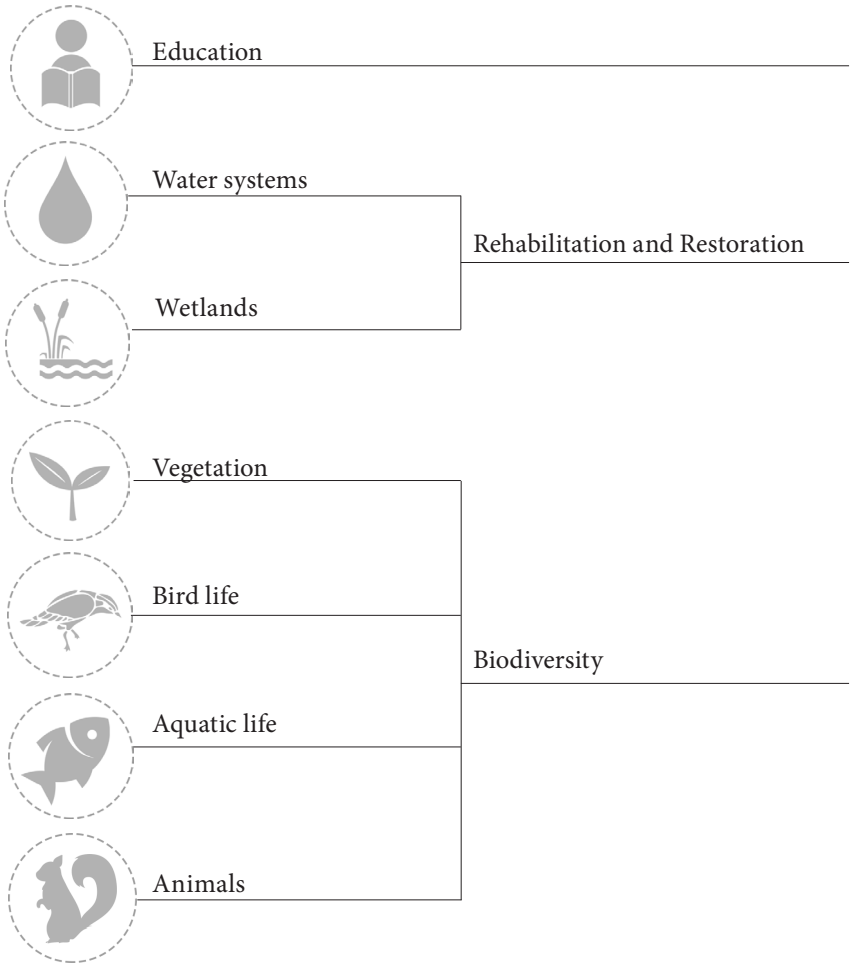


NATURAL ENVIRONMENT

Overall Intention

The rehabilitation, restoration and purification of the natural environment and systems. creating space within these ecologically significant areas for educational purposes and interaction while preserving the ecological value.

Figure 1.3.10: Natural Environment Intention. (Author, 2015)



Incorporated strategies for the education and building of awareness in people regarding the complexities of urban rivers for the understanding and promotion of sustainable use.

Rehabilitation and purification of ecological environment will benefit the economic and social environments surrounding the river system.

The rehabilitation of habitats and ecologies will provide for the re-establishment of aquatic and terrestrial biodiversity within the natural environment.

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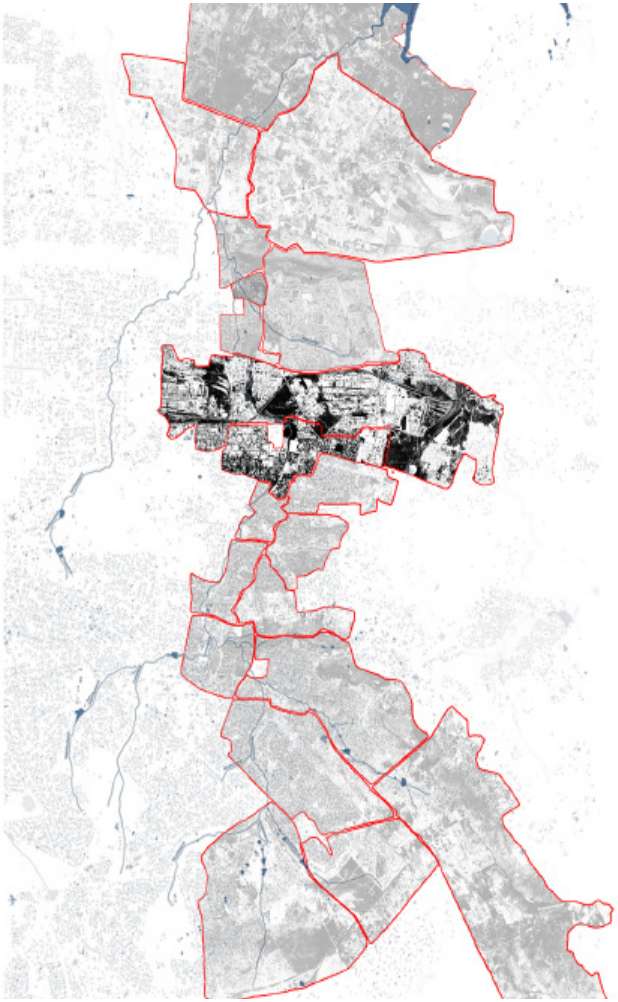

Economic and commercial use of natural system

Use of natural resource by economic sector will support preservation and ecological value of system.

Integration between industrial and natural environment

The production methods of industry which are more integrated into the natural environment and of standard which will not affect systems negatively.

Generator or resource for surrounding environment

The use of natural systems as a generator for urban environments will increase value and significance of system within environment, contributing to the preservation and support of the system.

INDUSTRIAL ENVIRONMENT

Overall Intention

Allowing the natural environment (systems and processes) to contribute to the economic and commercial sector of the built environment, the ability of the water system to become a generator and source for the developed areas and specific contexts within, adding value to the natural environment, going beyond the ecological significance.

Figure 1.3.11: Industrial Environment Intention. (Author, 2015)

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Photo 1.3.6/7/8: Moreleta Spruit Human Impact and Pollution. (Author, 2015)

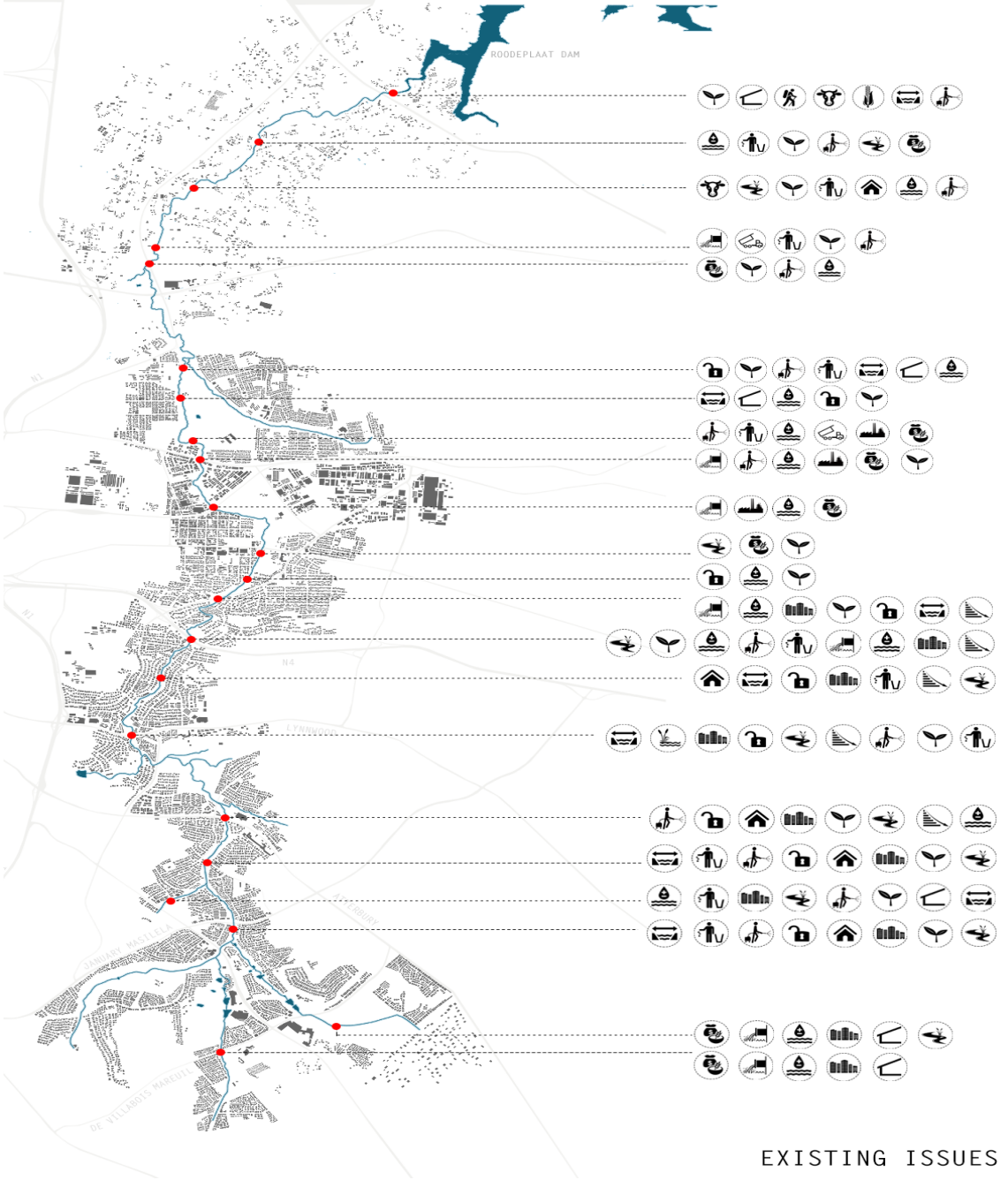

Figure 1.3.12: Mapping of issues along course of Moreleta Spruit (Author, 2015)

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EXISTING PROBLEMS ON SITE

Agriculture - concentration of animal pollution, runoff risk into river.

Economic and commercial growth and developing, infringing and influencing water system.

Informal settlements, lack of services and sanitation.

High pollution risk, low water quality.

Previously existing recreational activities, potentially dangerous due to crime.

Lack of maintenance of river systems in terms of vegetation and waste management.

Littering due to lack of waste collection services.

Limited and restricted access to natural environment. Crime prevention and natural environment protection.

Crop cultivation - runoff of low quality due to fertilizers and pesticides.

Dumping of sewage into river system.

High percentage of paved areas. High percentage of runoff and pollution transportation.

Alien invasive vegetation.

High density. Urbanisation. Expansion of the built environment.

Release of industrial waste and effluent into water system.

Private property access to river system, individual influences on system.

Unlawful dumping on riverbank and in river system.

River bank erosion. Addition of sediment into river system.

Destruction of wetland systems and threatened ecologies.

Limited open space and low rehabilitation potential.

Figure 1.3.13: Moreleta Spruit Environmental Issues Key (Author, 2015)

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As one of the most importat natural and cultural assets of Southeast Michigan this river system holds the basic elements of a vibrant urban place: nature, culture, people and economic activity.

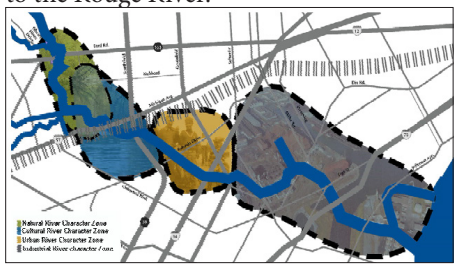
Through pollution, channelization and industry, the river and its surrounding environment are in a severe state of decline. The overall effect was the severed connection between man and the natural environment as a means to preserve and protect the reaource. As one of the most polluted rivers in the state, a masterplan was developed that will allow people, ecology and economy to coexist equitably in the landscape developing from the current condition of all elements being compartamentalized and seperated, reflective of traditional zoning patterns.

There is limited and uncomfortable public access to the river, hidden from the urban environment.

The intention of the master plan is to create connections where barriers currently exist. The concrete channels and poor water quality has reduced the ecological capability of the river to be able to support wildlife. The master plans serves as more than a greenway concept, it identifies sites of cultural and environmental importance, focuses on riverbank restoration, incorporates good planning principles with recreation, environmental stewardship and economic development and buffering residential areas from heavy industrial areas. Movement and accessibility is focused on the non-motorized pedestrian traffic through the site, including the river as a means of transportation through the inclusion of river taxis. Improved accessibility and convenience improves the connection between the urban dwellers and natural environment.

The improvement of the river increases wildlife habitat potential as well as acting as a catalyst for future development thereby improving quality of life in the existing environment, designed as a focal point and threat throughout the city which links cultural resources into a series of related experiences.

The comprehensive program proposes to merge strategies for ecological restoration, economic development, recreation and tourism by embracing the historical significance of the river and its capacity for renewal. The ultimate goal is to reinstate the river as an important resource that will enhace the ecology and quality of life in communities connected to the Rouge River.



Master Plan Development

The improved water quality and associated enhancement of the surrounding environment will expose the historical value of the river system, offering opportunities for recreation, social integration and economic development. Targeting industrial sectors to clean up effluent to a quality which is acceptable to be released into the river system. To establish continuity between the existing developments along the river system and the new opportunities four zones were identified along the river corridor:

1. Natural River Zone
2. Cultural River Zone
3. Urban River Zone
4. Industrial River Zone

Natural River Zone

Main activities in this section of the river are conservation and habitat enhancement. Opportunities have been identified in the immersion of visitors in the natural environment, using research and education as a means of interaction of people with the natural environment.

Cultural River Zone

Sensitive planning of cultural sites has created an underlying natural character which evolved from the overlapping natural zone into the cultural sites. Presence of museums add an alternative dimension to the regions past which can be experienced by the user.

Urban River Zone

Concentration of urban environment, people at work, reidential environments and recreational areas. Population growth is inevitable, the river has potential in this zone to transform from current use as a stormwater management channel to

Figure 1.3.14: Rouge River Rehabilitation Master Plan (A, Kelly and P.E, Cave - Rouge River Gateway Restoration of an Urban River)

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a central amenity for the surrounding environment, an interactive corridor for use by urban dwellers as an attractive recreational resource in the heart of human life. These areas represent a barrier between the population and the river system by the impassible industrial riverfront. The connection from these neighbourhoods to the existing and proposed recreational destinations upriver will benefit all areas.

Industrial River Zone

Including the reuse of land, new technologies, efficient use of resources, energies and waste will emerge in these areas as green engineering, biocompatibility and industrial ingenuity. Alternative design and engineering methods making use of the natural resources in a sustainable manner.

The understanding of the existing conditions and potential opportunities of each zone and its unique character provides a basis for the generation of a central theme. The extension of the traits within each zone leads to four corresponding theme. The management of the corridor will be guided by the integration of;

1. Environmental Stewardship
2. Cultural Heritage
3. Recreational
4. Economic Development.

The balance of the themes within each zone has established the Rouge as a model for urban river revitilization.

Environmental Stewardship

Protection and restoration of the natural environment throughout the corridor. The creation of a healthy environment is the foundation on which the other three themes are based which are essential to both wildlife and interaction of people. Focusing on preservation and enhancing natural areas such as lakes and wetlands which offer natural systems and processes.

Cultural Heritage

Respects the hopes and plans of people who have historically settled on the banks of the river, closely linked is the regions diverse ethnic background and labour history.

Recreational

Recognises the importance of the conenction of people to the river, incorporating convenient opportunities for exercise and relaxation. Including activities such as skateboarding, walking, jogging, rollerblading and biking.

Economic Development

Symbolizes the maximum economic development, this zone has fundamental impact on the economy of the state. The goal is the sustainable manufacturing and revitilization of the old industrial waterfront for public access as the driver for new economic developments. The theme recognized that within each zone will be the dominant theme in that area, however, the zones will share a certain degree of themes as a connective thread, integrating one zone into the other for the creation of an overall identity for the corridor. A strong relationship between cultural activities, environmental programs and recreational opportunities are essential components of the corridors economic success and the improvement of quality of life for surrounding communities.

Master Plan Interventions

The choice in interventions are a result of the study of various zones overlaid with the theme for each which resulted in a design solution. The design interventions consist of:

- Commercial Tour/Water Taxi Service
- Re-naturalization of the concrete channel
- Boardwalk overlook
- Interpretive signage and landscape restoration
- Riverboat dock
- Historic rest stop
- Recreational, historical and commercial connections
- Recreational sector
- Oxbow restoration
- Wetland restoration
- Rowing and wooden boat building
- Lagoon restoration
- Adaptive re-use of historic facility
- Riverfront views
- River events: fesitvals
- Greenway link
- Celebration of diversity and historic overpass
- Connecting neighbourhood attractions
- High-Tech Industrial Park
- Public fishing
- Wastewater treatment plant and modernization
- Detroit motor speedway (Kelly and Cave n.d)

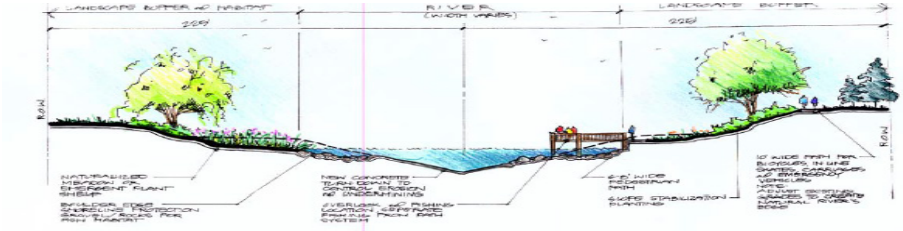

Figure 1.3.15: Rouge River Sectional Investigation. (A, Kelly and P.E, Cave - Rouge River Gateway Restoration of an Urban River)

Figure 1.3.16: Rouge River Rehabilitation Design (A, Kelly and P.E, Cave - Rouge River Gateway Restoration of an Urban River)

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Case Study Relation to the Authors Design Intervention

The Rouge River Gateway Project is used as a full river system precedent as the approach is very similar to that of the author for the rehabilitation of the Moreleta Spruit.

The integrated focus on social, ecological, economic and historical elements and how these elements are experienced by the urban dweller in order to create a sense of stewardship in man over the urban environment.

The zoning of the river system regarding the various environments it encounters along its banks and the various approaches associated with each, addresses the unique characteristics and conditions within each zone resulting in a specific engineered and resolved design solution.

The integration of the zones with one another allows for maximum connectivity along the river corridor. This project reflects the intentions and various approaches of the author, namely:

1.Ecosystem restoration, heritage reservation, increased interaction between urban dweller and natural environment and economic development through the improvement and use of the natural environment and its resources.
2.The enhancement of the ecological quality of the river system will yield economic and social benefits.
3.Economic use of the natural system is used to support and add value to the ecological systems and aid in their preservation.
4. People are inherently attracted to water, therefore, with the improvement of the water quality and increased accessibility to the water system will transform these water systems into the centerpieces of developed communities.

Photo 1.3.9: Rouge River Urban Environment.

Photo 1.3.10: Prior to rehabilitation

Photo 1.3.11: Post rehabilitation

Figure1.3.17: Rouge River Rehabilitation sketcht (A, Kelly and P.E, Cave - Rouge River Gateway Restoration of an Urban River)

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1. Understanding the characteristics of the unique relationship that the surrounding environment has with the Moreleta Spruit and how the relationship changes throughout the course of the river system. Understanding the direct association with the history of the city in order to celebrate the character of the development of Pretoria.

Technification

Urban dwellers and users of the riverfront should be made aware of the identity of the city as well as the provision of wildlife habitat, recreation, river interaction and job creation in the specific areas along the river. This integration will gain the respect and interest of inhabitants leading to the protection and rehabilitation of the riverfront. Obtaining a broad participation in the planning, design and rehabilitation of the riverfront from various neighbourhoods which will make use of the various needs required, providing for a more lively, inclusive and successful design due to the inclusion of various priorities. (Otto, McCormick and Leccese 2004 cited in May 2006)

2. Understanding the whole river system and plan on a larger urban scale, the watershed, floodplain, character of the river and its banks, hydrology, water quality and biological requirements. Protection and rehabilitation characteristics and functions of the river system, which are irreplaceable in terms of the necessary ecological functions they perform, benefitting both the natural and urban environments. Functions may not always be completely restorable but even a slight improvement can have widespread effects

3. Floodplain development should be minimized if not completely avoidable. Interventions should be designed to ensure that there will be no release of contaminants during a flooding event, as well as no decrease in the flood storage capacity or downstream impacts. (Otto, McCormick and Leccese 2004 cited in May 2006)

4. Provision of public access, connections and use of the river system and its banks without destruction thereof. The ease of accessibility will attract people to the riverfront, encouraging use and interaction through a number of possibilities and the regeneration of the riverfront into a public realm. Physical and visual connections should not be limited to that of commercial and residential areas, but include areas or facilities with a large variety of possible uses. Increased public use of the riverfront is essential in spite of physical, social and economic barriers. Providing for the community as a whole which in turn encourages a sense of strengthened social ties and a communal appreciation for nature. The diversity in activities and experiences which will develop along the course of the river system based on the needs and requirements of the immediate environment surrounding the individual interventions will create a dynamic experience linking open space throughout the urban environment. Inclusion of economic revitalization interventions along the riverfront tend to be more successful when integrating elements of the natural environment, through both physical and visual accessibility. Ecological and economic interventions should be mutually beneficial, providing a sense of connection attracting users to the waterfront. The more engaged a society is with the river system the more concerned it will tend to be about its long term sustainability. (Otto, McCormick and Leccese 2004 cited in May 2006)

5. Education regarding the river system is highly necessary, not only from an environmental perspective, but also from a historical point of view. The incorporation of informative and educational systems can aid in defining the river, its environment and historical connection. Through education, awareness and understanding, the development of stewardship and connection to urban river systems will materialise. (Otto, McCormick and Leccese 2004 cited in May 2006)

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CONCLUSION

There are set outcomes developed for the rehabilitation, restoration and purification of the Moreleta Spruit:

1. Improvement of water quality and cost effective clean-up and treatment of urban resource.
2. Naturalised flood management systems and moderation of food damages.
3. Improved stormwater quality and management system.
4. Increase in biodiversity and ecological integrity.
5. Improved education and awareness of urban river systems and processes.
6. Reactivation of the riverfront and new opportunities for development.
7. Creation of job opportunities.
8. Provision of recreational opportunities, open spaces and park areas.
9. Connectivity between ecological, social and economic sectors.

Through the identification and evaluation of the river system as a whole as well as the various zones, each zone has unique issues and potential opportunities for the rehabilitation of the river system, as well as the integration between the specific urban characteristics and demands and the natural environment. (Otto, McCormick and Leccese 2004 cited in May 2006)

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PART 2: POWER OF CONNECTION

“Today, our values are different. We are more aware of thecause-and-effect relationship between our actions and the fragile environment in which we live”

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CHAPTER 1: SITE SELECTION - ERA BRICK WORKS QUARRY

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Isolation and human exclusion from the natural environment as a response to the problem of polluted urban river systems is a plausible response in terms of the ecological environment.

However, through the disassociation of man from nature, it has led to the creation of a void and wasted landscape within the urban environment. "… the culturally innovative aspects of landscape architecture are often overlooked or even supressed as emphasis is placed on more technical procedures aimed at the restoration of an essentially cultureless natural world." (Corner 2009:3).

The problem is so expertly addressed by James Corner, where it is the relationship between man and nature, or landscape and the connection that man has to his environment which gives cultural value to that land.

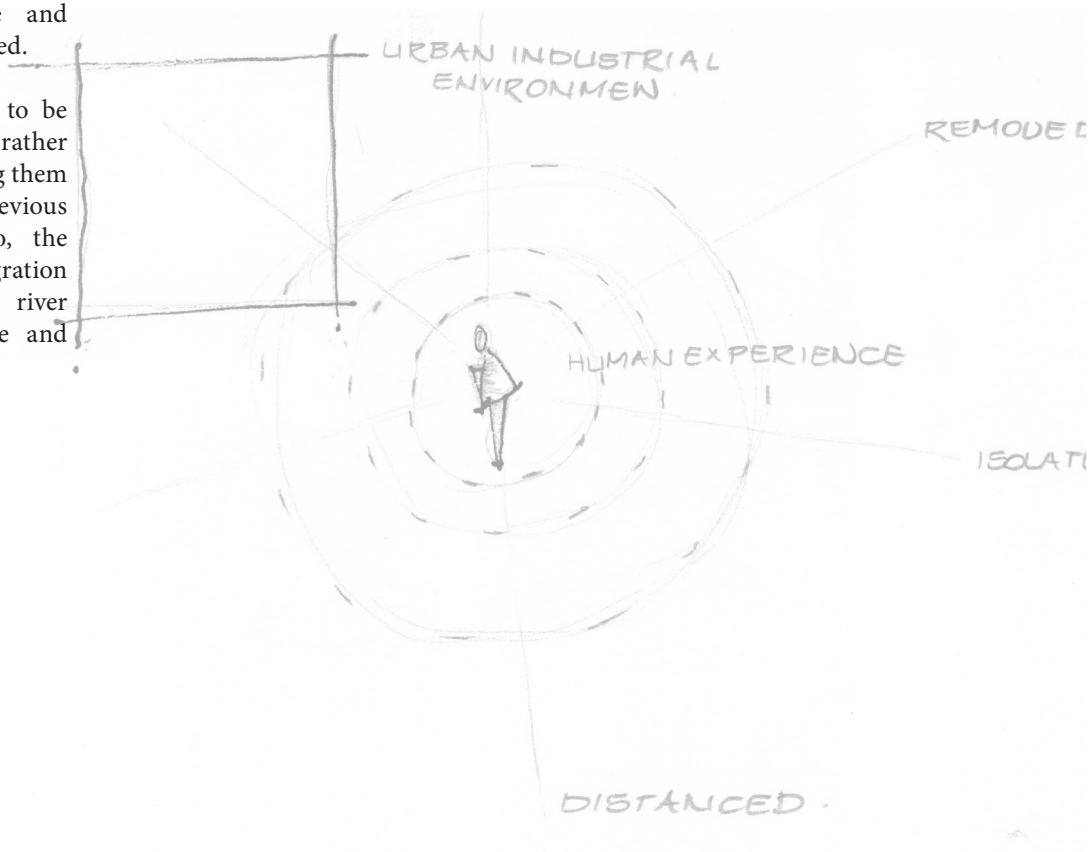
The social value which was historically placed on water systems as a resource has been significantly altered over time. This alteration took place through the development and use of water resources beyond the banks of the rivers on which human settlement originated, as resources would not be able to provide for the increase in demand.

The loss of that dependency on the river system led to loss of importance within the urban environment, degradation and pollution caused further damage to the relationship between man and the river as the river had now lost its aesthetic and economic value.

Part two of the dissertation focuses on the connection between man and the urban riverfront through the incorporation of river purification systems as a design informant for public space.

Humans, as the dominant species in an ecosystem, cannot be excluded from the protection and rehabilitation of urban river systems. If the ecological and hydrological approach to urban river systems does not align with the economic and social ideals of the modern day city, then it is fundamental that alternative ways of understanding and communicating the importance and value of the river system are explored.

Connectivity on all scales needs to be inclusive of the human species, rather than controlling rivers and framing them as an isolated aesthetic view as previous riverfront project tended to do, the intention has shifted to the integration of the complexity of an urban river ecosystem into the public image and experience of the city.



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PROBLEM IDENTIFICATION

First and foremost, the largest problems facing urban river systems are pollution and destruction of the surrounding natural environment through urbanisation. However, with the removal of the human element as an approach to river rehabilitation there is a loss of connection between man and his environment. The loss of economic and social value through this isolation has resulted in the degradation and loss of significance of smaller scale urban river systems that are no longer seen as a resource. With the increase in void and wasted landscapes along urban river banks and borders, failing to address these landscapes and reintroducing them into the public realm, will result in all connectivity being severed between man and the natural environment.

HYPOTHESIS

Only through integrating the public realm of the urban environment with areas of void or wasted landscape, and using the rehabilitation systems and processes of the Moreleta Spruit as a design generator and informant for the site, will connectivity on various levels concerning man and the natural and urban environments be re-established. Through the incorporation of social, ecological and economic aspects informed by the natural environment, the wasted landscape is transformed through the integration of the natural environment, into a public space centred on the interaction, education and awareness of the complexity and significance of urban river systems.

DESIGN QUESTION

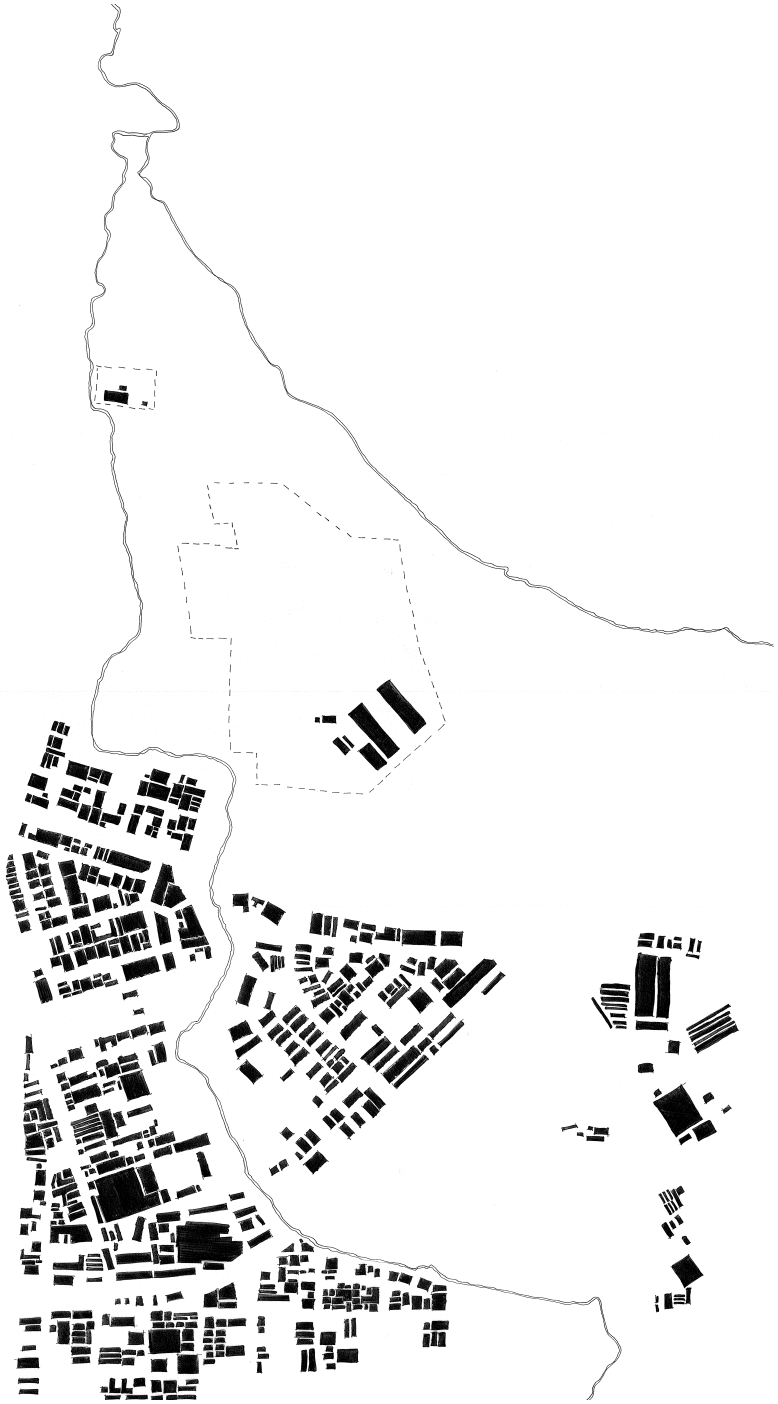
Can the rehabilitation of a polluted resource and the associated surrounding environment become a connecting feature with an impact on the surrounding environment? Through enhancing the spatial quality of the rehabilitation process and the incorporation of these processes into economic and social aspects of the intervention, will the public realm be drawn into the previously wasted landscape, connecting man and the environment through common participation and experience?

TECHNICAL QUESTION

How can the river system be diverted and incorporated into the economic and social elements of a place? What are the technical hydrological purification aspects and varying construction methods for the diversion of a water system? How can materials and technical aspects of the intervention be designed in varying degrees of urban and natural integration?

CLIENT IDENTIFICATION

How will the improvement of ecological functions within the river system be resolved while simultaneously increasing access and integration between the urban and ecological environment as well as minimizing the anthropogenic influence of the urban environment on the water resource?



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CHAPTER 2: SITE SELECTION- ERA BRICK WORKS

Photo 2.2.1: Decomissioned buildings

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INTRODUCTION

Bordered by the residential areas of Eersterust and Jan Niemand Park, as well as the industrial area of Silverton, the Era Brick Quarry is situated directly south of Derdepoort.

The Moreleta Spruit converges just north of the site with the Rietspruit tributary, originating further south in the more recent development of Pretoria, and flowing north and draining into the Roodeplaat Dam.

Clay bricks were first made on site approximately 60 years ago by the owner of the Derdepoort farm. The maize farmer discovered the abundance of quality clay and started producing handmade clay bricks, which later established into a brickworks company. (Jansen:2013)

The close proximity of the industrialized area of Silverton provided the brickworks with a constant and reliable client base.

In 1980 the private works was sold to Rosema and Klaver Company who were responsible for founding Era Bricks as it is known today. The depletion of clay in the quarry forced the company to rely on the importation of clay in order to continue brick production. The maintenance and cost involved in the unsustainable nature of production and upkeep resulted in the decommissioning of the Era Brickworks quarry. It was approximately two years ago that production ceased, and Era Bricks was sold and is currently in the process of change in ownership. (Van Dijkhorst 2013)

As an abandoned and decommissioned industrial site, like many others, they are perceived to be of low value and potential.

The sheer expanse of the abandoned quarry as well as the lack of activity and access to the surrounding communities has caused a disassociation between people from the residential areas and the site.

The site holds valuable historical significance and according to the research done by Jacques Pansengrouw, the site has become a landmark for the surrounding communities, with the the tall chimneys and a double row of Eucalyptus trees surrounding the factory and the quarry borders.

Through the integration of surrounding communities into the previously restricted site, it will provide a platform for not only ecological restoration but the restoration of the relationship between man and nature.

The current relationship between man and the site is the visual connection created by the view of the trees and chimneys. The intangible significance of the site has the potential to be transformed into a physical connection and experience through the design intervention.

Understanding the larger river system helped to inform the type of site to be investigated for the design intervention, through the detailed understanding and analysis of the chosen site, Era Brick Works, and its surroundings.

The opportunities and constrains can be identified and will ultimately guide the design response to meet the desired outcomes of the project intention.

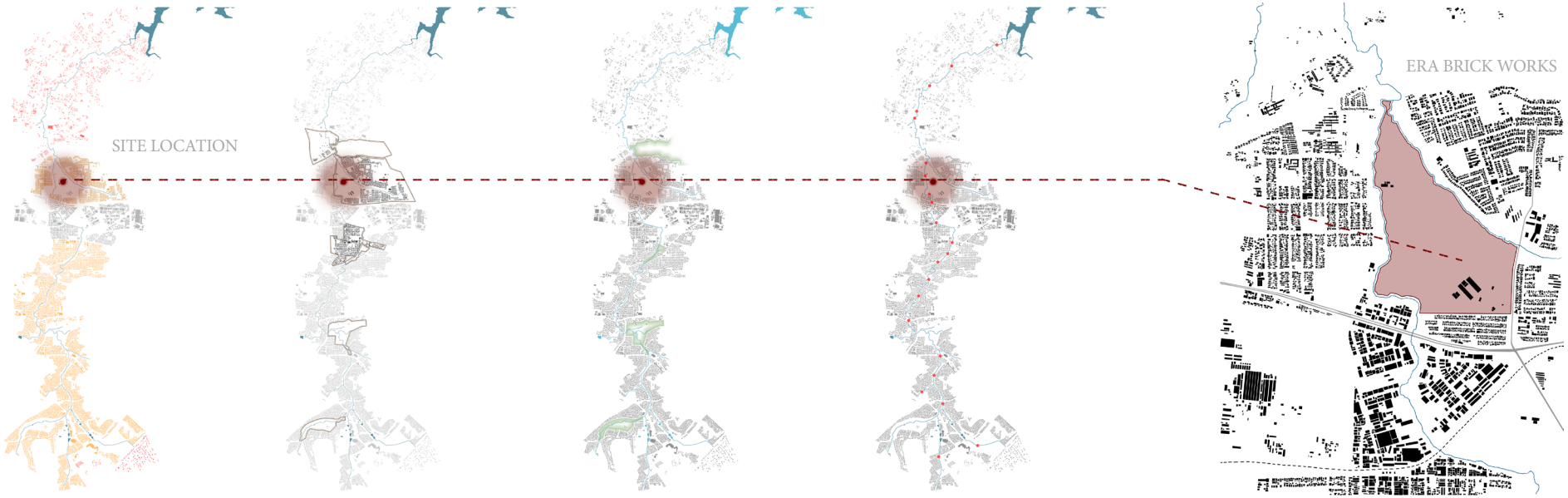

Figure 2.2.1: Site Location in relation to entire river system (Autor, 2015)

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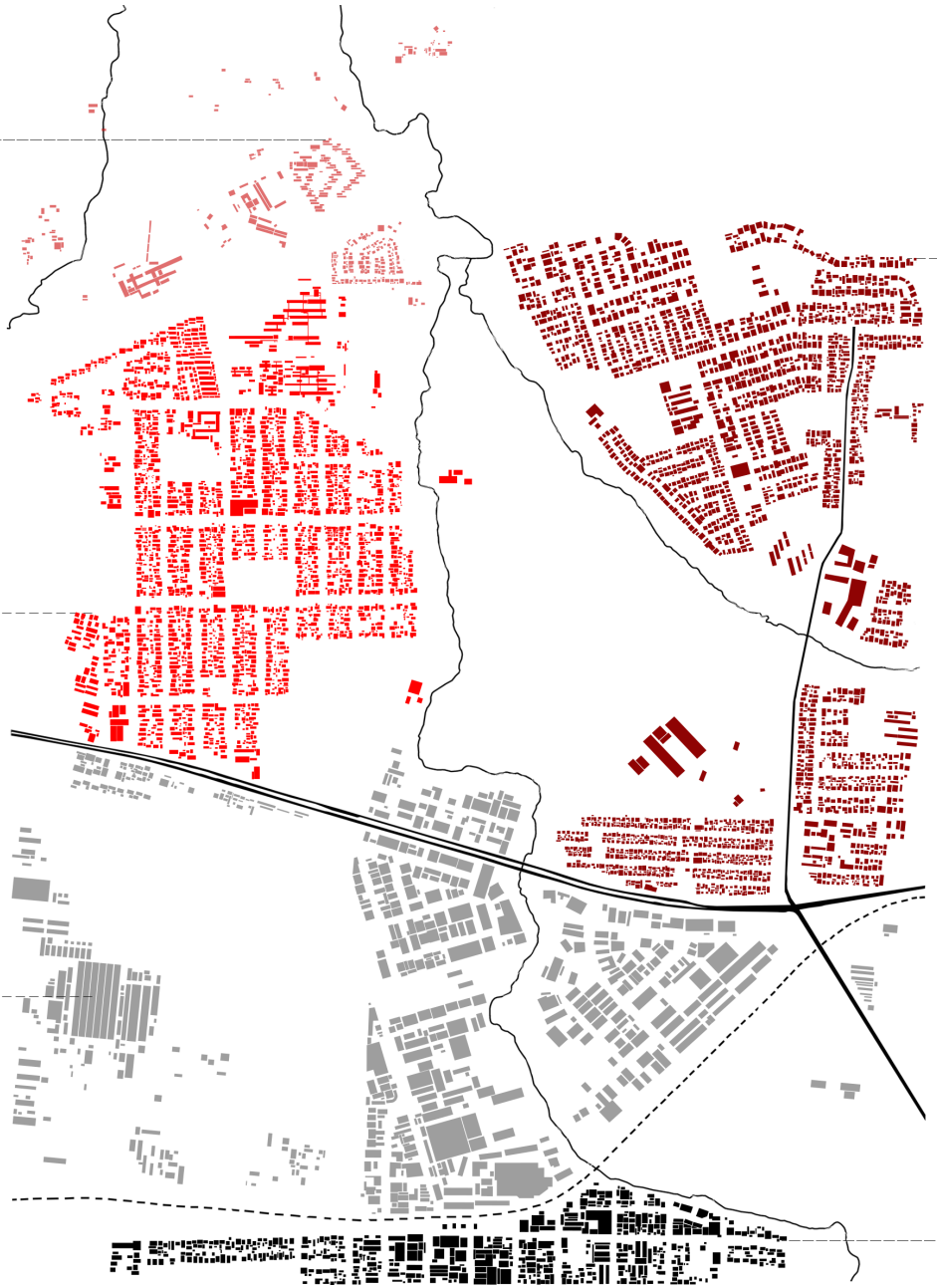
CONTEXTUAL OVERVIEW

DERDEPOORT
- Medium density
- Predominantly black community
- Historical value
- Low income residential area
- High crime and violence rate
- High pollution and runoff risk
- Unrestricted access to river

JAN NIEMAND
- Medium density
- Predominantly white community
- Low income residential area
- High pollution and runoff risk
- Unrestricted access to river

SILVERTONDALE
- Infrastructural area
- Direct influence on water quality entering residential areas
- High polution and runoff risk
- Direct access to river system



EERSTERUST
- Medium density
- Predominantly coloured community
- Area of historical value
- Low income residential area
- High crime and violence rate
- High pollution and runoff risk

SILVERTON
- Industrial area
- Area of historical value
- Negative influence on water system
- Partial residential suburb
- Medium density
- Unrestricted access to river system

Figure 2.2.2: Surrounding Urban Context (Author, 2015)

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Surrounding Transportation Routes

Public Transportation

Public transportation routes will be an important study to assess accessibility for people who do not live in the immediate environment and may be visiting the site.

The integration of people from the surrounding residential areas across the rivers will need to address the pick-up and drop off points regarding public transportation, how people will move from transportation nodes into the site and vice versa.

Jan Niemand Park is more developed in terms of public transportation, with a number of bus stops throughout the suburb, while Eersterust has one bus stop which will need to be addressed the design intervention.

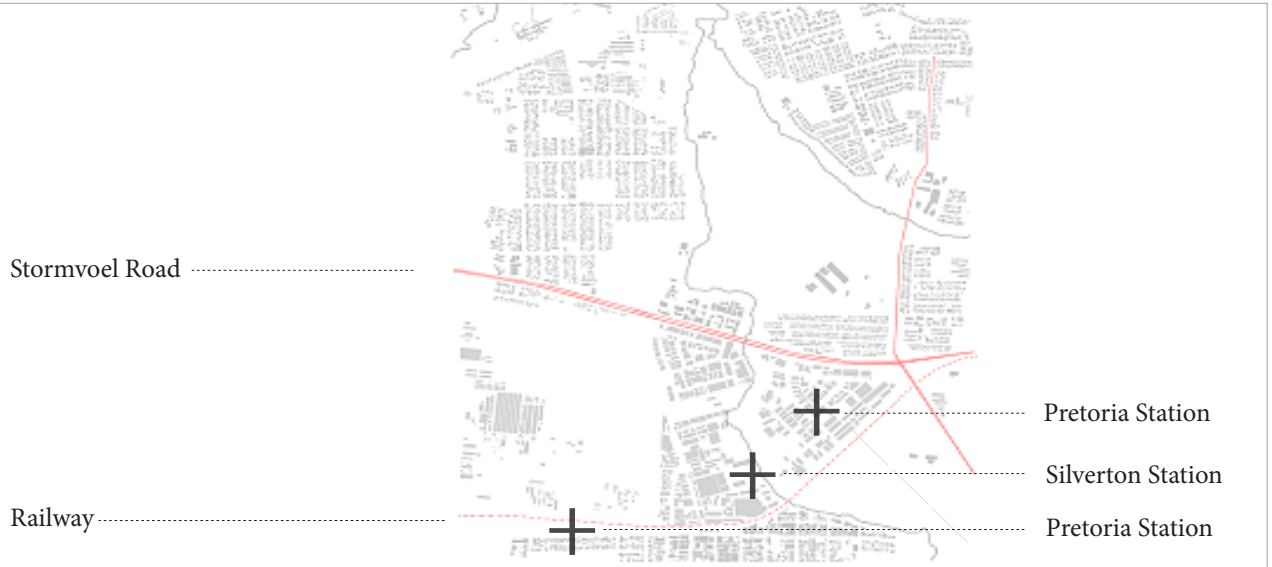

Figure 2.2.3: Transportation Routes - Roads and Railways (Author, 2015)

Surrounding Transportation Routes

Roads and Railways

The site is easily accessible from a number of important roads such as the N1 and Stormvoel road, which is also a main route to and from the Pretoria CBD.

There is close proximity to the railway line, as well as to two stations and the Koedoespoort shunting yards.

The ease of accessibility opens up many possibilities in terms of design for the site and is a major opportunity in terms of drawing people to the site from various areas, as well as for the servicing and delivery aspects associated with the site.

Figure 2.2.4: Transportation Routes - Public Transport (Author, 2015)

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Surrounding Educational Facilities

There are a number of educational facilities surrounding the site, providing for both primary and secondary levels of education.

The inclusion of so many educational facilities and the potential that the site has to offer in terms of use by the schools as a space of further and alternative education.

The movement patterns of children to and from school may address the space as a movement link between and within the various residential areas.

The high number of children that are concentrated in the area due to the number of schools in such close proximity will cause a peak flow of children at various times in the day, the design of a safe, outdoor space which will cater for children on various levels is an important consideration.

FIgure 2.2.5: Surrounding Educational Facilities (Author, 2015)

Further Surrounding Activities and Facilities

The diversity in surrounding activities and facilities enriches the surrounding context of the site to which the design intervention needs to respond.

Surrounding Green Space

There are a number of undeveloped green spaces surrounding the park, a large number of these areas are not public parks and designed urban green space.

The presence of the two river systems has left a green corridor running through the residential areas but due to lack of maintenance and management, the green areas have transformed into negative spaces with high safety risks in the communities.

The design and development of the site will connect and provide for a safe and secure environment for use by the communities.

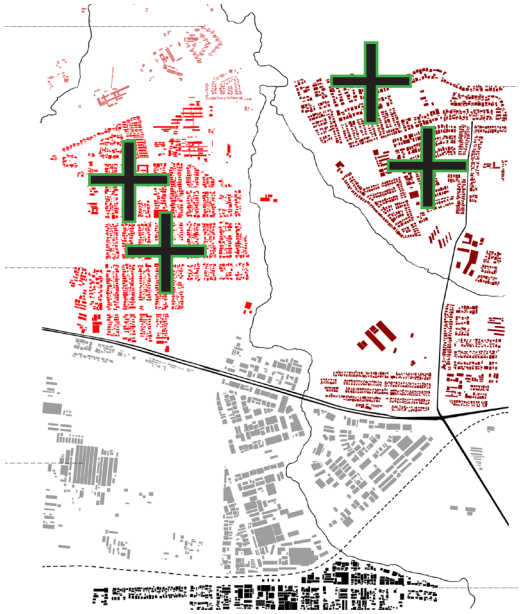

Figure 2.2.6: Surrounding Green Space (Author,2015)

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SITE OVERVIEW

- Decomissioned clay brick quarry

- Ran out of clay approximately 15 years ago

- In the process of handover to an excavation company

- Place for dumping of excavated soil - allows for regrowth and establishment of pinoeer species.

- Quarry already in the process of natural rehabilitation, certain areas partially covered in establishing vegetation

- Existing dams and birdlife

- Delapidated old structures, hold significant value as social connection to site

- Informal housing on site

- Scar on landscape

- Barrier or industrial boundary between communities

- Restricted access between suburbs

- Existing topography allows for water collection

- Restricted access into quarry

- Location was based on presence of clay, development of industrial activity due to close proximity the river system.

- Settlement developed around river due to historical establishment of agricultural farms close to the river as a source of irrigation

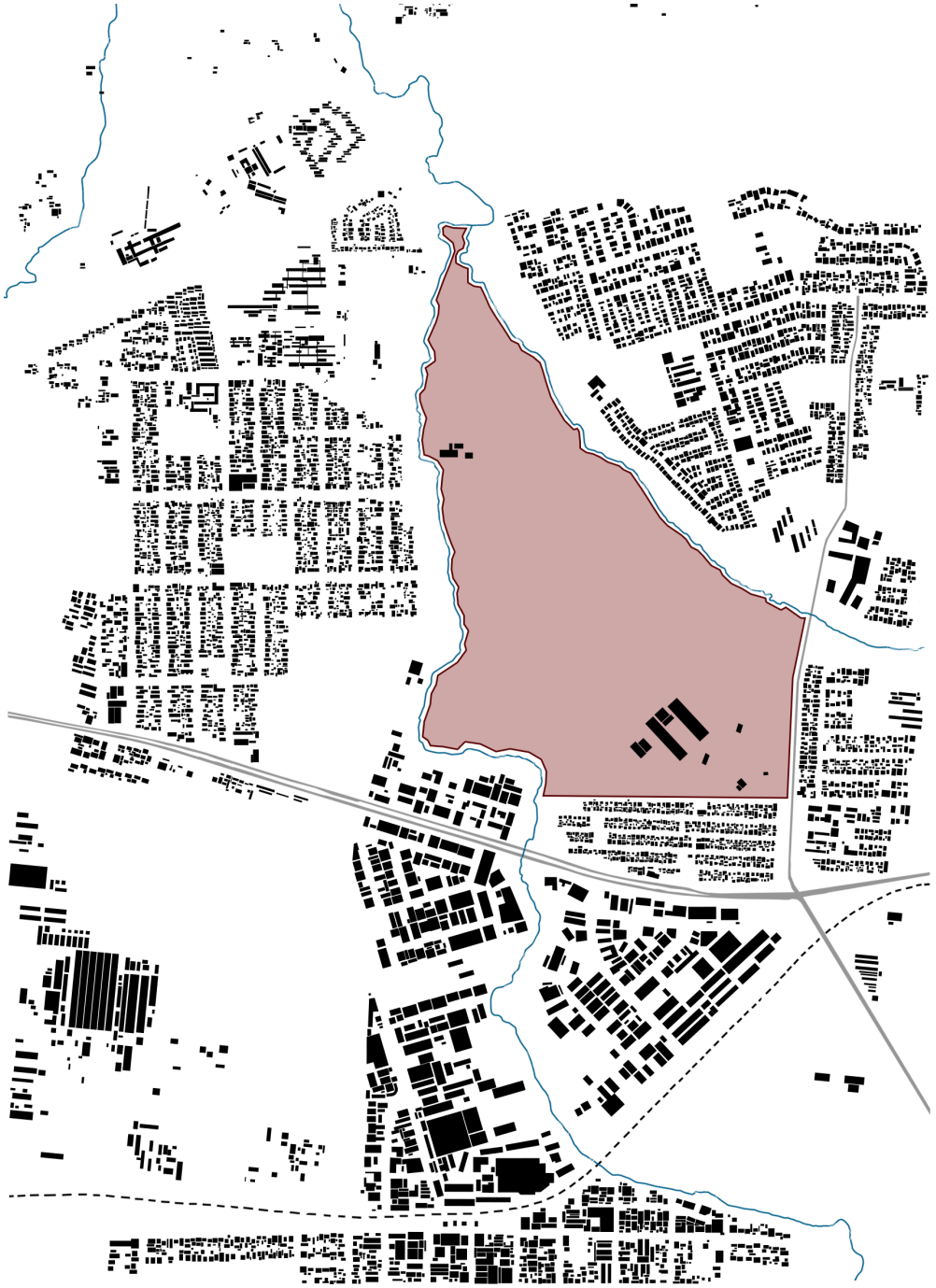

Figure 2.2.7: Site selection (Author, 2015)

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The surrounding residential areas fall under the low income sector of the urban distribution along the course of the river system. The communities struggle with high levels of violence, drug and alcohol addiction, teenage pregnancy and crime.

Through continuous visits to the surrounding communities, there were many children who were not attending school, spending their days in their streets and homes. The lack of activity and purpose is highly dangerous as children are exposed to negative influences and environments.

The level of unemployment in the society is evident through the number of older individuals who are constantly found at home or in the streets, a similar situation to that of the children. The lack of purpose and activity has a fundamentally negative impact on an individual.

The violence in Eersterust is worse than that found in Jan Niemand Park which has become a defining characteristic or association with the suburb, a stigma which is very hard to overcome when attempting to progress forward as a community.

There is a strong sense of community in-fighting against the struggles experienced on a daily basis, the division between positive and negative influences are clearly visible and a large portion of the community are attempting to improve their quality of life and the assisting with the upliftment of the struggling community.

Existing Elements

The existing buildings on site are not older than 60 years and are therefore not covered by the National Heritage Resources Act of 1999 and are therefore not required to be kept by law.

However, the significance of the buildings from a cultural and historical perspective in the sense of paying tribute to the industrial past as a catalyst for development in the surrounding area should be taken into consideration in the proposed design intervention.

The atmosphere of the post-industrial landscape which will now be accessible to the public forms a connection between sites progressing from a visual connection to a physical one.

Movement and Accessibility

The site is currently inaccessible to the public, and is completely fenced off with a security controlled access at the one main entrance.

The quarry is bordered by the Eersterust sports stadium which is also fenced off from the public but is accessible through the southern boundary entrance.

The Rietspruit and Moreleta Spruit limit access to the site on the eastern, western and northern boundaries.

Further north of the site is an extensive undeveloped greenspace which is overgrown natural habitat bordering the river systems, which further discourages and limits access to the site due to safety concerns, it is not a highly utilised movement area.

There are currently roads and areas of movement which are evident in the quarry itself from previous use and activity in the industrial process. These roads allowed for movement of heavy machinery and vehicles and due to the extent of their use during the production process, these roads have taken longer to rehabilitate and are therefore still prominent on the landscape.

These roads and areas of already disturbed vegetation hold potential to determine movement patterns and strategies in the proposed design.

Geological and Soil Conditions

The main soil type previously existing on site was clay, through years of use and excavation the clay has been depleted. The site now consists mainly of quartzite and shale which will play an important role in the vegetation selection. Various degrees of erosion are evident on the site, due to the lack of vegetation and steep slope the walls and edges of the quarry are subject to higher levels of erosion that the lower areas.

The drainage of stormwater into the quarry is also responsible for the higher areas of erosion, drainage manipulation and stormwater management will be addressed. The increase in vegetation and soil stabilisation will need to be considered in the proposed design intervention.

Hydrological Study

There are three runoff catchments existing within the site, firstly the larger Moreleta River existing on the western edge of the quarry is the main river system being addressed in the design intervention.

All stormwater runoff from the Jan Niemand and Derdepoort suburbs is captured by the river, with a number of municipal stormwater management outlets along the river edge.

The river emerges directly from the industrial suburb of Silverton as it enters the site, the water quality is at its lowest at this point compared to the whole river system.

The Rietspruit is the tributary converging with the Moreleta Spruit just north of the site, this river is of a poorer quality than that of the Moreleta Spruit due to its origin located in Mamelodi to the east of the site.

The stormwater runoff and municipal management system ensures that all runoff is captured and released into the river forming the second catchment on the site.

Thirdly is the quarry itself which captures all additional water in the area that is not diverted into one of the river catchments, this water is of a relatively good quality considering it is all runoff from predominantly green spaces since

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the quarry ceased production.

The water accumulates in the bottom of the quarry forming a permanent dam which is available for various uses, the dam water is not circulated and in order to maintain a higher quality of water this needs to be considered.

A wetland has also developed to the north of the dam with an abundance of water plants, there is great fluctuation on the water levels regarding seasonal change. Water leaving the wetland system is of a relatively high standard and accumulates along the northern boundary of the quarry.

There is no outlet for water from the quarry so water stands stagnant and decreases in quality, this is a fundamental consideration for the proposed water strategies.

The abundance of water for potential use and storage opens many possibilities and potential for design and incorporated activities.

The water quality concerning the river systems has been evaluated as well as the associated implications and purification potential.

The water was measured at various points by the COT and readings were given which were measured according to the water quality index, it is possible to monitor how the pollution fluctuates through the site and offers opportunity for purification interventions.

Vegetation Analysis

The site falls on the southern slope of the Magaliesberg Mountain range, on the boundary between the Savannah and Grassland Biomes. Many of the species are transitional and are found in both biomes, proving the site to be on vegetative level as well as economic and social level, a space of transition.

Through the severe destruction of the natural environment through the mining activity taking place on the site, minimal areas of natural vegetation are found, although natural rehabilitation did begin when production ended, it led to the invasion of the site by alien species. The main invasive found on site are the Eucalyptus trees, but no endangered or protected plants have been found.

The eucalyptus grandis trees hold value in the community as a visual connection to the site, if they are to be kept in terms of this significance, they will need to be addressed in the appropriate manner of a category 2 invasive species, requiring a demarcation permit for their existence. (According to SANBI (2014)).
The trees were planted originally as a dust barrier between the quarry and surrounding settlements. The vegetation type identified for the site is the Moot Plains Bushveld which is associated with the southern slopes of the Magaliesberg Mountains.

According to Mucina and Rutherford (2006), the Moot Plains Bushveld is characterised as a transitional open to closed composition of planting of low thorny savannah of which the Acacia species is dominant in the plains while the herbaceous layer is dominated by grasses.

The dominant species and complete Moot plains Bushveld vegetation will be further discussed and evaluated in chapter 13 regarding the planting strategy. This vegetation type is classified as vulnerable and requires a certain level of protection due to its invasion and disturbance through development of the built environment.

The significance of the site in terms of the existence of a river system and its associated habitats, environment and processes as well as a vulnerable vegetation type, gives the site potential and importance from an ecological aspect.

According to research previously done by Marina Burmeister (2014), there are a number of invasive plants identified on site which have been assessed according to the level of infestation ranging from light to intermediate and dense infestations throughout the site.

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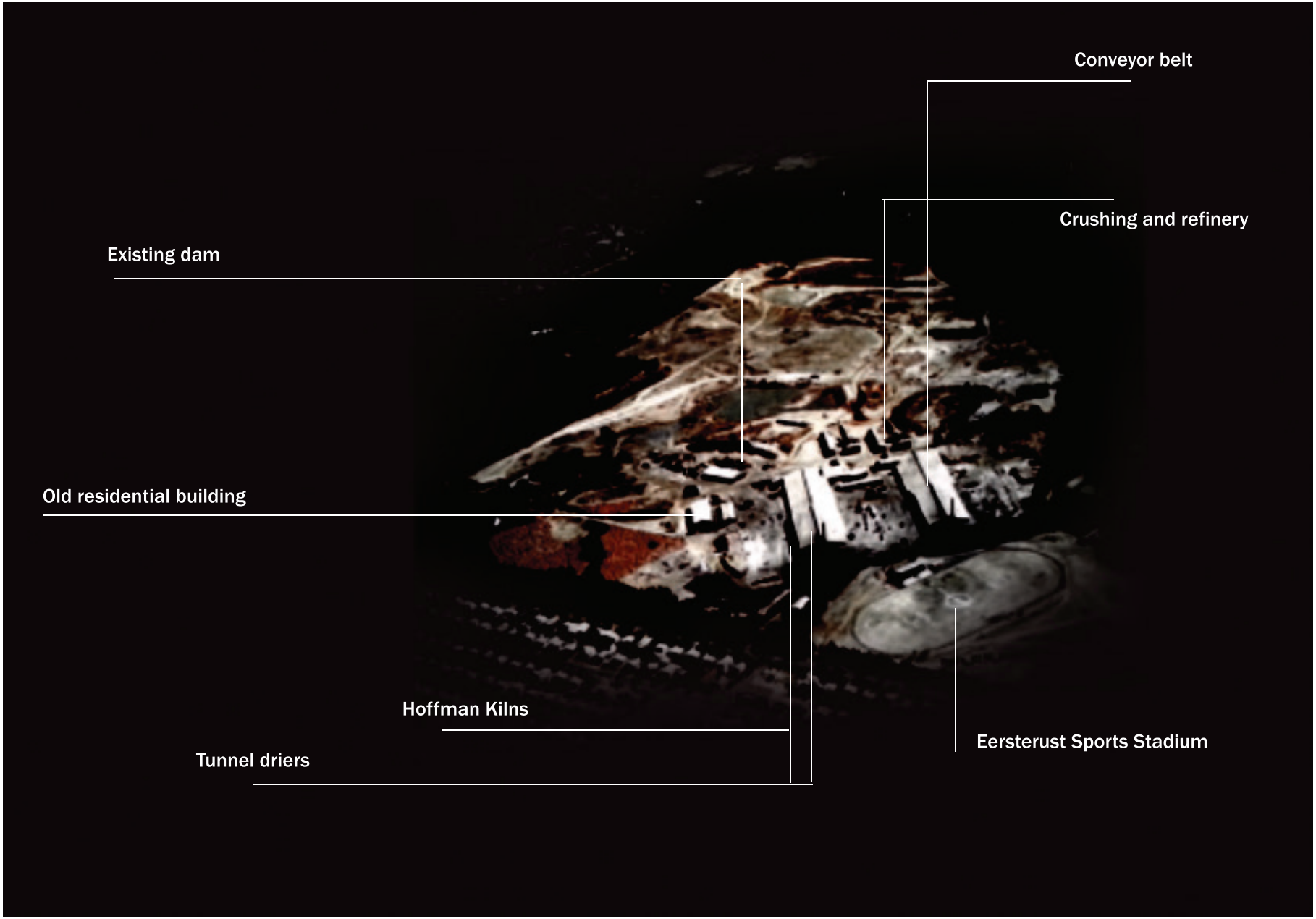

Figure 2.2.8: Existing structures on site (Author, 2015)

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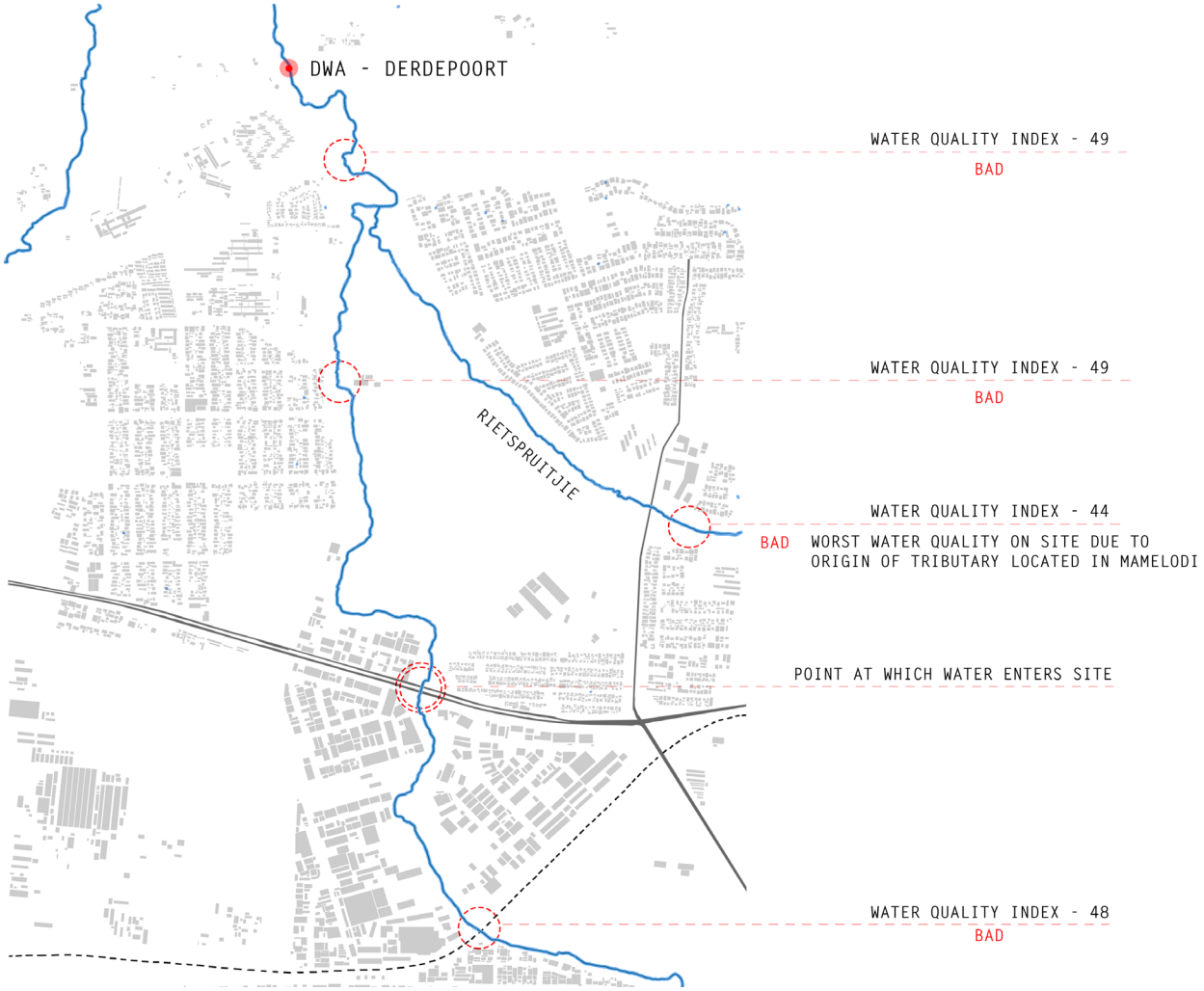

- CURRENT EXISTING WATER QUALITY = BAD.
- NO CONTACT WITH WATER SHOULD BE ALLOWED AND WATER
- IS NOT OF DRINKING STANDARD.
- WATER PURIFICATION IS AN IMPORTANT REQUIREMENT OF THE INTERVENTION.
- INTEGRATION OF PURIFICATION SYSTEM WITH OTHER SYSTEMS INCLUDED IN THE DESIGN SCHEME,

- INTENDED OUTCOME OF THE PURIFICATION PROCESS IS ACHIEVING A GOOD WATER QUALITY WHICH IS ABLE TO SUPPORT A HIGH DIVERSITY OF AQUATIC LIFE AS WELL AS OFFERING THE OPPORTUNITY FOR RECREATION AND HUMAN INTERACTION WITH WATER.
- THIS WILL BE DETERMINED THROUGH THE ANALYSIS OF THE COMPOSITION OF THE POLLUTANTS IN THE WATER AND CHOICE OF PLANTS WHICH SPECIALIZE IN THE REDUCTION AND ABSORPTION OF THE SPECIFIC POLLUTANTS.
- SECONDLY - MULTIPLE LEVELS AND PHASES OF PURIFICATION THROUGH VARIOUS SYSTEMS.

WATER INDEX QUALITY SCALE		
91 - 100	EXCELLENT	GOOD DRINKING QUALITY. MAY NEED SIMPLE PROCESSING. SUPPORT HIGH DIVERSITY OF AQUATIC LIFE. SUITABLE FOR ALL FORMS OF RECREATION, INVOLVING DIRECT CONTACT WITH WATER.
71 - 90	GOOD	SLIGHTLY POLLUTED, COULD BE USED AS DRINKING WATER AFTER TREATMENT SUPPORT HIGH DIVERSITY OF AQUATIC LIFE. SUITABLE FOR ALL FORMS OF RECREATION, INVOLVING DIRECT CONTACT WITH WATER.
51 - 70	MEDIUM	COULD BE USED FOR DRINKING AFTER PROCESSING, FOR SWIMMING AND FOR FISHING. LESS DIVERSITY OF AQUATIC ORGANISMS AND INCREASED ALGAE GROWTH
26 - 50	BAD	COULD BE USED FOR INDUSTRIAL PUTPOSES OR SERVICE INDUSTRY SUPPORT LOW DIVERSITY OF AQUATIC ORGANISMS
0 - 25	VERY BAD	COULD BE USED FOR IRRIGATION. ONLY SUPPORT LIMITED NUMBER OF AQUATIC LIFE FORMS ABUNDANT QUALITY PROBLEMS NOT ACCEPTABLE FOR ACTIVITIES INVOLVING DIRECT CONTACT WITH WATER

Figure 2.2.9: Water quality evaluation (Author, 2015)

Water Quality

There is a water meter located at Baviaanspoort just to the north of the site after the convergence of the Moreleta and Rietspruit rivers, the calculations of water volume, flow rates and water available for use is discussed further in when dealing with water strategies in Chapter 10.

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CHAPTER 3: THEORY

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Further development of the theoretical approach to the river system as a whole was necessary in order to determine the site specific approach for the intervention.

The intention behind the choice of intervention is placed on the idea of connectivity at various levels, depths and manifestations of connection will have an impact on the type of relationships developed by it.

When dealing with urban river front design, there are a number of aspects which need to be considered in order to be able to respond to the context in which it is placed, namely ecological, economic and social.

The promotion of human access to riverfronts and their effective restoration is an intervention which requires complex integration between the urban and natural environments.

This complex relationship is the reason that the idea of connectivity may have conflicting connotations depending on the nature and focus of the approach to the intervention - city development versus ecological preservation.

The success of the intervention will be determined through the capability of the design to find common ground between environments by minimizing the destruction of ecological systems while still maintaining the educational and aesthetic experience of the urban dweller.

The main issue is the accessibility of the river to people, linking the river conceptually, visually and physically to the surrounding environment, creating public space through the incorporation of social attractions.

It is important to investigate the various approaches to connectivity for the understanding of the role that the intervention will play in terms of meeting ecological and social requirements.

Figure 2.3.1: Intended connection between separated communities (Author, 2015)

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ECOLOGICAL CONNECTION

The rehabilitation of the natural environment and processes surrounding the urban river system is the main consideration of the intervention, through the purification and rehabilitation of the resource, it enables the connection to both social and economic possibilities resulting in the connection of the urban and natural environments.

The idealistic approach to urban river systems is their complete restoration, however due to the connection of the river systems to human processes, they differ fundamentally from rivers in their natural state.

It is important to take into consideration that the urban river will never be able to be restored back to its natural state due to the high level of influence and impact the urban environment will have on the river system. Godfried explained this relationship by saying "most human activity connects to the river not through the riverfront vistas but through the exposed fabric of nature that is all around us, roof tops, gutters, roads, factories, swimming pools and waste water treatment plants are all necessary parts of the urban water cycle.

The first step towards healthy urban rivers is then to restore connectivity between human behaviour and the very idea of the natural hydrological processes around out homes, on our streets and in our parks. Given the vast ingenuity humans have put on taming and controlling rivers throughout history, the possibilities are enormous if people can now become inspired to find equally creative ways to coexist with river systems." (May 2006)

This statement addresses the social and infrastructural connection with the urban water system and the water within the urban environment before it is released into urban river systems.

There is importance in the purification and addressing of the various parts of the urban water cycle, improving water quality from as early as possible and increasing the exposure and interaction of people with these systems in order to raise understanding and awareness.

Dealing with water from the urban environment before meeting the river system is a consideration and intervention strategy which needs to be taken into consideration when considering the low stormwater quality entering the site from the industrial area.

The focus of the intervention falls on the purification of the river system and the importance in the various processes and ecologies which have been destroyed or fundamentally impacted by the urbanisation of the surrounding areas.

The environmental habitat functions on many levels with a number of connections which enable it to be a self-sustaining system. These connections and processes will need to be understood in order to be able to rehabilitate them. The level of connectivity in a landscape is determined by the strength of the interactions between ecotones, the continuous flow and exchange throughout the landscape, "the antithesis of fragmentation". (Harrison 1996 cited in May 2006)

River corridors and riverbanks are linking elements between green spaces in the urban environment, they enable the movement of plants and animals in varying habitats with a constant supply of accessible water. The importance of the riverbank as a threshold as well as a connection between the river and land habitats surrounding it, which in the case of an urban river system, would be the area where the opposing environments are brought together.

The ideal connection of the river system and the surrounding environment in a riparian zone would need to support a diverse variety of amphibious species and wetland plants, achieved through the alternation between flooding periods and dry periods. This fluctuation in water levels and volume is responsible for the distribution of nutrients between aquatic and terrestrial habitats. (Ward, Tockner and Schiemer 1999 cited in Cengiz 2013)

The importance of the riverbank within the ecological system of an urban river, as well as in the social aspect for the design of publicly accessible riverfronts cannot be overstated and the design intervention will need to take into consideration the delicate role that the riverbank provides and how the intervention can enable, enhance or contribute to the ecological significance of the area.

Dealing with the river itself, the flow of water and hydrological connections within the flow of the river are fundamental to the ecologies, habitats and processes occurring in the river system, there are three forms of connectivity:

Lateral Relationship

Connection between watershed and river including the role of animals, plants, sedimentation, delivery of nutrients and other organisms in the relationship between water and shore.

Longitudinal Relationship

The relationship between upstream and downstream concerning the migration of species, water quality and the flow of nutrients.

Vertical Relationship

The subsurface habitats which occur in a river system.

The fluctuations of water level in river systems is fundamentally important to the ecology, but flooding is an important element to take into consideration when designing for interventions in close proximity to the water system.

The riverbanks are considered to be the regulators of flow, its ability to absorb the changes in flow and the various exchanges between river, riverbank and floodplain. 'Hydrological connectivity: the transfer of water between the river channel and the floodplain or between surface and subsurface compartments, has major implications for biodiversity patterns as well as plays an important role in structural succession patterns. (Ward, Tockner and Schiemer 1999 cited in Cengiz 2013)

The influence on the hydrological

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connectivity within a water system due to human intervention will have a detrimental effects on the environment and needs to be carefully evaluated.

The similarity between landscape, ecological and hydrological connectivity is the protection of undisturbed river environments, limiting the influences of fragmentation, impermeability, channelization and the overall influences of the urban environment and the effects this may have on the ecological functioning of the river system.

The higher the connectivity the lower the impact. (Pringle 2003 cited in May 2006) The approach to the design and development within a riparian zone and on a riverbank will require the preservation of both the river bank and the floodplain and the promotion of various levels of connectivity, ecological ly and hydrologically.

Interventions need to take into consideration the impact they will have on the various connections within the river system and technical and design resolution will need to be of minimal, if any, disturbance to the system and its ecologies.

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SOCIAL CONNECTION

Connection: People, Communities and Societies

In terms of the human element, there are certain social aspects which will need to be addressed through the connectivity of the intervention. Urban Rivers historical function as a natural boundary for racial segregation is clearly evident in the contextual analysis of the chosen site.

The coloured township of Eersterust was separated from the developing white community by placement across the Moreleta Spruit.

The industrial area of Silverton also served as an infrastructural boundary between white, black and coloured communities. Both elements are clearly defining characteristics in the urban city layout. Social understanding of the site is explained through the spatial logic of the apartheid city model, where racial segregation was defined by the infrastructural barriers of main road routes, railway lines and industrial areas, as well as the use of natural barriers such as rivers and mountain ranges.

Eersterust was considered to be a residential township which was created on the periphery of the city for non-white residents, located at the furthest point away from the CBD and buffered from it through the industrial area of Silverton. (Breed 2012)

Era Brick Works quarry is an industry which was used to enforce the old apartheid legacy, the intervention is intended to transform this site from a barrier between communities into an area of connection, drawing the previously segregated black and coloured communities of Eersterust and Mamelodi together with the predominantly whiter community of Jan Niemand Park. (May, Klein and Kashchenko 2004 cited in May 2006)

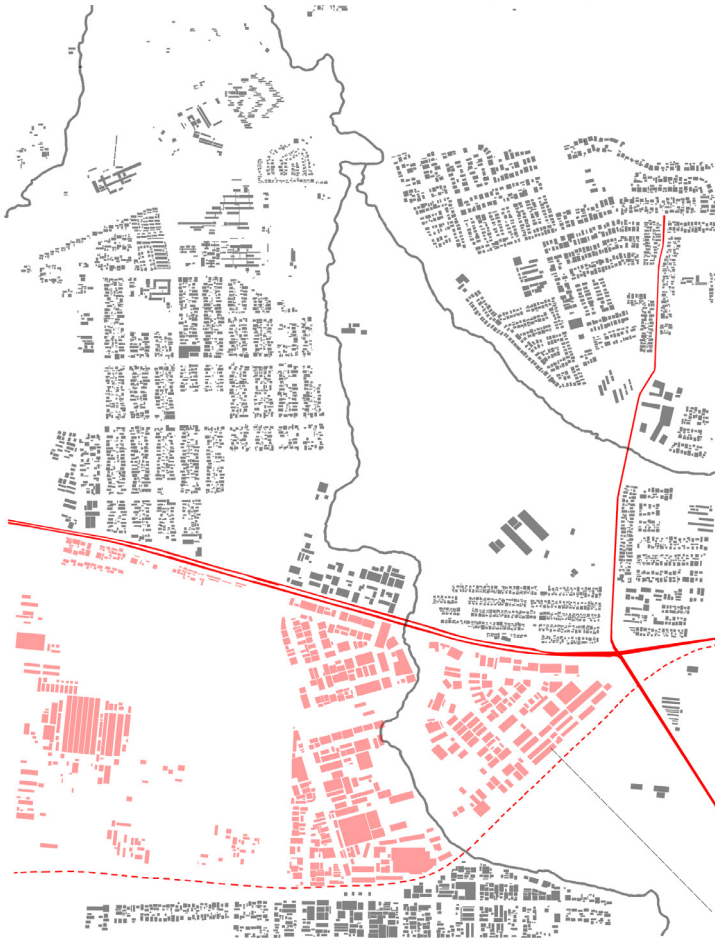

Figure 2.3.2: Surrounding Infrastructural Boundaries (Author, 2015)

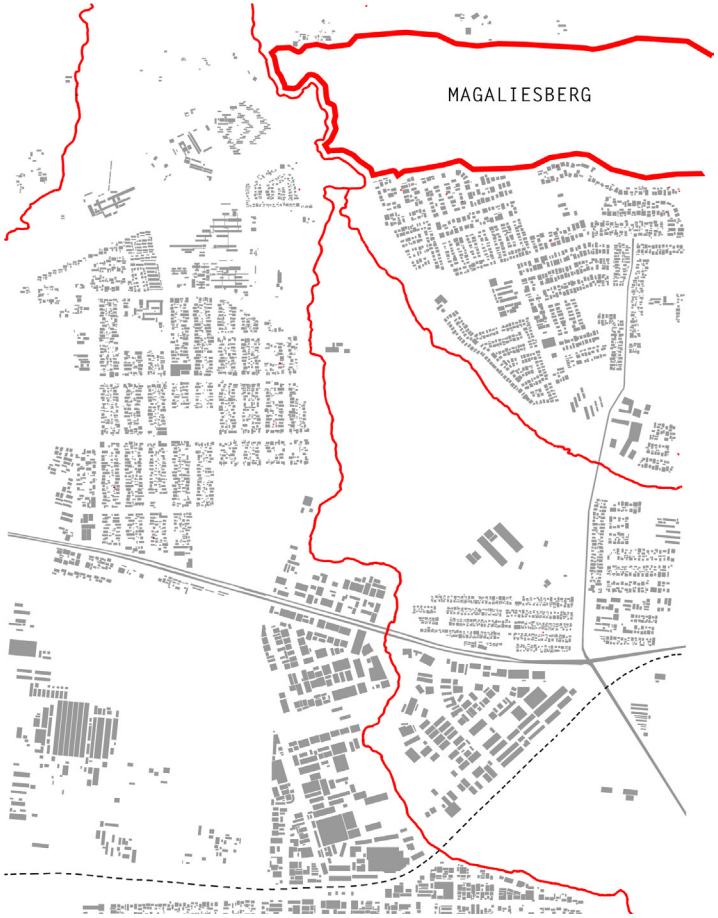

Figure 2.3.3: Surrounding Natural Boundaries (Author, 2015)

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APARTHEID CITY MODEL

Understanding the urban structure and layout based on the use of infrastructural and natural barriers to seperate people according to class and race.

The Apartheid city model was designed in such a way that races and classes were seperated from one another through the spatial configuration of the city and its elements.

The use of high industrial and commercial barriers as a buffer between areas of conflict created a distinct seperation in the urban environment.

The combination of natural and infrastructural barriers for the means of seperation and segregation is a strong link between the urban environment and our South African history.

The design intention of the author is to transform these barriers into public spaces for social and natural cohesion and healing.

Figure 2.3.4: The Apartheid city model (Ceasar Lopez, 2011)

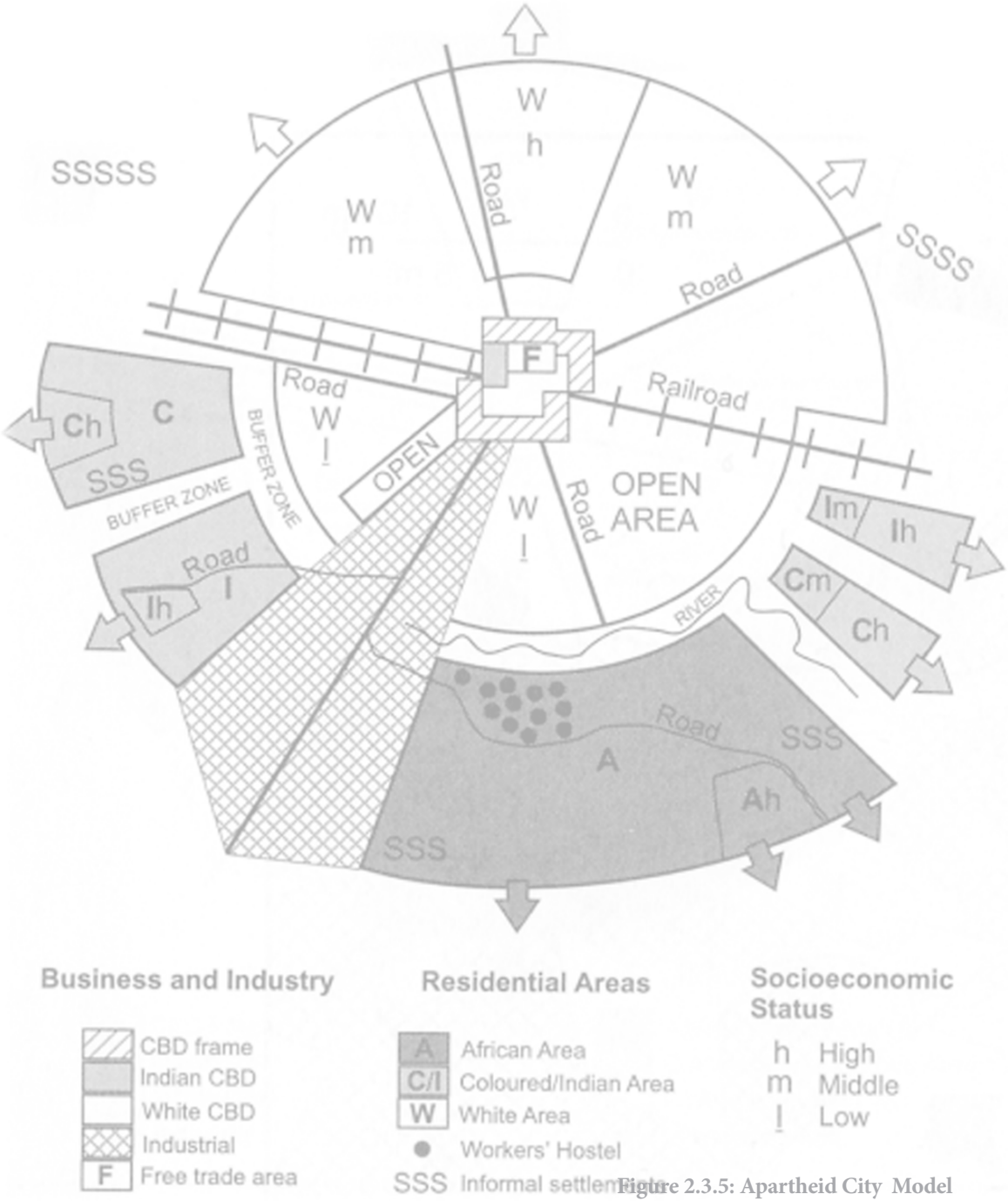

Figure 2.3.5: Apartheid City Model (Ceasar Lopez, 2011)

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The design needs to promote the relationship between river system and user, human interaction and interest in ecosystem integrity will raise awareness of the complexity of urban river systems.

The development of this connection through understanding will ease the degree of tension existing within the urban environment between cultural and ecological environments.

The development of urban rivers as public space will become the connecting element between the urban dweller and the natural processes which are hidden by the built environment, as well as the history of the development and establishment of the cities. The social connection of man and the environment requires a cognitive approach, the acknowledgement that humans are an integral component of the ecosystems on both a local and global scale.

Human presence and involvement in the natural environment needs to be understood and taken into consideration as well as acknowledging the degree of the consequences of their actions on the ecological environment and how to minimise these impacts.

The education of water systems should communicate the social cues for sustainable use and behaviour surrounding the ecological environment, creating a sense of stewardship in man concerning nature.

Concerning urban river fronts and their cognitive connections between the ecosystems and daily lives of urban residents, there are three main recent approaches to design interventions.

The overall outcome is to reverse the anthropogenic perception that man is dominant over nature and that the world is centred around human existence and the assertion of human dominance over river ecosystems, achieved through the awareness of the complexity and interdependence of all parts of the interrelated systems. (Hey 1994 cited in May 2006)

Pedagogical Restoration Plans

This approach is concerned with the education and teaching of the natural environment, the inclusion of elements within the landscape which are responsible for educating urban dwellers on the complexity of the ecological river systems and processes.

Riverfront Museums

These interventions are responsible for the introduction of the urban dweller to essential concepts which make up the urban river system such as watersheds, water quality and the water cycle. The importance is experience of these elements within the urban environment.

Exposing the processes that involve the urban river systems which are hidden by the urban environment educate people on the wastewater treatment systems as well as the direct influence that certain elements of the urban environment will have on the river system and ecology, for example, the relationship between increased impermeable surfaces and the resulting increase in urban runoff and flooding. The connection that these museums create through social and natural aspects of the city and its region, strengthens the connection through the cognitive relationship between the daily lives of the users and the water processes.

The location and significance of the sites for the creation of such interventions creates a symbolic link between human intrusion on the natural environment and the importance of the natural resource.

'Eco-Revelatory' Design

The creation of artistic elements within the architectural interventions and infrastructure, redesigning the built environment in a way that exposes and creates an awareness within the user of the daily role that the urban environment and its inhabitants play in ecological processes and the influence that they have on them.

This will forge new links and connections between the cities and their hydrological systems. (Spaid 2002 cited in May 2006)

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PEDAGOGICAL RESTORATION PLAN CASE STUDY

The Don River Restoration Project, Toronto, Ontario

The movement and transition of habitats and natural experiences along the Don River between marshes and deltas, more formally designed landscapes for recreational use to floodplains, meadows and forests as a means of understanding the complexities of river systems and their surrounding ecosystems holds its value in education through the interaction between people and their natural environment.

There are a number of educational facilities located along the river such as the research station where people can learn about the functioning of the river system throughout the watershed.

This station provides education in terms of how the impact on water hydrology can directly influence the complex habitats for wildlife within the river system.

The river was rehabilitated and designed to enhance the emotional and historic connection between urban and natural environments, the user and the river. (Hough 1995 cited in May 2006)

The Don River Restoration plan is focused around the protection, regeneration and stewardship for the polluted and neglected river system that has significant natural heritage value.

The watershed plan is intended to guide municipalities, provincial and federal governments in there policies for environmental protection, conservation and regeneration within the context of land and water use in the planning of future urban growth and development.

The project is directed not only to government but to local land owners addressing environmental management practices and stewardship.

The plan outlines three strategies for approach to the river restoration and regeneration project which are well aligned to the intention of the authors landscape intervention for the Moreleta Spruit. (Kelly and Cave n.d)

Build, Re-Build and Retrofit Communities to Restore Water Balance and Improve Sustainability

This approach deals with the flow regime of the river system, this aspect of the plan needs to be implemented during the redevelopment and infilling strategies of urban development, the retrofitting of the existing built environment as well as the development of the greenfield areas.

The intention is the balancing of the flow regime through stormwater management to reduce the flooding and erosion damage during peak flows while maintaining an adequate base flow to maintain river ecology.

The support, protection and regeneration of the aquatic and terrestrial habitats is an important aspect of the project plan. The redevelopment throughout the watershed will provide for a number of other opportunities and improvements within the natural environment including the protection of existing green space and cultural heritage structures, water quality improvement as well as improved watershed functions and ecological processes.

Regenerate the Aquatic and Terrestrial Landscapes

Strategies and interventions have been incorporated in the watershed to improve water quality, the planting of trees and aquatic flora for habitat creation and rehabilitation, removing of flow barriers hindering the movement of aquatic life as well as improved human activities along the river system to promote use and experience of the natural environment.

However, continued urbanisation and development place additional pressure and have increasing negative impacts on the watershed ecosystems, the approach to increasing impacts is the increased interaction of the community as well as funding for the continued interventions for restoration.

Engage the People of the Don

The inclusion and creation of human and nature interactive events have been incorporated such as Paddle the Don and others, in conjunction with the major naturalisation and brownfield rehabilitation projects which have taken place in areas alongside the river system, was successful in its intention to engage the community and provide wider awareness of the river system.

The interest which is sparked through these interventions needs to be capitalised upon as a starting point of reconnecting the people with the river system through understanding and awareness which will in turn lead to the voluntary transition of local residents to use sustainable practices which will aid in achieving the vision for future river city.

Stewardship and outreach education is important to build the understanding of the links between the actions of the surrounding landowners and the health of the riversystem. There is an importance in the inclusion of the youth in the education of natural resources, encouraging them to explore the natural features within the watershed will form a connection with the natural environment from a young age, encouraging stewardship. Sustainable practices in schools and at home will aid in youth edcation. (Kelly and Cave n.d)

Stewardship and Outreach Education

One of the main themes in the restoration project is the need for initiatives to increase awareness and understanding of the individuals, economic and commercial sector as well as the government, regarding their contribution to regenerating a healthy and sustainable watershed.

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The educational initiatives highlight the urgency of the shift to sustainable practices not only for the reduction in present impacts on the watershed but making people aware of the market for innovative community designs and strategies for a more sustainable community approach as populations continue to rise.

In order to promote the stewardship concerning green spaces and natural areas, there is a need to inform and educate people on the enroachment of floodplains and vulnerable habitats through activities such as dumping, mowing and incompatible recreational uses.

The best management for individual terrestrial and aquatic habitat regeneration is through planting, reduction of invasive species and maintenance as well as the promotion of the natural and cultural heritage existing within the water system.

The approach to each group of individuals will target the specific impacts that each results in and focus on the sustainable practices and education in those specific areas. Homeowners will be educated on more sustainable practices within their homes, green building strategies and community movements in a sustainable direction, property naturalisation, at source stormwater control, water and energy conservation.

The commercial, economic and construction sector will be educated on the new technologies for sustainable development in terms of stormwater management, water and energy conservation, increased education on erosion and sediment control practices for site construction and the best approach to restoration of a site after projects have been completed. (Syring 2008)

RIVERFRONT MUSEUM CASE STUDY

Fairmount Water Works Interpretive Center (FWWIC), Philadelphia, Pennsylvania

The historically significant site is made up of a complex of neoclassical buildings which were once responsible for the housing of steam engines, waterwheels and turbines that transported water from the Schuylkill River to the reservoir on Fair Mount, providing water for the surrounding urban environment.

The City of Philidelphia was the first large American city to regard the safe delivery of water as a municipal responsibility and the water works plant was established after an outbreak of Yellow Fever which was believed to be caused by unclean water. (A View on Cities 2015).

The water works was a significant engineering project which was responsible for the attraction of many tourists, it tells the story of the Schulkill River and its human connection throughout history, renowned for the integration of nature and technology.

Historically it recieved much acclaim and was the model for a number of similar projects throughout the US, however it was not only ahead of time engineering system that was responsible for all the attention, it was the Greek Revival structures designed to house the inner workings of the systems which recieved equal amounts of praise.

The Fairmount park was located directly above the buildings of the water works, one of the worlds largest urban parks which was designed as a means of protection for the city's watershed as well as providing a space for recreation for the city.

The buildings have been used in the showcasing of the ecological and engineering significance of the provision of water to an urban population. There are a number of exhibitions where people are able to gain an understanding of watersheds and the impact and influence that the urban environment and its resultant pollution has on them. (A view on cities 2015)

The fundamental success of this museum is the location of the buildings and the possibility for visitors to look inside the real workings and machinery and through a series of windows, watch the river rushing past the buildings. The lower lying structures have been designed to be submersible when the water level rises, or easily removable. Educational experiences are enhanced by the constant reminder visually, that the visitors are in the watershed. The water works is host to a number of events centered around the education of the importance of urban watersheds and how to take care of it. Events include workshops and summer camps and has won numerous awards for its educational outreach programs.

The exhibitions have been designed to be highly interactive, with the use of modern day technology for the simulation of rainstorms to follow the path of the water flow throug the watershed or to follow the water cycle from the river to the point of domestic use.

The understanding and connection to the modern day user is successful in education and awareness creation. (A view on cities 2015)

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'ECO-REVELATORY' DESIGN CASE STUDY

The Living Water Garden, Chengdu, China

The water quality education and green space park was designed by Betsy Damon in association with her foundation, Keepers of the Waters. Centered around the relationship between water and life, the park nourishes and educates the citizens through its design and purpose.

Designed to purify water from the Fu-Nan River, chemically polluted from the life of a large industrial city, the pollution which is slowly but surely responsible for the diminishing water quality in urban rivers, through a low technology purification system. The park makes use of exposing naturally occuring water purification systems which are often invisible and hidden form the human element and urbanised environments.

The Living Water Garden was designed in a way to sustain life, to show nature and water working together for the purification of water and through the integration of public space and human interaction with the systems, people are made aware of their relationship to water.

Water is taken from the River system into a settling pond, where natural systems are responsible for the removal of pollutants. Larger materials settle to the bottom of the pond while the water passes over a stony area to allow for aeration before passing through a vegetated area or wetland area for further absorption of pollutants through various plants.

The water is then designed to travel through a number of sculptures or flow forms which imitate nature very precisely to allow for the optimal movement of water for the formation of vortices. These vortices are the basis of most life forms and the motion is responsible for the cleaning of water.

It further flows into a series of ponds, the water is of standard to sustain life so the ponds are populated with fish and water plants which further aid in water purification. The incorporation of a second series of flow forms cleans the water to the point where it is of quality for human interaction and has been included in the childrens play area of the park.

The Living Water Garden has been designed so that the water is constantly visible and the inclusion of water monitoring stations and environmental education centre provides for exhibitions and programs for all citizens for education on water systems.

The flood walls of the garden have also been designed with an interactive intention between users and the river system.

The majority of the purified water is returned to the river system, however this is not enough to clean the river, the garden is symbolic and encourages learning, and is a constant reminder of the importance of reclamation of the river.

The users are drawn in to the Living Water Garden through the design of two smaller neighbourhood parks which honour the cities relationship to the river, gently leading the users to the river with places to rest and relax within the urban environment.

The strong relationship between the user and the river is an important point in this park, designing an entire urban park based on the processes and systems of water revitilization. The levels of interaction created by walkways passing though wetlands, interactive riverbanks and all stages of water purification are able to be seen, touched and understood.

The choice in form generation allows for human experience as well as ecological efficiency to follow the flowing and feeding of surrounding ecosystems.

There is a sense of wholeness and integration is the key for public experience of the space and the understanding of the complexity of natural water systems and the role it plays in their lives.

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ECONOMIC CONNECTION

The industrial areas were used as infrastructural boundaries separating communities of different classes and race, Era Brick Works was one of the industries used for defining the barrier between Eersterust and the white communities to the south.

Though historically established due to the presence of clay as a result of the proximity to the river, as social organisations developed and become more complex, the location of the quarry in relation to Eersterust and Silverton became involved as an industrial means of segregation.

The quarry made use of natural materials for production, the same approach adopted by the previously discussed masterplan of the Eersterust Urban Vision Group, including the fibre processing plant, ceramic production and apiary.

The downfall in this approach however is that the significance of the river system has not been taken into consideration, and the use thereof as a means of processing and production will contribute to the social interaction and provision for the surrounding communities, a connection between the economic, social and natural environments.

Although the direct connection deals with the immediately surrounding communities, in terms of growth and development on an economic level, neighbourhoods cities and even regions limit their growth if residents provide services exclusively for each other. There is a necessity in the provision of products to be sold to people and communities beyond their own as a means of income for the producer. The additional income is a means to reinvest in new production facilities and raw materials, this income provides a base from which the economic aspect of the society can progress.

The design intervention needs to be of such a nature that public space is created through the processes and products of the incorporated industries, exposing the user to the use of natural materials in the industrial processes in a manner with which they may interact.

The implementation has the potential to be done on various levels, including a number of different social organizations, as a means of bringing external purchasers to the place of intervention, this allows for the establishment of an internal market which facilitates internal transactions, production of goods and services for both the residents of the community and the external purchaser. (Ellis 2011. para.6)

Exposure to the natural environment has certain positive effects on the health of the person exposed to it, research regarding this connection has resulted in the identification of 5 mechanisms of action in which this link between nature and health manifests itself.

In rehabilitating the quarry, the creation of an expansive green space within the built environment which is catering for the connection between man and the natural environment will ultimately have an underlying positive effect on the health of urban dwellers that come into contact with the space.

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RELATIONSHIP BETWEEN NATURE AND HEALTH

The five mechanisms of action through which nature has an effect on human health are:

Recovery from Stress and Attention Fatigue

Even through brief exposure to nature there is a positive impact on physiological processes for example:
- Positive impact on mood and cognitive functioning
- increase in attention and concentration
- Improved self-discipline and aggressive behaviour due to increase in concentration

Stress is caused mainly by social and environmental factors which have a significant physiological impact due to the continuous adaption of physiological functions.

The result of chronic stress is that certain processes are disrupted which compromises the immune system, as well as plays an important role in the development of a number of physical and mental illness and health problems.

There is an importance in the presence of accessible green space within the urban environment to allow for a time of recovery with restorative effects on users of the space, through the removal of the individuals from the urban environment.

Design and Spatial Considerations

The characteristics of the environment will determine the ability of the landscape to automatically attract the user's attention and encourage a positive reaction.
These characteristics include a level ground surface, considerable spatial openness, presence of pattern or structure, curving sightlines as well as the presence of water.

Encouragement of Exercise

There are certain public health implications regarding the health risk associated with a lack of exercise. When designing for a community or neighbourhood, there should be a consideration in the design concerning the idea of exercise and how well the landscape lends itself to exercise and physical activites. The presence of an alternative environment allows for a mental break from the urban environment and associated stress, encouraging users to exercise more often and for longer periods of time. The more appealing and diverse the environment, the more attention is directed towards the landscape and away from physical signals of fatigue and exertion.

Design and Spatial Considerations

The conflict between pedestrians, joggers, cyclists and vehicles in the urban environment discourages people to exercise, this means that the site, in order to encourage exercise needs to minimise the dominance of vehicles to optimise and promote pedestrian movement and alternative forms of transportation and activity. Safety, appeal of the landscape, accessibility and surrounding land use are important indicators which need to be taken into consideration and addressed when designing a space which lends itself well to exercise.

The routes which are designed for exercise purposes need to take into consideration time constraints and distances for various users, as well as the experience of the landscape which will take place along each route.

Facilitation of Social Contact

Social connection is one of the aspects addressed in the approach to the nature of the design intervention, the promotion of public space and facilitation of social contact is essential for the success of the intervention. The presence of green space strengthens social ties within a neighbourhood through the development of the surrounding people, neighbourhoods and communities.

The reinforcement of social ties which contribute to strengthening the community are a result of increased face to face contact. The lack of social contact has a negative effect on human health as it results in a lack of support, security, and mental fatigue. Within the urban environment many people are reliant on public space for social contact. This theoy was summarised from: (Health Council of the Netherlands and Dutch Advisory Council for Research on Spatial Planning, Nature and the Environment 2004)

Design and Spatial Considerations

The design of public spaces which promote social contact are fundamental in public interventions, the presence of trees encourages people to linger and gather in certain areas through the provision of shade.

Through the promotion and ease of access to public spaces people, immobility and lack of transport will no longer restrict use of public spaces.

The incorporation of shared gardens or group responsibilities within public spaces promotes collective maintenance which is highly important for social significance and cohesion within a community.

Stimulation of Development in Children

The environments to which children are exposed has a direct influence on the development of attention, self-discipline, psychological resistance, cognitive, motor and socio-emotional understanding.

Intensive learning and playing experiences are necessary within an environment which encourages the exercise and physical activity of children, assisting in motor development, cognitive, emotional and social integration.

Age groups need to be taken into consideration concerning activities, safety, parental supervision etc. There is an importance in the understanding and exposure of children to experience change within an environment that is familiar to them. In a natural environment they are able to experience this while being exposed to the significant relationship between man and the non-human environment.

In an alternative environment the stimulation of the imagination is almost an automatic reflex to the change in surroundings. A natural environment is more attractive due to the greater variety of elements with which to interact creating a more stimulating experience.

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The removal of a child from their immediate environment is an important mental break from the constant living environment, it may also act as a buffer during stressful events as well as providing the child with a sense of freedom.

Design and Spatial Considerations

The incorporation of a savannah like landscape appeals to the innate, instinctive feeling of familiarity and safety, the alteration of landscapes will aid in the contrast between the familiar and the unknown providing for the child's sense of exploration and imagination.

The planting choice will provide for the relationship between change and familiarity through the choice of planting emphasising seasonal change and alteration throughout the year.

A variety in environments is necessary through use of various forms, materials and colours, catering to the sensory experience and development in children. Active and educational forms of play equipment will create exciting environments through the incorporation of many natural elements which will challenge children in a variety of ways and levels of complexity.

Provision of Opportunities for Personal Development and Sense of Purpose in Adults

The experience and interaction with the peaceful environments created by nature promotes a sense of purpose in people, a space allowing for reflection, peace and solitude aids in coping with stressful events.

The removal of individuals from the urban environment provides them with a stress free space to reflect and deal with the pressures of life in the presence of nature and the absence of social pressure.

The contemplative effect that nature has on individuals encourages individuals to address their deeper convictions and values, discovery and naming of their goals in life which will manifest itself in a sense of place, a relationship is formed between the natural environment and the individual through the identification of a specific area at where one feels at peace and at rest.

Design and Spatial Considerations

The encouragement of exercise brings people to places removed from stressful urban environment and allows for the escape from every-day problems.

The interaction with water is a soothing and meditative activity, contributing to both exercise, nature and man interaction as well as freeing of the mind.

The three basic needs which need to be considered and incorporated to achieve personal well-being and development are competence, the understanding of natural surroundings, systems and processes.

Autonomy, the idea of self-governance, taking control of ones own life and making decisions regarding future purpose and goals and lastly, relatedness, experiencing a place of understanding, order, freedom and connection.

It is important to design a space in such a manner stems are exposed so that man is aware of how man and individuals fit into the greater scheme of the environment as a whole.

This theory was summarised from: (Health Council of the Netherlands and Dutch Advisory Council for Research on Spatial Planning, Nature and the Environment 2004)

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CHAPTER 4: EERSTERUST URBAN VISION GROUP FRAMEWORK

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INTRODUCTION

During the course of 2013, three architectural MProf students created a group framework and design proposal for the Era Brick Works site as a large-scale urban strategy and vision.

The Eersterust Urban Vision Group consisted of Jacques Pansengrouw, Carla Taljaard and Carlheinz Von Geyso, who developed a framework and design proposal as a platform for their individual architectural design proposals.

The developed framework and proposals that came from the group have been evaluated and taken into consideration when approaching the landscape design intervention proposed in this project.

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EERSTERUST URBAN VISION GROUP APPROACH

The intention behind the project was the introduction of social and ecological value introduced to a site with an industrial heritage.

There is a strong focus on the rehabilitation process for the quarry itself, allowing for the integration of industrial, ecological and social aspects to coexist, making all relationships as a result of these aspects apparent.

The main approach to the urban intention of the project deals with the concept of currency, defined by the urban vision group as: currency (n.) "1650's, condition of flowing, from Latin currency, present participle of currere, to run, the sense of flow or course extended 1699 (by John Locke) to circulation of money." These currencies are seen as avenues of flow, determined to be either apparent such as the flow of labour and raw material, or non-apparent, such as human capital and natural systems. These currencies tend to be forgotten and disregarded through various processes, resulting in areas where they previously occurred to transform into spatial and social voids (Pansengrouw 2014).

The urban intentions for the space were focused on the increase in biodiversity and establish a connection with the Eersterust residential suburb, dissolving the physical and perceptible boundaries previously existing between industry and society. (Taljaard 2014).

Both the tangible and intangible networks of Era Bricks are consideredthrough the understanding of the various currencies of the site. The non-apparent currencies are considered to be low value yet are fundamental in the support and integration of the apparent currencies which are perceived to be of high value, for example the exchange between different end products.

The intention of the urban vision was the possibility of industry to become a converter between apparent and non-apparent currencies, the focus falling upon the relationships between industries, ecologies and compromised environments. (EUVG 2013)

The urban vision proposes to address the quarry in terms of natural industries, reflective of and emergent from naturally occurring processes, or industries which extract and work with raw materials in a mutually beneficial manner, aiming to further the potential of Era Bricks as a premise of natural industries. (Von Geyso 2013)

The park is intended to be an ecological and industrial catalyst which manages and activates the site through exploration and reinterpretation of the attributes presented on site. (EUVG 2013)

Each individual design proposal was based on the main intervention principle that any proposed interventions should be based on apparent and non-apparent natural industries, which are focused in dealing with the relationships between man and the ecological environments.
The master plan proposal included three architectural interventions which made use of the existing buildings on site as well as the development of additional structures as the interventions required.

Each industry involved natural materials and processes within the industrial ecology and the interdependency of the various products and systems.

The three architectural interventions were:

1. A natural fibre processing plant acts as a translator and creates spaces of interaction with old, new and natural industries, enhancing the significance of each. (Pansengrouw 2013)
2. An incubator for ceramic-based industries becomes an architectural solvent for natural, industrial and social endeavours. (Taljaard, 2013)
3. An apiary and honey-processing facility becomes a transitional exploration from enclosure to opening, revealing the totality of the post-industrial terrain. (Von Geyso, 2013)

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After the evaluation of the masterplan proposed by *The Eersterust Urban Vision Group*, there are a number of interventions which have been addressed and evaluated as necessary for the implementation of a landscape design proposal, evaluation of the master plan was conducted in the manner as any other existing site would have been, opportunities and constraints as well as possible alterations have been developed.

Individual Architectural Design Analysis

The individual designs have been taken into consideration and all proposed functions and activities have been accepted as existing. The water strategies proposed by both the fibre processing industry and the ceramic production industry are both accepted. Both industries have proposed roof harvesting of water which provides sufficient water for all requirements, these roofs and water demands have been excluded from the landscape intervention water strategies and calculations.

In terms of the Apiary and honey processing industry, the water harvesting from the roof was sufficient to meet all water demands, however the incorporation of an indoor wetland and UV filtration process in one of the existing structures reconsidered for the incorporation into the larger water strategy to be proposed by the landscape intervention.

The roof of the apiary will be the only roof water harvested to contribute to the overall stormwater management strategy of the site and the only industrial water demand to be considered.

The decision for the incorporation of *The Eersterust Urban Vision Group* proposal for the Era Brick Works as the existing infrastructure and activities to which the landscape intervention needs to respond, allows for the activation of the site in terms of an urban infrastructural aspect.

The notion of the incorporation of and transition in the direction of natural industries and processes for production as well as the integration of the site with the bordering ecological and residential environments, addresses the ecological, economic and social aspects which form the platform of an inclusive and balanced design.

The challenge of the landscape design intervention will be the connection of the site to the surrounding environments through the creation of a dynamic landscape which will draw people through the space while allowing for integration between the industrial and natural environment, focusing on the incorporation of rehabilitation and restoration of the bordering river systems.

The incorporation of the river systems as both a resource and a design informant for the creation of public space and production will recapture the important role and significance of water systems within the urban context.

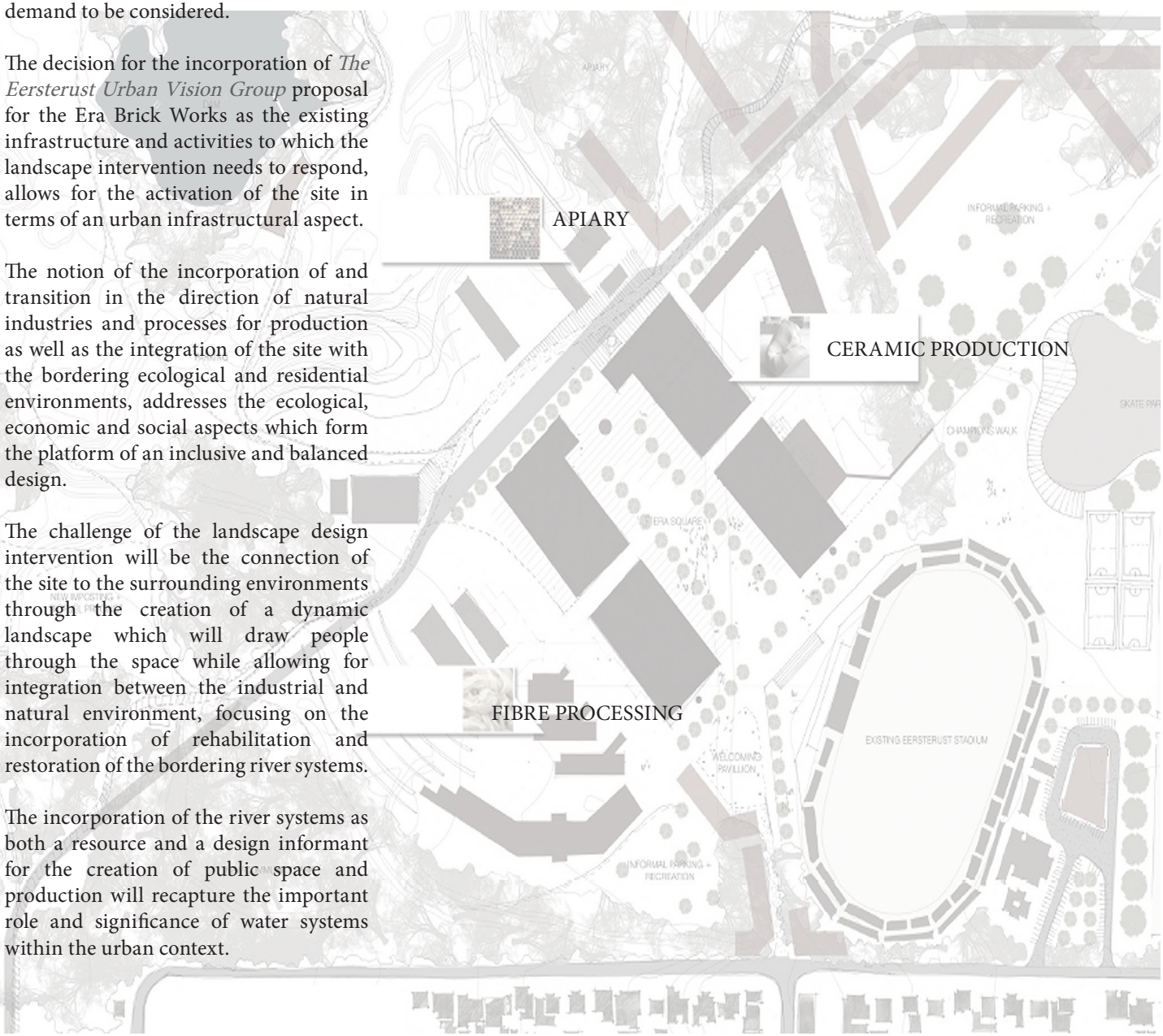

Figure 2.4.1: Eersterust Urban Vision GroupMaster Plan proposal (Taljaard, Von Geyso and Pansengrouw, 2013)

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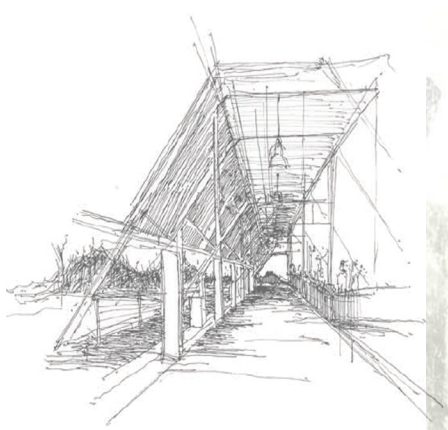

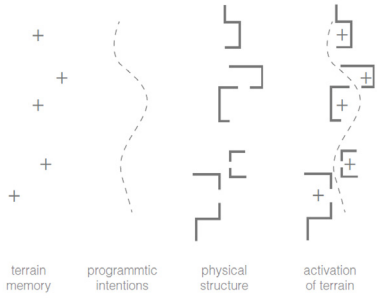

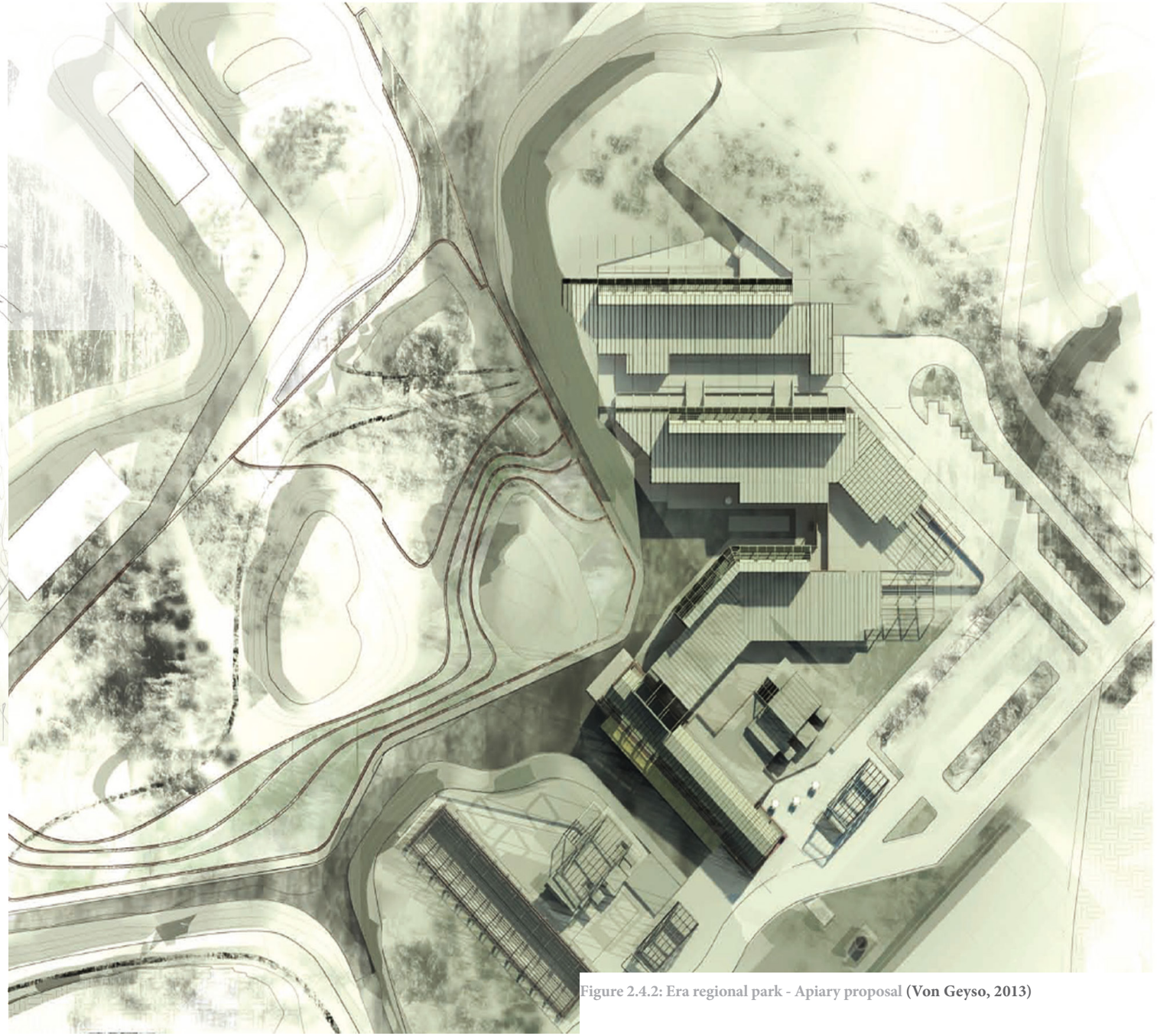

Figure 2.4.2: Era regional park - Apiary proposal **(Von Geyso, 2013)**

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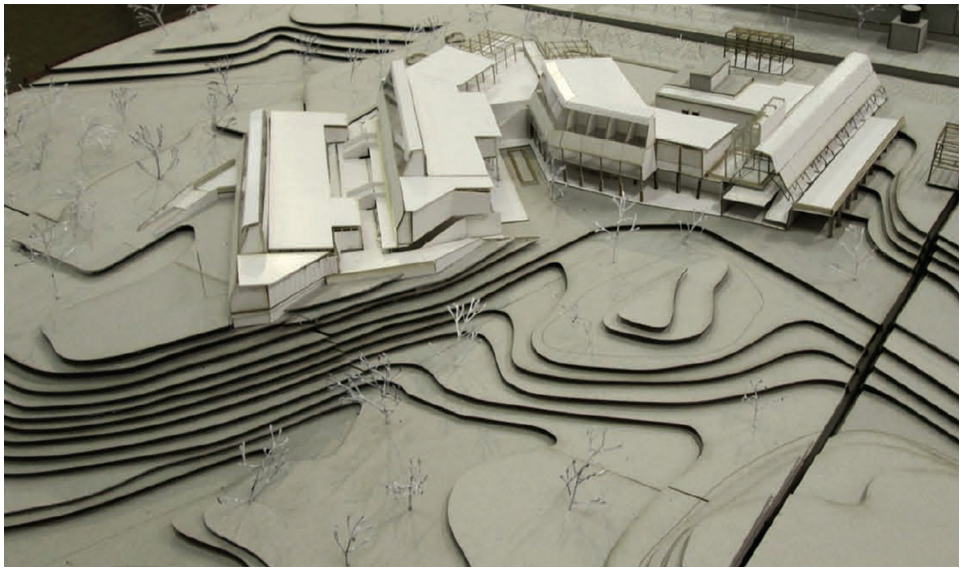
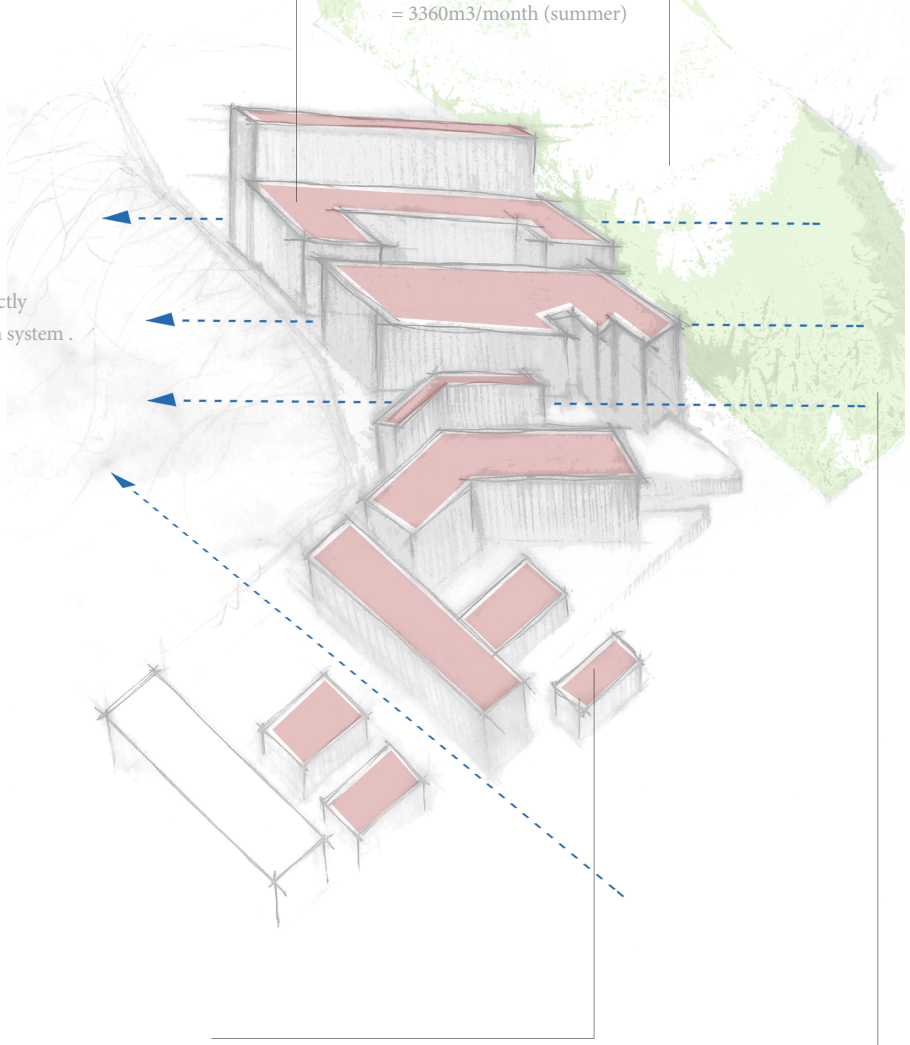


All rainwater harvested from the roofs will be used in the systems and processes in the Apriary; No water will be contributed to the stormwater runoff system.

Bee garden irrigation is included in the stormwater management system. The total demand for the bee garden is 35 910m3
= 2625m3/month (winter)
= 3360m3/month (summer)

Runoff directed into quarry. Directly related to stormwater purification system .



Water purification in a closed system incorporated into the existing buildings on site. The water needs to be purified to a potable water quality.

Bee garden runoff will drain directly into the quarry purification system.
Bee garden runoff = 5284m3/year.

Figure 2.4.3: Apiary investigation and design proposal
(Von Geyso, 2013)

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INCLUSION OF APIARY IN LANDSCAPE INTERVENTION

The water strategy proposal for the Apiary is successful due to the fact that it is able to harvest suffiient water from its roofs to be able to provide for the domestic water demand.

The water strategy includes the transformation of one of the existing buildings on site into an indoor wetland, the use of this building to house a natural system is not encouraged and rather proposed to be incorprated as an outdoor interactive and experiential element within the landscape.

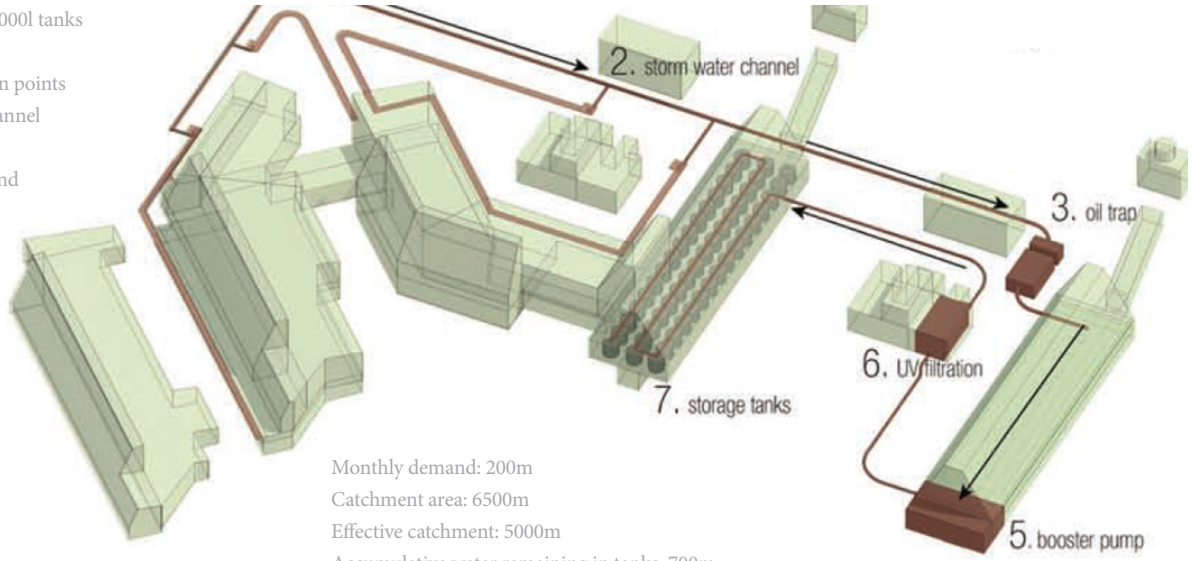
The indoor wetland is to be incorporated into the authors proposed water strategy and purification system and thus, the water demand for the apiary needs to be taken into consideration in the authors water calculations.

The rest of the water system will remain the same as stated in the proposal for the Apiary.

The irrigation of the bee garden has not been taken into consideration in the water strategy and therefore needs to be incorporated into the overall water demand for the site which will be provided for by the landscape intervention water strategy.

Proposal: 70 x 10 000l tanks

1. runoff collection points
2. storm water channel
3. oil trap
4. artificial weetland
5. booster pump
6.UV filtration
7.storage tanks



Monthly demand: 200m
Catchment area: 6500m
Effective catchment: 5000m
Accumulative water remaining in tanks: 700m

Effective irrigation: 10 000m
Total area for irrigation: 21 000m
Water requirement per month (summer): 3360m
Water requirement per month (winter): 2625m
Approximate reservoir size: 1200m

a. clay pit and water body
b. sludge pump
c. water reservoir
d. water channel and sluices
e. detention pond
f. discharge pipe

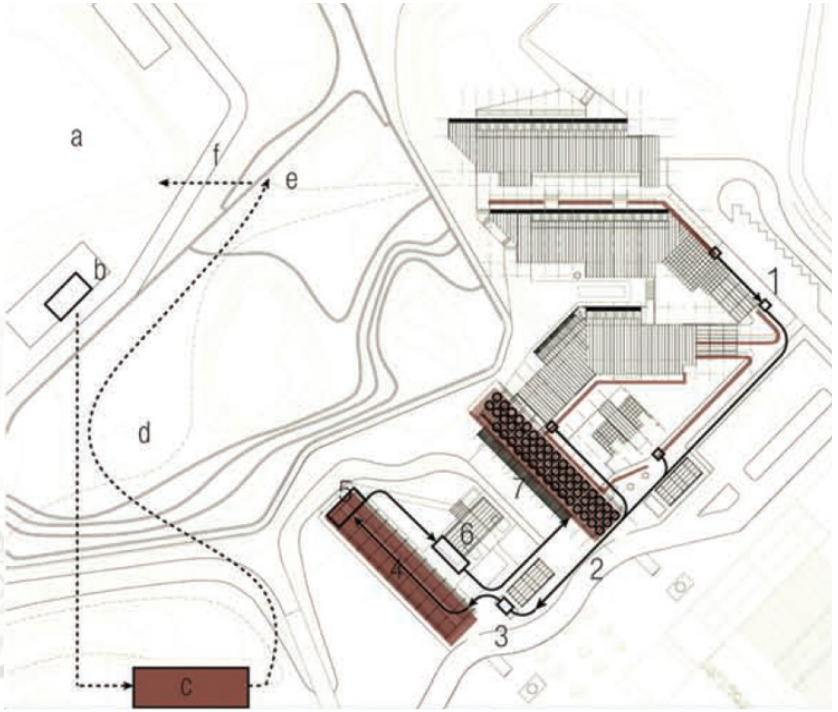


Figure 2.4.4: Apiary systems and processes (Von Geyso, 2013)

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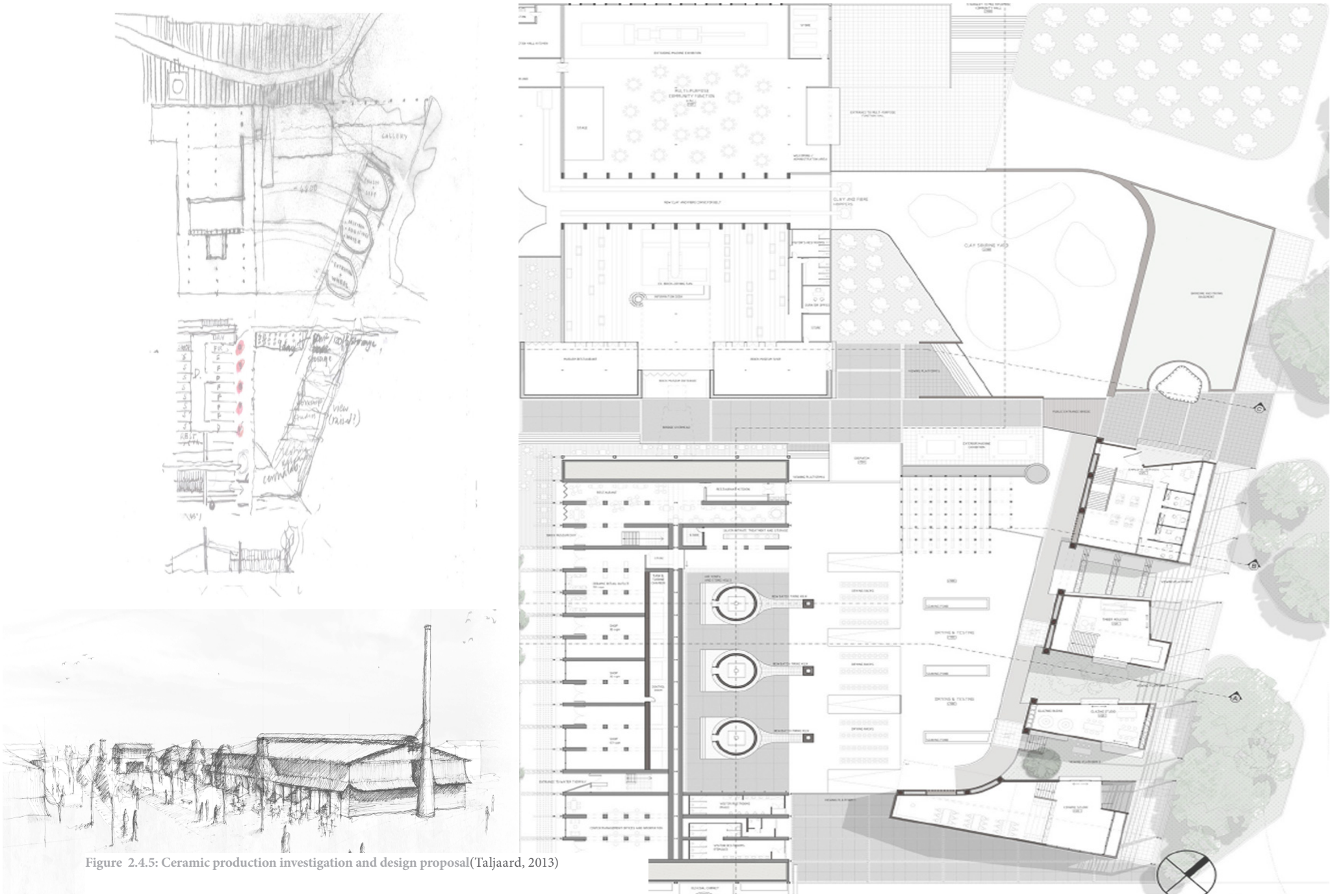

Figure 2.4.5: Ceramic production investigation and design proposal(Taljaard, 2013)

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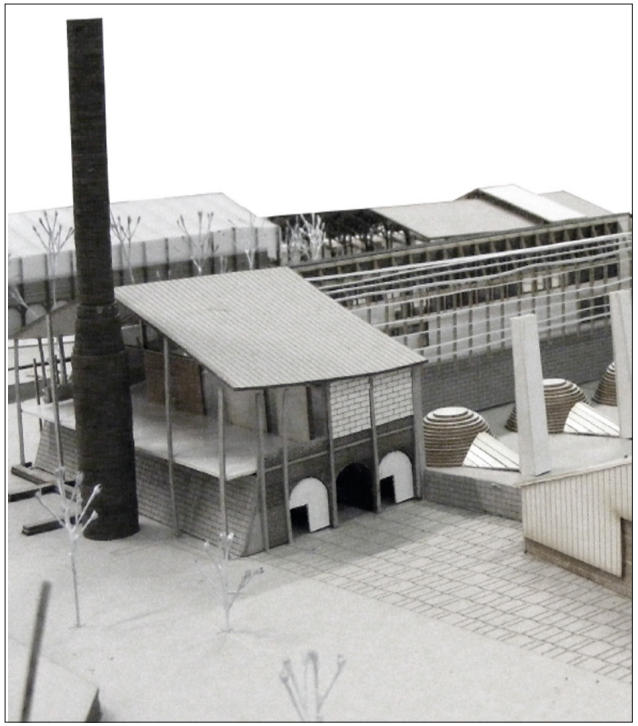
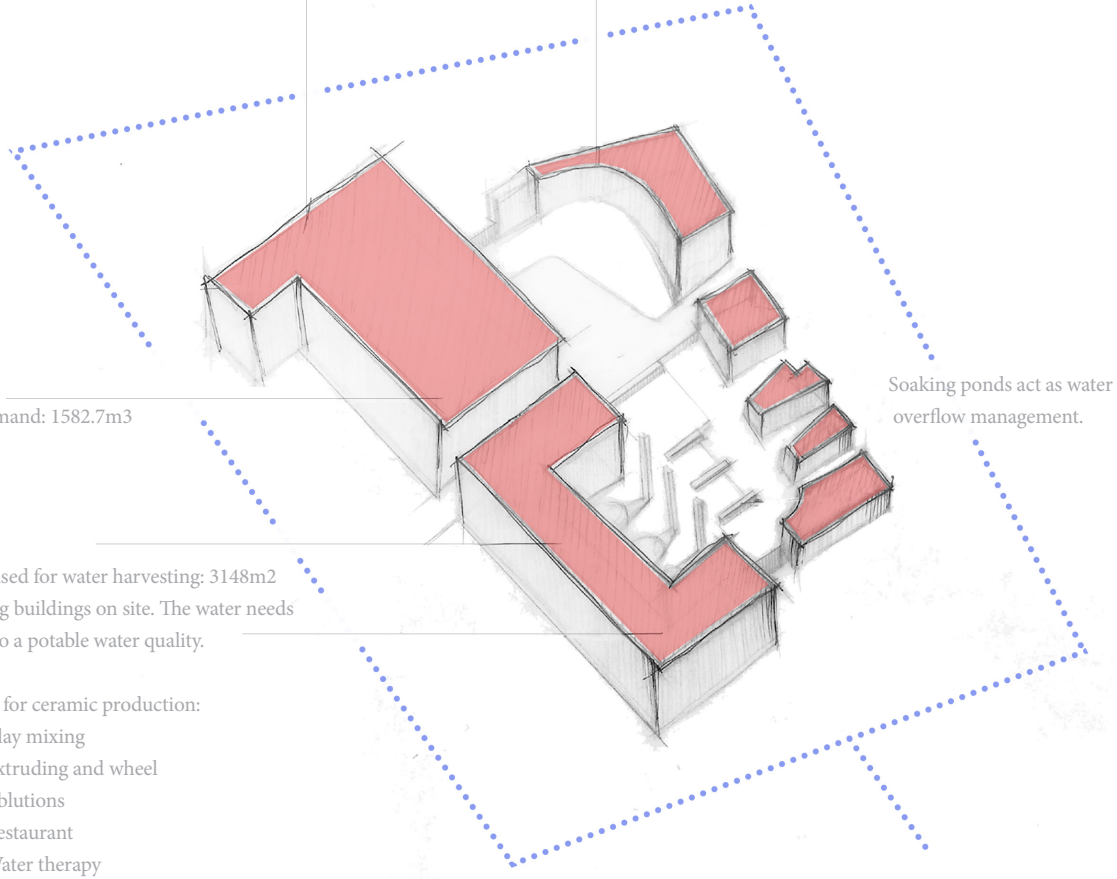


Roof harvested water is not included in landscape water calculations, all water is used in system to meet demands and requirements for ceramic production and domestic demand.

Stormwater runoff for ground surface water has not been addressed for the ceramic production area. The hardscaping surrounding buildings will be included in authors stormwater calculations for landscape intervention.



Total water demand: 1582.7m3

Soaking ponds act as water overflow management.

Total rof area used for water harvesting: 3148m2 into the existing buildings on site. The water needs to be purified to a potable water quality.

Water demand for ceramic production:

- Clay mixing
- Extruding and wheel
- Ablutions
- Restaurant
- Water therapy
- Cleaning

Stormwater runoff from hardscaping added to water purification system and used for irrigation.

Figure 2.4.6: Ceramic plant evaluation (Taljaard, 2013)

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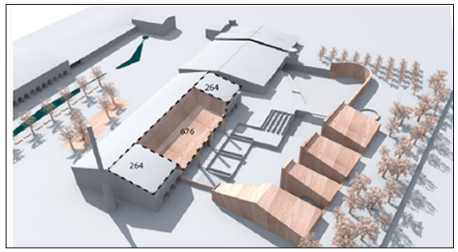
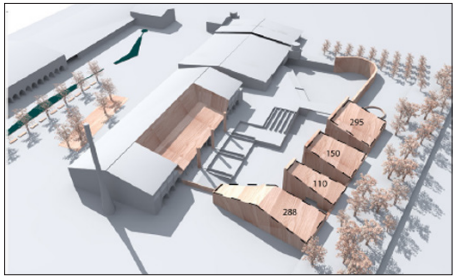
INCLUSION OF CERAMIC PRODUCTION IN LANDSCAPE INTERVENTION

The ceramic production plant is not taken into consideration for the authors landscape water calculations in terms of demand, the water demand is met by the water harvested from the roofs of the buildings. The ground surface runoff however has not been incorporated into the river strategy and will be included in water harvesting calculations.

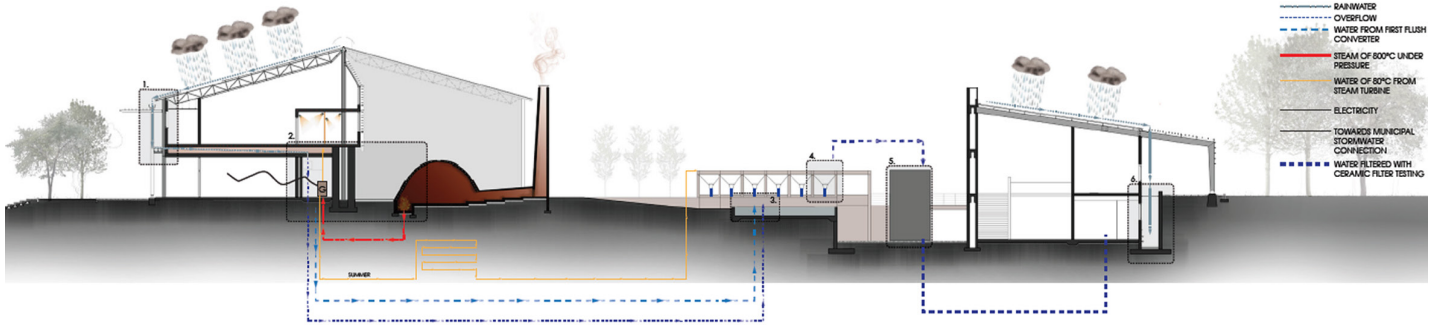
FIRING KILN BUILDING - EAST



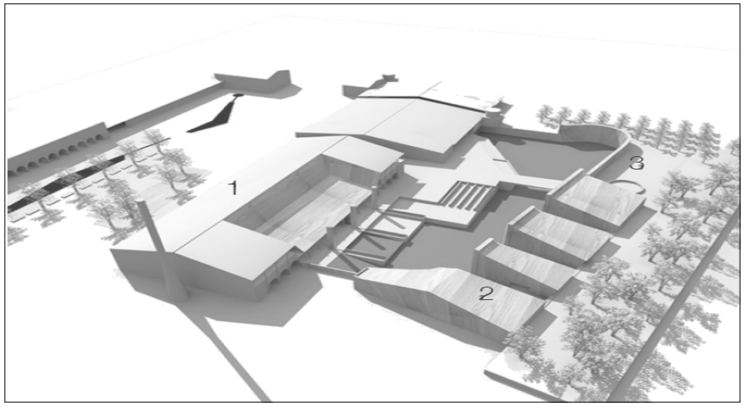
FIRING KILN BUILDING - WEST



EASTERN ADDITION

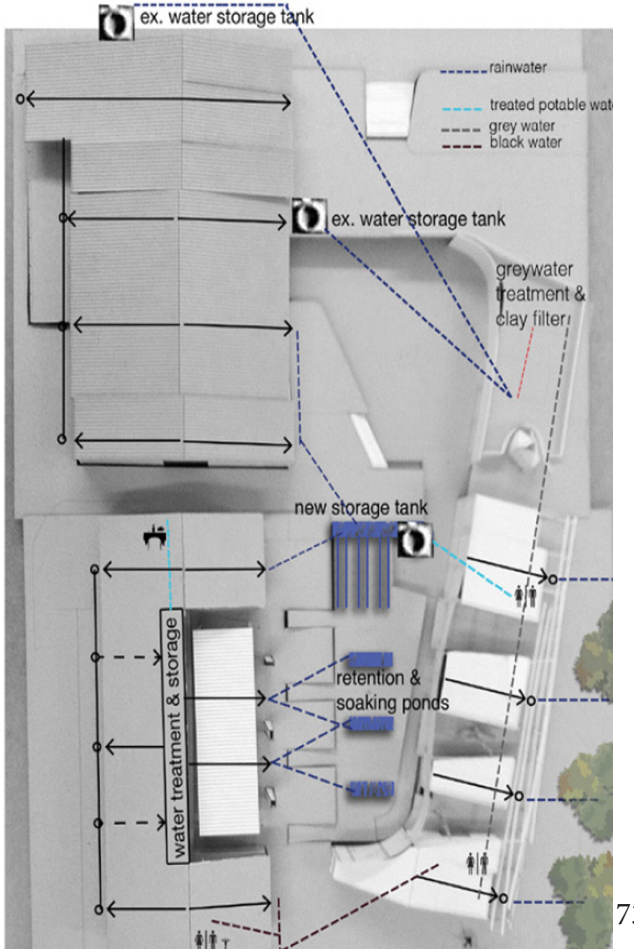


1. 3350l of water per tonne of cermaic product produced.
2. 2800l can be reused as greywater.
3. Production aim - 4 - 4.5 tonnes of ceramic products per day = 15kl of water per day.
4. Water not required to be potable, but must be oil free.
5. Old drying shed roof harvesting of water.
6. Stored in existing water tanks on site.
7. Relies on gravity flow for transportation.
8. Firing kiln roof harvesting - stored in service core and underground tanks. Used for restaurant, offices and public ablutions.
9. Ceramic filters - indirect filtration process - used for showers, sinks and flushing.



Approach to Systems:

1. Old firing kilns which now house offices and retail spaces located to the west, with new batch firing kilns located to the east.
2. The basement grinding and mixing workshops.
3. The studio, workshops and employee services building.



WATER SYSTEM

Figure 2.4.7: Ceramic plant system and process investigation (Taljaard, 2013)

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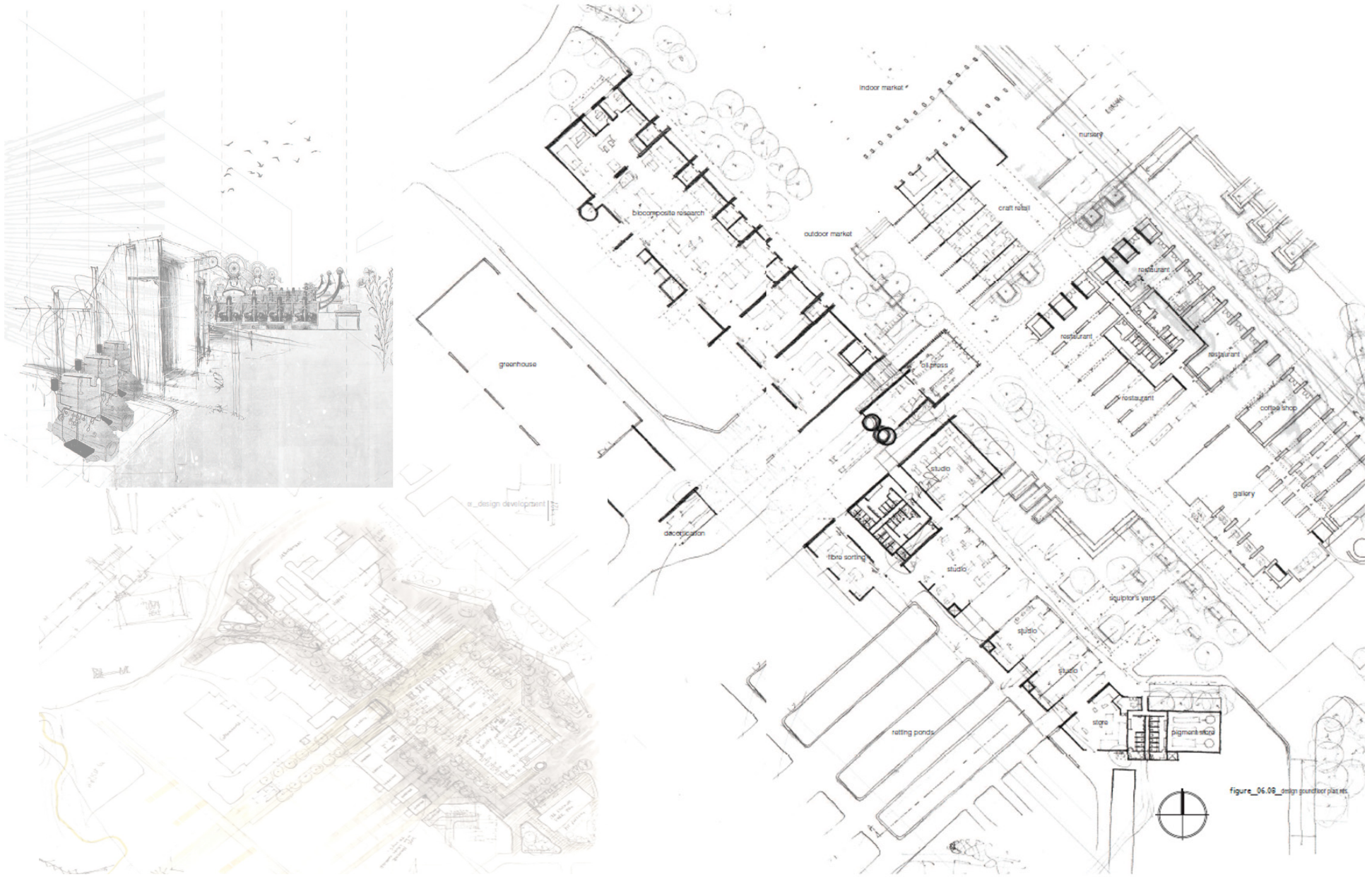

Figure 2.4.8: Fibre processing plant investigation and design proposal (Pansengrouw 2013)

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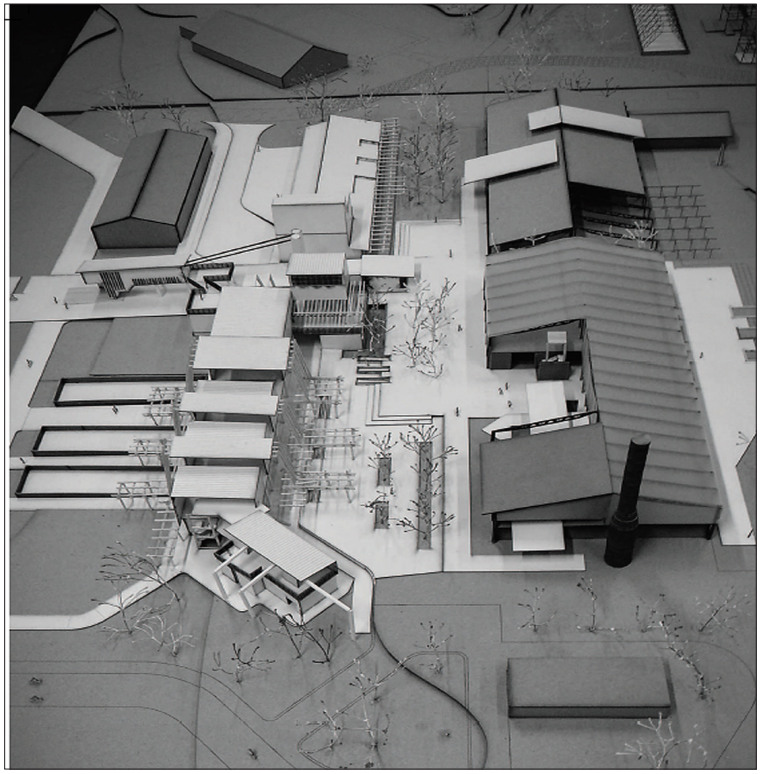

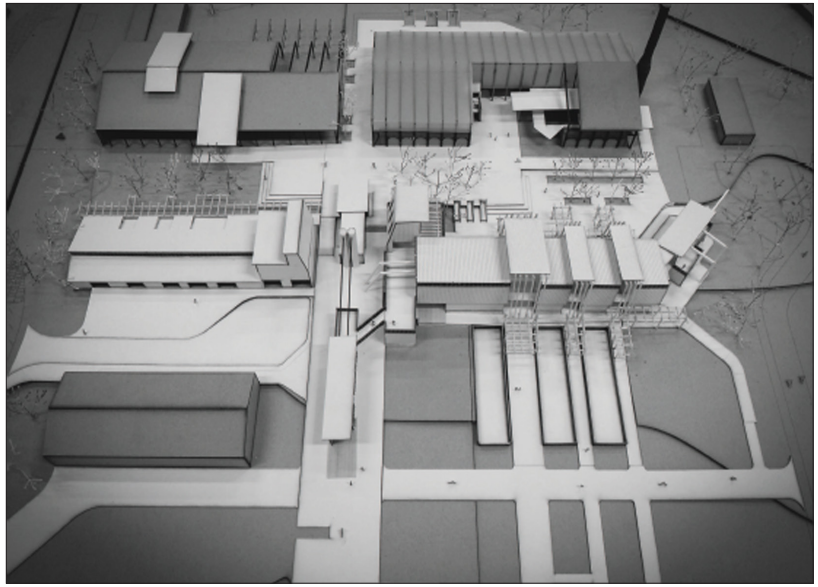

Figure 2.4.9: Fibre processing plant evaluation (Pansengrouw 2013)

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INCLUSION OF FIBRE PROCESSING IN LANDSCAPE INTERVENTION

The fibre processing plant is able to supply all water demands from the water harvested from the roofs of the buildings. No water from roofs will be taken into consideration during the authors water calculations.

The ground surface runoff from surrounding hardscape will not be included in stormwater calculations directly but will automatically be included in water calculations regarding the river system as the water stormwater naturally drains into the Moreleta spruit.

The agricultural demand for the growth of flax and bamboo has not been taken into consideration in the water strategy and will therefore be a water demand that will be provided by the authors landscape intervention and water strategy.

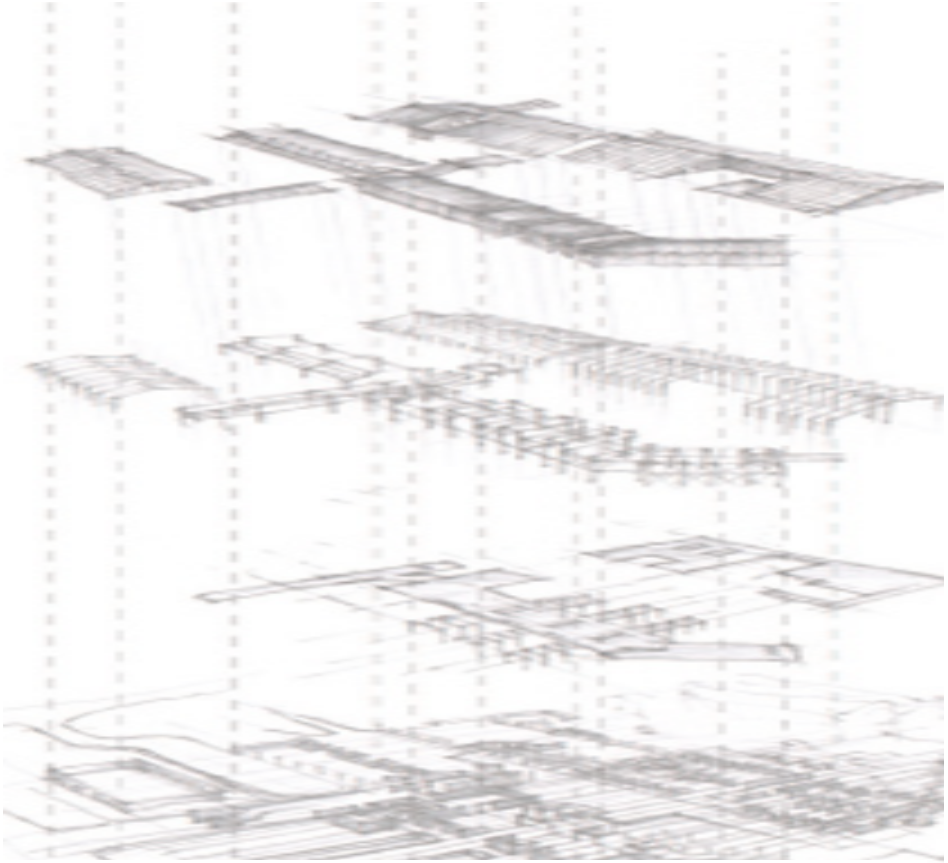
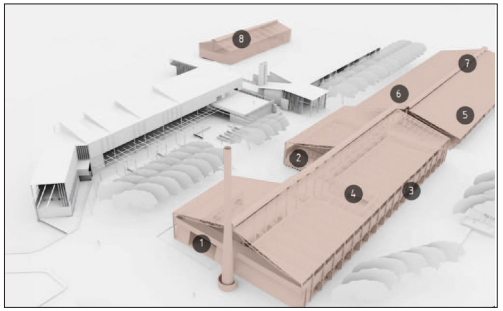


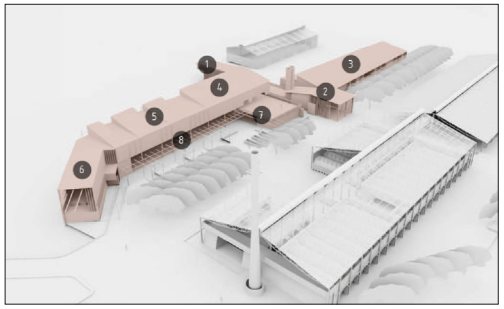
Figure 2.4.10: Fibre processing plant system and processes investigation
(Pansengrouw 2013)

EXISTING BUILDING PROGRAMMATIC ORGANISATION



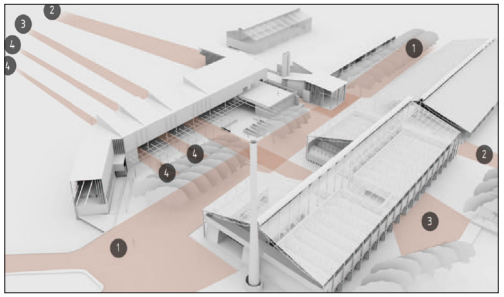
1. Fibre Gallery
2. Coffee shops
3. Restaurant
4. Greenhouse
5. Nursery
6. Retail
7. Market
8. Greenhouse

INTERVENTION PROGRAMMATIC ORGANISATION



1. Decortication
2. Oil press
3. Biocomposites
4. Spinning
5. Weaving
6. Dyeing
7. Sculptor studio
8. Artist studio

PUBLIC ROUTES



1. Primary
2. Secondary
3. Tertiary
4. Semi-private

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These proposals have been accepted into this dissertation to be the existing and the manner in which the landscape intervention will include and respond to the architectural and framework proposals. The buildings and related activities have been accepted as existing.

The Master Plan Proposal Evaluation and Critique

After the evaluation of the masterplan proposed by *The Eersterust Urban Vision Group*, there are a number of interventions which have been addressed and evaluated as necessary for the implementation of a landscape design proposal, evaluation of the master plan was conducted in the manner as any other existing site would have been, opportunities and constraints as well as possible alterations have been developed.

Individual Architectural Design Analysis

The individual designs have been taken into consideration and all proposed functions and activities have been accepted as existing. The water strategies proposed by both the fibre processing industry and the ceramic production industry are both accepted. Both industries have proposed roof harvesting of water which provides sufficient water for all requirements, these roofs and water demands have been excluded from the landscape intervention water strategies and calculations.

In terms of the Apiary and honey processing industry, the water harvesting from the roof was sufficient to meet all water demands, however the incorporation of an indoor wetland and UV filtration process in one of the existing structures reconsidered for the incorporation into the larger water strategy to be proposed by the landscape intervention.

The roof of the apiary will be the only roof water harvested to contribute to the overall stormwater management strategy of the site and the only industrial water demand to be considered.

The decision for the incorporation of *The Eersterust Urban Vision Group* proposal for the Era Brick Works as the existing infrastructure and activities to which the landscape intervention needs to respond, allows for the activation of the site in terms of an urban infrastructural aspect.

The notion of the incorporation of and transition in the direction of natural industries and processes for production as well as the integration of the site with the bordering ecological and residential environments, addresses the ecological, economic and social aspects which form the platform of an inclusive and balanced design.

The challenge of the landscape design intervention will be the connection of the site to the surrounding environments through the creation of a dynamic landscape which will draw people through the space while allowing for integration between the industrial and natural environment, focusing on the incorporation of rehabilitation and restoration of the bordering river systems.

The incorporation of the river systems as both a resource and a design informant for the creation of public space and production will recapture the important role and significance of water systems within the urban context.

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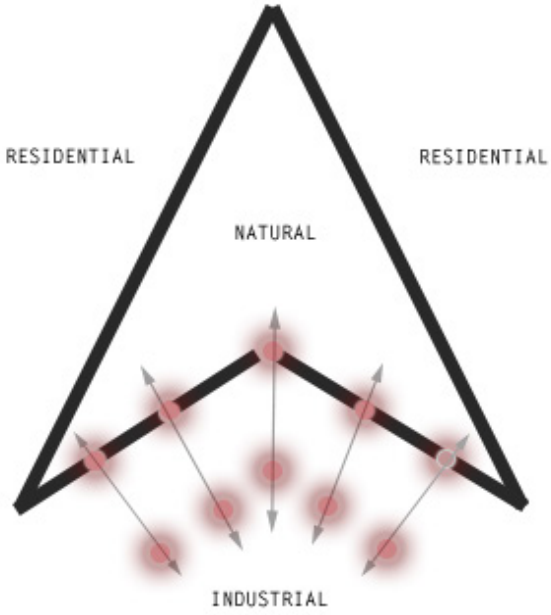

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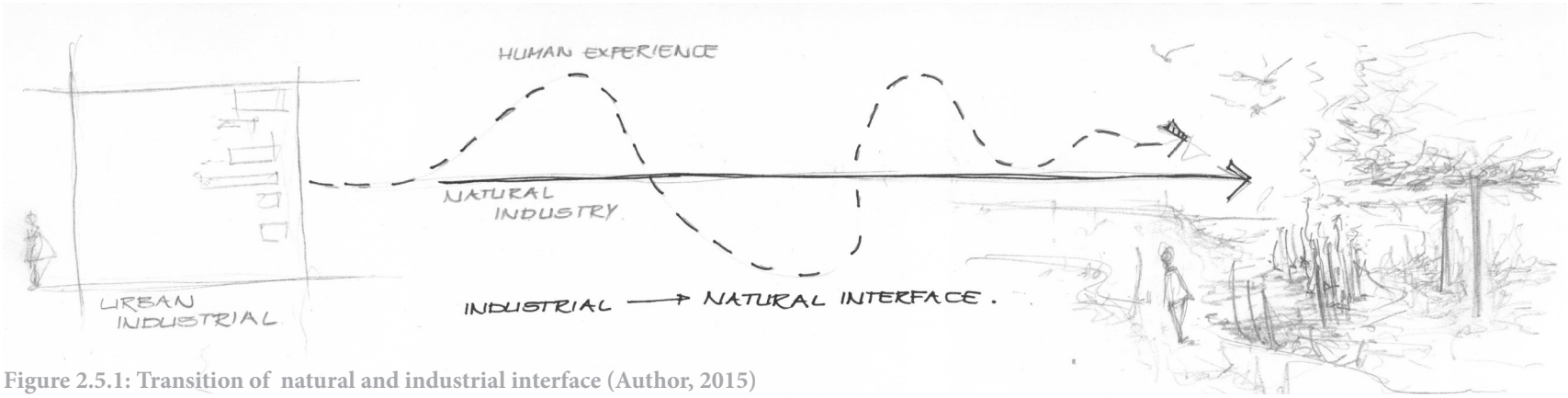
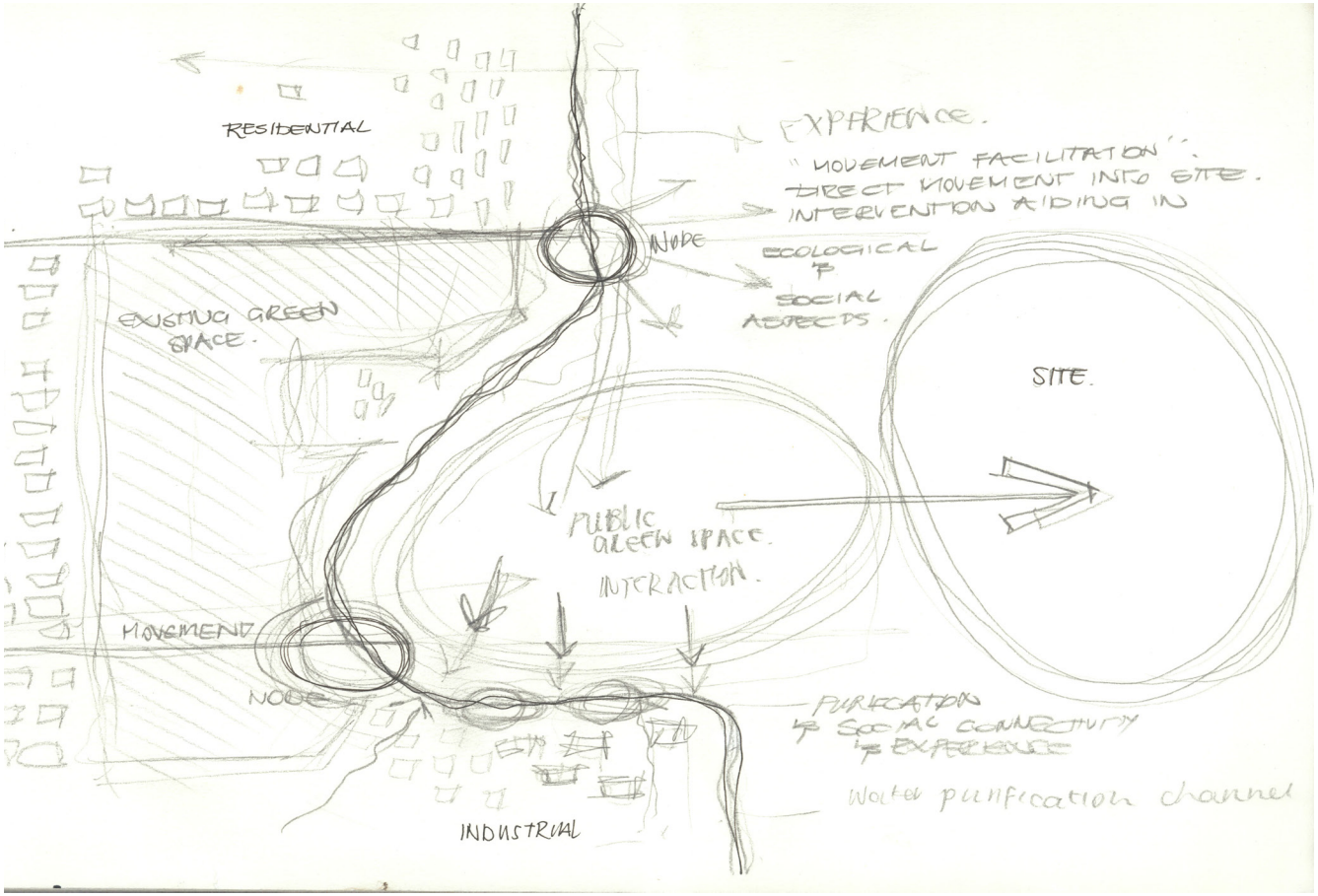


Figure 2.5.1: Transition of natural and industrial interface (Author, 2015)



The main intention of the design is the integration and immersion of man into the natural environment. The deelopment and desiign of the interface between industrial and natural environments. The creation of various levels of connections between people and environments.

Figure 2.5.2: Linking surrounding residential environment to the design intervention (Author, 2015)

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RIVER RESTORATION

The main intention of the intervention was the purification of the Moreleta Spruit. Focusing on both the Moreleta Spruit and the Rietspruit tributary, these two rivers border the site and converge to the north of the quarry.

The river systems are the most prominent and important element in the design, forming the base on which the rest of the design will be built and feed from. Each river system will be purified through the incorporation of a number of purification processes which deal with the type of effluent and pollutants present in the water, enhancing the river system and associated ecologies.

This phase is concerned with ecological connectivity.

Figure 2.5.3: Concept Development Diagram for Ecological Connection - River Purification (Author, 2015)

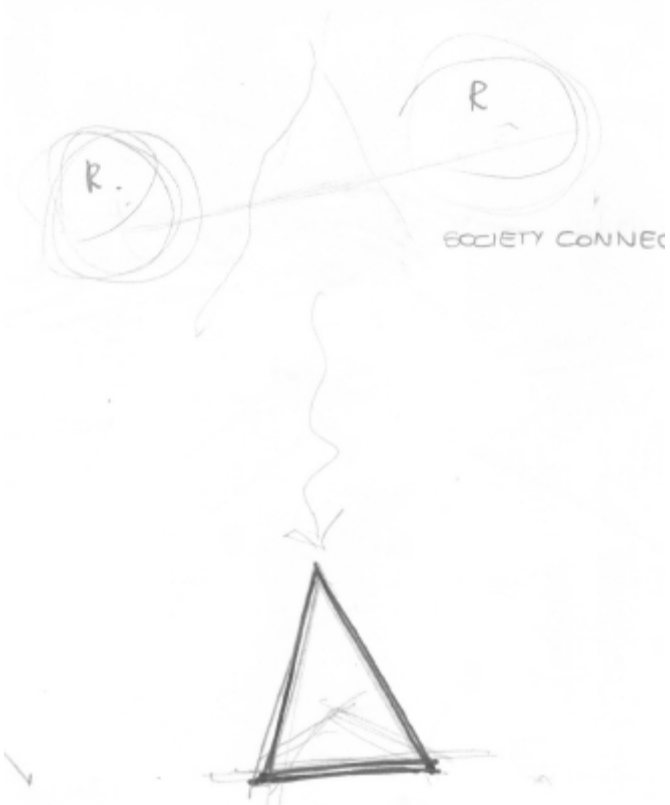

Figure 2.5.4: Concept Development Diagram for Social Connection (Author, 2015)

SOCIAL CONNECTION

The next development of the scheme was the connection of the separated societies of Jan Niemand Park and Eersterust, the connection forms a bridge between the two river systems and falls directly across the quarry, crossing both the historical infrastructural and natural boundaries.

This phase is concerned with the social connectivity between people, communities and societies.

RIVER AS A MEANS OF CONNECTION

As the connection between societies was defined through the bridge, the incorporation of water through the diversion of a portion of each river system, serves as both a visual and physical connection between societies.

The diversion of both the Moreleta Spruit and the Rietspruit into the quarry aids in connection and rehabilitation in a number of ways.

Firstly, the visual and physical connection of the river, emphasizing the social and now ecological connection between distanced communities transforms the river from a natural barrier into a means of connection.

Secondly, the manipulation of the river system into the decommissioned quarry is a means of bringing life back into a deserted space.

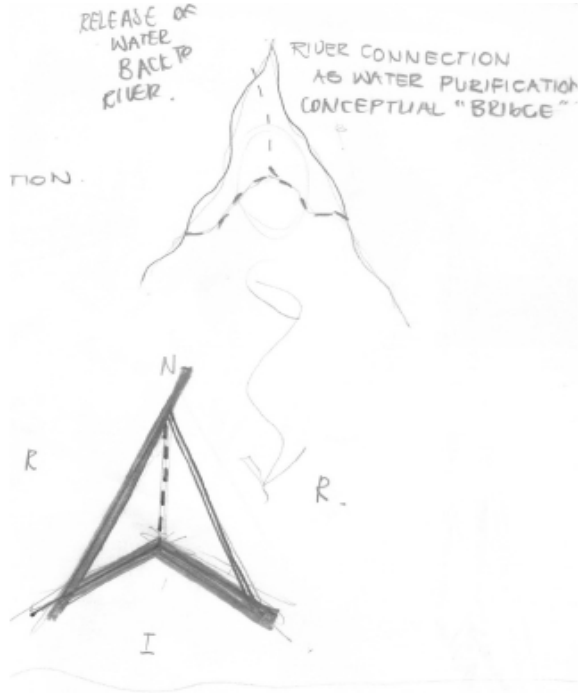

Figure 2.5.5: Concept Development Diagram for Physical Connection (Author, 2015)

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ECONOMIC AND NATURAL INTEGRATION

Addressing the economic aspect which is brought to the intervention through the post-industrial landscape is an important interface and connection between the industrial and natural environments.

The river becomes the transition between the urban industrial environment and the natural environment through the incorporation of economic activities which rely on the river system for production. The transition from the urban environment to the natural environment in the quarry itself is experienced as a process of immersion in nature.

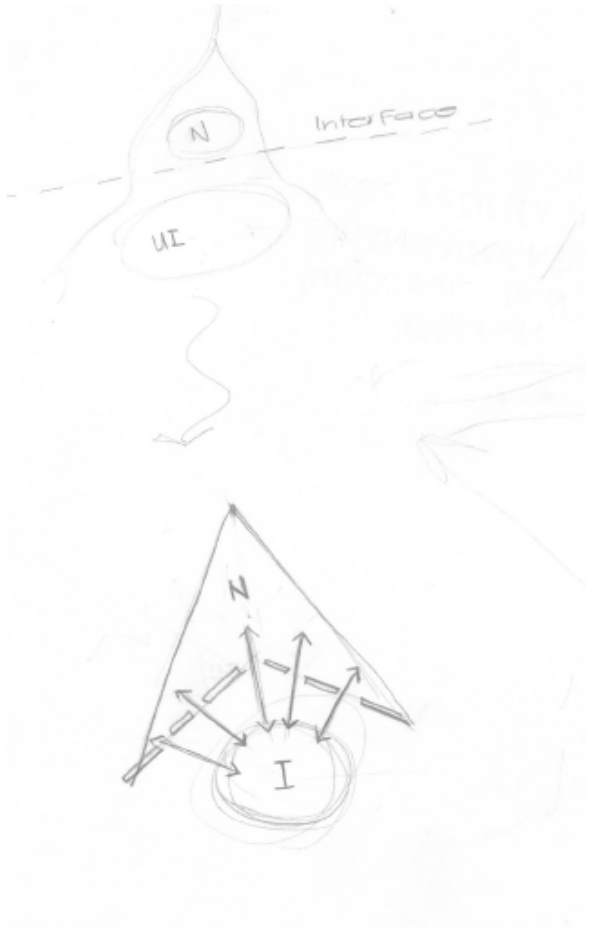

Figure 2.5.6: Concept Development Diagram for Natural Integration (Author, 2015)

SOCIAL INTERACTION, CREATION OF PUBLIC SPACE, PROCESS OF IMMERSION

The success of the connection created through the intervention depends on the social interaction, access and understanding of the importance and significance of the urban river system in terms of ecological, economic and social aspects.

The activities and levels of interaction which takes place along the connection will be responsible for its activation, providing public space and promoting human interaction with one another and the natural environment while experiencing natural systems and processes responsible for production within the industrial environment.

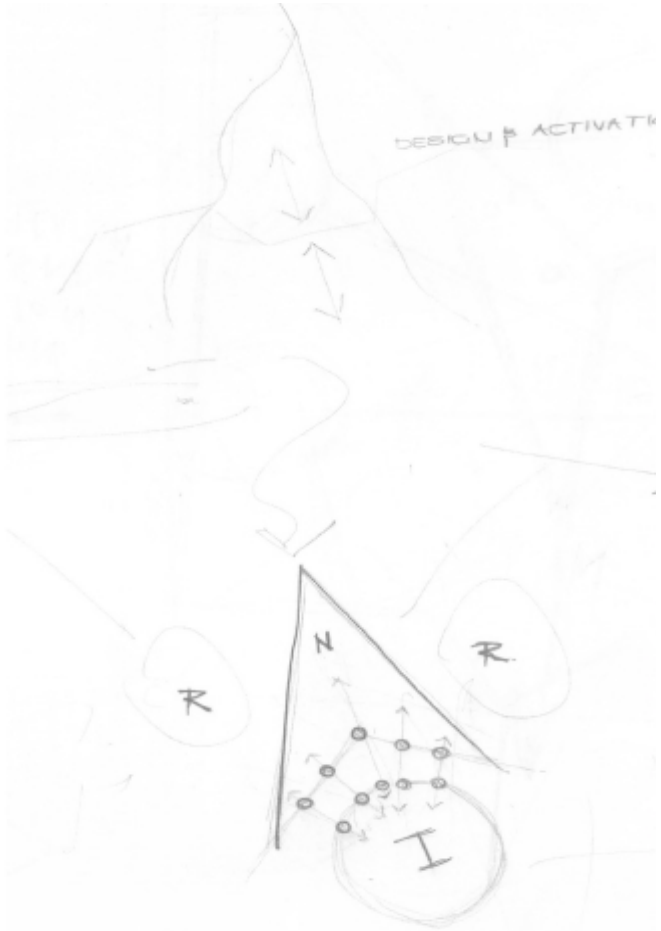

Figure 2.5.7: Concept Development Diagram for Immersion (Author, 2015)

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CHAPTER 6: DESIGN DEVELOPMENT

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INTEGRATING M AN AND THE NATURAL ENVIRONMENT

HYPOTHESIS

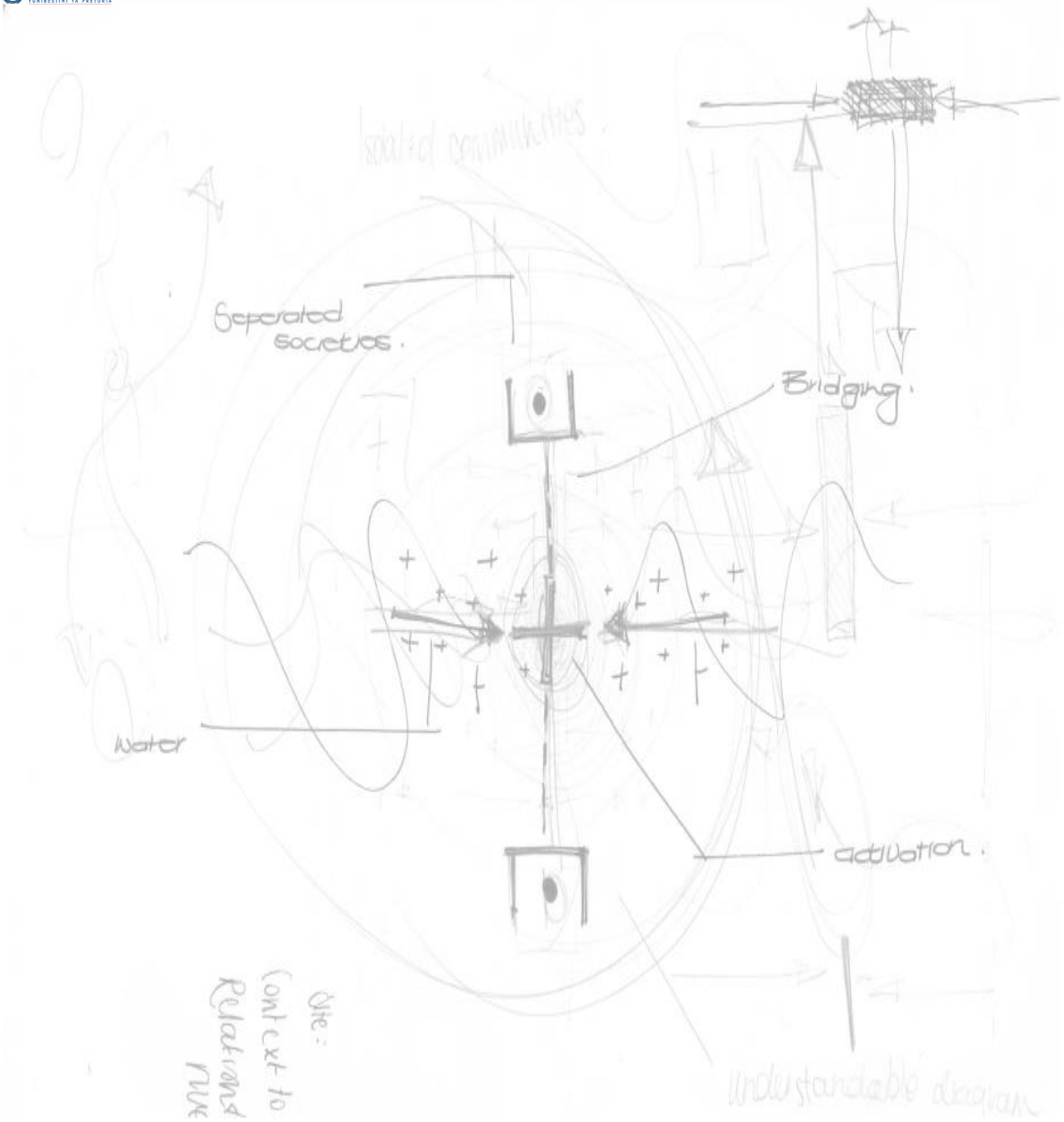
Integrating the public realm of the urban environment with areas of void or wasted landscape, through the use of rehabilitation systems and processes of the Moreleta Spruit as a design generator and informant for the site, will connect man on various levels to the natural and urban environments.

Through the incorporation of social, ecological and economic aspects, informed by the natural environment, the wasted landscape is transformed through the integration of the natural environment, into a public space centred on the interaction, education and awareness of the complexity and significance of urban river ecosystems.

DESIGN QUESTION

Can the rehabilitation of a polluted resource and the associated surrounding environment become a connecting feature with an impact on the surrounding environment?

Through enhancing the spatial quality of the rehabilitation process and incorporation of these processes into economic and social aspects of the intervention, will the public realm be drawn into the previously wasted landscape connecting man and the environment through common participation and experience?



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CONTOUR MANIPULATION

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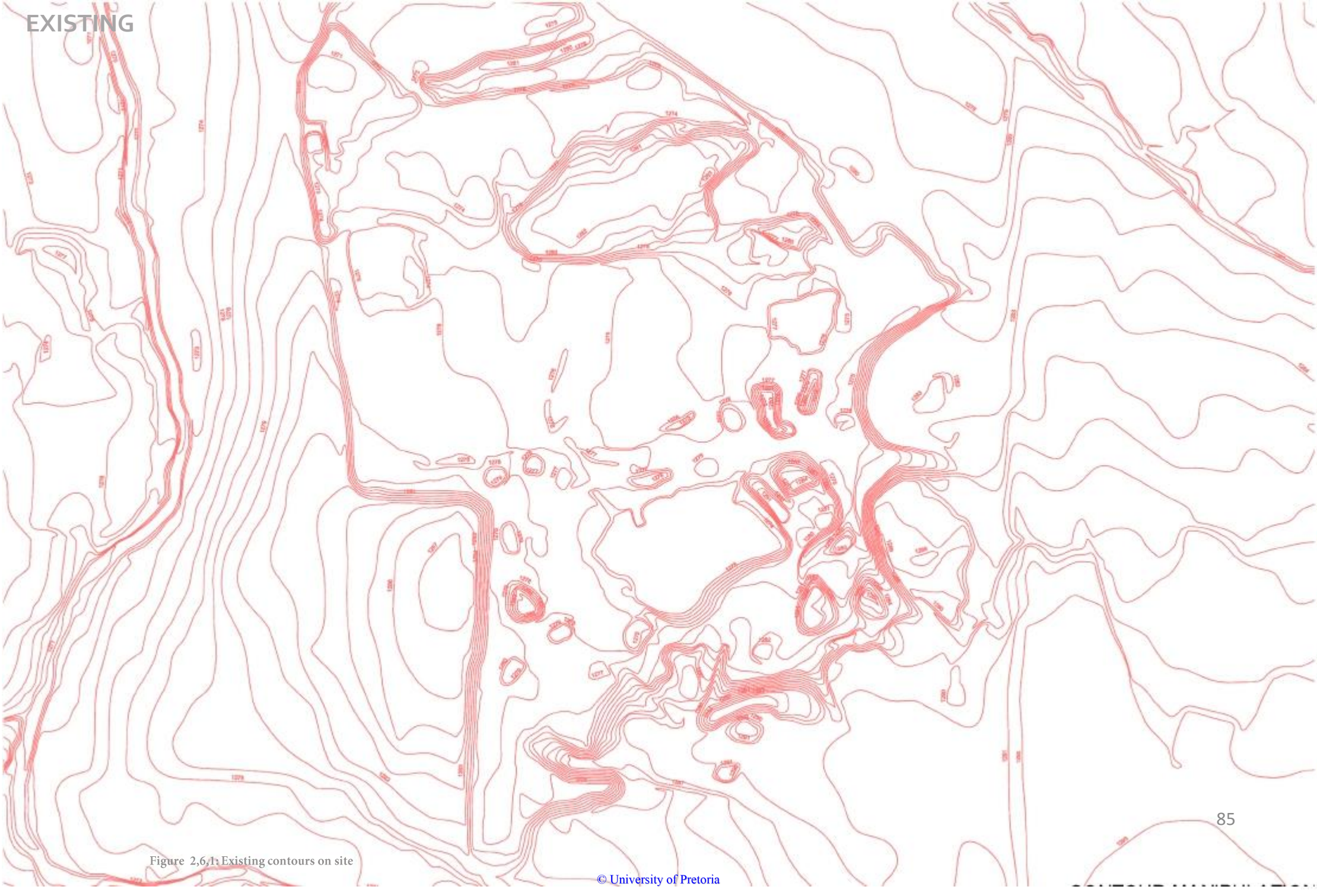

Figure 2,6,1: Existing contours on site

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MANIPULATED

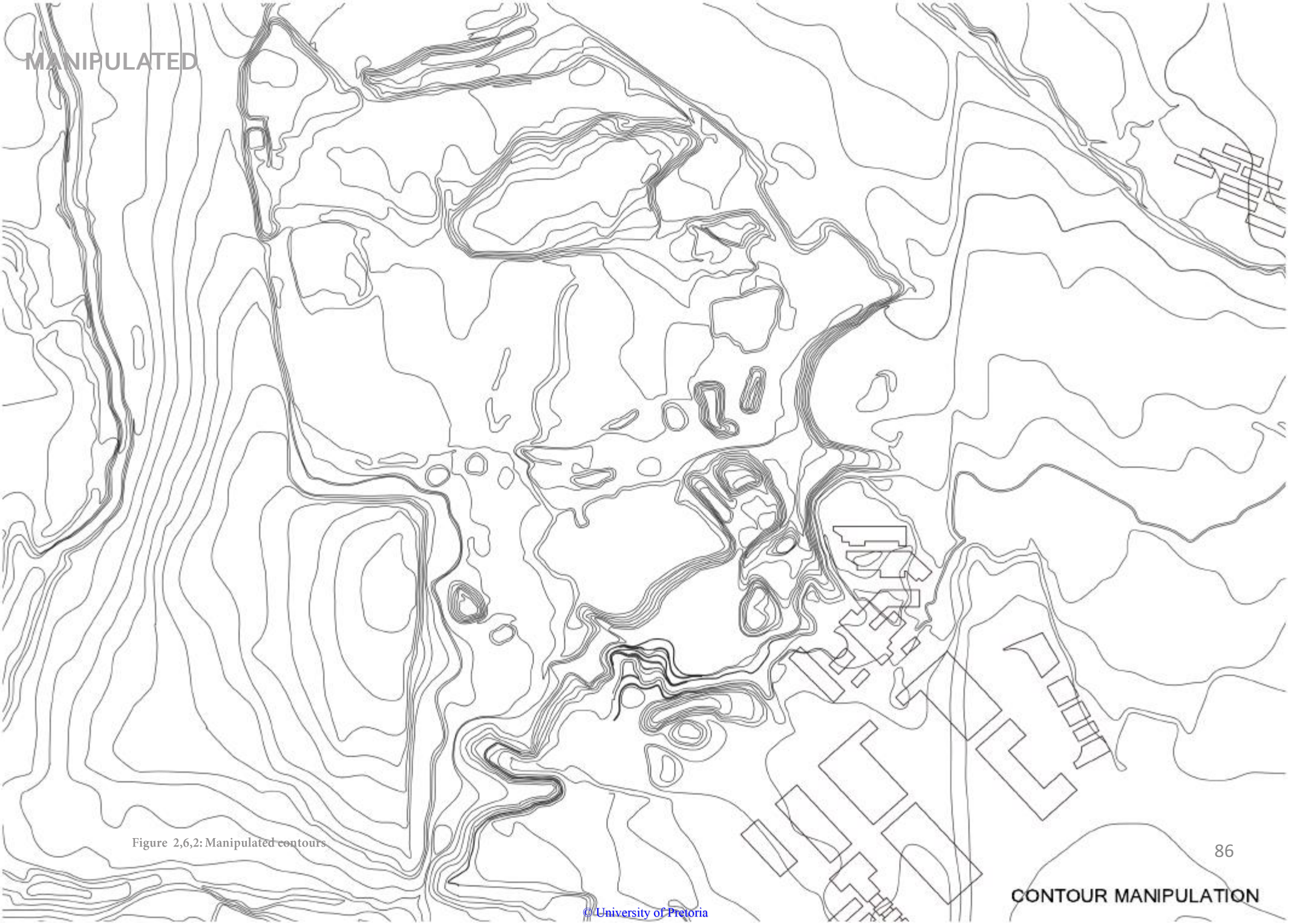

Figure 2,6,2: Manipulated contours

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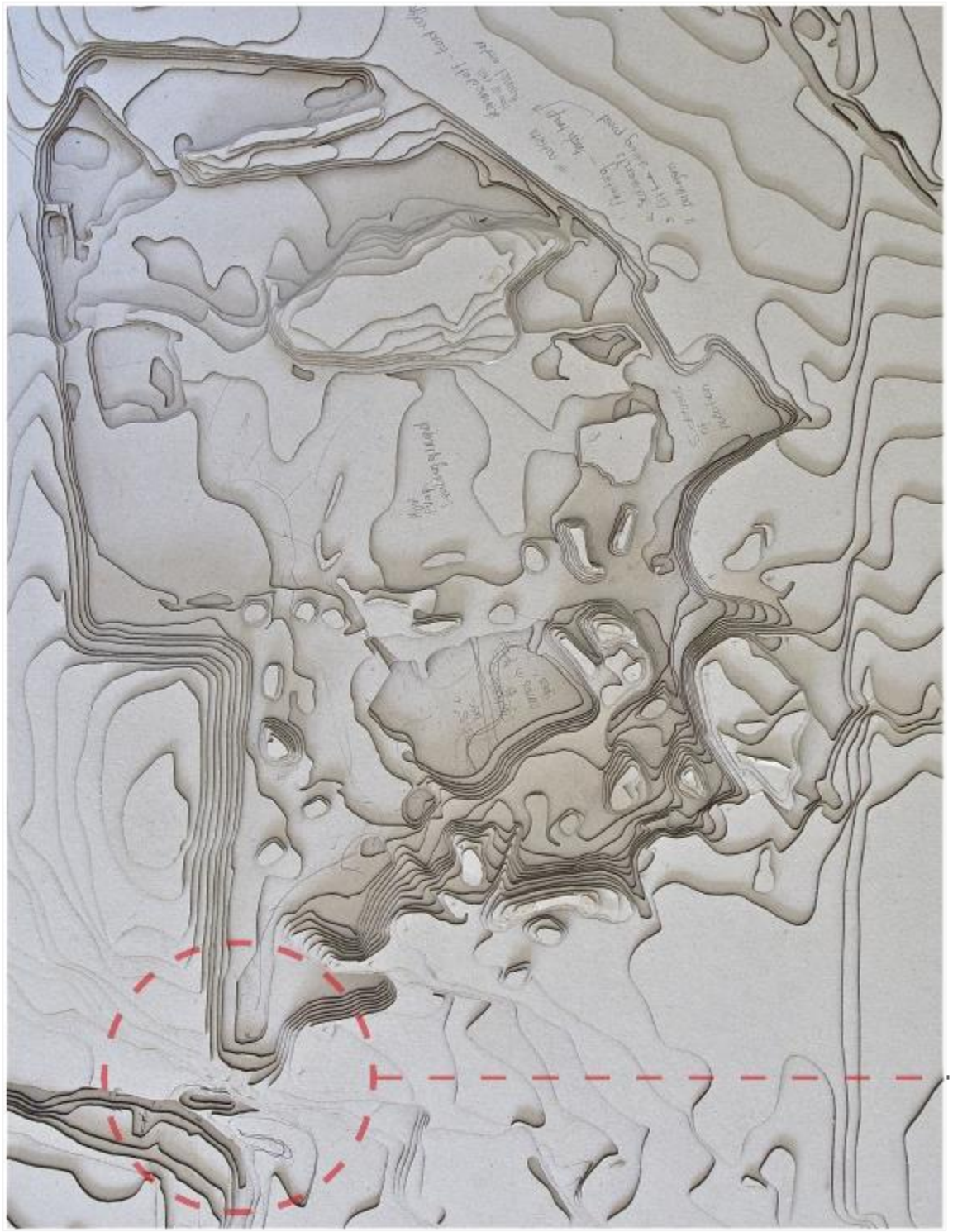

EXISTING CONTOURS BEFORE MANIPULATION FOR RIVER DIVERSION

Figure 2,6,3: Manipulated contours model investigation

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The main contour manipulation which was required related to the diversion of the Moreleta Spruit in to the purification system designed in the Era Brick Works Quarry. The presence of a ridge as well as the change in levels from the river to the proposed purification was resolved by removing the ridge through the excavation and creation of a narrow channel through which water would be able to flow from the dam. The dam was a result of contour manipulation and alterations of water levels in the existing river system, the dam allowed for the raising of the water level for the free flow water system in to the purification channels and wetlands.

Figure 2,6,4: Main river diversion manipulation

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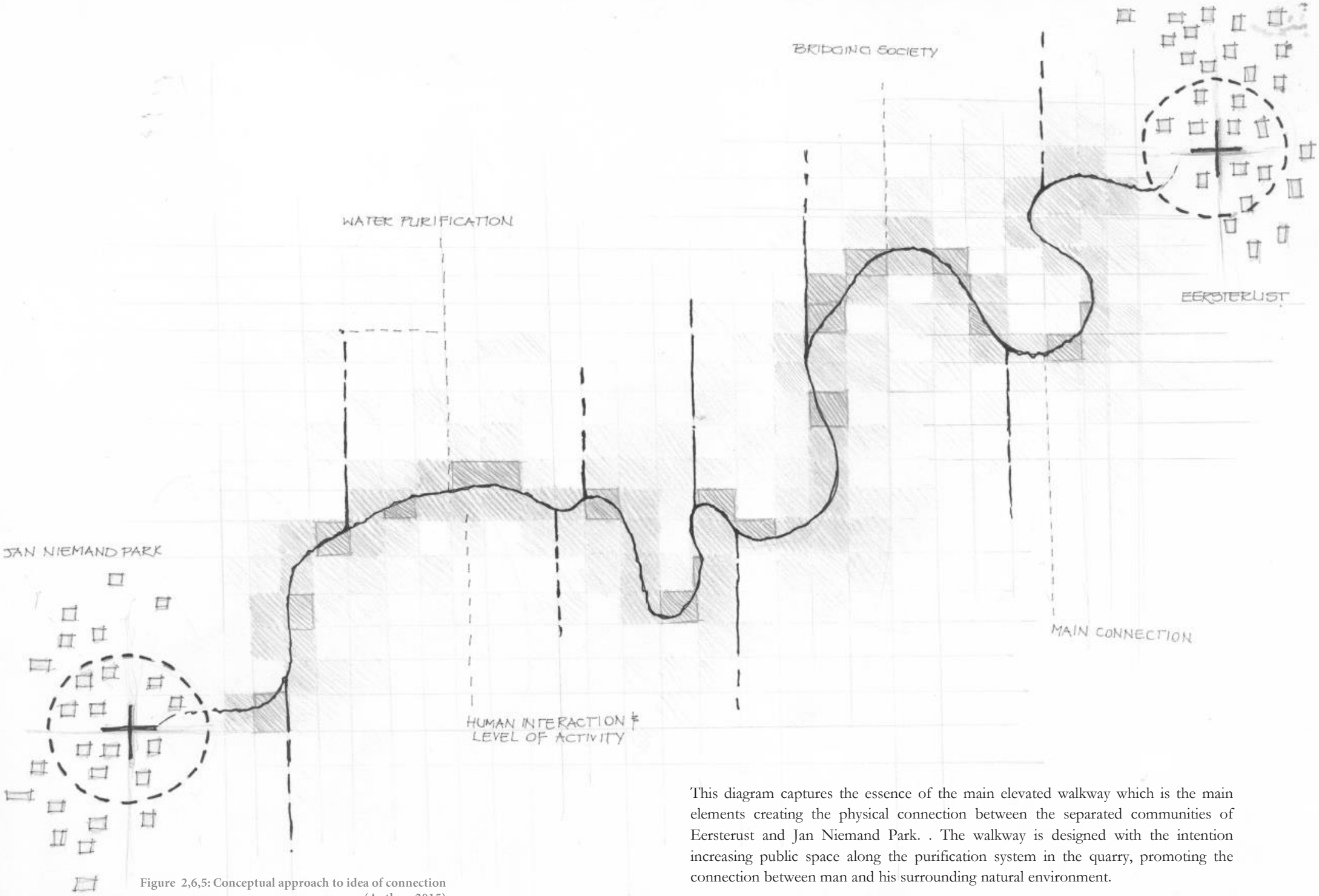

Figure 2,6,5: Conceptual approach to idea of connection (Author, 2015)

This diagram captures the essence of the main elevated walkway which is the main elements creating the physical connection between the separated communities of Eersterust and Jan Niemand Park. . The walkway is designed with the intention increasing public space along the purification system in the quarry, promoting the connection between man and his surrounding natural environment.

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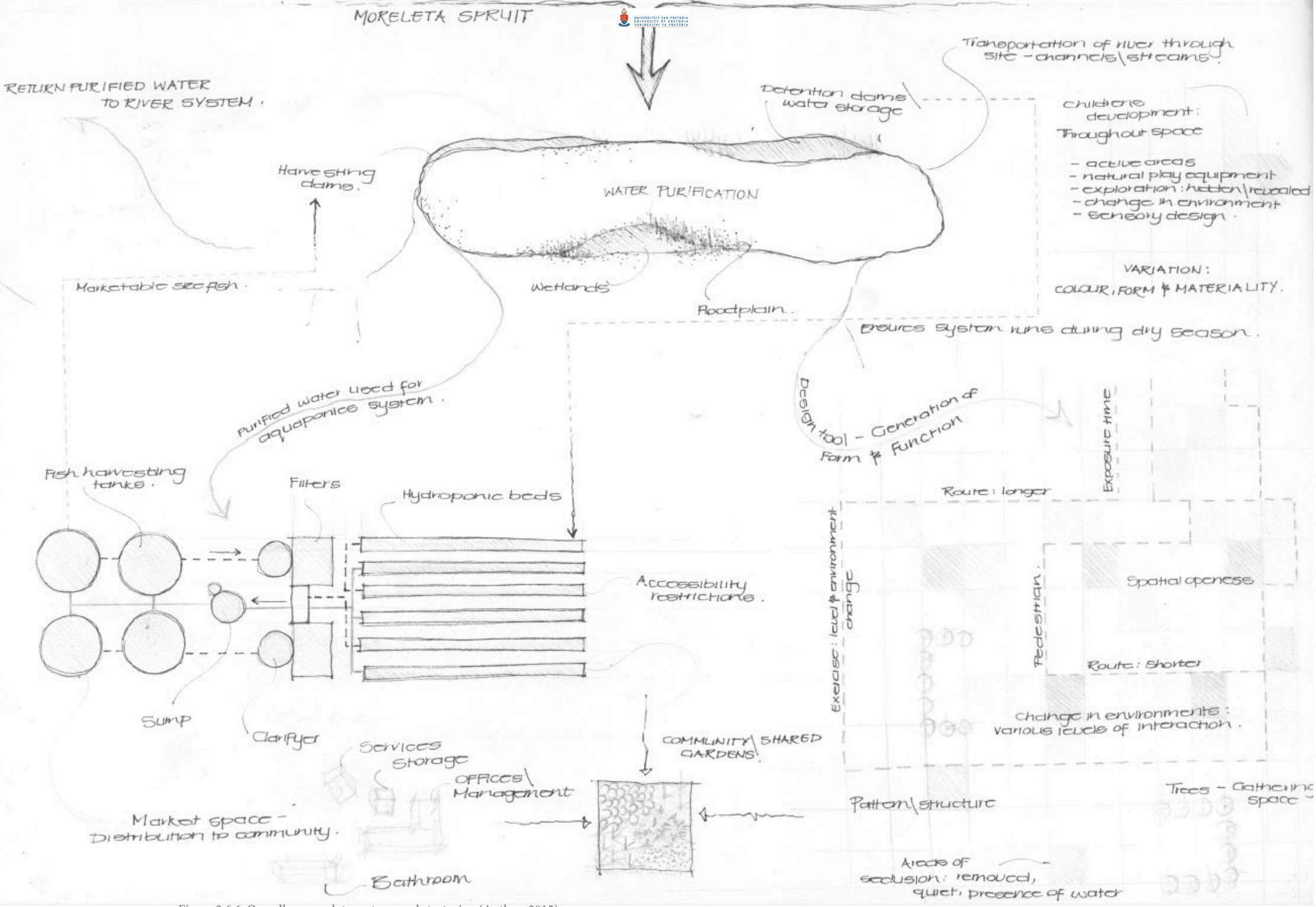

Figure 2,6,6: Overall approach to systems and strategies. (Author, 2015)

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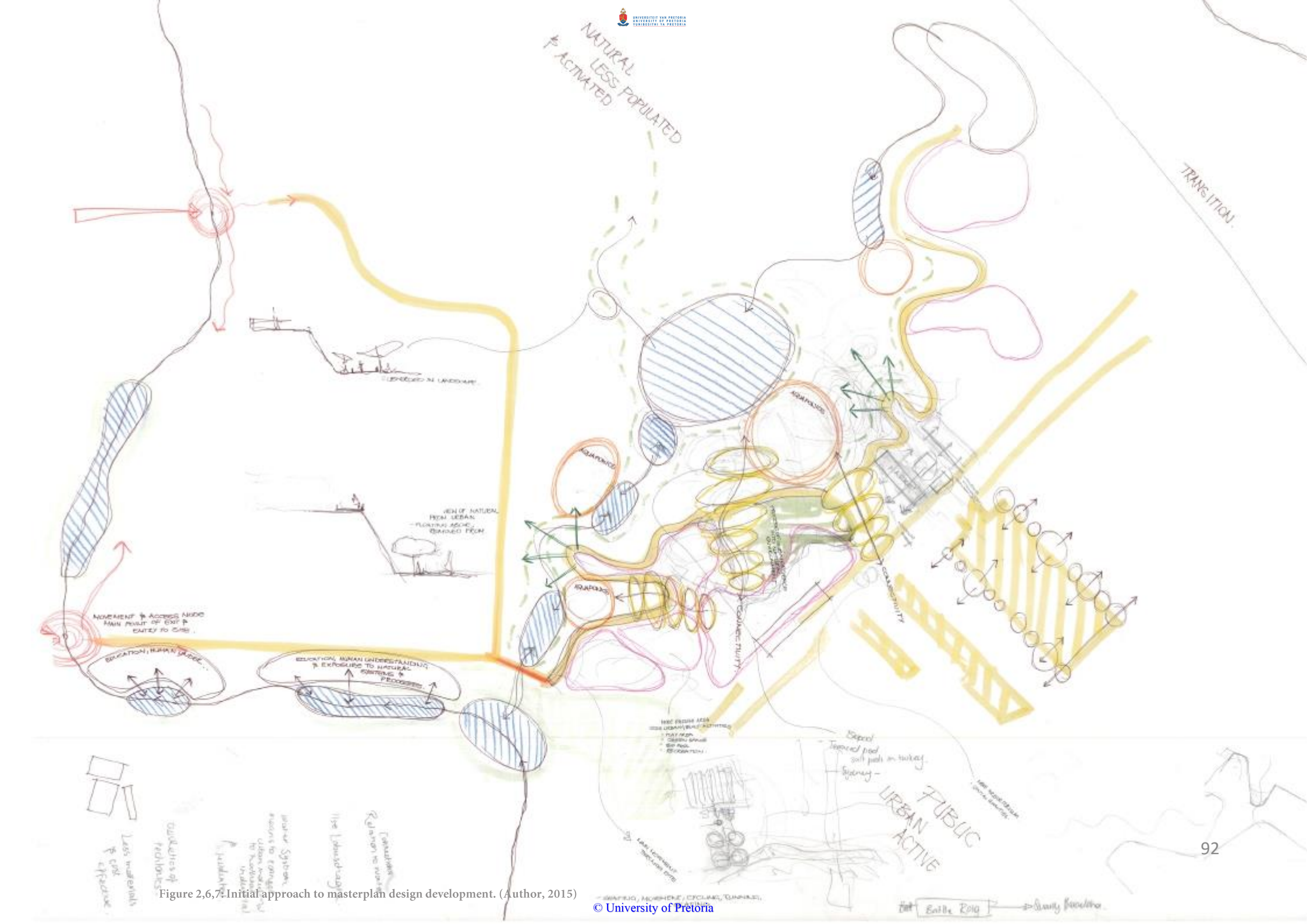

Figure 2,6,7: Initial approach to masterplan design development. (Author, 2015)

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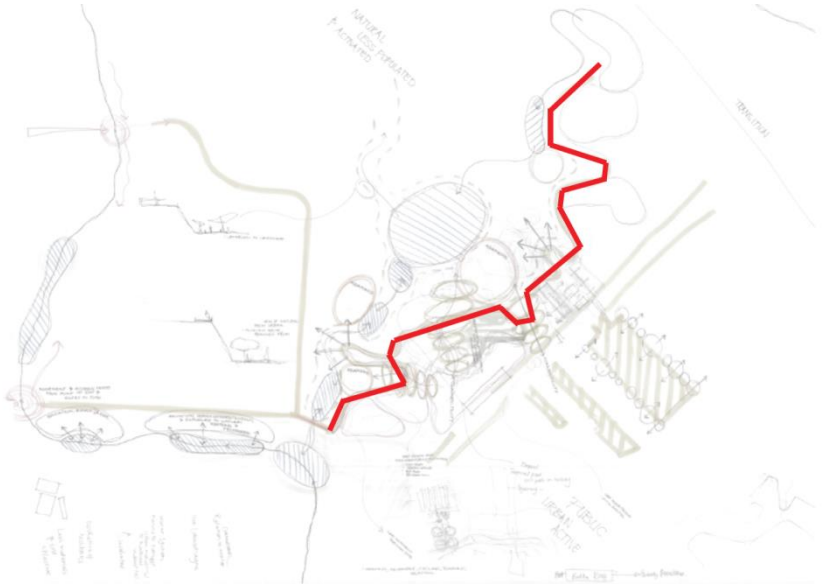
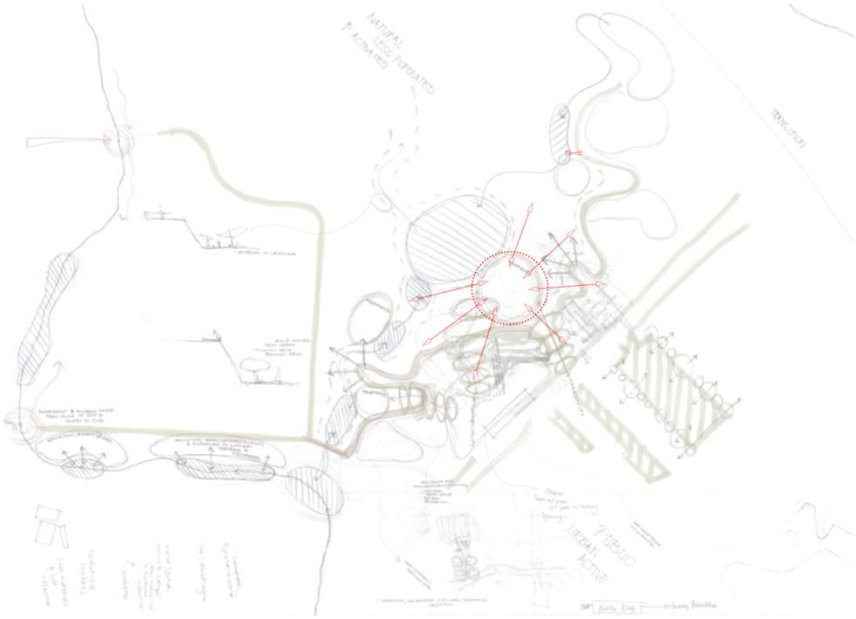
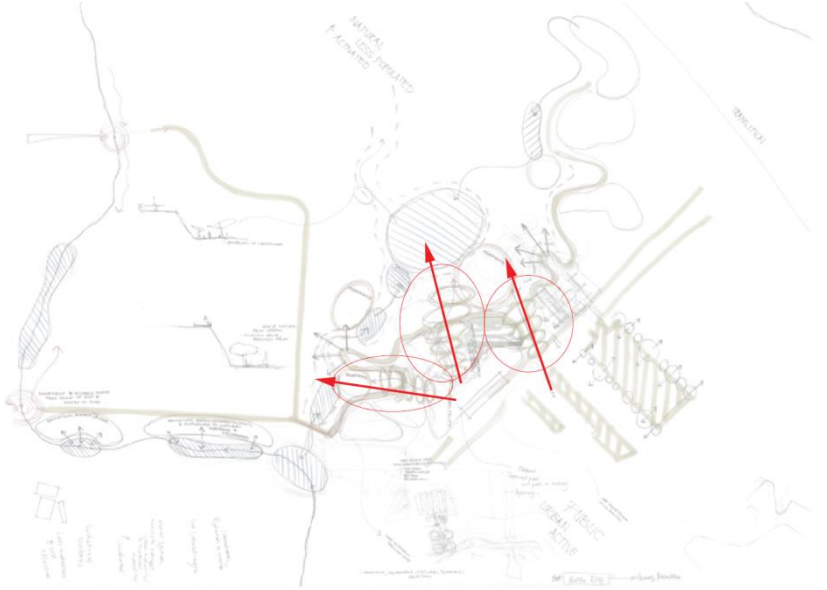


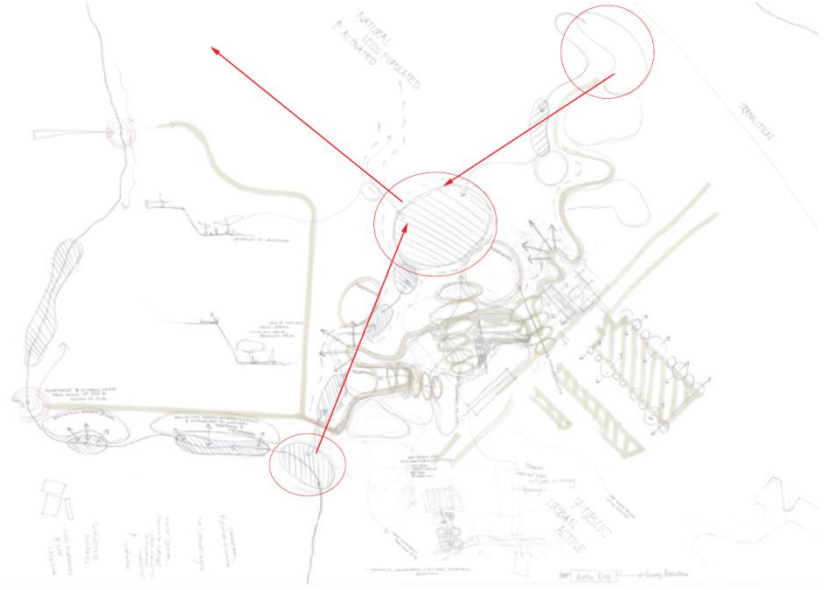
The physical connection created by the walkway, a solid constructed element within the landscape directly connecting separated societies.



The choice of event space and main lawn area is central to the design with easy movement and accessibility between both industrial, commercial and natural environments. A connection node between all three.



The points of connection between the higher levels (industrial and commercial area) are guided through the systems and processes of water, connecting to the lower levels or natural environment. The process of immersion in nature.



The main connection is the visual connection between the separated societies created through the merging of two river systems in to the purification system in the quarry. This visual connection gives the impression of the merging and convergence of societies and communities.

Figure 2.6.8: Evaluation and development of masterplan intention. (Author, 2015)

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DESIGN DEVELOPMENT

The design development clearly demonstrates the hierarchy of connectivity, initially starting with the diversion of river systems and the integration of the purification system in to the quarry. Slowly progressing to the design and development of the industrial and commercial sector of the design. Integration of previously proposed interventions with the vision and intention of the idea of connectivity between social, environmental and economic aspects. The bridge or main walkway through the site developed as a prominent connection within the design and from there activities and public space was created linking to and from the walkway.

Figure 2.6.9: Master plan development and iteration (Author, 2015)

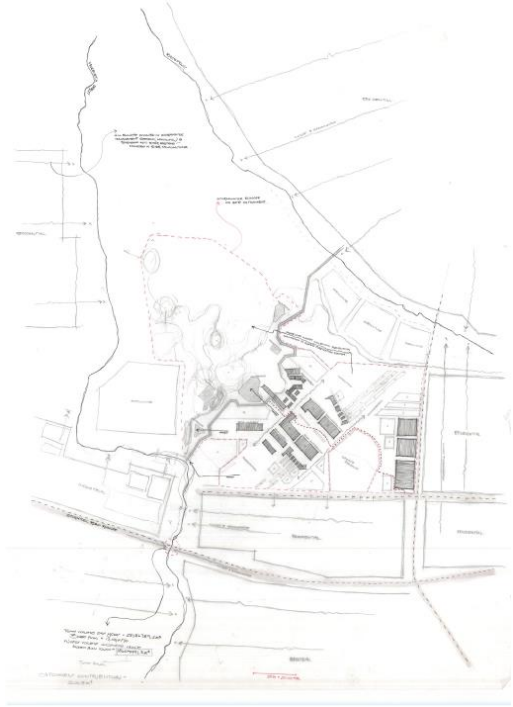

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Figure 2.6.10: Final Master plan proposal. (Author, 2015)

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MASTER PLAN

SCALE 1: 1000

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SKETCH PLAN DEVELOPMENT

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Figure 2.6.11: Sketch plan development. (Author, 2015)

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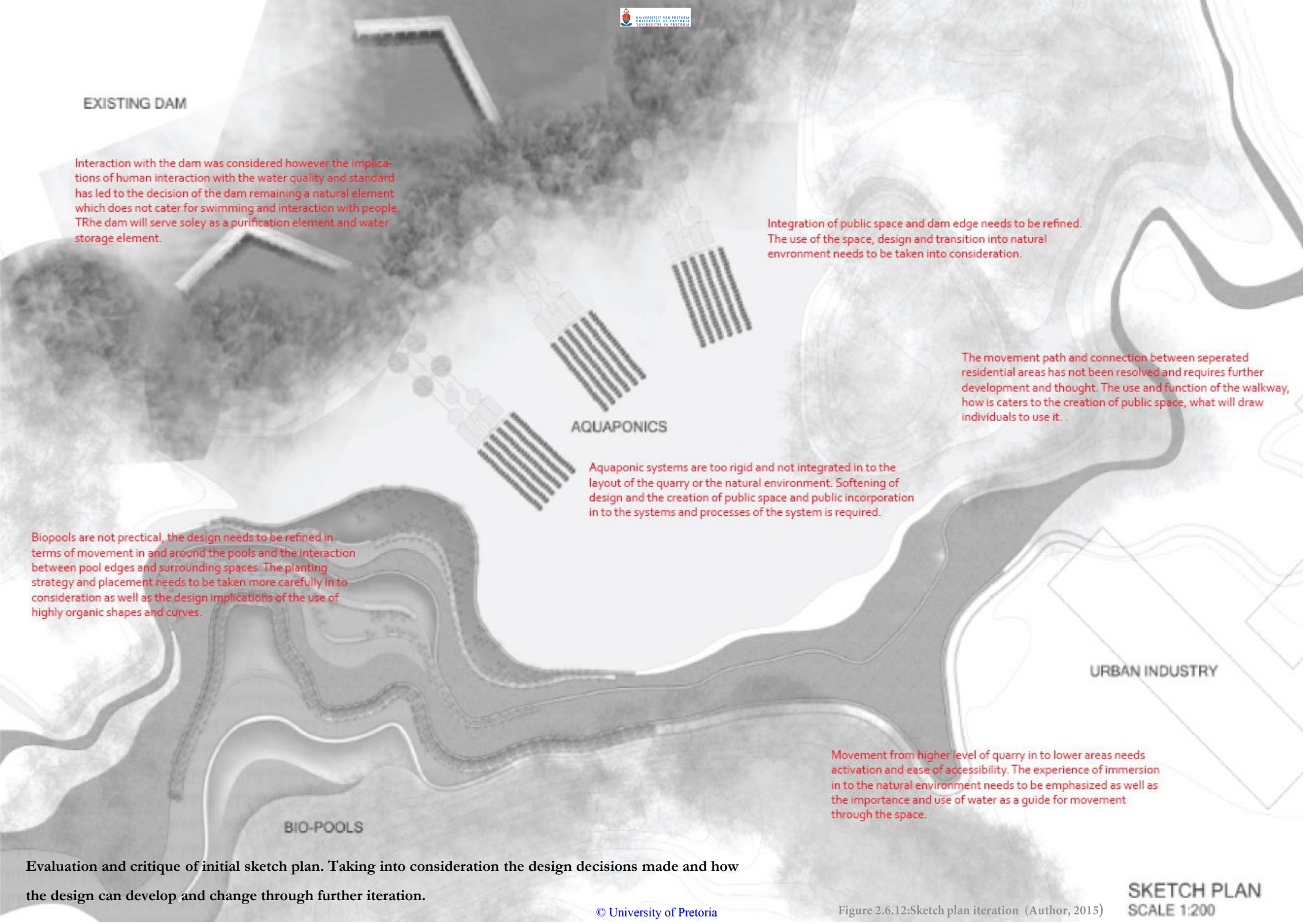

Evaluation and critique of initial sketch plan. Taking into consideration the design decisions made and how the design can develop and change through further iteration.

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Figure 2.6.12:Sketch plan iteration (Author, 2015)

SKETCH PLAN
SCALE 1: 200

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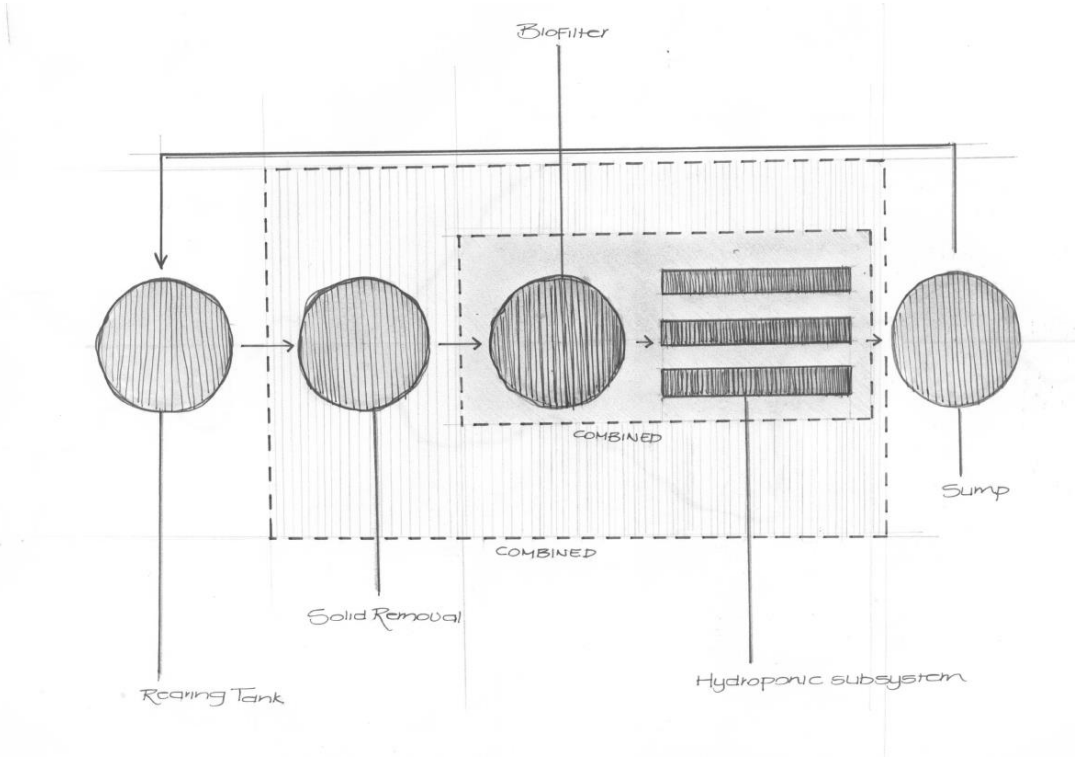

SYSTEM DESIGN DEVELOPMENT: AQUAPONICS

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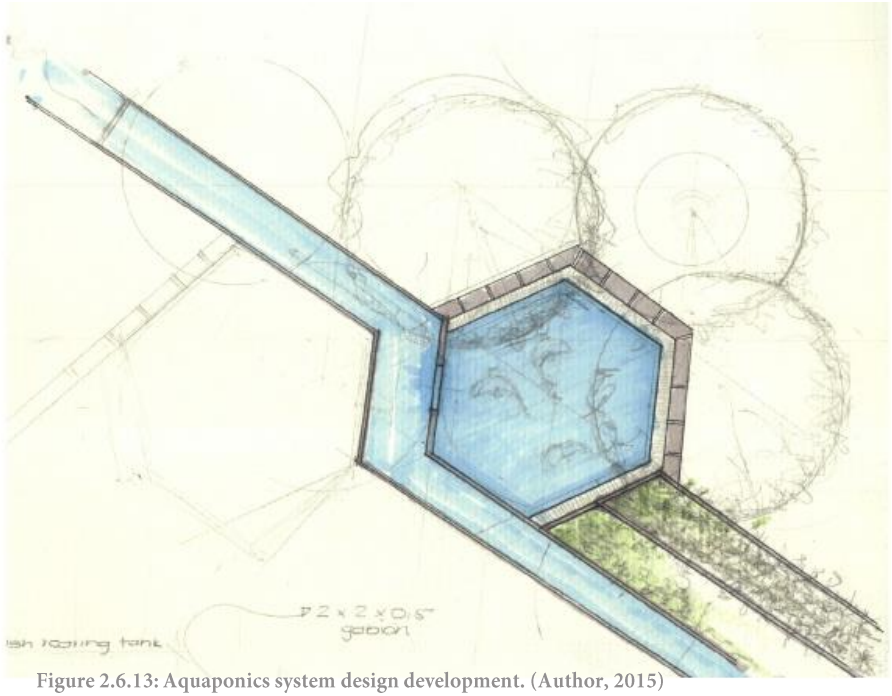
Understanding the systems and processes of the aquaponics system allowed for the redesign and development of such a system for the integration into the site for both form and function. The main intention with the incorporation of the aquaponics system, in addition to the economical benefits through the use of natural water systems, was the creation of public space and the promotion of human interaction with the productive landscape.

The development of a spatial system with which people would feel connected to and immersed in the natural environment would require the exposure of the hidden elements and systems of the aquaponics system. The initial design investigation drew inspiration from the surrounding proposed natural industries, in particular, the apiary. The hexagonal approach opened up the system through the creation of modular units which fit into and create spaces between one another.

The design did not respond well to the nature of the site in terms of the industrial feel and atmosphere of the quarry. The design required more integration with the slopes and drastic change in level which it was not as flexible to as the final design.



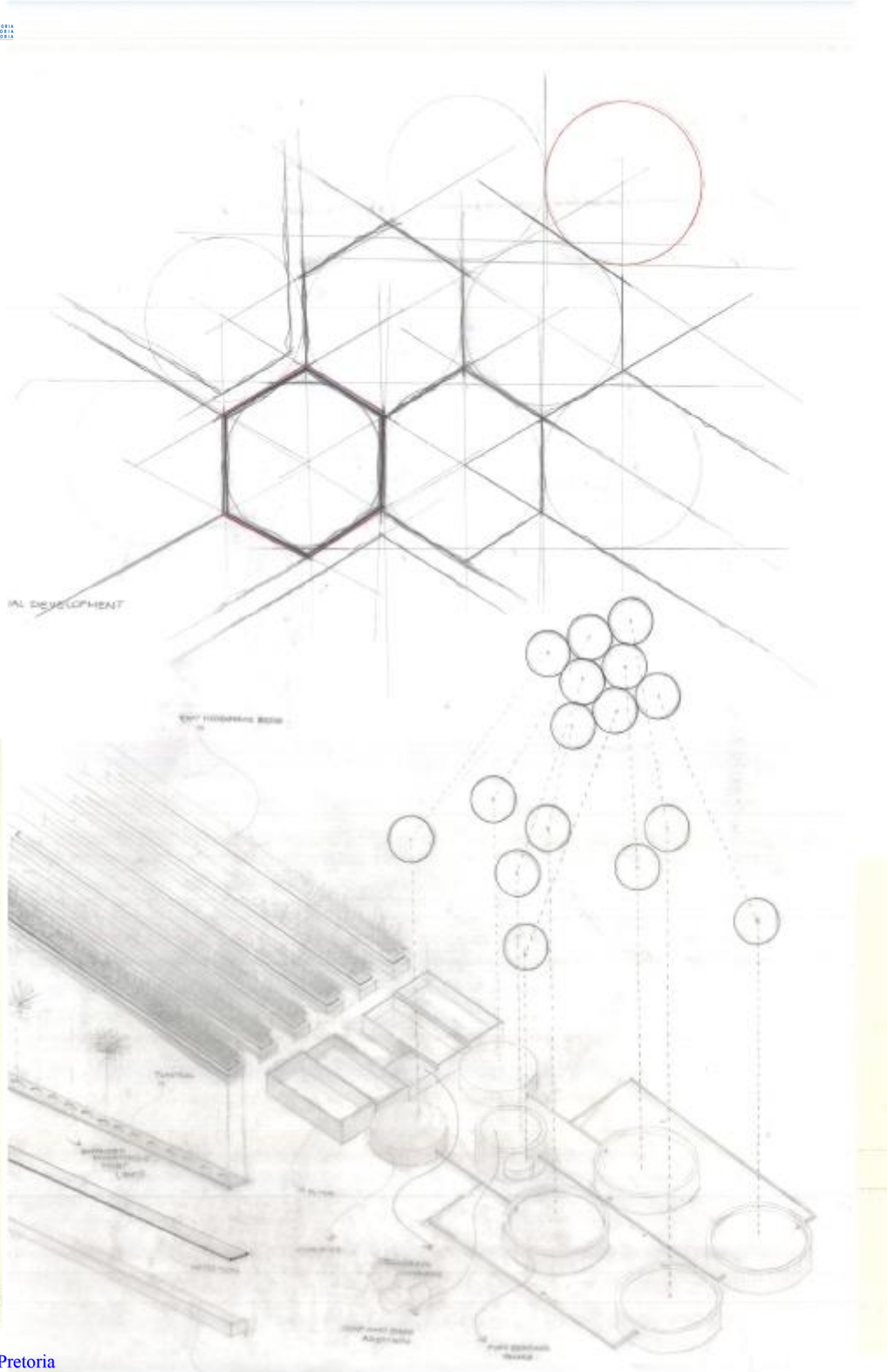


Figure 2.6.13: Aquaponics system design development. (Author, 2015)

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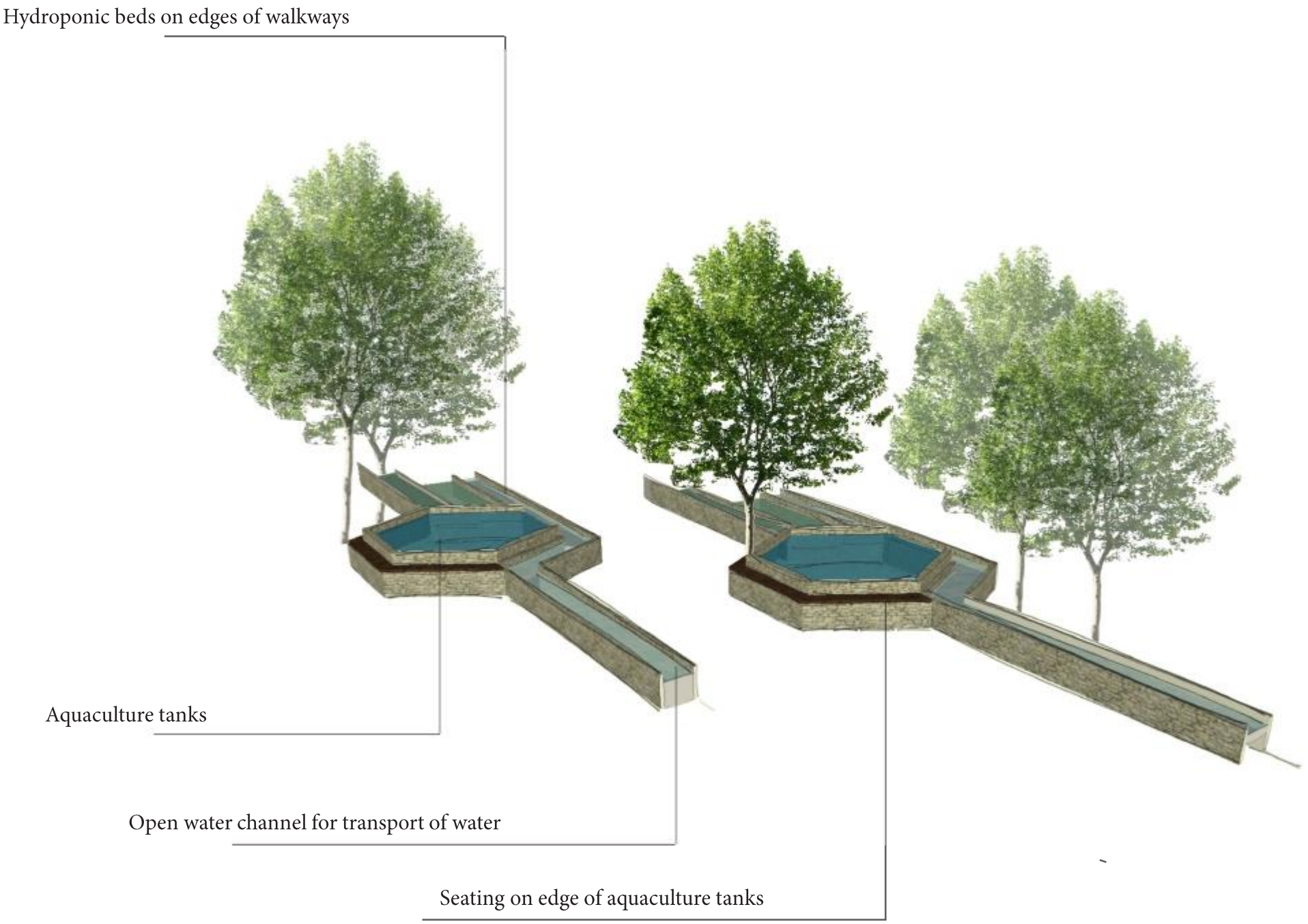

Figure 2.6.14: 3D development of Aquaponics elements(Author, 2015)

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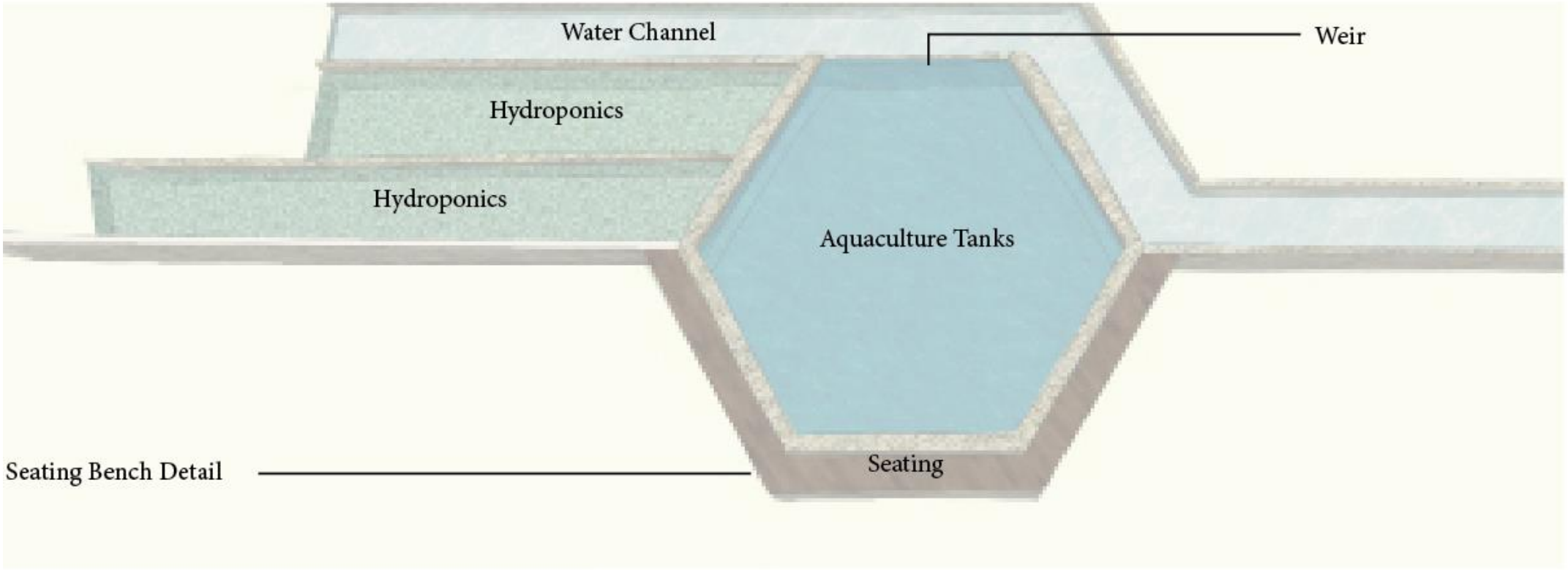
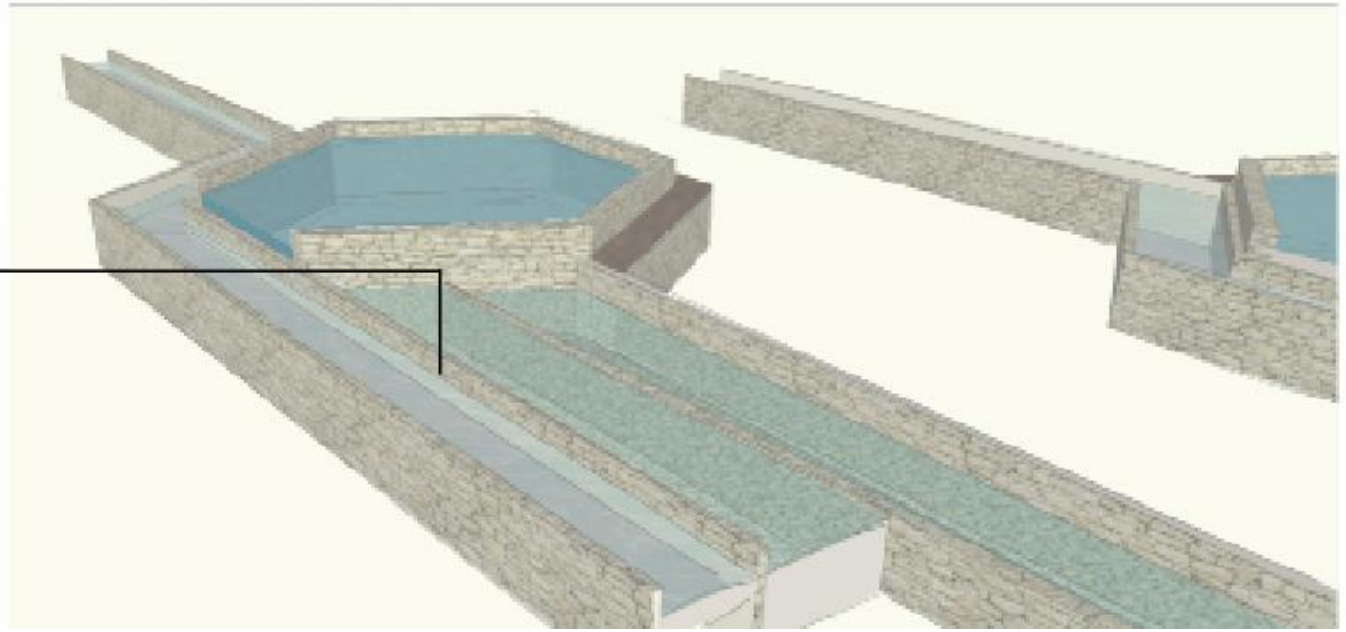


Water Channel Detail



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THE AQUAPONICS SYSTEM REQUIRES CERTAIN SYSTEMS AND PROCESSES FOR THE MAINTENANCE AND PURIFICATION OF THE WATER WITHIN THE SYSTEM. THESE SERVICES INCLUDE TWO CLARIFIERS, FOUR FILTERS AND A DEGASSING TANK. THESE HAVE BEEN INCORPORATED IN TO THE DESIGN IN A MANNER WHICH HAS COVERED THE SERVICES UP AND SERVES AS A SEATING SPACE WITHOUT PROHIBITING OR INFLUENCING THE FLOW OF WATER FROM THE AQUACULTURE TANKS TO THE HYDROPONIC BEDS.

LAWN AREA AND EVENT SPACE. THIS AREA WILL CATER FOR THE HOSTING OF EVENTS SUCH AS MARKETS, FESTIVALS, LIVE MUSIC, ETC.

ACCESSIBLE GREEN ROOF. THE ROOFS ARE RESPONSIBLE FOR THE PROVISION OF SHADE FOR SEATING SPACES BELOW AS WELL AS WIDENING THE ADJACENT WALKWAYS. INCREASED PUBLIC SPACE FOR BOTH MOVEMENT AND LINGERING.

HYDROPONIC BEDS ARE TERRACED IN TO THE QUARRY EDGE, AIDING IN THE TRANSPORTATION OF WATER THROUGH GRAVITY FLOW. THE TERRACED BEDS PROVIDE FOR SEATING SPACES AS WELL, ALLOWING FOR PUBLIC INTERACTION AND EXPOSURE TO THE SYSTEMS AND MEANS OF PRODUCTION.

AQUACULTURE TANKS OR FISH HARVESTING TANKS. THESE TANKS HAVE BEEN CONSTRUCTED IN TO THE SIDE OF THE MOUNTAIN AT THE HIGHEST POINT OF THE SYSTEM. THE FISH REQUIRE SHADE WHICH IS PROVIDED BY THE EXTENDED ROOF FROM THE RETAINING WALL. THE WATER IS GRAVITY FED FROM THE AQUACULTURE TANKS THROUGH THE FILTRATION SYSTEM AND IN TO THE HYDROPONIC BEDS. IF ADDITIONS WATER IS REQUIRED DUE TO EVAPORATION LOSS OR USE IN THE SYSTEM, WATER IS TAKEN FROM THE EXISTING DAM.

THE WATER PATH TRAVELS FROM THE AQUACULTURE TANKS THROUGH 50 DIAMETER PVC PIPING INTO THE CLARIFIERS, FILTERS AND DEGASSING TANK. THE WATER IS THEN GRAVITY FED IN TO THE HYDROPONIC BEDS WHERE IT IS RESPONSIBLE FOR THE GROWTH OF VARIOUS AGRICULTURAL CROPS. THROUGH FURTHER GRAVITY FLOW THE WATER IS TRANSPORTED TO A SUMP AND BASE ADDITION TANK FROM WHERE IS IT RECIRCULATED AND PUMPED BACK TO THE AQUACULTURE TANKS.

Figure 2.6.15: Aquaponics system explanation(Author, 2015)

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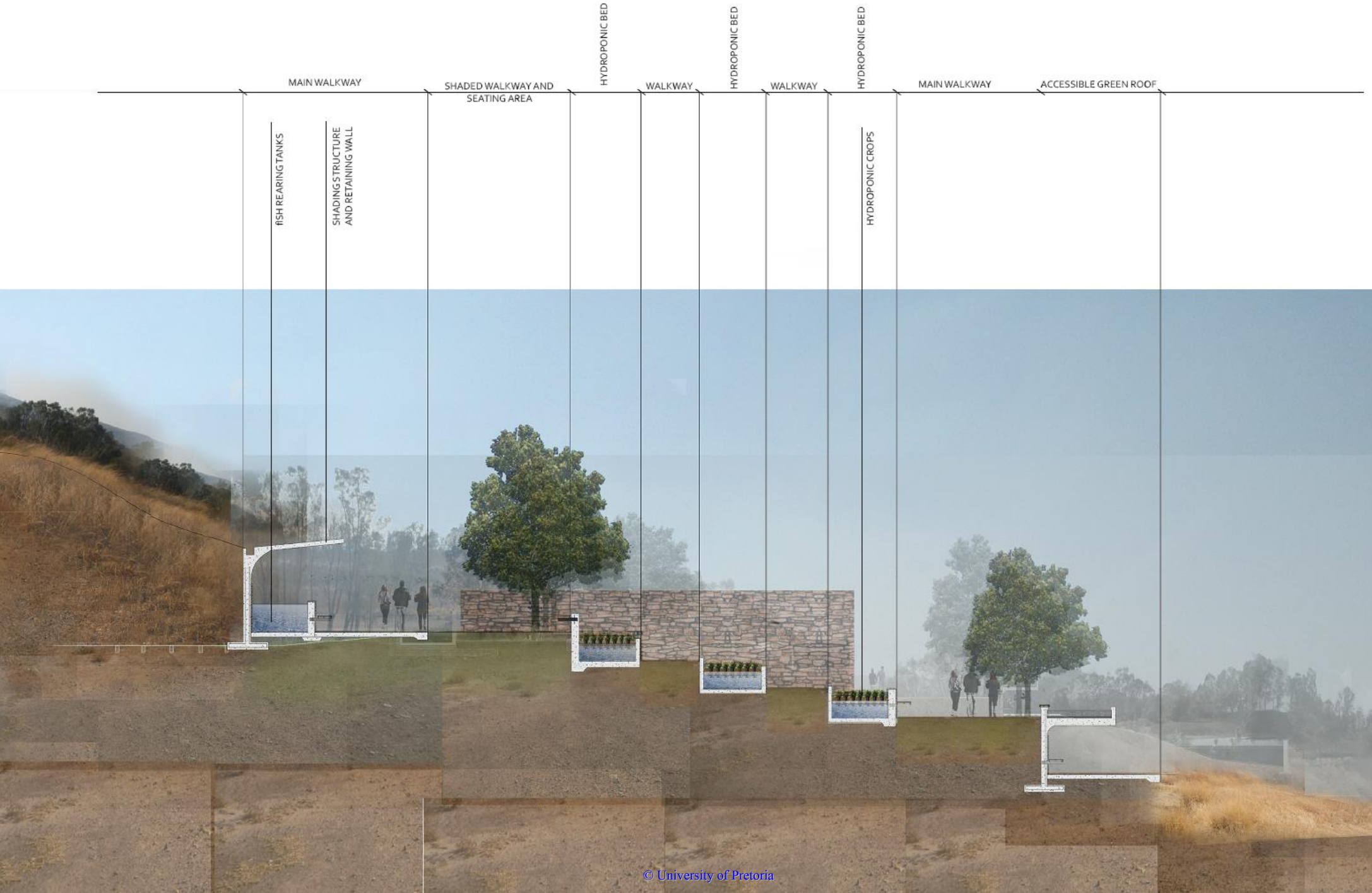
Figure 2.6.16: Section through aquaponics system (Author, 2015)



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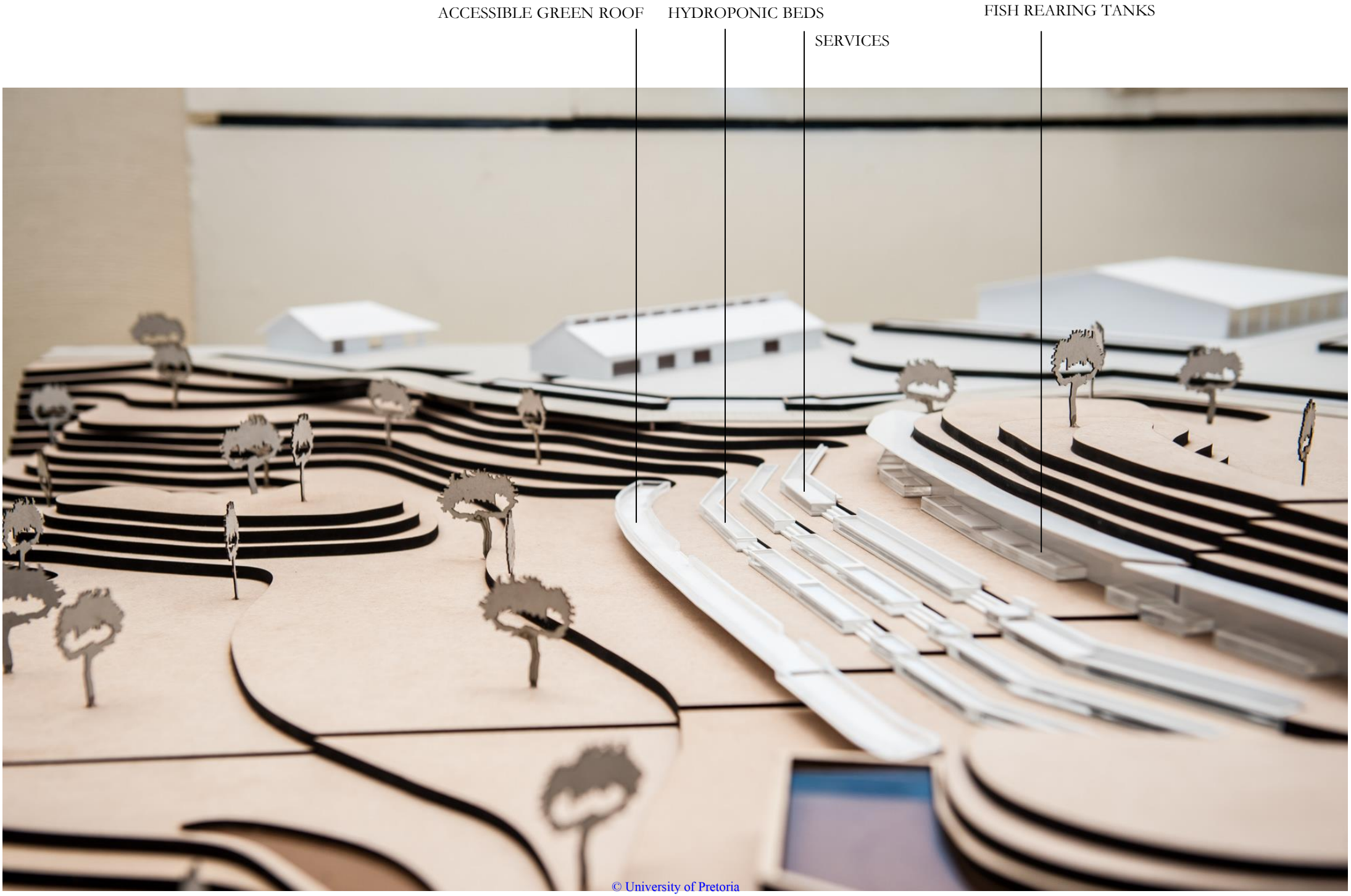

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SYSTEM DESIGN DEVELOPMENT: BIOPOOLS

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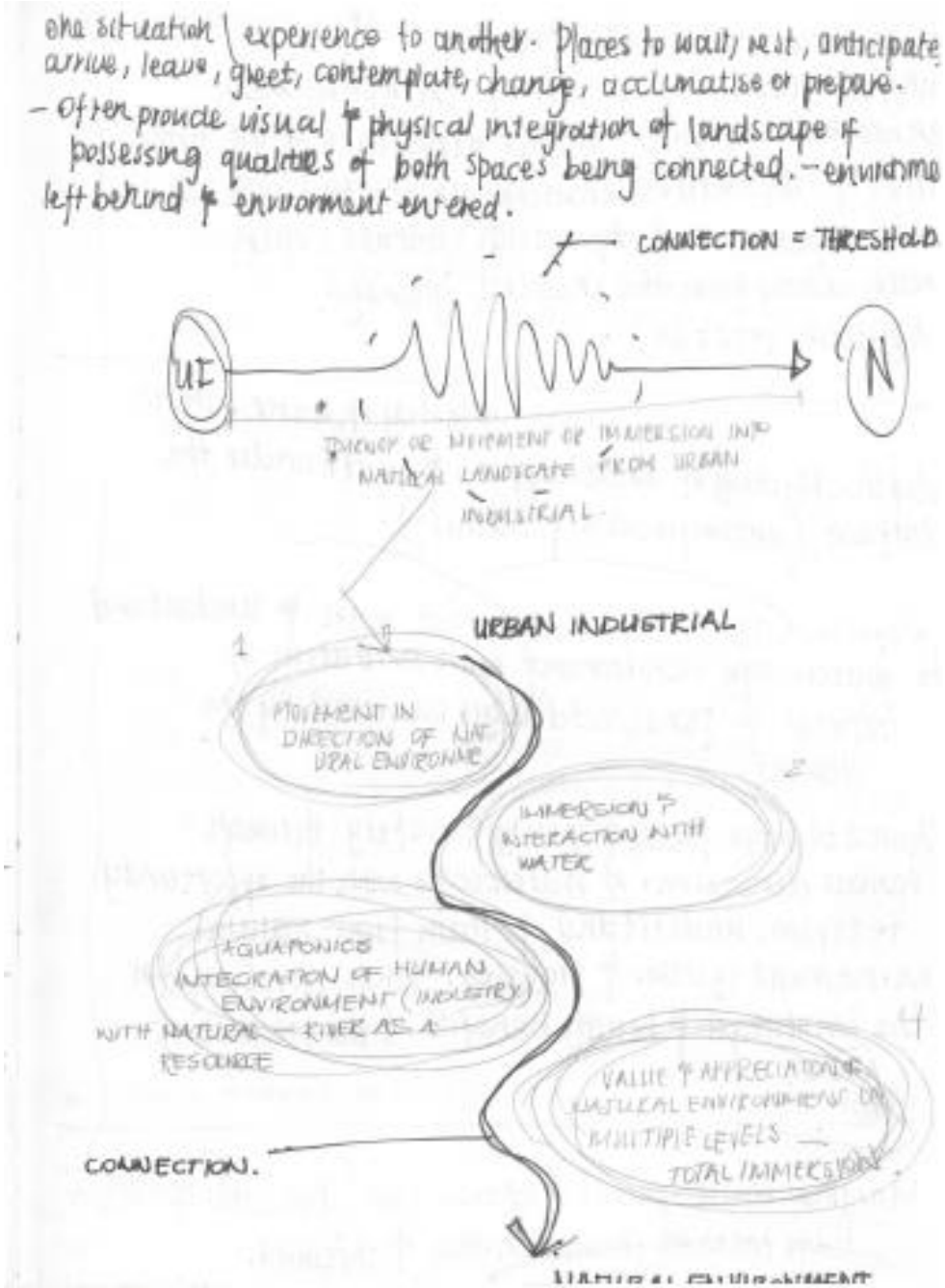

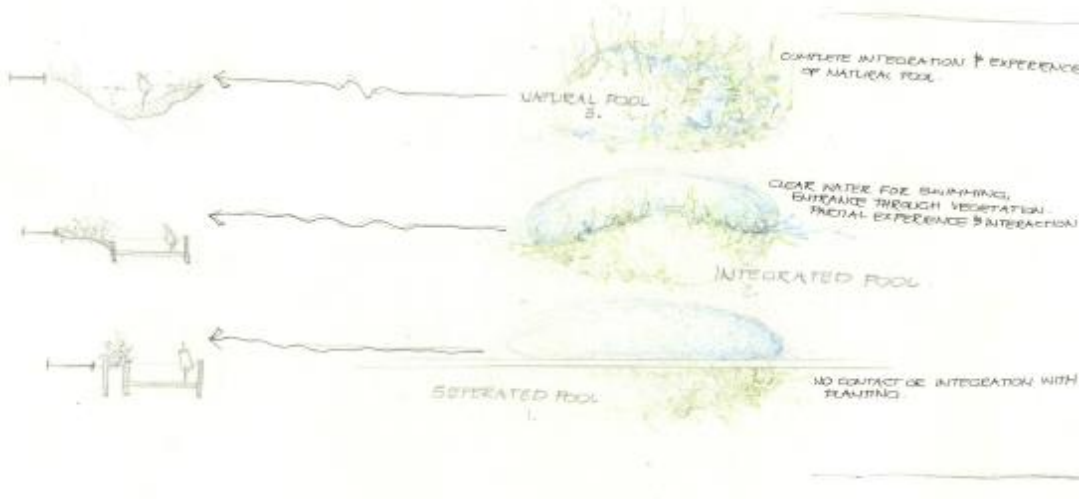

The movement paths that allow for pedestrian traffic moving from the higher levels to the lower levels are emphasized and directed by the presence of water systems and processes. The incorporation of terraced biopools allows for a public interface between the industrial and natural environments. Making use of the purified water from the purification system in the quarry, the recirculating systems are focused on the process of immersion of the user in the natural environment and they move down in to the quarry.

Each pool has been designed to provide a various level of immersion, a further interaction with both water systems as well as the planting and natural environments. The use of the river as a resource for the interaction and public use by users has added significant value to the river from a purely interactive and recreational point of view while the aquaponics systems add value to the river system from a productive and economic point of view. The biopools are largely responsible for the social aspect of the design.

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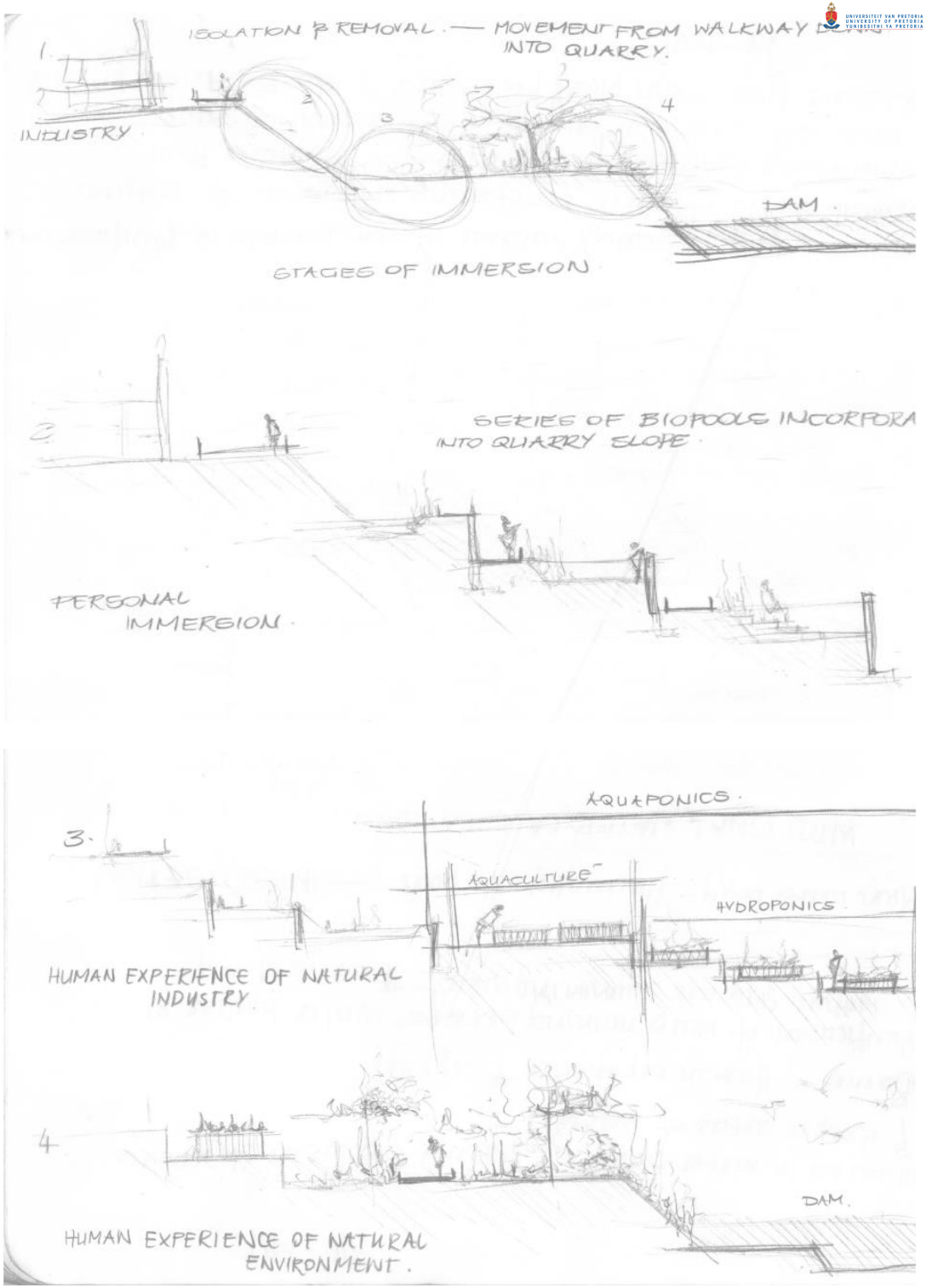

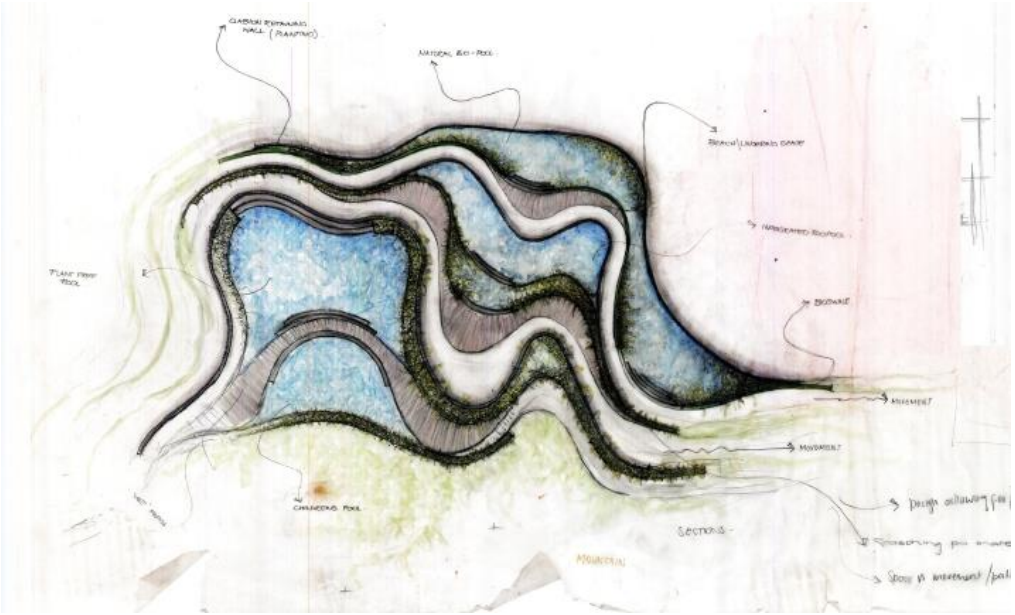

The sections explain and indicate the intention behind the incorporation of the biopools and their integration of and connection to the social and natural environments. The response of the biopool design to the existing quarry landscape allows for the user to feel immersed in and experience the landscape. Varying degrees of immersion and experience of the natural environment reconnects man to the river and its surrounding habitats in a socially comfortable and stimulating manner.

Figure 2.6.17: Biopool experiential development(Author, 2015)

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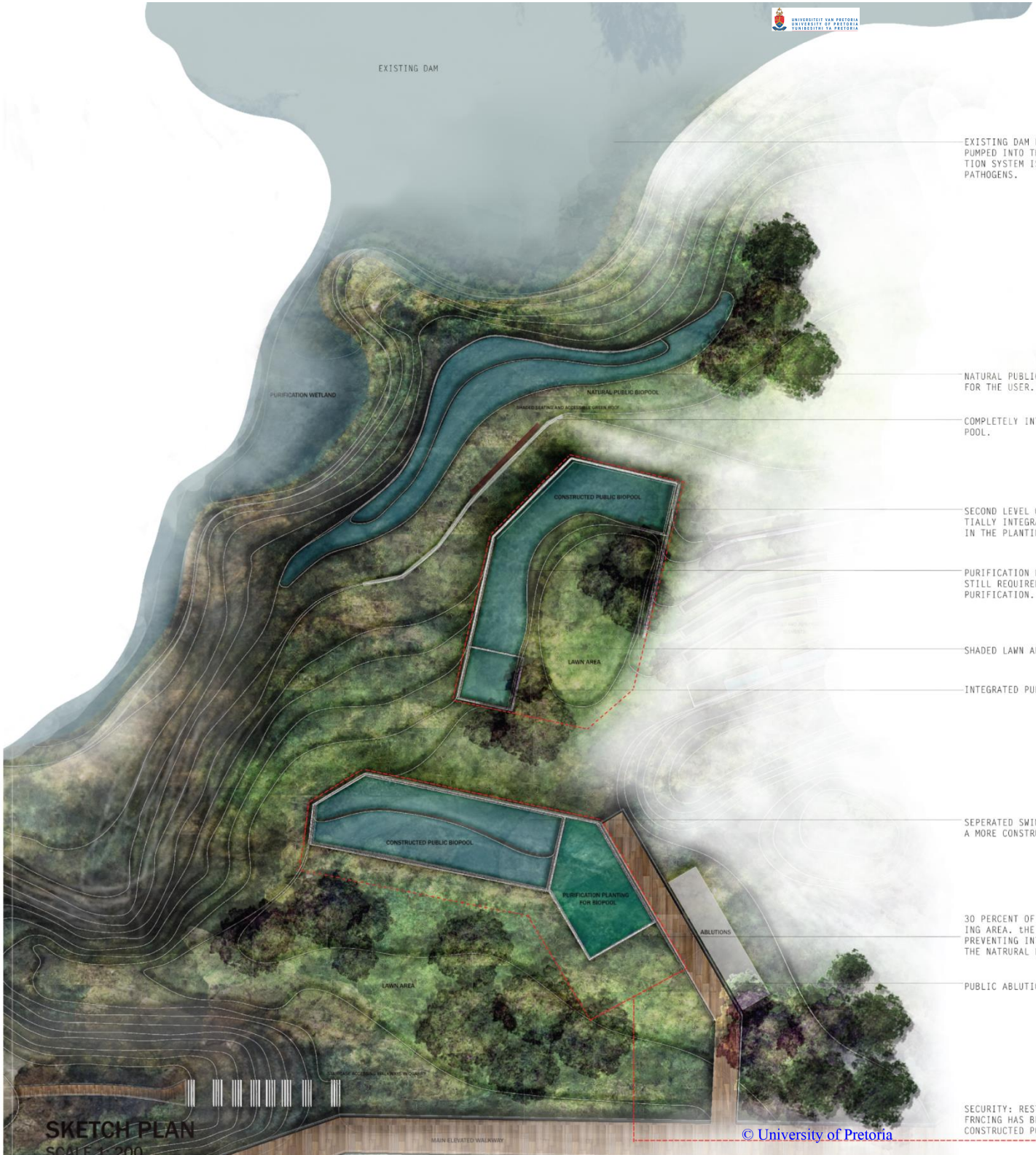

EXISTING DAM FOR THE STORAGE AND PURIFICATION OF WATER WHICH IS USED AND PUMPED INTO THE BIOPOOLS WHEN THEIR WATER LEVELS DROP. THE DAM AND PURIFICATION SYSTEM IS RESPONSIBLE FOR THE REMOVAL OF ALL FORMS OF POLLUTION EXCEPT PATHOGENS.

NATURAL PUBLIC BIOPOOL. THIRD LEVEL OF IMMERSION IN THE NATURAL ENVIRONMENT FOR THE USER.

COMPLETELY INTEGRATED PURIFICATION PLANTING WITH THE SWIMMING AREA OF THE POOL.

SECOND LEVEL OF IMMERSION CONSTRUCTED BIOPOOL. PURIFICATION PLANTING IS PARTIALLY INTEGRATED INTO THE SWIMMING AREA, PEOPLE ARE ABLE TO INTERACT AND MOVE IN THE PLANTING AREA.

PURIFICATION PLANTING. MORE NATURAL AND INTERACTIVE THAN THE FIRST BIOPOOL. STILL REQUIRED 30 PERCENT OF AREA IS CONVERED BY PLANTING FOR THE APPROPRIATE PURIFICATION.

SHADED LAWN AREA

INTEGRATED PURIFICATION PLANTING

SEPERATED SWIMMING AREA OF BIOPOOL. NO PLANTING IS INTEGRATED IN TO THE AREA, A MORE CONSTRUCTED AND UNNATURAL FEEL TO THE POOL.

30 PERCENT OF AREA OF WATER THAT REQUIRES PURIFICATION IS THE REQUIRED PLANTING AREA. tHE PLANTING AREA IS COMPLETELY SEPERATED FORM THE SWIMMING AREA, PREVENTING INTERACTION BETWEEN USER AND NATURAL ENVIRONMENT. NO IMMERSION IN THE NATRURAL ENVIRONMENT YET STILL USES NATURAL SYSTEMS FOR FUNCTION.

PUBLIC ABLUTIONS

SECURITY: RESTRICTED ACCESS TO PUBLIC BIOPOOLS. FRNCING HAS BEEN INCORPORATED AROUND EACH OF THE CONSTRUCTED POOLS

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Figure 2.6.18: Biopool explanation. (Author, 2015)

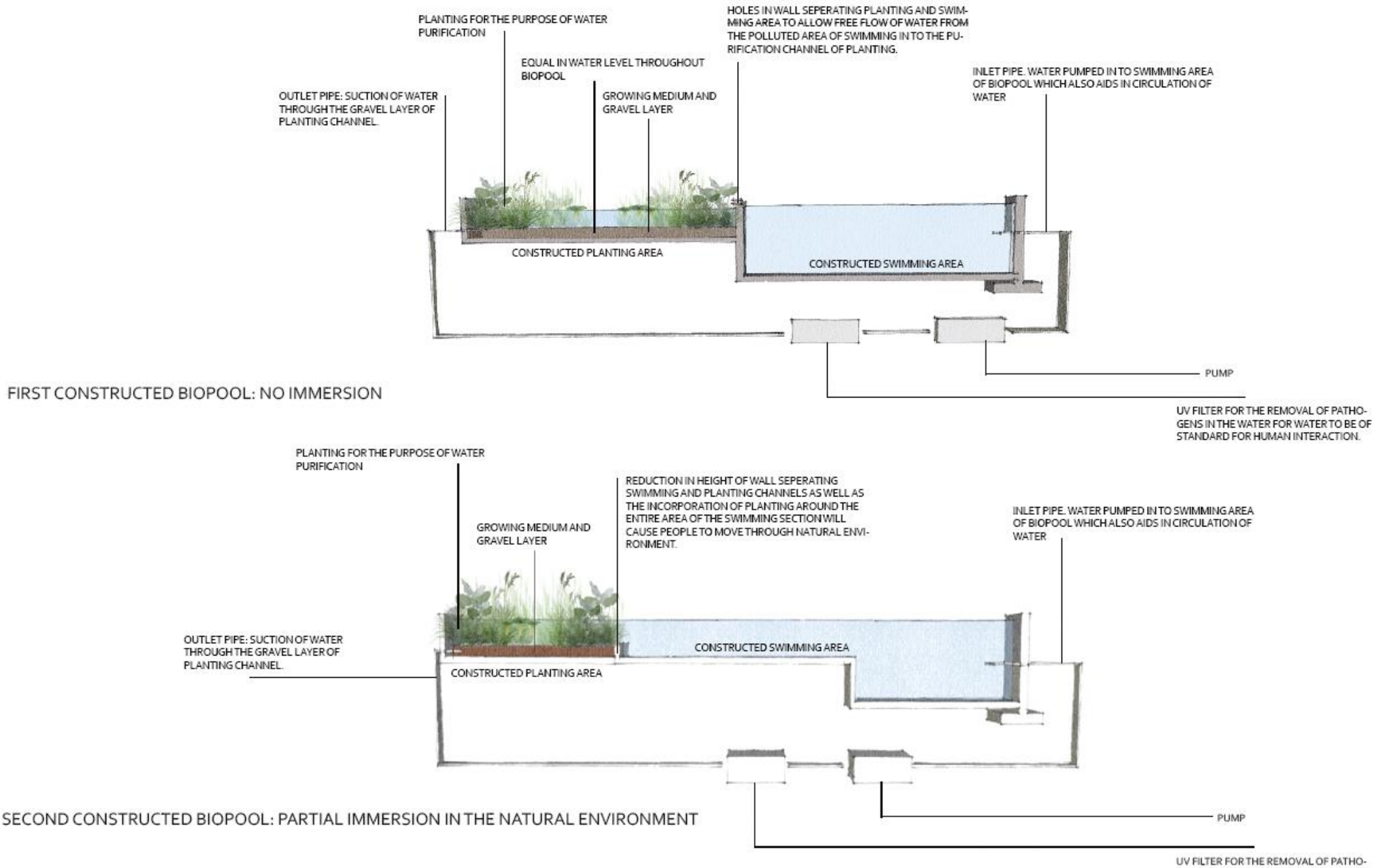

Figure 2.6.19: Explanation of various Biopool construction approaches(Author, 2015)

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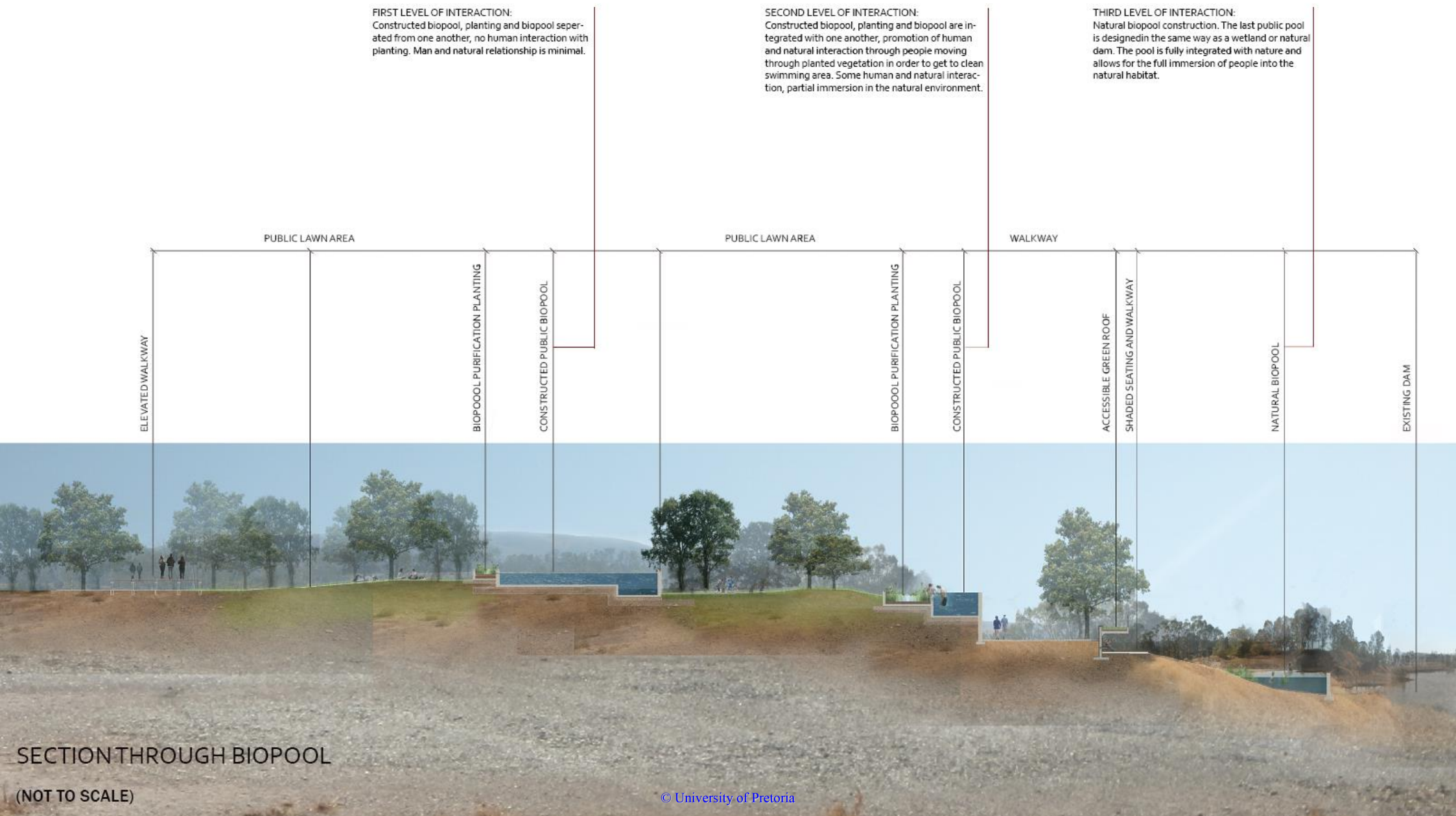
Figure 2.6.12: Section through Biopools
(Author, 2015)



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BIOPOOL 3

BIOPOOL 2

BIOPOOL 1

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CHAPTER 7: SYSTEMS DEVELOPMENT AND TECHNIFICATION

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TOTAL CATCHMENT AREA: 204.22 km2

CATCHMENT COEFFICIENT: 0.2

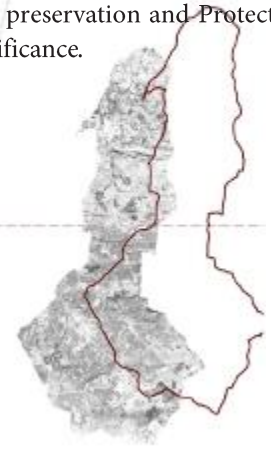

Figure 2.7.1 – Catchment Area (Author,2015)

The main intention for the water systems in the design intervention deals with the water on three levels, ecological, social and economic.

The most important aspect of the water strategy is to ensure the purification of the river system, improving the water quality through various natural systems and processes.

The enhancement of ecological quality will yield economic and social benefits, forming the foundation of the success of the intervention. The rehabilitation of the quarry through the integration of the river systems and the process of purification is important for the improvement of ecologies, habitat creation and increase in biodiversity in the area.

The social element is concerned with the integration and connection of man and the natural environment, using the water systems and processes as a means of educating and raising awareness concerning the complexity of urban river systems and why their preservation and Protection is of great significance.

The connection of societies as well as an and nature will influence and inform the use and structure of the water system.

The choice of a decommissioned post-industrial landscape, a wasted space in the urban environment aids in the further connection of urban and natural environments on an economic and industrial level.

The transition between urban industrial and natural industrial will be created through the incorporation and use of the river system as a means of production for the surrounding environment.

The approach to the water systems was making use of natural systems and processes for purification, limited technological input into the system but used in a sustainable manner when required.

The design is intended to be able to harvest and make available through use of the river system and urban runoff, enough water to sustain all activities and meet all demands on site as a result of social and economic activities.

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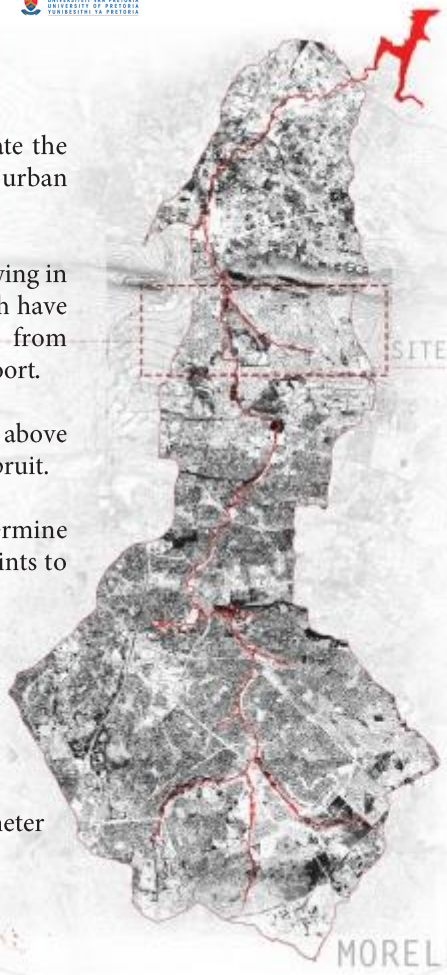
CALCULATION OF WATER CATCHMENT

The success of the design depends on the ability to Understand and manipulate the water systems in order to be able to purify and incorporate them into the urban environment as a resource for a number of activities.

The chosen site includes the main Moreleta Spruit, the Rietspruit tributary flowing in to the site from the east, as well as the Era Brick quarry. These three elements each have their own catchment in terms of runoff. The water readings given were obtained from the Department of Water Affairs water meter placed at Baviaanspoort in Derdepoort.

These readings are not able to be directly applied to the site as the meter is located above the site and after the point of convergence of the Moreleta Spruit and the Rietspruit.

These readings were however used in the calculations which were able to determine the water volumes of both the Rietspruit and the Moreleta Spruit at the entry points to the site.



Total site catchment: 14.8km2

Figure 2.7.2 – Location of site catchment in relation to Moreleta Spruit Catchment Area (Author, 2015)

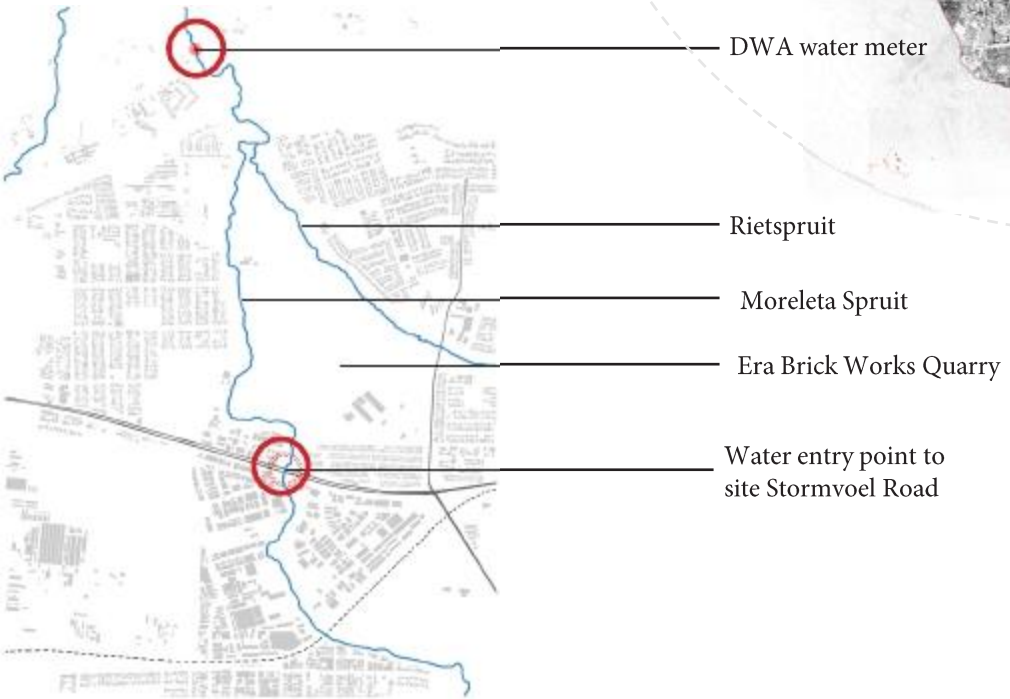


Figure 2.7.3 – Catchment Location Map (Author, 2015)

To calculate the available water at Stormvoel road, the smaller catchments of the Moreleta Spruit, Rietspruit and quarry on site need to be calculated as a percentage of the entire river catchment.

The percentage of area that the site catchment is of the entire river catchment will determine the percentage of water that is accumulated in these three catchments. The percentage of water will be removed from the total water volumes accumulated from the DWA meter located at Derdepoort.

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DAILY FLOW RATE (M^3/S) READINGS AND CALCULATIONS FROM DWA METER AT DERDEPOORT OVER A 12 MONTH PERIOD

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
1	0,479	2,512	0,477	0,886	0,625	0,574	0,536	0,472	0,346	0,242	0,266	0,777
2	0,765	3,69		0,881	0,626	0,584	0,505	0,46	0,327	0,255	0,379	0,455
3	0,642	6,769		2,014	0,614	0,539	0,498	0,462	0,306	0,242	0,444	0,403
4	0,398	1,276		0,887	0,625	0,491	0,487	0,459	0,297	0,31	0,368	0,357
5	0,305	0,705		0,854	0,608	0,494	0,481	0,462	0,315	0,268	0,286	0,322
6	0,292	1,175	3,108	0,847	0,605	0,509	0,482	0,457	0,332	0,272	0,239	0,309
7	0,292	1,937	5,433	0,32	0,637	0,512	0,523	0,45	0,319	0,317	0,228	1,406
8	0,462	0,811	4,22	0,803	0,647	0,548	0,526	0,445	0,324	0,27	0,276	0,773
9	0,32	8,491	1,927	0,789	0,629	0,585	0,512	0,445	0,32	0,234	0,489	2,263
10	0,307	1,697	13,642	0,777	0,577	0,56	0,515	0,448	0,316	0,234	0,299	0,731
11	0,261	1,014	10,66	0,758	0,572	0,56	0,509	0,456	0,335	0,237	4,848	0,854
12	0,237	0,749	9,897	0,751	0,581	0,588	0,48	0,469	0,287	0,205	0,771	2,087
13	0,831	0,634	5,117	0,747	0,553	0,582	0,497	0,455	0,285	0,206	0,602	0,752
14	0,586	0,561	2,845	0,791	0,559	0,561	0,508	0,433	0,331	0,197	0,441	1,231
15	0,399	0,511	2,148	0,793	0,582	0,582	0,541	0,429	0,301	0,214	3,812	2,32
16	0,541	0,474	1,767	1,153	0,603	0,601	0,531	1,181	0,27	0,223	1,013	2,604
17	0,289	0,429	3,247	0,793	0,608	0,577	0,559	1,491	0,297	0,211	0,832	0,836
18	0,235	0,396	1,838	0,769	0,579	0,555	0,538		0,249	0,19	0,822	1,95
19	0,226	0,413	2,562	0,772	0,714	0,539	0,525		0,24	0,189	0,478	3,439
20	0,333	0,367	1,361	0,76	0,639	0,513	0,527		0,24	0,197	0,402	2,578
21	0,426	2,434	1,234	0,733	0,635	0,506	0,504	0,414	0,234	0,18	0,364	1,105
22	0,243	1,523	1,182	0,697	0,64	0,522	0,516	0,376	0,246	0,175	0,555	0,94
23	0,217	1,865	1,13	0,71	0,603	0,536	0,549	0,374	0,266	0,173	1,333	3,932
24	0,22	1,041	1,091	0,735	0,628	0,519	0,559	0,337	0,24	0,189	0,713	2,735
25	1,677	1,417	1,047	0,678	0,62	0,509	0,557	0,329	0,233	1,763	0,405	1,078
26	2,249	0,658	0,975	0,634	0,618	0,508	0,534	0,323	0,229	3,625	0,347	0,739
27	0,434	0,523	1,035	0,652	0,599	0,51	0,479	0,32	0,252	0,529	5,414	5,868
28	0,331	0,478	1,039	0,664	0,584	0,483	0,474	0,369	0,217	0,397	0,775	9,846
29	0,299		0,892	0,648	0,583	0,519	0,478	0,361	0,227	0,328	0,55	2,007
30	0,263		1,306	0,628	0,57	0,617	0,486	0,349	0,24	0,3	1,072	1,213
31	1,372		1,169		0,58		0,484	0,371		0,297		1,341
Average Flow Rate per day (m^3/second)	**1,719**	**1,58**	**2,656**	**0,785**	**0,601**	**0,543**	**0,513**	**0,476**	**0,28**	**0,402**	**0,955**	**1,84**
Average Volume per day (m^3)	148549,47	136512	229495,01	67824	51926,4	46828,8	44314,83	41126,4	24105,6	34732,8	82512	158976
Average volume per month (m^3)	4605033,6	3822336	7114348,8	2034720	1609718,4	1404864	1373760	1274918,4	723168	1076716,8	2475360	4928256
Average volume per year (m^3)	32443200										Minimum flow rate	Maximum flow rate

Table 2.7.1 – Daily Flow Rates at Derdepoort (Author, 2015)

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FLOOD VOLUME (M^3/S) READINGS FOR DERDEPOORT OVER THE LAST TEN YEARS

Year – October to October (Lowest and Highest Readings in that Month)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
JANUARY	0,828	2,005	2,143	0,767	1,734	1,954	0,845	2,919	1,471	0,928	1,12
	8,455	16,35	16,35	7,203	16,35	16,35	8,819	16,35	16,35	10,674	15,52
FEBRUARY	1,533	0,893	1,535	0,925	0,944	2,638	1,133	1,151	1,855	1,199	3,935
	16,35	9,881	16,35	10,615	11,052	16,35	15,874	16,35	16,35	16,35	16,35
MARCH	1,345	0,729	2,833	0,48	1,806	1,671	1,077	3,185	1,195	0,697	2,904
	16,35	6,482	16,35	2,512	16,35	16,35	14,372	16,35	16,35	5,883	16,35
APRIL	1,055	1,002	1,241	0,602	0,879	0,267	0,889	1,28	0,504	1,235	0,774
	15,8	12,551	16,35	4,205	5,502	0,574	5,783	16,35	2,823	16,35	7,35
MAY	1,456	0,219	0,257	0,217	0,76	0,353	0,888	0,608	0,222	0,481	0,313
	16,35	0,35	0,522	0,341	7,08	1,161	9,762	4,352	0,361	2,525	0,857
JUNE	0,36	0,18	0,205	0,991	0,347	0,573	0,272	0,918	0,199	0,28	0,293
	1,219	0,215	0,296	12,184	1,114	3,812	0,602	10,444	0,275	0,647	0,726
JULY	0,242	0,203	0,187	0,271	0,26	0,252	0,324	0,244	0,201	0,222	0,271
	0,499	0,287	0,235	0,596	0,535	0,495	0,935	0,458	0,281	0,361	0,596
AUGUST	0,212	0,252	1,036	0,147	0,244	0,563	0,215	0,682	0,207	0,237	0,707
	0,322	0,499	13,319	0,128	0,369	3,661	0,333	5,614	0,303	0,426	6,066
SEPTEMBER	0,146	0,199	0,232	0,936	0,162	0,646	0,181	0,289	1,564	0,346	0,23
	0,126	0,275	0,403	10,864	0,134	4,987	0,217	0,701	16,35	1,103	0,395
OCTOBER	0,463	0,45	0,881	1,386	0,669	0,887	0,749	1,272	1,372	1,249	1,399
	2,3	2,139	9,61	16,35	5,384	9,606	6,859	16,35	16,35	16,35	16,35
NOVEMBER	0,689	0,885	1,058	0,971	1,594	1,155	1,182	2,249	1,509	1,249	1,413
	5,742	9,697	13,889	11,694	16,35	16,35	16,35	16,35	16,35	16,35	16,35
DECEMBER	1,614	1,023	2,969	1,677	1,229	1,053	3,281	1,882	1,152	1,833	2,851
	16,35	12,967	16,35	16,35	16,35	13,747	16,35	16,35	16,35	16,35	16,35

Table 2.7.2 – Monthly Flood Volumes at Derdepoort (Author, 2015)

The peak floods have been highlighted in each year to gain an understanding of the trends in flooding as well as the values for further calculations. The designs of the water systems will need to cater for flood management and these values will provide maximum water rates and volumes.

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QUARRY CATCHMENT AND CALCULATION

All stormwater which lands on the site is either directed towards the Moreleta Spruit, Rietspruit or into the quarry. The quarry catchment is removed from all calculations regarding the river systems as no water which falls on the quarry site ends up in the river systems. The quarry catchment is focused on the collection of storm water, harvesting and directing the storm water on site into the purification system.

The storm water management system within the quarry and industrial area will be responsible for draining the site of all runoff from hard surfaces including the purification and storage of the water for use and incorporation into the social and economic elements proposed in the design intervention.

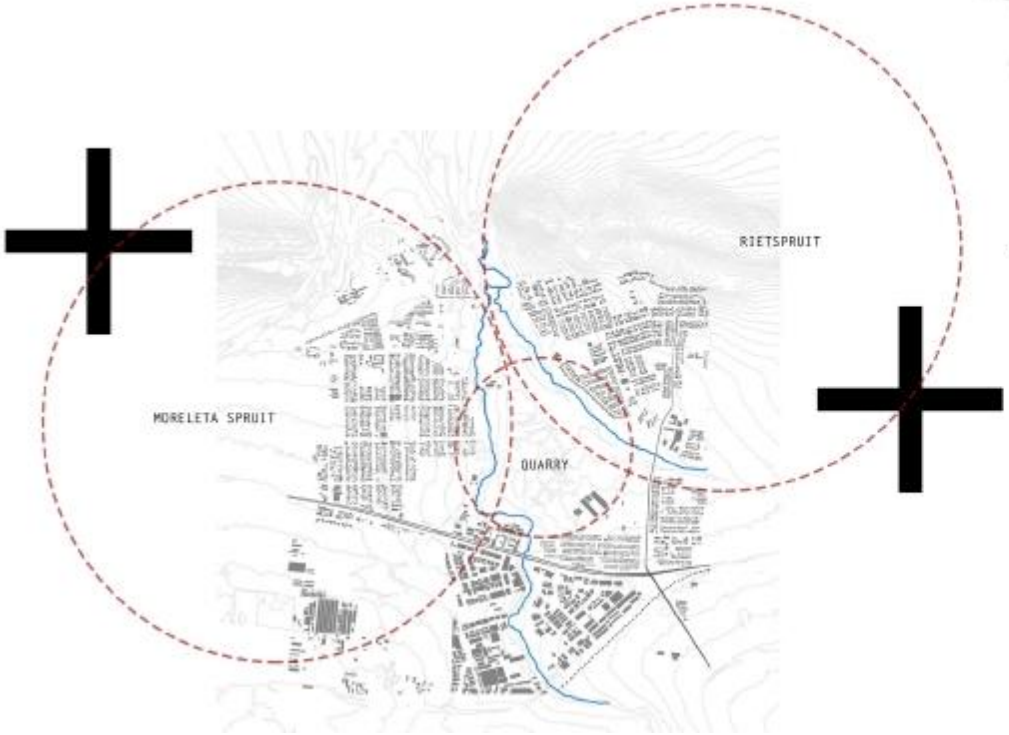

Figure 2.7.5 – Division of various catchments for the site (Author, 2015)

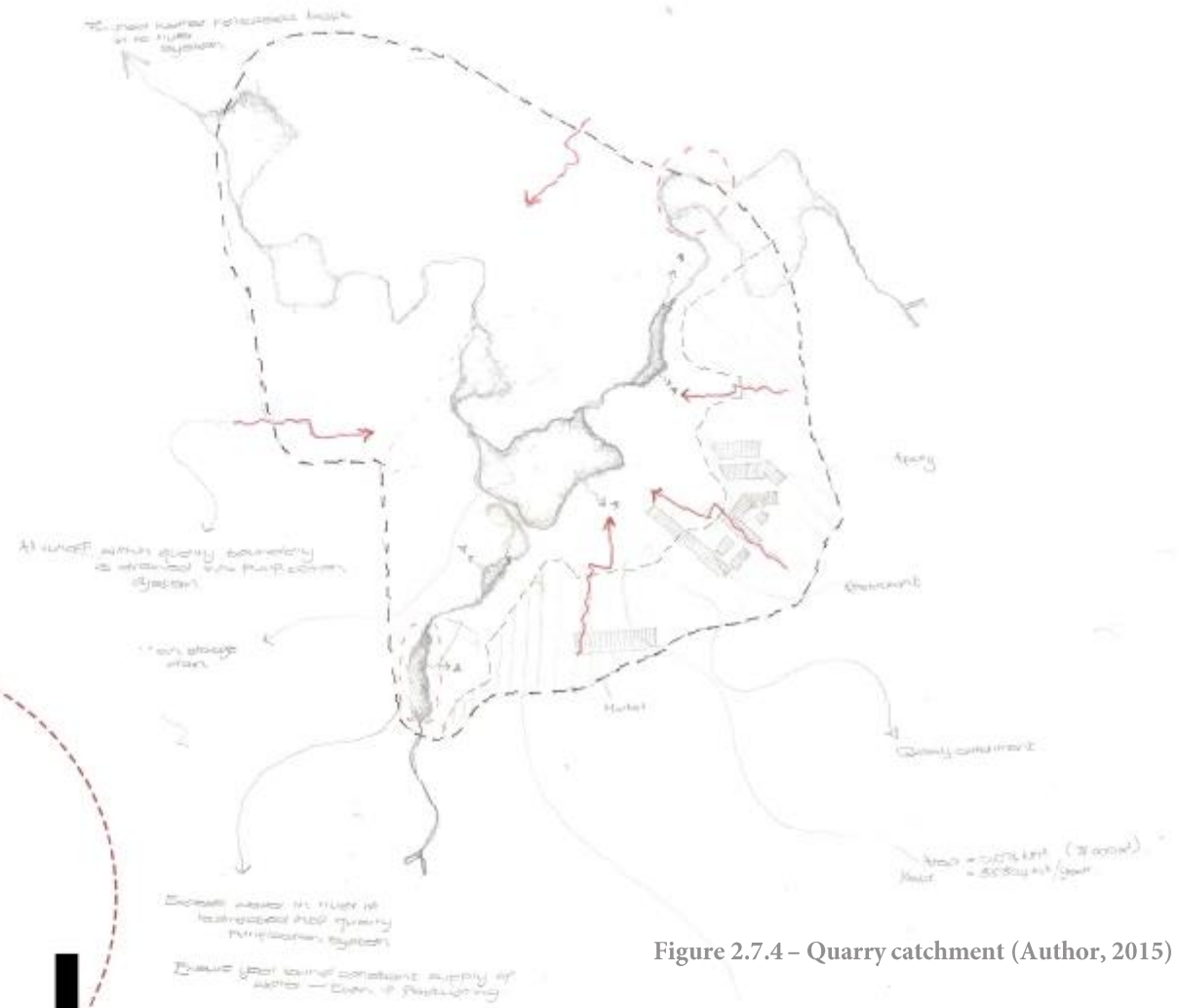

Figure 2.7.4 – Quarry catchment (Author, 2015)

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CALCULATION OF WATER VOLUMES AND FLOOD RATES AT STORMVOEL ROAD

The quarry catchment is a closed catchment area as no water from the quarry enters into the river system. The quarry water calculations will be calculated at a later stage and contribute to the water systems as a calculation of a Storm water runoff value for that catchment area.

The Moreleta Spruit and Rietspruit catchments are calculated as 7% of the total river catchment area. The total water volumes from the Derdepoort water meter will need to be reduced by 7% in order to determine the total water volumes in both the Rietspruit and Moreleta Spruit when entering the site.

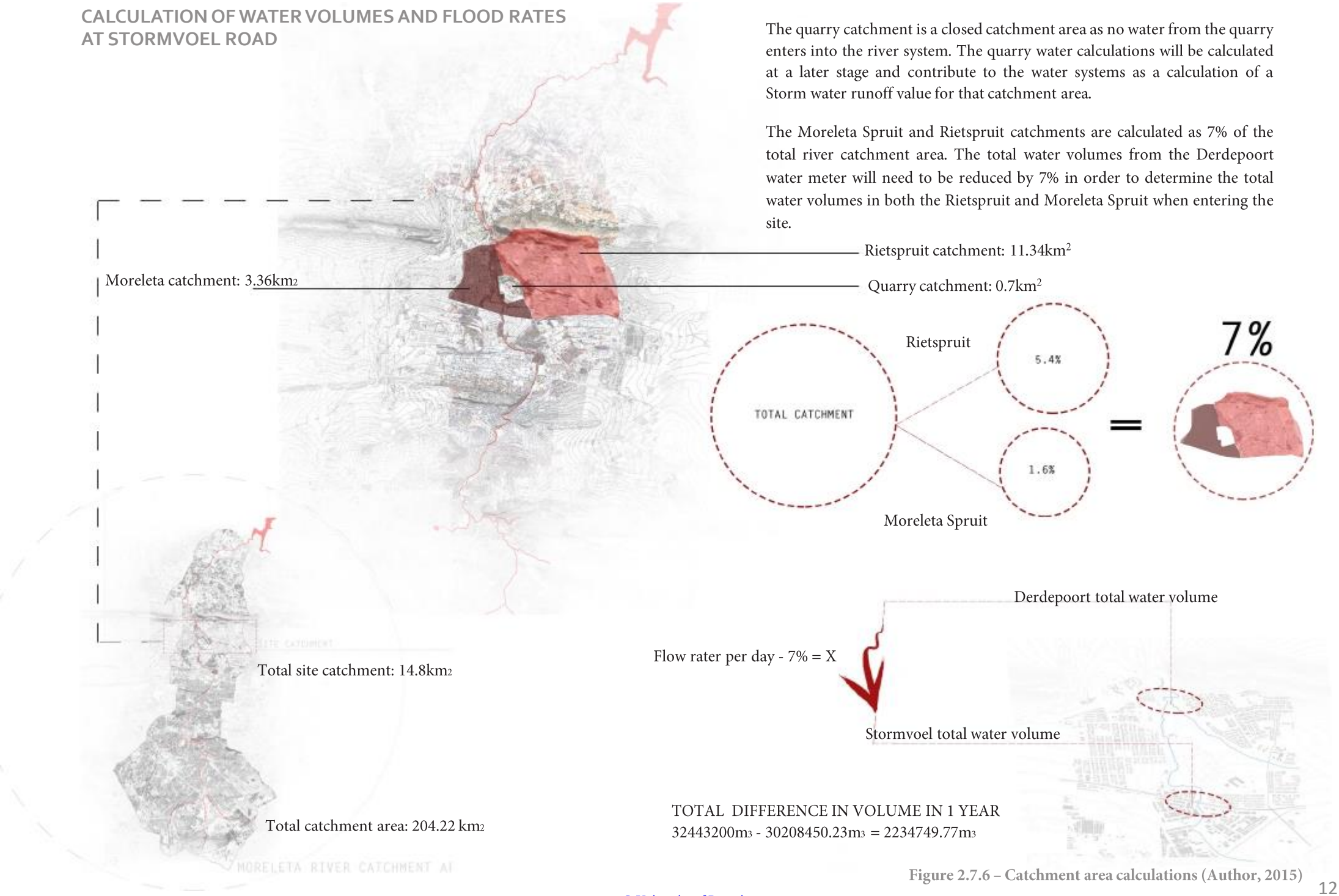

Figure 2.7.6 – Catchment area calculations (Author, 2015)

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DAILY FLOW RATE (M^3/S) READINGS AND CALCULATIONS FOR MORELETA SPRUIT ENTERING SITE

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
1	0,446	2,336	0,433	0,823	0,581	0,533	0,498	0,438	0,321	0,225	0,247	0,722
2	0,711	3,431		0,819	0,582	0,543	0,469	0,427	0,304	0,237	0,352	0,423
3	0,579	6,225		1,873	0,571	0,501	0,473	0,429	0,284	0,225	0,412	0,374
4	0,37	1,186		0,824	0,581	0,456	0,452	0,426	0,276	0,288	0,342	0,332
5	0,283	0,655		0,794	0,565	0,459	0,447	0,429	0,292	0,249	0,265	0,299
6	0,271	1,092	3,016	0,787	0,562	0,473	0,448	0,425	0,308	0,252	0,222	0,287
7	0,271	1,801	5,052	0,297	0,592	0,476	0,486	0,418	0,296	0,294	0,212	1,307
8	0,429	0,754	3,924	0,746	0,601	0,509	0,489	0,413	0,301	0,251	0,256	0,718
9	0,297	7,896	1,792	0,733	0,584	0,544	0,476	0,413	0,297	0,217	0,454	2,104
10	0,285	1,578	12,687	0,722	0,536	0,52	0,478	0,416	0,293	0,217	0,278	0,679
11	0,242	0,943	9,913	0,704	0,531	0,52	0,473	0,424	0,311	0,22	4,508	0,794
12	0,22	0,696	9,287	0,698	0,54	0,546	0,446	0,436	0,266	0,19	0,717	1,94
13	0,772	0,589	4,758	0,694	0,514	0,541	0,462	0,423	0,265	0,191	0,559	0,699
14	0,358	0,521	2,645	0,735	0,519	0,521	0,472	0,402	0,307	0,183	0,41	1,144
15	0,371	0,475	1,997	0,737	0,541	0,541	0,503	0,398	0,279	0,199	3,545	2,073
16	0,503	0,44	1,643	1,072	0,56	0,558	0,493	1,098	0,251	0,207	0,942	2,421
17	0,268	0,398	3,019	0,737	0,565	0,536	0,519	1,386	0,276	0,196	0,773	0,777
18	0,218	0,368	1,709	0,715	0,538	0,516	0,5		0,231	0,176	0,764	1,181
19	0,21	0,384	2,382	0,717	0,664	0,501	0,488		0,223	0,175	0,444	3,198
20	0,309	0,341	1,265	0,706	0,594	0,477	0,49		0,223	0,183	0,373	2,397
21	0,396	2,263	1,147	0,681	0,59	0,47	0,468	0,385	0,217	0,167	0,338	1,027
22	0,225	1,416	1,099	0,648	0,595	0,485	0,479	0,349	0,228	0,162	0,516	0,874
23	0,201	1,734	1,05	0,66	0,56	0,498	0,51	0,347	0,247	0,16	1,239	3,656
24	0,204	0,968	1,014	0,683	0,584	0,482	0,519	0,313	0,223	0,175	0,663	2,543
25	1,559	1,317	0,973	0,638	0,576	0,473	0,518	0,305	0,216	1,639	0,376	1,002
26	2,091	0,611	0,906	0,589	0,574	0,472	0,496	0,3	0,212	3,371	0,322	0,687
27	0,403	0,486	0,962	0,606	0,557	0,474	0,445	0,297	0,234	0,491	5,035	5,457
28	0,307	0,444	0,966	0,617	0,543	0,449	0,44	0,343	0,201	0,369	0,72	9,156
29	0,278		0,829	0,602	0,542	0,482	0,444	0,335	0,211	0,305	0,511	1,866
30	0,244		1,241	0,584	0,53	0,573	0,451	0,324	0,223	0,279	0,996	1,128
31	1,275		1,087		0,539		0,45	0,345		0,259		1,247
Average Flow Rate per day (m^3/second)	**1,586**	**1,476**	**2,47**	**0,741**	**0,565**	**0,504**	**0,476**	**0,444**	**0,26**	**0,379**	**0,893**	**1,693**
Average Volume per day (m^3)	137055,48	127588,11	214037,88	64054,08	48816,85	43545,6	41198,86	38398,62	22510	32753,96	77158,08	146356,02
Average volume per month (m^3)	4248720	3572467,2	6635174,4	1921644	1513322,35	1307145,6	1277164,8	1190357,48	675302,4	1015372,8	2314742,4	4537036,8
Average volume per year (m^3)	30208450,23										Minimum flow rate	Maximum flow rate

Table 2.7.3 – Daily Flow Rates for Moreleta Spruit (Author, 2015)

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FLOOD VOLUME (M^3/S) READINGS FOR MORELETA SPRUIT OVER THE LAST TEN YEARS

Year – October to October (Lowest and Highest Readings in that Month)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
JANUARY	0,77	1,864	1,992	0,713	1,612	1,817	0,785	2,714	1,368	0,863	1,041
	7,872	16,35	16,35	6,698	16,35	16,35	8,201	16,35	16,35	9,926	14,433
FEBRUARY	1,425	0,83	1,427	0,86	0,877	2,453	1,053	1,07	1,726	1,115	3,659
	16,35	9,189	16,35	9,871	10,278	16,35	14,762	16,35	16,35	16,35	16,35
MARCH	1,25	0,677	2,634	0,446	1,679	1,554	1,001	2,962	1,111	0,648	2,7
	16,35	6,028	16,35	2,336	16,35	16,35	13,365	16,35	16,35	5,471	16,35
APRIL	0,981	0,931	1,154	0,559	0,817	0,248	0,826	1,19	0,458	1,148	0,719
	12,834	12,044	16,35	3,564	8,892	0,533	9,1	16,35	2,627	16,35	6,835
MAY	1,354	0,203	0,239	0,201	0,706	0,328	0,825	0,565	0,206	0,447	0,291
	16,35	0,325	0,485	0,317	6,584	1,079	9,078	4,047	0,335	2,348	0,737
JUNE	0,334	0,167	0,19	0,921	0,322	0,532	0,252	0,853	0,185	0,26	0,272
	1,13367	0,199	0,275	11,331	1,036	3,545	0,559	9,712	0,255	0,601	0,675
JULY	0,225	0,188	0,173	0,252	0,241	0,234	0,301	0,226	0,186	0,206	0,252
	0,464	0,266	0,218	0,554	0,497	0,46	0,869	0,425	0,261	0,335	0,554
AUGUST	0,197	0,234	0,963	0,136	0,226	0,523	0,199	0,634	0,192	0,22	0,657
	0,299	0,464	12,386	0,119	0,343	3,404	0,309	5,221	0,281	0,396	5,641
SEPTEMBER	0,135	0,185	0,215	0,87	0,15	0,6	0,168	0,268	1,454	0,321	0,213
	0,117	0,255	0,374	10,103	0,124	4,637	0,201	0,651	16,35	1,1025	0,357
OCTOBER	0,43	0,418	0,819	1,288	0,622	0,824	0,696	1,182	1,275	1,161	1,301
	2,139	1,989	8,937	16,35	5,007	8,933	6,378	16,35	16,35	16,35	16,35
NOVEMBER	0,64	0,823	0,983	0,906	1,482	1,074	1,099	2,091	1,403	1,161	1,314
	5,34	9,018	12,916	10,875	16,35	16,35	16,35	16,35	16,35	16,35	16,35
DECEMBER	1,501	0,951	2,761	1,559	1,142	0,979	3,051	1,75	1,071	1,704	2,651
	16,35	12,059	16,35	16,35	16,35	12,781	16,35	16,35	16,35	16,35	16,35

Table 2.7.4 – Monthly Flood Volumes at Moreleta Spruit (Author, 2015)

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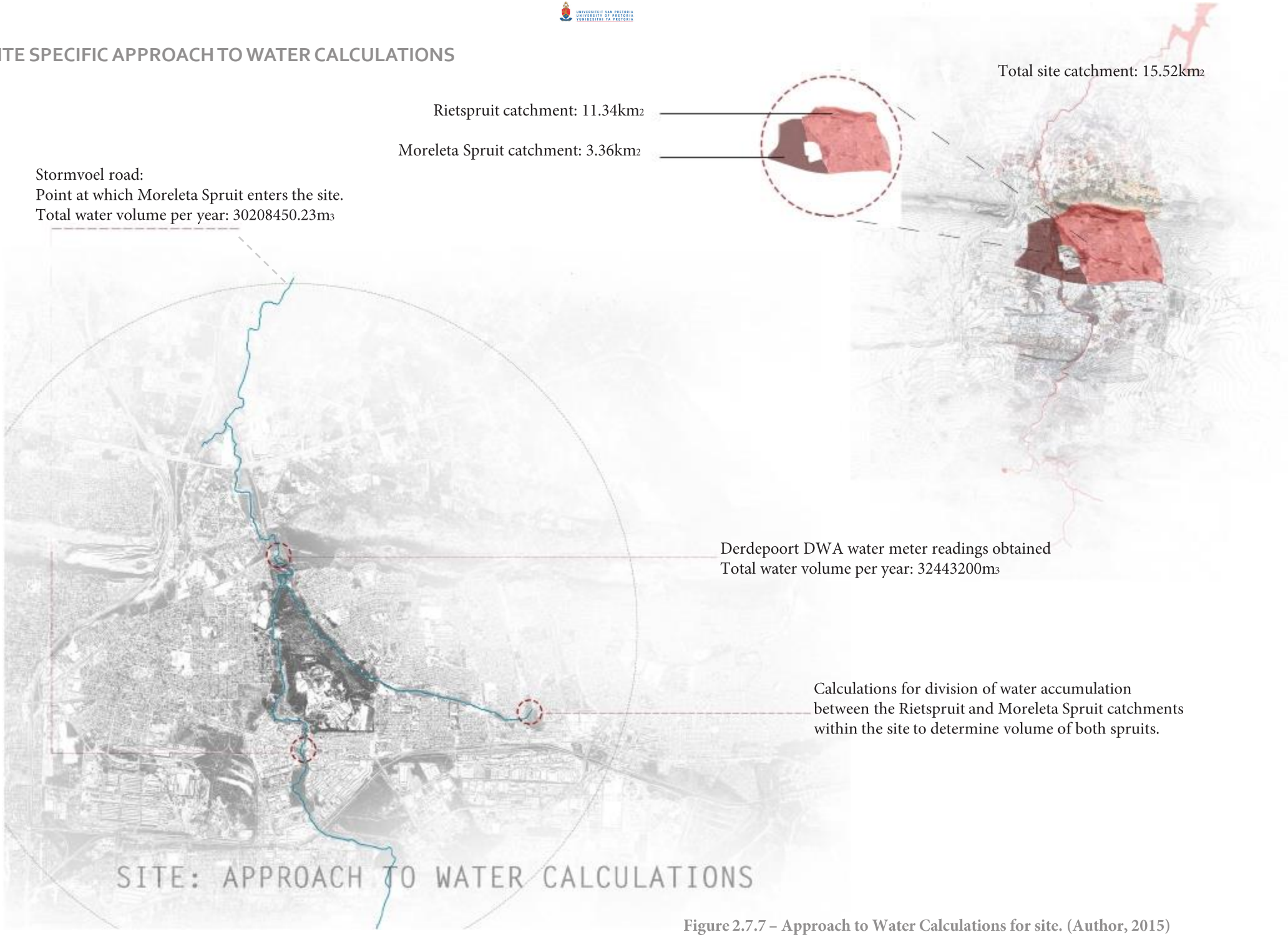

Figure 2.7.7 – Approach to Water Calculations for site. (Author, 2015)

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DIVISION OF ACCUMULATED WATER BETWEEN RIETSPRUIT AND MORELETA SPRUIT

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The catchment of the site will be divided between the two river systems, the percentage of each rivers accumulation throughout the year will depend on the percentage of each catchment within the larger catchment of the overall site.

Rietspruit has a larger catchment area, all water in the river system is accumulated from this catchment. The Rietspruit will have a volume of 1720757.32m3 per year.

The Moreleta Spruit has a volume of 30208450.23m3 flowing into the site and through catchment runoff Accumulates 513992.44m3 during the year, the total volume of water leaving the site will be 30722442.67m3.

The total volumes from each river system:
- Moreleta Spruit 30722442.67m2
- Rietspruit 1720757.32m2

Which adds up to an accumulative volume of 32443200m2 which is equal to the volume of water obtained from the DWA water meter at Derdepoort.

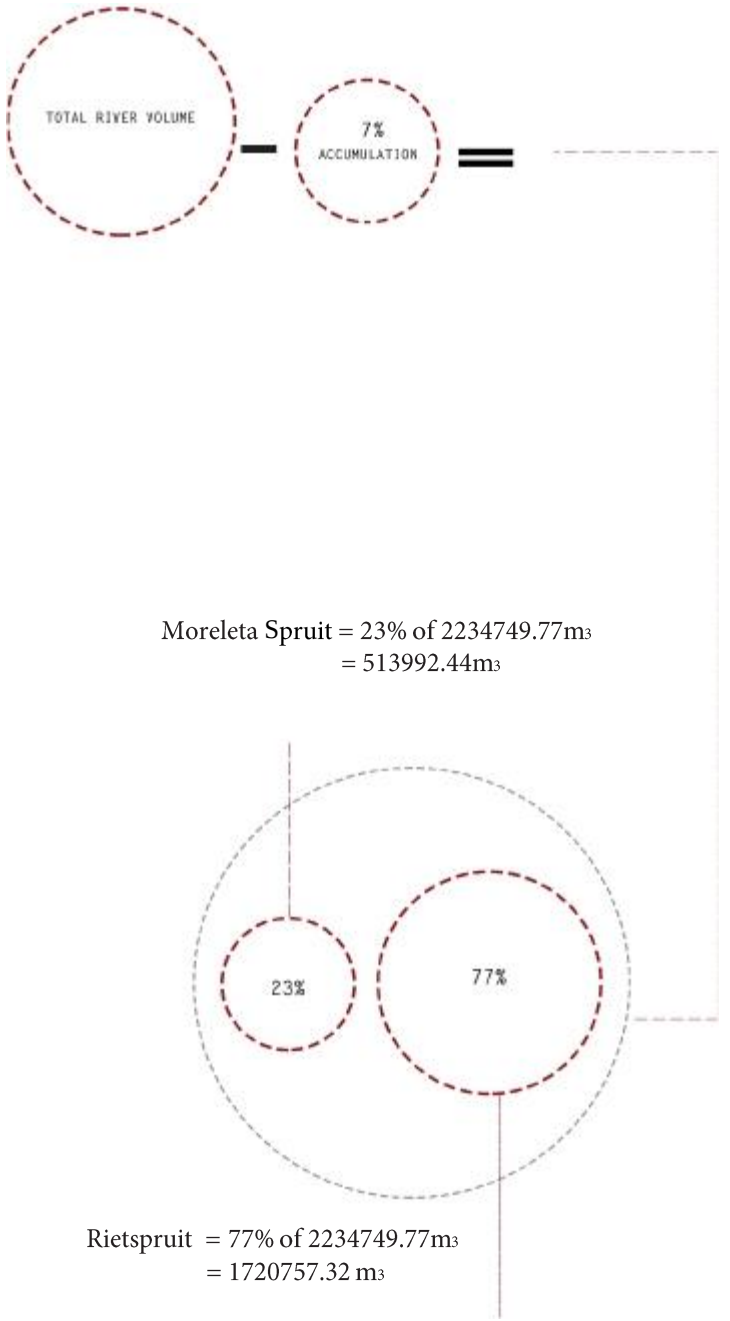

Figure 2.7.8 – Water division between river systems (Author, 2015)

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DAILY FLOW RATE (M^3/S) READINGS AND CALCULATIONS FOR RIETSPRUIT TRIBUTARY

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
1	0,024	0,126	0,024	0,044	0,031	0,029	0,027	0,024	0,017	0,012	0,013	0,039
2	0,038	0,185		0,044	0,031	0,029	0,025	0,023	0,016	0,013	0,019	0,023
3	0,032	0,338		0,101	0,031	0,027	0,025	0,023	0,015	0,012	0,022	0,020
4	0,020	0,064		0,044	0,031	0,025	0,024	0,023	0,015	0,016	0,018	0,018
5	0,015	0,035		0,043	0,030	0,025	0,024	0,023	0,016	0,013	0,014	0,016
6	0,015	0,059	0,155	0,042	0,030	0,025	0,024	0,023	0,017	0,014	0,012	0,015
7	0,015	0,097	0,272	0,016	0,032	0,026	0,026	0,023	0,016	0,016	0,011	0,070
8	0,023	0,041	0,211	0,040	0,032	0,027	0,026	0,022	0,016	0,014	0,014	0,039
9	0,016	0,425	0,096	0,039	0,031	0,029	0,026	0,022	0,016	0,012	0,024	0,113
10	0,015	0,085	0,682	0,039	0,029	0,028	0,026	0,022	0,016	0,012	0,015	0,037
11	0,013	0,051	0,533	0,038	0,029	0,028	0,025	0,023	0,017	0,012	0,242	0,043
12	0,012	0,037	0,495	0,038	0,029	0,029	0,024	0,023	0,014	0,010	0,039	0,104
13	0,042	0,032	0,256	0,037	0,028	0,029	0,025	0,023	0,014	0,010	0,030	0,038
14	0,029	0,028	0,142	0,040	0,028	0,028	0,025	0,022	0,017	0,010	0,022	0,062
15	0,020	0,026	0,107	0,040	0,029	0,029	0,027	0,021	0,015	0,011	0,191	0,116
16	0,027	0,024	0,088	0,058	0,030	0,030	0,027	0,059	0,014	0,011	0,051	0,130
17	0,014	0,021	0,162	0,040	0,030	0,029	0,028	0,075	0,015	0,011	0,042	0,042
18	0,012	0,020	0,092	0,038	0,029	0,028	0,027		0,012	0,010	0,041	0,098
19	0,011	0,021	0,128	0,039	0,036	0,027	0,026		0,012	0,009	0,024	0,172
20	0,017	0,018	0,068	0,038	0,032	0,026	0,026		0,012	0,010	0,020	0,129
21	0,021	0,122	0,062	0,037	0,032	0,025	0,025	0,021	0,012	0,009	0,018	0,055
22	0,012	0,076	0,059	0,035	0,032	0,026	0,026	0,019	0,012	0,009	0,028	0,047
23	0,011	0,093	0,057	0,036	0,030	0,027	0,027	0,019	0,013	0,009	0,067	0,197
24	0,011	0,052	0,055	0,037	0,031	0,026	0,028	0,017	0,012	0,009	0,036	0,137
25	0,084	0,071	0,052	0,034	0,031	0,025	0,028	0,016	0,012	0,088	0,020	0,054
26	0,112	0,033	0,049	0,032	0,031	0,025	0,027	0,016	0,011	0,181	0,017	0,037
27	0,022	0,026	0,052	0,033	0,030	0,026	0,024	0,016	0,013	0,026	0,271	0,293
28	0,017	0,024	0,052	0,033	0,029	0,024	0,024	0,018	0,011	0,020	0,039	0,492
29	0,015		0,045	0,032	0,029	0,026	0,024	0,018	0,011	0,016	0,028	0,100
30	0,013		0,065	0,031	0,029	0,031	0,024	0,017	0,012	0,015	0,054	0,061
31	0,069		0,058		0,029		0,024	0,019		0,015		0,067
Average Flow Rate per day (m^3/second)	**0,086**	**0,08**	**0,132**	**0,06**	**0,033**	**0,027**	**0,028**	**0,026**	**0,017**	**0,021**	**0,04**	**0,093**
Average Volume per day (m^3)	7447,12	6912	11474,47	5184	2851,2	2332,8	2419,2	2246,4	1468,8	1814,4	3456	8035,2
Average volume per month (m^3)	230860,72	214272	355708,8	160704	88387,2	72316,8	74995,2	69638,4	45532,8	56246,4	107136	249091,2
Average volume per year (m^3)	1724889,52										Minimum flow rate	Maximum flow rate

Table 2.7.5 – Daily Flow Rates for Rietpruit Tributary (Author, 2015)

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FLOOD VOLUME (M^3/S) READINGS FOR STORM VOEL OVER THE LAST TEN YEARS

Year – October to October (Lowest and Highest Readings in that Month)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
JANUARY	0,041	0,100	0,107	0,038	0,087	0,098	0,042	0,146	0,074	0,046	0,056
	0,423	0,818	0,818	0,360	0,818	0,818	0,441	0,818	0,818	0,534	0,776
FEBRUARY	0,077	0,045	0,077	0,046	0,047	0,132	0,057	0,058	0,093	0,060	0,197
	0,818	0,494	0,818	0,531	0,553	0,818	0,794	0,818	0,818	0,818	0,818
MARCH	0,067	0,036	0,142	0,024	0,090	0,084	0,054	0,159	0,060	0,035	0,145
	0,818	0,324	0,818	0,126	0,818	0,818	0,719	0,818	0,818	0,294	0,818
APRIL	0,053	0,050	0,062	0,030	0,044	0,013	0,044	0,064	0,025	0,062	0,039
	0,690	0,648	0,818	0,213	0,478	0,029	0,489	0,818	0,141	0,818	0,368
MAY	0,073	0,011	0,013	0,011	0,038	0,018	0,044	0,030	0,011	0,024	0,016
	0,818	0,018	0,026	0,017	0,354	0,058	0,488	0,218	0,018	0,126	0,043
JUNE	0,018	0,009	0,010	0,050	0,017	0,029	0,014	0,046	0,010	0,014	0,015
	0,061	0,011	0,015	0,609	0,056	0,191	0,030	0,522	0,014	0,032	0,036
JULY	0,012	0,010	0,009	0,014	0,013	0,013	0,016	0,012	0,010	0,011	0,014
	0,025	0,014	0,012	0,030	0,027	0,025	0,047	0,023	0,014	0,018	0,030
AUGUST	0,011	0,013	0,052	0,007	0,012	0,028	0,011	0,034	0,010	0,012	0,035
	0,016	0,025	0,566	0,006	0,018	0,183	0,017	0,281	0,015	0,021	0,303
SEPTEMBER	0,007	0,010	0,012	0,047	0,008	0,032	0,009	0,014	0,078	0,017	0,012
	0,006	0,014	0,020	0,543	0,007	0,249	0,011	0,035	0,818	0,055	0,020
OCTOBER	0,023	0,023	0,044	0,069	0,033	0,044	0,037	0,064	0,069	0,062	0,070
	0,115	0,107	0,481	0,818	0,269	0,480	0,343	0,818	0,818	0,818	0,818
NOVEMBER	0,034	0,044	0,053	0,049	0,080	0,058	0,059	0,112	0,075	0,062	0,071
	0,287	0,485	0,594	0,585	0,818	0,818	0,818	0,818	0,818	0,818	0,818
DECEMBER	0,081	0,051	0,148	0,084	0,061	0,053	0,164	0,094	0,058	0,092	0,143
	0,818	0,648	0,818	0,818	0,818	0,687	0,818	0,818	0,818	0,818	0,818

Table 2.7.6 – Monthly Flood Volumes at Stormvoel (Author, 2015)

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VOLUMES FOR USE IN FURTHER CALCULATIONS

Making use of the calculations previously explained, the same process was carried out for the last ten years worth of water data from the DWA Meter and Derdepoort.

This enabled the use of averages for each year and month for a more reliable and consistent set of data for the further calculations in the water scheme for the site.

The water calculations have determined the monthly average for each month over a period of the last ten years and from these averages the design will be able to ensure the functioning of the system at both the average maximum and average minimum flow rates and volumes. The system is designed to be in constant flow for the purification of water through the wetlands, additional calculations were done regarding the absolute minimum and maximum volumes and flow rates and have been designed to ensure the constant flow and functioning of the system even in extreme conditions. The absolute minimum value was determined through evaluation of all years and flow rates and the lowest recorded flow rate in the last ten years was used as the absolute minimum.

The absolute maximum value was determined by the analysis of the floods recorded in the last ten years and the highest value was used as this is the maximum volume of water that the system will need to handle.

ABSOLUTE MINIMUM: 0.16m3/s
ABSOLUTE MAXIMUM: 16,35m3/s

AVERAGE MONTHLY FLOW RATES (M^3/S) AND VOLUMES (M^3) 2004-2014

MONTH	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		MOTHLY AVERAGE
JANUARY	0,863	4,15	5,26	0,997	4,93	3,85	0,962	5,34	1,84	1,46	1,38		3,1032
FEBRUARY	2,27	0,994	5,13	0,659	1,19	4,02	1,63	1,36	1,48	1,31	3,85		2,3893
MARCH	3,74	0,682	2,32	0,282	4	2,3	1,32	4,03	1,41	1,01	7,11		2,8204
APRIL	1,15	1,3	1,2	0,292	0,967	0,593	3,79	2,11	0,79	1,94	2,07		1,62
MAY	0,684	0,423	0,687	0,215	1,02	0,648	1,86	1,42	0,593	0,866	1,63		1,0046
JUNE	0,398	0,349	0,515	0,91	0,607	0,872	0,966	1,26	0,574	0,831	1,41		0,8665
JULY	0,405	0,363	0,462	0,347	0,6	0,696	0,93	1,04	0,546	0,635	1,37		0,7394
AUGUST	0,345	0,314	0,949	0,265	0,49	0,759	0,695	1,04	0,5	0,56	1,16		0,7077
SEPTEMBER	0,214	0,192	0,382	0,511	0,3	0,461	0,402	0,676	2,21	0,489	0,728		0,6475
OCTOBER	0,305	0,347	0,407	3,03	0,537	1,06	0,544	1,69	2,33	1,75	1,09		1,309
NOVEMBER	0,364	1,61	1,07	0,732	3,3	2,43	1,04	2,06	1,72	1,95	2,49		2,1836
DECEMBER	2,18	1,52	1,8	2,34	1,54	2,33	3,2	2,99	3,09	3,77	4,95		2,671
MONTHLY AVERAGE (million m^3)	1076500	1020333,3	1681833	881666,66	1623416,66	1668250	1444916,66	2084666,66	1423583,33	1380916,66	2436500	Average minimum	
TOTAL VOLUME PER YEAR (m^3)	12918000	12244000	20182000	10580000	19481000	20019000	17339000	25016000	17083000	16571000	29238000	Average maximum	

Table 2.7.7 – Monthly Average Flowrates and Volumes (Author, 2015)

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Figure 2.7.9– Overall Water Strategy(Author, 2015)

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STRATEGY 3:
Diversion of portion of Rietspruit into quarry purification system using same principles as described in Strategy 1, but with the inclusion of bioswale for irrigation of agriculture and storm water management.

STRATEGY 1:
Diversion of portion of Moreleta Spruit into the quarry purification system.
Contour manipulation and dam creation for manipulation of water in to quarry.

STRATEGY 2:
Purification of water that is not diverted in to the purification system. In river purification strategy managing and purifying polluted runoff and stormwater outlets released in to river system.

Figure 2.7.10 – River Diversion and Purification Strategy (Author, 2015)

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STORM WATER COLLECTION MANAGEMENT

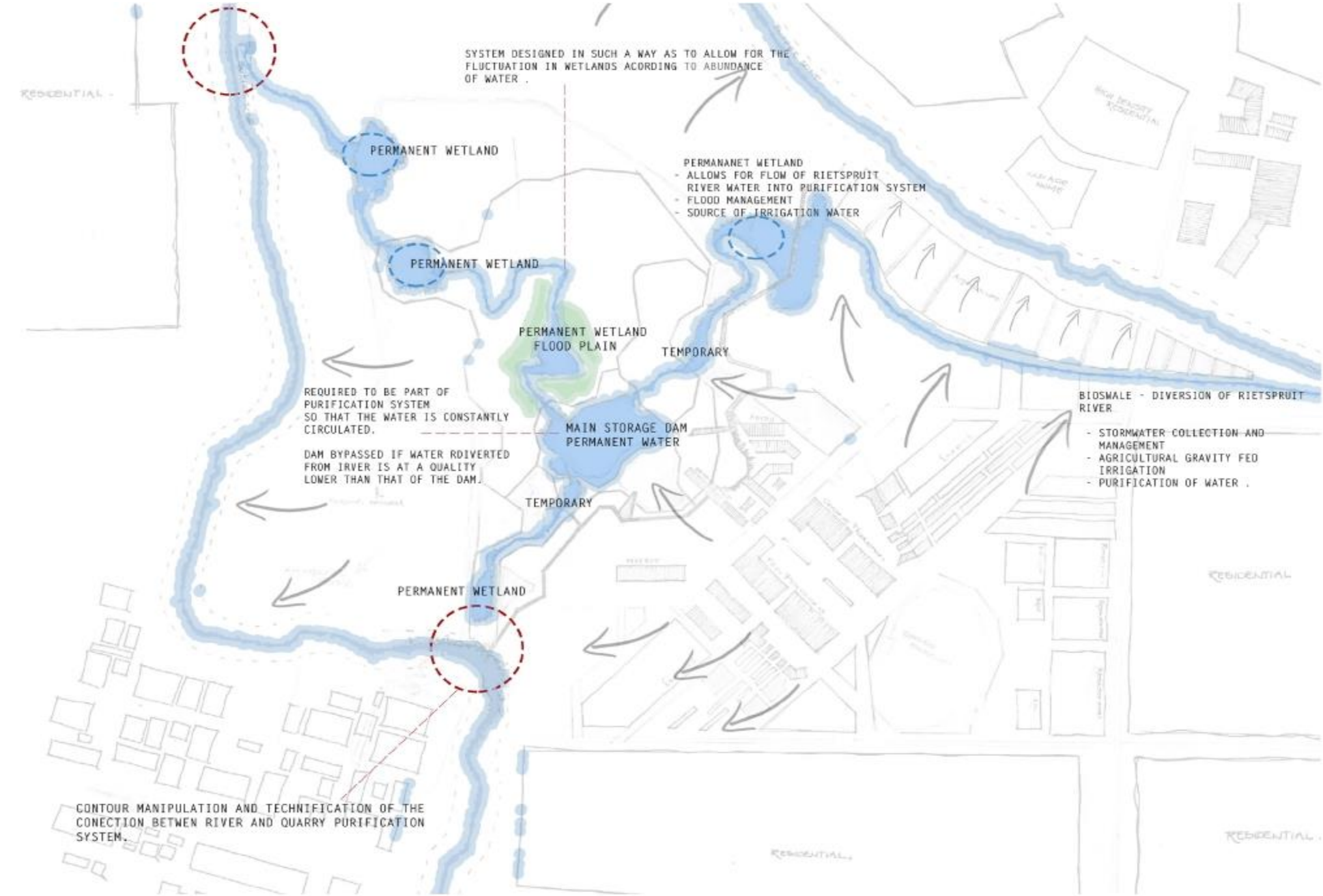

Figure 2.7.11 – Storm Water Collection (Author, 2015)

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The diversion of the Moreleta Spruit requires intensive contour manipulation of the edge of the quarry to allow for direct water flow. The contour difference will require damming of the spruit to raise the water level allowing for free flow into the purification system.

Not all water will be diverted in order to preserve the spruit ecology. The spruit will be split upstream allowing half of the flow into the dam while the other half will be transported through a pipe beyond the dam directly into the river system downstream.

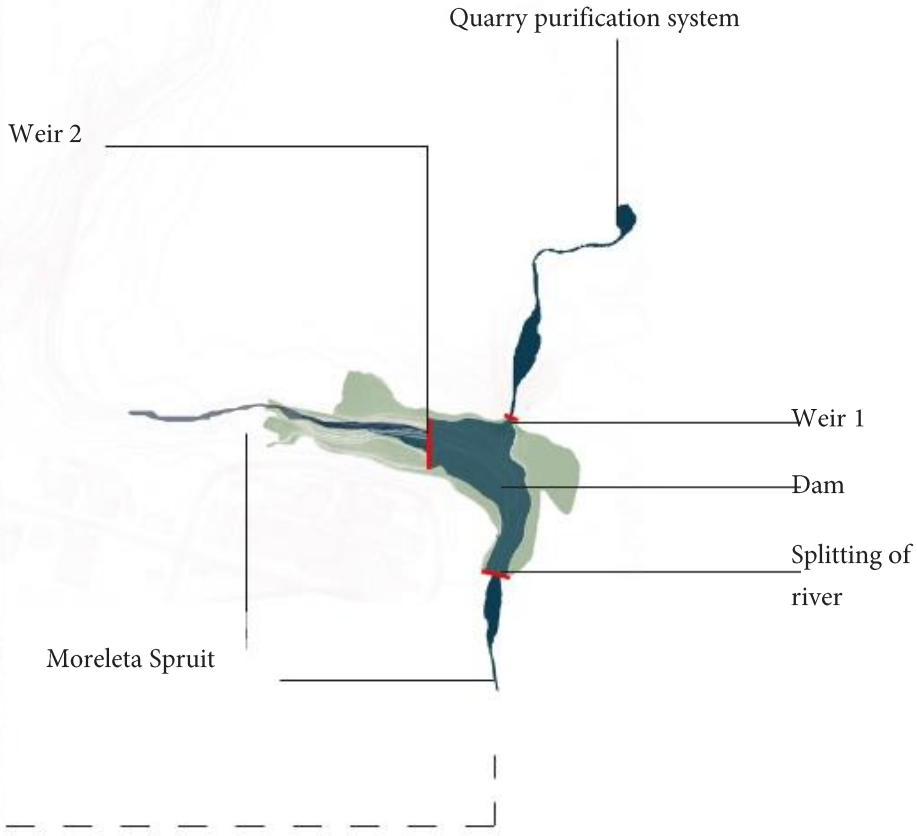

Figure 2.7.12 – Overall Water Strategy 1 and Contour Mapping (Author, 2015)

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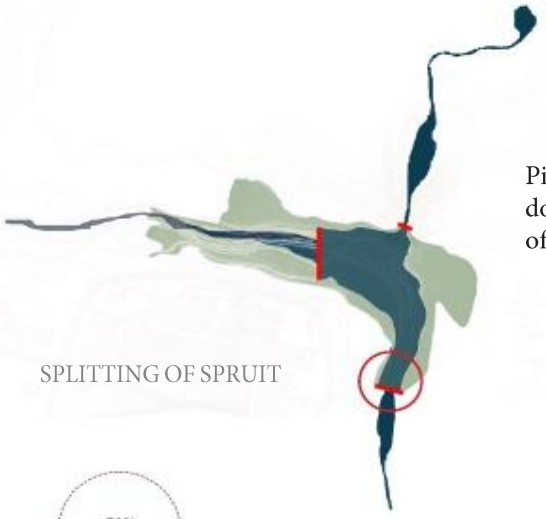
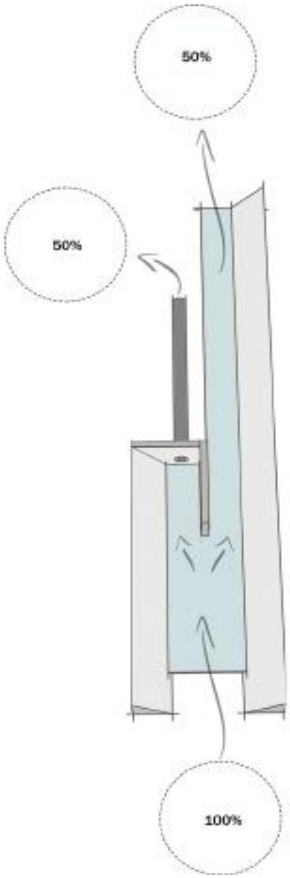
RIVER SYSTEM DIVERSION



SPLITTING OF SPRUIT



Open channel for diverted water from river system into constructed dam.

Pipe for transportation of the portion of water downstream, bypassing dam. Maintaining ecology of existing river system.

Diverted water for purification

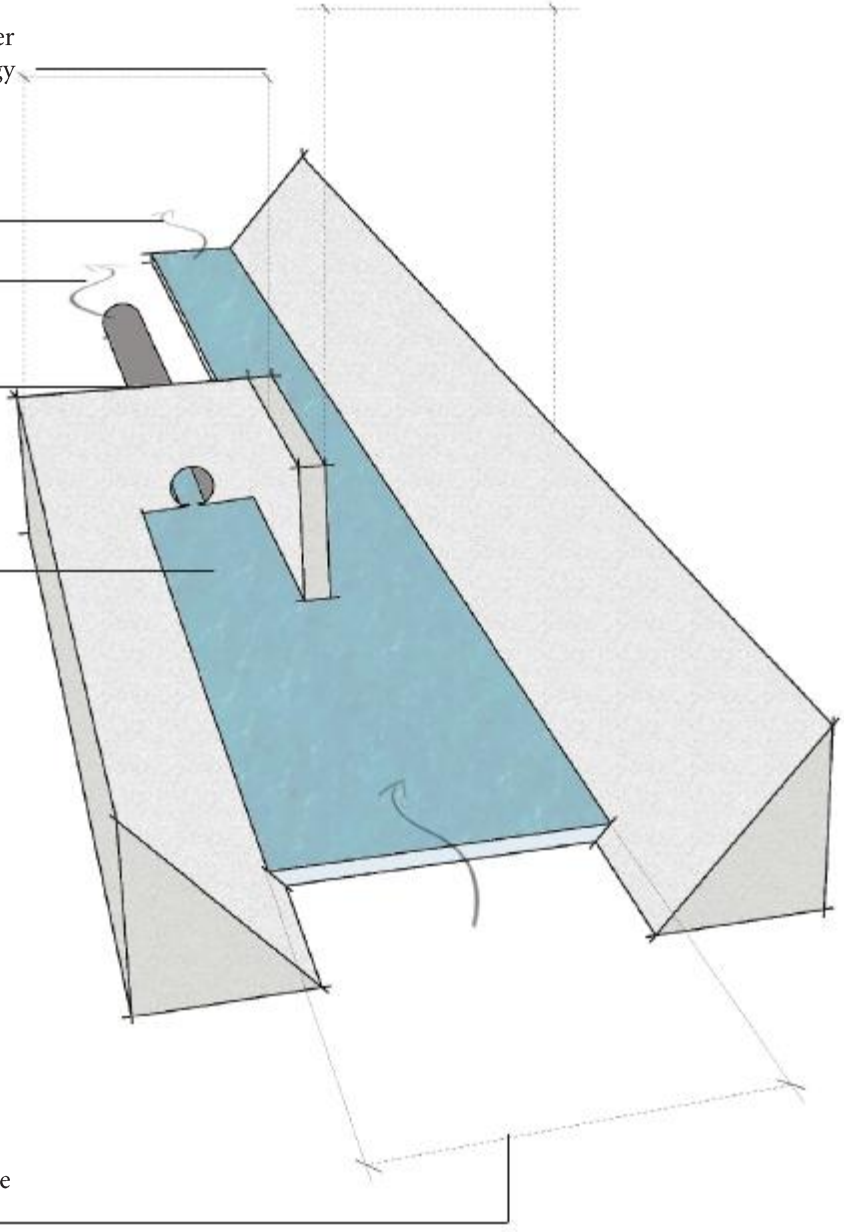
Maintained natural flow

Pipe size determined by average maximum volume calculation

Necessary incorporation of a litter trap

The Moreleta Spruit will flow in the channel at 100% flow rate, the constructed divider will split the river in half, ensuring 50% of the water is released back into the natural system and 50% is diverted to the quarry purification system.

The pipe will be sized according to the average maximum flow rate, ensuring that it is able to handle 50% of the flow.



Channalized Moreleta Spruit before splitting of system

Figure 2.7.13 – River System Diversion Technification (Author, 2015)

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WEIR 1 SIZING - QUARRY ENTRANCE

Level X was determined by the height to which the water needed to be raised in order to be able to flow into the quarry which was 2m.

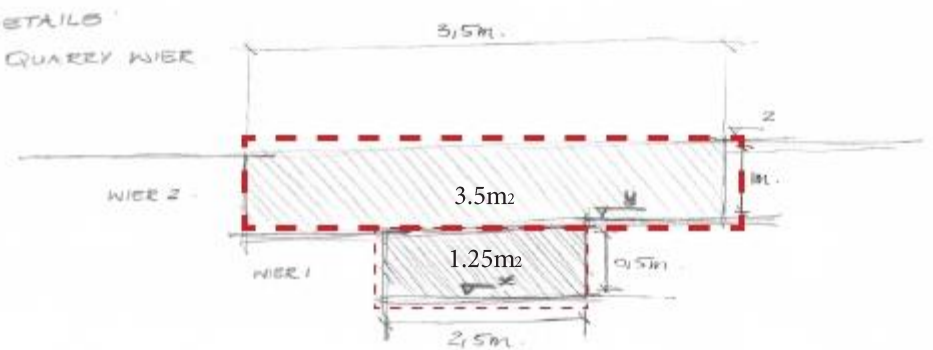
For the calculation of level Z, the cross sections of the wiers need to be able to accommodate 7.39m³/s. Therefore;

The first allows for 1.55m³/s, so the second part of the weir will need to allow through 5.84m³/s.

The flow rate for Z was calculated as follows:

Flow rate: 16.35m³/s/2 = 8.175m³/s
8.175m³/s - 1.55m³/s = 6.625m³/s
8.175m³/s + 6.625m³/s = 14.8m³/s

Therefore 14.8m³/s is entering the dam so between weir 1 and weir 2 each will allow for 7.39m³/s



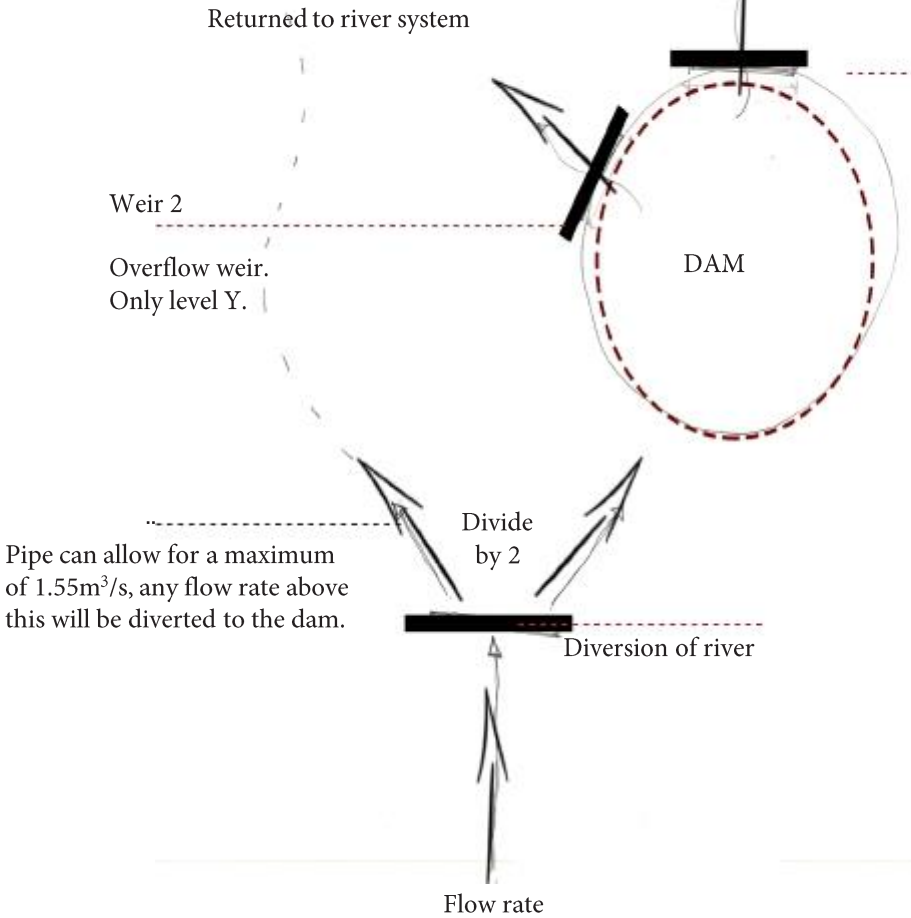
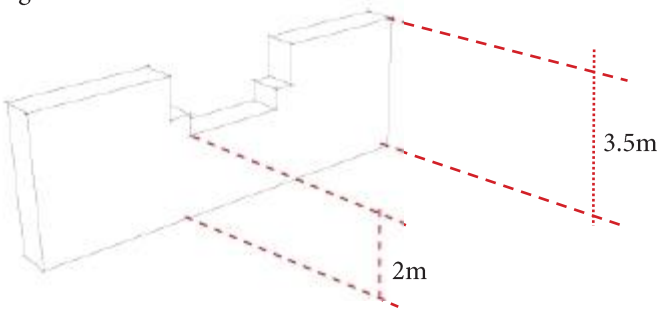


Figure 2.7.14 – Weir 1 Diversion and Flow Rates (Author, 2015)

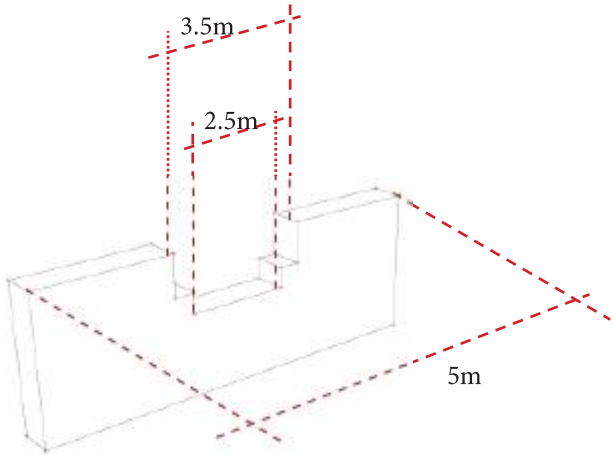
Level Y is determined by the average maximum: 3.10m³/s

Calculation
Size: 2.5m x 0.5m = 1.25m²
Flow rate = 1.55m³/s
Velocity = 1.24m/s
Volume = 133 920m³/day
= 4 151 520m³/month



Level Z is determined by the absolute maximum: 16.35m³/s

Calculation:
Size: 3.5m x 1m = 3.5m²
Flow rate = 5.84m³/s
Velocity = 1.66m/sm/s
Volume = 504 576m³/day
FLOOD



Drg2.7.6a – Weir 1 Sizing (Author, 2015)

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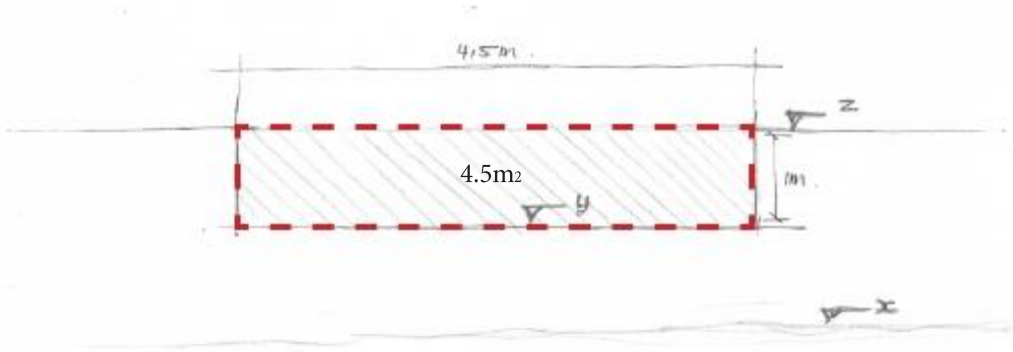
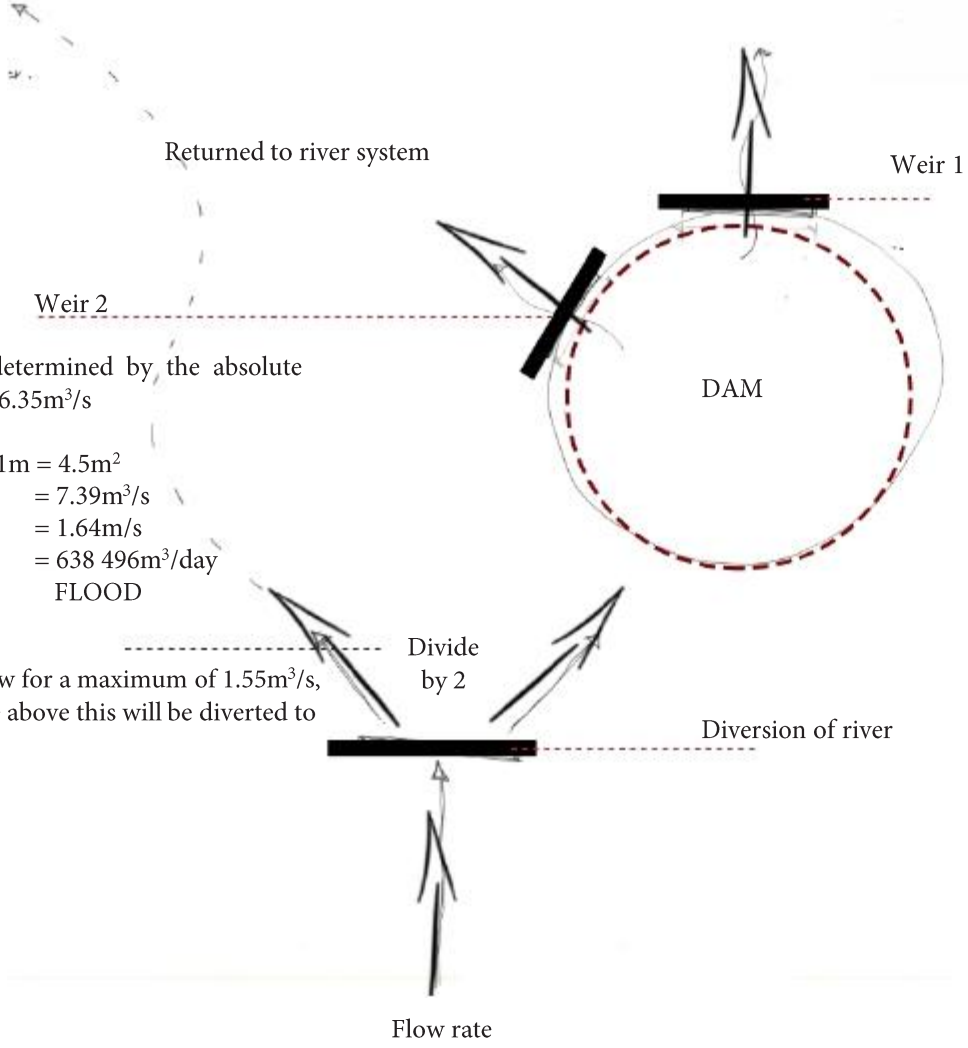
WEIR 2 SIZING: RETURN TO RIVER

Weir 2 allows for the average maximum volume of water to be evenly distributed between the quarry purification system and the existing river system. This weir differs from Weir 1 as it has no X level, only a Y. This ensures that the river and the purification system receive approximately the same amount of water. The second weir is wider than the forst weir and will differ slightly in design and cross sectional area.

Level X: 2m
Level Y: 2.5m





Level Z is determined by the absolute maximum: 16.35m³/s
Calculation:
Size: 4.5m x 1m = 4.5m²
Flow rate = 7.39m³/s
Velocity = 1.64m/s
Volume = 638 496m³/day
FLOOD

Pipe can allow for a maximum of 1.55m³/s, any flow rate above this will be diverted to the dam.

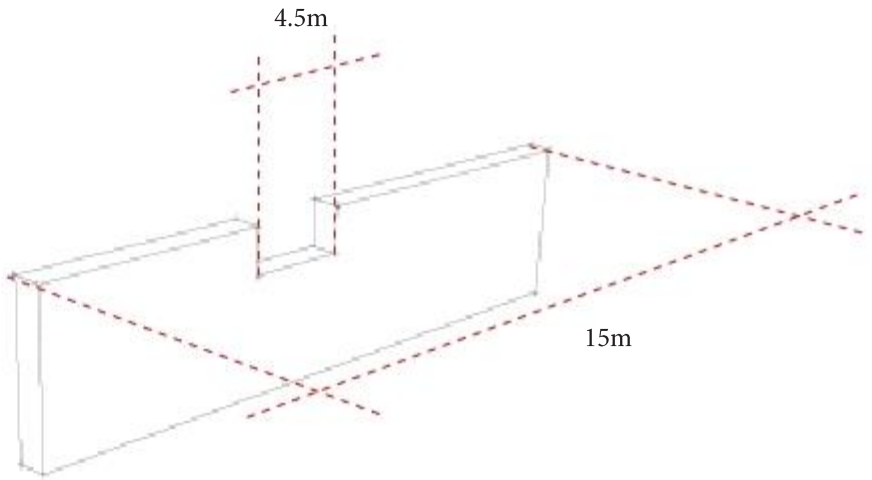


Figure 2.7.15 – Weir 2 Diversion and Flow Rates (Author, 2015)

Drg 2.7.7a – Weir 2 Sizing (Author, 2015)

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The water flowing from the dam needs to be slowed down in order for the water to travel at the optimum speed through the wetland for maximum purification.

The ideal speed would be 0.1m/s. Each calculation will determine the cross sectional area of the river channel for that specific volume of water, the size will ensure that the volume of water entering the system is slowed down and assisted through the system at 0.1m/s.a.

Level a is the Absolute minimum flow rate that has been recorded, the design of the system ensures that the system will continuously flow even when minimal water is available. In terms of the wetland channel design, this value will determine the permanent water level within the system and permanent channel sizes. Plants that require permanent water will be planted in this zone.

Level b is the Average minimum flow rate that will pass through the system, this zone will be relatively permanent throughout the year and will be a zone of transitional planting for marginal plants

Level c will be determined by the Average maximum flow rate that passes through the system, if the volume of water at this level passes through the system at a speed of 0.1m/s, it ensures that smaller volumes of water will pass through at a slower rate, ideal for maximum purification.

This is a transitional zone between aquatic and terrestrial environments and will consist of marginal plants.

Level d, is the Absolute maximum and is the floodplain area which will aid in flood management .

The large volumes of water which will be passing through the system in such an event will not be able to pass through at a rate ideal for purification, but will be able to prevent damage downstream.

The design interventions will need to take into consideration the floodplain areas.

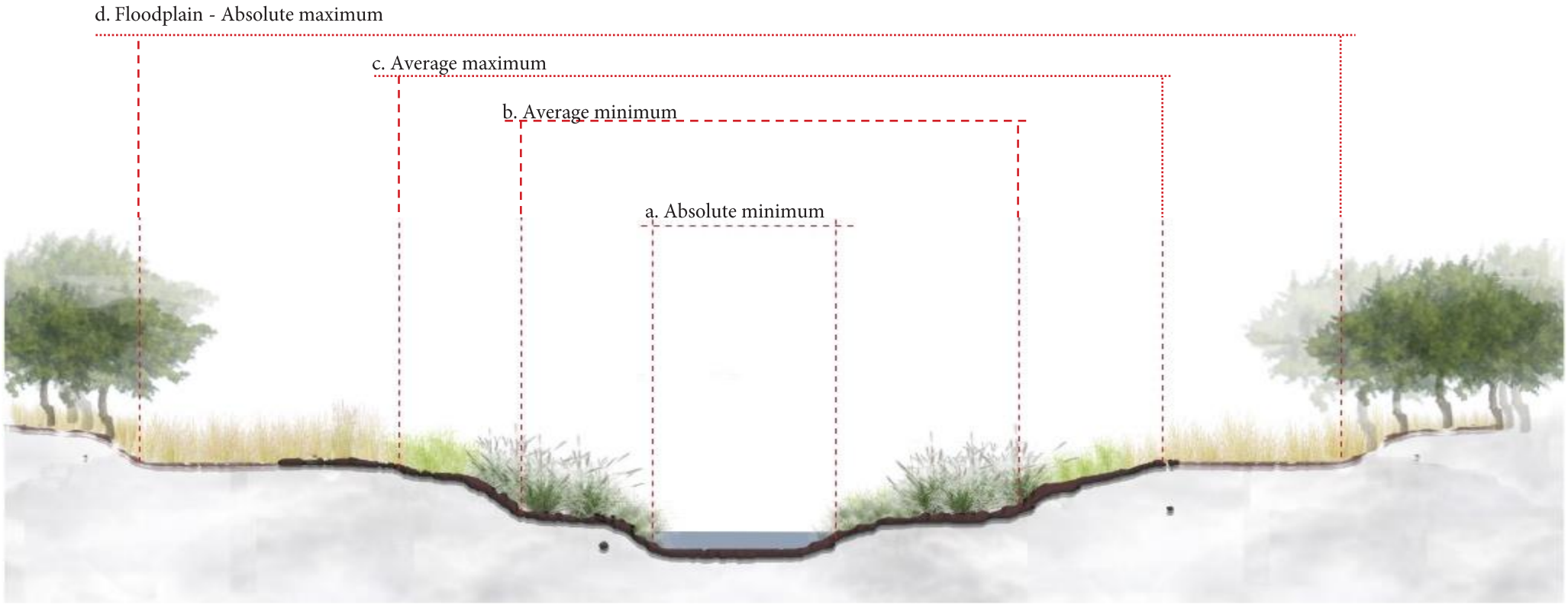

Figure 2.7.16 – Weir and Channel Sizing (Author, 2015)

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CHANNEL A

Flow rate: 0.16m^3/s
= 0.08m^3/s (division of river)
= 0.08m^3/s passing through site

Water enters system at 0.08m^3/s
Required speed: 0.1m/s

Area = 0.8m^2

Volume = 0.08m^3/s x 60 x 60 x 24
= 6912m^3/day
= 214 272m^3/month

CHANNEL B

Flow rate: 0.65m^3/s
= 0.32m^3/s (division of river)
= 0.32m^3/s passing through site

Water enters system at 0.32m^3/s
Required speed: 0.1m/s

Area = 3.25m^2

Volume = 0.32m^3/s x 60 x 60 x 24
= 28 080m^3/day
= 870 480m^3/month

CHANNEL C

Flow rate: 3.10m^3/s
= 1.55m^3/s (division of river)
= 1.55m^3/s passing through site

Water enters system at 1.55m^3/s
Required speed: 0.1m/s

Area = 15.5m^2

Volume = 1.55m^3/s x 60 x 60 x 24
= 133 920m^3/day
= 4 151 520m^3/month

CHANNEL D

Flow rate: 16.35m^3/s
= 8.17m^3/s - 1.55m^3/s
= 6.625m^3/s (division of river)

8.17m^3/s + 6.625m^3/s = 14.75m^3/s

14.75m^3/s / 2 = 7.39m^3/s

7.39m^3/s passing through site
Water enters system at 7.39m^3/s
Required speed: 0.1m/s

Area = 73.9m^2 - too large, speed will not be 0.1m.s

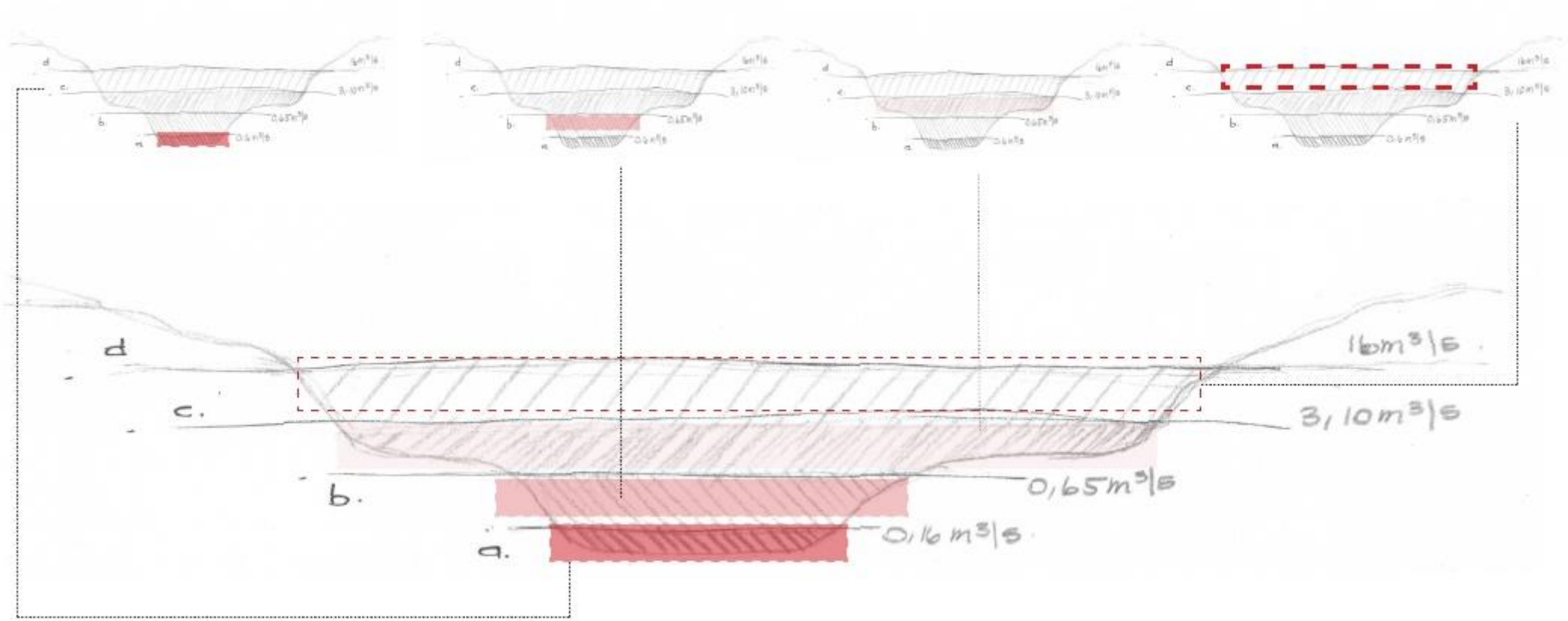

Figure 2.7.17 – Weir and Channel Sizing for Flow Rates (Author, 2015)

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The water remaining in the Moreleta Spruit which is not diverted to the purification system needs to be treated as all storm water outlets from the urban runoff management system are located along the spruit. The highly polluted effluent requires treatment before joining the Moreleta Spruit. Pin point interventions are incorporated at the outlets, creating a treatment path for the water as it travels to the Moreleta Spruit.

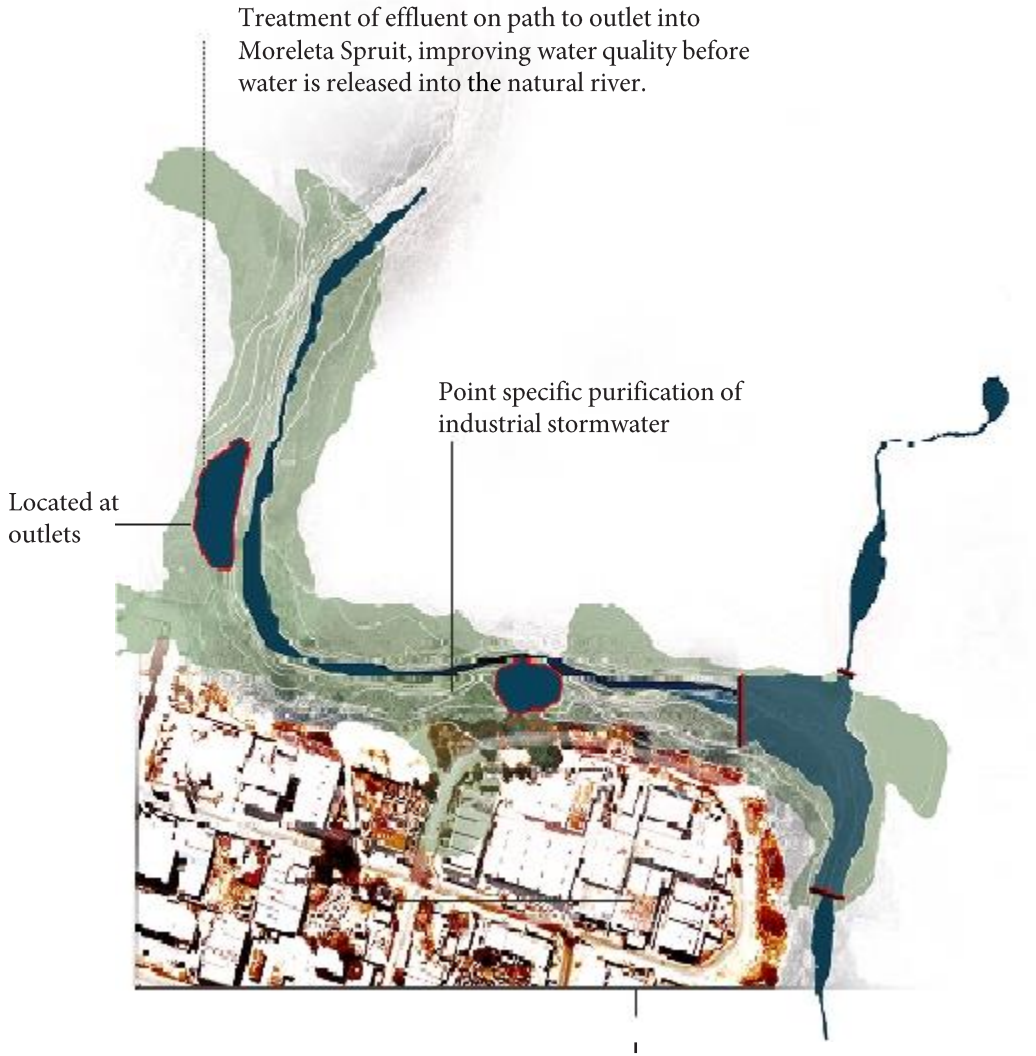

Figure 2.7.18 – Strategy 2 (Author, 2015)

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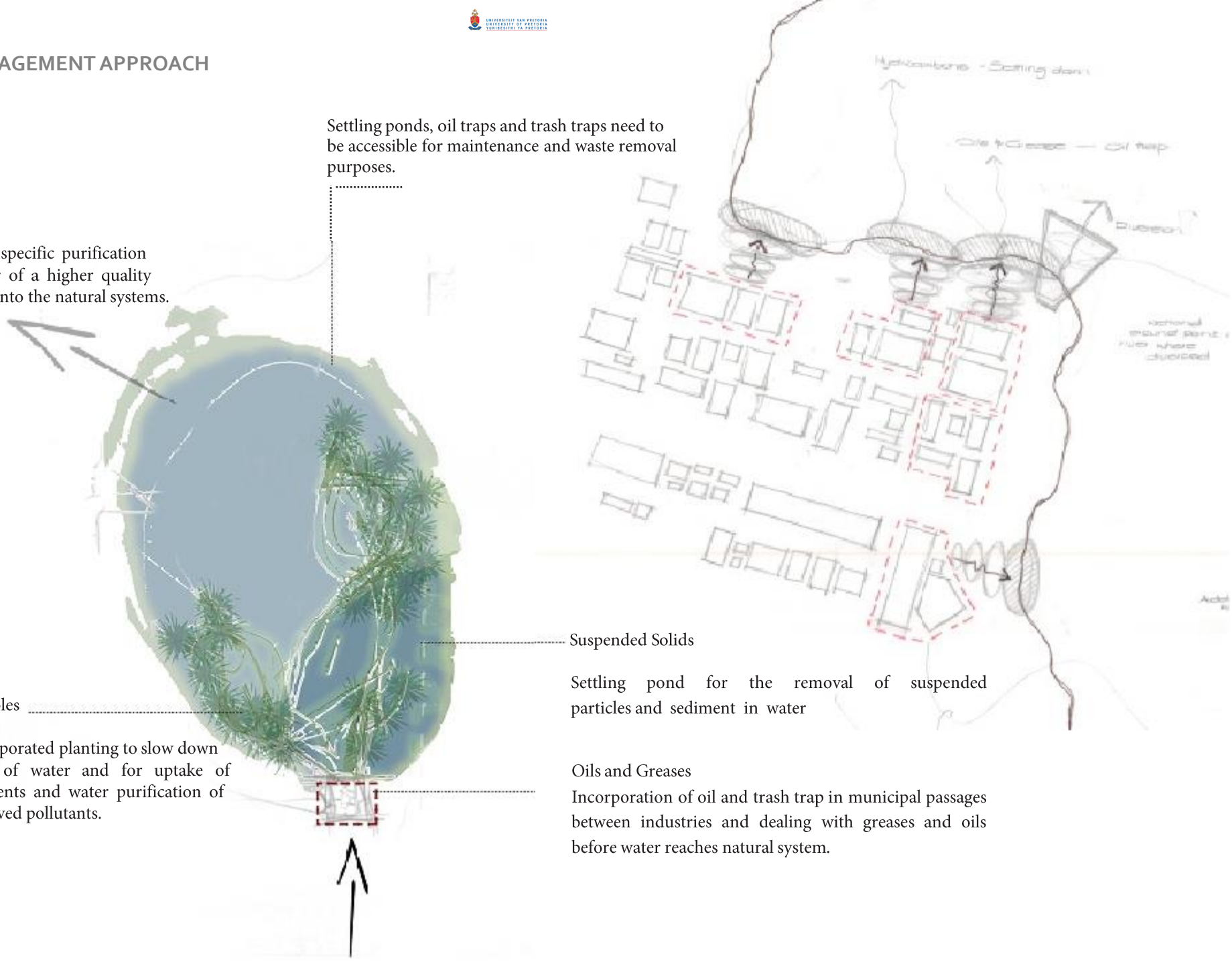
Settling ponds, oil traps and trash traps need to be accessible for maintenance and waste removal purposes.

Through point specific purification strategies, water of a higher quality will be released into the natural systems.



Suspended Solids

Settling pond for the removal of suspended particles and sediment in water

Solubles

Incorporated planting to slow down flow of water and for uptake of nutrients and water purification of dissolved pollutants.

Oils and Greases

Incorporation of oil and trash trap in municipal passages between industries and dealing with greases and oils before water reaches natural system.

Effluent from industrial area.

Figure 2.7.19 – Effluent Handling (Author, 2015)

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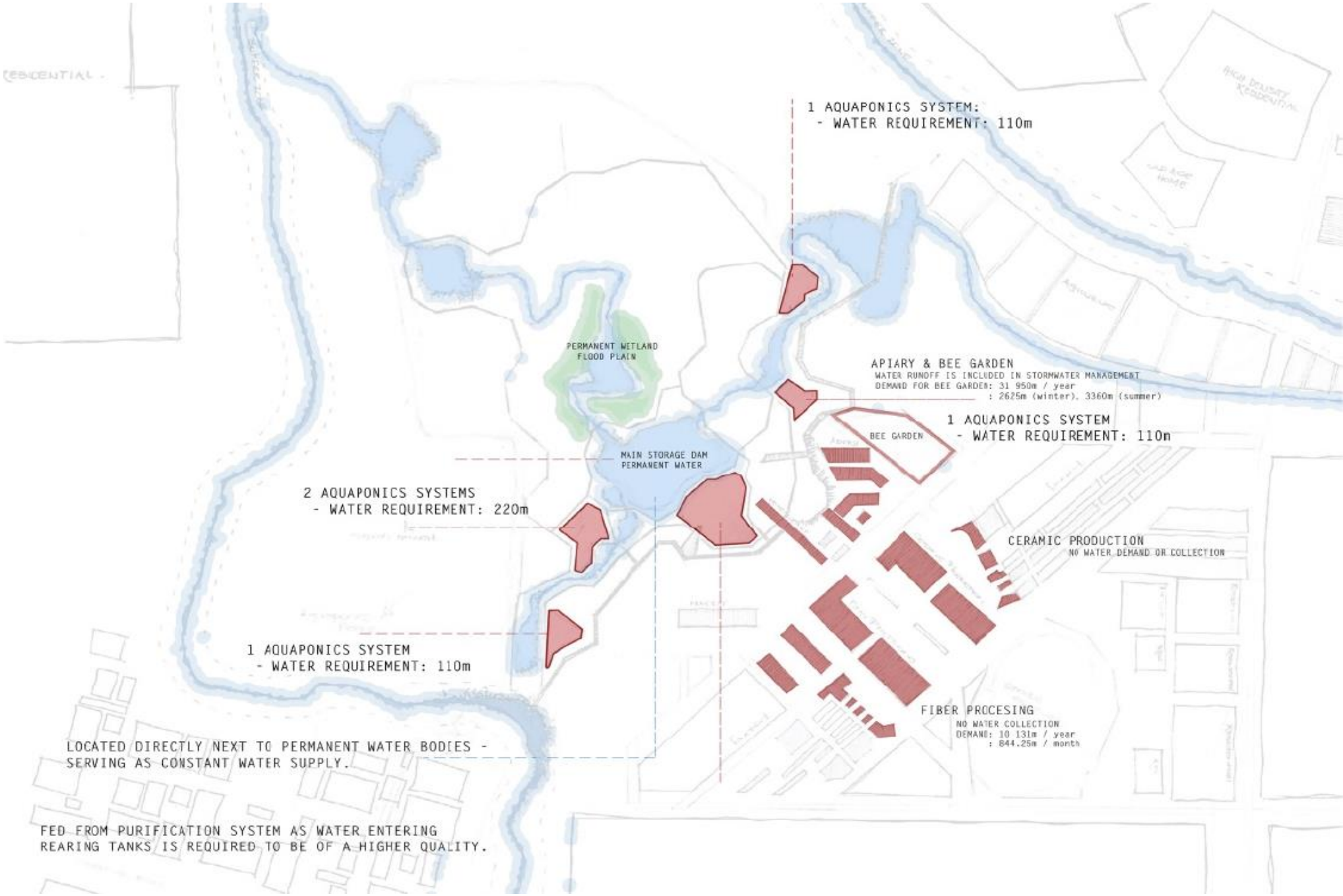

Figure 2.7.20 – Aquaponics System Layout (Author, 2015)

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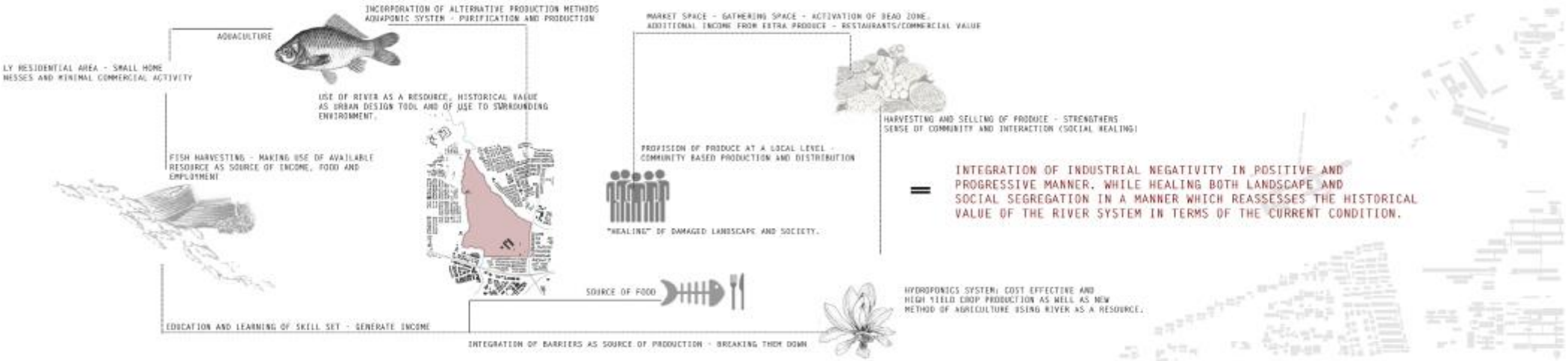

Figure 2.7.21– Aquaponics Systems Benefits (Author, 2015)

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The approach to the project was the purification of the Moreleta Spruit and using the river once again as a natural resource to rebuild the lost connection between man and the natural environment. The choice of site location to be in a wasted landscape, a post-industrial landscape brought in the economic element and the isolation of man from industrial systems and processes. The incorporation of aquaponics was able to form a link between man and the natural environment as well as the natural and industrial environments. The recirculating system will be able to use the water from the purification system in the quarry, providing produce for the surrounding community and potentially external purchasers as a means of income for the area. The integration of the social, ecological and economic aspects around the introduction of this system to the area is a catalyst for further and more sustainable production practices within the urban environment. The water from the purification that comes from the Moreleta Spruit is successfully being used as both a resource, feeding and providing for the urban environment, as well as an urban design tool through the generation of public space centered around the functioning and production activities of the river. The fish species chosen is the Tilapia, one of the most successfully cultured fish for aquaculture. Tilapia occurs naturally in the river system but have sufficiently decreased in population as the quality of their natural environment was so drastically affected. There aquaponics system offers an opportunity to repopulate the river system if not all fish are harvested.

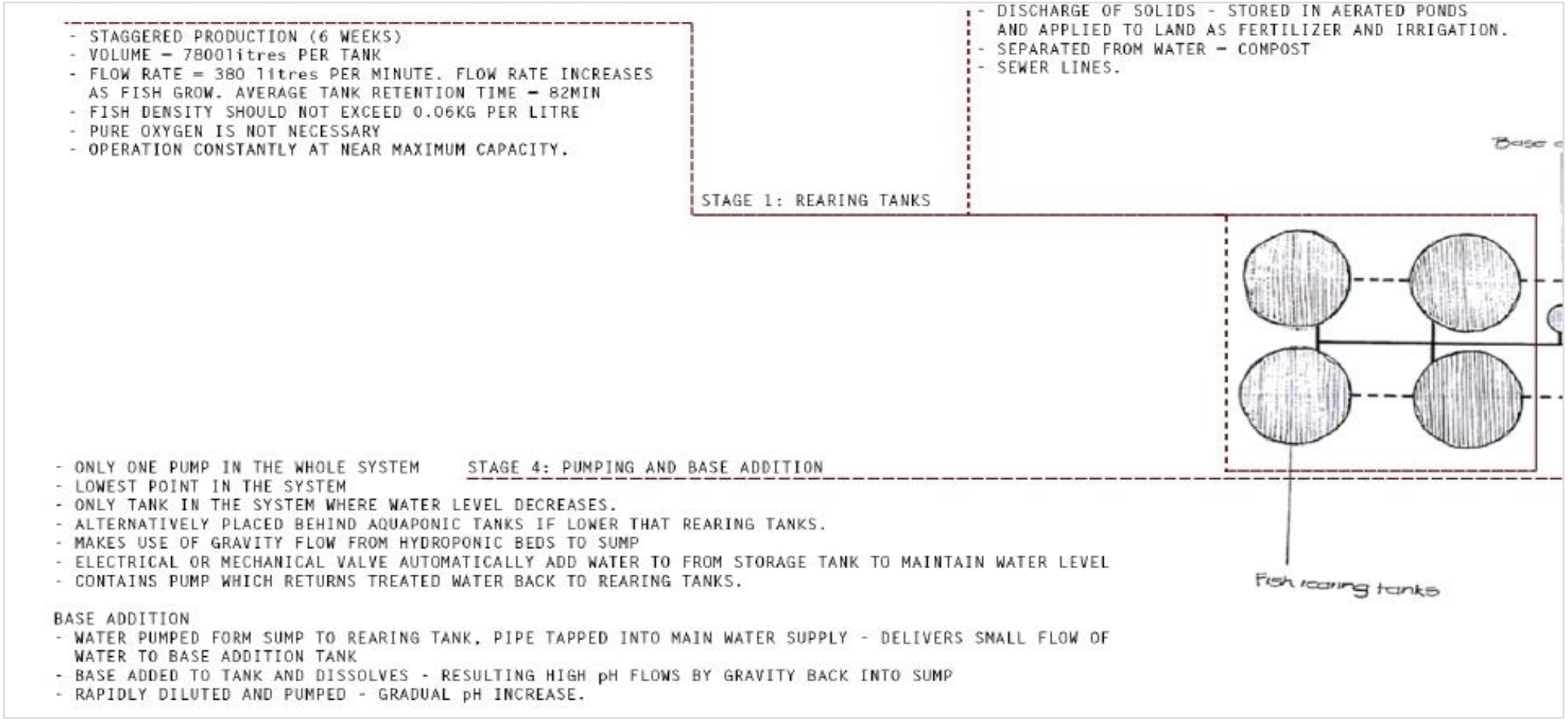

Figure 2.7.22– Aquaponics Systems Explanation (Author, 2015)

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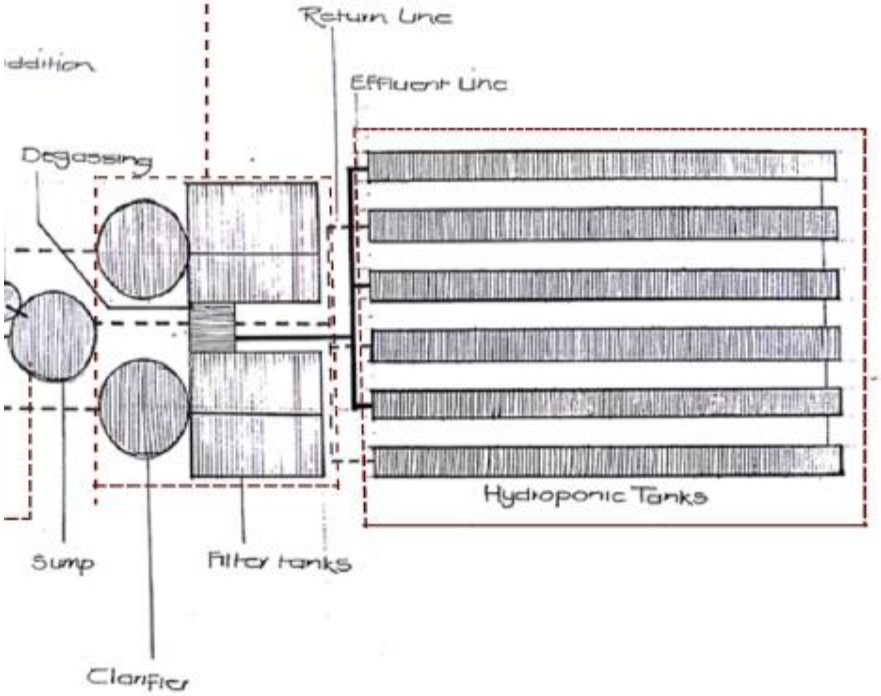
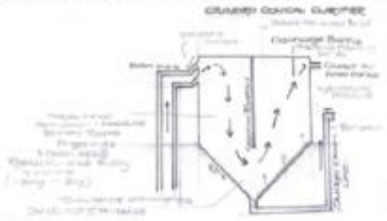


STAGE 2: CLARIFICATION AND FILTRATION

- CLARIFIER - REMOVES SETTLE-ABLE SOLIDS (50%)

- FILTER TANKS
  - REMOVE RESUSPENDED AND FINE SOLIDS (50%)
  - TWO FILER TANKS IN SERIES
  - MESH CLEANED ONCE/TWICE PER WEEK
  - BACTERIA PREVENT NUTRIENT UPTAKE IN PLANTS.
  - 185 GALLONS EACH



- DEGASSING
  - ACCUMULATION OF ORGANIC MATTER FORMS THICK SLUDGE AND DUE TO ANAEROBIC CONDITIONS – FORMATION OF GASSES
  - WATER IS SPLIT INTO THE IRRIGATION OF THREE HYDROPONIC BEDS.

STAGE 3: HYDROPONIC BEDS

- 3 SETS OF 2 RAFT HYDROPONIC TANKS
- MAXIMUM EXPOSURE OF ROOTS TO WATER
- DISRUPTION IN PUMPING DOES NOT AFFECT PLANTS WATER SUPPLY. (SAND, GRAVEL ETC.)
- EASILY MOVED SHEETS FOR HARVEST.
- SHEETS SHIELD WATER FROM DIRECT SUNLIGHT - MAINTAINING IDEAL WATER TEMPERATURE.

DETAILS:
- BEDS - 30.4m x 1.2m x 0.5m deep
- CHANNELS LINED WITH LOW DENSITY POLYETHYLENE LINERS (20mm)
- COVERED BY EXPANDED POLYSTYRENE SHEETS (RAFTS) - 2.4m x 1.2m x
- GROWTH OF LEAFY GREENS - TYPE OF GROWTH DEPENDS ON EFFLUENT IN

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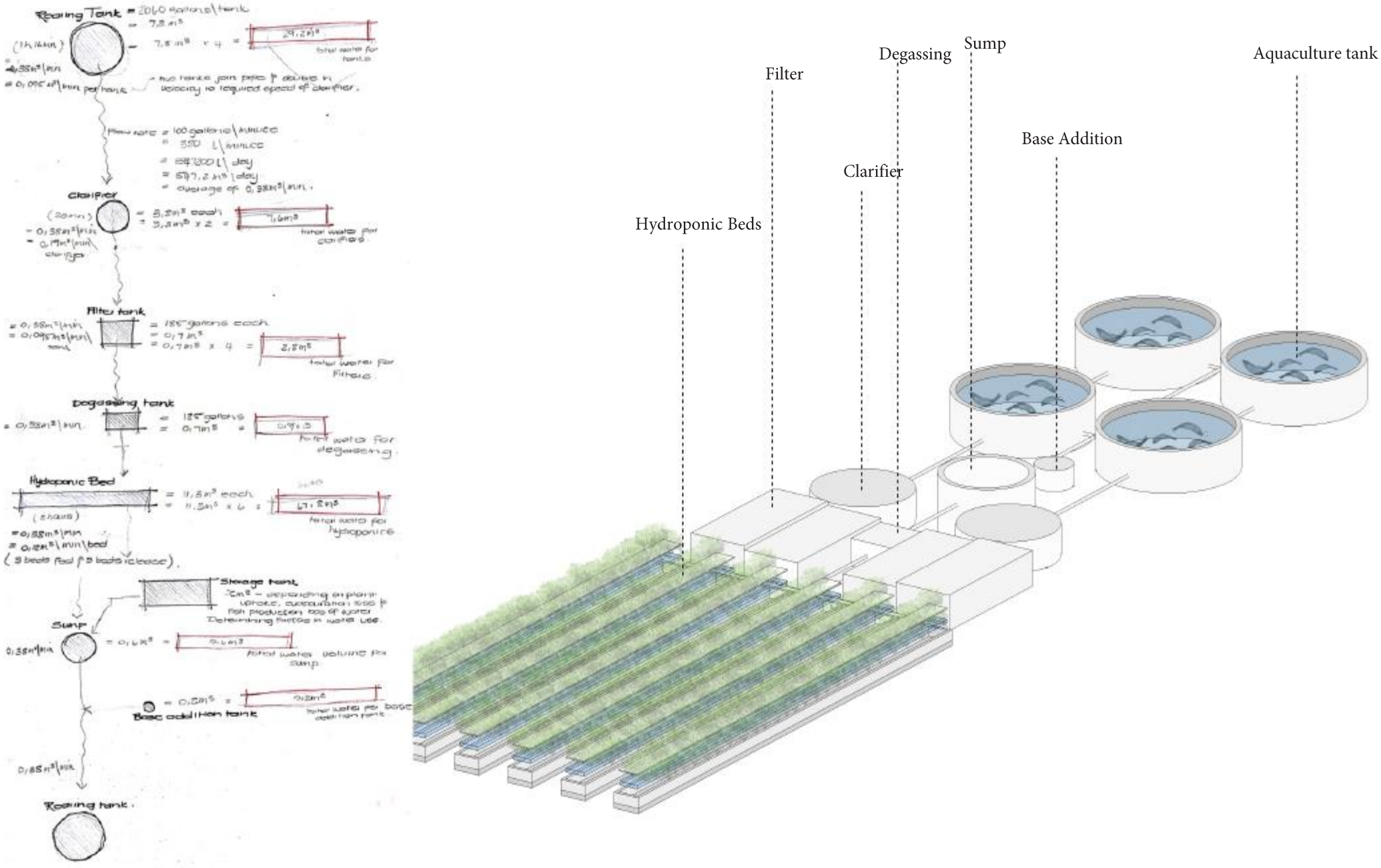

Figure 2.7.23– Aquaponics Systems Design and flow rates (Author, 2015)

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CHAPTER 8: DESIGN TECHNIFICATION

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BIOPOOL 1

The first biopool has the lowest interaction levels between man and the natural environment. The purification planting has been seperated from the swimming area entirely, preventing interaction. The pool will make use of the existing dam as a water supply when water levels drop. Each pool is an individual circulating system, keeping the volume of water running through the pumps and UV filters relatively small for an effective cleaning and purification standard. The system makes use of a UV filter for the removal of harmful pathogens from the water and is not responisble for any stormwater management. All storm water is diverted away from the Biopools to prevent sedimentation from occuring in the pools. The first bipool provides a splash and very shallow pool for use by children as well as close location to the lifeguard towe. The design of a lawn area surrounding the pool is allows for the passive surveillance by users and a space of relaxation for parents while watching their children.

Figure 2.8.1: Section through biopool 1. (Author, 2015)

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TECHNICAL DETAIL BIOPOOL 1

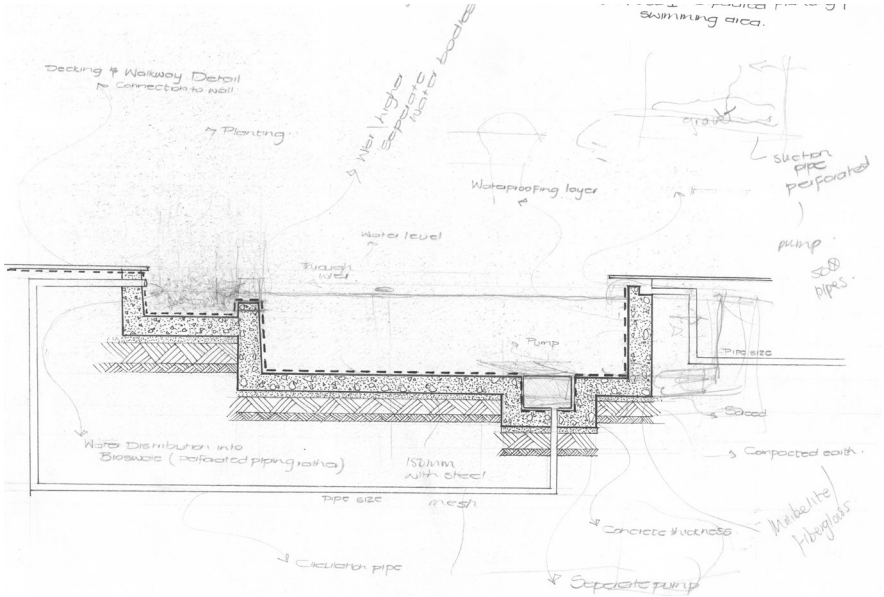

Figure 2.8.2: Detail sketch of Biopool 1 (Author, 2015)

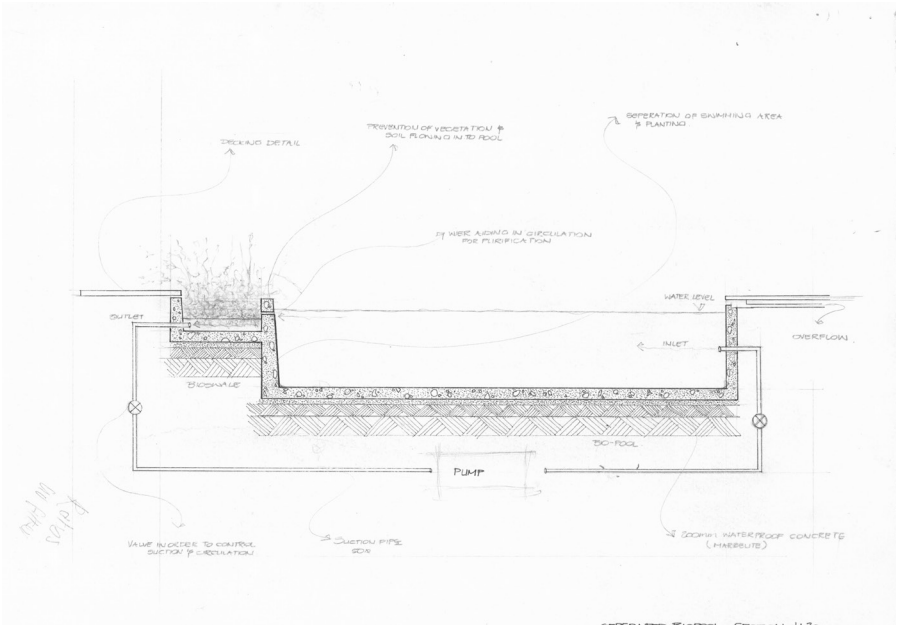

Figure 2.8.3: Detail sketch iteration of Biopool 1 (Author, 2015)

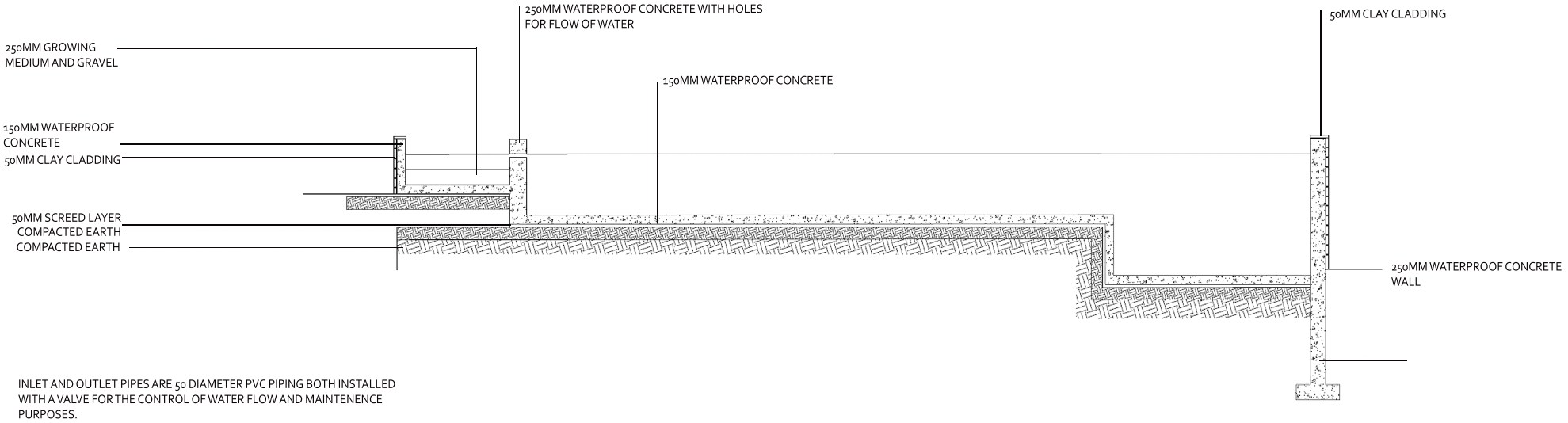

Figure 2.8.4: Construction detail of Biopool 1 (Author, 2015)

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BIOPOOL 2

The second biopool is responsible for the initial interaction between man and the natural environment. The planting has been incorporated into the swimming experience, with minimal barriers or restrictions of movement for the user between the planted areas and the swimming areas. The interaction with the natural environment is completely dependent on the user, while all pools allow for a view over the natural environment and rehabilitated post industrial quarry.

Figure 2.8.5: Section through Biopool 2 (Author, 2015)

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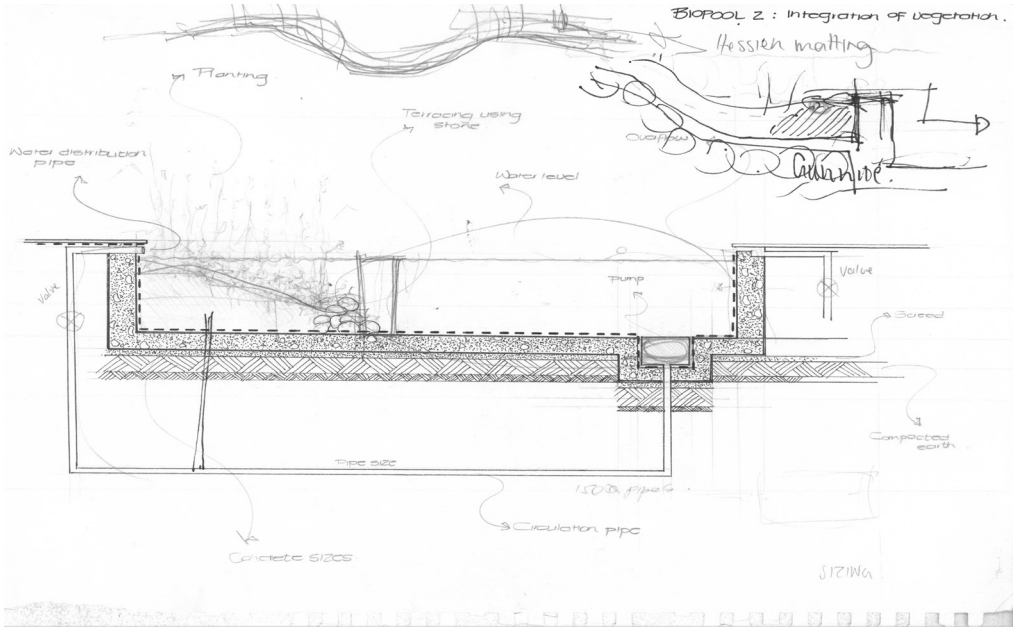

Figure 2.8.6: Deatil sketch of biopool 2 (Author, 2015)

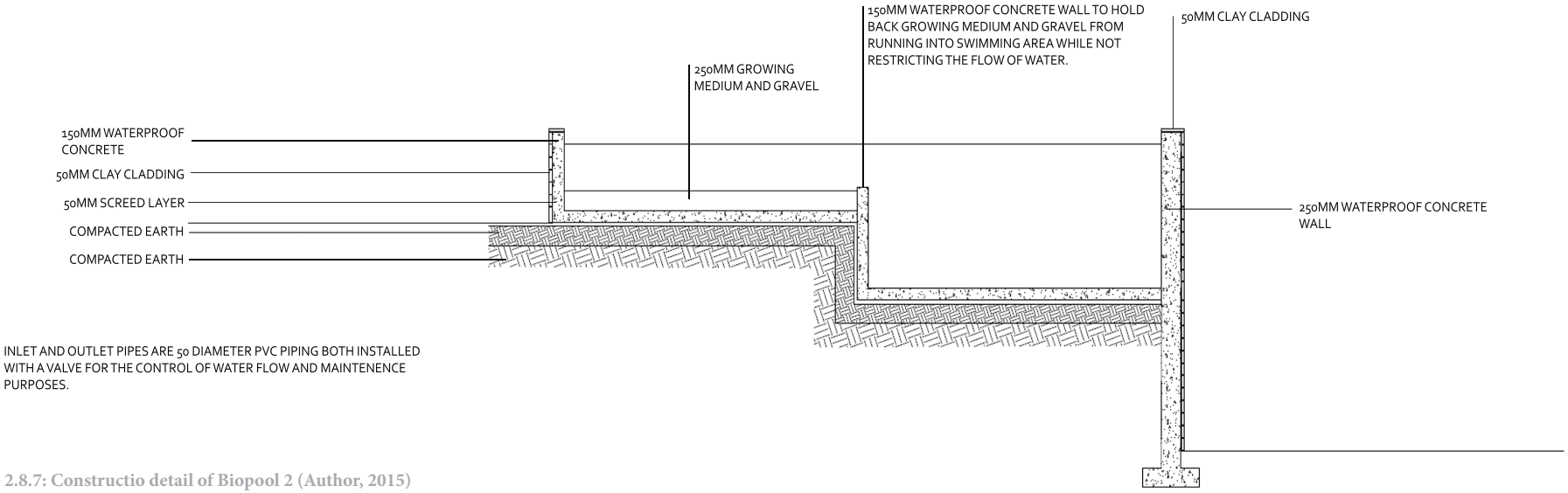

Figure 2.8.7: Constructio detail of Biopool 2 (Author, 2015)

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AQUAPONICS SYSTEM: AQUACULTURE TANKS AND RETAINING WALL

The fish rearing tanks require shade and were designed to sit into the site of the mountain currently existing on site. The creation of a stable retaining wall and shade structure was designed for the fish tanks. Seating and walking space was included and a main movement route and walkway was developed on the site. This allowed for the integration of the public in to the aquaponics ayatem, making the system accessible .

Figure 2.8.8: Section through aquaculture tanks and retaining wall. (Author, 2015)

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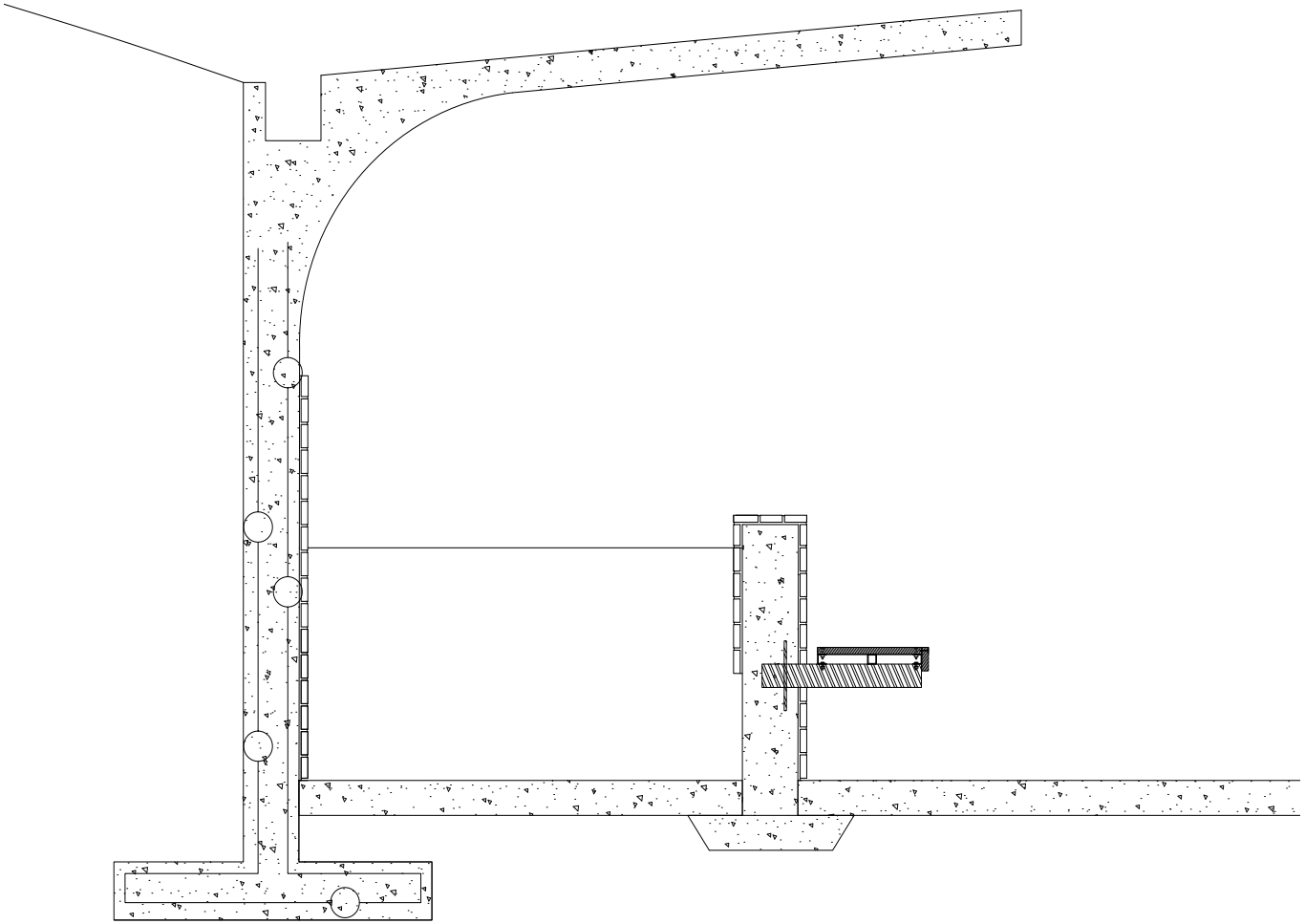

Figure 2.8.9: Construction detail of retaining wall and aquaculture tanks. (Author, 2015)

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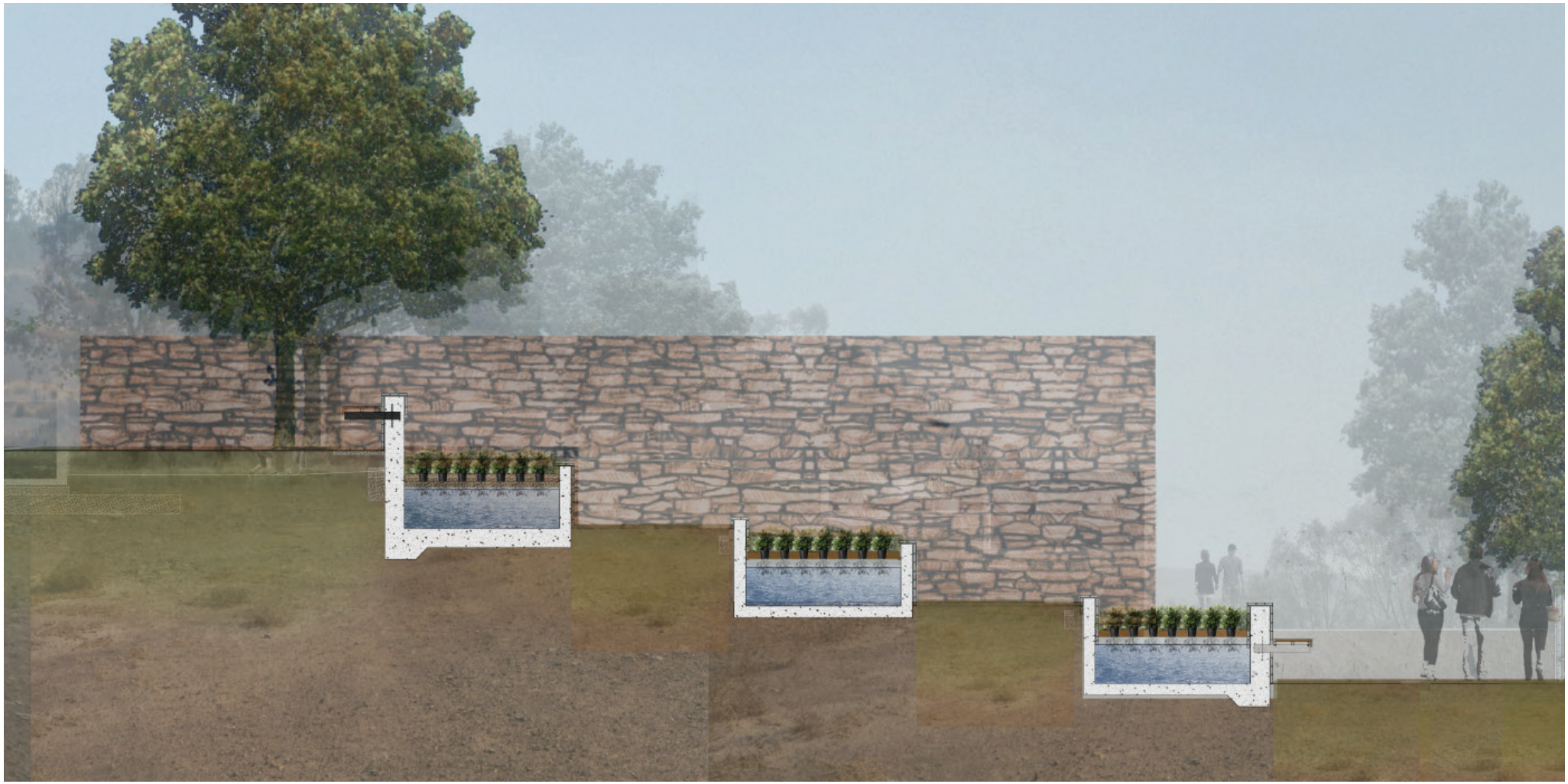
AQUAPONICS SYSTEM: HYDROPONIC BEDS

The hydroponic beds have been terraced in to the side of the quarry, the terracing allowed for the creation of public space and movement corridors between the beds. Incorporated seating was designed for the promotion of lingering by users in the area. THe beds are open for the education and inclusion of users in to the productive system for the understanding of the importance of water in the production scheme.

Figure 2.8.10: Section through hydroponic beds. (Author, 2015)



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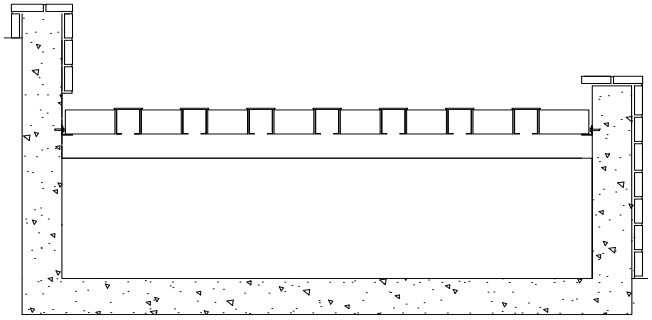

Figure 2.8.11: Construction detail of hydroponic bed with raft construction (Author, 2015)

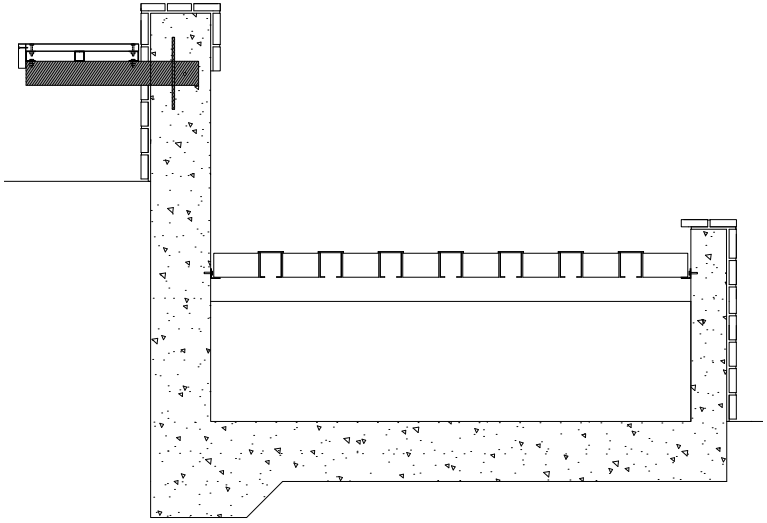

Figure 2.8.12: Construction detail of hydroponic bed with raft construction and incorporated seating. (Author, 2015)

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GREEN ROOF DETAILING

GREEN ROOF TECHNICAL CONSIDERATIONS:

in order for the green roofing system to be functional and successful, there are a number of technical considerations that must be met and incorporated into the design and construction of the roof. The visual appeal that a green roof can create and the value that it will add to a space needs to be structurally and systematically adressed. The construction of a green roof will require the location and proposed design of the structure to be checked by an engineer in order to determine weather or not the structure would be able to bear the load of the green roof, the planting as well as technical layering required for a successful green roof as well as the people who are expected to be on the green roof at any time are all taken into consideration when determining the suitability of a structure for green roof construction.

Access - A green roof, like any other designed landscape, will be required to be accessible for maintenance purposes. The area will need to be maintained, even if not regularly, the systems and layers within a green roof structure will need to be maintained as well. The access is not required to be a permentant element, as long as it is possible to gain access to the space.

Waterproofing layer - The roof surface that is to be greened requires a very reliable waterproofing and root penetration protection layer. If the waterproofing and root barrier layers are not done up to standard, it would lead to the leaking of the structure in which case it would be a highly costly exercise to lift and repair the proofing layer. For the root barrier, it is essential that no roots are able to penetrate the existing roof structure as this has the potential to cause serious structural problems. The waterproofing layer needs to be extended way above the top level of the growing medium in order to ensure that no water or roots are able to enter behind it. A protective
geotexile may sometimes be recommended to place over the waterproofing and root barrier layer in order to protect it from any damage that may take place during the following construction of the green roof.

Drainage layer - The drainage of the green roof system is enssential for both preventing water logging of the soils leading to root rot, as well as the added weight that access water would add to load supported by the existing structure. The lightweight drainage layer will collect excess water drained through the soil and allow the water to be removed from the roof structure.

Seperation layer - Between the growing medium and the drainage layer, a thin geotextile will be incorporated into the layering of the green roof construction, this will allow for particles to be removed or prohibited from entering into the water drainage layer.

Growing medium - the growing medium is one of the most important considerations when designing a green roof, the growing medium for a structure that has not been designed to be able to support a very heavy load will require the soil to be lightweight, yet still well drained that will give the highest amount of water retention, also promoting plant growth without water becomming waterlogged.

Vegetation - Appropriate planting choices need to be made in order to ensure that the planting will survive the conditions experienced. Planting on a green roof will require vegetation choices of plants that are drought resistant, high temperature and wind resistant, easily reproduce and have non-agressive root systems. Planting with the species I have chosen, representing the Grassland and Rocky Grassland veld types are generally characterised by hardy plants that are easily established and meet many, if not all of the reqirement of green roof species.

TECHNICAL DETAIL SHOWING LAYERING OF GREEN ROOF CONSTRUCTION:

Layer 1 - Vegetation
Layer 2 - Growing Medium
Layer 3 - Seperation Barrier, geotextile
Layer 4 - Drainage Layer
Layer 5 - 50mm Screed Layer acting as root barrier protection, can be substituted for a grotextile.
Layer 6 - Water Proofing and Root Barrier
Layer 7 - Existing Structure

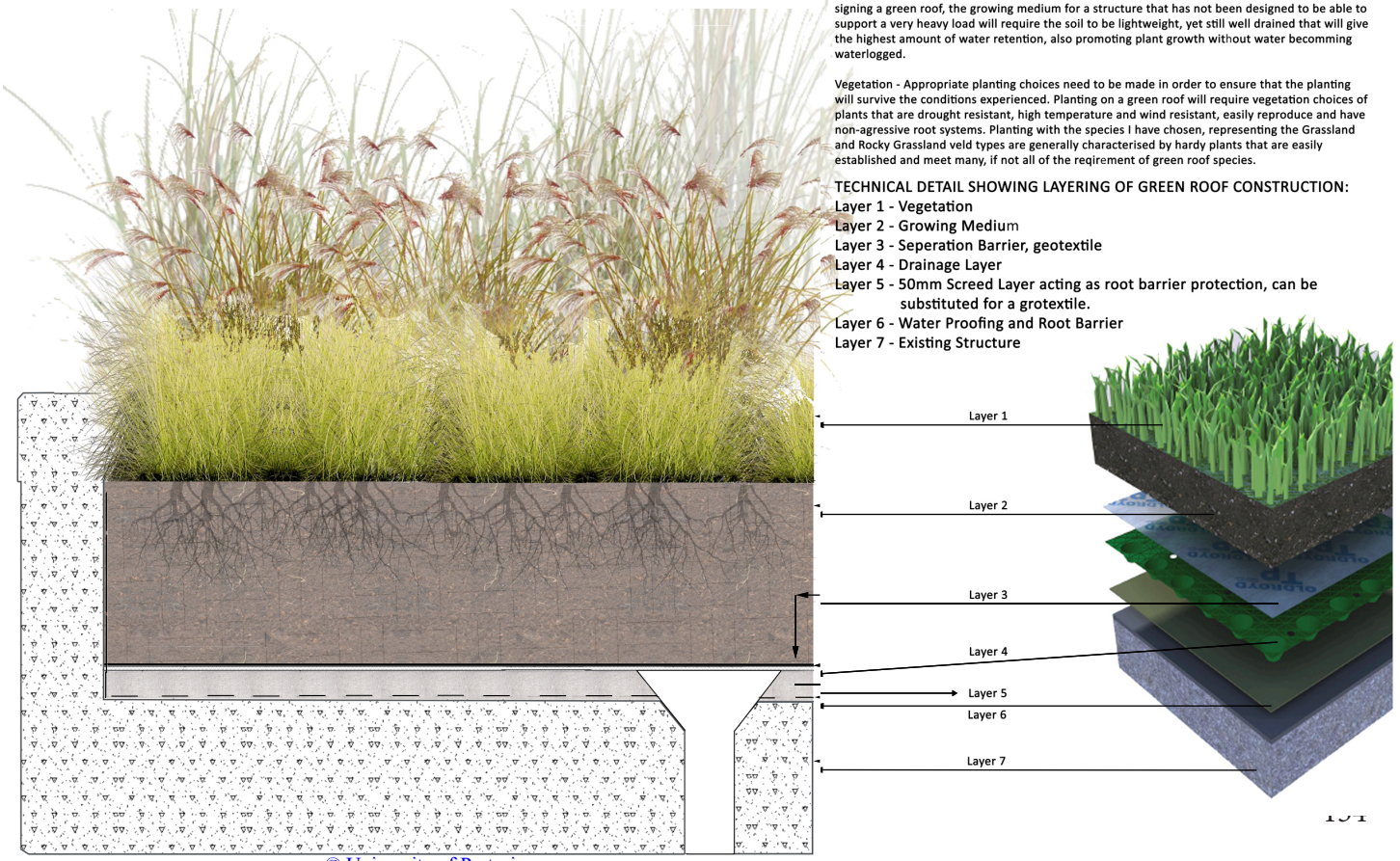

Figure 2.8.13: Green roof technification (Author, 2015)

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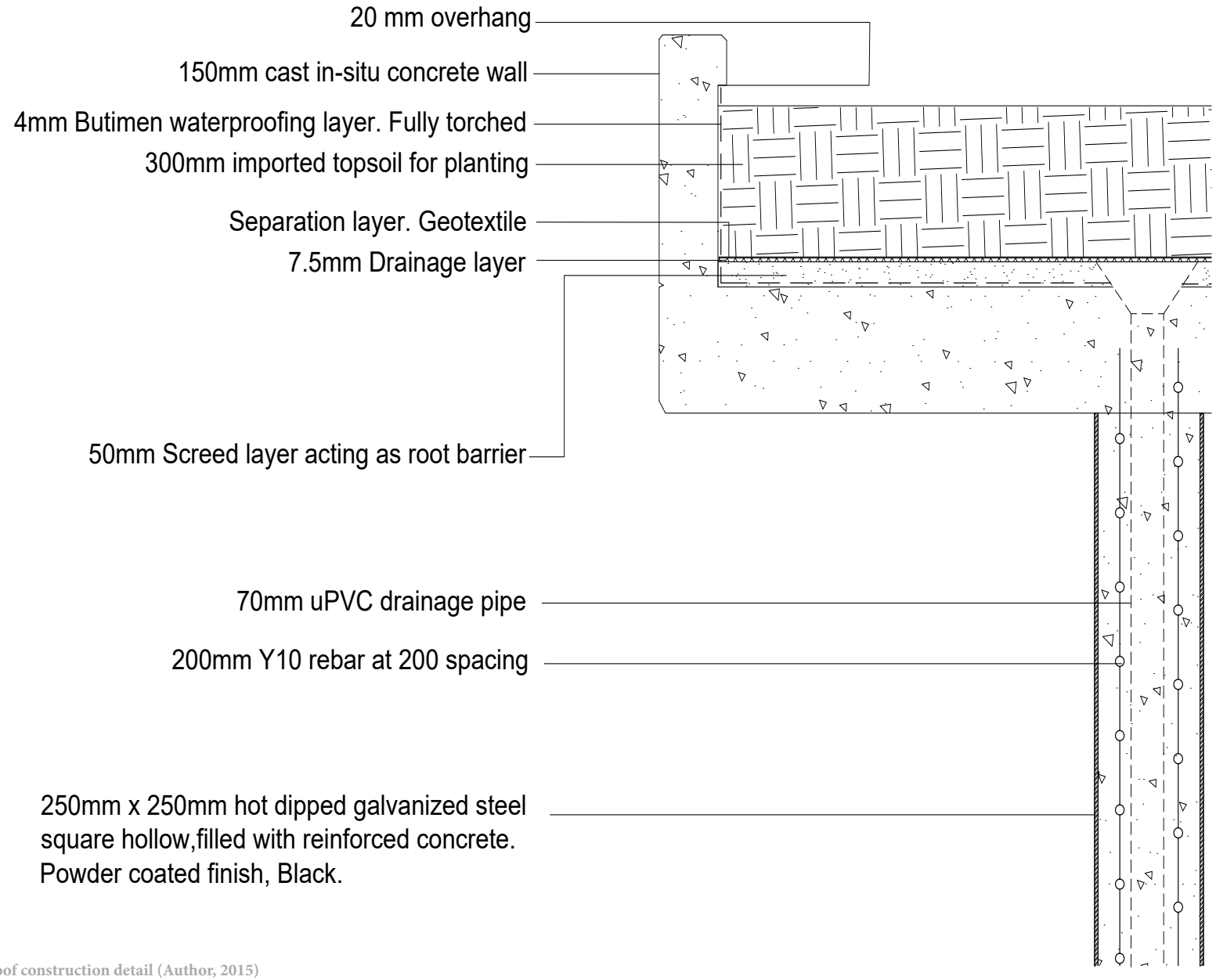

Figure 2.8.14: Green Roof construction detail (Author, 2015)

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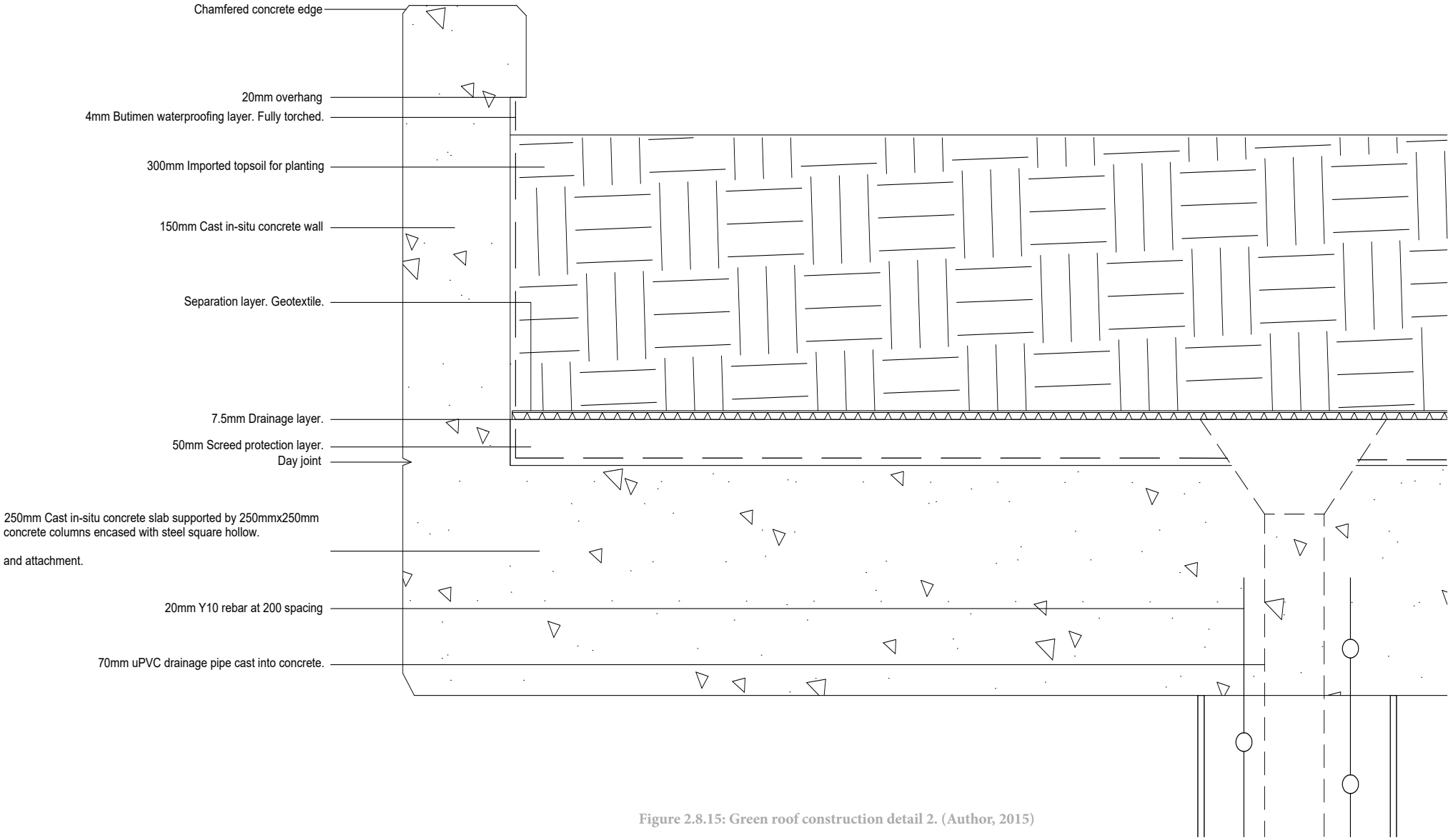

Figure 2.8.15: Green roof construction detail 2. (Author, 2015)

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TECHNICAL DETAILS FOR SEATING BENCHES:

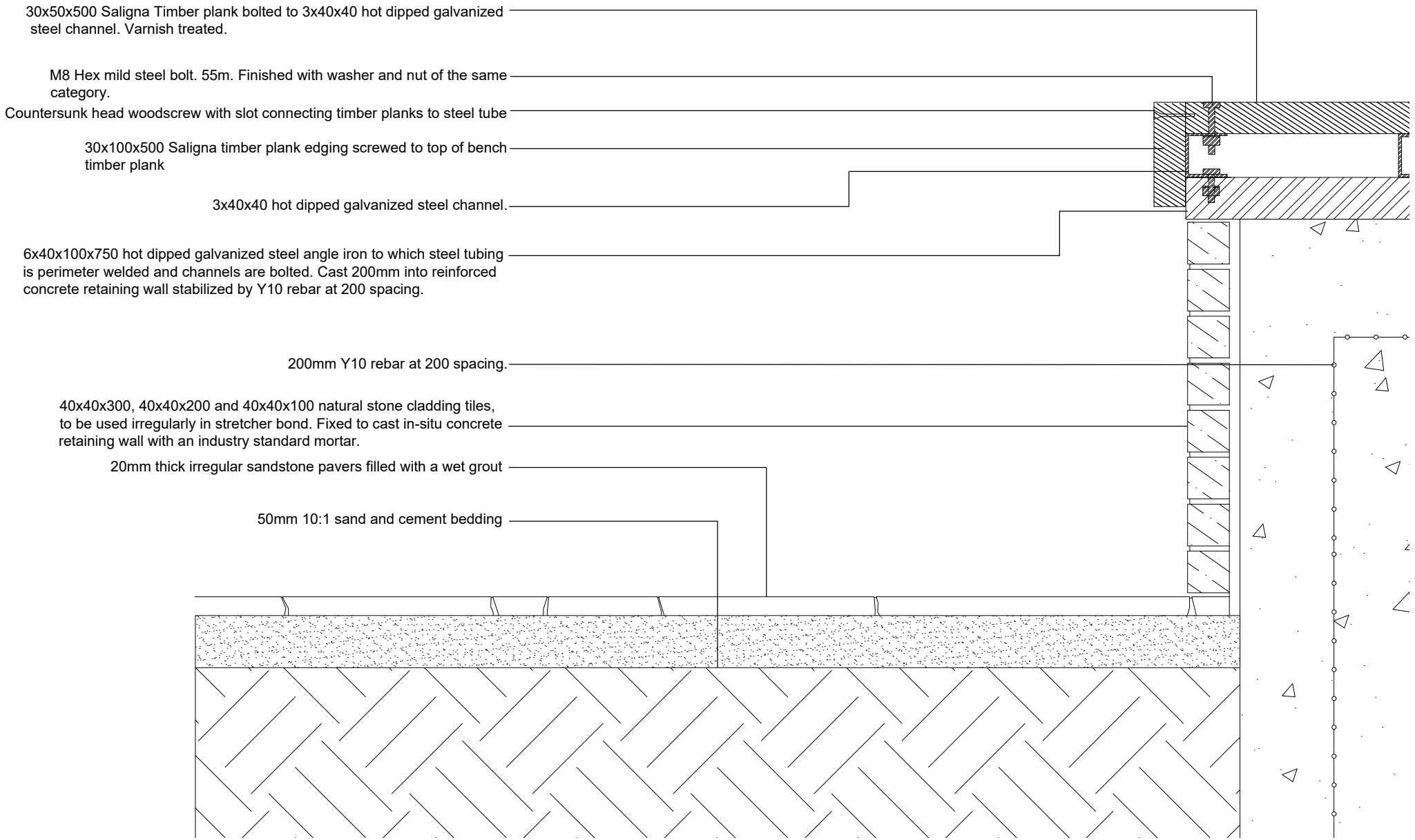

Figure 2.8.16: Seating bench for green roof construction detail (Author, 2015)

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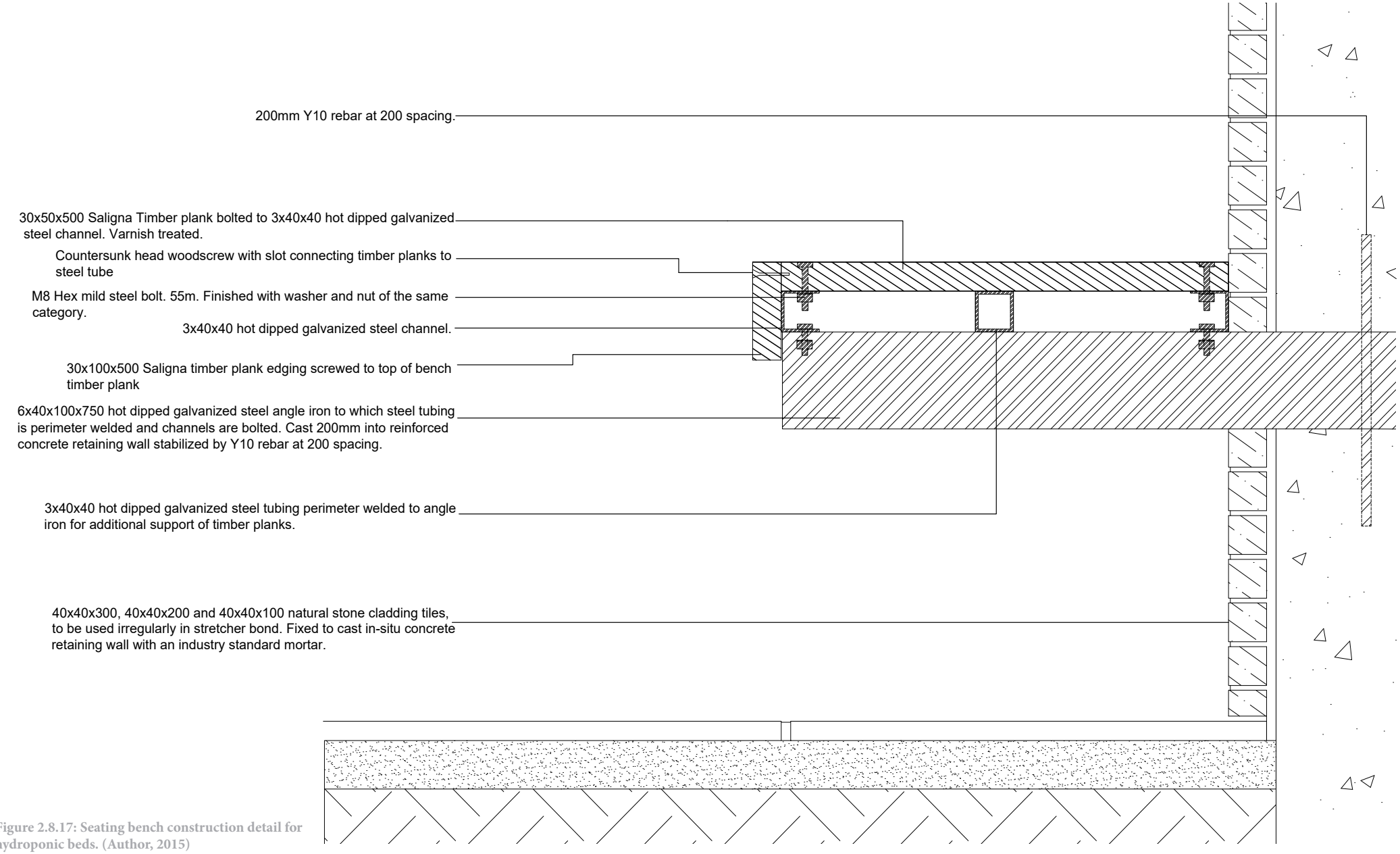

Figure 2.8.17: Seating bench construction detail for hydroponic beds. (Author, 2015)

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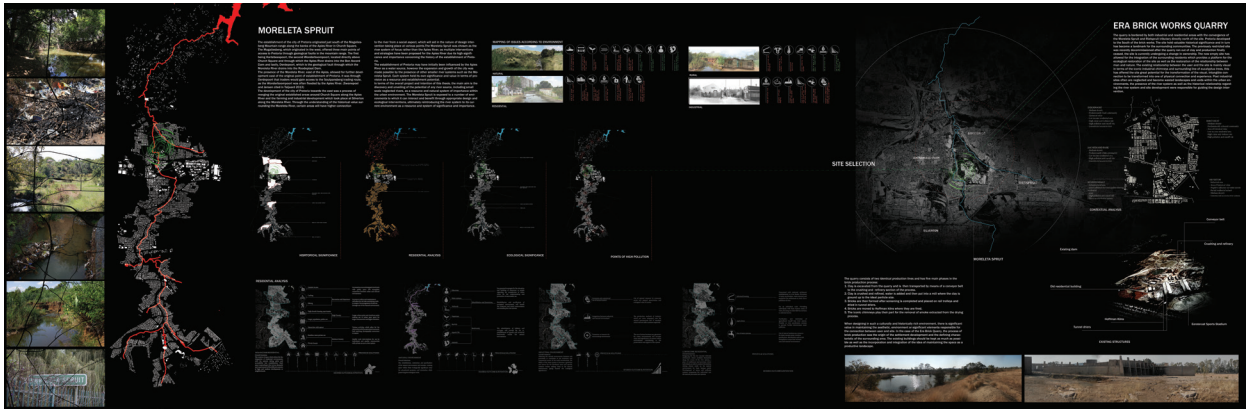
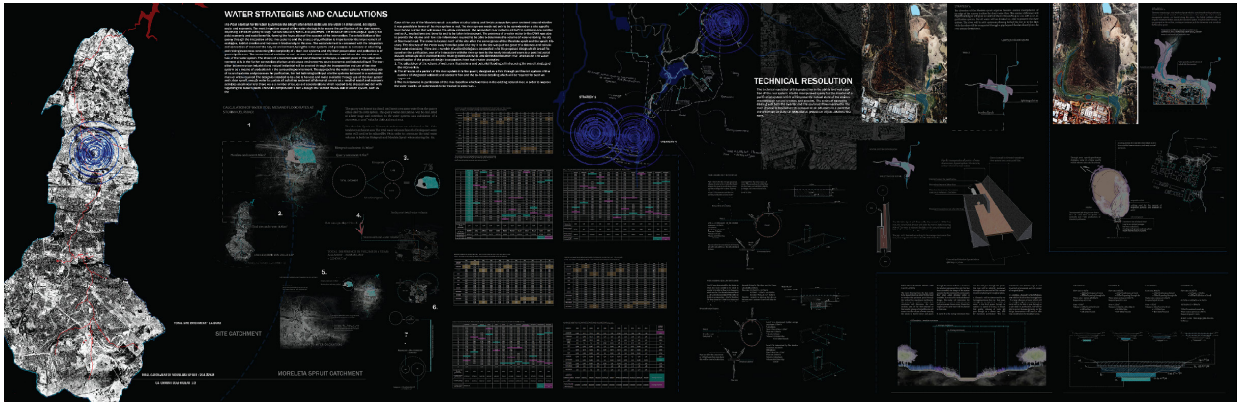
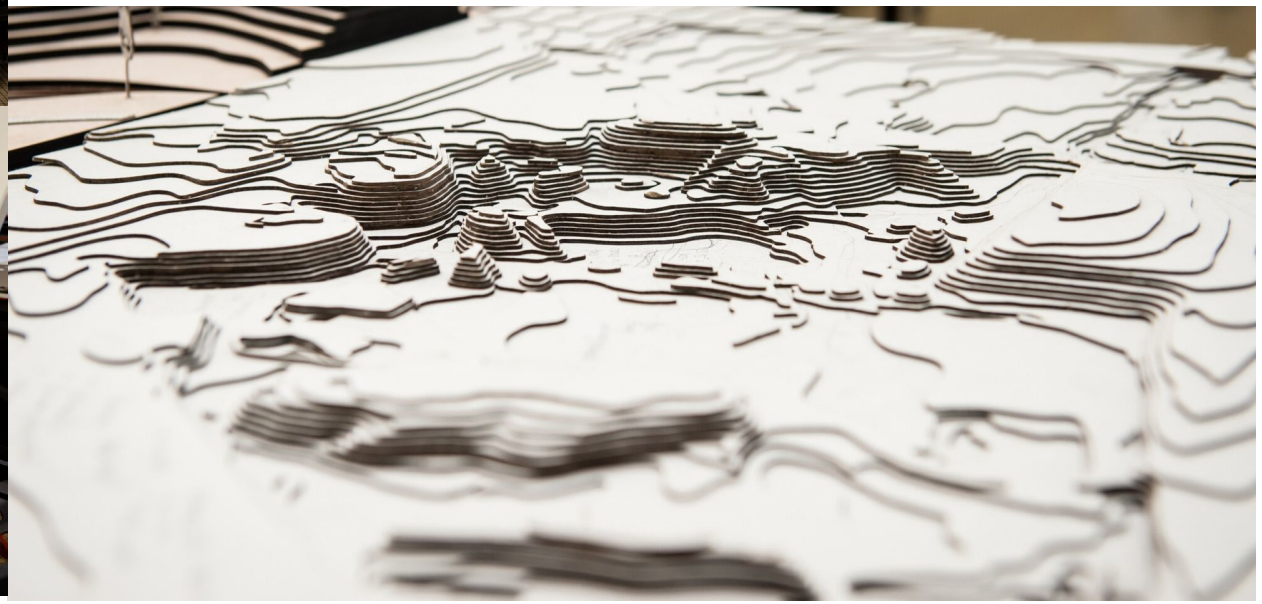
FINAL POSTERS







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