Swimming with the fishes:
a public aquaponics park in Pretoria

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of part of the requirements for the degree

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I further state that no part of my thesis has already been, or is currently being, submitted for any such degree, diploma or other qualification. I further declare that this thesis is substantially my own work. Where reference is made to the works of others, the extent to which that work has been used is indicated and fully acknowledged in the text and list of references.

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Site Description	Industrial Site
Client	ArcelorMittal and Open Space Planning Department, City of Tshwane
Users	Surrounding Community and Tourists
Research Field	Environmental Potential

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My family for their enthusiasm throughout my studies.

"We learnt that God is more interested in our characters than in our comfort, and that submitting ourselves to a process of learning builds a strong character leading to maturity in Christ" – Willem Botes, *The Miracle is to Walk on the Earth.*

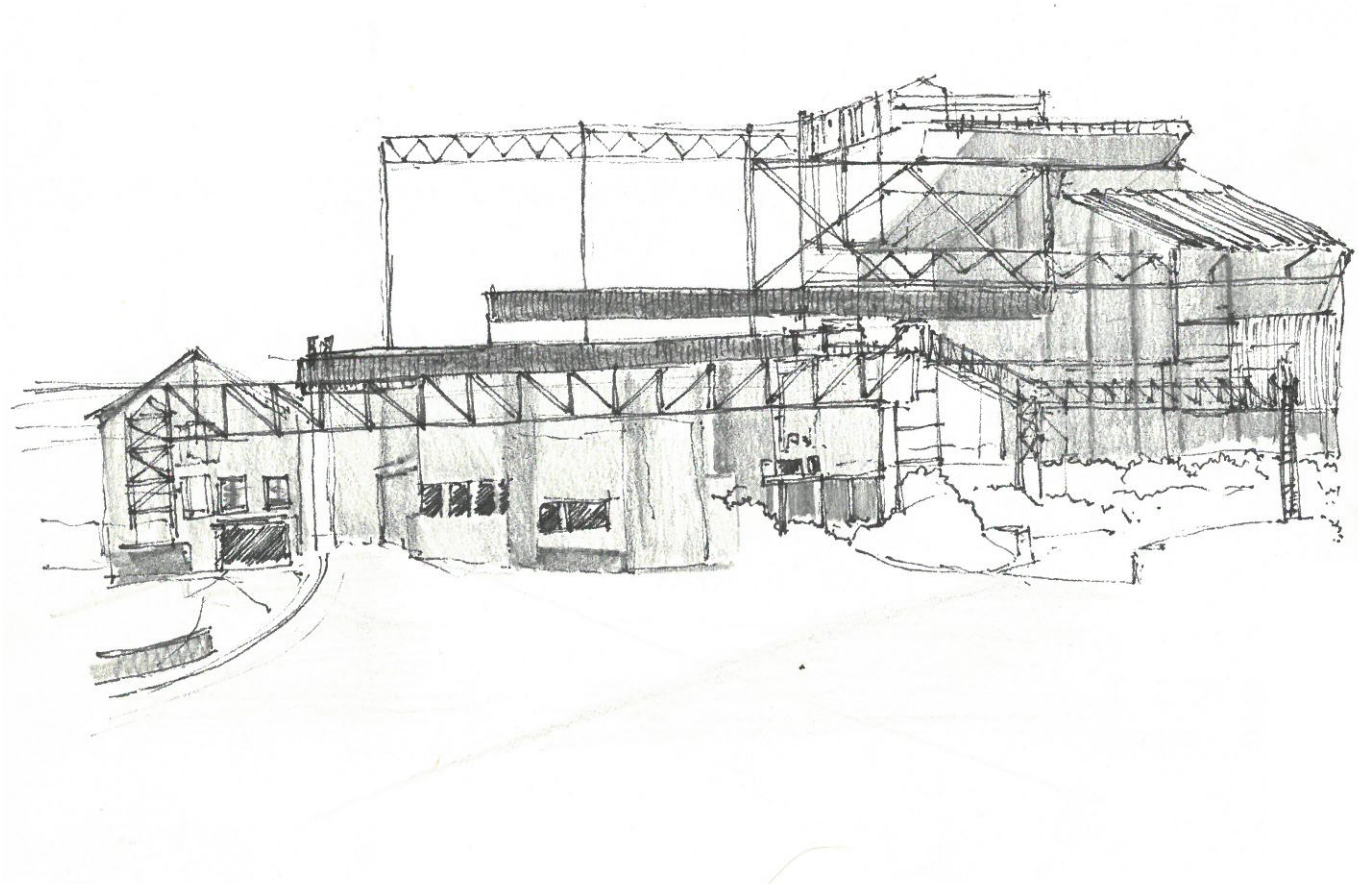


Fig 1.1 Pretoria Works unattended steel foundry (Author 2018)


Frikkie Meyer Road
Roger Dyason Road
Pretoria Main Road
Voortrekker Road

Abstract

The site for this dissertation is Pretoria Works, an industrial site in Pretoria West managed by Arcelor-Mittal. The competition amongst international steel manufacturers, as well as the move to end protectionist trade policies forced Pretoria Works to improve its efficiency. The efforts to improve efficiency were also necessitated because of the relatively high production cost to produce steel in South Africa in 1994, which led to thousands of people losing their jobs.

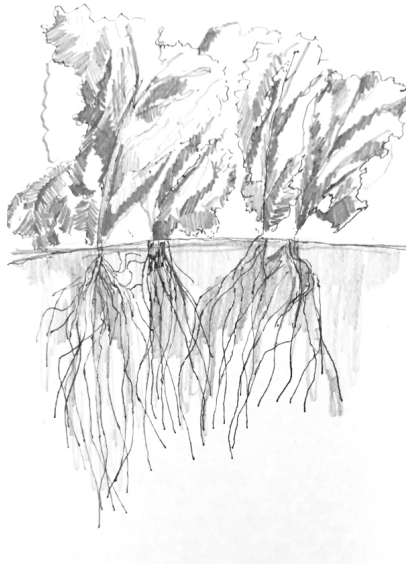
This surplus treated industrial waste water, together with the availability of rain water falling on the terrain, a natural stream from the top of the ridge and water from the nine boreholes on-site present an opportunity to promote a more sustainable use of water. The industrial waste water at Pretoria Works has the latent potential to be treated through phytoremediation for a regenerative system. This system, together with the provision of leisure activities through a proposed natural public swimming pool, has the potential to be popular. This intervention could open up various opportunities for job creation, tourism and improving the natural conditions of the area and, therefore, positively impact the well-being of the community.

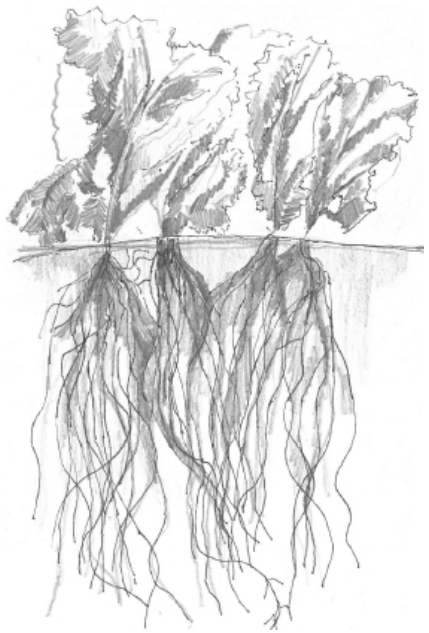
In order to get a better understanding of the value of water as a resource, people need to become emotionally attached by experience water before they will care for it. To become emotionally attached, individuals need to have a phenomenological perspective of water.

When the conceptual approach for the design was considered, the phenomenology of water as a resource was found to be a substantial influence. Water is spatially characterised as one of four aspects in architecture: a point, a line, a pool and an edge. The spatial experience that has been created through the integration of these grouped spaces was decided upon after observing and analysing natural water spaces and exploring aquatic cultures during snorkelling activities at two KwaZulu Natal beaches, namely Cape Vidal and Ballito.

Fig 1.2 Opposite page: Pretoria Works in Pretoria (Author 2018)

Table of Contents





List of figures

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Fig 1.3 Pretoria Works industrial waste water plant (Author 2018)

Introduction 1

1.1 Introduction

Pretoria's classical landscape – its mountains, valleys, fountains, rivers and gorges/ *poorte* in relation to its grid layout is emphasised by prominent axes. This layout has a symbolic and practical explanation. Symbolically, it is the primary cosmic ordering mechanism that integrates the four wind directions with the church at the heart of the city. The Apies River flows from the east to the west through the city following the movement of the sun, representing birth and death, see figures 1.4 and 1.5 (Jordaan 1989:28). Practically, the river provided water for the city through irrigation furrows; a technique familiar to the Voortrekkers from Graaff-Reinet, which influenced the development framework of the city (Jordaan 1989:29).

"Daar was niks waarvoor Pretoria in die ou dae beroemder was as sy water nie. Die Apiesrivier was 'n dolomietstroom, 'n sterk riviertjie met water so helder soos kristal. In die diepste kuile was die kleinste klippie op die bodem sigbaar. As mens vandag die vuil klein straaltjie water aanskou, kan jy nooit 'n denkbeeld vorm van die märchenhafte stroom van ouds nie, die walle bedek met varings en kapokvelde; varkblomme het elke vleitjie versier" Eugène Marais 1984:777).

The description of the city more than a hundred years ago was followed by the experience of water which has disappeared into concrete channels. The Apies River currently acts as a storm water distributor, destroying the value of its original function as a natural barrier (Jordaan 1989:29).

The channelised Apies River that flows through the city of Pretoria is an example of how water has become relatively hidden and 'invisible' in society. Betsky (1995:13) argues that the value of water in cities has been lost to a degree. This loss has been caused by water banished to tunnels, sewers and water storage tanks that are hidden inside attics or anonymous buildings (Betsky 1995:13).

It should be noted, however, that Pretoria Works, which forms the site for this project, is an example of the loss of water's value. The vision of Mr Kotze, leading Transvaal mining engineer in 1909, was to make South Africa the dominant iron producer amongst its neighbours; he, furthermore, proposed the construction of a blast furnace in Pretoria, close to abundant fresh water for operations (Dondofema, Matope & Akdogan 2017:3). Using fresh water for the blast furnace operations meant that the water became more hidden in the industrial process.

The site chosen for this project is in Pretoria West on the south-west ridge of the city, where the South Africa Iron and Steel Corporation (Iscor) operated. The production of steel stopped with the closure of Iscor in 1997, leaving the site partly de-industrialised and partly used for other industrial activities. These additional activities include a quarry where the waste from past processes is 'mined' for sand, aggregate and brick making. Part of the site is managed by ArcelorMittal Coke and Chemicals (also known as AMCC or Pretoria Works), whilst other buildings and warehouses are hired by private industries. The coke and chemicals plant produces commercial coke. Coke can be described as a solid black substance that is produced from coal and is burned as a fuel (Collins Dictionary 2018). Coke can be used for local ferro-alloy industries, together with by-products such as coal tar that are sold as raw material to make aggregates, cement, fertilisers and plastics (ArcelorMittal South Africa Limited 2009:17).

Looking beyond the boundaries of the site, the typical person living in the area is around twenty years of age with a limited requirement for a qualification higher

1.4

1.5

Fig 1.4 Pretoria City 1872 and Fig 1.5 Pretoria City from 1967 (Jordaan 1989:28, adapted by Author 2018)

than matric. The unemployment rate is close to 20% (City of Tshwane [COT] 2017:30). This foreshadows a potential crisis resulting from the ongoing process of de-industrialisation and the need to provide permanent, unskilled jobs in the area.

Pretoria Works can partly be seen as a post-industrial site due to the closing of its main industrial activity of steel production. Berger (2007:46) defines post-industrial sites as sites that are essentially static and in isolation from their surrounding contexts. On one hand, the closing of Pretoria Works' steel production has led to a general decline in job security in the area, which has further led to a lack of private sector investment and an increase in the poverty percentage (COT 2017:38-39). On the other hand, the closing of the production of steel stopped the pollution and the general degrading of the environment associated with industry (Lyle 1944:3-5). The assumption often made by management of industries is that there are unlimited resources (Lyle 1944:3-5). Such thinking emphasises their degenerative behaviours (Lyle 1944:3-5). This requires a paradigm shift amongst management within industries towards more sustainable approaches (Lyle 1994:3-5).

The post-industrial landscape in general begs a quest for futuristic solutions to static industrial sites within the context of a vulnerable socio-economy society (Cossons 2012:8). The resources in the form of steel structures and vacated buildings in a post-industrial landscape often plead to be re-used; as is evident in the case of Pretoria Works.

The Pretoria Works' site can be described as a Drosscape which implies that waste in the form of slag, as a by-product during the production of steel, be resurfaced with the view to put it to new uses (Berger 2007:210). A Drosscape is dependent on waste in order to survive, whereby new conditions for vacant industries are created by using new programmes or value systems (Berger 2007:236-237). Drosscaping is the act of creating an adaptable socio-economic programme that transforms industrial waste landscapes into a productive urbanised landscape (Berger 2007:236-237. Drosscaping allows a site to contribute to its surrounding context, thereby achieving a sustainable design that can support both itself and its surrounding environment.

Apart from looking into the nature of Drosscaping, it is also worthwhile to view the Stewart Scott International (SSI) Environmental (2011) tabled *Final Environmental Scoping Report for the Proposed Gas Plant Upgrade at the Coke Battery within the Arcelor-Mittal Coke and Chemicals.* According to this report, Pretoria Works has taken the following measures to improve the quality of the ground water:

- The recovery and reuse of waste water;
- The bunding of operational areas so as to contain spills and potentially contaminated surface water;
- The prevention of spillages at operational plants; and
- The sealing off of areas with open soils adjacent to its operational areas (SSI Environmental 2011:3-4).

The operations at Pretoria Works meet the requirements for Zero Effluent Discharge (ZED) (SSI Environmental 2011:3-4) . Furthermore, all water at the site, as regulated, must either be reused or recycled (SSI Environmental 2011:3-4). The sump system at the site acts as a buffer storage capacity, storing and controlling contaminated storm water in the event of spillage and rain (SSI Environmental 2011:3-4).

Against the backdrop of SSI Environmental's (2011) report, the current management of Pretoria Works are of the view that when heavy rain and storm water exceed the buffer storage capacity, the volume of waste water which flows into the Apies River should rather be put to better use. Furthermore, the availability of surplus industrial water, a natural stream from top of the ridge and water from the nine boreholes on-site all present an opportunity to promote more sustainable water use.

Against this background, the growth of the human population, together with the ever-accelerating effects of global warming, soil degradation, food shortage, water and fossil fuel-scarcities (Suhla et al. 2016:335), could lead to job creation, as well as water as resource and food security, becoming strategically and crucially important for survival.

1.2 Problem statement

The competition amongst international steel manufacturers, as well as a general move to end protectionist trade policies, forced Pretoria Works to improve its efficiency (Funding Universe 2004). The efforts to improve efficiency were also necessitated because of the relatively high production cost to produce steel in South Africa in 1994. In order to survive, management decided to cut nearly 2 000 jobs, primarily administrative, towards the end of 1994 and 30 000 jobs at all their plants in South Africa in 1995 (Funding Universe 2004). It became gradually unattractive to continue producing steel, which led to Pretoria Works having to shut down in 1997 (Funding Universe 2004).

The number of people who lost their jobs added to the overall unemployment rate in Pretoria West and had a diminishing effect on local communities.
This dissertation asks how a design intervention can transform a site that relies on the extraction of finite resources to a landscape that can replenish itself as a resource. In a nutshell, the dissertation focusses on how the factory might become a farm.

1.3 Thesis statement

The introduction of aquaponics to Pretoria Works could create jobs and a sustainable food system that could, in turn, improve the well-being of people in the community.

1.4 Research questions

- How can treated industrial waste water be utilised for an aquaponics system?
- How can an aquaponics system be designed to include spaces for the poetic and recreational experience of water?

1.5 Aims and objectives

The aim of the project is to develop a landscape architectural response for a semi-industrialised site in Pretoria West that draws on the practical and poetic potential of water. This raises the following objectives:

- To argue for a regenerative approach to landscape design;
- To demonstrate the viability of aquaponics on the site; and
- To translate the experiential qualities of water to a series of designed spaces.

1.6 Methodology

The following serves as an outline of the process followed in order to achieve the aforementioned objectives:

- The principles of regenerative design have been applied in order to develop a framework for the site, including the proposal for an aquaponics

system.

- The technical requirements for aquaponics have been determined by reviewing scientific literature, conducting interviews with experts and visiting successful fish farms. The findings have been applied to the design of the aquaponics system, and to test its viability.
- The poetics of water have been developed as a series of typologies derived from the theory of phenomenology and from personal experience.

An appreciation for the genus loci of the industrial site, and for the aesthetic of agricultural landscapes, underpin the design explorations throughout.

1.7 Assumptions & Delimitations

During the rainy season in summer, the required volume of water for this project is considered to be adequately supplied by rain water (see Appendix A, which contains a calculation for the total rain water harvested). At times when there is a relative scarcity of rain water supply, the harvested accessed rain water collected during summer, along with the water from the aforementioned boreholes and the supply of water coming from the stream from the ridge, should meet the minimum water volume requirements for this project, see figure 1.6.
Pretoria Works' industrial waste water quality after secondary treatment meets the minimum water quality requirements stated in The South Africa Government Gazette (1984), as confirmed by Pretoria Works' Manager of Projects, Johan van Rensburg (personal communication, 12 February 2018). In Chapter 2, South Africa's set standards are compared to those of developed countries, which adds further value to this confirmation.

1.8 The plan for the investigation

In this investigation the focus is on providing relevant theoretical background about the process required before planning and during design. A description of the seven chapters that cover this investigation follow in the next paragraph

Chapter 1 deals with the problem statement of Pretoria Works and the methodology used for the investigation. Chapter 2 covers a contextual analysis of Pretoria Works, which forms the site for this investigation. In Chapter 3, the focus is on the industrial waste water at Pretoria Works, which has the latent potential to be tertiary-treated through phytoremediation for future use. The description of the waste water is followed by a manageable design vision. Chapter 4 provides a better understanding of the value of water as a resource, whereby people need to become emotionally attached before they will care for it. Chapter 5 focusses on a conceptual approach to water spaces. Chapter 6 covers the technical refinement to make Pretoria Works a productive landscape that is based on the development of its phenomenological spatial qualities of water. Chapter 7 concludes this investigation and encourages relevant future research.

Fig 1.6 Pretoria Works zoning of water resources (Author 2018)

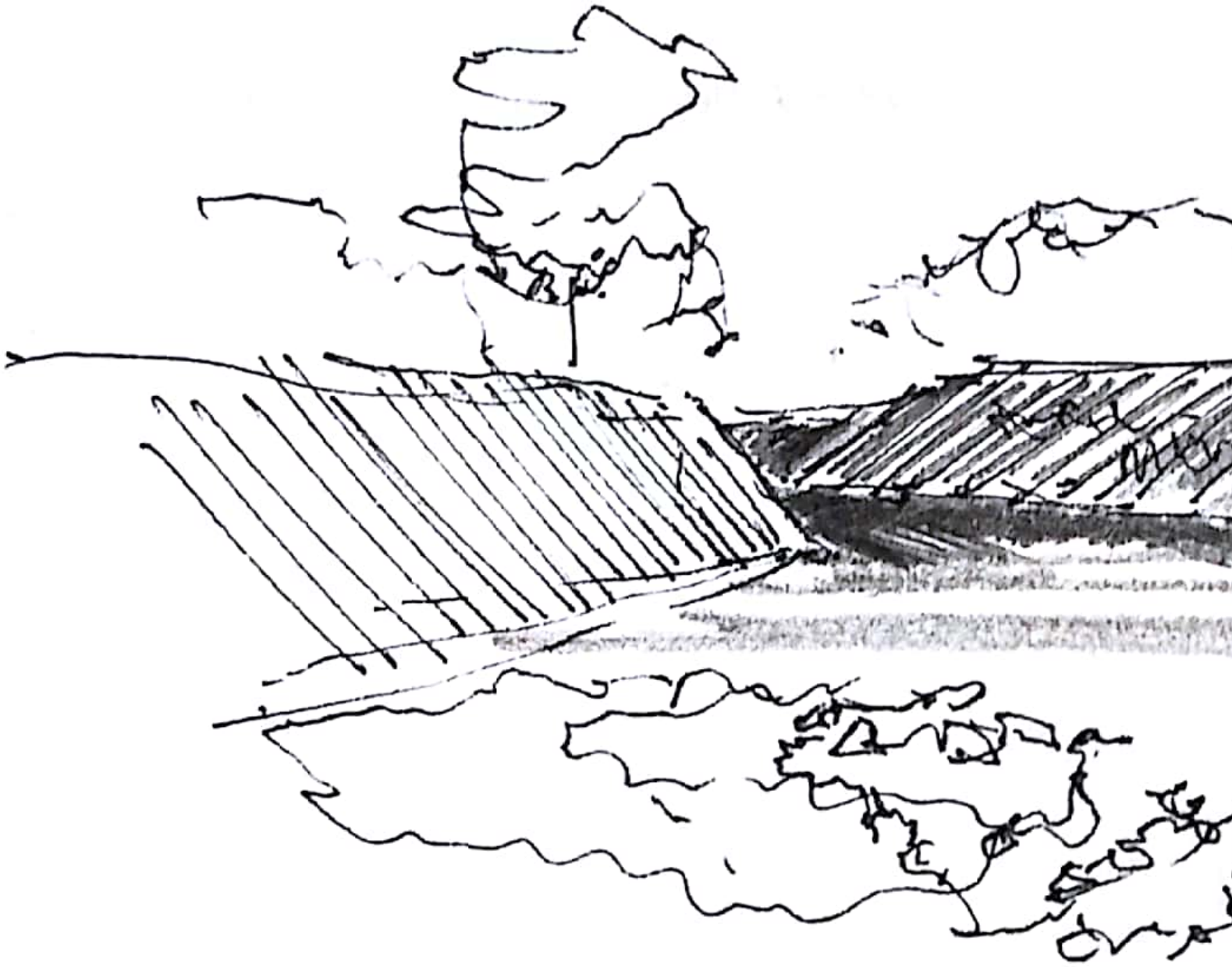


Fig 1.7 The channelised Apies River (Author 2018)

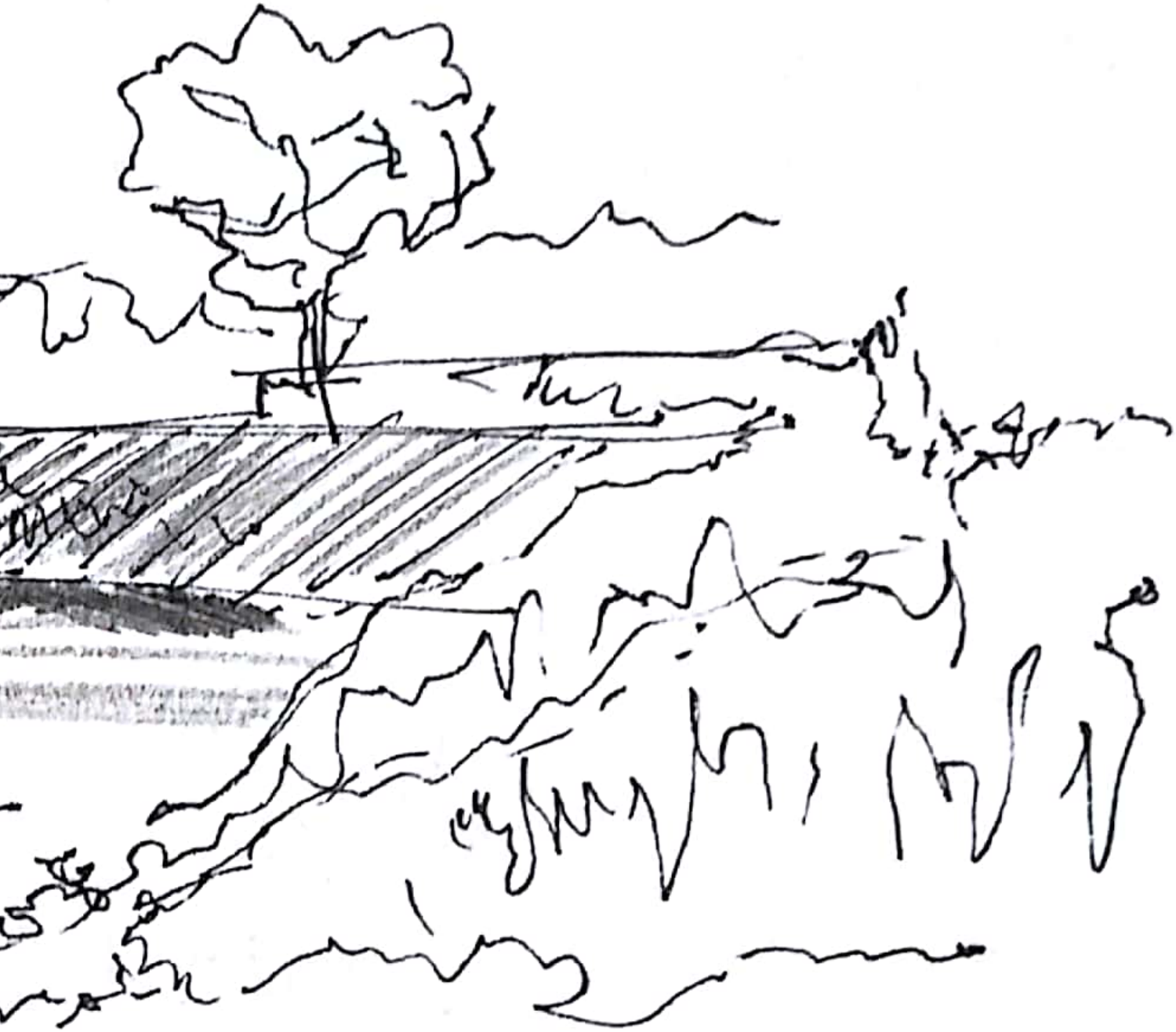


Fig 2.1 Pretoria Works view over Pretoria