Context 2

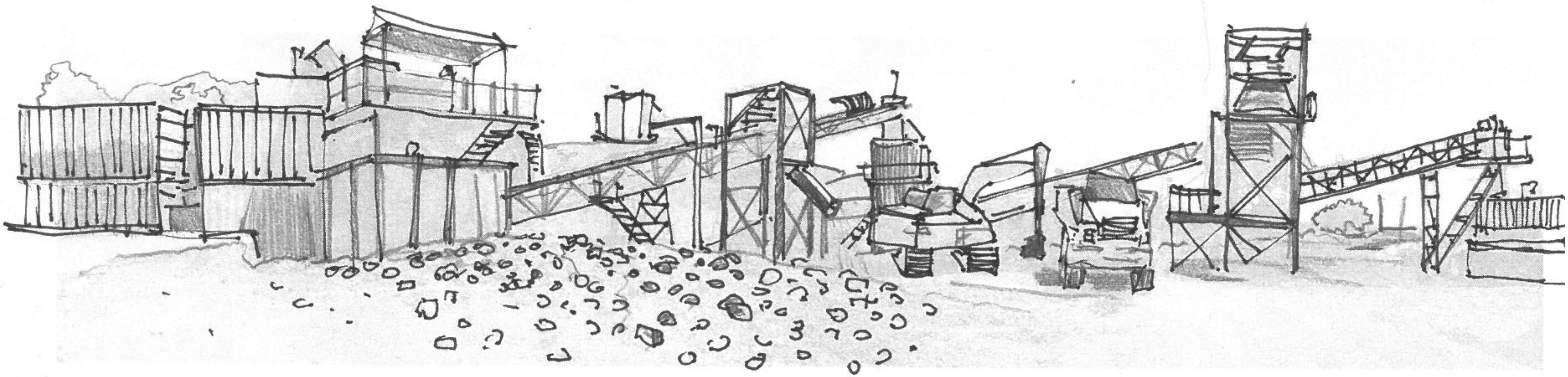


Fig 2.2 The active quarry collecting and crushing slag for brick-making (Author 2018)

2.1 Introduction

Pretoria Works is visible from various angles throughout the city of Pretoria. This chapter looks at the waste found and treated on the site, and provides an analysis of the terrain and potential responses to it. The chapter also presents an urban vision for this site. The analysis of the terrain predominantly focusses on treated industrial waste water.

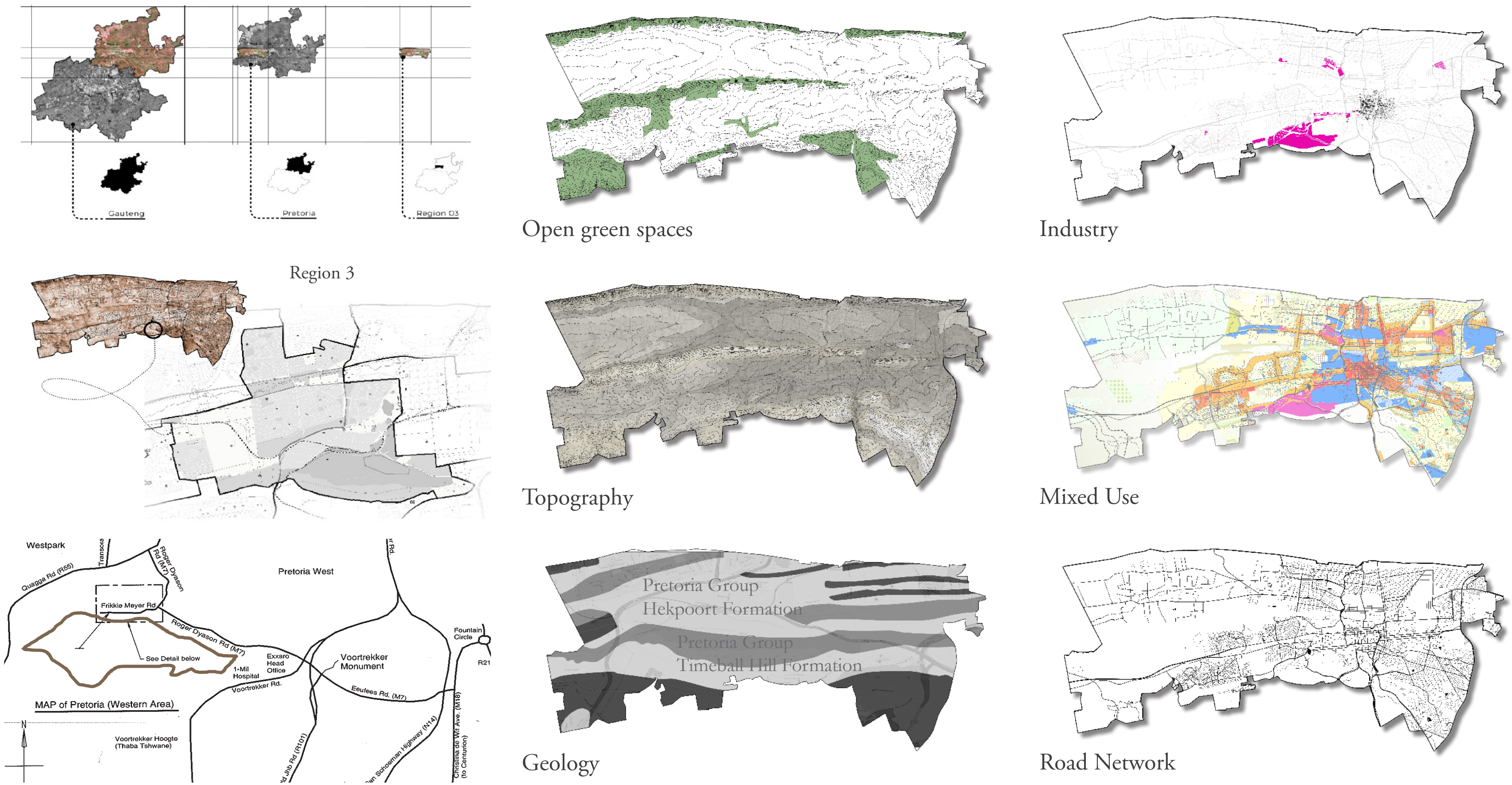
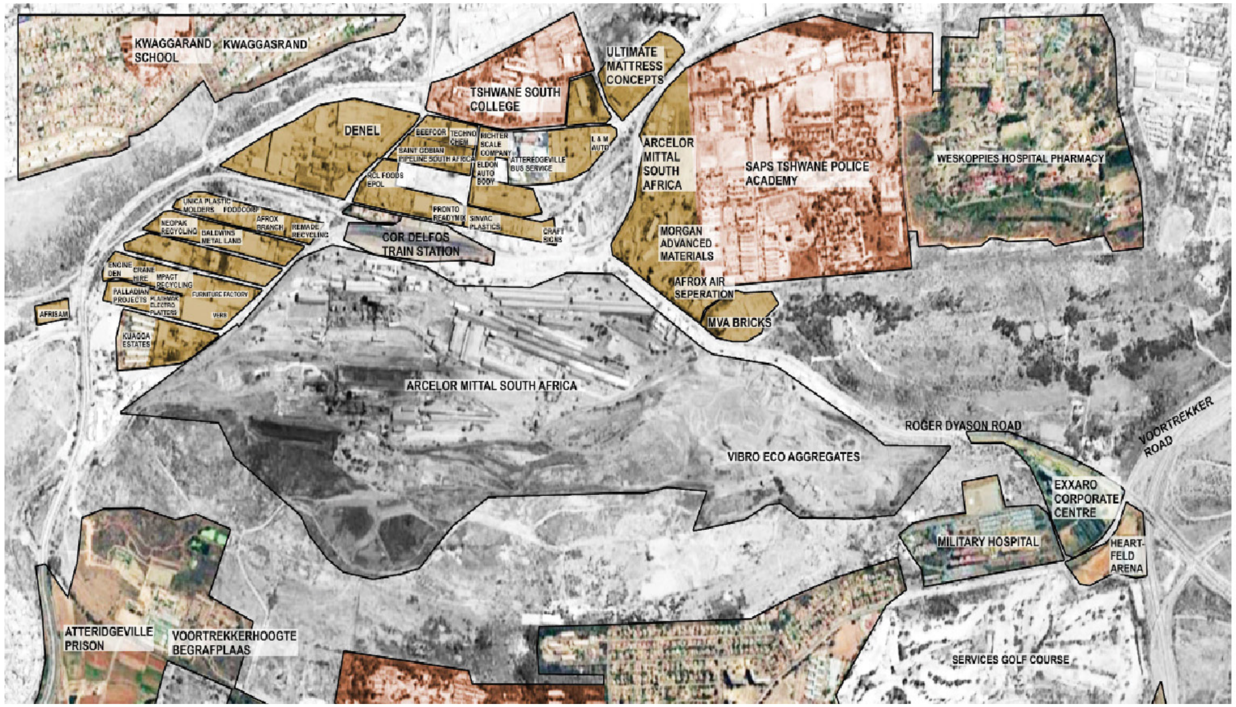


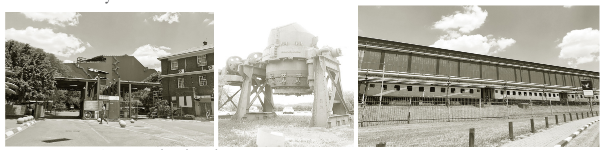
Fig 2.3 Location and analysis of Pretoria Works that is part of region 3 (Group framework 2018)



Industrial
Educational
Residential


Frikkie Meyer Rd


Frikkie Meyer Rd


Entrance ArcerolMittal


ArcerolMittal to Cor Delfos Station


Roger Dyason Rd


Cor Delfos Station


Housing at Cor Delfos Station

Fig 2.4 Pretoria Works context (Group framework 2018)

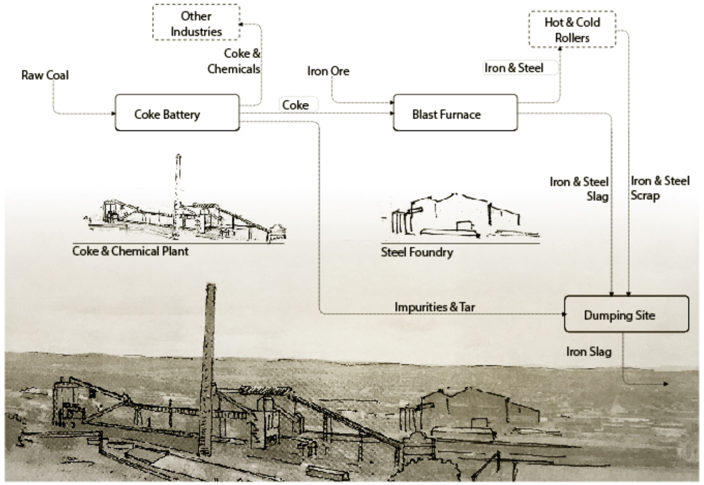
2.2 Pretoria's iron and steel history

Iscor's history dates back to when the Pretoria municipality permitted Mr Delfos, the director of Pretoria Iron Mines Limited, the mining rights over certain iron ore reserves within Pretoria (Dondofema et al. 2017:5). He built an experimental blast furnace in November 1917, although he struggled to obtain financial support from Europe, as the European iron masters assumed that coal was not an efficient resource for a coke plant that managed iron ore in its blast furnaces (Dondofema et al. 2017:5). However, Pretoria Iron Mines Limited still managed to achieve a fixed market, in the form of a contract to supply 50% of the projected iron and steel requirements of the South African Railways. In an effort to meet the obligation, a partnership was formed with Anglo American, Central Mining and Investment Corporation, the National Industrial Corporation and Delagoa Bay Collieries (Dondofema et al. 2017:5). This partnership led to an enormous iron and steel industry being established in June 1928 in Pretoria, known as Iscor. Mr Delfos had, thus, finally achieved his dream of constructing a blast furnace in Pretoria where there was abundant fresh water for the operation (Dondofema et al. 2017:5).

The iron and steel industry in Pretoria was driven by a coke and chemical plant, which was formed by ovens placed together functioning as a battery. The battery's most important raw material was high quality coke, because it acted as fuel that provided suitable heat for the necessary chemical reactions to occur for melting iron ore and charcoal (ArcelorMittal South Africa Limited 2009:17). The system continued with various processes through cooling, hot and/or cold strip milling, flame cutting, etc. before the final steel products were created (see figure 2.5). These steel products ranged from long bars, billets, fencing profiles and window frames to various other products (ArcelorMittal South Africa Limited, 2009:18-19). Certain waste, such as slag, tar and gases were produced from the system (Tupkary & Tupkary 2018:58-59).

The Pretoria Works' summarised timeline from 1916-2018 is as follows (see figure 2.6):

- 1916: The establishment of South Africa's own steel feedstock which launched the country's first ferrous ore mine. The beginning of feeding a newly-constructed blast furnace, which produced approximately 4,000 tons of pig iron between 1918 and 1921 (Funding Universe 2004).



2.5

Fig 2.5 Pretoria Works Coke & Chemicals Plant (Group framework 2018)

- 1928: Iscor becomes the dominant steel producer in South Africa and initiates construction in Pretoria with a steel mill (Funding Universe 2004).
- 1934: The Pretoria Mill and Works begins steel production (Funding Universe 2004).
- 1939: Local demand increases, which sees production figures doubling (Funding Universe 2004).
- 1988: Iscor incorporates the technology of the Corex process for Pretoria Works, where this process functions with a non-coking coal as a source of energy that also reduces the demand for iron ore (Dondofema et al. 2017:7).
- 1997: The Corex process cannot sustain Pretoria Works, and, together with international steel competition, results in Pretoria Works having to be shut down (Dondofema et al. 2017:8). This shutdown results in unattended sedimentation dams that used to be part of the industrial waste water treatment infrastructure.
- 2004: ArcelorMittal starts to manage Pretoria Works' old Iscor site, states Pretoria Works' Manager of Projects, Johan van Rensburg (personal communication, 12 February 2018)
- 2010: The unattended sedimentation dams are filled with topsoil by ArcelorMittal as a means of

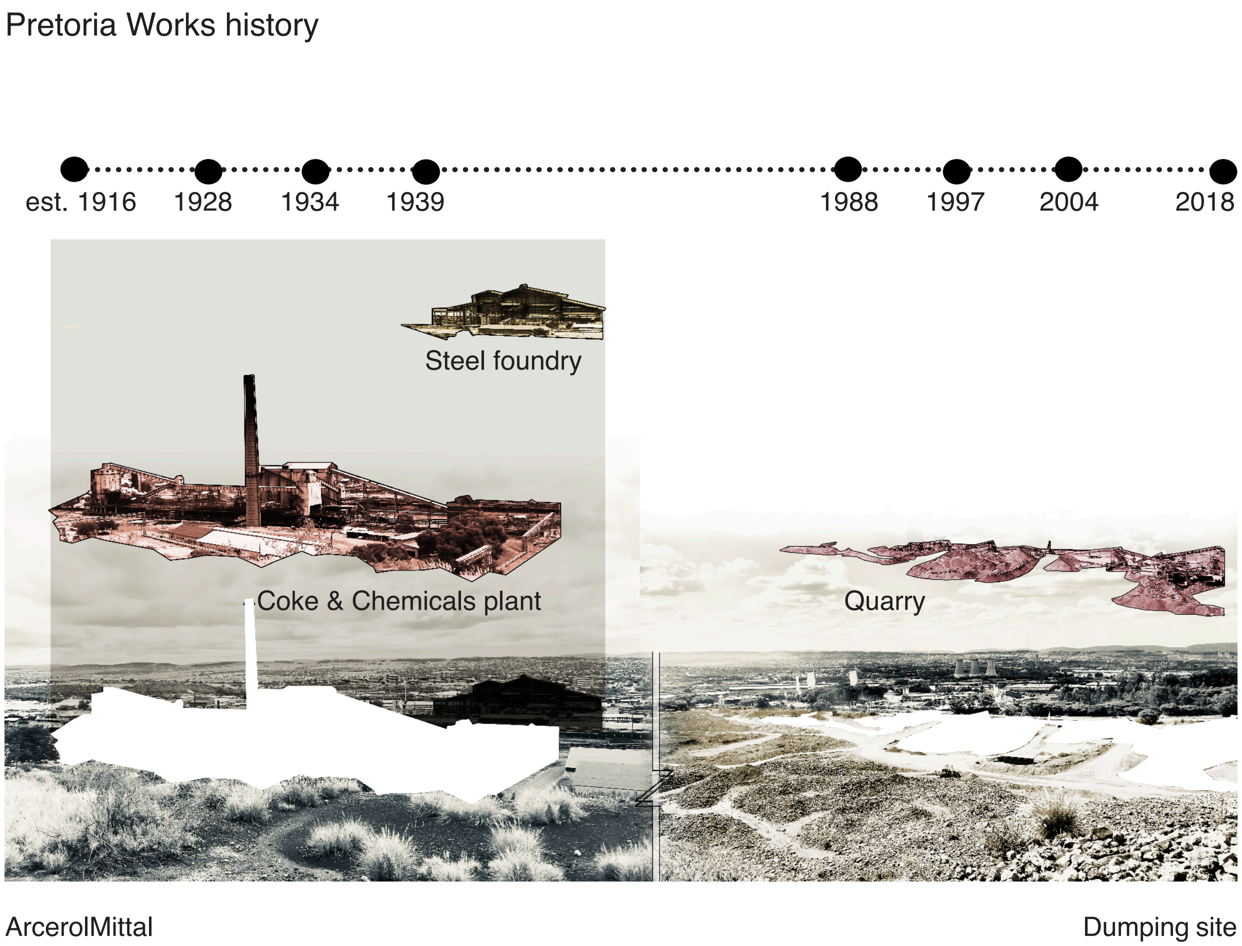


Fig 2.6 Pretoria Works time-line (Group framework 2018)

improving the site's security (van Rensburg, personal communication, 12 February 2018)
- 2018: The only industrial activity on the site is the AMCC plant, together with the private industries that hire approximately 90% of the site's buildings. Vibro Eco Aggregate is also active on the site; rehabilitating Pretoria Works' dumped waste (e.g. tar, steel and iron slag waste), for which an estimated 10-15 years is needed for effective processing (van Rensburg, personal communication, 12 February 2018)

The industrial activities on the site get water from Pretoria Works' industrial waste water treatment plant. For a more comprehensive explanation of the process on-site. The quality of water flowing into streams and rivers after waste water and sewerage treatment needs to meet water quality standards. This water quality within rivers should be of a state that is not harmful to the rivers' aquatic life and/or the general environment (Palmer 2004). Pretoria Works' industrial waste water quality after secondary treatment meets the required standards, although the exact figures remain confidential.

Currently, the South Africa Government Gazette's (1984) requirements and standards for effluent produced by or resulting from the use of water for industrial purposes are: chemical oxygen demand (COD) 30 mg/l; total suspended solids (SS) 10 mg/l; total phosphorus (P) 1 mg/l; and total nitrogen (N) 1.5mg/l. However, the required water quality for the project in this dissertation, where aquaponics make use of wetlands, needs to be of a better standard than is currently available, states Stephen van Staden the owner of Scientific Aquatic Services Johannesburg Area (Personal communication, 8 August 2018).

Water quality standards are imperative for limiting potentially harmful contaminants entering the general water supply. For an analysis of waste water contaminants commonly produced from steel and iron industry plants, see Appendix B.

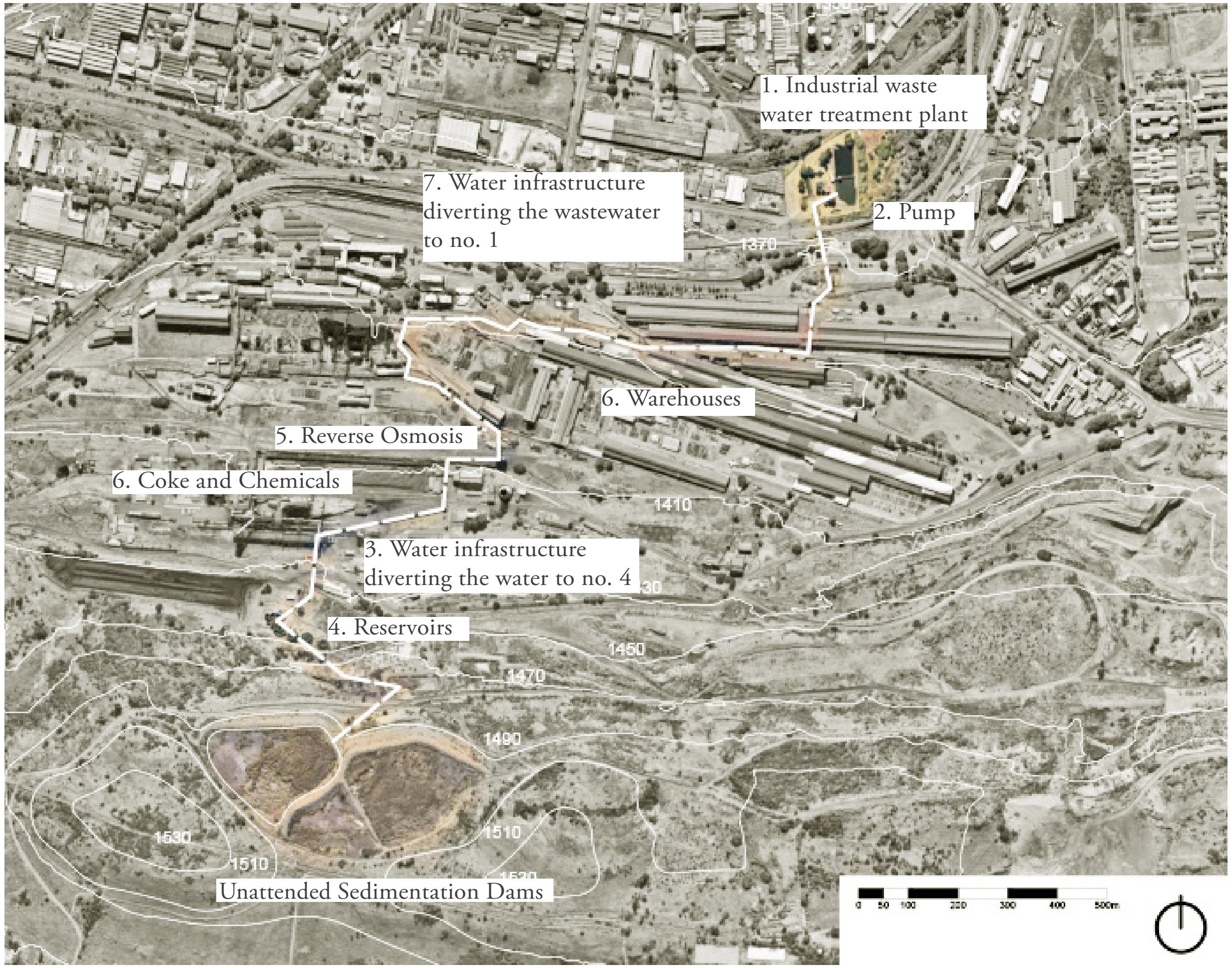


Fig 2.7 Pretoria Works industrial waste water system (Author 2018)

2.3 Pretoria Works' industrial waste water treatment (WWT)

The waste water plant at Pretoria Works is monitored daily, and an alarm goes off if the industries operating on the site expose the waste water to any hazardous contaminants. Industries can receive a heavy fine as a result of exposing any hazardous contaminants to the water supply states Project Manager Johan van Rensburg, Pretoria Works (Personal communication, 12 February 2018).

As noted previously, the elements within the industrial effluent present at Pretoria Works are eliminated through the treatment facility. Figures 2.7-2.10 show the different ways, in chronological order, taken when treating industrial waste water, before it is sent back for reuse into the industrial system. Each stage is discussed in the subsections that follow.

2.3.1 Preliminary treatment

Screening

Pretoria Works utilises manual screens that collect and remove plastic and foreign materials that can interfere with the treatment processes or damage the plant equipment if not removed.


6. Water pump (treated waste water to reservoirs)
5. Facultative Ponds
Water infrastructure
4. Sedimentation Ponds
Water infrastructure
Reservoirs
Iscors Sedimentation Dams

Fig 2.8 Pretoria Works industrial waste water infrastructure (Author 2018)

Grit removal
Grit refers to organic and inorganic substances, such as sand, silt, glass, small stones and other larger substances (i.e. detritus). The grit removal process involves the removal of these substances.

Waste disposal options for screenings and grit
The waste collected after screenings and grit removal requires site removal, so as to prevent human health concerns, the breeding of water insect and/or odours (The South African Local Government Association [SALGA] 2016).

2.3.2 Primary treatment

Flow measurement
The water flow volume is measured after preliminary treatment. The Process Controller is alerted if the volume of water entering the plant is not at a constant rate. Constant water flow is achieved through the use of balancing tanks (SALGA 2016).

Sedimentation
The purpose of having sedimentation dams is to separate organic solids and liquids found in waste water, such as oils, fats and grease, from one another (SALGA 2016).

2.3.3 Secondary treatment

Secondary treatment happens within aerobic and anaerobic ponds, whereby micro-organisms attach themselves to solid mediums, such as stones, and remove organic matter found in the waste water. The process contributes to nitrification, which is the conversion of ammonia to nitrate/nitrite with an increase of oxygen in the water (SALGA 2016).

Anaerobic ponds
The anaerobic pond is typically 4-5 meters deep and requires low energy. This process achieves solid separations by producing excess sludge that settles on the bottom of the pond. This system is driven by anaerobic and facultative organisms and uses oxygen from elements found in water as hydrogen acceptors (i.e. nitrates and sulphates) (Arceivala & Asolekar 2007).

Aerobic ponds
A detention time of 15-30 days is required in the anaerobic pond before the water flows to aerobic ponds that have been designed to maximise light penetration and algae growth through photosynthesis. Aerobic ponds require temperatures above 15°C to function effectively (Arceivala & Asolekar 2007).

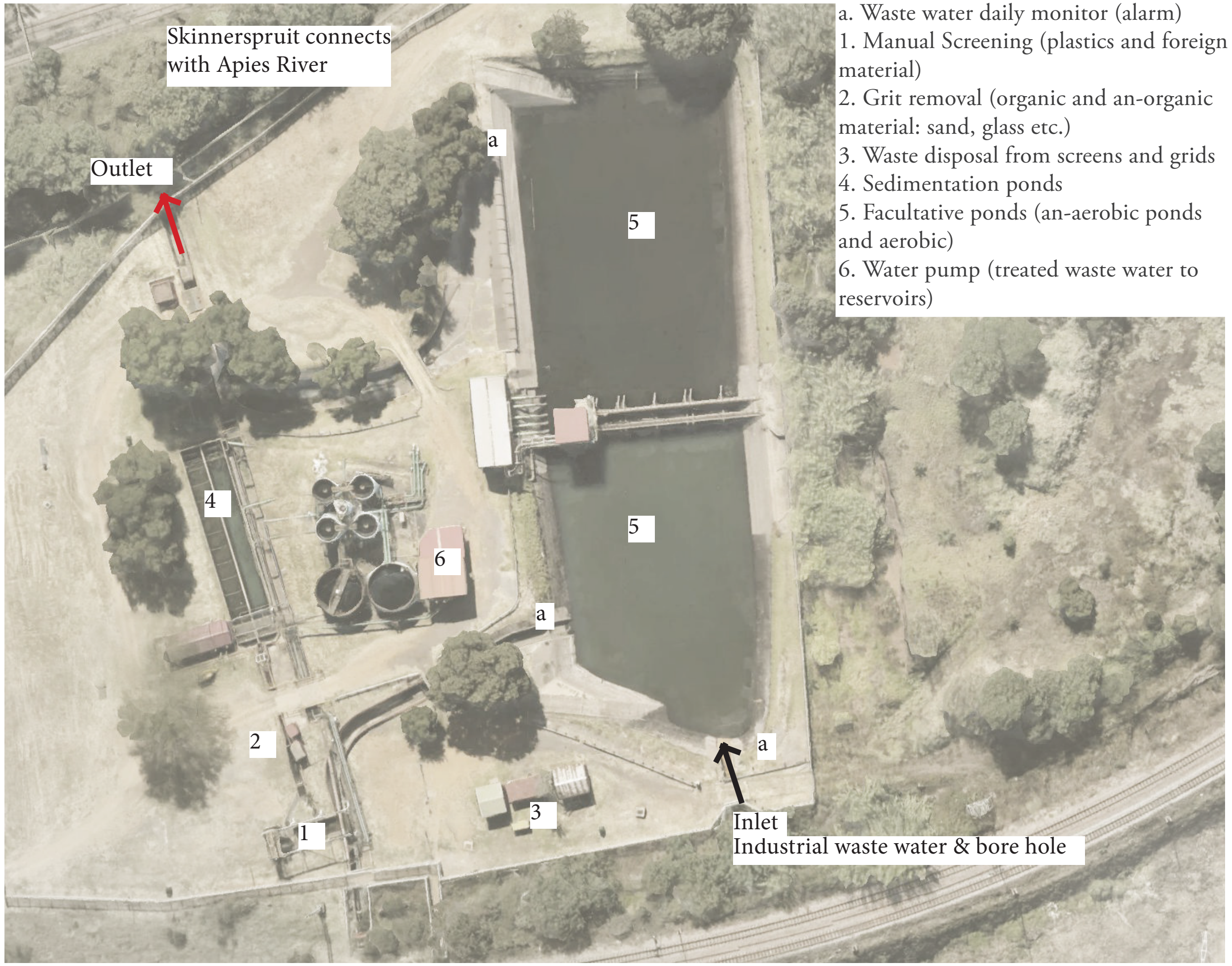


Fig 2.9 Pretoria Works industrial waste water treatment plant (Author 2018)

2.3.4 Tertiary treatment

Desalination through reverse osmosis (RO)

The RO process forces water with pressure from a high salt concentration chamber through semi-permeable membranes towards a region of low solute concentration (Rao 2007:1333). The process uses treated secondary waste water to produce water that is free from any pathogens, bacteria and/or viruses (Kruger 2005:39). This process is common in industrial waste water treatment before the water is reused for industrial purposes and even to irrigate vegetation (Bunani 2015:3036). Per this project, utilising post-RO water could restore the connectivity of green nodes found within Pretoria Works and improve the green corridor by filling it with indigenous vegetation and productive landscapes.

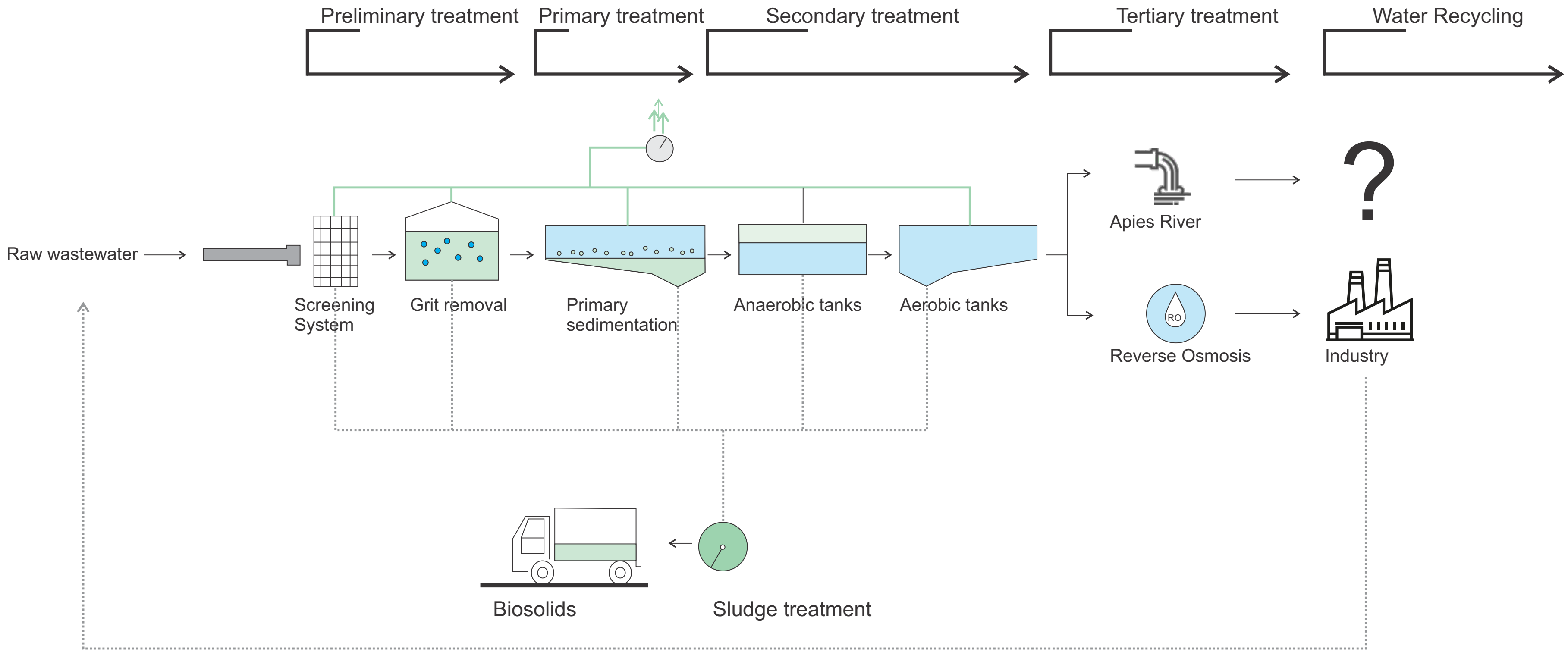


Fig 2.10 Pretoria Works industrial waste water treatment plant systems (Author 2018)

Fig 2.11 Pretoria Works adjacent to a natural ridge (Author 2018)

2.4 Analysis of the terrain

2.4.1 The natural environment

The rehabilitation quarry owned by Pretoria Works is adjacent to the coke and chemical plant (see figure 2.11). The rehabilitation process is not only an economical act but also a vital aspect of restoring the land to a condition that is not contaminated. The waste from this site has been rehabilitated for the past 30 years. The rehabilitation process functions with construction vehicles and machinery used for collecting iron and steel slag from the dumped mounds. The slag is transported to machinery for crushing, thereby producing gravel, sand and finer sand that is suitable for brick-making (see figures 2.12-2.16).

The restoring of the quarry is necessary for it to contribute to constructive activities. Quarries associated with post-industrial activity often cut off geographical locations with urban boundaries. These locations should be reclaimed, especially within cities, as they are too valuable to disregard and might be useful for economic or natural upliftment (Vosloo 2018:55). The latent potential of these sites lies in their ability to be used to regenerate natural and social systems by functioning as a green network that can contribute to a resilient city. There is an increasing demand for green areas that form networks within the city, as such spaces are necessary for inhabitants to meet their recreational desires and increase their environmental awareness (Vosloo 2018:43-46).

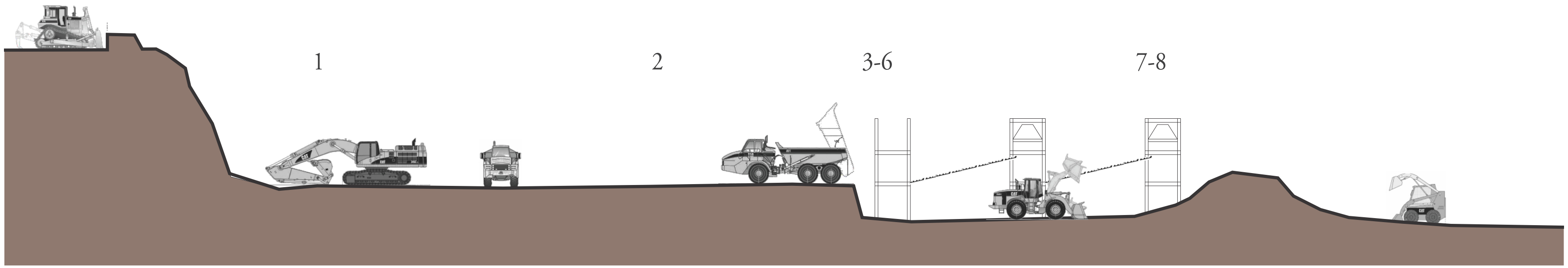
Green areas that form networks are also vital in cities as they allow for ecological processes to function effectively with each other, thereby promoting an increase in biodiversity (COT 2005:11). These green networks function as an integrated mechanism between the urban and natural ecology and can be successful when people understand the critical relationship that a city has with its integrated or surrounding natural spaces (COT 2005:11).

Green networks are visible either as green nodes or green ways. Green nodes are classified by ecological systems, processes and concentrated green values (COT 2005:11, 25). Green ways, however, consist of ridge systems that are steeper than 5°, in which ecological system processes and values are concentrated (COT 2005:11, 25). The green ways (i.e. class 1 and 2 ridges) mostly occur in a pristine or natural state, and are generally characterised as 'natural' (COT 2005:11, 25). Every attempt must be made to retain green ways in as pristine a state as possible, with minimal human intervention (COT 2005:11, 25). Thus, a network of low-impact movements between human interventions can be allowed in specific instances. For example, intervention or interaction activities within such areas must focus on ecological research, education, the conservation of biodiversity, eco-tourism, trails and/or guided walks (COT 2005:11, 25).

It may be possible to conduct such activities within the area surrounding the Pretoria Works site. The south-west facing ridge of Pretoria Works, where a large portion of the vegetation is indigenous, is almost untouched by the site's industrial activity. Therefore, it is possible to create green ways that connect to the south ridge, the rehabilitated quarry and the adjacent ridge opposite Roger Dyason Road. These green ways could improve the protection of biodiversity found in the green networks, which, in turn, could enhance eco-tourism in the area.

2.12

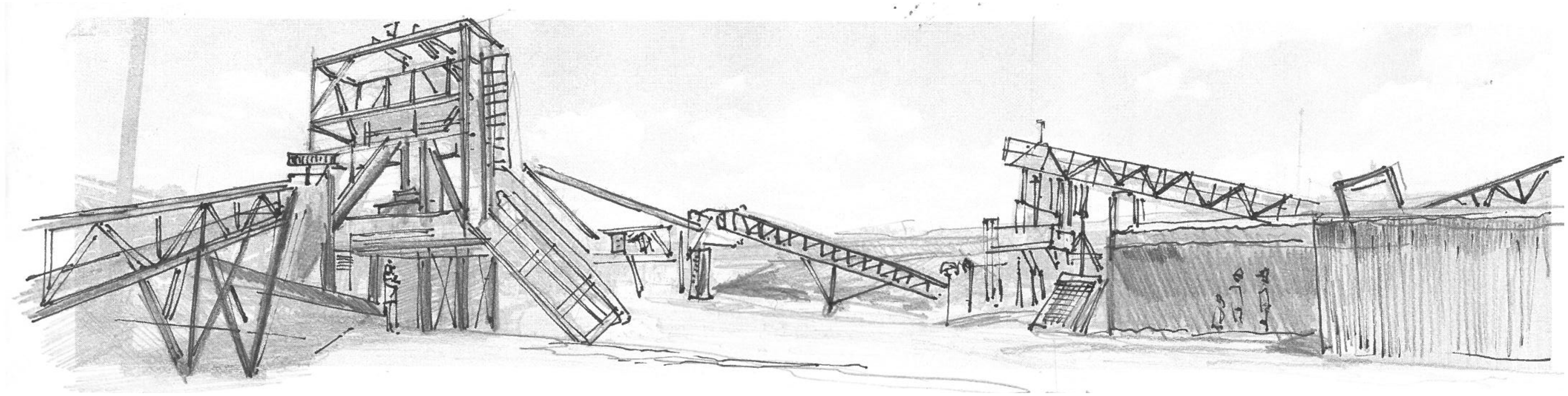
2.13



2.14

Fig 2.12 Plan view of the quarry (Author 2018)

Fig 2.13 and Fig 2.14 The process of brick-making, slag is transported to machinery for crushing, thereby producing gravel, sand and finer sand that is suitable for brick-making (Author 2018)



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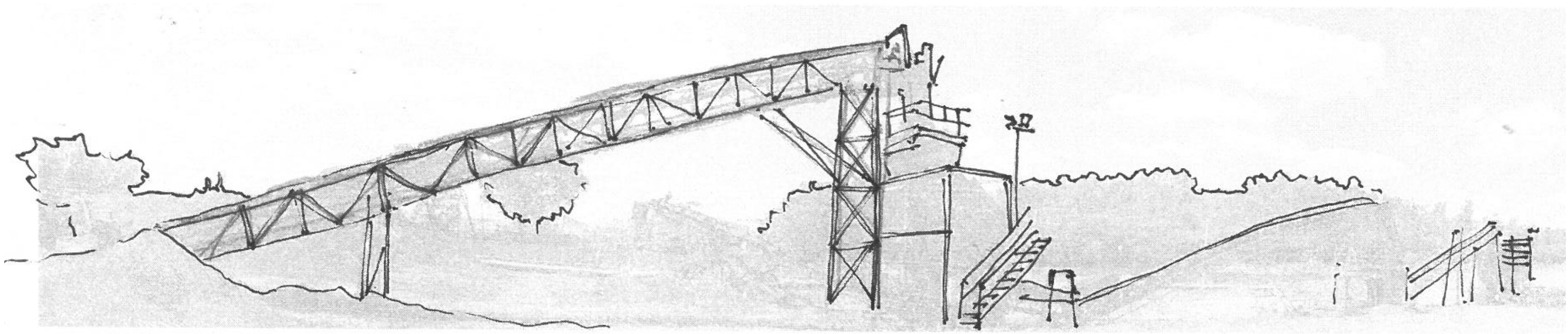


2.16

Fig 2.15 and Fig 2.16 Machinery for crushing, thereby producing gravel, sand and finer sand that is suitable for brick-making (Author 2018)

2.4.2 Pretoria Works' existing vegetation

Pretoria Works falls within the indigenous Gauteng Shale Mountain Bushveld Vegetation Area but, due to the effects of the 20th century's industrialisation, indigenous vegetation in the south-east has been disturbed, and invasive vegetation that have adjusted to the soil conditions have been introduced. The effect is most visible close to the rehabilitation quarry.

The invasive species growing in this area are:
Albizia procera, Arundo donax, Campuloclinium macrocephalum, Cinnamomum camphora, Datura ferox, Datura stramonium, Euclea camaldulensis, Euclea sideroxylon rosea, Ipomoea purpurea, Lantana camara, Pennisetum setaceum, Schinus molle, Senna pendula and *Tithonia rotundifolia* (see figure 2.17).

Conversely, the south ridge is still covered with indigenous species, as this area, essentially, forms part of the original Gauteng Shale Mountain Bushveld Vegetation Area. The characteristics of this region are noticeable not only at Pretoria Works but throughout a large portion of Pretoria, especially from Atteridgeville to the Klapperkop Nature Reserve (Mucina & Rutherford 2011:466). The region is characterised by low, broken ridges

Arundo donax *Tithonia rotundifolia* *Albizia procera* *Cinnamomum camphora* *Datura ferox*
Datura stramonium *Pennisetum setaceum* *Lantana camara*
Schinus molle *Datura stramoium* *Eucalyptus camaldulensis*

Fig 2.17 Invasive plant species growing at Pretoria Works (Author 2018) that vary in steepness and have high surface rock covering (Mucina & Rutherford 2011:466). The vegetation consists of a short (3-6 metre tall), semi-open thicket dominated by a variety of woody species and covered with a number of grasses, which dominate the understory. The ridges located on the north-facing slopes are predominantly scrubby grasslands that cover high rock surfaces (Mucina & Rutherford 2011:466).

This landscape includes a variety of small trees, shrubs, succulents, woody climbers, graminoids and herbs:
Small trees: *Acacia caffra, Dombeya rotudifolia, Acacia karoo, Celtis Africana, Combretum molle, Cussonia spicata, Englerophytum magalismontanum, Pretora caffra, Searsiea leptodictya, Vangueria infausta,* and *Zanthoxylum capense.*

Tall shrubs: *Asparagus laricinus, Afrocanthium gilfillanii, Chrysanthemoides monlifera, Dichrostachys cinerea, Diospyros austro-africana, Euclea crispa, subsp. Crispa, Grewia occidentalis, Gymnosporia polycantha, Olea europaea subsp. Africana,* and *Tephrosia capensis.*

Low shrubs: *Acalypha angustata, Asparagus suaveloens, Athrixia elata, Felicia muricata, Indigofera comosa* and *Searsia magalismontana subsp. Magalismontana.*

Succulent shrubs: *Kalanchoe rotundifolia.*

Woody climber: *Ancylobotrys capensis.*

Graminoids: *Hyparrhenia dregeana, Cymbopogon caesius, Digitaria eriantha subsp. Eriantha* and *Eragrotis curvula.*

Herbs: *Dicoma zeyheri, Helicrysum nudifolium, Hermannia Lancifolia, Hibiscus pusililus, Selaginella dregei, Senecio venosus, Vernonia natalensis* and *V. oligocephala.*

Geogytic herbs: *Cheilanthes hirta, Pellaea calomelanos,* and *Scadoxus puniceus.*

The response to the analysis of the vegetation is to plan, constructively, how to engage with the invasive and indigenous vegetation in order to establish a green network.

2.4.3 Climatic analysis of Pretoria

Pretoria has an altitude ranging from 1 300 to 1 750 metres and is characterised by essential rain that falls predominantly during spring and the hot summer season (Mucina & Rutherford 2011:466). The autumn and winter seasons are characteristically cold and dry (Mucina & Rutherford 2011:466). The average temperature is 15.6°C and varies approximately 10°C between summer and winter. The seasons' mean minimum and maximum temperatures range from 0°C-30°C, with approximately 33 days of mean annual frost days (Mucina & Rutherford 2011:466). The wind blows predominately from the north and north-easterly directions, reaching speeds of 5.7-8.8 metres/s (SSI Environmental 2011:20). In response to the climatic analysis, it is crucial that the selection of plants and fish for the aquaponics and agriculture at the site is done in accordance with the climatic variables indicated.

2.4.4 Transportation in the area of Pretoria Works

The map in figure 2.18 indicates the location of Pretoria Works within the greater city of Pretoria. This map also shows primary metropolitan distributor roads, railways, existing Bus Rapid Transit (BRT) routes and future BRT routes, as well as rivers, waterbodies and streams.

The Cor Delfos train station adjacent to Pretoria Works connects with the Pretoria Station, and is in close proximity to the bigger Ring of Pretoria Rail

Stations. This train station manages trains that are active throughout the whole of Pretoria, and is a significant mediator between Attridgeville (or Saulsville Station) and Pretoria Station (COT 2017:31). This link is an important element in the public transport system's contribution to job opportunities. This source of transportation also decreases the use of private transportation and provides access to the area for both local residents and tourists. The COT (2017:31) proposes to densify land use along public transportation corridors, thereby increasing the use of public transport via the BRT system present throughout the city. A future BRT route has also been proposed that will begin approximately 500 metres from the Cor Delfos train station (COT 2017:38-39). This possible new route could further increase the potential for user-friendly transportation that may successfully integrate people with Pretoria Works.

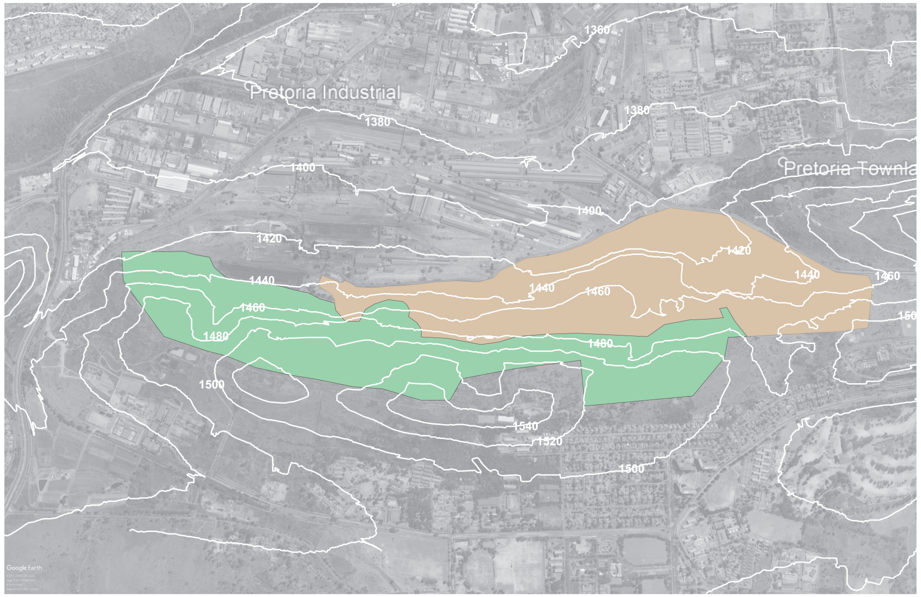
For an analysis of the strengths, weaknesses, opportunities and threats manifested in Region Three, wherein Pretoria Works is located, see Appendix B.

2.18

2.19

2.20

Fig 2.18 Pretoria Works part of Pretoria's transportation and water systems (Author 2018)
Fig 2.19-Fig 2.20 Apies River in close proximity to Pretoria Works (Author 2018)



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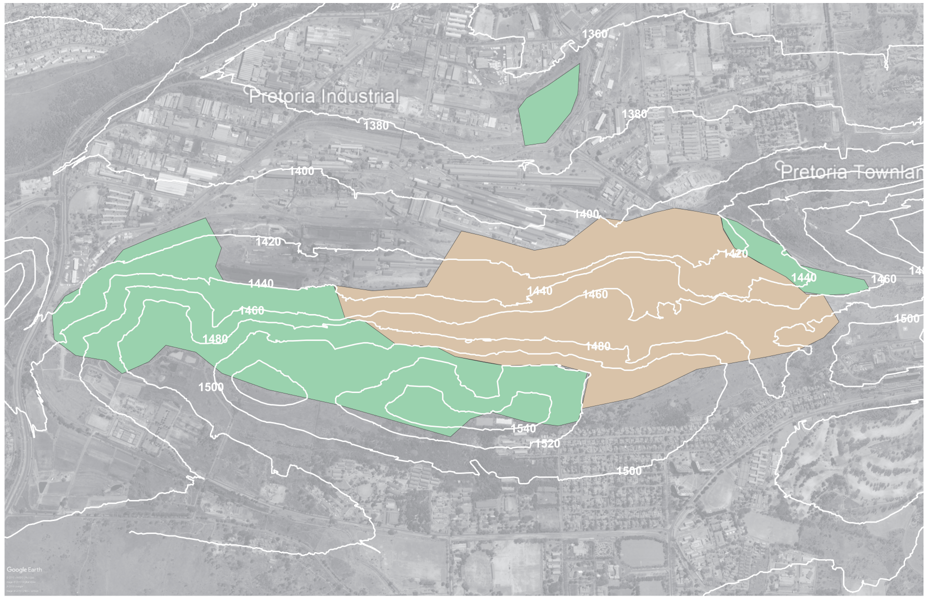
Vegetation

Invasive vegetation

Indigenous vegetation: Gauteng Shale Mountain Bushveld Vegetation

2.21



0 400m

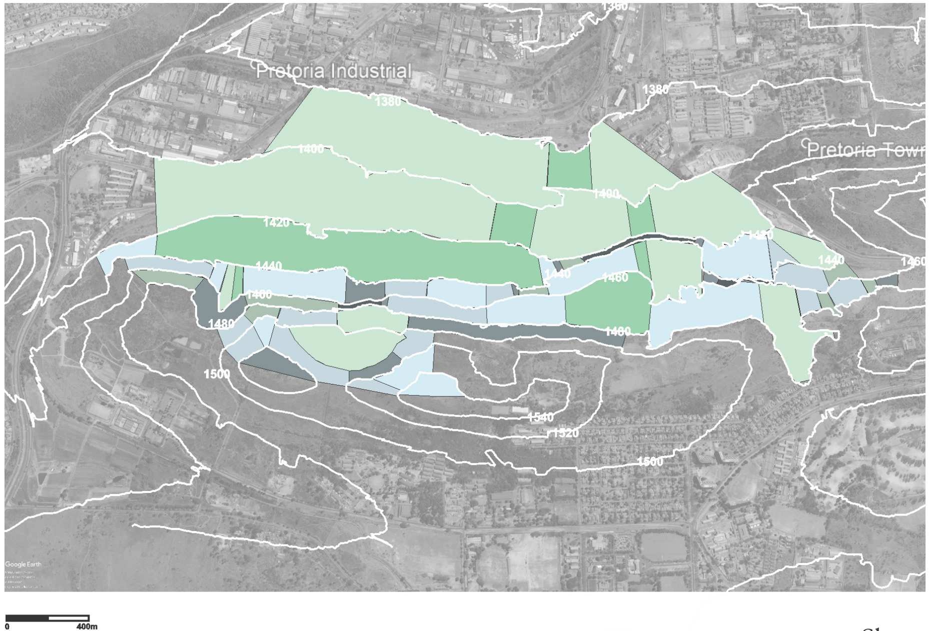
Ground water

Contaminated groundwater

Clean groundwater for domestic use

2.22

Fig 2.21 Analysis of the vegetation at Pretoria Works (Author 2018)
Fig 2.22 Analysis of the ground water at Pretoria Works (Author 2018)



Slope

0-10%	20-30%	40-50%	60-70%
10-20%	30-40%	50-60%	70-80%

2.23

Nolli map

2.24

Fig 2.23 Analysis of terrain at Pretoria Works (Author 2018)
Fig 2.24 Nolli map of Pretoria Works (Author 2018)

2.5 Urban vision for Pretoria Works

Landscape Urbanism is a theory of urban planning based on the thinking that the best way to organise cities is through the design of the city's landscape, rather than through the design of its buildings (Waldheim 2016:1).

This means that a city should be viewed through the lens of 'landscape as a medium of urbanism'. 'Landscape' is an important factor in generating urban form in the wake of macro-economic transformations (Waldheim 2016:1-4). Landscapes include brown fields and abandoned sites left in the face of economic renovations. Therefore, 'landscape as a medium of urbanism' has often been used to absorb and, in some ways, relieve negative impacts associated with social, environmental and/or economic crises (Waldheim 2016:1-4).

Pretoria Works' land use is classified as an industry and critical biodiversity area (COT 2017:84-87). The land management objective for this and similar areas is to introduce denser industrial activities and maintain natural environments by utilising ecological processes; rehabilitating degraded areas to a natural state; managing the land with minimal degradation; and, at the same time, proposing opportunities for eco-tourism operations that monitor environmental impacts and carrying capabilities, thereby achieving overall biodiversity improvement (COT 2017:84-87). Against the described land management objective of the COT, management at Pretoria Works also stress the rehabilitation of their degraded areas to a natural state (van Rensburg, personal communication, 12 February 2018), which places the emphasis on green rehabilitation as presented in this project.
By using the theory of 'landscape as a medium of urbanism', it is possible to propose a food-producing landscape for the industrial Pretoria Works site. In so-doing, the site may begin to open up various opportunities for job creation, tourism and improving the natural conditions of the area. This could create a place that can contribute to the bigger Pretoria at a social, environmental and economical level (see figure 2.25).

The site of Pretoria Works is proposed to be used for agriculture, aquaponics and human recreational activities, which may all lead to job creation, tourism and improving the natural conditions of the area. These aspects are discussed in further detail in Chapter 3.

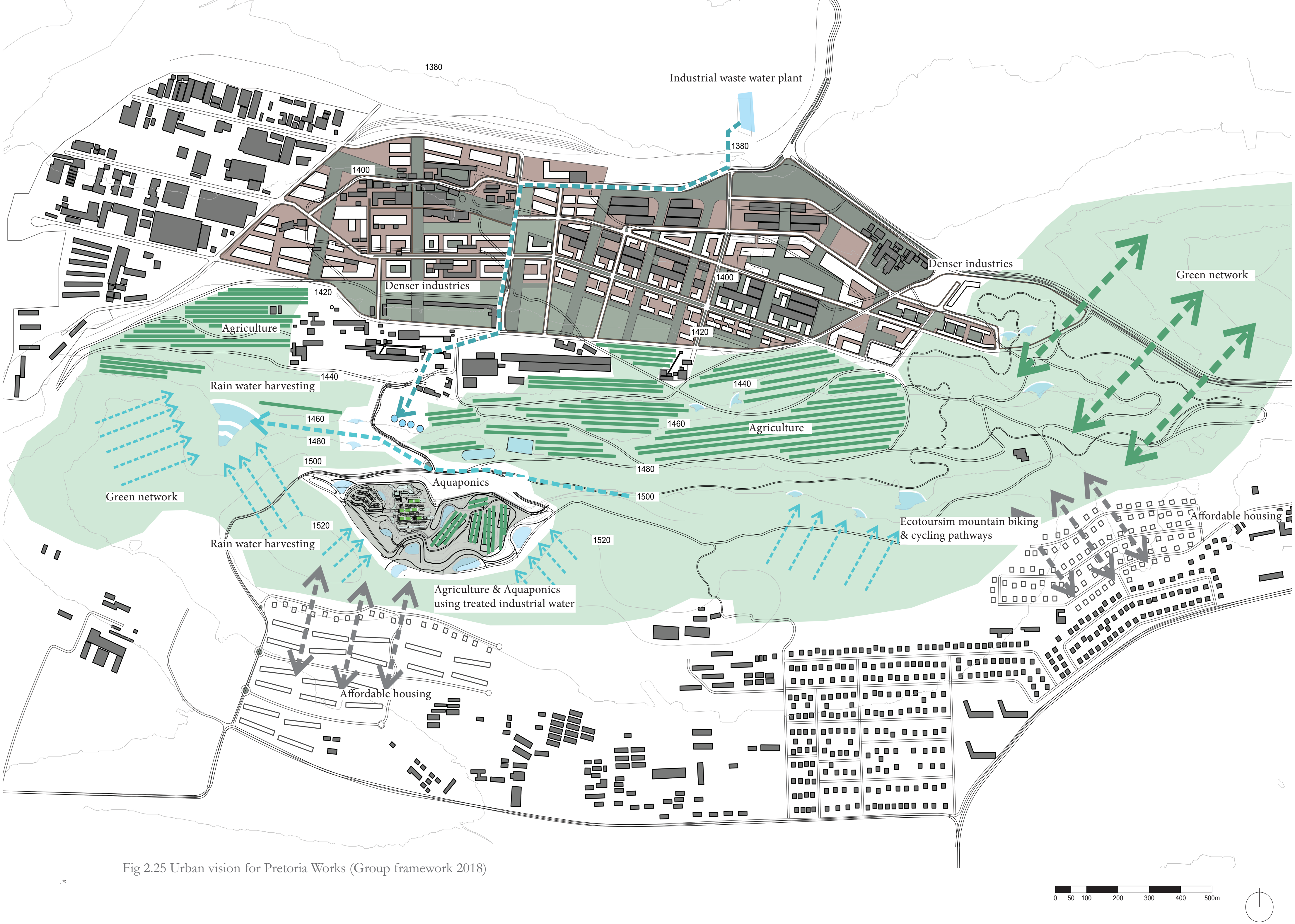


Fig 2.25 Urban vision for Pretoria Works (Group framework 2018)

Fig 3.1 Pretoria Works (Author 2018)