



UNLOCKING THE GAUTENG HIGHVELD LANDSCAPE

Exploring the experience of
regional identity along a freeway route

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In accordance with Regulation 4 (e) of the General Regulations (G57) for dissertations and theses, I Declare that this dissertation, which I hereby submit for the degree Masters of Landscape Architecture (Professional) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

I further state that no part of my dissertation has already been, or is currently being, submitted for any such degree, diploma or other qualification.

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

Susan De Kiewit

Samevatting

Die skrywer argumenteer hoe imperatief die plaaslike landskap is en die voordele om die ervaring en identiteit daarvan te behou. Die snelweg landskap, as die optimale grondgebied vir menslike ervaring van 'n streek, word deur die outeur geïdentifiseer.

Die dissertasie fokus op die R21-snelweg roete wat die OR Tambo Internasionale Lughawe met die stad van Tshwane verbind. Die roete word goed gebruik deur pendelaars en vervoernetwerke binne die streek van Gauteng. Die roete dien ook as die internasionale poort na Suid Afrika.

Die huidige toestand van die pad en omliggende omgewing is die gevolg van ontwerp nalatigheid. Min inisiatiewe is geneem met die oorweging van die roete as eerste indruk van die land.

Die ontwerp ingryping vier die unieke karakter van die algemene Gauteng Hoëveld landskap en die spesifieke eienskappe van die landskap wat langs die R21-snelweg gesien kan word.

Die outeur identifiseer 'n reeks problematiese en sinvolle kulturele, sosiale en ekologiese aspekte langs die snelweg, en het ten doel om hulle aan te spreek deur die aangryping van die gees van die Gauteng Hoëveld.

Die doelwit van die ontwerp is om die elemente van die landskap wat nie noodwendig gesien of waardeer word nie, te ontsluit. 'n Poging word ook aangewend om die huidige persepsies oor skoonheid en estetika aan te spreek.

Die finale gevolgtrekking van die ondersoek is om die tegniese oplossing van die voorstelling onder lede te neem.

Abstract

The author argues the imperative of the regional landscape and the benefits of preserving experience of regional identity. The author identifies the freeway landscape as the optimal territory for one's experience of a region.

The dissertation focuses on the R21 freeway route connecting O.R Tambo International Airport to the city of Pretoria. The route is well used commuter and transportation network within the region of Gauteng. The route also serves as the international gateway to South Africa.

The current condition of the roadside environment has been neglected by design. Few initiatives have been taken in considering the route as the first impression of the country.

The design intervention celebrates the unique character of the Gauteng Highveld landscape in general and specifically the qualities of the landscape seen along the R21 freeway.

The author identifies a series of problematic and opportune cultural, social and ecological aspects along the freeway and aims to address them through embracing the spirit of the Gauteng Highveld.

The design objective is to unlock elements of the landscape that are not necessarily seen or appreciated in attempt to challenge current perceptions about beauty and aesthetics.

Thanks to

My Husband and Family
Carmen van den Einde

Fourie Pieterse
Johan N Prinsloo

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Definition of terms

Aesthetics

The attractiveness of an object or place.

Character

The essential qualities of a place or space that makes it unique

Gateway

To be a prominent entrance to or exit from area or a specific part of an area, consisting of man-made or natural features and creating a strong sense of arrival or departure.

Gauteng Highveld

The geographic region of the highveld, situated within the province of Gauteng

Identity

Uniqueness of a place or region which helps to distinguish it from another place

Illuminate

To highlight, emphasize or bring to the fore front.

Imageability

The ease in which one can recognize the patterns and meanings of their environment, the more pleasure and utility they will extract from it.

Regional

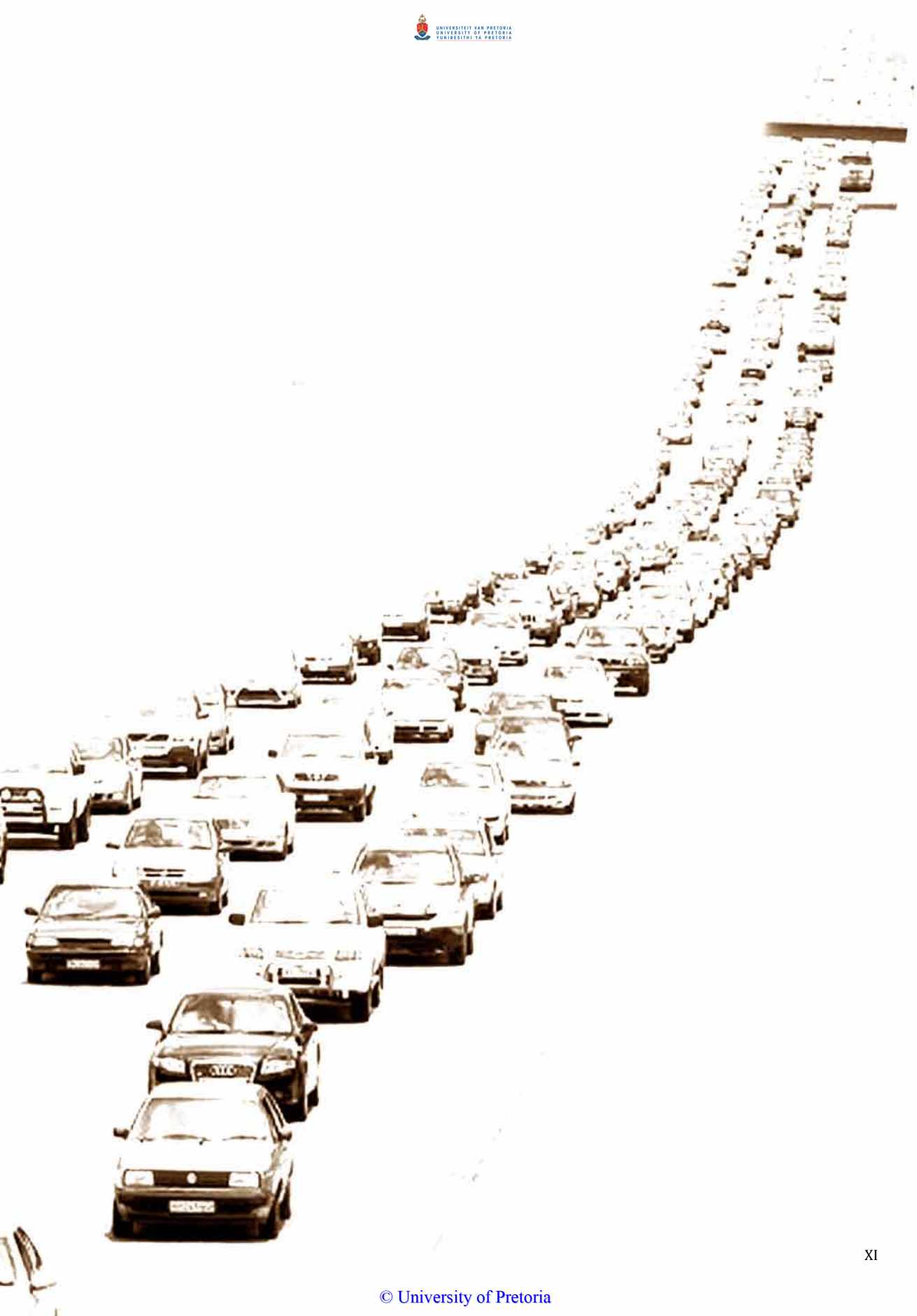
Defined as the geographical area of a place marked by visible or invisible boundaries

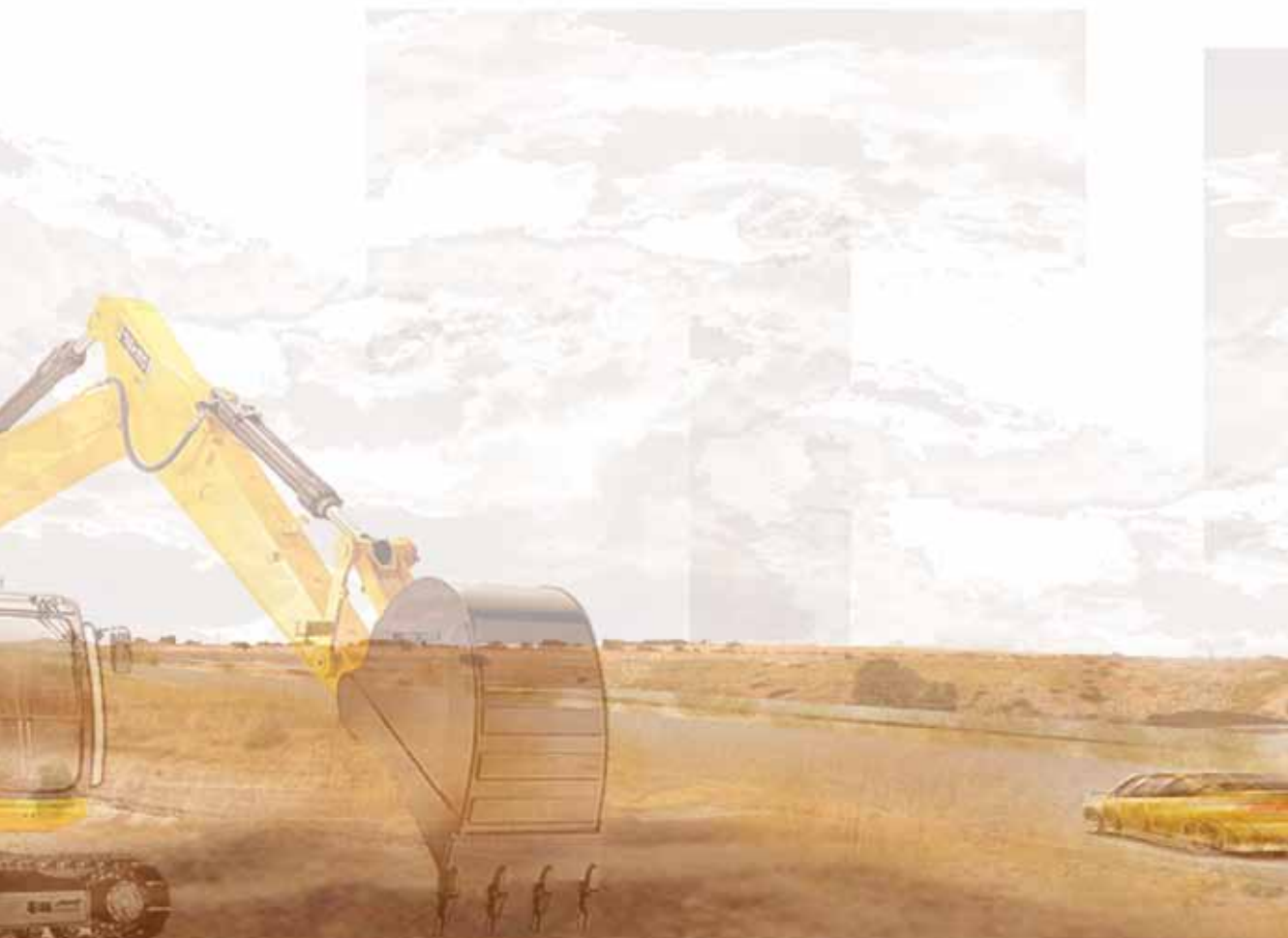
Unlocking

Making something apparent which is not necessarily seen or understood

The author by no means through the dissertation encourages or justifies the use of unsustainable transportation methods. It would be far better if our cities were designed so that everybody could walk to work. However, the author accepts the automobile as part of contemporary lifestyle and therefore seeks a means (through landscape design) of improving one's experience along the freeway, where so much time is spent.







Prologue

“While the highway right of way has become a dominant force in reinforcing placelessness, it is also potentially the most powerful agent for reinforcing regional character” (Hough, 1990:108).

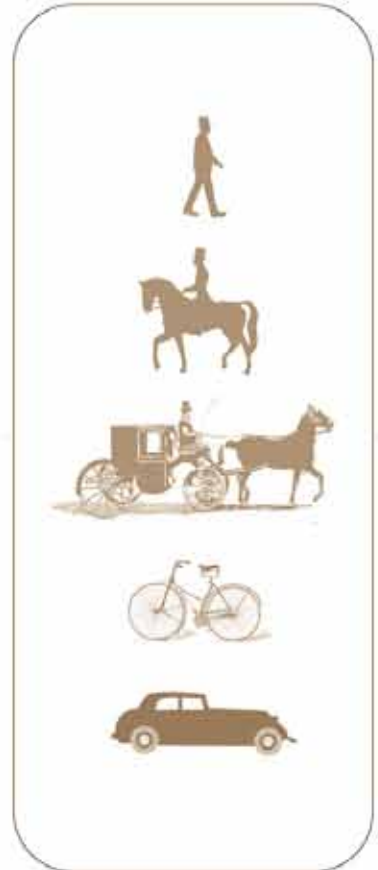
Chapter 1

Introduction

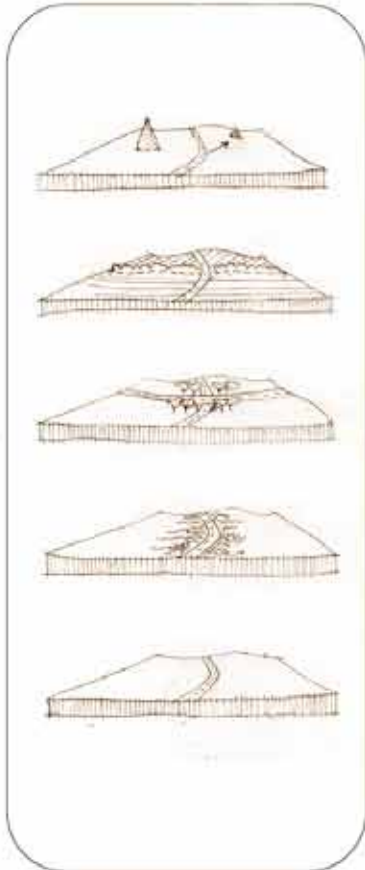




General issue:
Urbanisation has led to a
loss of the regional landscape
resulting in a loss of exposure
to the regional landscape



Landscape design opportunity:
Considering freeways as a
tool to enhance perception
of regional identity from the
automobile



Investigating a theory which improves our experience of regional identity along a freeway



Application of theory explored along a freeway route

Figure_1.1. Summary of the dissertation process (Author,2015)

1. Background

1.1 Placelessness and regional identity

Michael Hough, in his book *Out of Place* (Hough,1990) questions why all modern cities and landscapes seem to look the same. He searches for answers to why vernacular landscapes seem to attract people yet the profession pushes designers in the opposite direction. Why do roadside environments look alike when there are inherent differences between provincial districts. Frampton, in his hypothesis expressed his theory that if architecture responds to a particular place, with recognition of regional vernacular and its response to light and climate, the outcome will be that of an architecture of greater experiential meaning. (Frampton,1983). Our current environments are less concerned with the local but rather driven by trade, economy and profit (Hough,2004). One could argue that the contemporary city and landscape has become non-place. Philosopher Marc Auge in *The Anthropology to Super Modernity* (Auge,1995) explains if a place can be defined as relational, historical and concerned with identity, then a space which cannot be defined as relational, or historical, or concerned with identity will be a non-place. The freeway is no exception and has been blamed for the loss of identity in many of our cities. It is described as placeless. If asked to identify our whereabouts along most modern freeways, one would have a difficult time in determining in which region one was driving. Auge, together with others considers the freeway a non-place. But some thinkers have shared light that the freeway might be a very significant place in its own unique experience of how one perceives space.

“While the highway right of way has become a dominant force in reinforcing placelessness, it is also potentially the most powerful agent for reinforcing regional character” (Hough, 1990:108).

1.2 Landscape perception from the automobile

It has been brought to the attention of landscape architects that the discipline has largely overlooked designing the roadside environment for the automobile user. John Dixon Hunt in *The Afterlife of Gardens* explains that there are contemporary ways of travel that have transformed how we experience landscape, such as the motor car which has changed the speed at which we are required to respond to our surroundings. Hunt criticises the discipline’s lack of response to the modern way of perceiving landscape. “Modern landscape architecture has largely ignored the opportunities of designing for the modern world of fast transport” (Hunt,2004:174). Landscape architect, Christophe Girot explains that, “outside the home window, today’s reference frame for landscape is

almost always in motion, be it the windshield of a car, the window of a train or an airplane.” (Giro,2004:199). If the way in which we perceive our surroundings has changed, then the way in which we design our surroundings also needs to change.

Roads have been able to create equity of landscapes and made them visually accessible to a variety of road users, from the truck driver to the taxi driver. For many the drive to work in the automobile is the only experience of landscape one might encounter in a day. No matter the environment through which we pass, the travel right of way is how we see the wider landscape most of the time (Hough,1990:102). One could argue that if our limited exposure to landscape is most often on the route to work, then designers need to turn to these environments which have so often been poorly served by design.

1.3 Aesthetics and representation

Hough writes that our perceptions about what is beautiful has been greatly influenced by poets and painters. Perceptions about what is aesthetically pleasing have leaned towards the dramatic such as mountain and forest scenery. Much of this scenery has been made popular as it has been represented in paintings, on postcards and the coffee table picture books (Hough,1990:24). This study aims to challenge perceptions about beauty and practice which favours one landscape type over another. The author suggests that landscape architecture has an important role to play regarding preconceived ideas about aesthetics. The roadside environment presents the ideal opportunity for the representation of landscapes which have been disregarded, as in the case of this study, the Gauteng Highveld.

2.1 Route selection: R21 freeway

The route was identified by considering a number of freeways within the provincial landscape. The study area falls within the parameters of the Gauteng regional landscape, a well used commuter route and a potential tourism route.

2.1.1 Regional landscape

Routes that transverse the regional landscape offer potential to unlock local character and strengthen experience of a place.

2.1.2 Commuter Route

Commuting has proven to be a stressful task. The daily commute experience may be improved through design of the roadside environment.

2.1.3 Importance of Roads connecting Airports to Capital Cities

For visitors the first experience of a new destination is the drive from the airport to the city. First impressions have a lasting impact on one's memory of place. One of the ways in which an outsider experiences the landscape of a country is from the automobile. Scenic landscapes and cultural streetscapes establish major tourist attractions. Each province and town has its own unique visual appeal, which can contribute to enhancing any tourist experience (SAMOAC, 1998). Christopher Girot describes this first encounter of a place as *Landing* or touching ground within his theory of *Four Trace Concepts*. (Girot, 1999).

This draws attention to the importance of the study route as the threshold to South Africa. The R21 regional route is the optimal route choice as it fulfils the criteria set out for the study. The R21 (Albertina Sisulu Freeway) is a provincial route situated in eastern Gauteng connecting the O.R Tambo International Airport to South Africa's capital City, Pretoria. The north-south road was constructed in the early 1970's and is one of the major freeways connecting Johannesburg to Pretoria. The freeway is a dual carriageway consisting of four lanes in either direction for most of the road. The road currently belongs to South African National Roads Agency (SANRAL). The freeway occupies two regions within the Gauteng Highveld, Ekurhuleni Municipality and Tshwane Municipality. The significance of the route lies in its capacity as a tourism route connecting the airport to the capital city of South Africa.



O.R Tambo International Airport

Figure_1.2. Portion of R21 freeway connecting O.R Tambo International Airport to Pretoria (Author,2015)

3. Research Question

How can a landscape design intervention enhance experience of regional character along a freeway route in order to create a greater appreciation for the Gauteng Highveld landscape?

4. Hypothesis

Enhancing the roadside environment can create awareness of the major cultural and biophysical aspects along the R21 freeway and illuminate the perception of regional identity for an enriched experience from the automobile.

5. Sub Questions

What was, is and could be the role of landscape architecture along a freeway?

How can the experience in an automobile be enhanced through application of space motion principles?

How can the experience of regional character be enriched along a freeway through landscape design?

What are the major cultural and biophysical aspects along the R21 freeway which offer potential for a landscape design intervention?

6. Objectives

To enrich the experience from the automobile

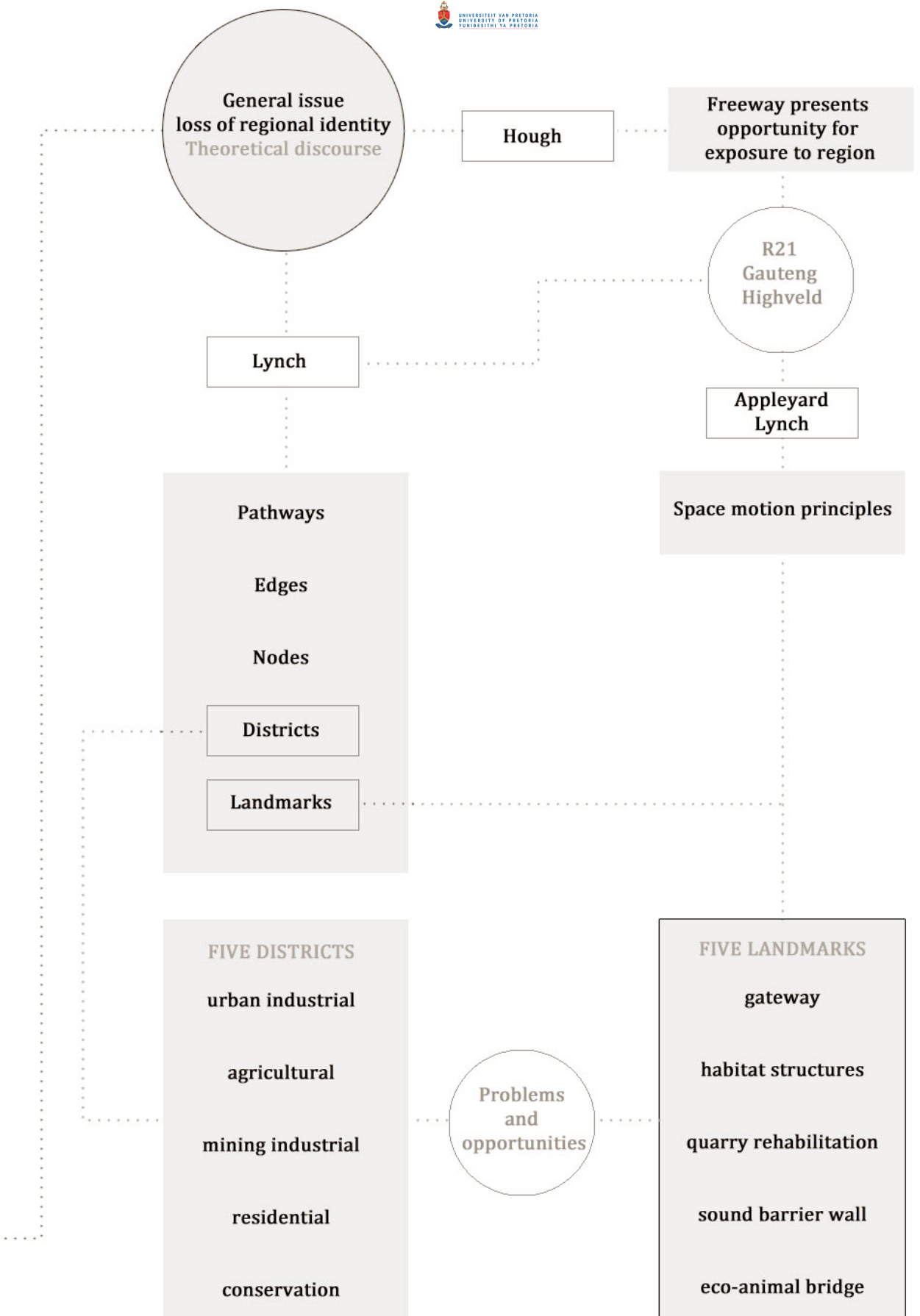
To improve the roadside environment

To strengthen experience of regional identity from the automobile

To change perceptions about what is considered beautiful and ultimately valuable

7.

Methodology



8. Limitations

The study limits the investigation to the roadside environment and does not propose to change or manipulate the road alignment. The design investigation falls in the parameters of the road reserve and adjacent land, including agricultural farmland, mining land and conservation areas. This study discusses the perceived experience of the driver and his passengers.

8. Delimitations

The study area is focused on the road reserve as well as the five selected areas along the road which includes the urban junction, the agricultural fields, the mining industrial area, the residential road reserve and the conservation area in terms of the design intention. Contextual influences and connections have been considered where applicable.

8. Assumptions

Assumptions are made that the general attitude toward the Gauteng Highveld landscape is not appreciated or considered beautiful, although a minority may appreciate its visual quality.

The study assumes various landowners would participate in the selected projects proposed along the R21 route.

9. Client User Profile

South African National Roads Agency Limited (SANRAL) is an independent, statutory company registered in terms of the Companies Act. The South African government is the owner of SANRAL. The client is committed to carry out its mandate by protecting and preserving the environment through context-sensitive solutions. SANRAL is also committed to rehabilitating and returning areas of operation, to their sustainable preoperational state, so that they may still be viable for the use of future generations. SANRAL envisage these goals to be in support of the sustainability aims of respecting and maintaining natural capital and building human capital. SANRAL encourages planting partnerships in its quest to re-populate the road reserve to a similar state it was in before the construction of the road. (SANRAL,2012)

SANRAL, together with the tourism departments of Ekurhuleni Metropolitan Municipality and Tshwane Metropolitan Municipality would sponsor the scheme as an initiative in promoting tourism in the province as well as attempting to improve the lives of commuters.

Interested and effected parties include landowners of property adjacent to the R21 who could get involved and benefit from roadside improvements. These parties include, corporate entities, agricultural landowners and mining land owners.

Site	Client	Client benefit
Site A: Gateway	Airports Company South Africa	international excellence
Site B: Habitat structures	Agricultural land owner	biological control
Site C: Quarry rehabilitation	Sterkfontein Bricks	community stewardship
Site D: Sound barrier wall	Tshwane Municipality	resident satisfaction
Site E: Eco-animal bridge	Tshwane Parks and Recreation	biological diversity

User groups include drivers of taxis, trucks, motorcycles, busses, cars as well as South African and international road users.

Chapter 2

Theoretical Discourse





Part 1

The past, current and future role of landscape architects in roadway design



Figure 2.1. A juxtaposition between a getaway road and our urban freeways

1.1 Pleasure driving and scenic roads

1.1.1 The American Parkway

There is evidence of historical concern for roadside aesthetics (Parsons et al, 1998) which can be fairly well documented among professional designers. This may be surprising if one looks at the current the condition of most urban freeway roadsides, where landscape design has played a comparatively insignificant role. In the past landscape architects played a key part in the design of roads. Roads were more than just a means of transporting people from point a to point b. They were a means of showcasing the landscape. In the United States these roads that were designed to exhibit the landscape were called Parkways. Renowned landscape architect, Frederick Law Olmstead when designing Prospect Park in Brooklyn, New York in 1868, coined the term. The design was based on a means of moving from one park to another or a way through the park. It was through these roads that many tourists learned to appreciate nature and the regional landscape. Seeing and recognizing particular landscapes through the windshield became an important part of the tourism industry in America. (Parsons et al,1998)

The Bronx River Parkway is a great example of how the design of parkways approached utilitarian infrastructural design as a means to strengthen perceptions of regional character. The main intention of the Bronx River Parkway was to transform a polluted river valley into a linear park. The landscape architect, Hermann Merkel, had the intention to include recreational facilities along the route and frame attractive scenery. The objectives were to preserve the unique character of the road, create a balance between utility and amenity, express sensitivity to the natural environment and optimise visual connections. One of the ways visual connectivity was enhanced was the removal of roadside elements which obstructed important views. Initiatives were taken to remove invasive planting along the river edge and promote the growth of local species.

Although the R21 regional route may not offer all the opportunities as the Bronx River Parkway did, there are principles that one might learn from the design of the parkway.

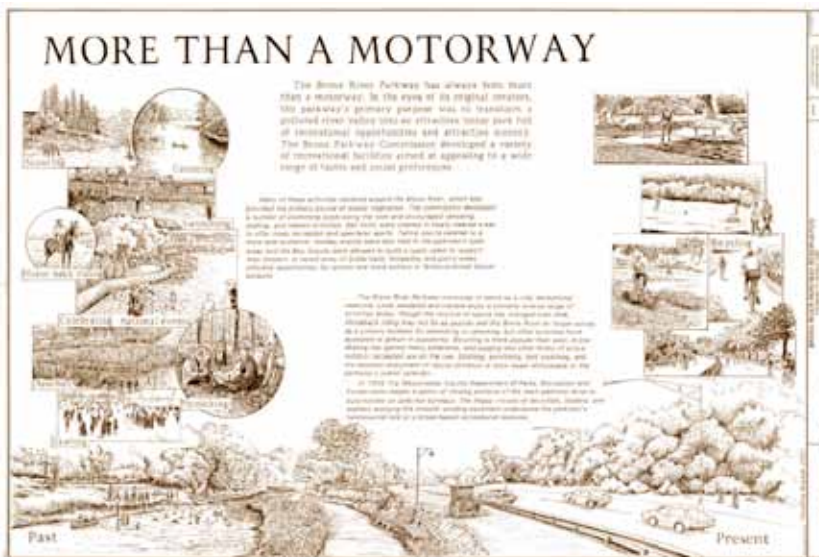
1.1.2 America's scenic byways program

The National Scenic Byways Program is part of the U.S. Department of Transportation, Federal Highway Administration. The program is a collaborative effort established to help recognize, preserve and enhance selected roads throughout the United States. These road are recognised as possessing archeological, cultural, historic, natural, recreational and

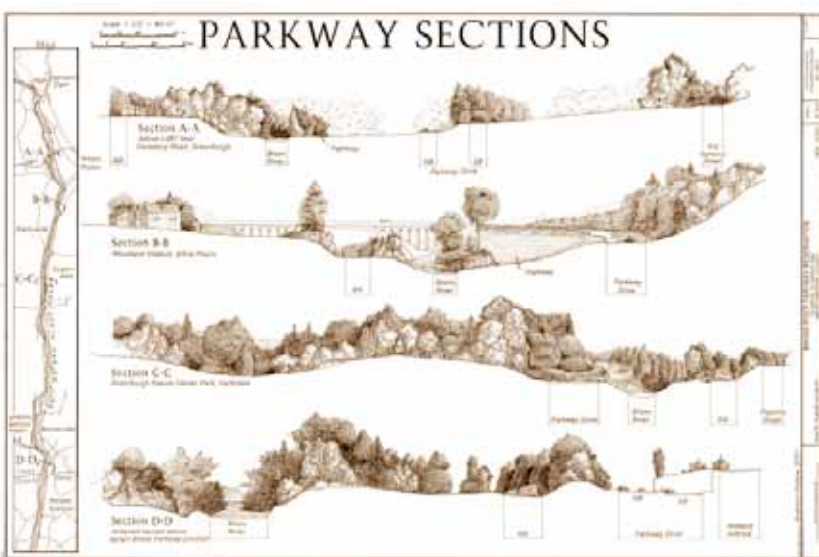
scenic qualities.

In South Africa there are a variety of tourism and travel routes within the different provinces. These include the Garden route in the Western Cape, the Friendly Route in the Eastern Cape, The Midland Meander in KwaZulu Natal and the Panorama route in Mpumalanga, just to mention a few.

Much of the discipline's attention has been focused on these scenic routes. The irony is that most citizens spend most of their time on urban freeways as opposed to these leisure roadways. None or little effort has been made to improving the quality of urban freeways.



Figure_2.2. The Bronx River Parkway initiative(Wikimedia,2014)



Figure_2.3. The Bronx River Parkway sections (Wikimedia,2014)

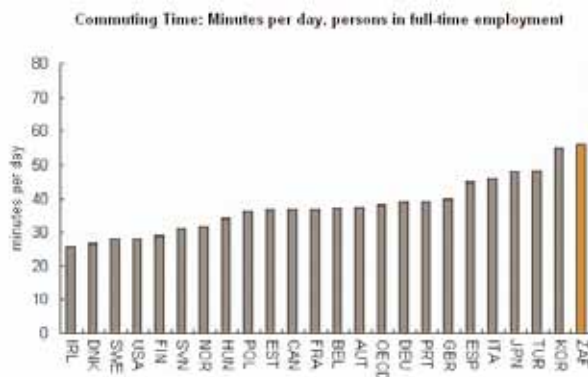
1.2 Urban freeways and the daily commute

In recent years there has been a shift from pleasure driving to task orientated driving. Commuting has been proved to have negative effects on lifestyle. Aside from the driving task, research has discovered that commuting is a stressful activity. It has negative effects concerned with health and quality of life for those who drive to work, it has reduced the time people spend with family, on physical exercise, leisure activities and sleep. (Novaco et al, 1979)

Human behaviour can be influenced by scenic quality of environments through which they drive. Research studies have been conducted to see how exposure to roadside environments has an effect on stress levels. Results concluded that natural-setting road side environments have an effect on reduced stress levels as opposed to artefact related road side environments, which revealed higher blood stress levels. The study explained that natural environments discussed weren't completely natural but consisted of wilderness like settings including water, trees, and planting in comparison with artefact related settings which include billboards, warehouses and industrial development (Parsons et al, 1998:116). This literature presents the need for designers to engage with the roadside environments together with sustainable development practices along the freeway in order to limit the exposure to the artefact related environments and preserve and instil road side development that allows for exposure to natural like settings suggested in the study (Parsons et al, 1979).

The problem with most of our commuter routes is that the roadsides are extremely overpopulated with development and are artefact dominant which have proven to have negative impacts on road users.

According to an article published in the New York times in 2014, (Rampell, 2014) South Africans have the highest commuting average of 56 minutes per day. Of which 64,9% of travel to work by taxi, bus or car, making use of



Figure_2.4. Global commuting times (Rampell, 2014)

the country's roads. (National Household Survey, 2013)

1.2.1. Gauteng Commuter Routes: a lack of regionalism

Termed in the Landscape Urbanism Reader (Waldheim,2006:227)

Collisive sites are places where transaction happens. These locations include airports, train stations, harbours and freeway intersections. These sites are catalysts for exchange and activity. Mobility routes serve as catalysts for development. It is no wonder that typical intersections of the highway between Pretoria and Johannesburg are completely developed by retail and commercial industries as the freeway off ramps offer optimal opportunity for access. These freeway off ramps are the ideal places for shopping malls and business districts. The problem with modern planning is that this kind of development leads to a loss of exposure to the regional landscape.

The portion of the M1 highway between Pretoria and Johannesburg is the country's most used commuter route, with 300 000 vehicles travelling on the route each week day. According to TomTom South Africans are spending an average of 3.5 days a year stuck in traffic.(News24, 2013)

Another point is that contemporary lifestyles and have left little room for exposure to the outdoors. But the freeway experience presents an opportunity for visual exposure of ones environment. The way in which these outdoor environments are addressed becomes vital in impacting the daily lives of commuters on the road. (Kaplan,1995,174)

The drive to work is thus an ideal opportunity for one to have visual exposure to nature and is the responsibility of the design professionals to address this reality. Donald Apple yard has proposed that the urban freeway becomes an educational tool where landmarks, history, cultural and ecological processes can be of visual interest (Appleyard,1964). A vital component of this prospect can be achieved through strengthening variation, change and threshold from one environment to another. Crucial points of identity along the freeway can help with orientation.

Other research has shown that during freeway driving, drowsiness and hypo-vigilance commonly transpire, which have severe consequences in resulting road accidents. Investigations were conducted to assess the roadside visual stimulation and how it relates to drivers alertness. Results revealed that repetitive and monotonous roadside visual elements concluded in greater fatigue in comparison with roadside environments with strong visual elements that disrupt monotony. Fatigue is one of the causes of many road accidents. If monotony is to be avoided during driving, then there is opportunity to for design to create visual interest of roadside environments.

The challenge for the design disciplines is acknowledging the need for development along freeway corridors while learning how to manage the balance between legitimate development and conserving vital open space along freeway corridors. Landscape design can play a critical role in recognising the road reserves as potential connector spaces which could become the parks of the future. This can be achieved if we consider the road reserve as a linear ecological habitat. Another responsibility of the discipline is to ensure that road environments are protected against monotonous industrial and commercial development. This seems to be the trend in our cities, which has impacts on our mental health and our relationship to our regional whereabouts.

There are regulatory bodies in place which serve as guideline for development along freeways. The South African Manual for Outdoor Advertising control (SAMOAC) is a guideline document for assessing advertising control measures in South Africa. The manual outlines three landscape types namely, natural, rural and urban. There is a greater sensitive approach to signage which can be erected within the natural areas as opposed to the urban areas. This manual gives an indication of the approach to land use planning. Landscape type is used to give an indication of basic landscape sensitivity and forms a broad framework for spatial classification. (SAMOAC,1999)

Other guidelines for development not only related to the freeway include Environmental Impact Assessments and Visual Impact Assessments which measure the potential affect of a development on a certain piece of land in terms of ecology, culture, land quality and scenic quality. The guides all adhere to a similar approaches to development, with a greater sensitivity toward natural environments.

Along the R21 freeway there is evidence of illegal billboards in sensitive areas and rapid encroachment of development in highly valuable agricultural land. The concern is that regulations are not being enforced regarding development within the Gauteng Highveld, with specific reference to the R21 freeway environment. The author questions this unsustainable practice as a possible result of lack of appreciation for the regional landscape. The author suggest that only once a regional landscape is appreciated, then will the developmental laws and guides to protect the land may be effective.

1.3 Beauty and the barren: perceptions and the disappearing Gauteng Highveld

Why is it that some provincial landscapes have been appreciated over others? As suggested in the introductory chapter some landscapes

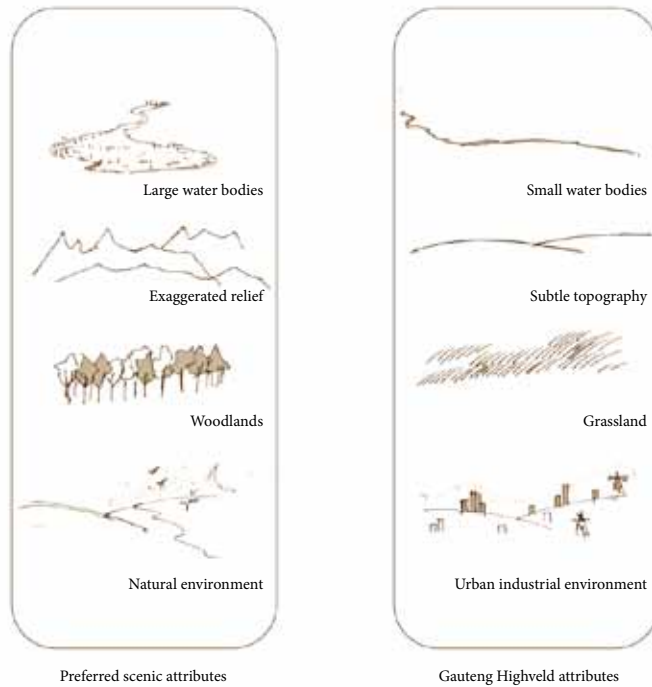
are overlooked because of their lack of drama and thus are not valued or considered aesthetically pleasing. Other reasons for lack of appreciation may be because of lack of representation and lack of awareness. "Without knowledge of one's place, without the faithfulness to one's place, it is inevitable that the place will be used carelessly and eventually destroyed" (Kellert et al, 2008). "Gauteng is the most densely populated province in South Africa. Its remaining natural areas are constantly under threat from urban development and the associated impacts" (Bredenkamp, Brown, 2006). This unsustainable development BrendenKamp talks of could be because of insufficient recognition of the Gauteng Highveld as valuable.

A series of review papers (Kaplan, 2008) found four physical characteristics to be strongly related to visual preference. Surface water, topography, woodlands and land use. A strong visual preference is found towards higher presence of surface water bodies, such as dams, rivers and wetlands. The more relief the more favourable the environment, such a mountain scenery. Woodland areas are desired as opposed to scenery that is absent of trees and natural environments or seemingly natural are preferred over those that are artefact related.

This helps one understand why the Gauteng Highveld landscape may be under appreciated. The Gauteng Highveld's physical character is contrary to preferred scenic environments, as it is characterised by small streams, low profile topography constituting of subtle hills and valleys. Grasses dominate the vegetation structure with little presence of trees. And land use is governed by urban or industrial development.

Other characteristics of the region include wide open maize fields, which are a representation of the unseen fertile soils. Large expanse of shifting sky dominates the flat grass plains. The deep red earth is powerful in its own right. The seasonal blackened fields promote growth displaying an intriguing contrast between the burnt veld and new germination. And the intense thundershowers, which light up the summer skies are all attributes of regional landscape which contribute to the authors appreciation of the Gauteng Highveld. Even the endless of construction suggests something of the growing economy and the endless ribbons of asphalt are what make a the land a landscape for landscape includes cultural phenomenon too."Landscape is an area as perceived by people, whose character is the result of action and interaction of natural and/or human factors." (Council of Europe, 2000).

Similar challenges are found in America. Hough (Hough, 1990:25) writes about the prairie landscape which can be perceived as having little or



Figure_2.5. Comparison between preferred visual scenery and the Gauteng Highveld scenery (Author,2015)

no value. But he illustrates how the prairies' diverse weather offers magnificent momentary images of the landscape and how the sky is a feature of the landscape in itself. Neil Evernden in *Beauty and Nothingness: Prairie as failed Resource*, (Evernden1983:3) accounts for this lack of appreciation for the prairies as a result of the absence of things within the landscape. How can an environment be beautiful when there is nothing there to possess aesthetic interest?

But in relatively recent years the highveld has been captured within the discipline of landscape design, but only some aspects of the Highveld have been romanticized such as the grassy plains(Forum Homini). But what about the other aspects that make up the regional landscape?

A minority of photographers and painters who have appreciated the authentic beauty of the region.(Figure_2.7 and Figure _2.8)

However, our representations methods may need to extend further than the art gallery and the picture book. The author again suggests that if our reference for landscape is most often in the automobile, does the freeway not present the ideal opportunity for representation? This may be the means to reach a wider scope of individuals and ultimately challenge how the general public feels about the Gauteng Highveld.

The representation of the landscape experienced through the automobile may change perceptions about what one considers valuable which could

influence the way we think about the landscape.



Figure_2.6. Pierneef, *Approaching storm Highveld* (mutualart,2014)



Figure_2.7. William Kentridge *Highveld Landscape* (mutualart,2014)

An illustration by the author called *Beauty and the Barren* symbolises our preconceived ideas about beauty and aims to challenge our perceptions of aesthetics.





Part 2

A suitable approach to enhancing
perception of regional identity

Figure_2.8. Figure depicting our
preconceived ideas on aesthetics
(Author,2015)

2.1 Imageability: recognising the environment

In his literature, *Image of the City*, Kevin Lynch categorizes how a city can be divided into certain components. These components consist of pathways, edges, districts, nodes and landmarks. The theory explains that by organising, enhancing and defining these components one can strengthen the perceived character of a place, or what Lynch calls Imageability. The ease in which one can recognize the patterns and meanings of their environment, the more pleasure and utility they will extract from it (Lynch,1960). In his later literature, *The View from the Road*, Lynch refers to his earlier theory of Imageability and how it can be used in road design to enhance ones experience on the freeway.

Pathways (in this case the Freeway) are the mobility routes along which users are intended to move. These routes are often principle ordering devices with powerful directional qualities and it is along them that the other environmental elements are arranged, related and experienced. (Lynch,1960)

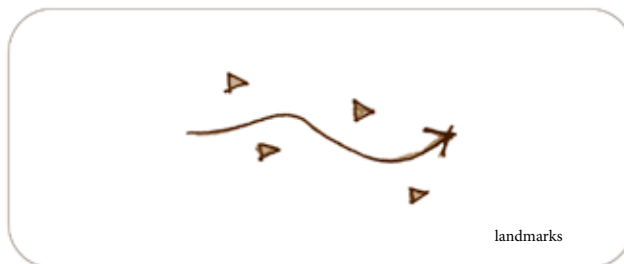
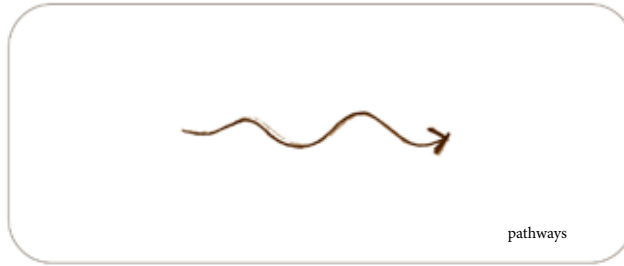
Edges are the linear routes not considered to be paths. They are boundaries that may be geographical, topographical or man-made. The edges contribute to the perceived depth of the corridor and hold the capacity to connect or fragment a route.

Nodes are the focus areas of activity. They are spaces that users may enter into and may be primary junctions, off ramps or intersections.

Districts are the parts that divide the magnitude of a region so that it may be legible. They are organised by similar character and become important reference points for the users of the road. Users may see themselves within a district or moving towards a district.

Landmarks are reference points within the landscape. They are distinguished by a component which is chosen to stand out within a given environment. Often considered important for recollection, they are ordering, identifying and structuring elements.

The approach to the study aims to enhance these components of Imageability. By using the ordering elements of Lynch's theory the author hopes to strengthen perceived character and meaning on the route. Theories involved with place (such as Lynch's) stress the importance of spatial experience and perception which is often lacking in modern planning of freeways.



Figure_2.9. Lynch's principles on how to read the landscape (Author,2015)

2.2 Space-motion: tools for comfort

Donald Appleyard in, *The View From the Road* (Apple yard, 1964) compiled a series of observations and tools in order to improve ones experience on the freeway.

Some environments can be exceptionally pleasant at certain speeds and most uneasy at others. Monumental scale as opposed to the desired human scale and loss of detail in contrary to attention to detail are all considerations for designing for the automobile user. The dissertation outlines a few space motion principles developed by Appleyard.

Turning motion comfort

The turning motion can be a comfortable experience when assisted by objects which appear to be pushing the road in a certain direction. Contrary, objects placed on the inside of a bend form a pivot around which the road appears to turns.

Animation of objects in the landscape

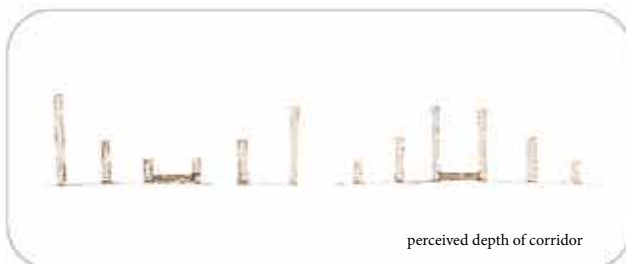
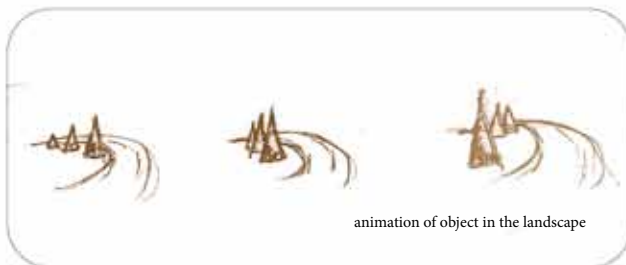
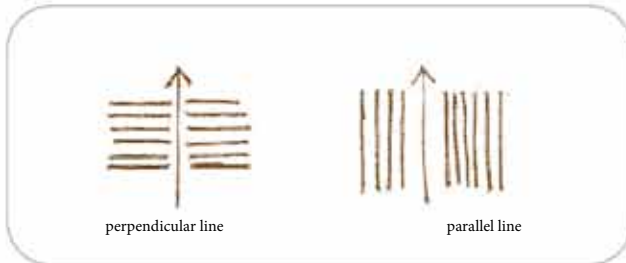
Speed and displacement creates the illusion that objects are moving in the landscape and the driver is stationary.

Rhythm

Rhythmic lines can create an illusion of increased or decreased speed, lines which lie perpendicular to the road create a perception of decrease speed as they break the direction of movement, while lines which run parallel to the road create a feeling of increases speed.

Perceived depth of corridor

Vertical objects close to the road makes one appear to be moving much faster than reality. 60km/h on a narrow tree lined road may feel the same as 120km/h on a wider open road.



Figure_2.10. Space motion principles
(Author,2015)

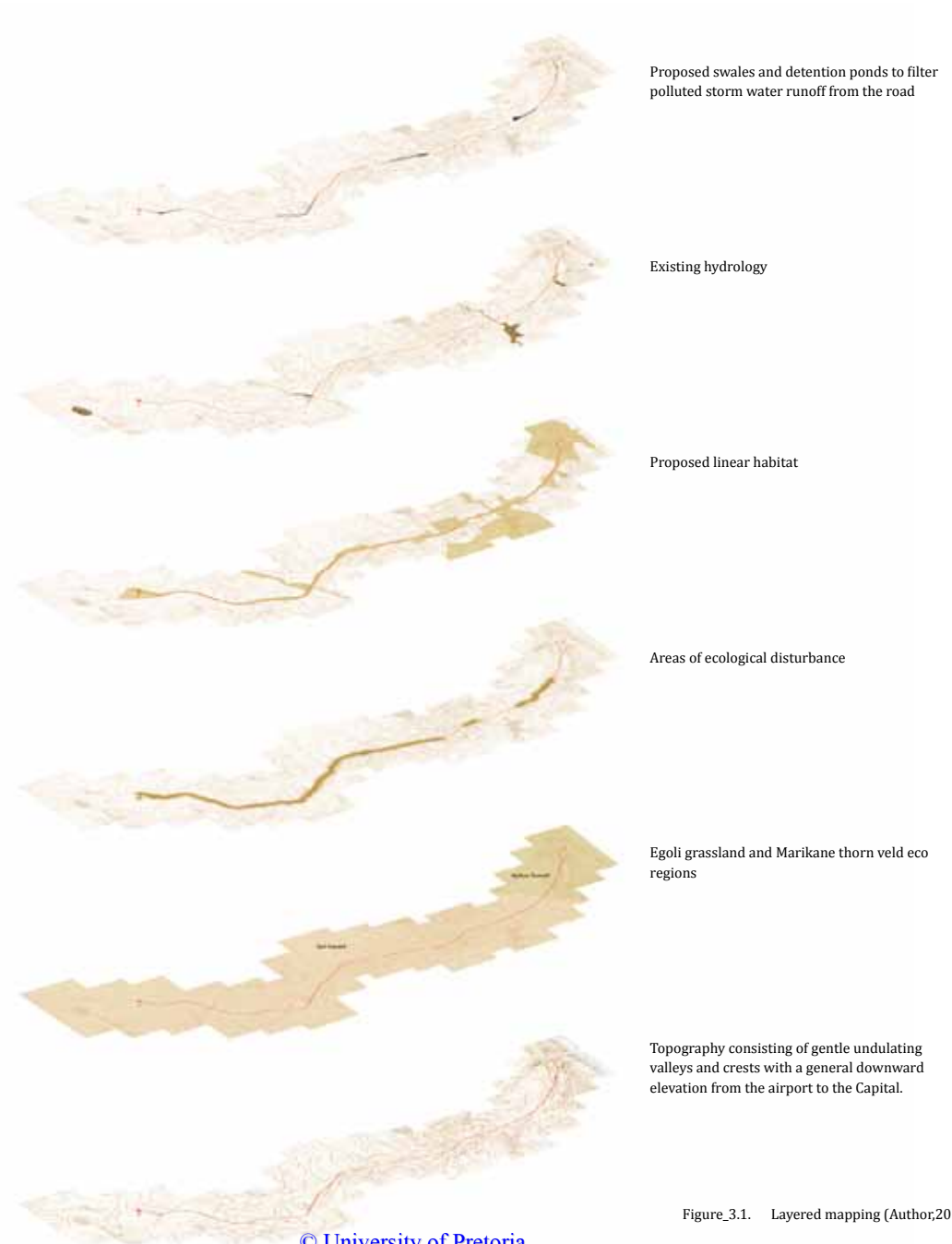
Chapter 3 Framework

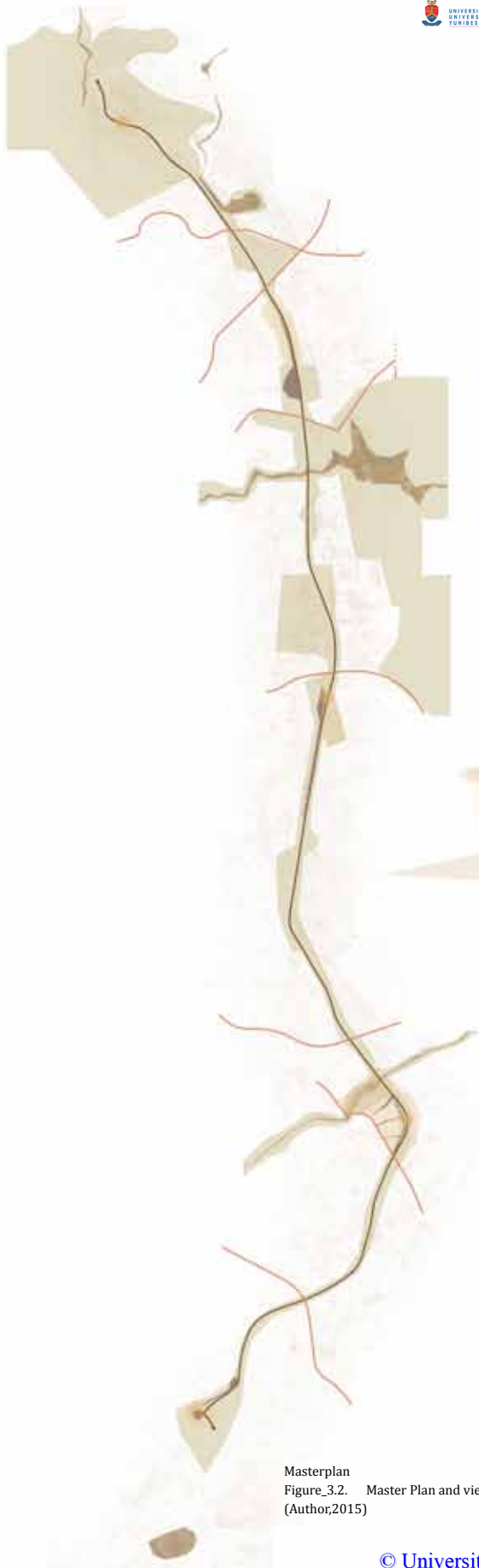


1. The freeway as a linear regional habitat

The intention of the framework is to facilitate a process towards utilising the road reserve for ecological benefit. Wide medians and road verges offer potential for habitat creation and may even serve in the future as productive agricultural land.

The framework will further be examined in terms of Lynch’s principles and how by looking at the route through the lens of regional character, elements of the landscape can be illuminated.





conservation area



residential area



mining industrial area



agricultural area

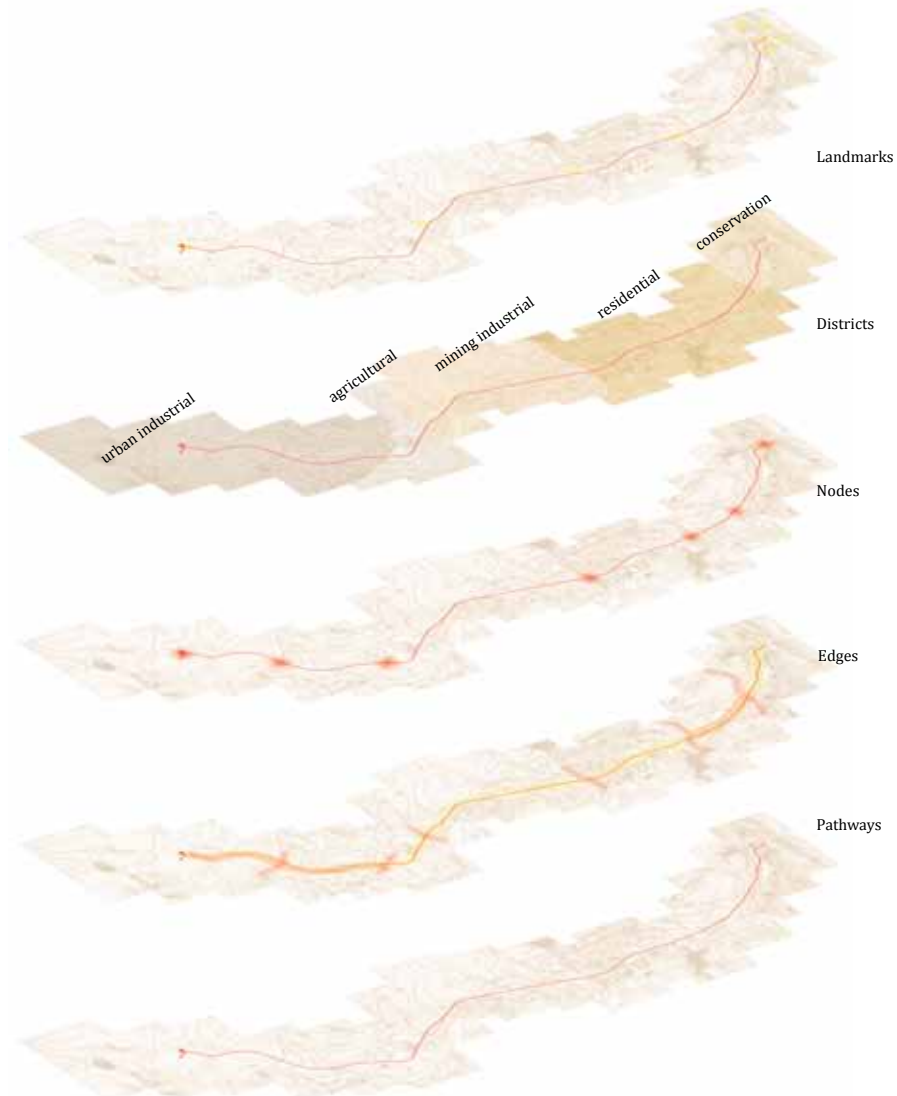


urban industrial area

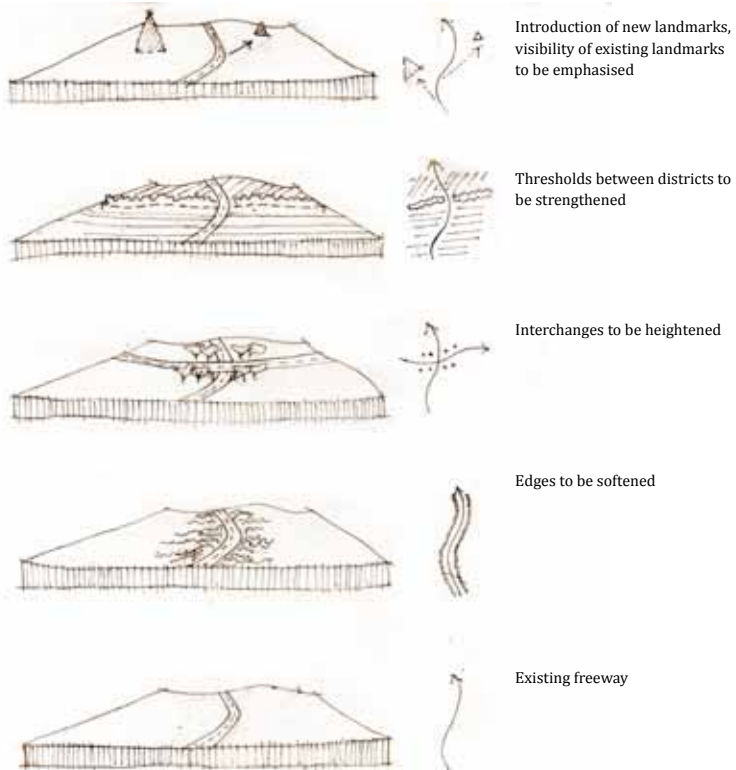
Masterplan
Figure_3.2. Master Plan and views from the road
(Author,2015)

1.1 Freeway

The movement route in this dissertation is the freeway. It is a fixed linear route along which the driver moves. Subtle variation in topography creates a fast dynamic movement route. The general speed limit is 120km/hour with slower speed restrictions at the start and end of the route. The main focus of the design interventions will be from a south-north direction, from the airport to the capital.



Figure_3.3. Application of Lynch's principles to the R21 (Author,2015)

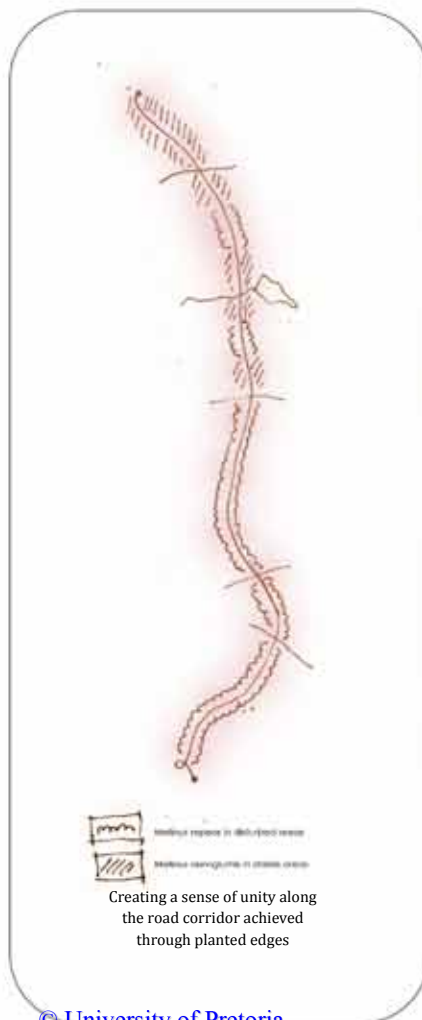
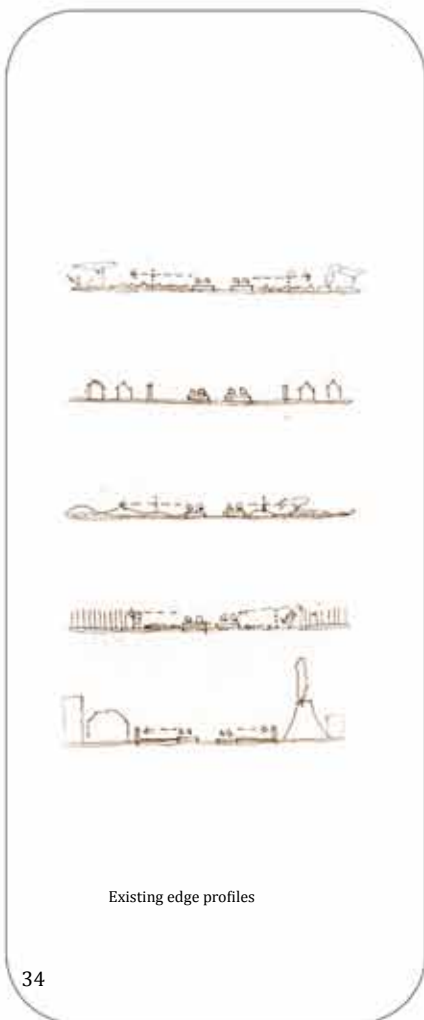


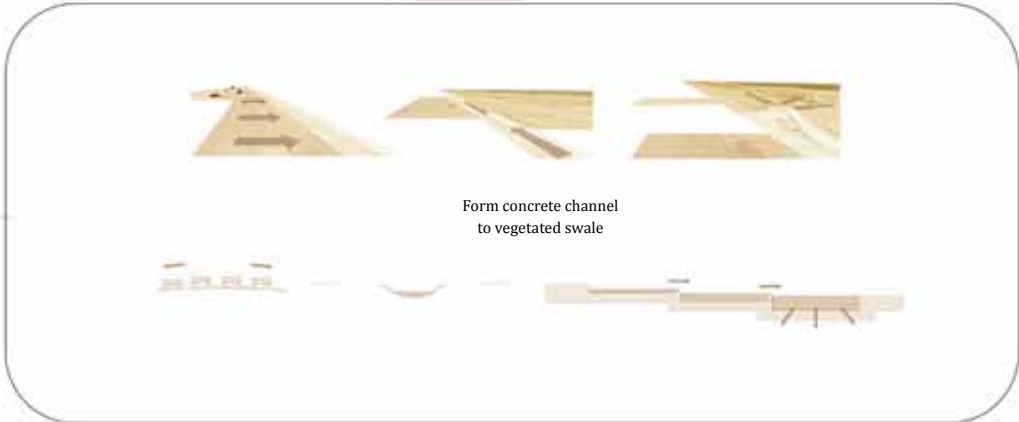
Figure_3.4. Conceptual image of Lynch's principles (Author,2015)

1.2 Edges

By challenging the notion of roads as physical barriers and recognising them as potential connectors these overlooked spaces can become the parks of the future. By linking the corridor through planting design and swales the freeway becomes a linear habitat. Regional plant species are selected to inform the driver of his whereabouts. The *Melinus repens* is selected for disturbed areas and the *Melinus nerviglumis* for stable areas. Masses of these species together with less ornamental grass species planted within the road reserve will form a pink crystal corridor in flowering season, creating a unique and iconic experience.

Current v-shaped concrete channels convey storm water onto adjacent property. The framework proposes a series of vegetated swales to slow down the rate of runoff, which lead to a series of dams where heavy metal from the road are cleaned before recharging ground water. This will enable the driver to view the native fauna and flora species these swales will house.





Form concrete channel to vegetated swale

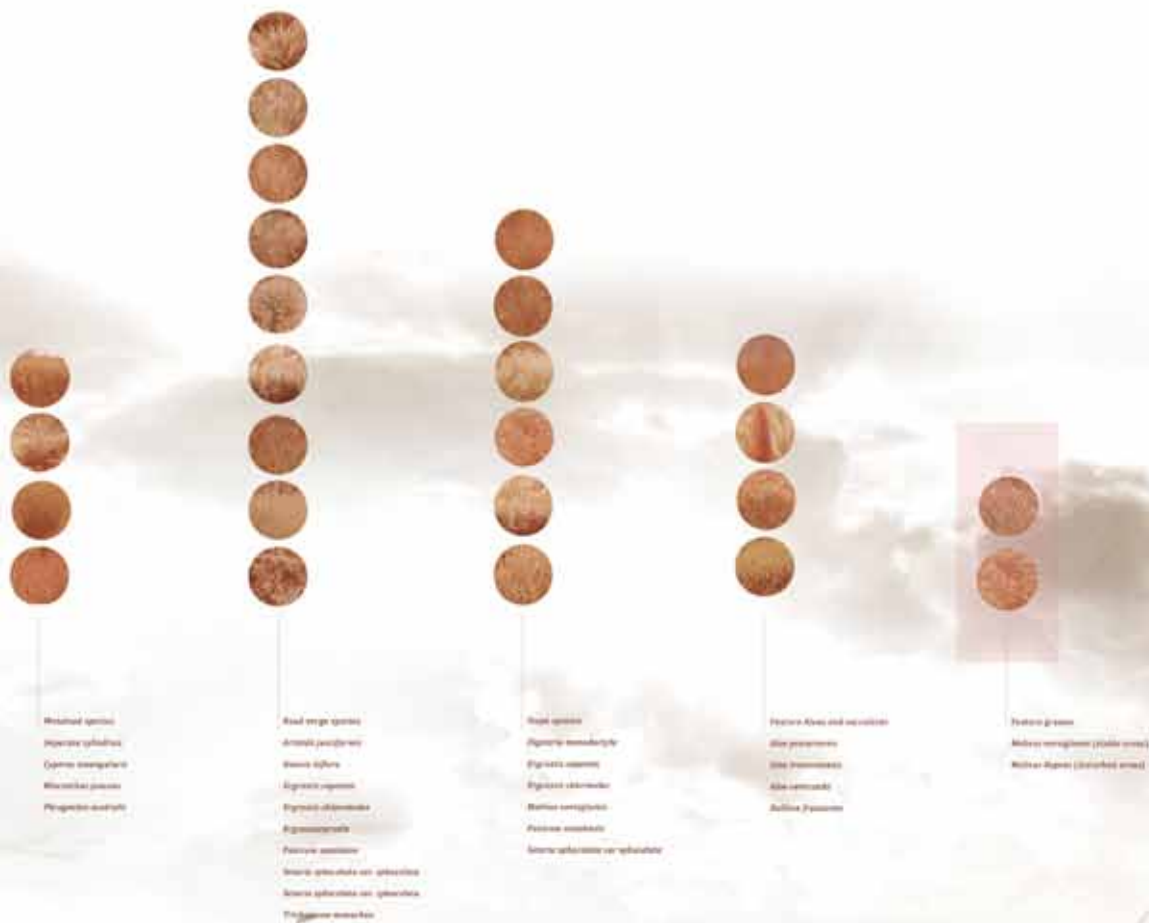
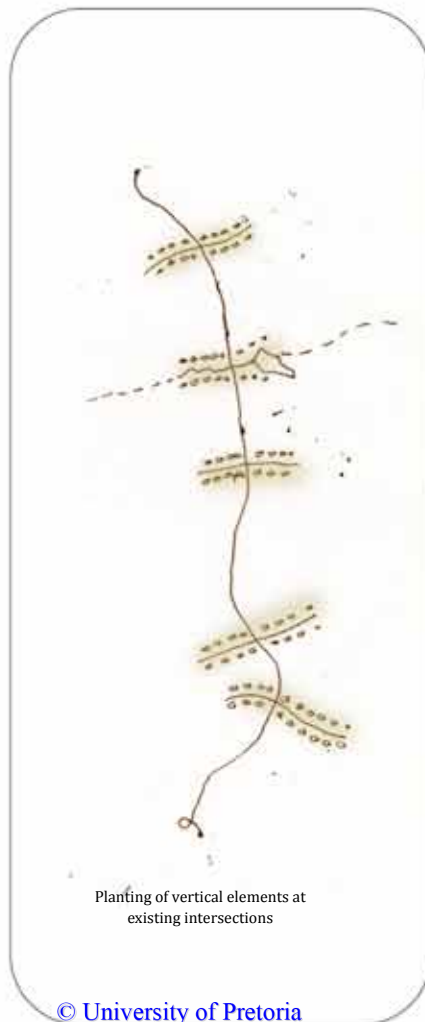
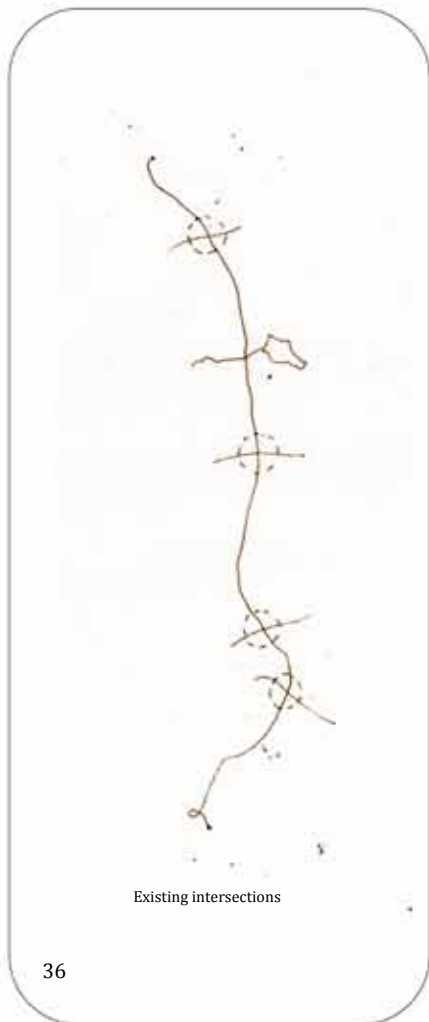
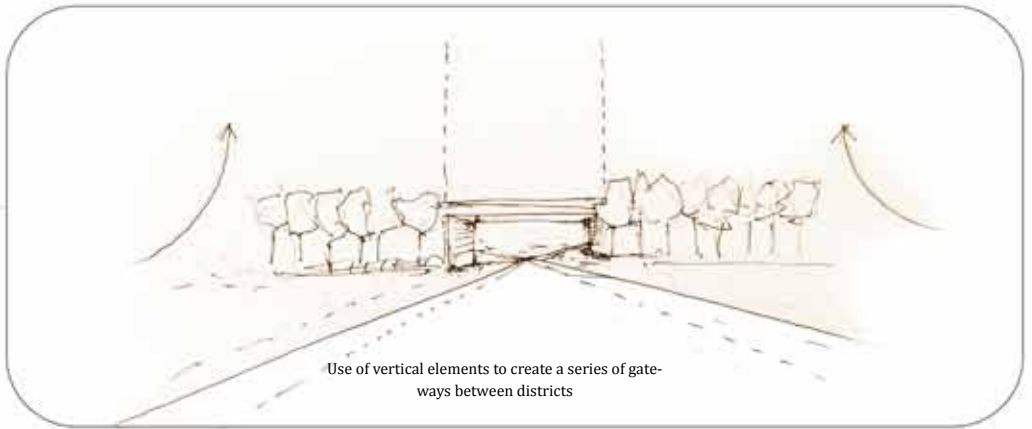


Figure 3.5. Investigation into Edges (Author, 2015)

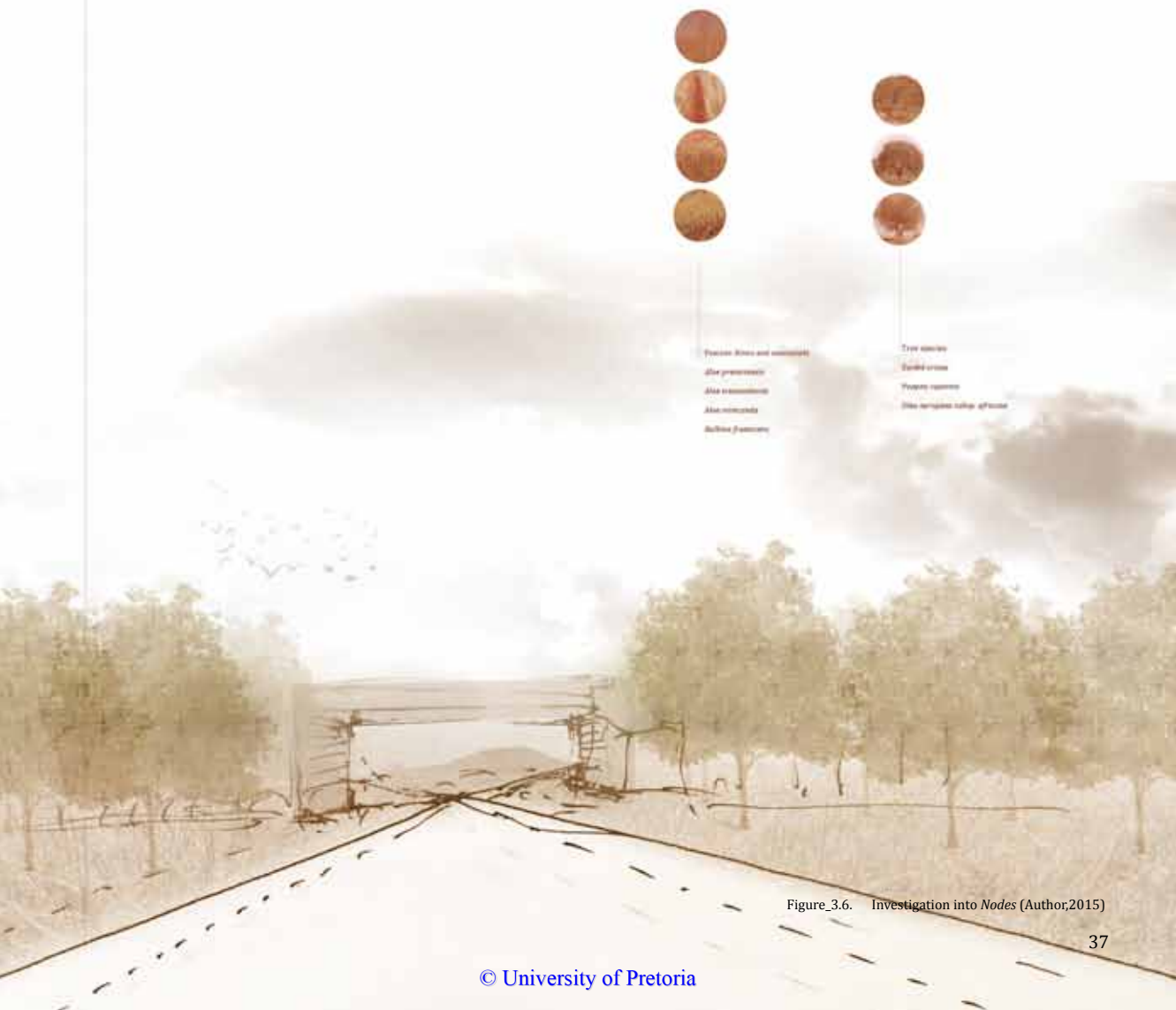
1.3 Nodes

Along the route there are a number of intersections which form the nodes of the route. These existing nodes create important thresholds from one district to another. Emphasis on thresholds between districts is achieved through vertical planting structure which creates a spatial gateway between different land use types. This spatial strategy helps to coordinate the boundaries of land use zoning and may aid in determining where development may and may not occur. The same planting types will be used to remind the driver of the route one is on. Again, a use of regional species are selected to achieve the desired effect.





Use of vertical elements to create a series of gateways between districts



Figure_3.6. Investigation into Nodes (Author,2015)

1.4 Districts

Five distinct districts were identified along the route. Each district environment presented a series of either social, ecological or cultural problems and opportunities which can be addressed by the discipline of landscape architecture. The five regions discussed are presented in a south-north direction, starting from the airport to Pretoria. The environments are urban industrial, agricultural, mining industrial, residential and conservation. The author investigates these subregions of the Highveld by searching for key features on a site specific level and using these feature to enhance ones perceived experience of the region. Each district forms part of the region's cultural and biophysical authenticity and thus these regions should be celebrated as part of what makes up the Highveld landscape.



Conservation



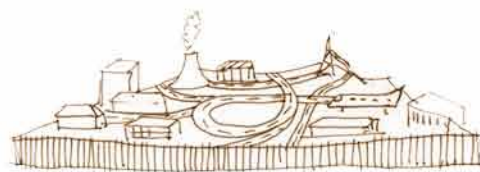
Residential



Mining industrial








Agricultural



Urban industrial

Figure 3.7. Investigation into Districts (Author,2015)

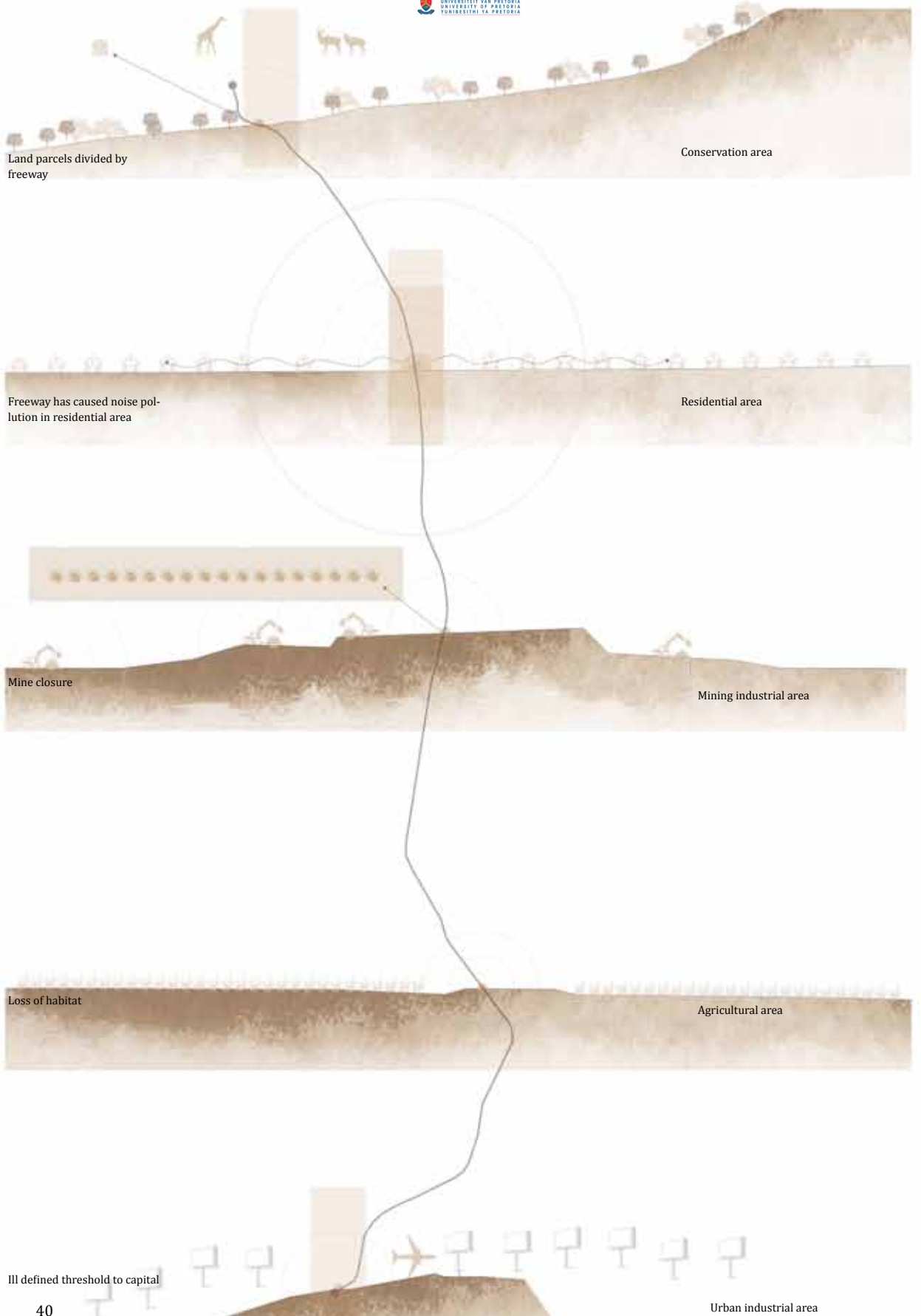
A site matrix was compiled by the author to identify problematic areas and opportune areas within the districts as well as characteristic elements found in each environment. The term 'locked' used in the matrix refers to an aspect which is hidden or not perceived as aesthetically pleasing.

	District Site	Problem	Solution	'Locked' Regional Characteristic	Opportunity
Urban Industrial	A  Spaghetti junction at O.R Tambo International Airport	Ill defined threshold to capital	Gateway	Steel, lights, billboards, asphalt	Lighting gateway
Agricultural	B  Afrigri agricultural fields	Loss of habitat	Vertical habitat structure	Electricity pylon	Pylon nesting structure
Mining Industrial	C  Sterkfontein brick quarry	Mine closure	Rehabilitation	Overburden soil	Soil sculpture rehabilitation
Residential	D  Irene residential	Noise pollution	Acoustic barrier	Brick housing typology	Brick design sound barrier
Conservation	E  Groenkloof and Klapperkop nature reserves	Severed land parcel	Animal bridge	Shale rock and threatened aloe species Distant view of historical monument	Eco bridge built from shale that displays threatened aloes Bridge can frame view

1.5 Landmarks

Through addressing the problems and opportunities within the districts, the author investigates ways in which landmarks can be created with inspiration from the intrinsic features of each district. These landmarks embrace the character of the district, within the Gauteng Highveld context.

Figure 3.8. Site Matrix (Author, 2015)





Figure_3.10. Design strategy (Author,2015)

Chapter 4 Concept



1. Eastern Scheldt storm surge barrier

West 8

West 8 designed the surrounding landscape of the Eastern Scheldt storm surge barrier by flattening out the sand into a broad expanse covered with shells. At high water, these shells provide the ideal grounding place for coastal birds. Birds select areas which provide optimal camouflage. The white birds settle upon white shells and black birds upon black shells (Tepper,2011).The design manipulated the organisation of the shells into artificial, rhythmic lines placing emphasis on the settlement nature of the bird colonies. The design offers the motorist crossing the storm surge barrier and interesting take on the regional bird life as well as breathtaking views across the ocean. The designers solved a real problem of the storm water but also focused on the surrounding landscape and how it might be an educational experience for the motorist. The nature of the project displays a reactivity to regional aspects by illustrating the essence of a place through a designed landscape.



Figure_4.1. West 8's abstract sea shells (Tepper,2011)

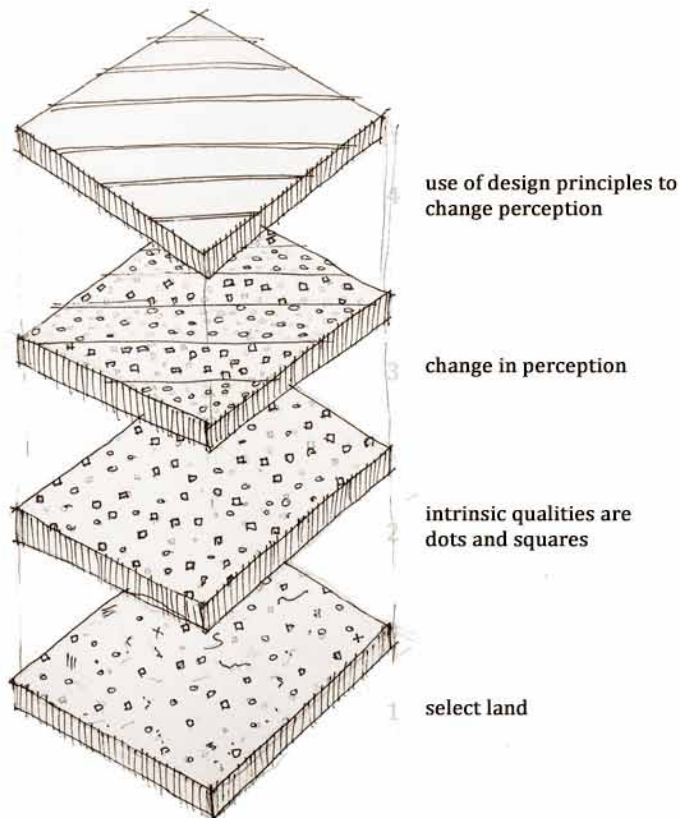
2. Concept: Unlocking the landscape

The author has identified a means by which the landscape may be *unlocked*. The concept of unlocking is to be understood as the process of making something plain or obvious. It includes the attempt to change how one perceives.

The intention of this concept is not necessarily to change *what* one sees but rather *how* one sees. Ultimately changing perceptions.

Steps to UNLOCKING the regional landscape

1. Select land to unlock
2. Identify intrinsic characteristics of the selected environment
3. Change *how* one sees intrinsic characteristics. Do not change the characteristic inherent qualities.
4. Achieve change in perception through design principles



Figure_4.2. Steps to unlocking the landscape (Author;2015)

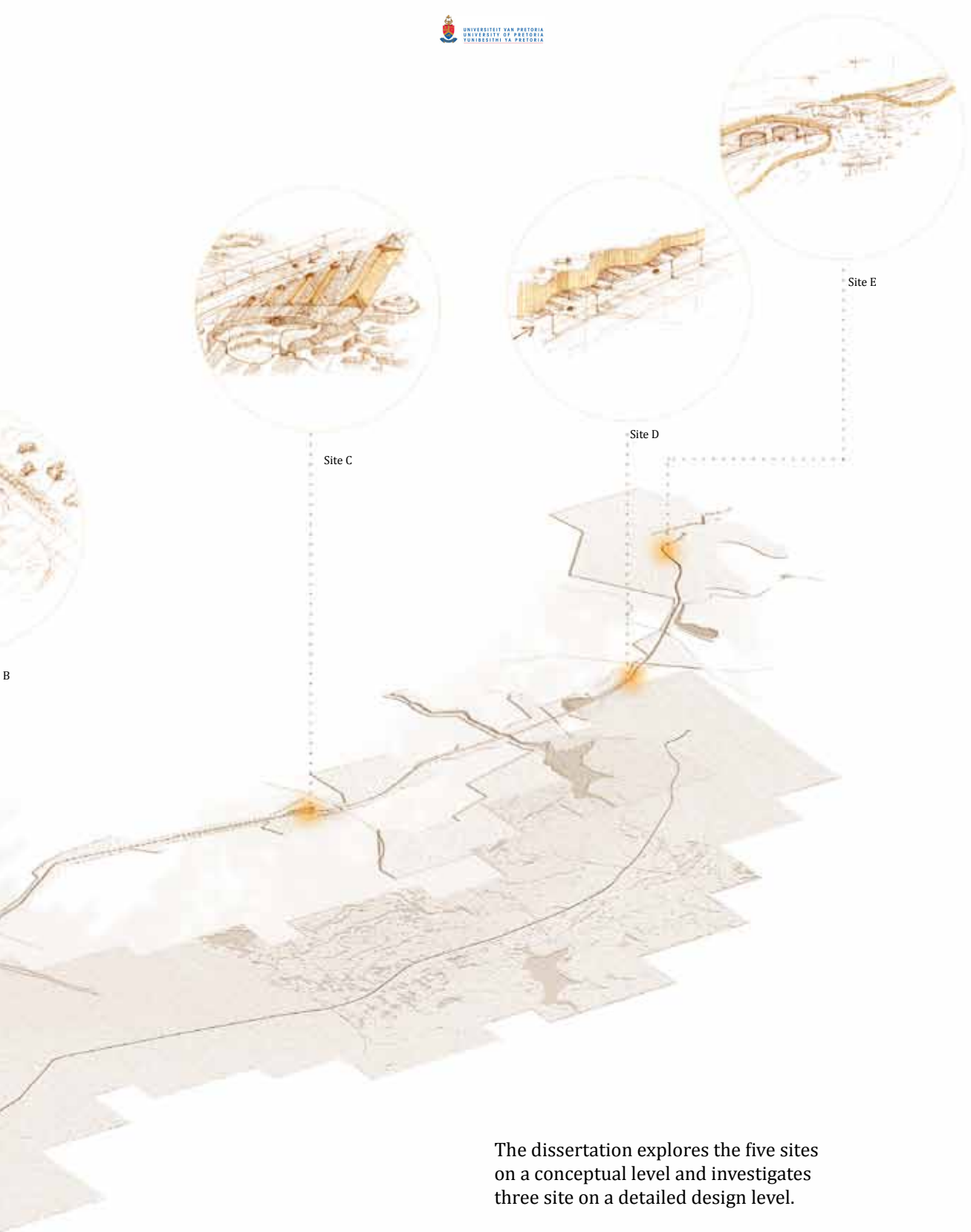


Site A



Site





The dissertation explores the five sites on a conceptual level and investigates three sites on a detailed design level.

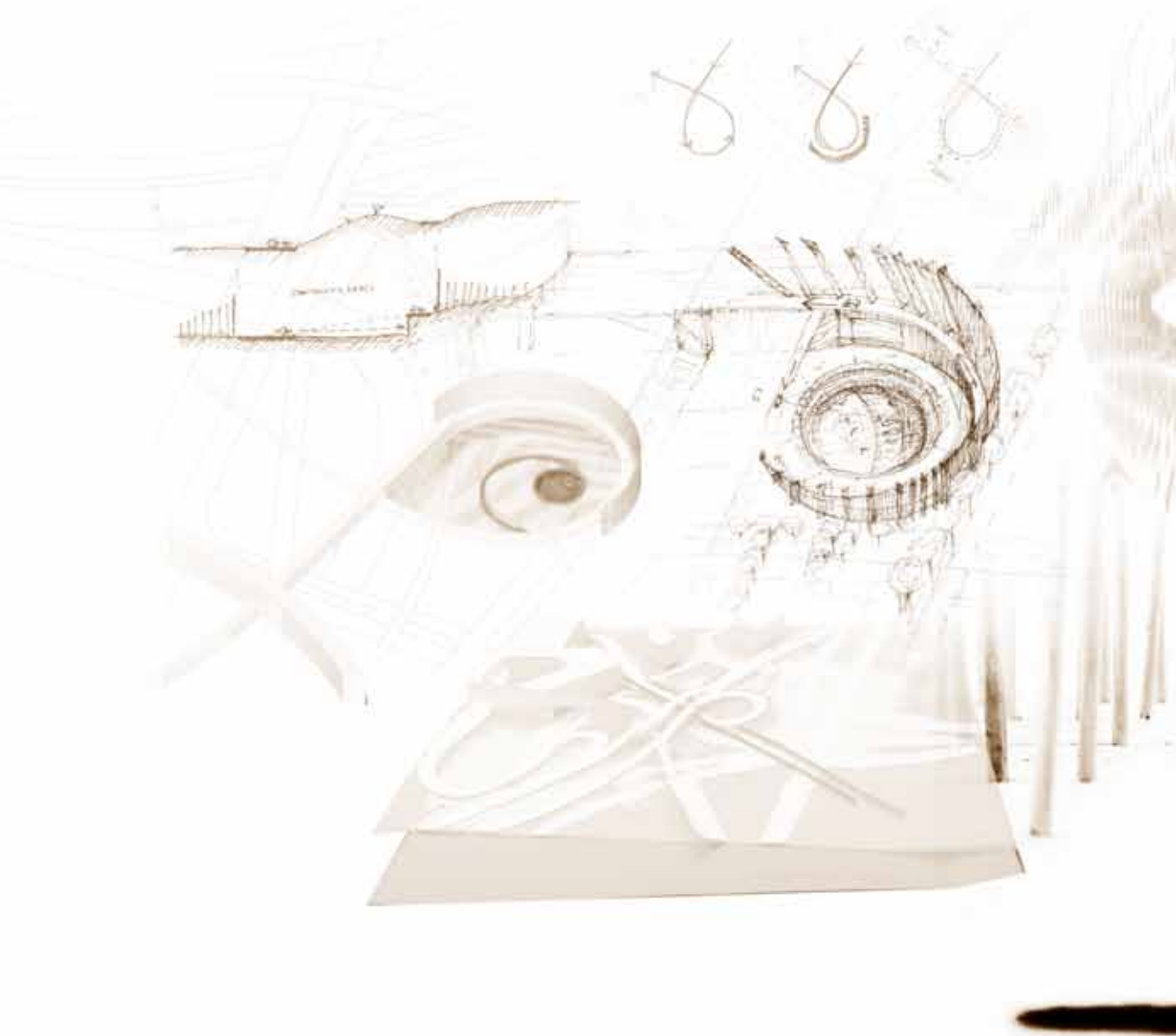
Figure_4.3. Five sites along the R21 (Author;2015)

Chapter 5

Design development & Detailed design



This site is investigated
on a conceptual and
detailed design level.



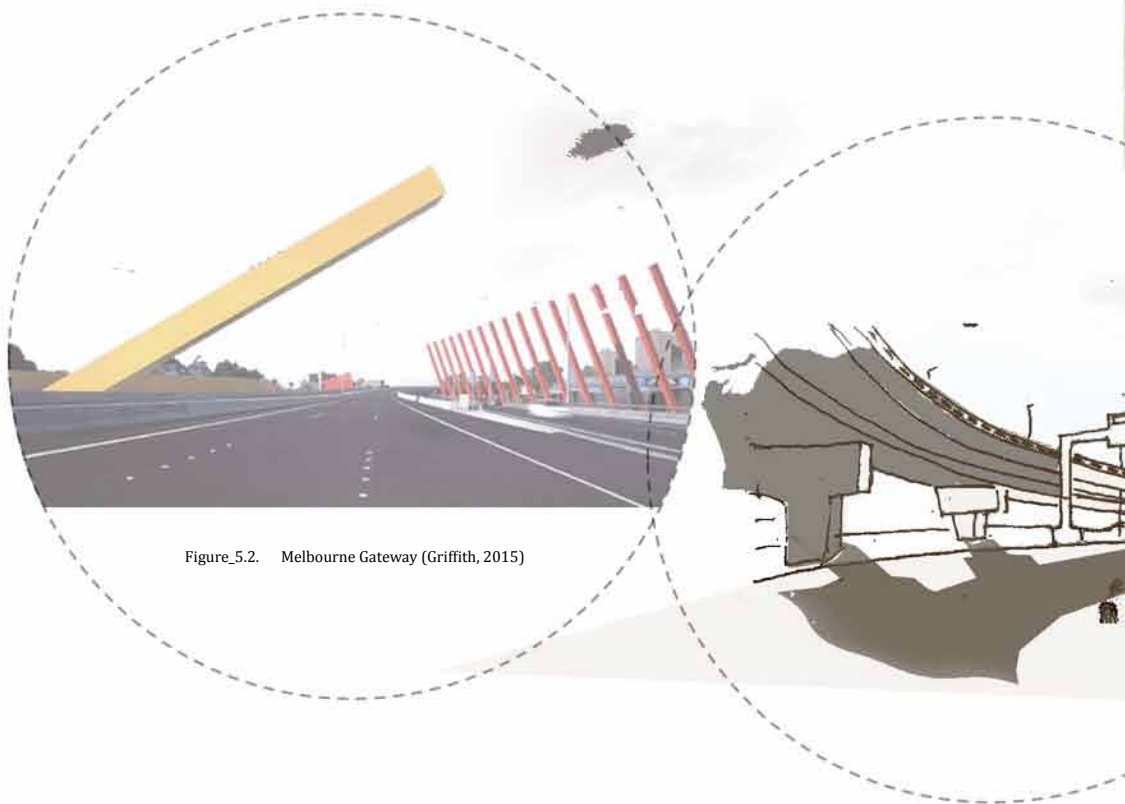


Site A
Spaghetti junction gateway

1.1.1 The city gateway

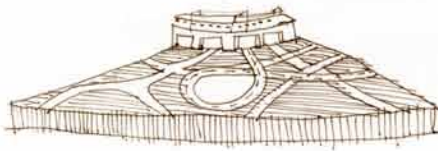
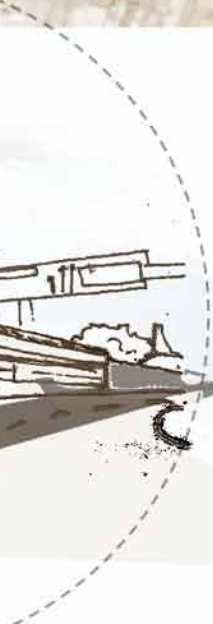
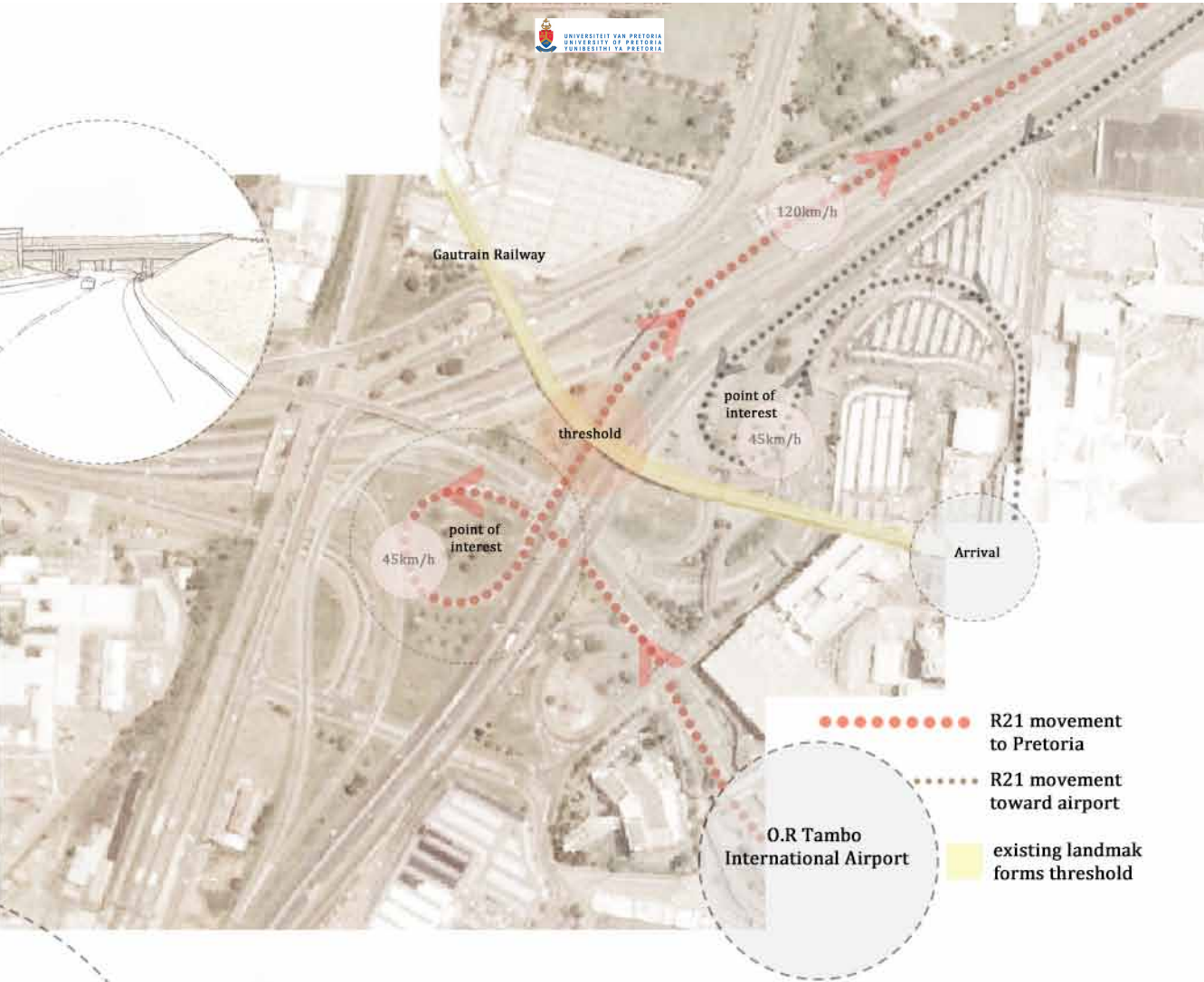
Cities used to have walls, not only for defence but to divide the urban from the non urban domain. The entrance to a city was a gate left open during day time hours and closed at night. Like all thresholds the gate became an important node for activities other than functions of arrival and departure. Although the industrial revolution changed the form of cities the concept of wall and gate resides rooted in our subconscious. In the late 19th century the gate was the railway station, which usually featured as monumental urban reception. (Raggat, 2012) Contemporary cities have no walls or gates. Boundaries are blurred and points of entry are often unclear. This is the case at the freeway intersection of O.R Tambo International Airport. The spaghetti junction throws the user into a whirlwind of concrete and asphalt. The author proposes a clear defining entry way that signifies the arrival to the country. Points of arrival and departure should possess a certain hierarchy. And elements of the urban industrial area should be acknowledged. Although passing beneath the Gautrain rail line creates somewhat of a threshold on route to the capital, the author suggests a bolder approach may be more suitable when travelling at high speeds. The air plane and metro rail uses should also be considered when passing by.

The Melbourne gateway is an example of a powerful contemporary gateway. The monumental scale and bold use of colour are elements that contrast the monotonous city tones.

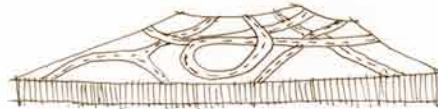


Figure_5.2. Melbourne Gateway (Griffith, 2015)

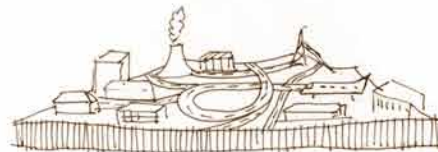




Gautrain is an existing landmark



Non regional planting of mowedges

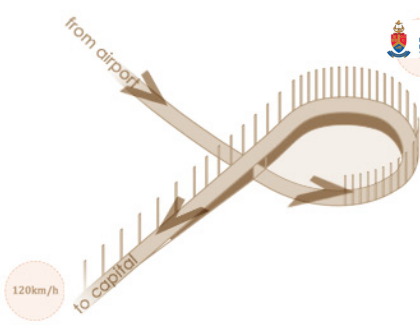


Urban industrial area

Figure 5.3. Site A site analysis (Author, 2015)



5.

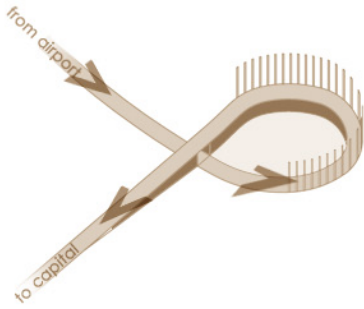


spatial elements extended

slower speed requires more frequent elements
45km/h around bend

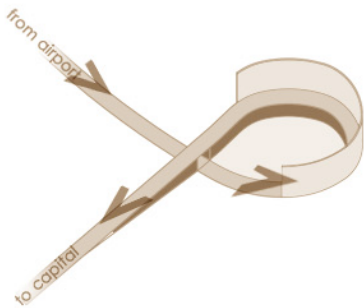
increased speed requires elements to be spaced further apart
120km/h on the straight

4.



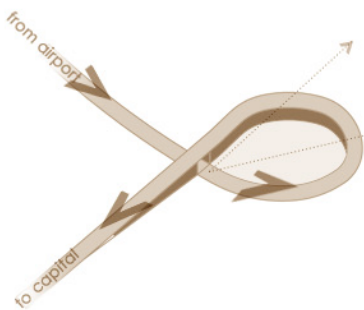
barrier resembles urban industrial structures

3.



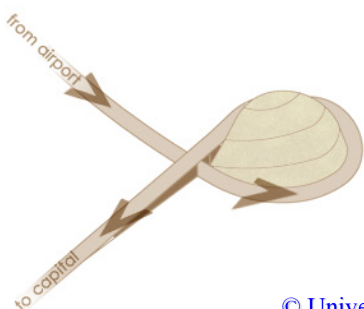
Space motion application of 'push' barrier
vertical elements create strong sense of threshold

2.

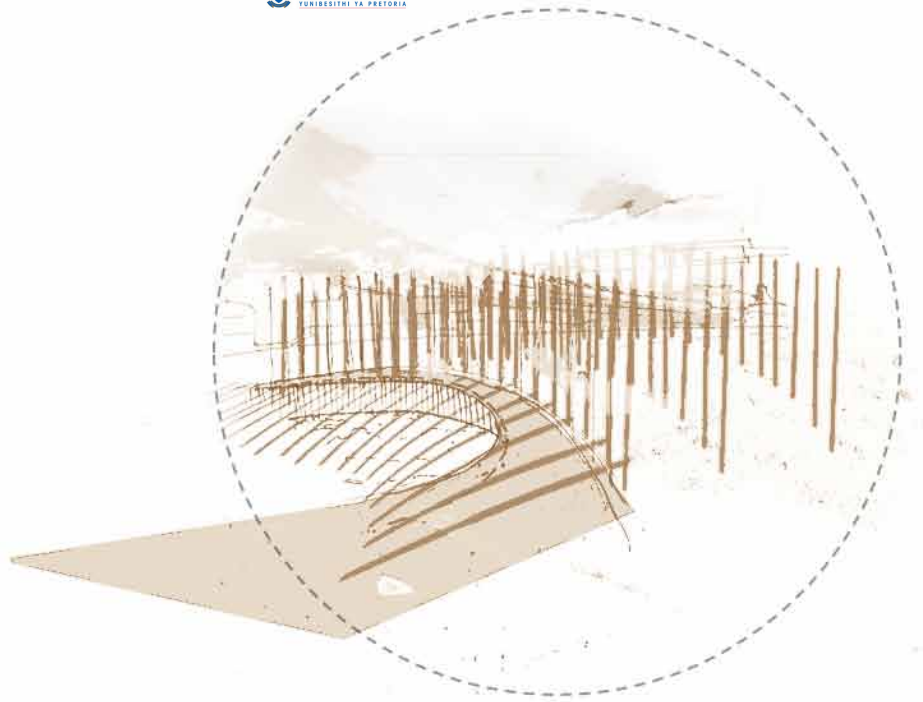


'Cut' to open space up for visual reference

1.

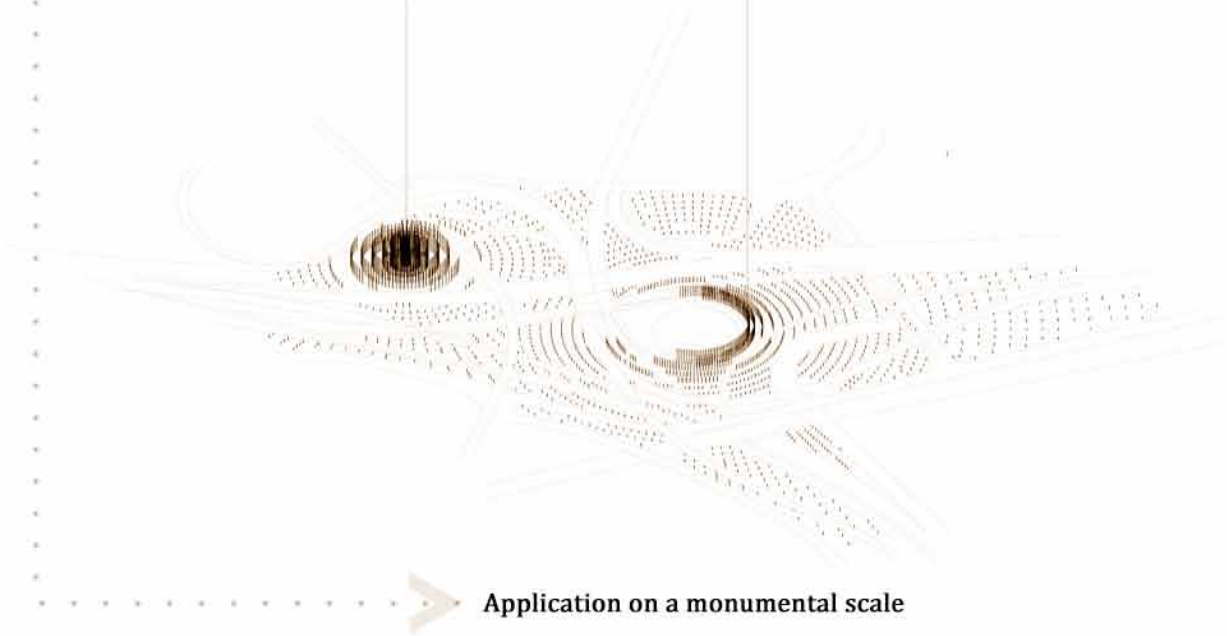


Existing



Heirachy of arrival
to airport

Heirachy of departure
from airport



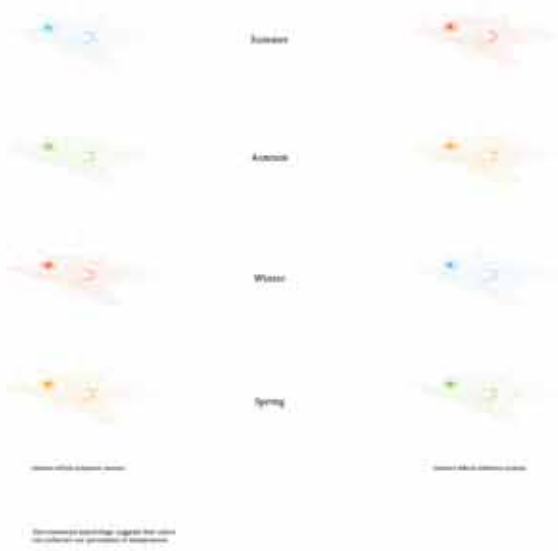
Figure_5.4. Site A design process (Author,2015)

1.1.2 Preliminary design

Critique:

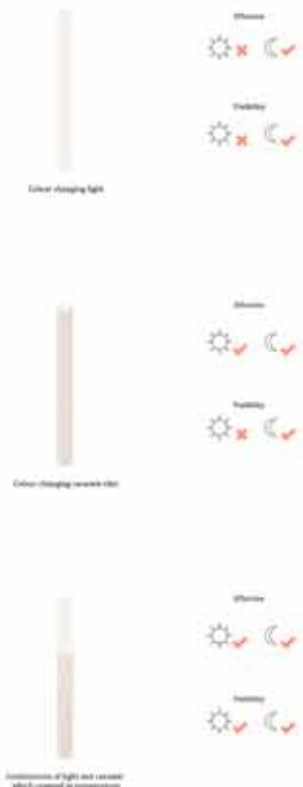
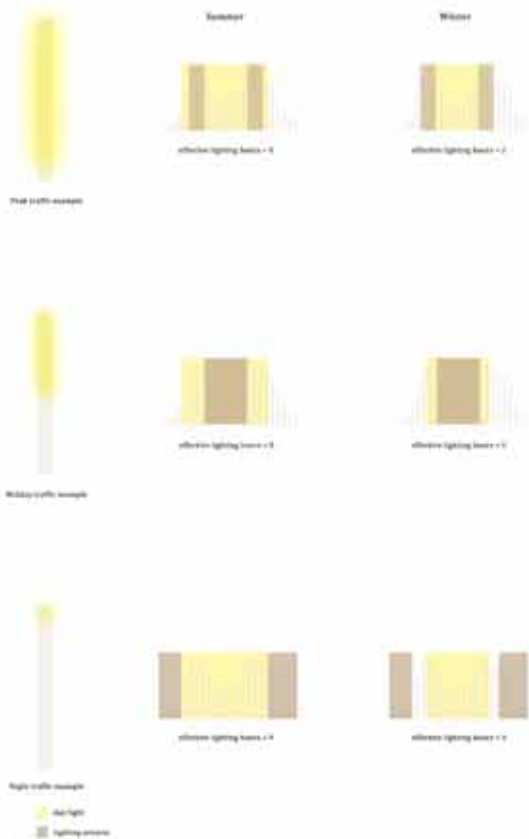
The preliminary design is somewhat responsive to spatial movement, with rhythm of trees fanning out as speed increases. Trees however do not celebrate the urban industrial environment. Junctions of the barrier wall are abrupt, a more subtle approach should be considered. The arrival portal is not considered. The grid layout of the trees do not embrace the chaotic nature of the junction. The water collection pool is not viable.



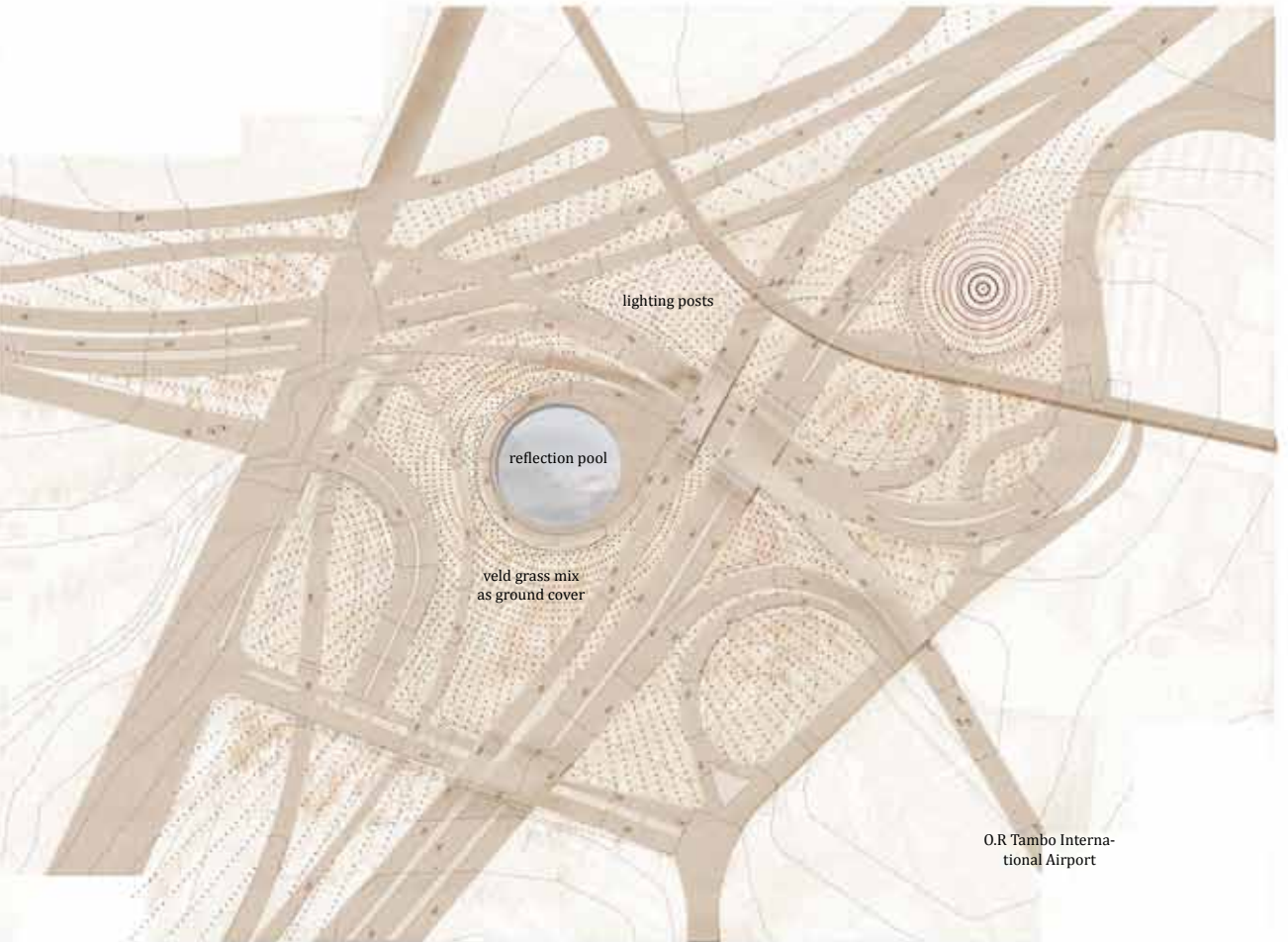


Environmental psychology and seasonal change

Diurnal Temperature change



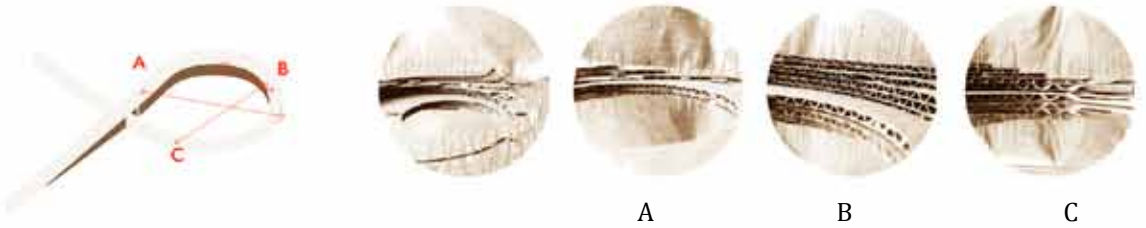
Figure_5.6. Site A lighting investigation (Author:2015) 57



Sketch plan



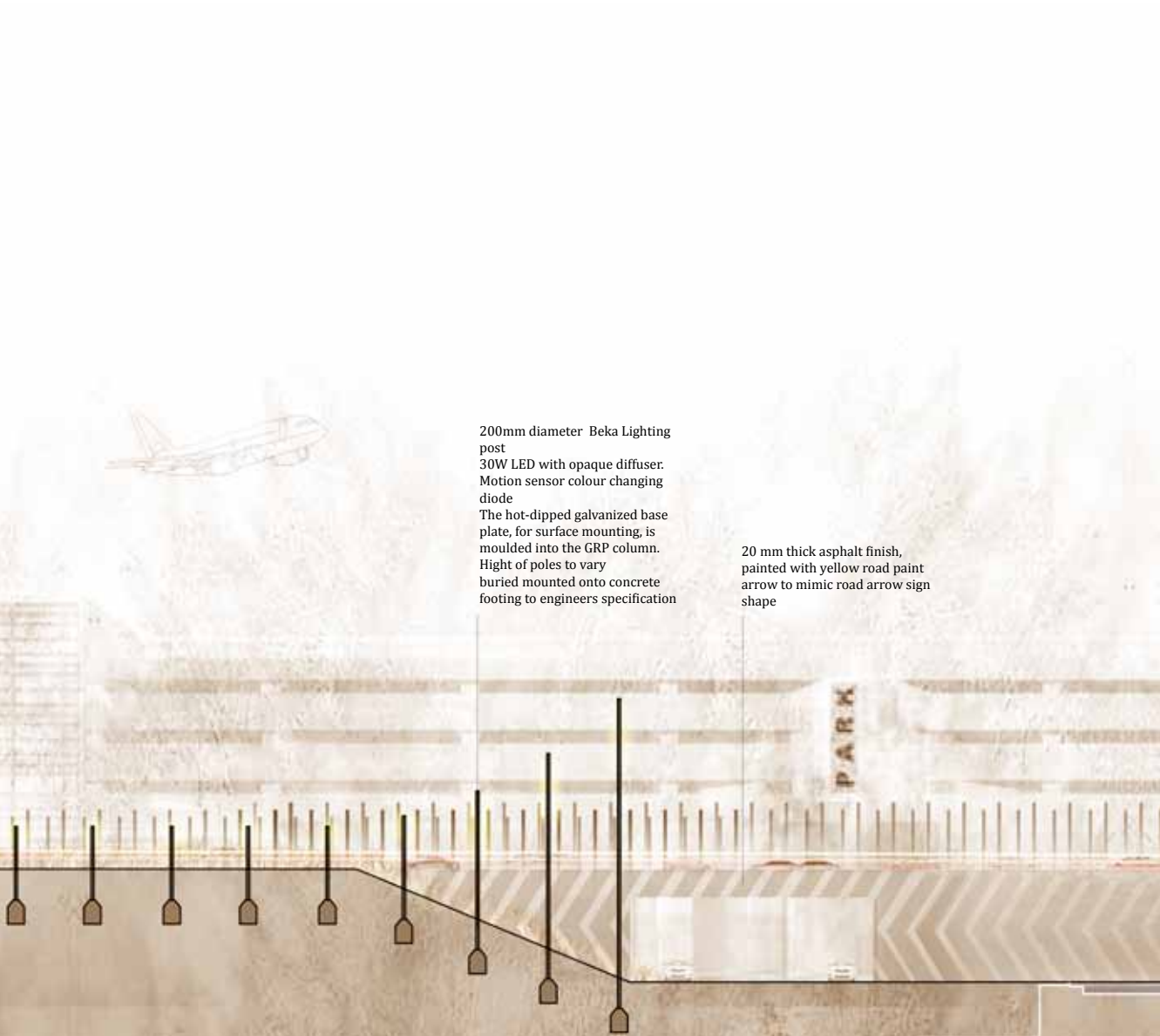
Contour manipulation model
illustration of void creating gateway



Investigation into visual effect of
reflection pool



Lighting strategy responding to various transportation
motion sensed lighting allows for a variation of light displays

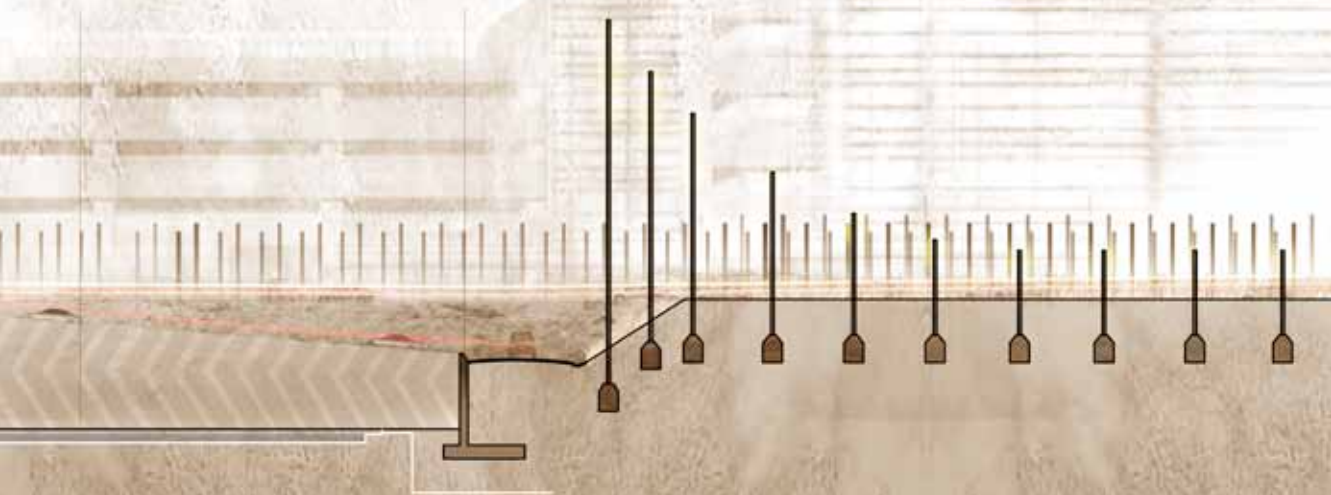


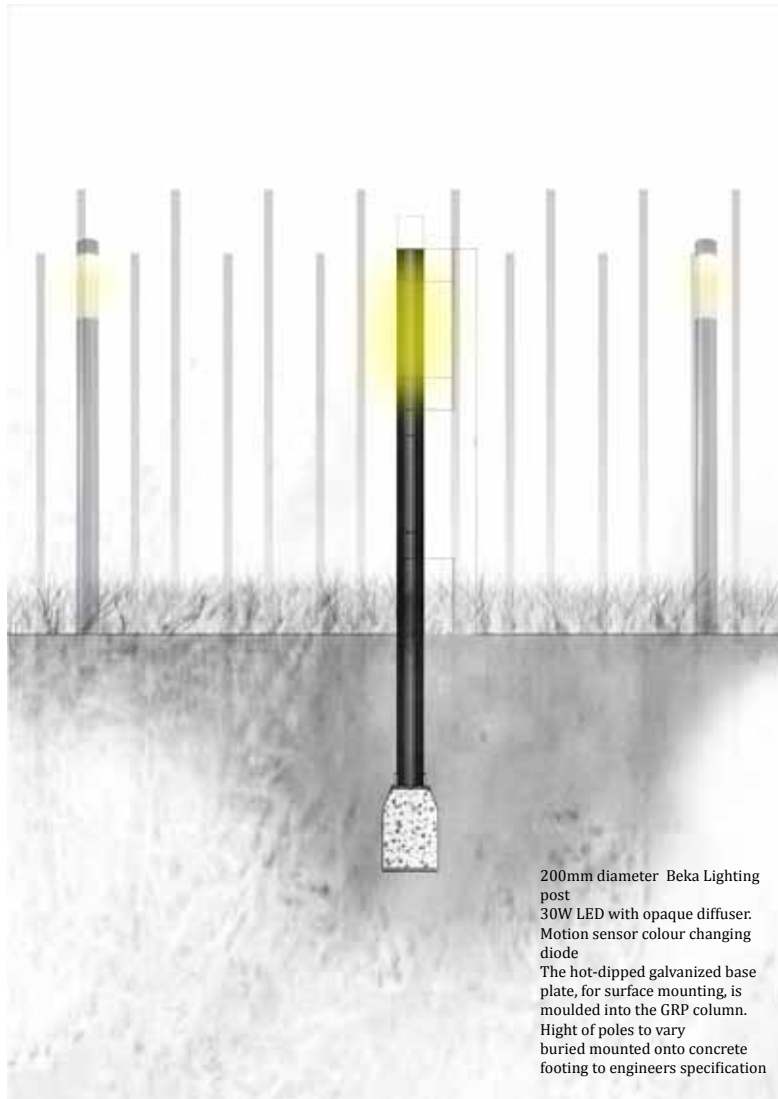
200mm diameter Beka Lighting post
30W LED with opaque diffuser.
Motion sensor colour changing diode
The hot-dipped galvanized base plate, for surface mounting, is moulded into the GRP column.
Height of poles to vary buried mounted onto concrete footing to engineers specification

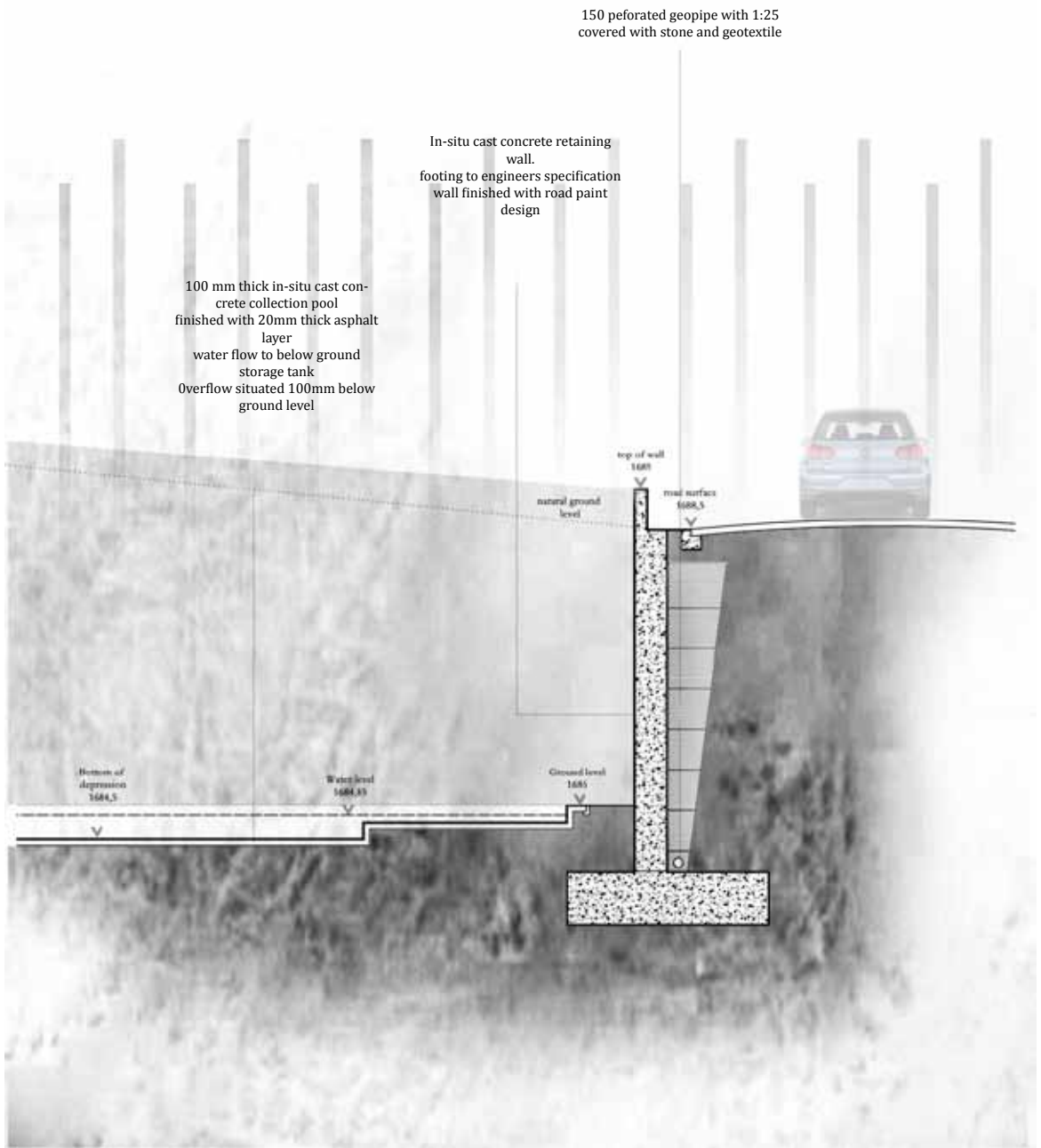
20 mm thick asphalt finish, painted with yellow road paint arrow to mimic road arrow sign shape

100 mm thick in-situ cast concrete collection pool
finished with 20mm thick asphalt layer
water flow to below ground storage tank
Overflow situated 100mm below ground level

In-situ cast concrete retaining wall.
footing to engineers specification







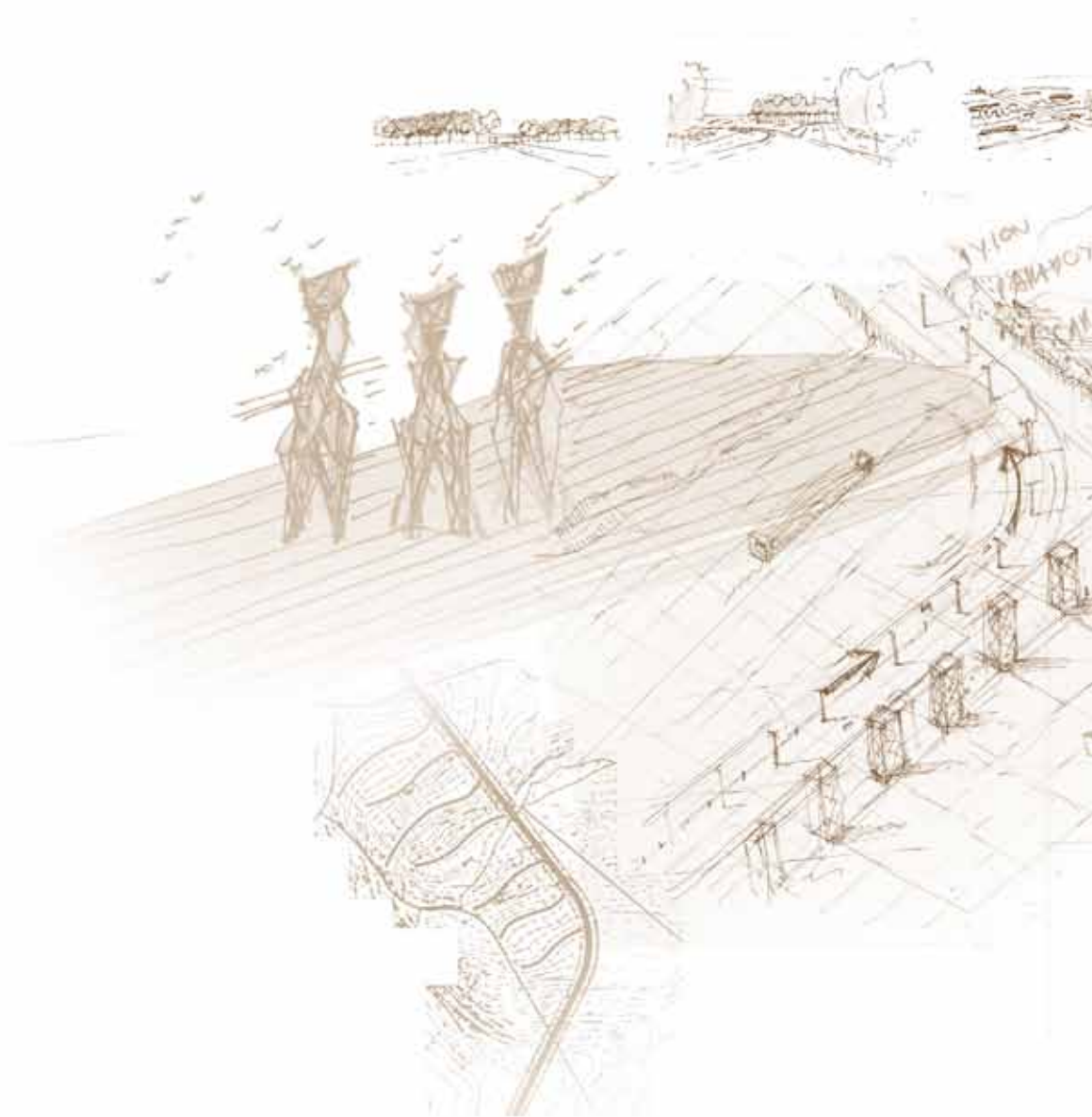
Figure_5.11. Site A detail (Author,2015)





Figure_5.12. Site A perspective (Author,2015) 65

This site is investigated
on a conceptual level
only.





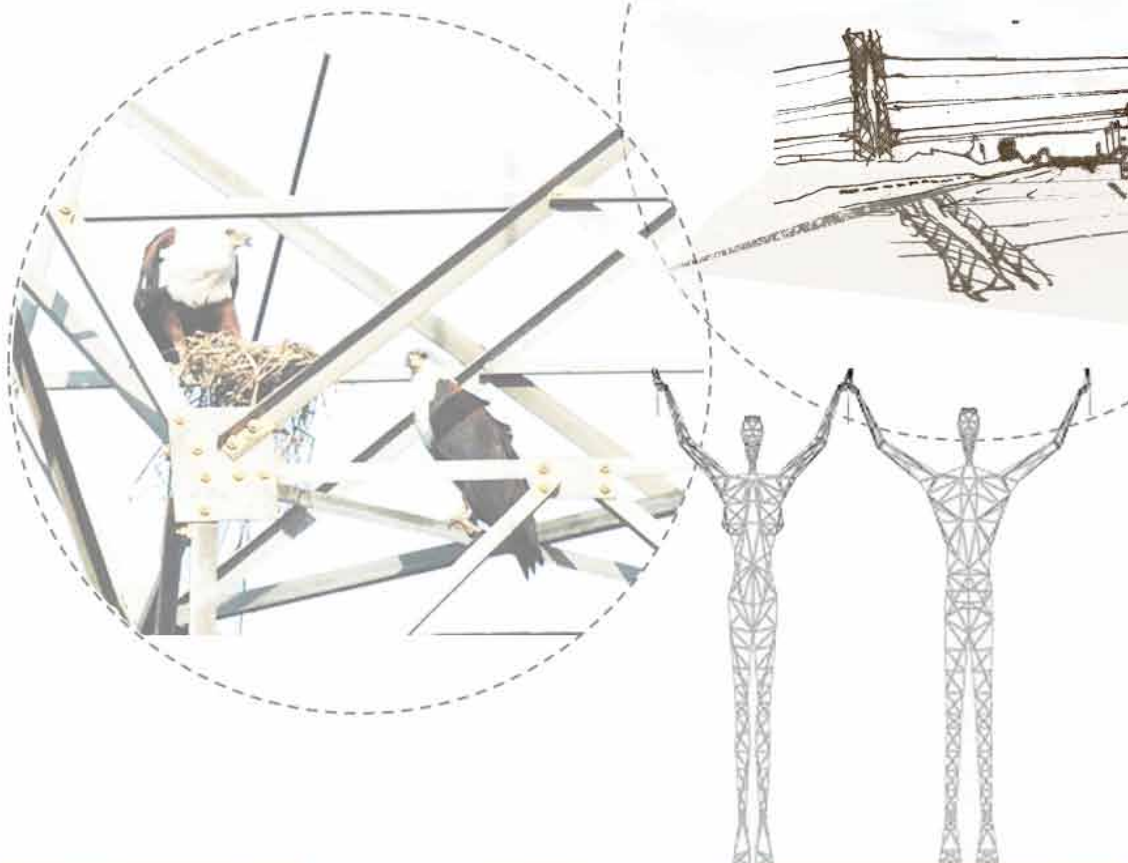
Site B Nesting units

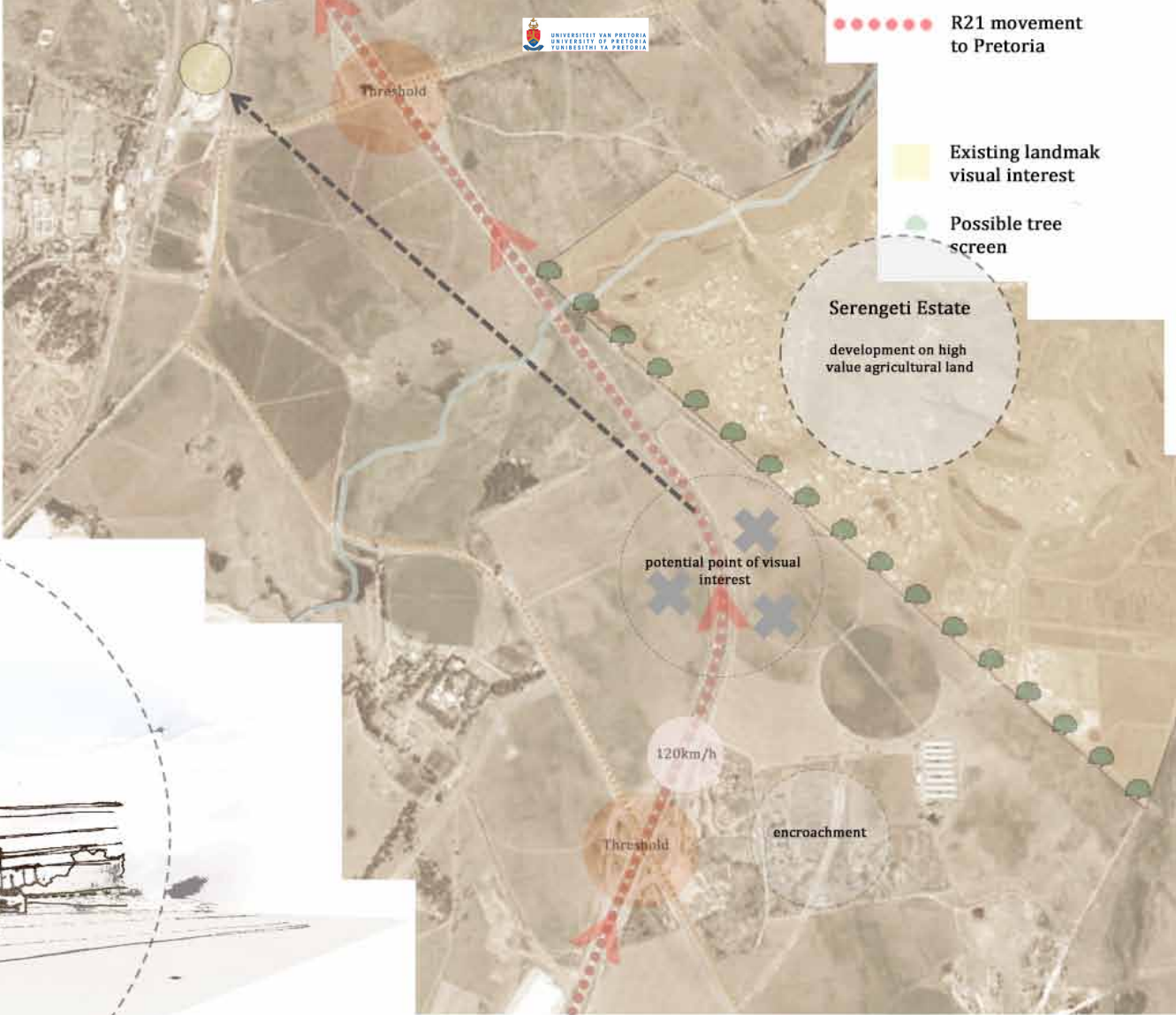
1.2.1 The pylon paradox

Over the past century, electricity power lines have been a conspicuous part of the landscape. These structures are generally known to cause fatalities to birds. However, some bird species use electricity poles as nesting structures, song posts, or for perching. Other, but not-acknowledged, benefits probably include the marginal habitats around the base of pylons. Differences were tested in breeding bird communities under pylons, under electricity high-voltage power lines, and in adjacent open fields. Birds were counted twice during the 2011 breeding season in a total of 91 study plots located in the intensive farmland of western Poland. Both species number and bird abundance were significantly higher under pylons and under power lines at control points than in open fields, especially where there were shrubs under the pylons. Pylons and power lines locally may play a positive role for the avian community in intensive farmland. (Tryjanowski,2012:34)

The pylon is an inherent part of the road environment. A loss of habitat in agricultural areas presents the challenge of introducing wildlife back into the landscape. The design intention is to introduce vertical perching and nesting structures into the vast horizontal landscape which resembles the pylon structure. The aim is to rethink the pylon.

An investigation into placement of vertical structures for an animation effect is investigated.





Encroachment



Grain silos create land mark



Disturbed ecology



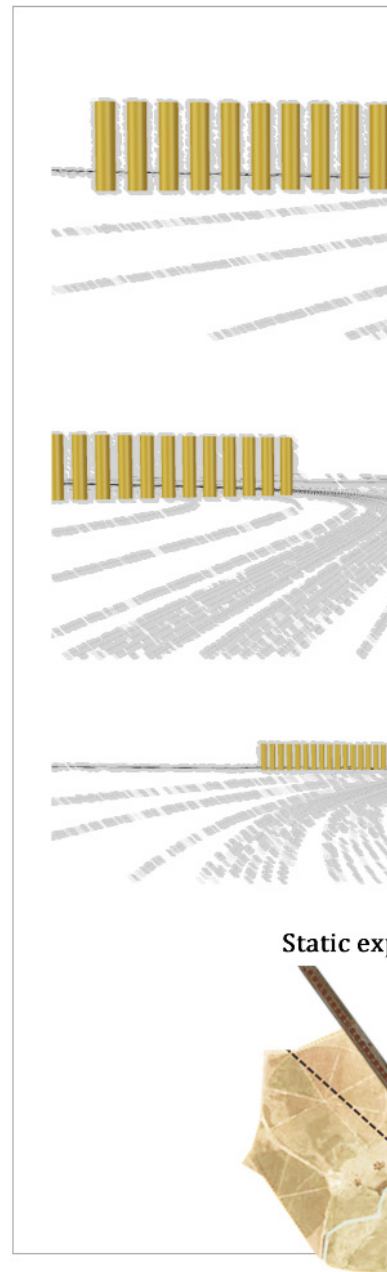
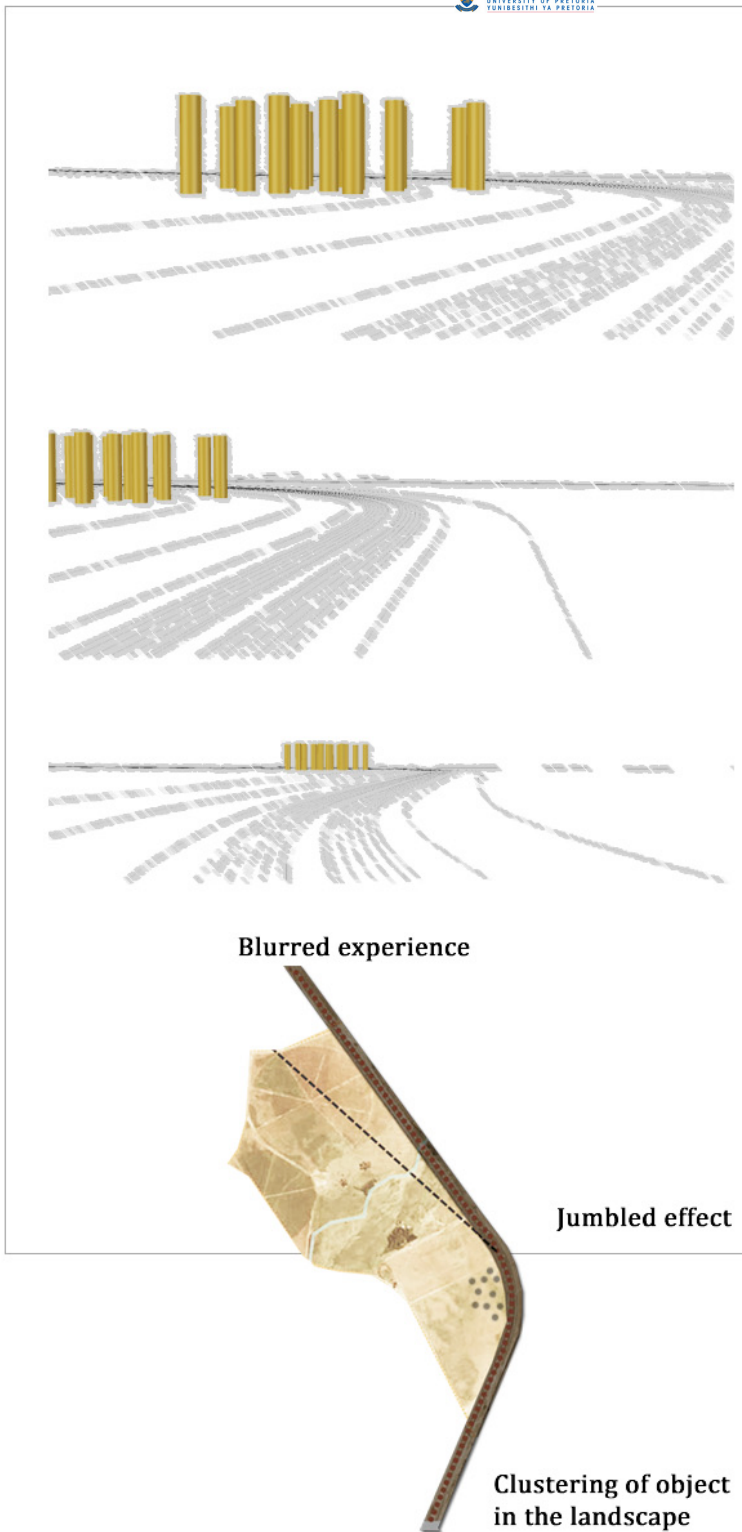
Hydrology



Agricultural land use

Figure_5.14. Site B site analysis (Author:2015)





Investigating how placement of objects in the landscape may be animated when passing around a bend
Vertical pylon-inspired nesting structures will be introduced as dancing objects in the landscape

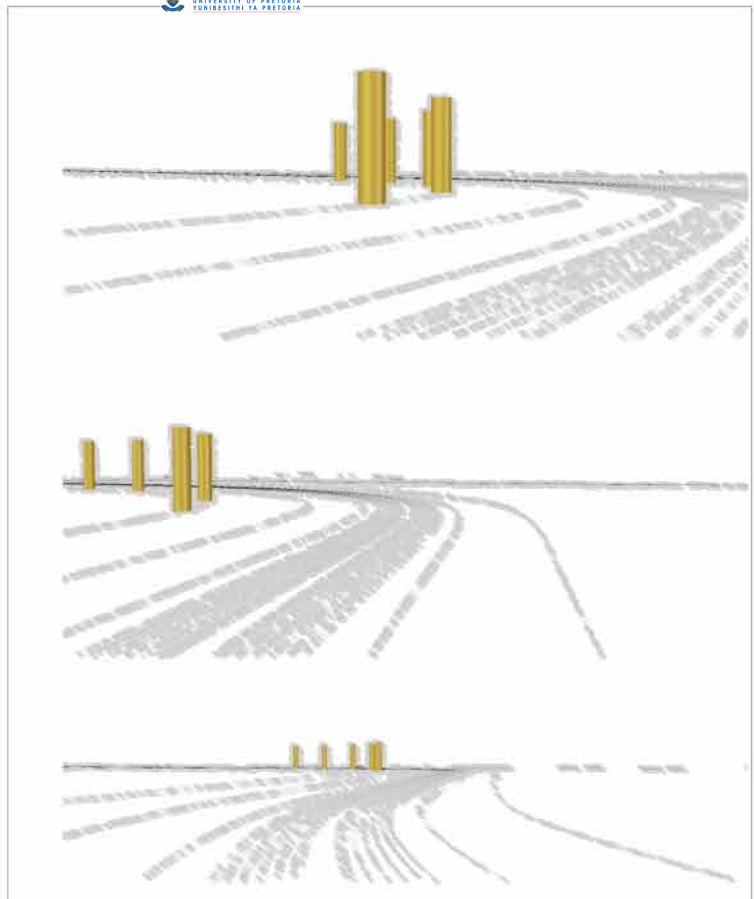


experience



Barricade effect

Transverse alignment of object in the landscape



Dynamic experience

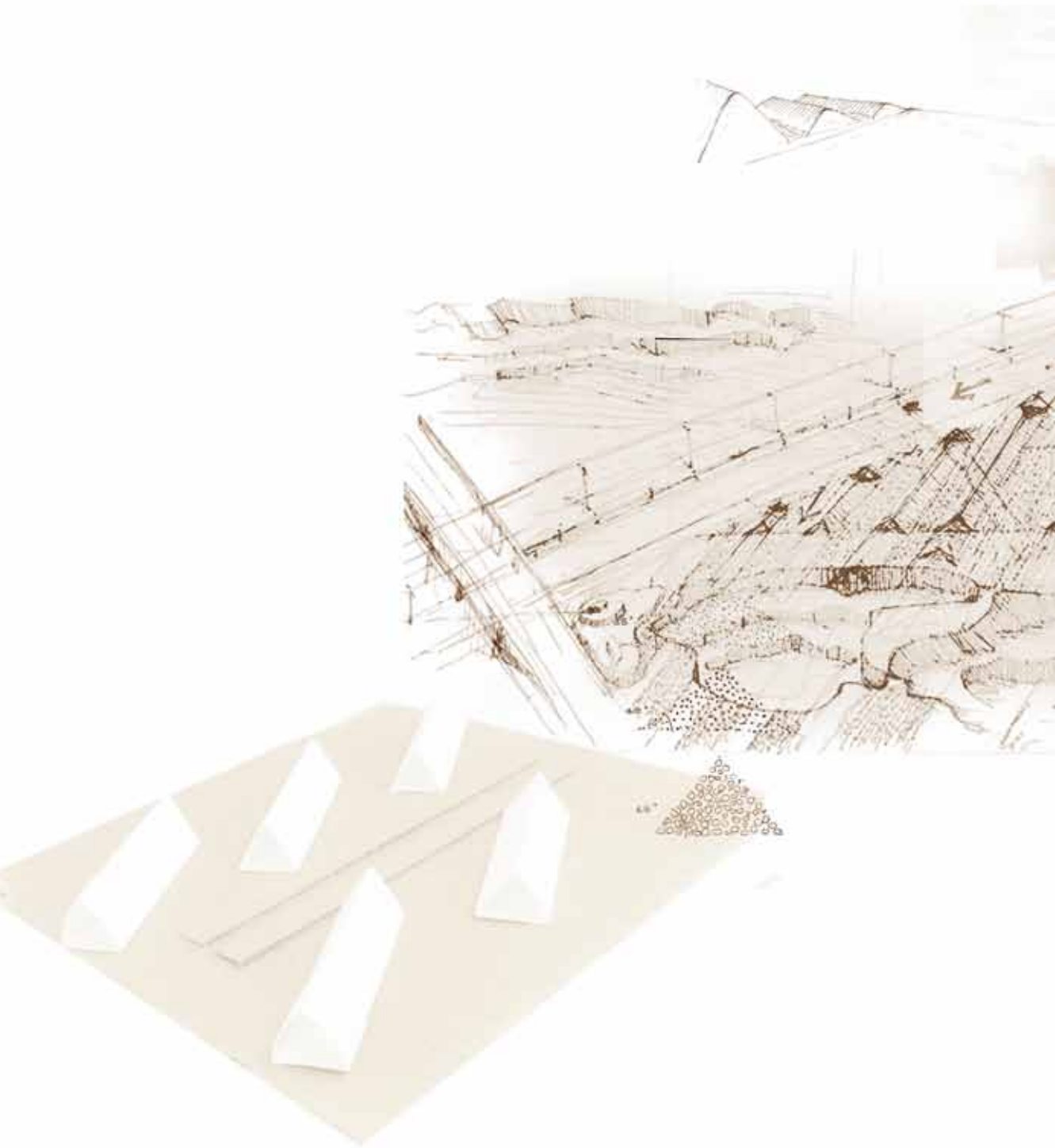


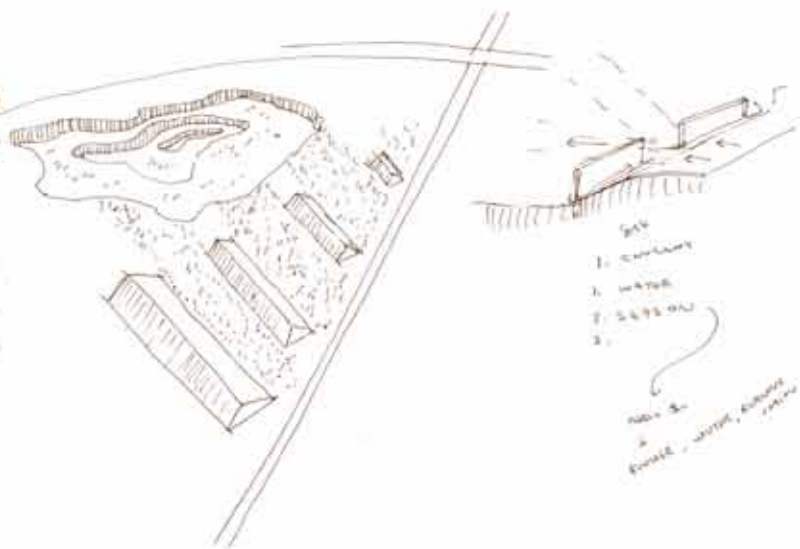
Dancing effect

Paralleled placement of objects in the landscape

Figure_5.15. Site B investigation into animation of objects in the landscape (Author;2015)

This site is investigated
on a conceptual and
detailed design level.

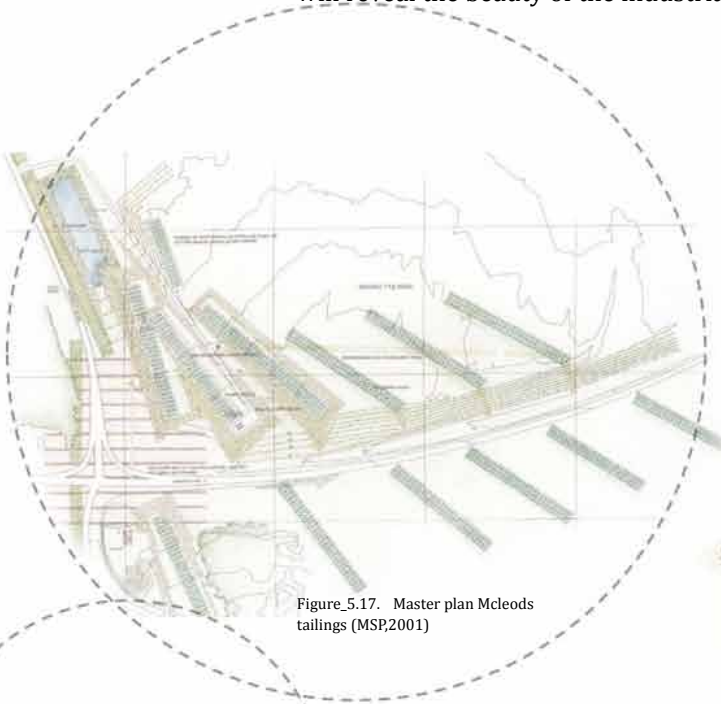




Site C Quarry rehabilitation

1.3.1 Post industrial beauty

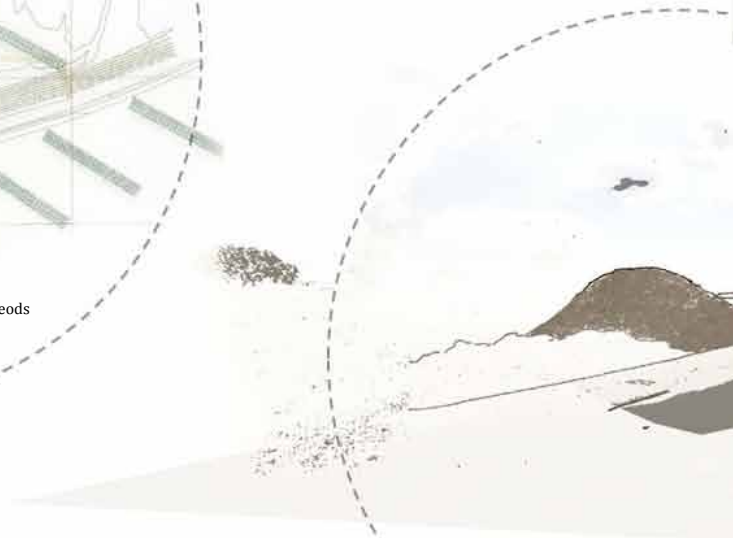
Contemporary landscape projects have had the ability to change perceptions about disregarded sites. These sites include the Highline, a once abandoned railway and Landschaftspark Duisburg-Nord a former coal and steel plant. Both projects are examples of how perceptions have been changed through landscape design. The projects are successful attempts at celebrating the industrial qualities attached to the sites. A good example of post-industrial rehabilitation, is MacLeod Tailings, by Martha Schwartz. The design embraces the cultural landscape by sculpting 'golden' soil bars which communicate the once industrial nature of the site. The sculptural landscape forms an interesting perspective from the freeway which appears to cut through the sculptures. The project did not try to return the site to a pre-mine condition but sought the means of rehabilitation by working with the existing fabric. Along the R21 freeway lies a series of clay brick quarries. The Strekfontein brick quarry's life span is coming to an end. The opportunity arises to rehabilitate the land as per environmental law, but in a manner that will reveal the beauty of the industrial landscape.



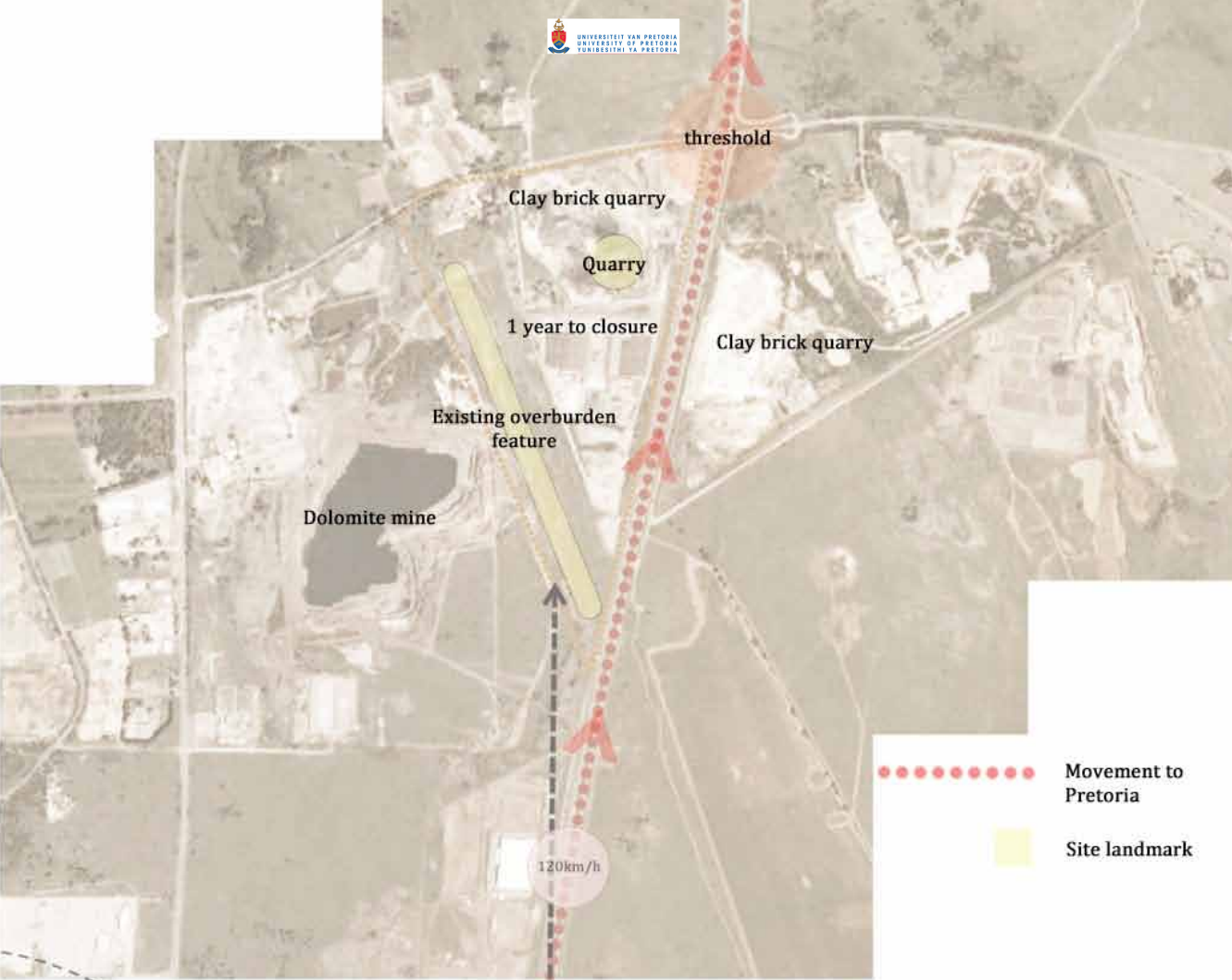
Figure_5.17. Master plan Mcleods tailings (MSP,2001)



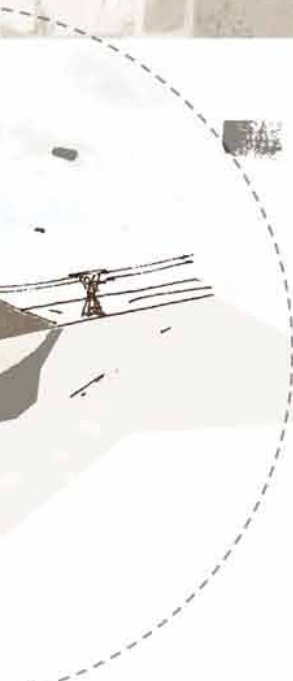
Figure_5.18. Mine reclamation at Mcleods tailings(MSP,2001)



Site feature



- Movement to Pretoria
- Site landmark



Overburden is main site feature



Disturbed ecology

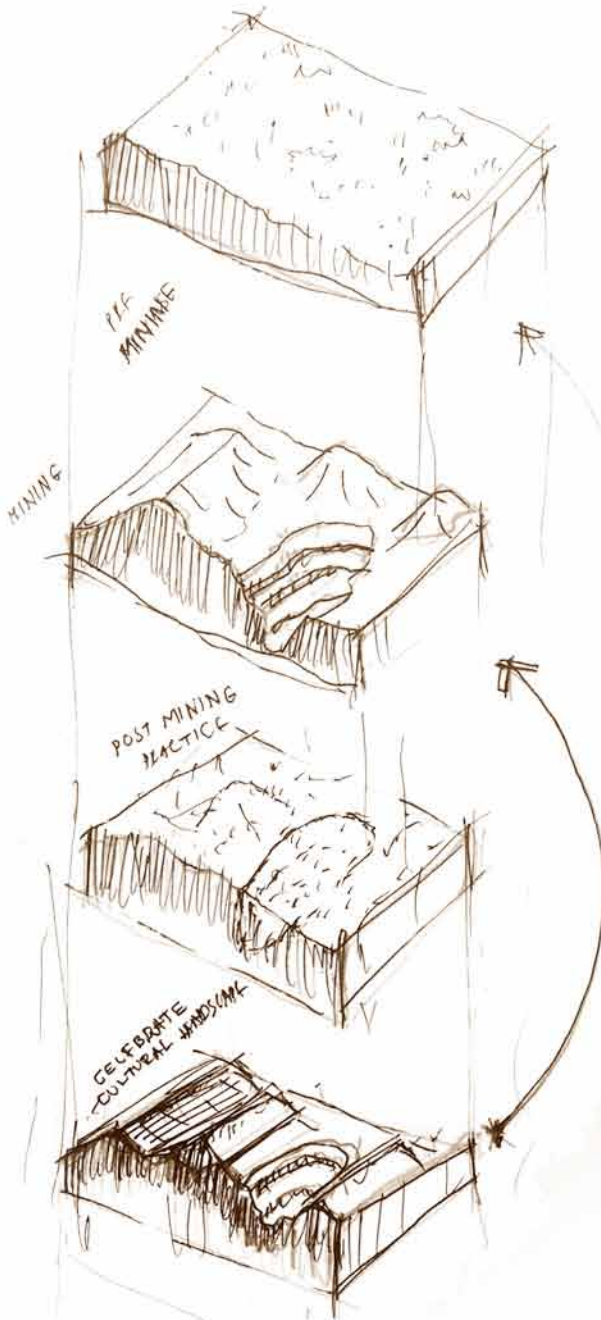


Mining landuse

Figure_5.19. Site C site analysis (Author,2015)



Aim: The design intention is to celebrate the cultural mining aspect of the region by creating a feature along the route. When one thinks of a scenic environment, a mine dump is not necessarily the first thing that comes to mind. The design is based on the use of existing overburden material to form a sculptural landscape while still performing the role of rehabilitating the land. Instead of returning the land to its pre-mine condition, where memory of the land use is forgotten, the author embraces the previous mining land use, this is achieved through sculpting the overburden pile in to a geometric shape which resembles a stock pile. Through repetition of this geometric form, the driver is reminded of the cultural land which has a major contribution to the regional landscape.

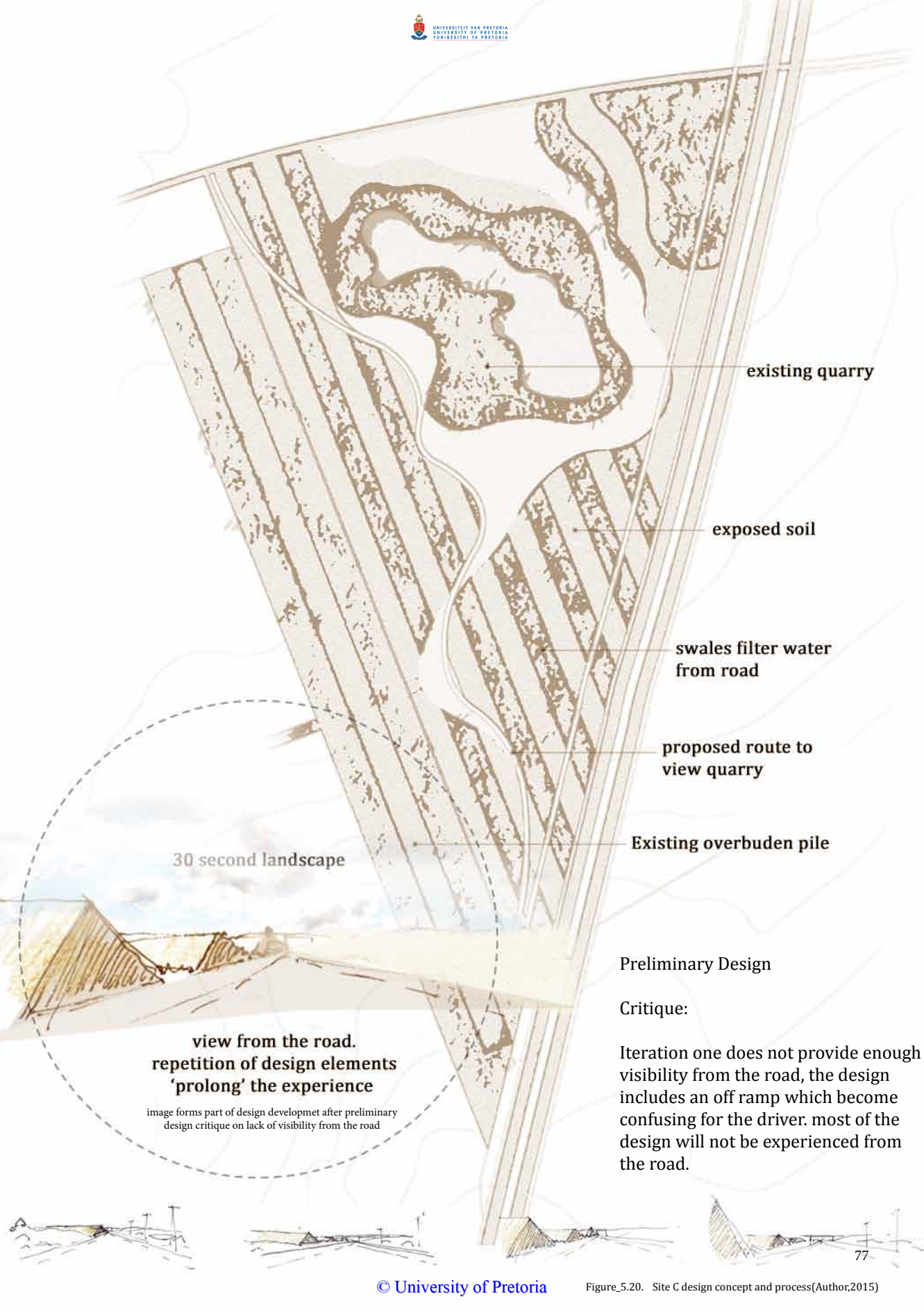


Pre-mine condition

Mine operational condition

General post mine rehabilitation attempts to return mine to pre-mine state by disguising mine operation. This leads to loss of memory of regional landscape.

Landscape design intention to rehabilitate yet retain qualities of quarry's operational state.



existing quarry

exposed soil

swales filter water from road

proposed route to view quarry

Existing overbuden pile

30 second landscape

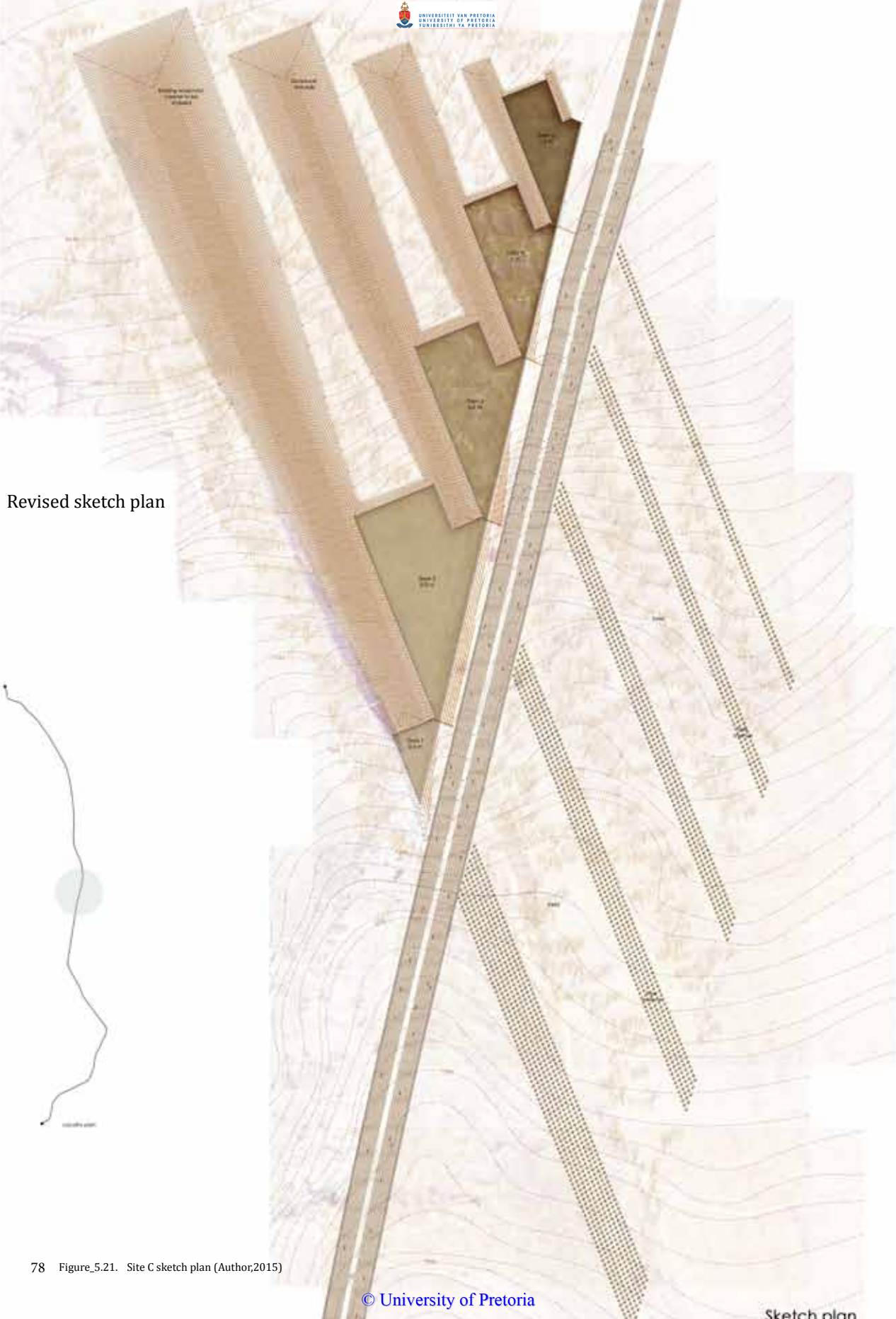
view from the road.
repetition of design elements
'prolong' the experience

image forms part of design developmet after preliminary design critique on lack of visibility from the road

Preliminary Design

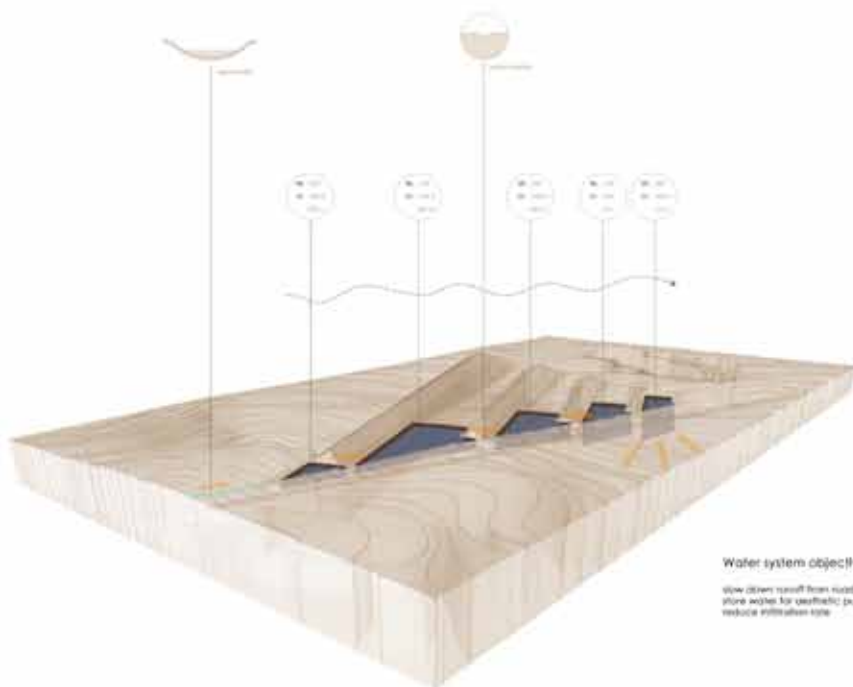
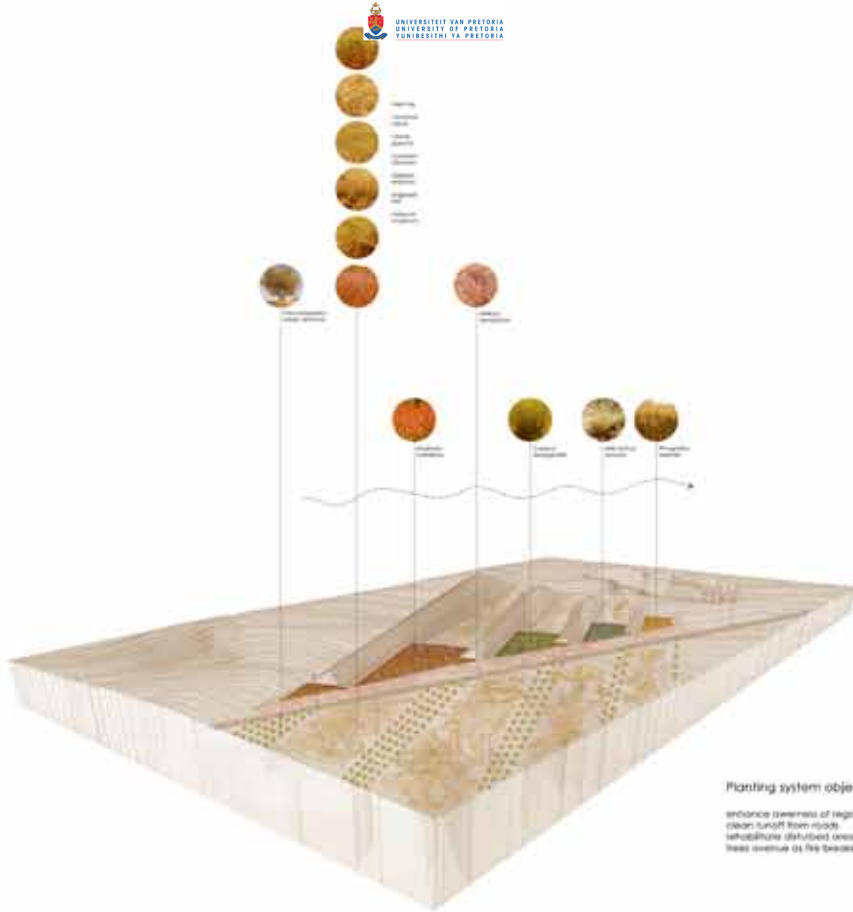
Critique:

Iteration one does not provide enough visibility from the road, the design includes an off ramp which become confusing for the driver. most of the design will not be experienced from the road.

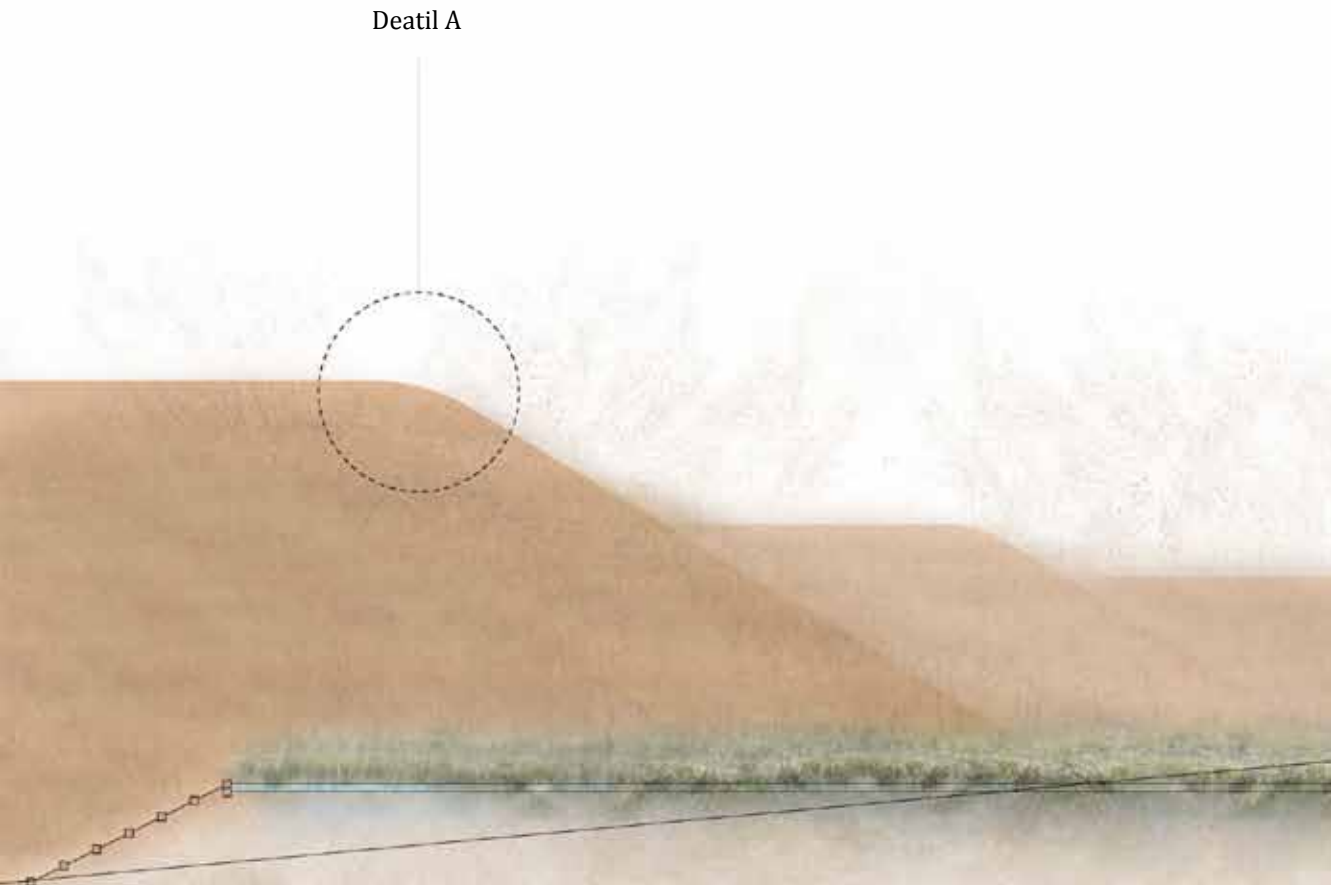


Revised sketch plan

Planting

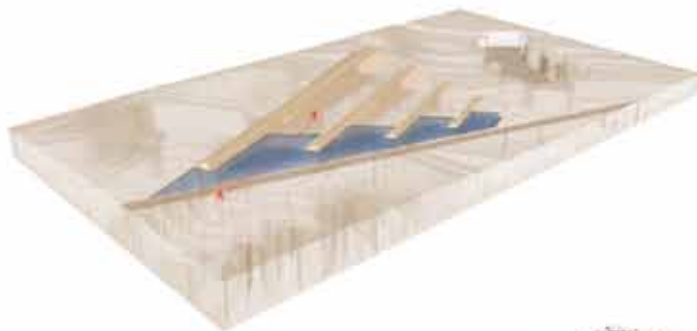


Figure_5.22. Site C planting and water strategy (Author,2015) 79



Detail A

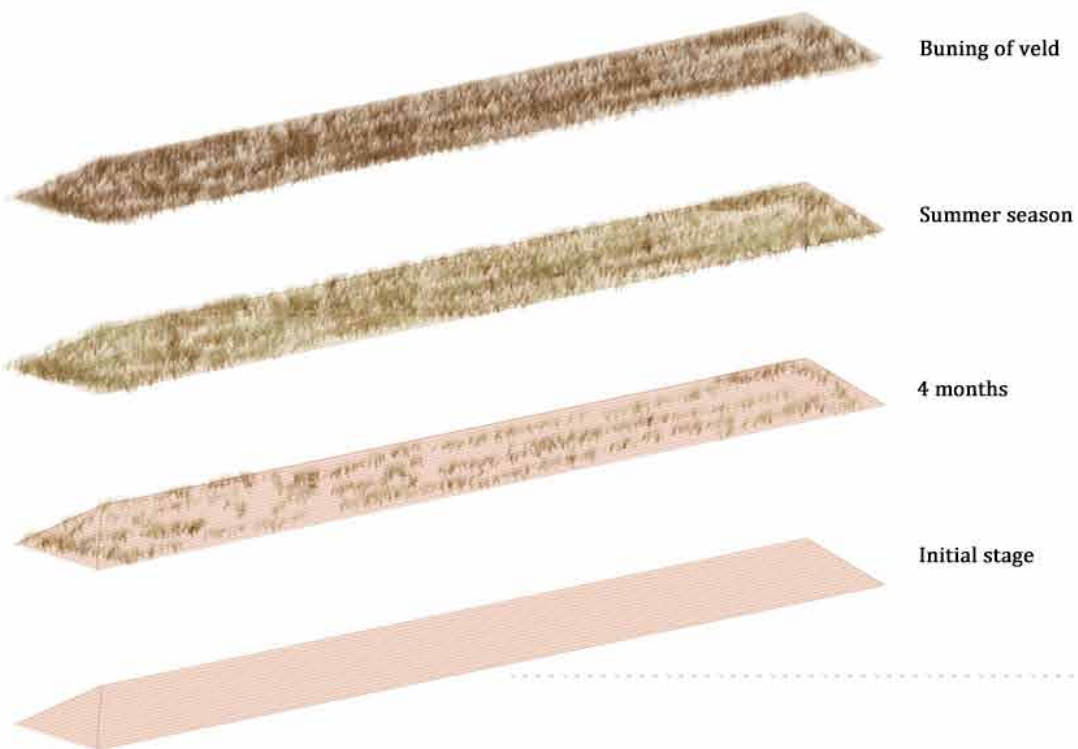
80 Figure_5.23. Site C design section (Author,2015)



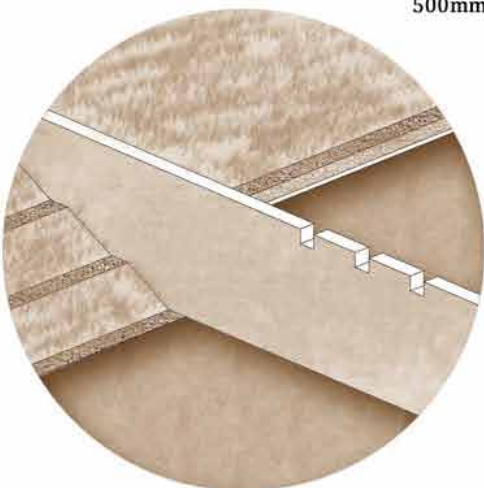
Detail B

Contour manipulation
model



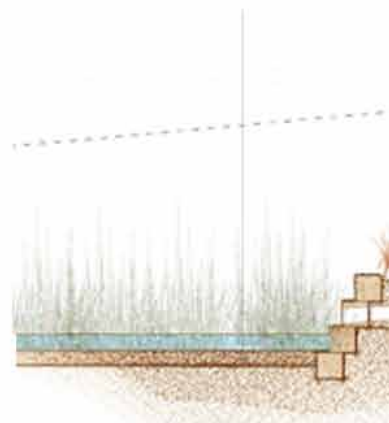


500mm thick 25mpa insitu cast
concrete retaining dam wall with
500mm wide overflow



Detail C
Dam weir

300mm soil growth
medium on bidum line





Pre-sowed bio textile

Application process

Remove rocks and the pre-existing grass or vegetation by the roots, turn up 100 mm topsoil. Crush the ground solids and prep soil to 60 degree slope.

On slopes, dig a trench 600 mm over the crest, 300 mm wide and 300 mm deep.

Unroll bio- textile and install into the trench, making sure that the pre-sowed bio-textile remains attached to the ground.

Secure to the centre of the trench using U-shaped staples, 20 cm in length and 6 mm in diameter.

Unroll from top to bottom making sure that it remains attached to the ground and secure it to the roll edges, slightly overlapped, using U-shaped pegs, placed at a variable distance, depending on the inclination and on the location and terrain features.

On average, 1 peg every 1-2 square metres of geo-mat. ou might notice it does not perfectly adhere to the soil. cover and consolidate the trench.

Another consideration was the use of stacked recycled tyres

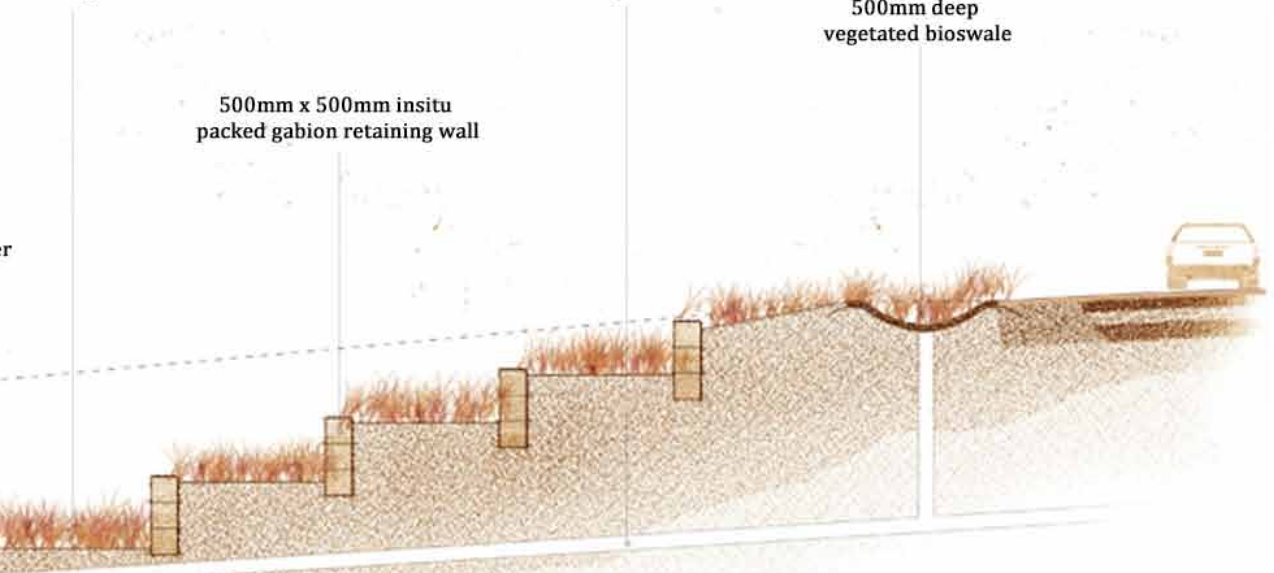
Detail A: Soil mound stabilization

soil to sit 300mm below gabion

350mm storm water pipe connecting swale to dam

500mm deep vegetated bioswale

500mm x 500mm insitu packed gabion retaining wall



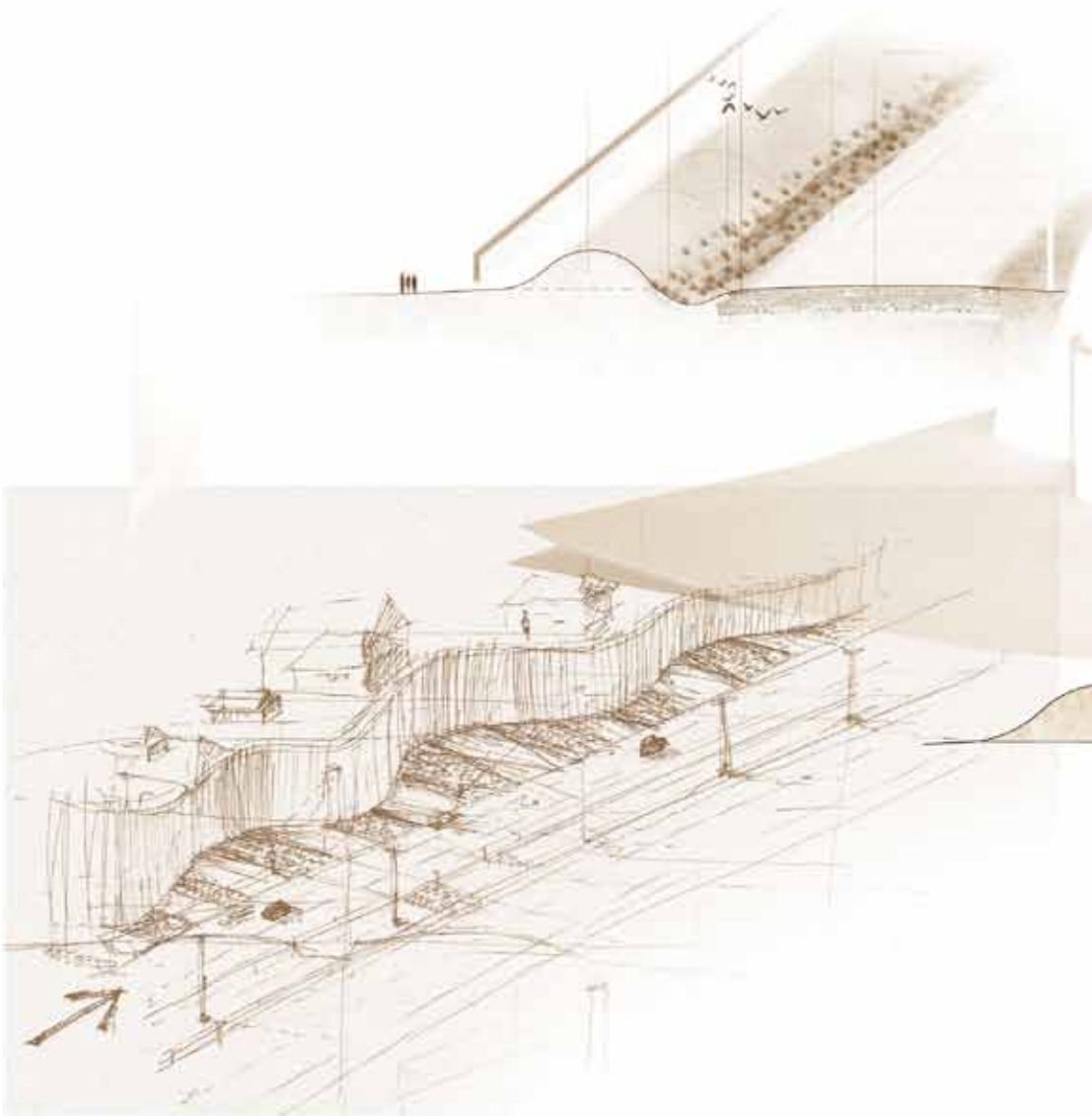
Detail B: Road-dam edge

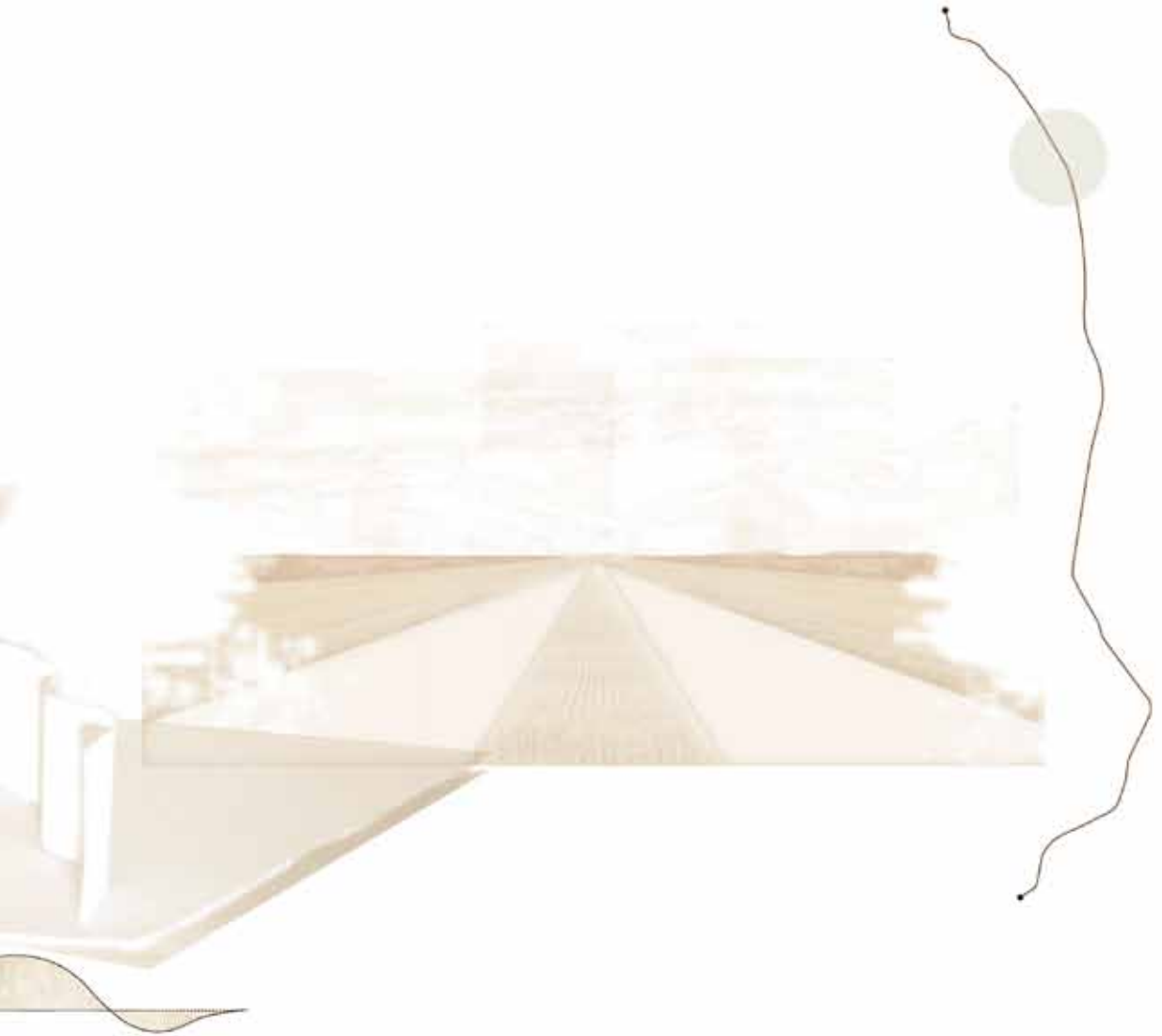




Figure_5.25. Site C perspective (Author,2015)

This site is investigated
on a conceptual level
only.





Site D Sound barrier

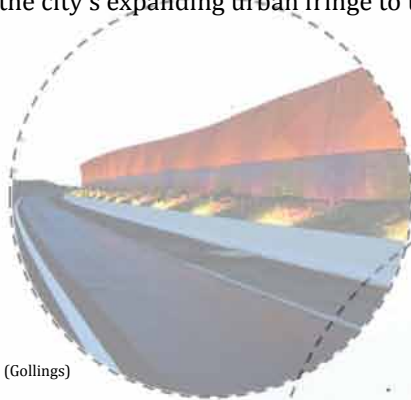
1.4 Acoustic barrier

As part of a new freeway construction project connection to northern Melbourne, the Federal Government, undertook a competition for the design of a gateway aspect and noise attenuation features.

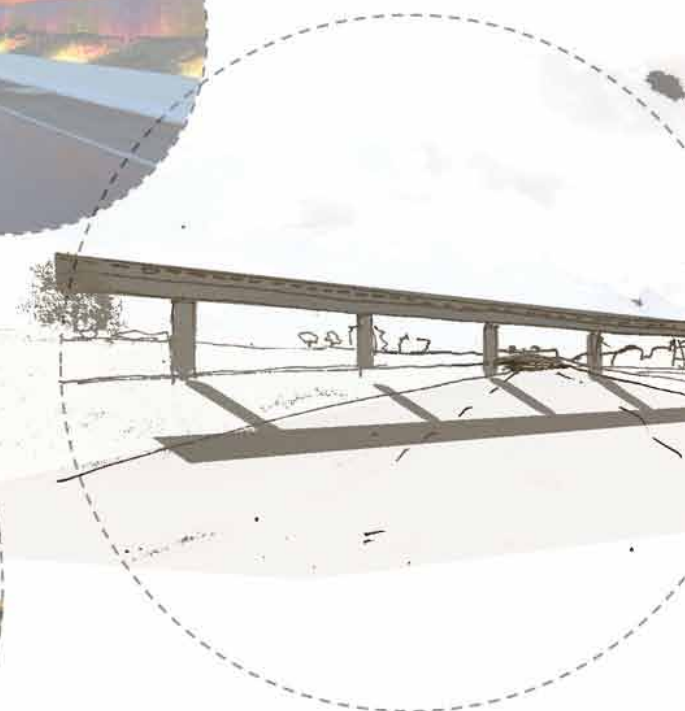
The design competition was awarded to Taylor Cullity Lethlean, Tonkin Zulaikha Greer and Robert Owen in 2003. The winning design, comprising walls, bridges and landscapes, was informed by a poetic reading of the site and a freeway environment largely experienced at speed. (Tonkin) In particular the design explores how otherwise static objects begin to exhibit dynamism or are activated by the travelling motorist. Two wall types were developed each distinctive and responding to their adjacent condition.

The 'Curtain Wall' a long sinuous steel ribbon is fluid in its form, dynamic and experiential. The 'Scrim Wall' by contrast is located alongside a residential interface and is composed of patterned acrylic panels and repeated louvres.

The project is not a problem-solving-based solution, but rather a creative response to concepts of movement, arrival and reference. The design was born out of the need to re-route the Hume Highway and the tension along the selected bypass route between the basalt plain grasslands to the west and the city's expanding urban fringe to the east.



Figure_5.27. Craigieburn bypass (Gollings)

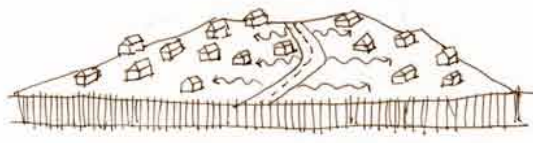


●●●●●●●●●● Movement

■ Absence of landmark



brick walled and gated communities



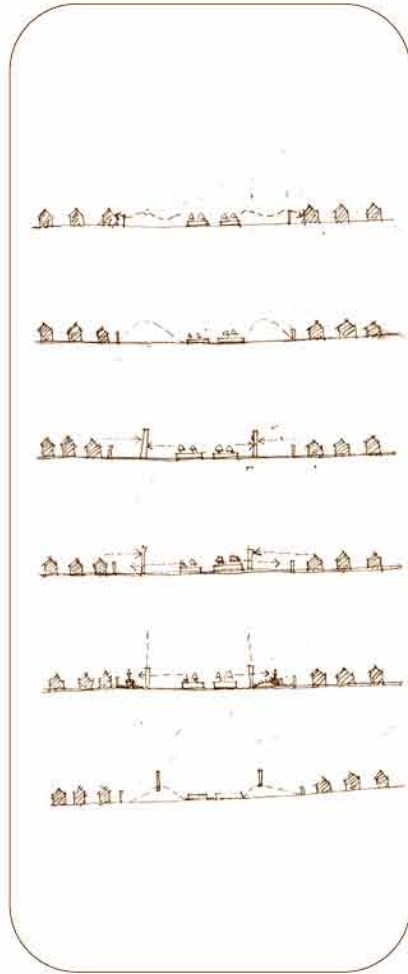
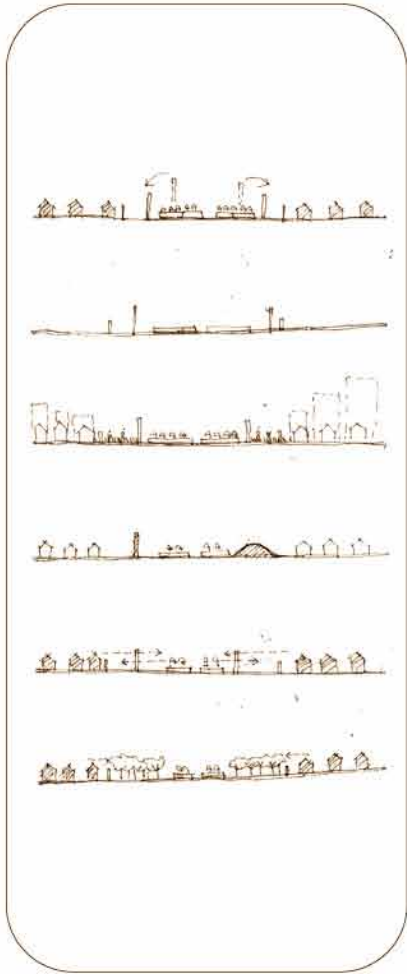
Noise pollution



residential land use

Figure_5.28. Site D site analysis (Author, 2015)





exploring possibilities of sound barriers
in context



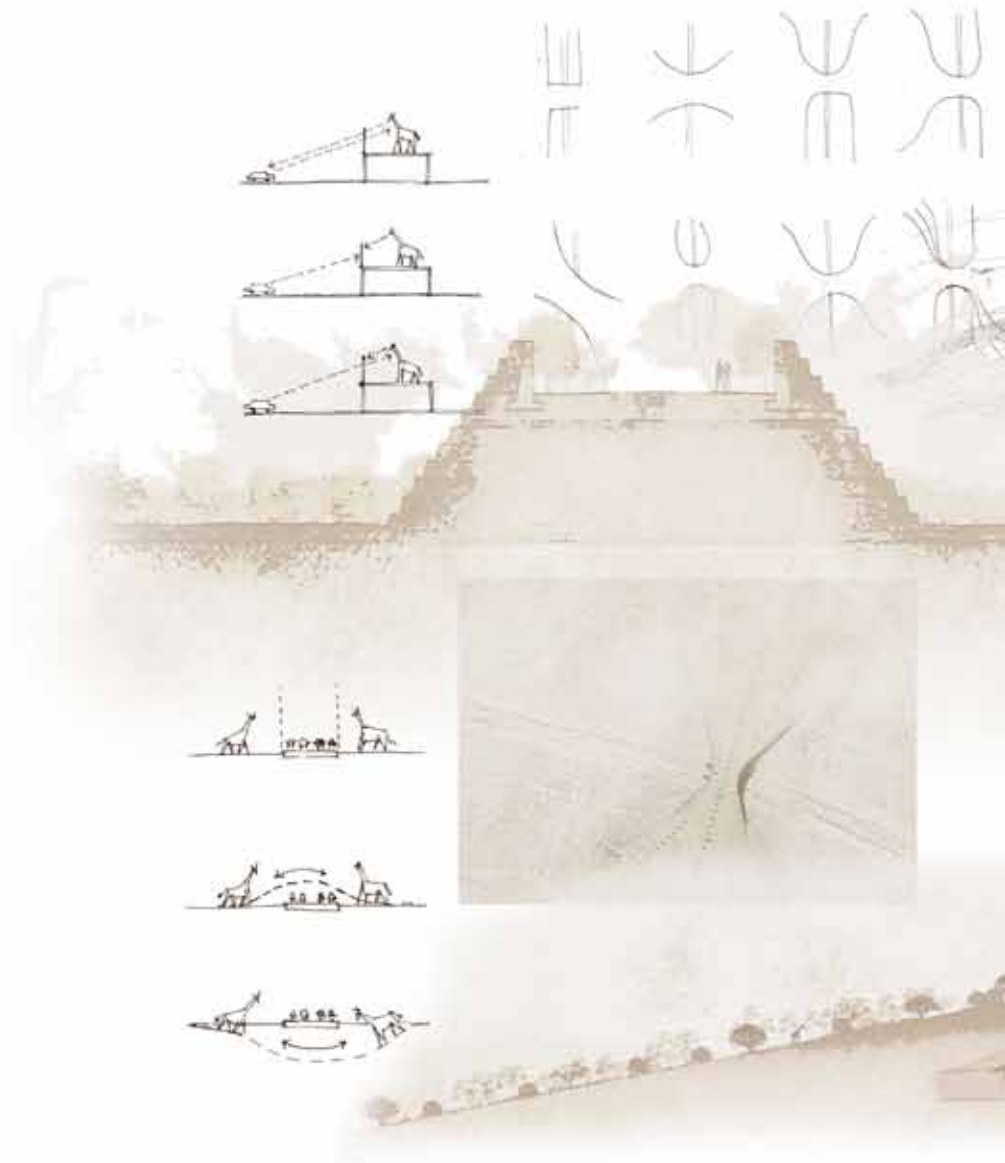


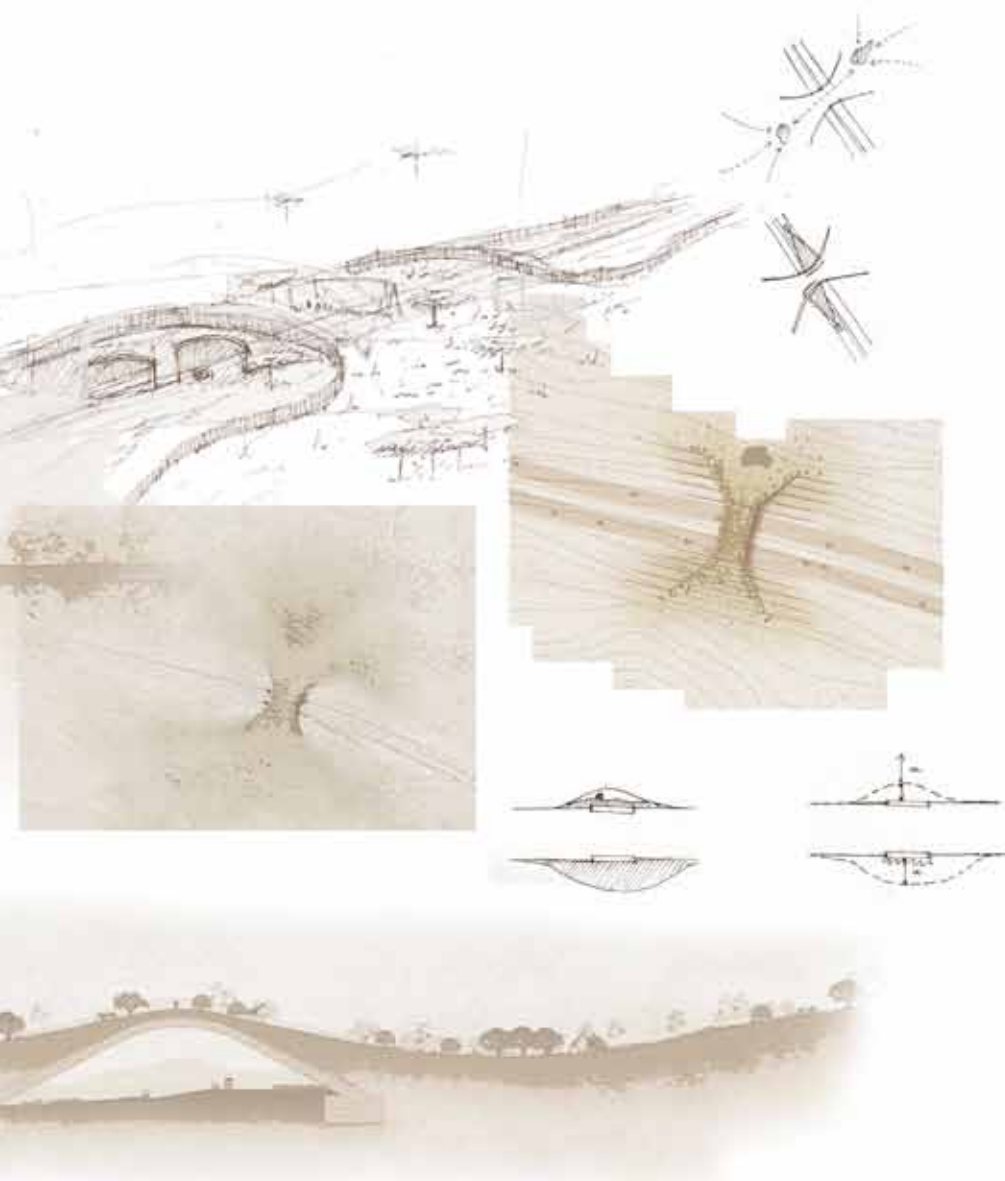
concept image of fluid
acoustic wall

The view from the road

Figure 5.29. Site D site analysis (Author, 2015)

This site is investigated
on a conceptual and
detailed design level.





Site E Animal bridge

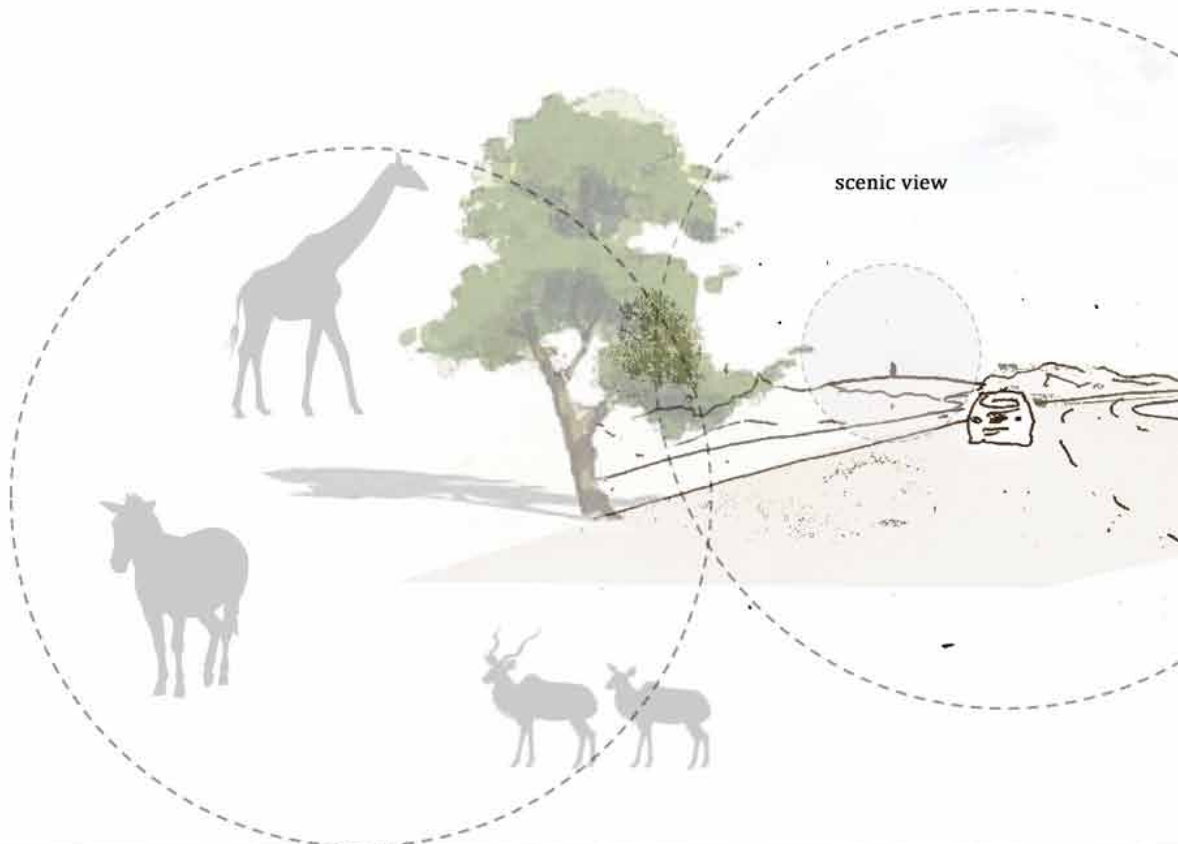
1.5 The ecological link

Spatial considerations in landscape typology suggest that areas connected by corridors are better than isolated areas for increasing the potential range of species. Larger areas are preferred over smaller areas which have greater population capacity, which makes them more resilient. (Oberholzer, 2014:63)

The R21 freeway acts as a divide between two protected nature reserves in the Tshwane municipality district. The landscape design intention is to connect these ecological units.

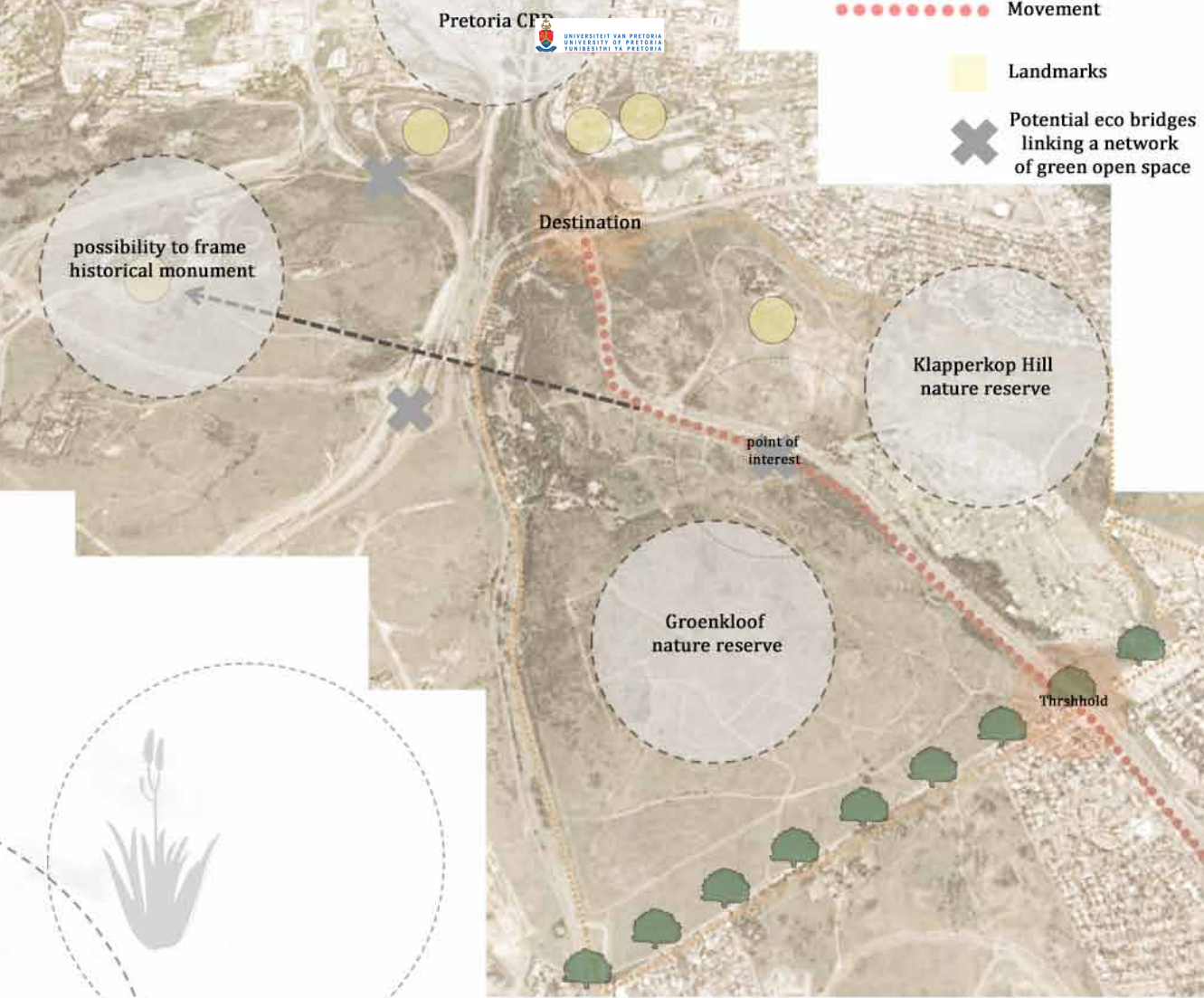
The parks provide other recreational activities such as mountain biking and trail running, a restaurant and picnic areas. The proposed connection may serve as more than an animal passage way, but a recreational facility too.

The proposal will aim to reflect the conservation area by housing a series of threatened grass aloes. Shale geology also forms an important aspect of the area and is considered as structural material which may be made visible to the driver.

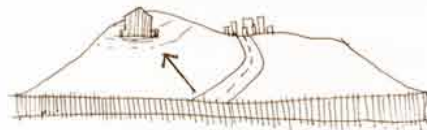


Landmarks

Potential eco bridges linking a network of green open space



Figure_5.31. De Borkeld animal crossing (Freeman, 2012)



Historical monument



Stable ecology

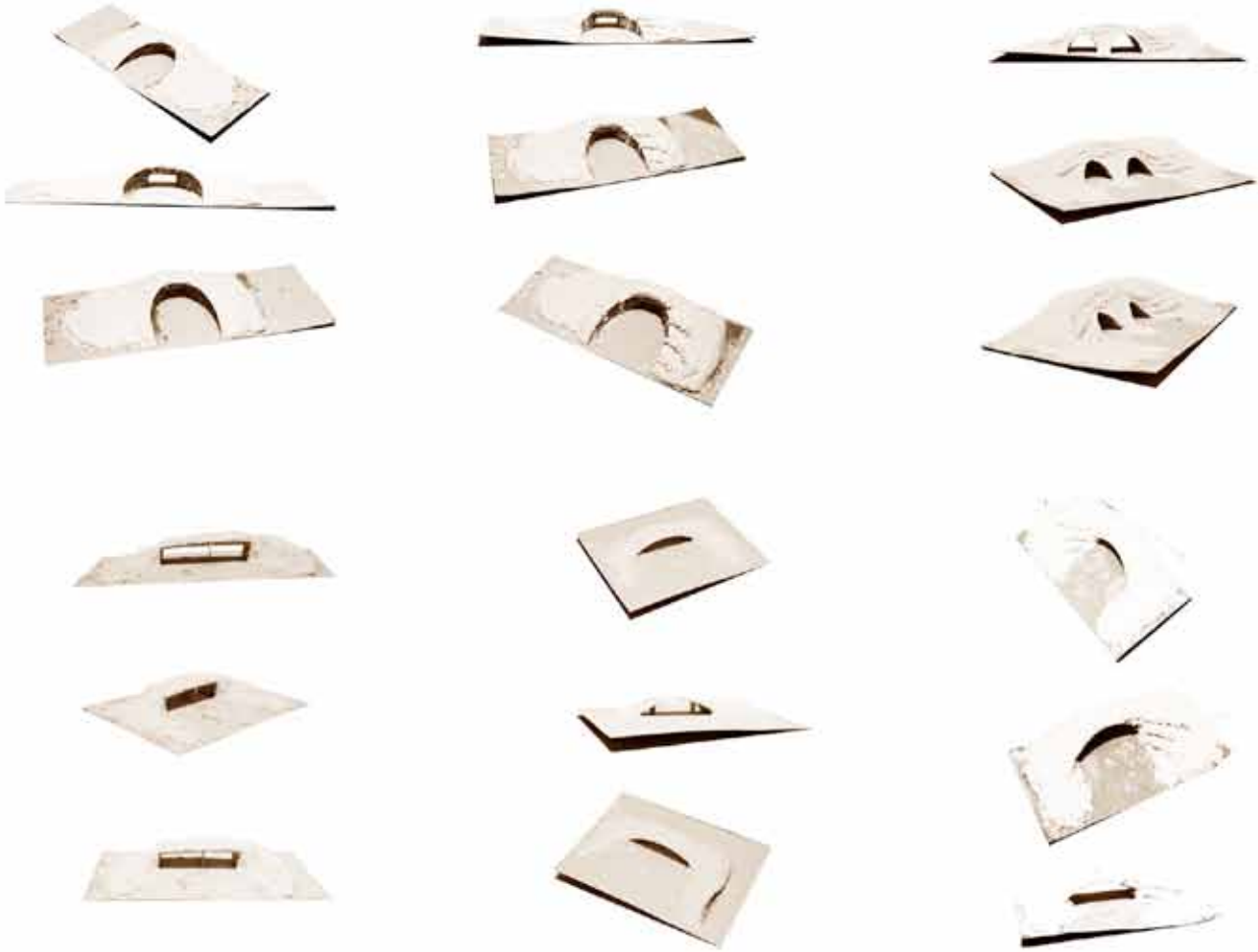


Conservation sites severed by road

Figure_5.32. Site E site analysis (Author, 2015)



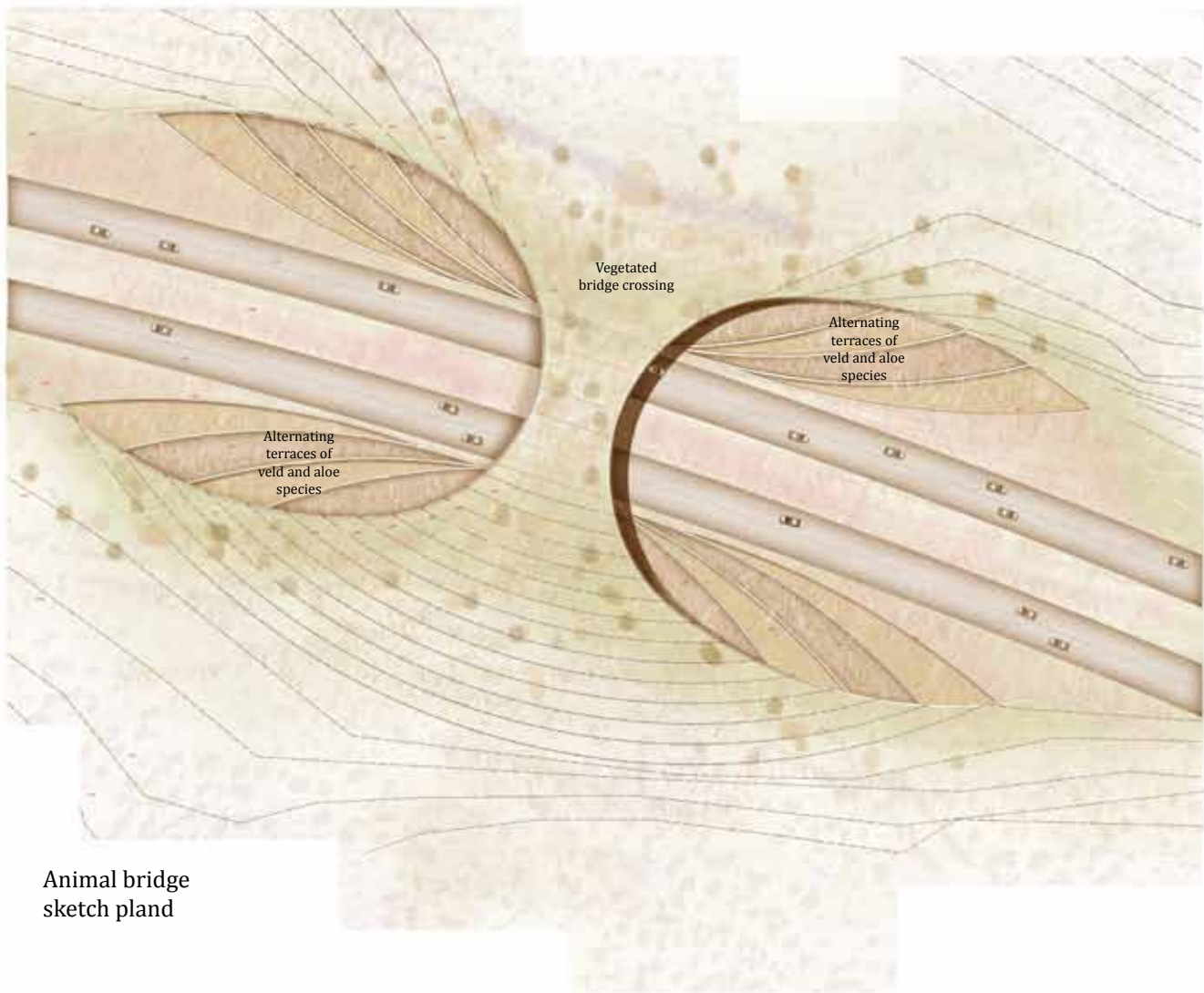


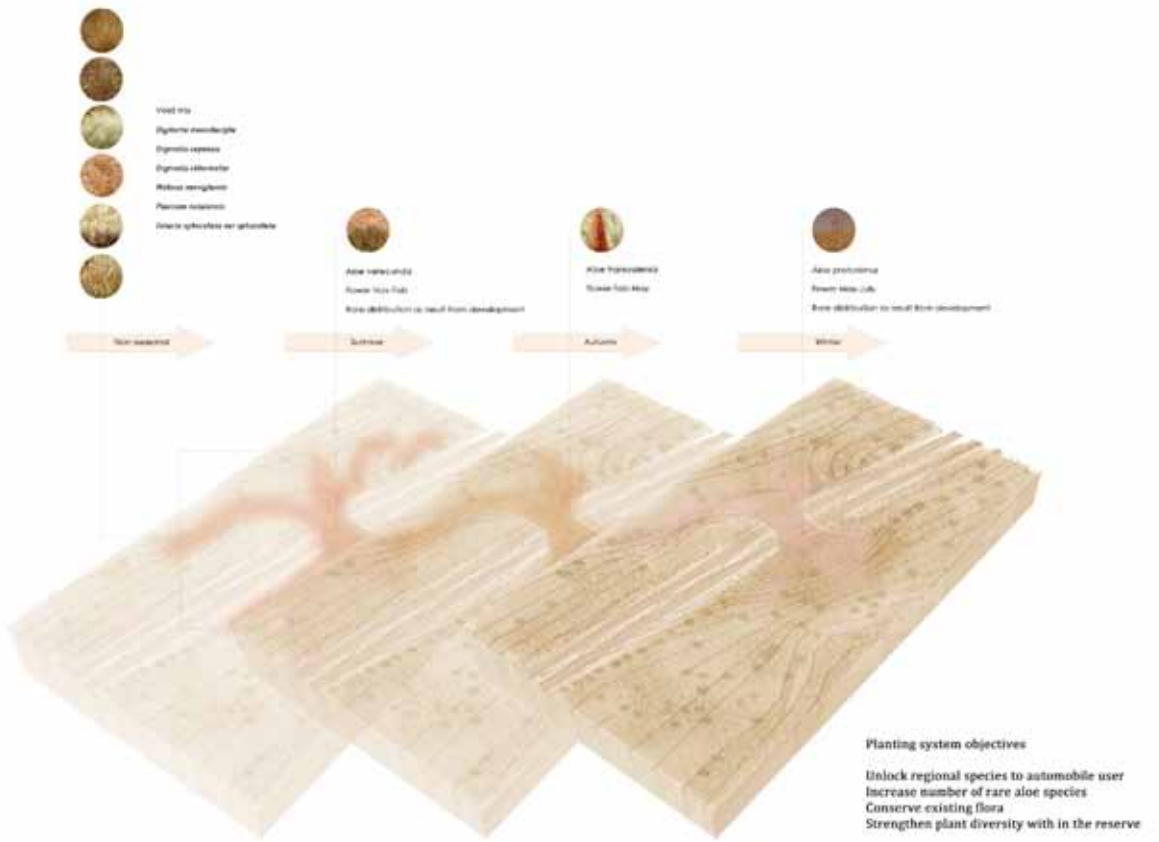


series of clay models by author investigating animal crossing options



Contour manipulation model





Figure_5.36. Site E planting strategy (Author, 2015)

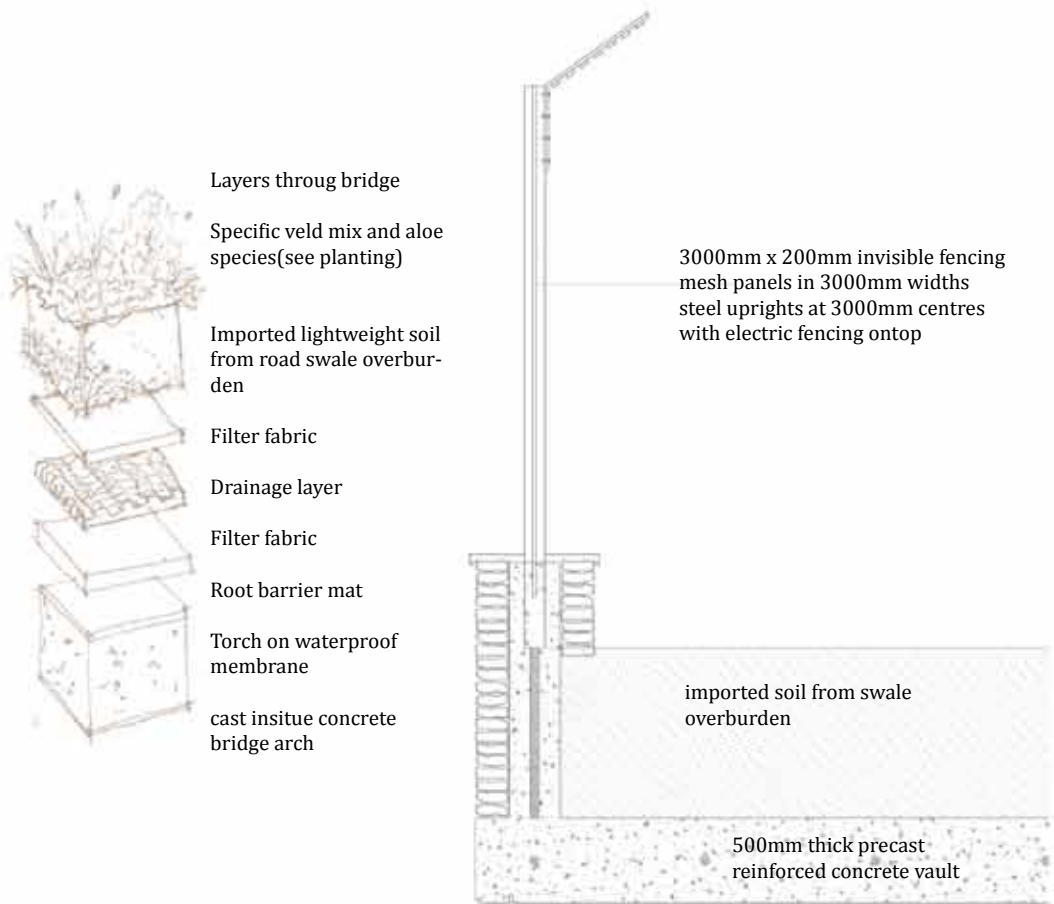
3000mm x 200mm invisible
fencing
mesh panels in 3000mm widths
steel uprights at 3000mm
centres

1000mm x 1000mm
gabion basket
retaining walls
separation of aloe
and grass
species in absence of
grazing

1000mm x 1000mm
gabion basket retaining walls
separation of aloe and grass
species in absence of grazing

wall level to be minimum
of
500mm above retained
ground level

soil level to sit 300mm
below gabion basket



Figure_5.37. Site E detail design images (Author, 2015)





Figure_5.38. Site E perspective (Author, 2015)

Chapter 6

Conclusion



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A word in closing

This dissertation explored how a landscape design intervention may strengthen the experience of regional identity along a freeway. This could be achieved by embracing and protecting the elements of our natural and man-made environments that make them unique, be they a view, a landmark or an abandoned quarry. The investigation considered a freeway route connecting O.R Tambo International Airport to the capital city of Pretoria, which became the testing ground through which to unlock the regional landscape.

Although the dissertation provides no evidence of an enhanced experience it further more challenges the reader about issues concerning regional character, and specifically aesthetic values related to the Gauteng Highveld regional landscape.

The dissertation serves as a challenge to the discipline of landscape architecture and our role along freeways.

Appendices

WATER MANAGEMENT MODEL

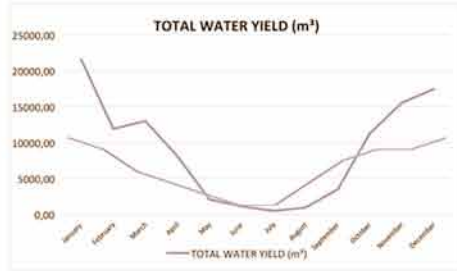
A WATER RESOURCE INFORMATION (YIELD, m³)

A1 RAIN WATER HARVESTING DATA

DESCRIPTION	AREA (m ²)	RUNOFF COEFF. (C)
Roof structures	0	0,9
Paving A	198371,6	0,8
Paving B	0	0,7
Lawn	0	0,1
Other	0	0,3
TOTAL AREA (A)		198371,60
WEIGHTED C		0,80

A3 TOTAL WATER YIELD

MONTH	AVE RAINFALL , P (m)	CATCHMENT YIELD (m ³) (Yield = PxAxC)	ALTERNATIVE WATER SOURCE (m ³)	TOTAL WATER YIELD (m ³)
January	0,136	21582,83	0,00	21582,83
February	0,075	11902,30	0,00	11902,30
March	0,082	13013,18	0,00	13013,18
April	0,051	8093,56	0,00	8093,56
May	0,013	2063,06	0,00	2063,06
June	0,007	1110,88	0,00	1110,88
July	0,003	476,09	0,00	476,09
August	0,006	952,18	0,00	952,18
September	0,022	3491,34	0,00	3491,34
October	0,071	11267,51	0,00	11267,51
November	0,098	15552,33	0,00	15552,33
December	0,110	17456,70	0,00	17456,70
ANNUAL AVE.	0,674	106961,97	0,00	106961,97



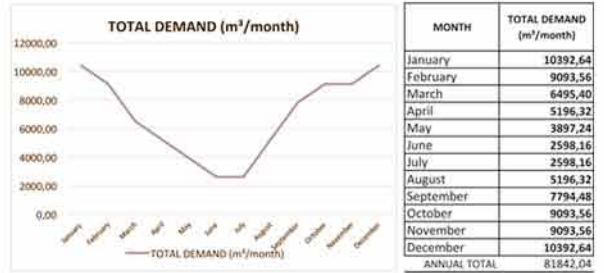
B WATER DEMAND

B3 EVAPORATION LOSS (For 'open' reservoirs)

MONTH	EVAPORATION RATE (m/week)	EVAPORATION RATE (m/month)	TOTAL LOSS (m ³ /month)
January	0,04	0,16	10392,64
February	0,035	0,14	9093,56
March	0,025	0,1	6495,4
April	0,02	0,08	5196,32
May	0,015	0,06	3897,24
June	0,01	0,04	2598,16
July	0,01	0,04	2598,16
August	0,02	0,08	5196,32
September	0,03	0,12	7794,48
October	0,035	0,14	9093,56
November	0,035	0,14	9093,56
December	0,04	0,16	10392,64
ANNUAL TOTAL	0,32	1,26	81842,04

35mm - 45mm/week in summer

B4 TOTAL WATER LOSS & DEMAND

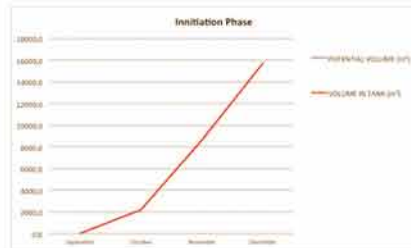


C WATER BUDGET

RESERVOIR CAPACITY (m ³):	38000
MIN VOLUME (m ³):	0

C1 WATER BUDGET

MONTH	YIELD (m ³ /month)	DEMAND (m ³ /month)	MONTHLY BALANCE	POTENTIAL VOLUME (m ³)	VOLUME IN TANK (m ³)
September	3491,3	7794,5	-4303,1	0,0	0,0
October	11267,5	9093,6	2173,9	2173,9	2173,9
November	15552,3	9093,6	6458,8	8632,7	8632,7
December	17456,7	10392,6	7064,1	15696,8	15696,8
ANNUAL AVE.	47767,9	36374,2	11393,6		



C2 WATER BUDGET

MONTH	YIELD (m ³ /month)	DEMAND (m ³ /month)	MONTHLY BALANCE	POTENTIAL VOLUME (m ³)	VOLUME IN TANK (m ³)
January	21582,8	10392,6	11190,2	26887,0	26887,0
February	11902,3	9093,6	2808,7	29695,7	29695,7
March	13013,2	6495,4	6517,8	36213,5	36213,5
April	8093,6	5196,3	2897,2	39110,7	38000,0
May	2063,1	3897,2	-1834,2	37276,6	36165,8
June	1110,9	2598,2	-1487,3	35789,3	34678,5
July	476,1	2598,2	-2122,1	33667,2	32566,5
August	952,2	5196,3	-4244,1	29423,1	28312,3
September	3491,3	7794,5	-4303,1	25119,9	24009,2
October	11267,5	9093,6	2173,9	27293,9	26188,1
November	15552,3	9093,6	6458,8	33752,6	32641,9
December	17456,7	10392,6	7064,1	40816,7	38000,0
ANNUAL AVE.	106962,0	81842,0	25119,9		

