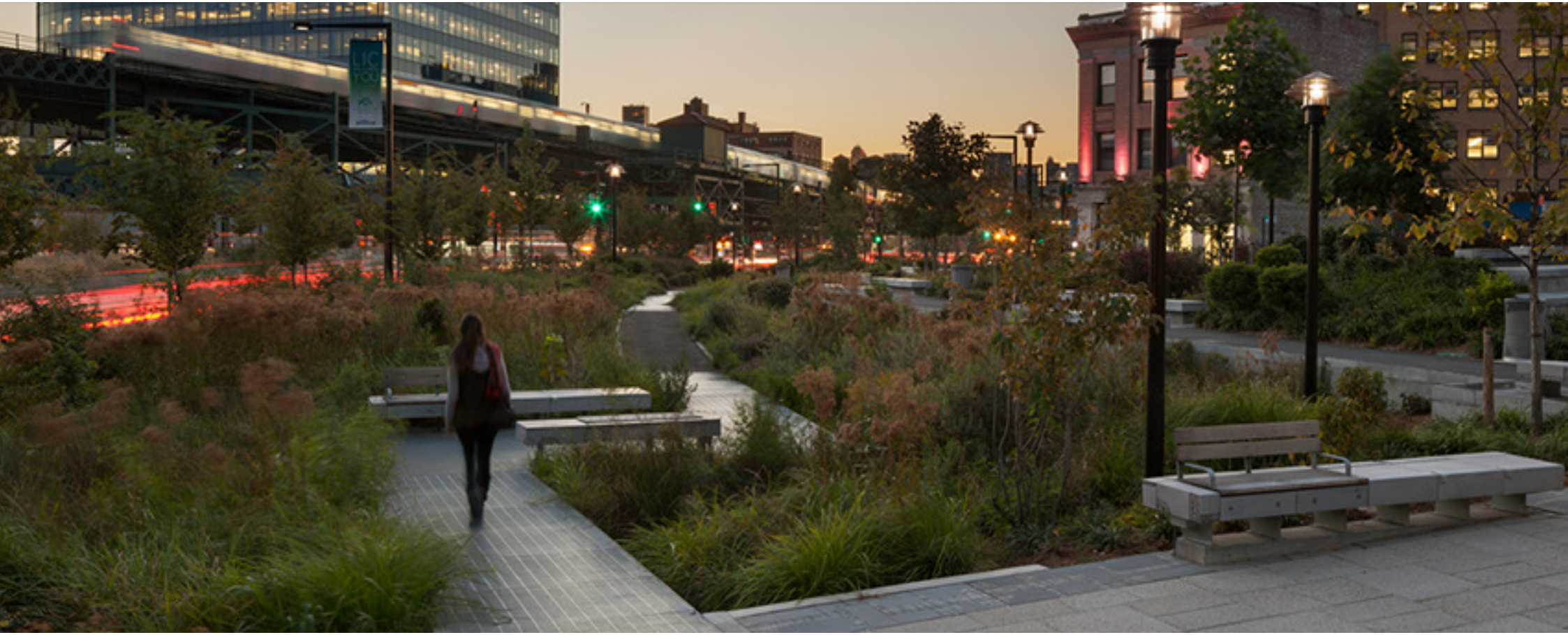
# Healing Landscape

[Regenerating the cityscape with regard to healing potential of the biophysical environment]

Mariska Coetzee | Department of Architecture | University of Pretoria

Figure 1 Biodiversity within the city (http://www.eventbrite.com)



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|---|---|
| Full Dissertation Title: | Healing Landscapes: Regenerating the cityscape with regard to healing potential of the biophysical environment. |
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In accordance with Regulations 4(e) of the General Regulations (G.57) for Dissertation and Thesis, I declare that this dissertation which I hereby submit for the degree Master of Landscape Architecture (Professional) at the University of Pretoria, is my own work and has not previously been submitted by me for any 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 references is made to the works of others, the extent to which that work has been used is indicated and fully acknowledged in the text and list of references.

Signature:
Mariska Coetzee

**Project Summary**

| | |
|---|---|
| Site Description: | The site is located within the city, an ideal location for implementation of the theory behind the project. |
| Client: | City of Tshwane:<br>City Planning and Environmental Management Department |
| Users: | City dwellers from the surrounding area |
| Site Location: | The site is located between Scheiding Street, the Metro and Gautrain railway lines, Van Der Walt Street and Nelson Mandela Drive. |
| GPS Coordinates: | 25º 45.43'' 50' S<br>28º 11'' 21.03' E |
| Architectural Theoretical Premise: | A regenerative landscape which will have a regenerative affect on the human development (mental and physical wellbeing) |
| Architectural Approach: | A regenerative approach to landscape |
| Research Field: | Environmental Potential |

Figure 2 Reintroducing nature into the city (http://www.city-data.com)


## Acknowledgements

I dedicate this dissertation to the Landscape Architect of Landscape Architects that permits me to be a junior partner in His creation of Landscapes.

Thanks to my study leader; Fourie Pieterse, studio master; Author Barker, course leader; Professor Piet Vosloo and all other lecturers who played a significant part in my education.

And I am grateful to my family, friends and my boyfriend for all their support throughout the year.

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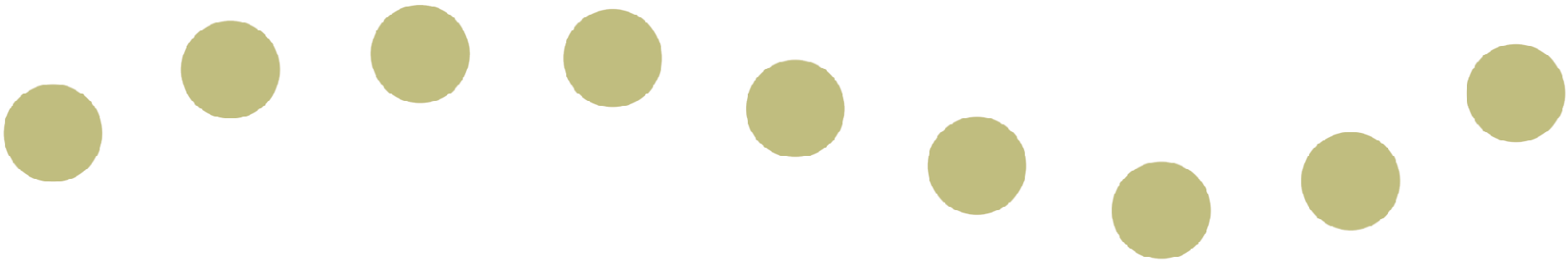
## Abstract

The chosen project is a response to the need of human beings to connect with nature. It demonstrates how landscape architecture can help to develop recreational open space that improves the natural systems within the city and ultimately enhance human and ecological wellbeing. The proposed solution will investigate the relationship between population growth, urbanisation, open space requirements and how to fulfil the need to connect with an ecologically sound environment in order to create responsive landscape architecture. The aim is to steer away from a mono-functional landscape but to design ecologically functional spaces that will address the public need and be the intermediate biophysical connection.

Open space typologies are investigated in relation to their functionality within the urban environment. Spatial requirements according to the CSIR guidelines are used in order to determine whether existing open spaces provision is adequate. The scales of investigation range from microscopic research to the implementation of the design. Recreational facilities should be included according to the need thereof. The proposed facility is thus composed out of various different programmes, each with its own specific requirements. The composition of the open spaces is according to the CSIR's settlement development requirements, proposals done by Encha Properties and MDC (Pty) Ltd. A proposal by Tshwane identifies open spaces in general and to complete the intermediate biophysical connection the design propose a general programme assigned to other unidentified adjacent spaces along the Apies River.

The spaces can broadly be divided into recreational open space, educational recreation, sports recreation, cultural recreation, and some mixed use spaces.

The Apies River serves as connector between spaces, as an opportunity to create a green corridor along which people, plants and animals can migrate



## Abstrak

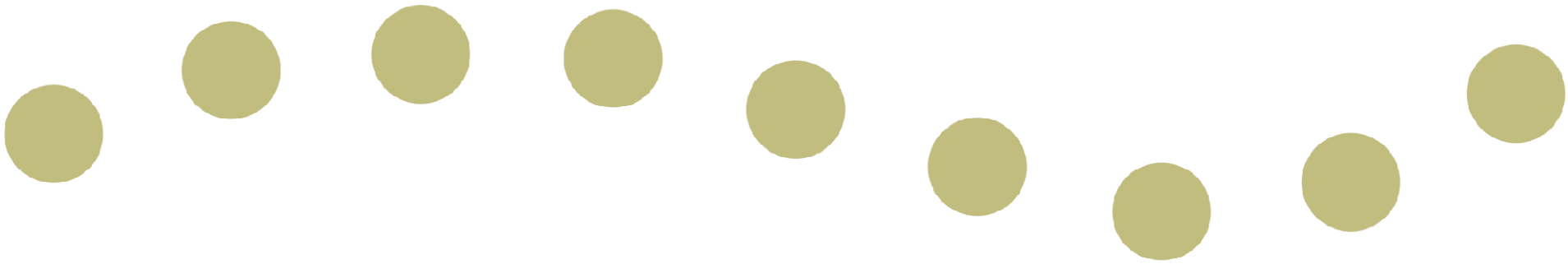
Die verkose projek is n reaksie op die nood van mense om in aanraking te wees met die natuur. Dit demonstreer hoe landskap Argitektuur n oop ontspannings ruimte kan ontwikkel wat natuurlike sisteme in die stad ondersteun en verbeter en uiteindelik mense en ecologiese welstand verbeter. Die voorgestelde oplossing sal die verhouding tussen populasie groei, verstedeliking, vereistes vir oop ruimtes ondersoek en hoe dit die nood om in aanraking te wees met n ekologiese ryk omgewing vervul om ten einde n landskap te ontwikkel wat daarop reageer. Die doel is om weg te beweeg van mono-funksionele lanskappe maar om ekologiese funksionele ruimtes te ontwerp wat die publieke nood adresseer wat ook n intermediêre biofisiese konneksie is.

Oop ruimte tipologies word ondersoek in verband met die verhouding tussen die funksionaliteit binne die stads omgewing. Ruimtelike vereistes volgens die WNNR riglyne word gebruik om te bepaal of die huidige oop ruimtes voldoende is en onspannings faciliteite moet volgens die nood daarvan geimplienteer word. Die skale van ondersoek strek van mikroskopiese navorsing tot implimentasie van die ontwerp voorstel.

Die voorgestelde fasiliteite is dus saamgestel uit verskillende programme, elkeen met n spesifieke vereiste. Die samestelling van die oop ruimtes is volgens die WNNR's nedersetting ontwikeling vereistes, vorige ontwikkelingsvoorstelle is gedoen deur Encha Properties and MDC (Pty) Ltd. 'n Voorsetl deur Tshwane identifiseer en groepeer ruimtes in algemeen en in voltooiding van die intermediêre biofisiese konneksie stel die ontwerp voorstel n algemene program voor vir die ongeidentifiseerde ruimtes al langs die Apies Rivier Gang.

Die ruimtes kan breedliks onderskei word tussen oop ontspannings ruimtes, opvoedkundige ontspannings ruimtes, sport ontspanning, kulturele ontspanning en ander gemengde gebruik ruimtes.

Die Apies Rivier Gang sal as die aansluitingsmeganisme tussen ruimtes wees, om geleentheid te skep vir n groen gang waar langs mense, plante en diere kan migreer.



# Chapter 1
# Introduction

## 1.1 Review and Reasoning

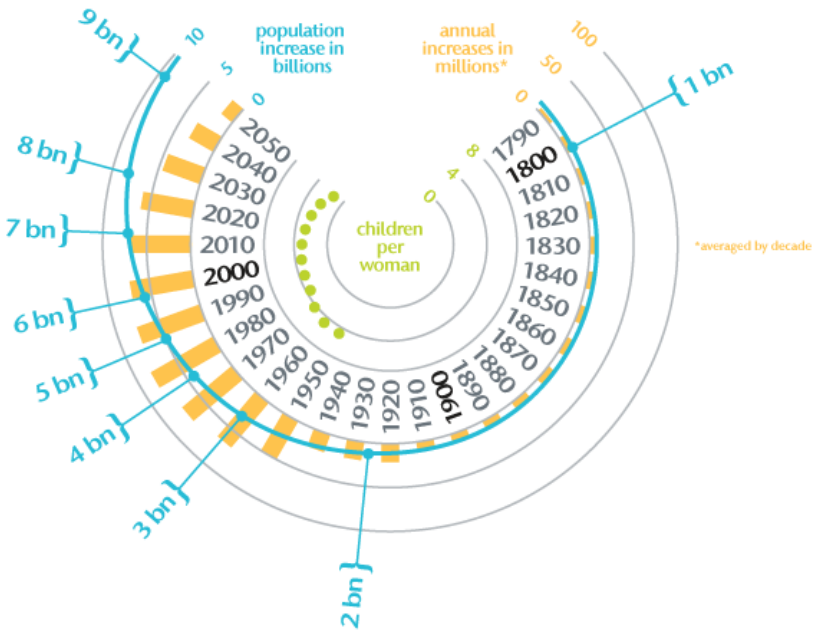



Figure 4 Global Population Stability (Living Green Magazine 2013)

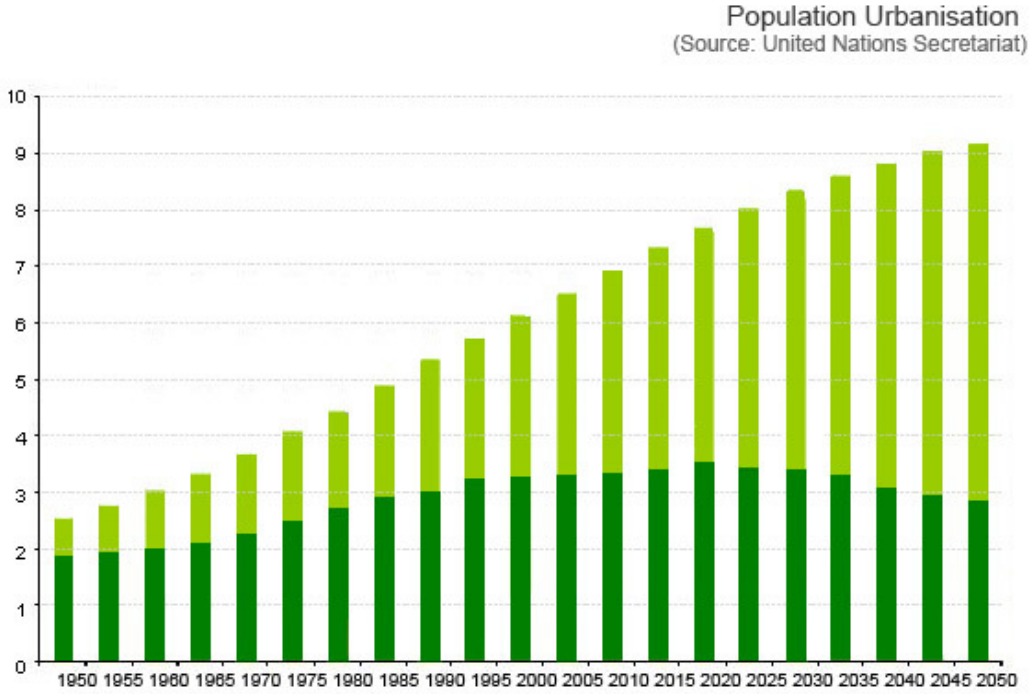



Figure 3 Population urbanisation

According to Fuggle and Rabie in the book Environmental Management in South Africa [27], it is universally accepted that keeping up with present trends, we must expect an urban population growth spurt and development to happen. It is estimated that 60% of the global population will be living in urban areas by 2030 (figure 1).

Human population growth rate is currently 1.2% per annum. Most of the growth occurs in the nations with high poverty levels, showing the direct link between high population growth and low standards of living. The nations with high standards of living generally have low or zero rates of population growth; in South Africa the rate is 1.3% per annum. It is not particularly high but it is definitely not a balanced rate; this can ultimately cause problems of spatial demand. This will lead to expansion of city borders; taking up more land, making it less ecologically stable and more vulnerable to natural hazards in the years to come, leading to a reduction in quality of life and difficult access to open space.

The fact that development often suggests urban sprawl (Fuggle et al 2000); implies that natural corridors are diminished as well as undervaluing the biophysical environment and its goods and services (natural environmental systems that directly benefit humans) that are provided for free are taken for granted. These environmental systems perform a variety of functions that are essential to human health and welfare (Largo 2001). If people do not realize the importance of the landscape's ecological infrastructure not only will natural ecosystems diminish but also human wellbeing will suffer.

The current state of wellbeing of human beings within an urban environment of South Africa is not a given statistic but according to the Economic and Financial Science Journal; South Africans experience higher levels of well-being living outside the main urban areas.

*"Physical settings influence human inhabitants and contribute to their well being and satisfaction."* URBEM Aesthetic Evaluation

These problems highlight the opportunity for development of ecologically focused open spaces within the city. Development should occur in areas best situated to allow for protection of intrinsic environmental systems (Largo 2001) [22] and provide for interaction and exchange between man and nature.

People need to realize the importance of the biophysical environment and its systems and its benefits for human development and wellbeing. Therefore development of space within the over populated dense cities should take inspiration from a regenerative stance which can accommodate for progressive development **and** human wellbeing (Gerlach-Spriggs, Kaufman & Warner Jr. 1998) [18].

The Tshwane Open Space Framework suggests that open spaces and recreational spaces are an essential element within our cities (figure 23 depicts open space as an entity where the roots and upper most branches start and end with 'natural' spaces. The idea is to develop open space in order to branch out into a 'green' ecological and recreational network bringing the city to life). These spaces need to be developed in terms of its ecological, socio-economic, cultural and place-making functions which interact with one another by means of a coherent system which ties man and nature together in a well knit infrastructure that enhance the quality of city life.


Figure 5 Urban Concept Development (Author 2014)

## 1.2. Problem Statement

The users of the densely populated city have a need to improve their quality of life. Life within the urban environment can be improved by fulfilling the subconscious need to connect with nature. This can be done by providing adequate interaction with the biophysical environment through open space. It is important to analyse available open space in terms of quantitative and qualitative value in order to determine whether there is enough open space available and whether it is functionally sound to accomplish an enhancing environment.

## 1.3. Hypothesis

All human beings have the subconscious need to connect with nature. From a more practical point of view; analysis of the current quantity and quality of open space in relation to open space requirements can reveal how landscape architecture can optimize the open spaces to create a connection between humans and the biophysical environment.

### 1.3.1. Sub-Questions

- What is the relationship of urban population to open space?
- Is the open space within the city adequate according to spatial standards?
- What are the spatial requirements for a functional open space network?
- Can the available recreational facilities fulfil the need of open space – link to nature?

## 1.4. Intention

The aim of this dissertation is to determine whether the spatial requirements within the site context are met in terms of the biophysical environment's potential, and whether it connects people with nature. Furthermore determining spatial interaction between man and the environment and how it can be modified to provide and/or develop open space with an ecological approach to successively enhance wellbeing within the city.

### 1.4.1. General Intention

The aim of this dissertation is to determine whether there is enough open space available within the urban environment to provide access to the biophysical environment; if not, a green space network will be proposed to create a green corridor. The design proposal should incorporate a functional recreational network (green corridor) to form part of a larger system which accommodates nature and its systems to address the need to connect with nature and allow people, plants and animals to circulate and migrate between.

The intention of the intervention will be to find available open space within an urban environment which can be regenerated to subtly strengthen the relationship between man and nature.

### 1.4.2. Theoretical Intention

The theoretical discourse will be informed by the subconscious need identified by many theorists; a need to connect with nature and natural systems (Ruse 2007; Tyson 1998; Wilson 1984). Healing (regenerating) will be the driver to shape a landscape architectural intervention in an appropriate location where the biophysical environment can be accessed daily to fulfil the subconscious need of man to connect with nature.

### 1.4.3. Design Intention

The challenge is to design a responsive programme which address the intentions and include designing an intervention that is sensitive to existing context. The design should exhibit strategies to address problems in the urban environment to create coherence through pulling the biophysical environment into the urban environment.

## 1.5. Objectives

**The objectives of this dissertation are:**

**To create operationally sustainable and resilient environments with:**

- Appropriate materials & technologies
- Appropriate urban context
- Minimize energy usage
- Maximize water harvesting/storing/utilising
- Conservation and rehabilitation
- Re-establish natural systems and biodiversity

**Based on Life's Principles Framework to:**

- Evolve to survive
- Be resource efficient
- Adapt to changing
- Integrate development with growth
- Be locally attuned and responsive

**To regenerate open space within an urban environment by:**

- Expressing the concept of time by integrating elements of old and new
- Spatial definition must be adhered to
- Adding a network of open space
- Addressing the social responsiveness to place and space

## 1.6. Delimitations and Limitations

- The filtering process entails following criteria to find an appropriate site (Chapter 3).
- After the appropriate site is chosen the intentions must be reflected on to determine whether further filtering is needed.
- The site may possess many influencing attributes which will require ongoing research investigations.
- The site may not have been researched enough which will leave a gap of understanding.
- The current conditions may not have been investigated.
- For the purpose of this dissertation however what can be found will be accepted as accurate to facilitate proposals of intervention.

## 1.7. Research Methodology

In order to develop a sound proposal where man and nature can both be adhered to, the relationship between urban population density and open space should be analysed. The urban population density will determine the quantity of open space required to fulfil the need according to Open Space Requirements Guidelines from the CSIR.

Furthermore open spaces should be analysed according to recreational needs (Appendix A) and whether these spaces are environmentally equipped to enhance wellbeing within the urban environment.

In order to find an appropriate site within an urban environment; criteria needs to be followed to find these available open spaces which the design intentions can be applied to. The regenerative intentions of the design need to be investigated to determine the most suitable programme for the space which will help fulfil the need for functionally sound open space. Furthermore research on the site's context needs to be compiled from varied sources in order to assess the current conditions and make informed design decisions. Architectural interventions will be explored to ensure comprehensive and contemporary design solutions are applied. Design tools will help generate the most apt design solution.

## 1.8. Proposed site context

The information provided in the next section is merely a brief introduction of the selected site. An in-depth site selection and analysis is completed in Chapter 3 and 4.

Figure 6 Figure ground & Focus area (Author 2014)

### 1.8.1. Study Area

The most appropriate site identified for the study is Pretoria CBD, more specifically, the corridor stretched from Groenkloof Nature Reserve and the open spaces along the Apies River to the Zoological Gardens of Pretoria. The site is located along the Pretoria CBD gateway, see figure 4. The Apies River will form the spine of the development; it is a significant feature within the city and it is part of an ecological network which will support the intent along to pull nature through the city. The focus area is surrounded by a complex land use matrix which supports the intent and makes it an opportunistic site.

### 1.8.2. Physical Context

The linear site is located in the Elandspoort strip which runs from Fountains Valley through to the Magaliesberg Mountain range. The vegetation is part of the Marikana Thornveld planting community and the site mainly consists of indigenous species but disturbance is evident mainly along the river edge where invasive alien species are recorded as well as pioneer species in some areas.

The topography of the area is mainly flat but falling to the North. The eastern and western edge tapers to the centre indicating that the site sits in a valley.

### 1.8.3. Historical, Cultural & Social Context

The city of Pretoria was found in the immediate vicinity of an artesian water source. This water source (called the Fountains to this day) is unusually strong and consistent – the only water source for Pretoria from 1855 until 1935. Moreover, it yielded (and still does today) water of very good quality.

The first “Boer” homestead in the Pretoria area was probably the home of J.G.S. Bronkhorst, who settled in the Fountains Valley in 1840 (City of Tshwane Pretoria 2011) [26]. Fountains Valley can be regarded as a welcoming feature of the city. Figure 26 depicts Tshwane’s urban environment and the Apies River Corridor with known landmarks and points of interests.

Pretoria was registered as a town on 16 November, 1855. The Commandant-General of the Transvaal Republic, Marthinus Wessel Pretorius, considered it the ideal location for the establishment of a new capital due to its abundant water supply and the natural topography of the area. His motivation for registration was that it was 'well situated to build a city with large and unlimited available area and water'. The town would be called Pretoria in honour of his father, Andries Pretorius, the Voortrekker leader prominent in South African history after his role in Natal between 1838 and 1848.

A remarkable historical engineers' work of the city the NZASM "Nederlandsche Zuid-Afrikaansche Spoorweg-Maatschappij" Bridge was built in 1893. The remainder of the bridge is situated south of the present railway bridge, on the western side of the road. The bridge is built from chiselled rock, about 10 meters high, 5 meters wide and 9 meters deep with two bow openings which overlooked the north and built over the Apies River in the Elandspoort gateway (Geocoaching 2009). The bridge marks the entrance into the city.

The entrance into the city has significant historical context, but is now fragmented. The Elandspoort gateway is known to have the oldest recorded Celtis' in Pretoria, the most prominent of these are still to be seen in the Groenkloof Nature Reserve's northern edge. This edge was known as lover's lane. It opens up into the city, welcoming one with gardens on either side of the Nelson Mandela Drive where an automotive cluster frames the southern part of the site (located between Willow Street and the edge of the Gautrain Bridge).

Running parallel with Nelson Mandela Drive, through the three central open plots is the most significant geographical feature the Apies River. The Apies River precinct features in many proposals of development of the city. It is part of an existing proposal "Overzicht Park Development Proposal, Atterbury & Holm Jordaan (2006)" which was permitted before the now approved Mandela Development Corridor by a joint venture partnership between Encha Properties and MDC (Pty) Ltd. The proposal is to develop a mixed use corridor along the Nelson Mandela Drive in which it is proposed to accelerate higher and shared economic growth and development. Consideration of this proposal is taken since it is an extension of the chosen site.

## 1.9. Problems

- Lacking accessibility to the biophysical environment
- Lack of coherence in the urban environment
- Lack of pedestrian access to and from spaces
- Detachment of recreational spaces
- Fragmented landscape
- Under-utilisation of recreational spaces
- Erosion of Apies river channel embankment
- Water quality decrease to the north
- Planting community recedes
- Ecologies declination

### 1.9.1. Users

The residents of Berea Park have only the Groenkloof Nature Reserve as open space to use. It is bombarded by users over public holidays and it is not accessible by pedestrians from the city.

The chosen strip will serve as a connection from the highly urban environment to the vast natural environments of Fountains Valley and Groenkloof Nature Reserve, using the Apies River as connector from which a design proposal will latch onto.

## 1.10. Opportunities

- A balance between hard urban fabric and soft natural landscape can be created
- Incorporating more of the natural environment into the urban environment
- And adding touches of man-made features into the natural environment
- Using existing context to help users associate with the spaces
- Create nodes to function as a retreat for the everyday city dweller

- Design connection spaces to make access for pedestrians easier
- Create opportunity for interaction with natural systems
- Conserve, preserve and strengthen natural ecologies

## 1.11. Client & Client Brief

The chosen corridor consists of many sites and owners. The programme will suggest that there should be a partnership between the different stakeholders to ensure that there is a shared and common vision. The Client will be The City of Tshwane: City Planning and Environmental Management Department, a framework (Tshwane 2005) [15] provided by the city of Tshwane will serve as the brief for the site.

The Tshwane Open Space Framework suggests that:

- The open space / park should allow for every citizen to associate with the area and build new memories
- The park should function as a retreat, for a daily lunch hour break or a Saturday picnic
- A site should be inspiration for resilient living – catalyst for change
- While the site may be stable, after development, in general outlines for some time, it is ever changing in detail
- Use the site for nature conservation student's practical year experience
- The site should be informed by the surrounding context

## 1.12. Definition of terms

| | |
|---|---|
| Biophysical Environment | Nature |
| Nature | Resource |
| | Ecologies |
| Resources | A resource is a source or supply from which benefit is produced like the environmental systems |
| Ecologies | Interactions among organisms and their environment |
| Open space | Within the urban context – unused space |
| Healing Landscape | It can be soothing in its sensitivity or stimulating in its exuberance. |
| Regeneration | Reshaping especially with improvements or removal of defects; renewing and reconstituting |
| Threshold population | The minimum number of people necessary before a particular good or service can be provided in an area (Wikipedia.org 2014) |
| Natural environmental systems | |

**Table 1 (Largo Jr. 2001)**

| Function | Goods or Services |
|---|---|
| Production | Oxygen<br>Water<br>Food and Fibre<br>Fuel and Energy<br>Medicinal Resource |
| Regulation | Storage and recycling of organic matter<br>Decomposition and recycling of human waste<br>Regulation of local and global climate |
| Carrier | Space for settlements<br>Space for agriculture<br>Space for recreation |
| Information | Aesthetic resources<br>Historic (heritage) information<br>Scientific and educational information |

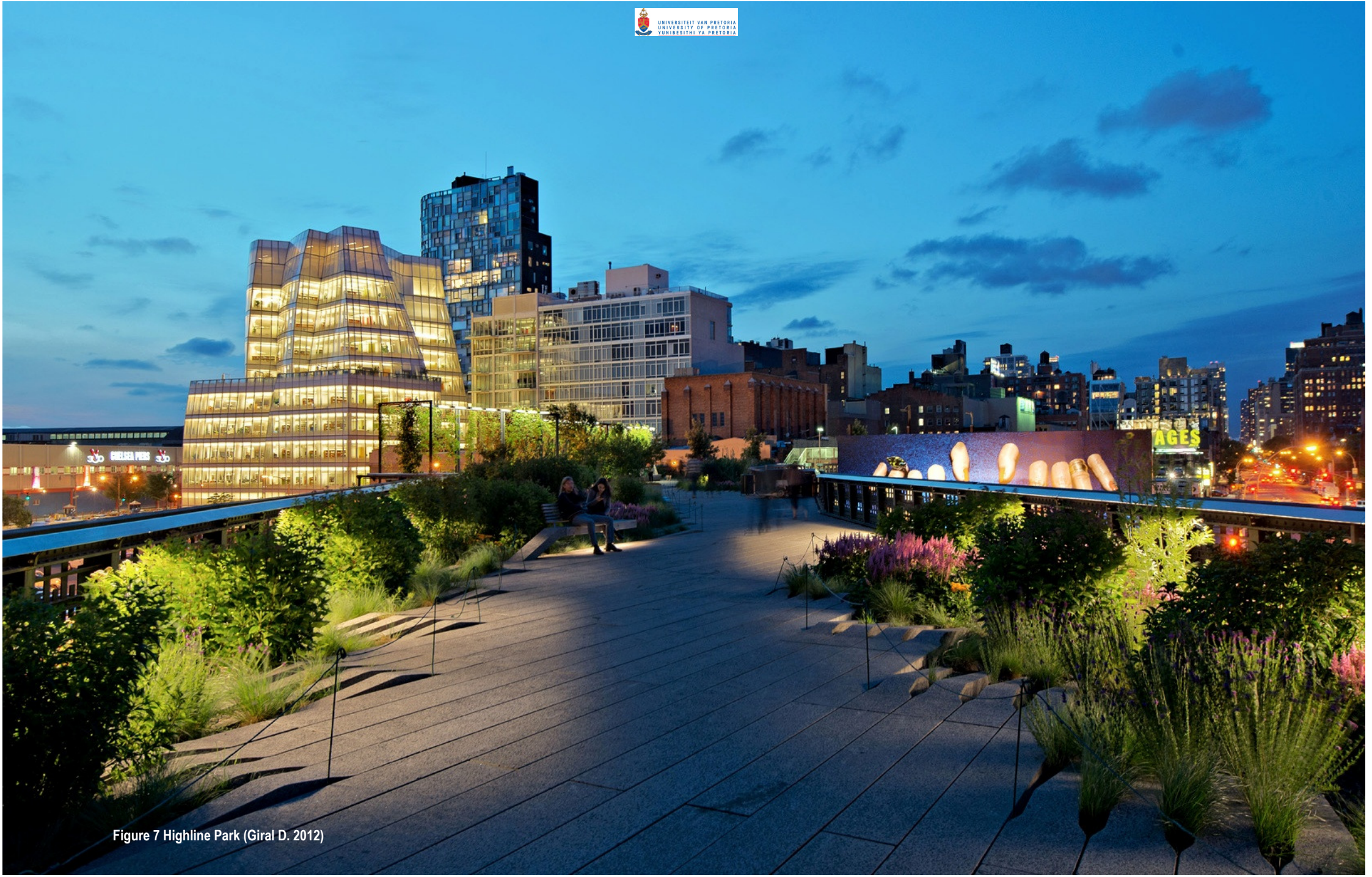



Figure 7 Highline Park (Giral D. 2012)

# Chapter 2
# Theoretical Discourse

## 2.1. Introduction

From the beginning of our existence we were attuned to the natural world. Our sentient specie started out in savannah-like places, with “grassy plains dotted with trees and groves of vegetation, and denser woods near rivers and lakes” (Gerlach-Spriggs, Kauffman and Warner 1998). Jay Appleton, Gordon Orians and Judith Heerwagen suggest that we are attracted to these savannah-like landscapes due to a precognitive basis of survival and the benefits it provides.

As human life evolved and development proceeded people moved further away from the natural settings. This called for incorporation of designed gardens into towns and villas. Nature were brought into the built environment to promote sociability among companions, relaxation and contemplation for solitary visitors, or to create a sense of community among residents who live in quarters around the garden.

Designed landscapes stretched even further with the idea of Healing Landscapes which existed from the medieval times; these healing / restorative / regenerative landscapes were incorporated into hospital designs since it was believed that gardens had a calming effect on the spirit which leads to faster recovery of patients. Charles Lewis gives examples of places where contact with nature makes us feel better. This confirms that we are all evolutionary prepared for the healing benefits of nature.

In contemporary culture the presence of psychological possibilities of these healing landscapes are sometimes neglected or denied. Therefore the idea to reintroduce the concept is the aim of this dissertation.

Through various literature reviews assumption were made leading to concept development. The first source is a hypothesis by Wilson, E.O., which describes how human beings subconsciously have the need to connect with nature and natural systems, this is called Biophilia. The term "biophilia" were first used to describe a psychological orientation of being attracted to all that is alive. Its literal meaning is "love of life or living systems". Edward O. Wilson’s *Biophilia* suggests that our ties to nature are in fact biologically based and part of our evolutionary heritage and he believes that our humanity derives in large part from our connectedness to other species, both flora and fauna. The dissertation will revolve around this biophilic theory and how the connection with the biophysical environment can enhance mental and physical wellbeing.

According to the book Restorative Gardens; nature in more general terms and landscapes has healing power to the ill. *The restorative garden is intended to provide an ordered place where its occupants will experience a sense of well-being and wonder that will alter their mood* (Gerlach-Spriggs, Kauffman and Warner 1998).

The nature of the healing landscape concept is to provide a open space network within the city which grants a sense of comfort, familiarity, identification, meaning, security, a pleasant experience through all the senses and finally to affect mental and physical wellbeing.

This dissertation will try to prove that the theory of healing landscapes and the application of them will fulfil the subconscious need. I would like to prove that intimate contact with a natural environment and its cycles as well as other living biological beings can calm the spirit to ultimately uplift physical and mental wellbeing.

## 2.2. The natural environment

“Open space allows natural systems, without which human beings cannot survive, to function: it purifies water, harbours plant and animal life, cleans the air and is the most threatened by urban development” (City of Tshwane Environmental Planning Section 2006).

(“As humans we are doubly lucky, of course. We enjoy not only the privilege of existence, but also the singular ability to appreciate it and even, in a magnitude of ways, to make it better. It is a trick we have only just begun to grasp” Bryson (2003).)

If human beings, the most advanced specie on earth, can “make it better” then why not strengthen our interdependence and use the potential benefits the natural environment holds? Humans now realise that nature need not be only incorporated into our living environment but that we are fundamentally interdependent of all phenomena and the fact that we are all embedded in and ultimately dependent on the cyclical processes of nature.

As previously mentioned the natural environment provides many benefits to every living being and its system on earth. The potential it holds can not only improve our lives but also heal our shortfalls. The following services are provided to us for free. Many people experience the outdoor world only to have sensuous experience but what they do not realise is the many services nature provides and the benefits it holds. Environmental services are embedded within the biophysical environment which holds benefits for our living and surviving conditions.

The Environmental Service diagram, figure 8, indicates 17 different environmental services provided by Open Space resources. These services are natural systems that occur within the natural environment which either controls, store, produce or provide. Other more basic services provided by the natural environment are fresh air and vitamin D through sunlight.

All these services are crucial to our wellbeing and needs to be respected in order to utilize the benefits it holds.

### 2.2.1. Environmental services

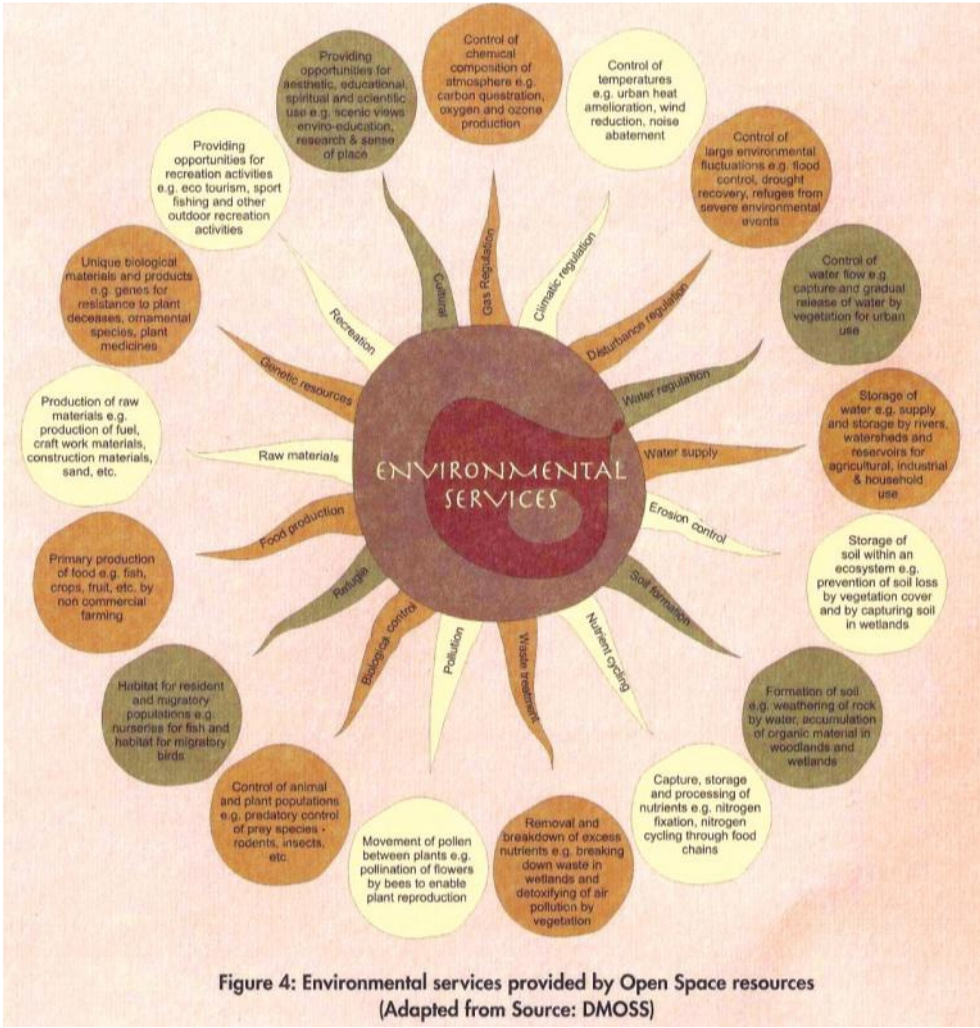



Figure 8 Environmental Services (City of Tshwane Environmental Planning Section 2006)

### 2.2.2. Interaction with nature

There is a need for beauty and good aesthetics. Even the Bowerbirds of New Guinea and Australia appreciates beauty which is evident in their nest building. Human beings have seen how the environment can change the basic brain chemistry like the rat experiment reported by Diamond, M.C., Krech, D. & Rosenzweig, M.R.. Those in deprived environments seem to struggle more, and when looked at it globally, nine percent of the world lives in such conditions. Yet it is now known that there are more than enough resources to go around and that there is enough for everyone if only it is properly managed by planning, sustainable installations, distribution and consumption.

A small change can make a big difference. By providing adequate greenery with aesthetic appeal and opportunity for interaction with the living environment can make major improvement in living environments, which will hopefully allow users to take ownership. Connecting fragmented green open space will fulfil the need for open space in the urban environment. The open space then provides opportunity for animal owners and animal companions to enjoy the space. (Animal companions are animals that stay in the company of humans or providing company to humans (Odendaal 2007)).

According to Professor JSJ Odendaal, his companionship theory, investigates trends regarding companion animals. The most appropriate for this study is the Human-animal interaction contributed much to the understanding of modern human-companion animal relationships. A neurotransmitter tested the interaction between human and companion animal where both parties experienced the positive effects of the interaction. Then the ethology of both owner and animal are assessed to understand basic needs of each in this relationship. This theory can also be a blueprint for the interaction between man and other living species such as plants.

Environmental needs also come into play; enrichment of environments is a well-accepted behavioural principle. The provision of basic life-spaces, including suitable exercise areas is important. With the provision of connected open space within the urban environment will allow sustainable and happy living.

### 2.2.3. Benefits

The benefits of total interaction with the biophysical environment with a friendly companion or just experiencing the aesthetics of the outdoors will have a calming or relaxing sensation successively restoring body and mind.

## 2.3. Theoretical Intention

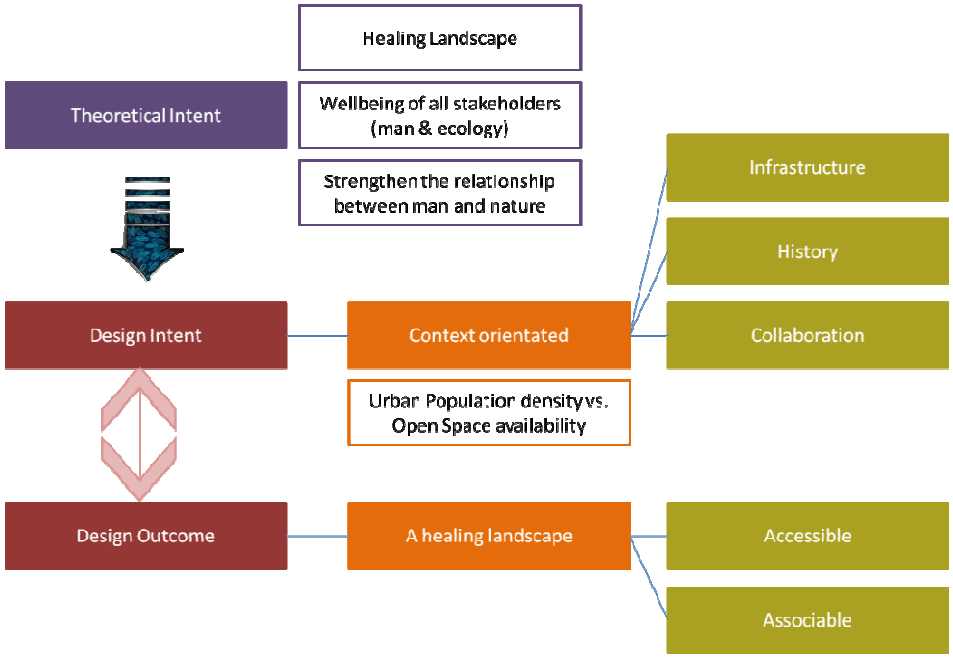



Figure 9 Methodology Diagram (Author 2014)

### 2.3.1. Finding Available Space

Finding a space to implement a healing or restorative landscape can be done by analysing the urban environment through Trancik's theories as well as using one's own site selection matrix informed by the theoretical approach.

In the case of Trancik it is to find space to express the concept of time by integrating elements of old and new. Morphing this idea into my own; to find space with historical or heritage value which can be regenerated into something new with identity and meaning added.

Trancik then describes a space with spatial definition which must be adhered to, a space adding connective quality and addressing the social responsiveness to place and space. Interacting infrastructure can inform design intervention which will provide spatial identification.

Context and site analysis will be the design drivers to follow these approaches. Visual documentation and analysis can be found in Chapter 3 & 4 of the Context analysis.

### 2.3.2. A regenerated space to strengthen the relationship between man and nature

According to the Red Book by the CSIR a nature-centred approach towards development should be taken when developing. In our urban environment this is difficult due to loss of ecological environments, but the remaining natural features, systems and processes should be respected. The nature-centred approach creates a synergy between man-made and ecological systems. This ensures that the developmental needs and activities of people are catered for and, in particular, that opportunity for people to achieve their full potential exists as well as having emphasises on designing with nature.

#### *2.3.2.1. Need for comfortable space*

According to Orians and Heerwagen people prefer spaces with open plains with scattered trees and groves, water, tame grazing animals, refuges and paths that suggest ease and movement. Within the urban environment these preferred spaces are no longer available, therefore open space should be optimized by stitching the open space together to shape a comfortable space everyone can find refuge in.

#### *2.3.2.2. Need for familiar Space*

In order to ensure appropriation of the site and the facilities, it will be important to look at the use and activities of it and maintain its association to the site to ensure a sense of belonging is derived from familiarity of the site.

#### *2.3.2.3. Need for identifiable space*

The identity of a space is associated with its activities and perceived connections to the site and the surrounding environment; this is of utmost importance to become an identifiable space to its users.

#### *2.3.2.4. Need for meaningful space*

According to Must Landscape Mean by Marc Treib 1995 [6] all landscapes must have meaning; meaning in terms of relation to the site's existing natural forms, the history, culture or social environment.

#### *2.3.2.5. Need for secure space*

The site needs to promote a sense of security, whether it is by means of the space design, visibility, passive surveillance or feeling comfortable within the space.

When all these aspects of the space is understood and accepted a sense of wellbeing will transpire. The space will be comfortable in terms of the users who can then express total enjoyment, in familiarity of an identifiable space with layered meaning of significance.

### 2.3.3. A sense of wellbeing

In order to produce a site that provides a sense of wellbeing to the user, the site's attributes needs to be investigated. The attributes needed to be looked at are:

- A high threshold population in the surrounding area
  - Determine the threshold populations for facilities and basic land requirements [32]
- Capacity to service the catchment of people
  - Provision and the optimal location of community social facilities and open space [32]
- Creation of an open space network

- Each development, however small, should be required to contribute proportionally towards larger facilities [32]

- Opportunity to provide a mobility spine
  - Provide a basis for developing a spatial distribution network for a facility[32]

If the site has these attributes the opportunity to fulfil the need to connect to open space is more achievable. The fragmented open space will be stitched together to provide ample amount of open space to city dwellers.

### 2.3.4. Standards for open space in relation to population

The government's Urban Development Framework (South Africa 1997) calls for "the physical, social and economic integration of our towns and cities" and stresses the need for higher density, more compact and, in terms of land use, more mixed-use settlements. Similarly, the Development Facilitation Act, No 67 of 1995 (South Africa 1995) [34], inter alia, calls for environments which

- promote the integration of the social, economic, institutional and physical aspects of land development;
- promote integrated land development in rural and urban areas in support of each other;
- promote the availability of residential and employment opportunities in close proximity to or integrated with each other;
- optimise the use of existing resources, including resources relating to agriculture, land, minerals, bulk infrastructure, roads, transportation and social facilities;
- promote a diverse combination of land uses, also at the level of individual erven or sub-divisions of land;
- discourage the phenomenon of "urban sprawl" and contribute to the development of more compact towns and cities;
- contribute to the correction of historically distorted spatial patterns of settlement in the Republic and to the optimum use of existing infrastructure; and
- encourage environmentally sustainable land development practices and processes.

This framework should begin to move us in this direction. It is based on the integration of the human and nature-centred approaches to settlement-making.

The standards used in this document are based on a study done by the CSIR in eThekwini, and these "standards are provided mainly in terms of demand thresholds, access measures and service level targets(travel time or distance by preferred mode), and provide a framework for debating appropriate site sizes within a range of contexts" (Green & Argue 2008) [32] .

The empirical data that are produced from these data collection indicates whether there is a level of compliance to the standards and if it does not comply with the standards modifications needed to be made.

The table in Appendix 1 propose standards for spatial needs per hectare in relation to the population density. It suggests that a population density of 158636 people (the average of population according to open space highlighted in appendix 1) should have a minimum of 5.57 ha (sum of open space required) of soft open space and 11.86 ha of hard open space.

Not only is there a need for open space but for recreational space. John Moeller, the preparing officer of the document on Standards for Outdoor Recreational Areas in America, compiled standards acquired from various sources to produce the documentation and according to the N.R.A.s published standards for municipal recreation space the volume ranges between 1.6 ha per 1,000 population to the 4 ha of recreational space per 1,000 (Table 2, Appendix 2) (Planning.org 2008) [36].

The above standards need to be adjusted and measured against the available open space of Tshwane to determine whether there is ample open and recreation space available and if not modification of the city development needs to commence. This testing and modification process is done in Chapter 3 of the context analysis.

# Chapter 3
# Site Selection

## 3.1. Context Analysis

Diminishing green open space within an urban environment is a concern, access to these are also a problem. The fragmented green space within the city should be addressed. It should be stitched together to form a larger green space, to fulfil the relationship between population and open space, which are easily accessible from the urban nodes.

The standard for open space in relation to demand for open space is also addressed.

Tshwane as an evolving city within Gauteng can be seen as one of the most diverse urban nodes; the matrix of land use and users are evident in the context analysis. The analysis entails a filtering process in which the most appropriate site is chosen according to criteria which fits the theoretical intent.

### 3.1.1. Criteria for an appropriate site:

- The site should be within an urban environment
- The site should be near a high density area
- The site should be vacant / available
- The site should have recreational opportunity
- The site should have historical context
- The site should be significant
- The site should be accessible
- The site needs to be informed by surrounding historical context
- The site should not be zoned for residential development
- The site should be near recognised landmarks to provide historical context
- The site should have flexible zoning


Figure 10 Locality Maps

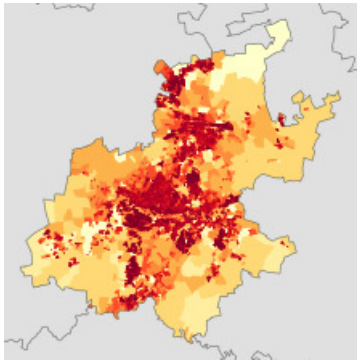
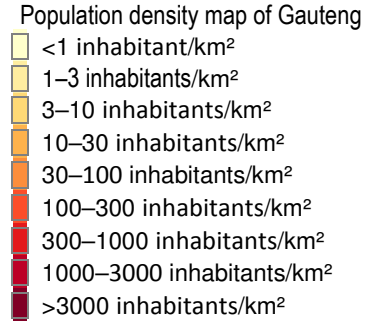


Figure 11 Population density of Gauteng (Wikipedia.org 2014)



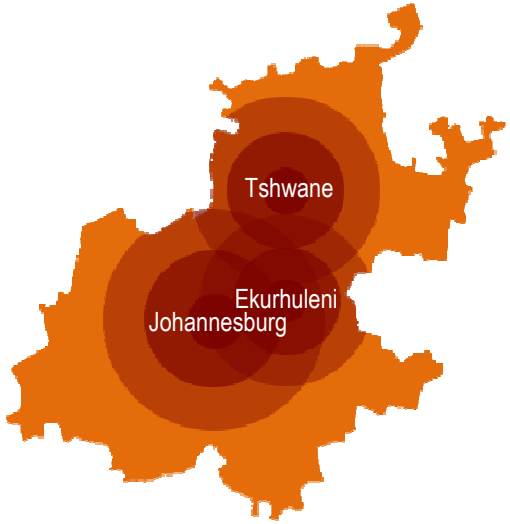




Figure 12 Urban Nodes (Author 2014)

Within the filtering process different spatial information had to be acquired to answer the overarching question of whether there is enough open space for regenerating purposes.

In figure 12 the highest density nodes are identified, the urban node is identified and indicated with figure 13 and then in figure 15 a synthesis of the nodal choice. The node is chosen for its diverse characteristics. It is within the urban context of the Tshwane CBD which has diversity in terms of history, users and land use. This supports the government's Urban Development Framework (South Africa 1997) which calls for "the physical, social and economic integration of our towns and cities".

## 3.2. Filtering Process

Three high density areas arose from the first filtering process of which the urban nodes are Johannesburg, Tshwane and Ekurhuleni. Tshwane will be the urban node of choice supported by the following facts:

- The city's diversity is evident from its:
  - Users
  - Business and residential zones
  - live and/or work in the city
  - Etc.
- The city has rich history

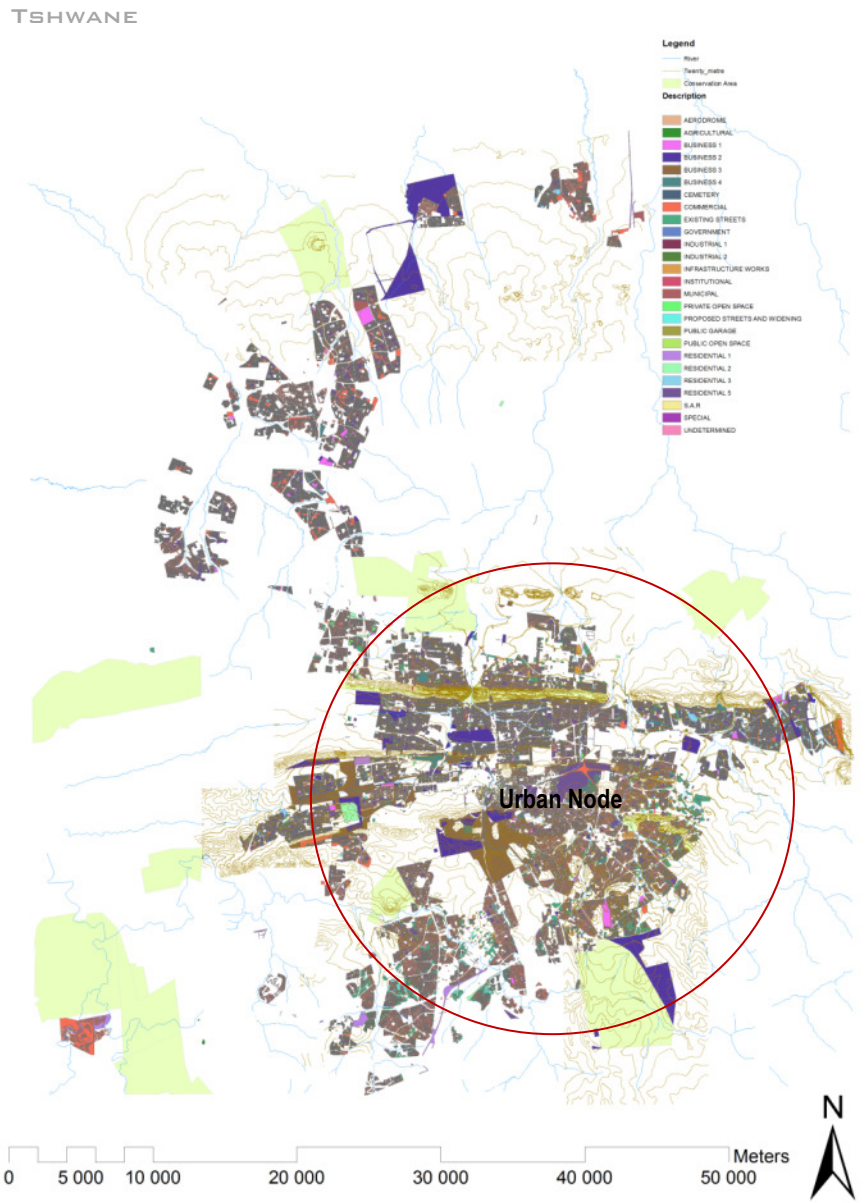



Figure 13 Urban node (Author 2014)

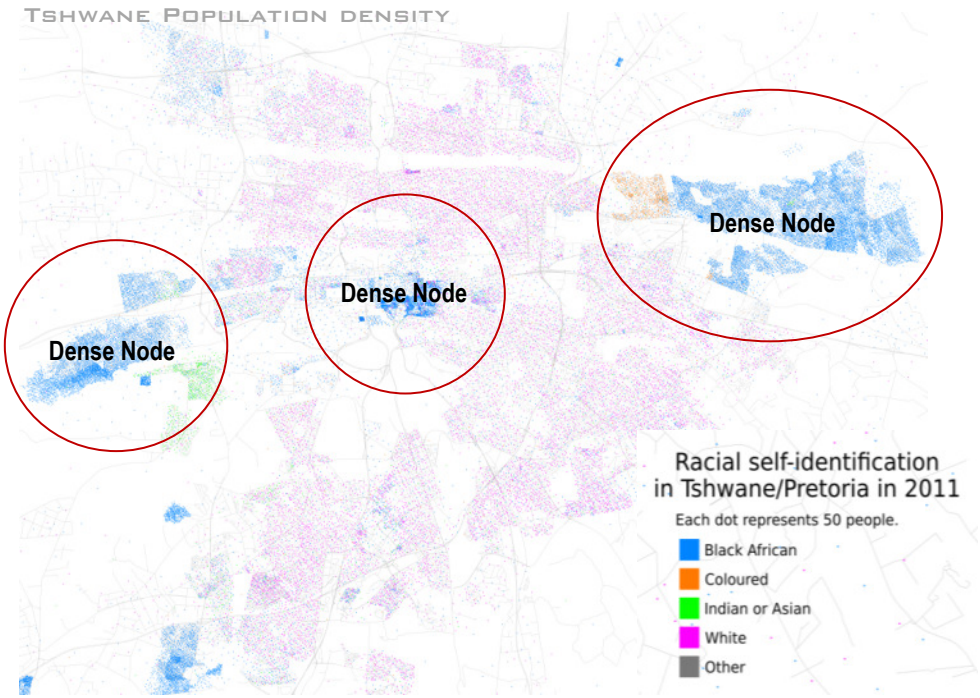



Figure 14 Population Density & Diversity (Joubert 2014)

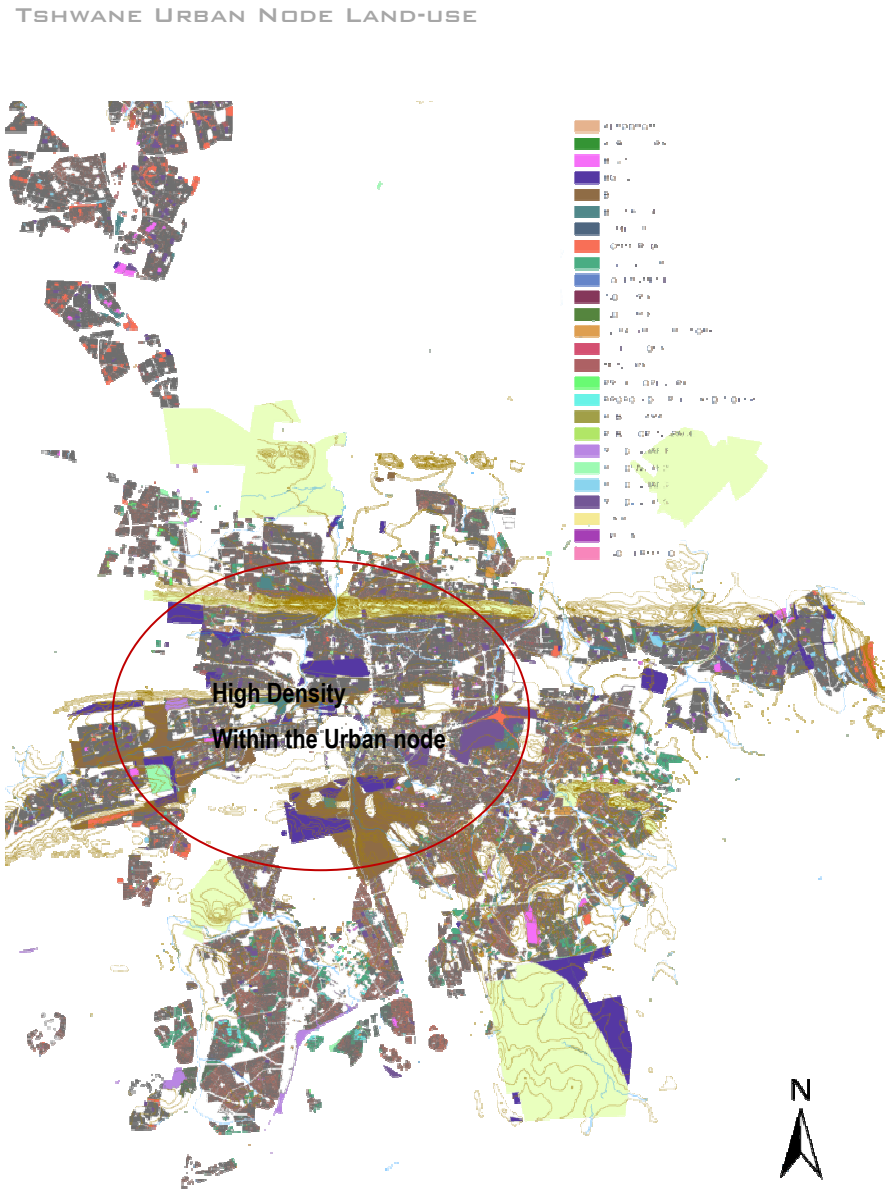



Figure 15 (Author 2014)

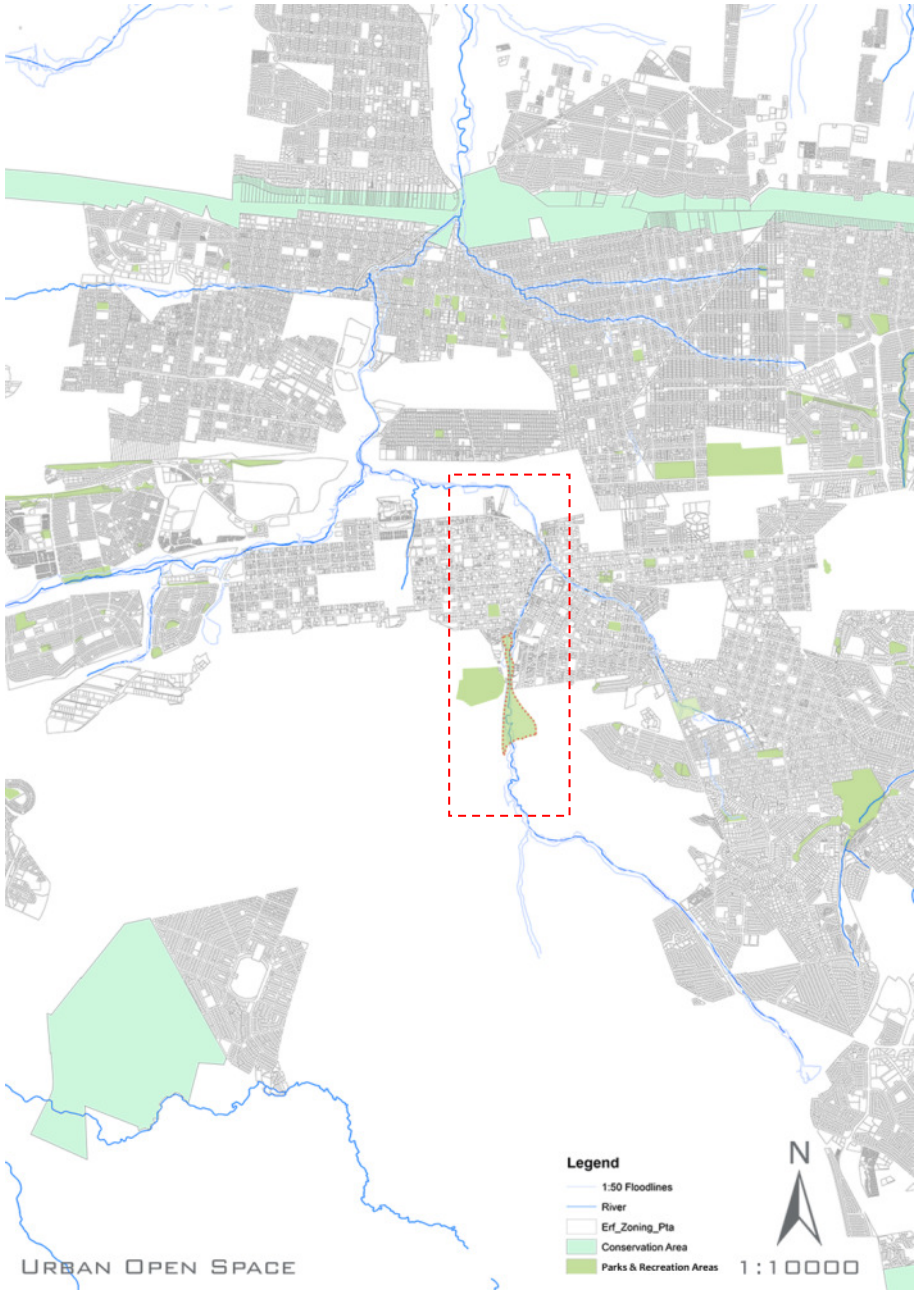



Figure 16 (Author 2014)

Figure 17 Available Green Space Spine (Author 2014)

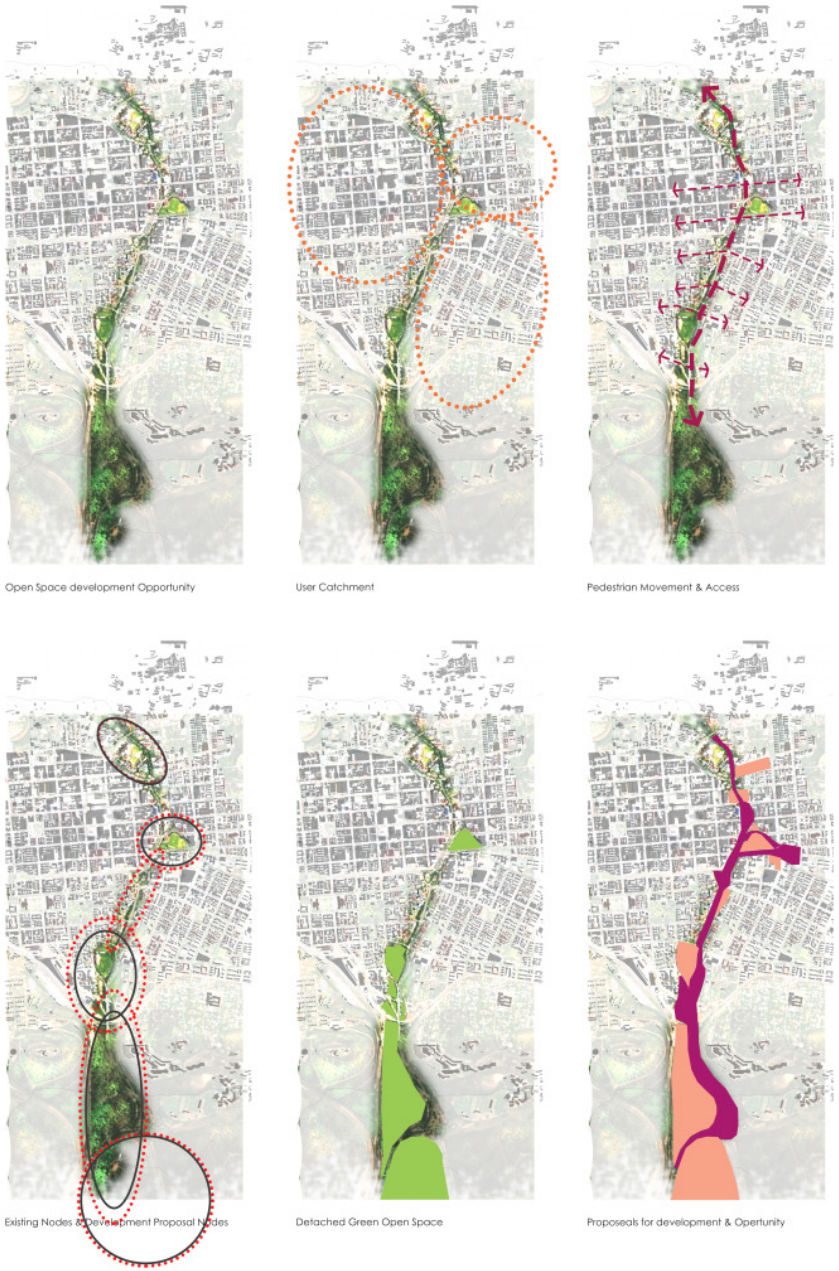



Figure 19 Analysis of available open space (Author 2014)

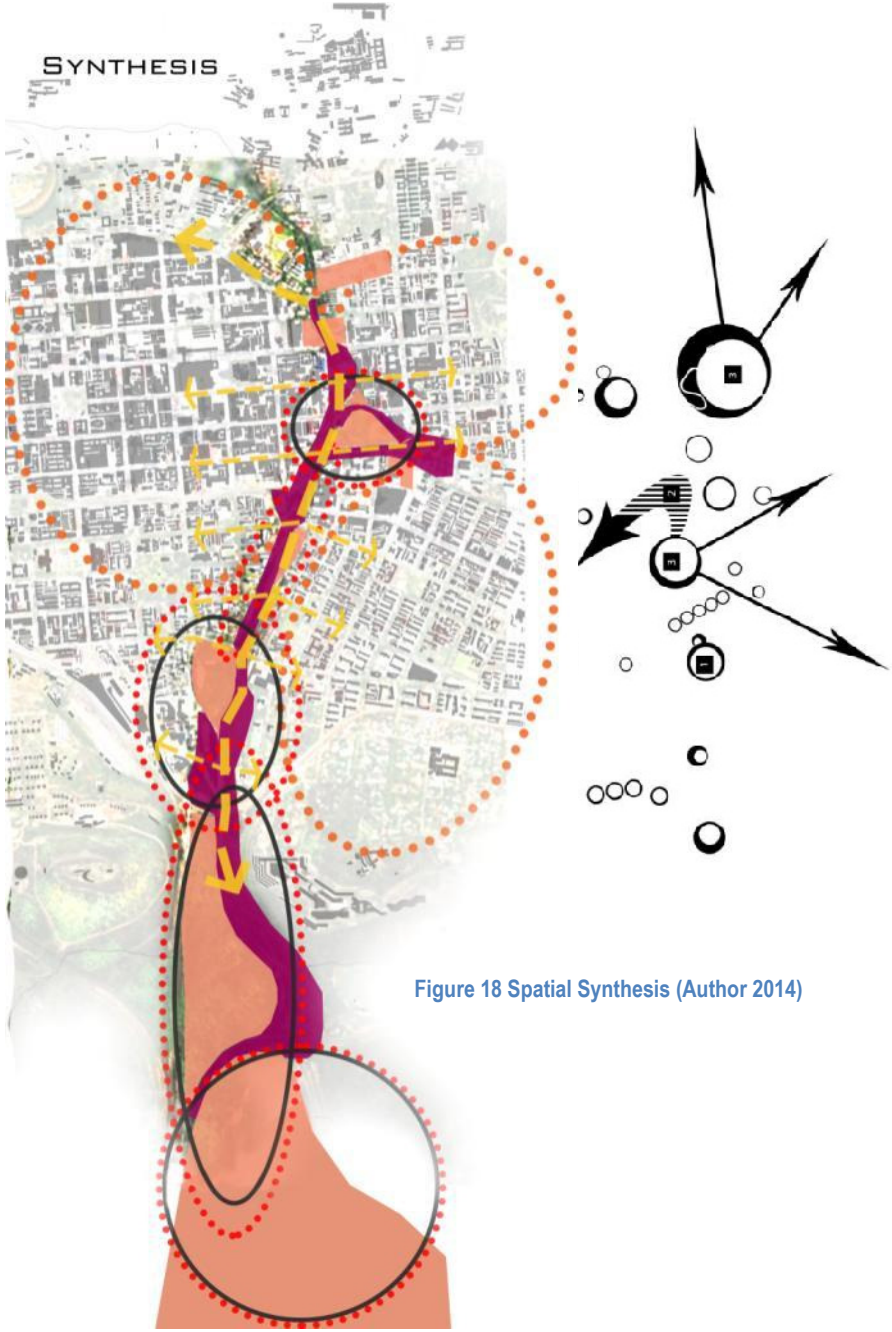



Figure 18 Spatial Synthesis (Author 2014)

Tshwane as the urban node of choice quantitative analysis (CSIR 2009) has to be done to address the spatial needs. As previously set out by Moeller a population density of 1000 people requires 10ha of passive and active recreational space. Tshwane has a total population of 2,921,488 (Census 2011) in a total area of 6,298 km² and a population density of 460/km² indicating, according to standards, that a total spatial and recreational need of 1769ha exists. But according to the space available within the urban environment (urban open spaces measured from Figure 16) there is too little. Within the urban environment there are more than 100000 people suggesting that a total open and recreational space of 809ha is required. The current availability stands at 510ha, which is not satisfying the need.

In order for modification in terms of open space development to occur the various spaces located within the urban catchments (catchment of people) (shown with orange dotted lines in figure 18) are analysed according to recreational use. This was qualitative analysis (CSIR vol. 1 2009) of spatial relationship within the urban environment. This is done to determine whether standards for spatial and recreational use apply.

The opportunity for one site to develop into an all providing facility is not plausible therefore to fulfil the need some sort of connection between spaces needed to be applied. Investigating this idea the most appropriate site had to be within close proximity of existing open spaces and or sites with public facilities. The most appropriate site is along the Nelson Mandela Drive, it is the gateway into the city with many public spaces attached to it. Recreational facilities like Fountains valley and the Groenkloof Nature Reserve are two very prominent nodes which can fulfil the need for recreational space. The opportunity is to stitch all of these spaces together to create a public mobility corridor where the landscape and the users can move from and into the city by means of open space facilities which will ultimately fulfil the need to connect to nature by providing ample amount of open space within the city.

With all the spaces mapped and measured (Figure 16) a decision had to be made of where the opportunity lies to stitch spaces together. The idea is to form a larger space with many facilities to fulfil the need for recreational space. Sites within the catchment was analysed according to the existing and proposed development to successively know which sites and spaces are appropriate to include in the urban framework. A common ground had to be identified onto which the sites will be attached to; the most prominent feature is the Apies River the connector between the clustered sites. The chosen sites' attributes within the corridor follows.

## 3.3. Urban attributes

Opportunity to enforce the standards over a broad area and each development, however small, should be required to contribute proportionally towards larger facilities. The capacity of the mobility corridor or spine to host facilitating nodes is available. These facilities can function as a public realm where mobility and access are high priority. Many of the sites along Nelson Mandela Drive are developed sites with new development proposals as suggested with the Approval of the Mandela Development Corridor (MDC) which runs from Edmond Street to Kotzé Street near Berea Sorts Complex.

The MDC proposal is available as a pdf. format at Tshwane.gov.za/services/City and Regional Development/Approval_of_Mandela_Development_Coridor {34}. This proposal will be accepted within the urban framework and the framework for the development proposal of the entire Nelson Mandela Drive as public open space will be attached to it.

Further up to the South in between Kotzé and Willow Street, lies the Berea Park Sorts Complex and adjacent sites. Two development proposals exist for the Berea Park Sports Ground where the old rugby and cricket fields and club houses were. A Landscape Architectural Proposal of waste management and an Architectural Proposal of Regenerating Berea Park. These two proposals will be discarded as they are not approved proposals but only suggestions and some other facilities will be incorporated onto the site according to the CSIR standards for open space development.

The Berea Sports Complex and bordering sites, even though detached from one another, will form part of the larger public facility. At the Southernmost tip of one of the sites, known as Du

Preezhoek, neighbouring Berea Park is where the new Gautrain and old National South African Railway (NSAR) bridges cuts across, an imaginary detaching agent. At this point, Founts valley Park starts with a development proposal that stretch into the Groenkloof Nature Reserve. This proposal is assumingly about recreation in terms of recreational needs. Some recreational facilities include active and passive activity space like braai area, pools etc.

With the proposal of the urban framework I suggest to stitch the fragmented sites together to form a large open space. The open space will have various regenerative facilities to address the need for open space and to connect with nature to regenerate ones wellbeing.

Proposals for development along the corridor exist for many if not all of the sites adjacent to Nelson Mandela Drive. Therefore the chosen site marked with a red dotted line on figure 6 indicates where the most prominent link between city and natural open space will occur. The idea is to create a linear green space with various facility nodes which contributes to the larger recreational green space.

The programme was developed according to the approved proposal and where opportunity exists for other sites. The programme is shown in figure 24.

Figure 20 Optimizing Space (highline. Giral, D. 2012

# Chapter 4
# Concept Development

## 4.1. Background of Design Development

According to the Standards for Outdoor Recreational Areas (Moeller 2009) the total recreational area required for a population density of 100000 people is 610 ha. The available open space of 510ha is not adequate. By connecting the natural environment in the south (Groenkloof Nature reserve and Fountains Valley) to the urban environment in the north a functional recreational network can be created. This functional recreational network will exist by connecting open space and underutilized space with the MDC Proposal to form an intermediate network of the biophysical environment. The aim is to steer away from a mono-functional landscape but to design ecologically functional spaces that will address the public need and be the intermediate biophysical connection between man and nature.

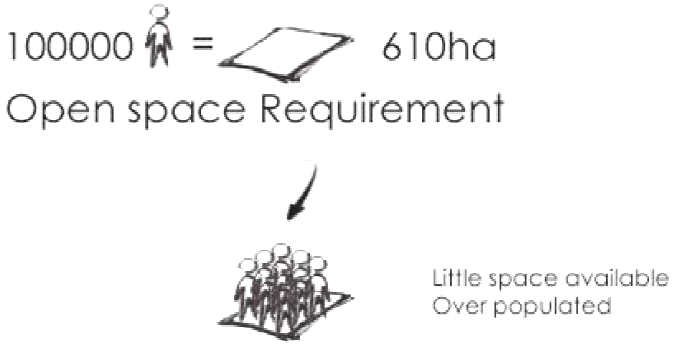



Figure 21 Open space requirement (Author 2014)

Table 2 Spatial Requirements (Planning.org 2009)

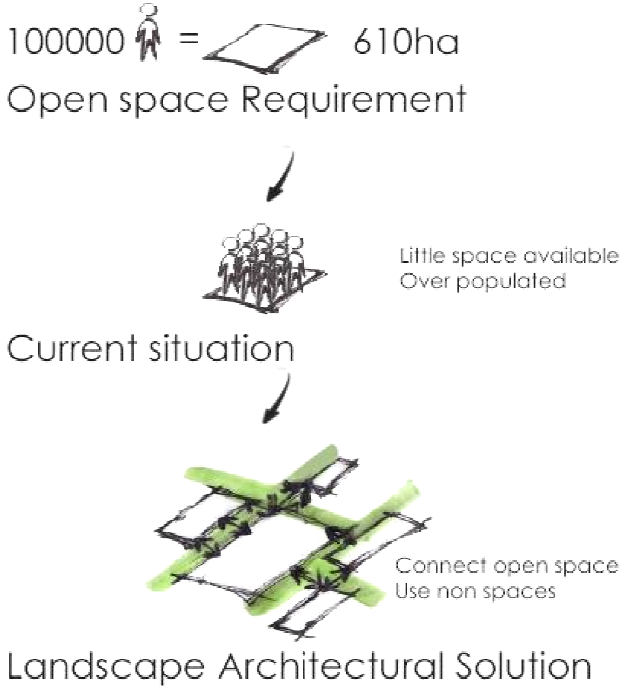
| Recreational Uses | Quantity | Area |
|---|---|---|
| Reservations | 1 | 280ha |
| Large city park | 1 | 160ha |
| Neighbourhood parks | 10 | 100ha |
| Playgrounds | 50 | 40ha |
| Gardens and squares | | 30ha |
| **Total** | | **610ha** |

The total open space available in Tshwane's urban environment is derived from a measurement acquired from a Tshwane municipal erf map (Table 3).

Table 3 Total open space available in Tshwane (Author 2014)

| Recreational Uses | Quantity | Area |
|---|---|---|
| **Total** | | **510ha** |

Figure 22 Concept Development (Author 2014)



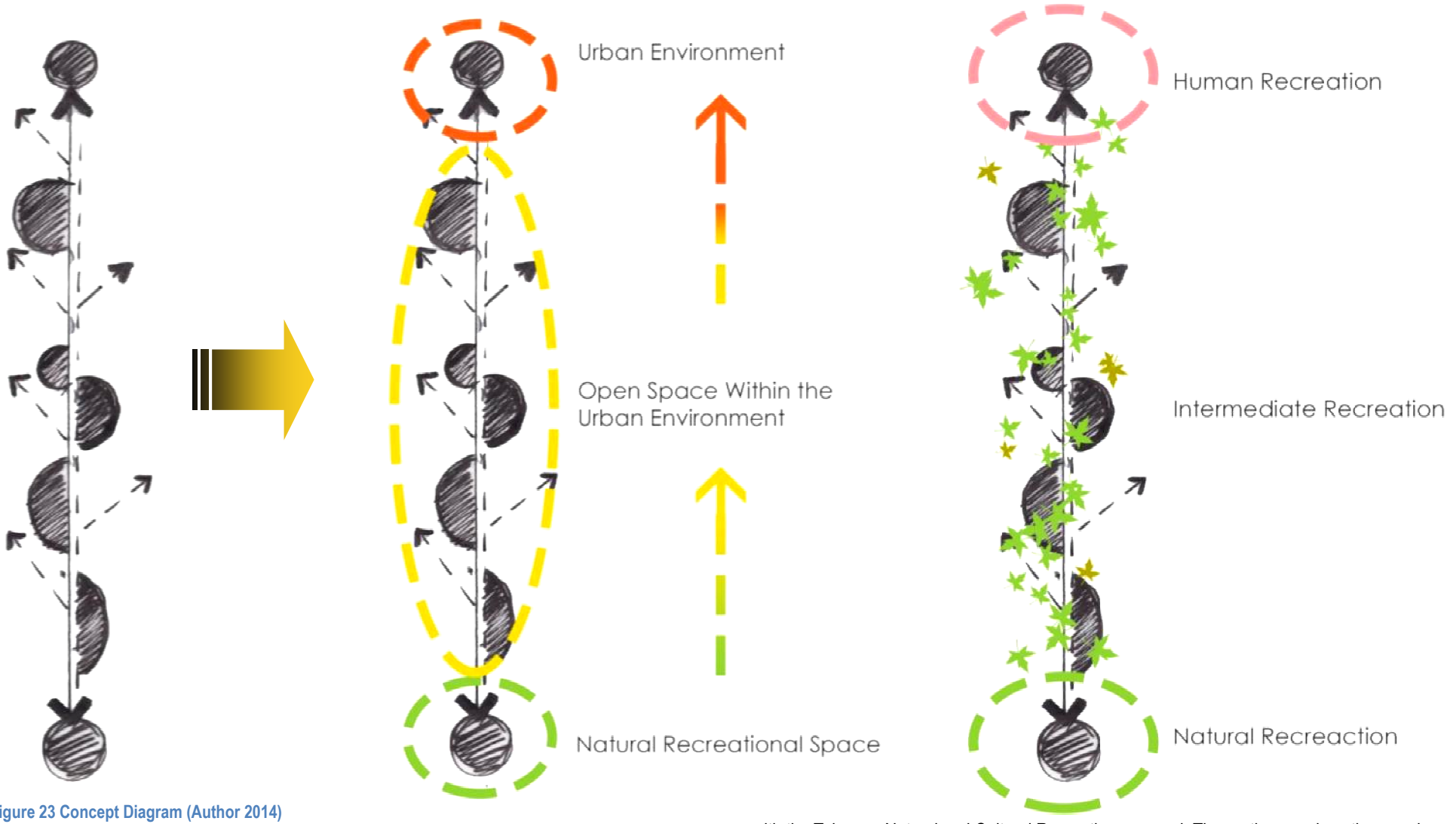



Figure 23 Concept Diagram (Author 2014)

The idea is to connect open spaces within the urban environment to form a larger recreational facility. The connection will be a biophysical network that provides an intermediate connection between man and nature. The northern node is located within the urban environment it is represented with the MDC proposal by Encha Properties as a human recreational facility. The southern node is located in the Groenkloof Nature Reserve and Fountains Valley; it is represented with the Tshwane Natural and Cultural Recreation proposal. The northern and southern nodes are not accessible to one another and have the opportunity to inform an intermediate recreational facility which can become a functional network of open space with interacting facilities.

In order to create a coherent network both proposals should interact with this new intermediate recreational proposal by using the same landscape palette.

## 4.2. Urban Framework

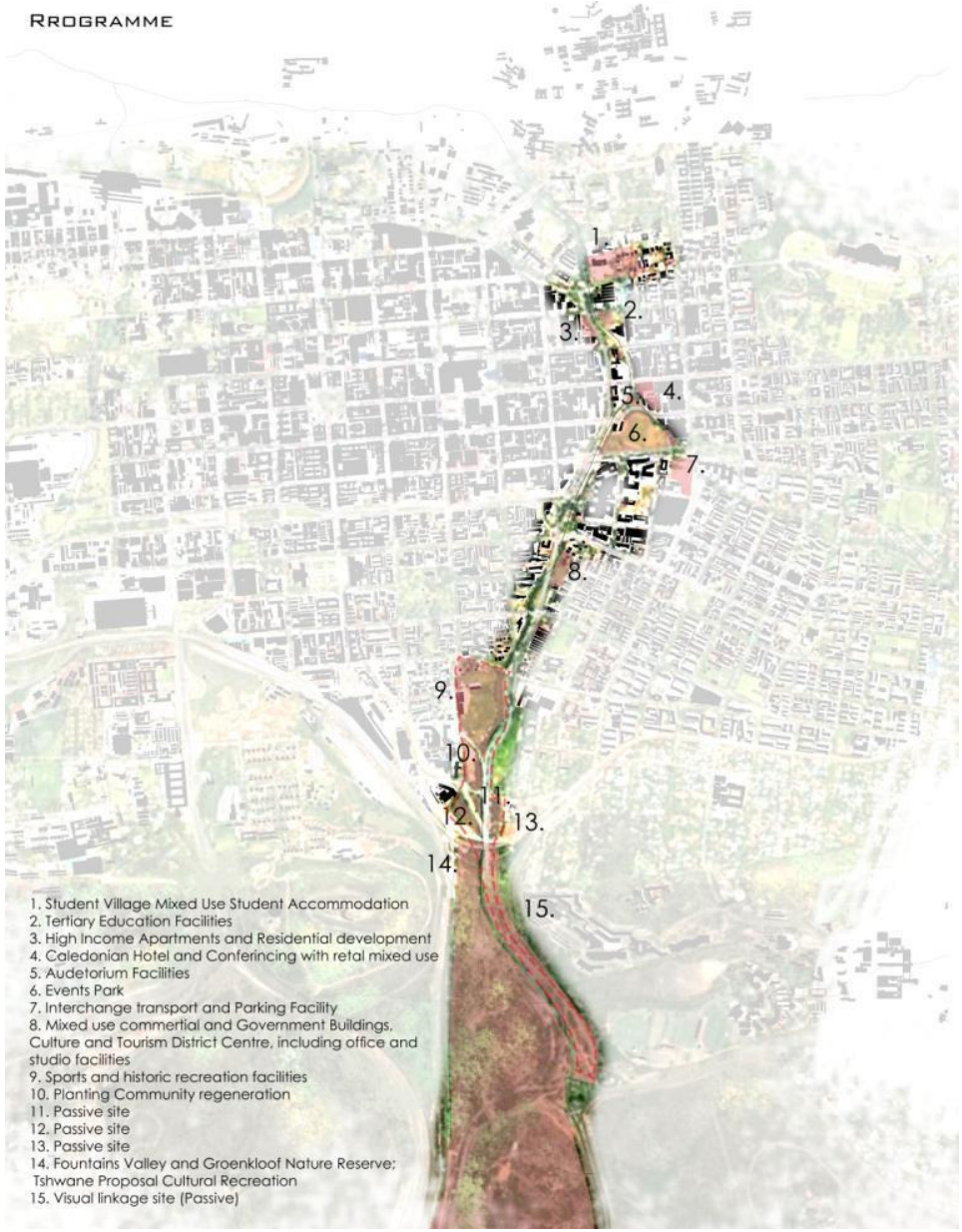



Figure 24 Urban Framework (Author 2014)

The framework suggests facilities accepted from the MDC proposal, indicated in figure 20 as site 1 to 8. Other recreational facilities will be introduced according to the environment the site is in. With the programme one can see where the collection of sites 9 – 15 are, is the entrance into the city, making this an important node.

This is where the main focus will be, where all natural environment enters the hard urban environment to spread as a mobility spine through the city. Mobility in terms of vehicular movement, pedestrian access, vegetation corridors and migration of animals where possible, this enforce linkages where there is almost none.

Figure 25 Sagrera Linear Park (West 8 2011)

# Chapter 5
# Urban Analysis

## 5.1. Site Analysis

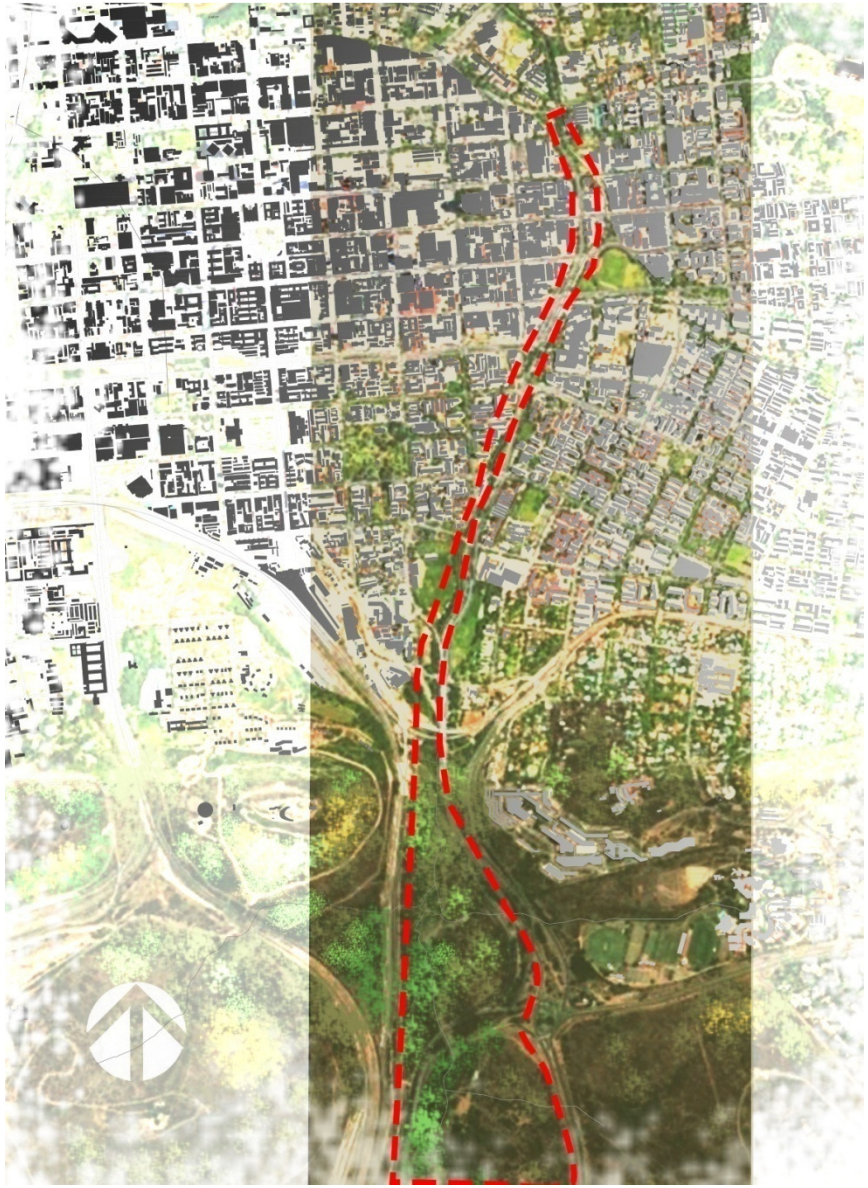


Figure 26( Chosen Site (Author 2004)

The ecological elements and systems need to be intertwined with the total design in order to accomplish what the dissertation is all about. Figure 22 shows the site's spatial analysis with regard to the ecological systems within the spine which needs to be addressed. Each feature has its own spatial limitations and opportunities like the Apies River and its flood line which runs along Nelson Mandela Drive. Other features include constraining roads making access to and from one space to another a difficult task. From the site many scenic viewsheds are available and these pose opportunity for passive space making.

Detailed analysis of the site's spatial identification is inspired by Lynch's space identification of paths, districts, edges, nodes, and landmarks (Lynch 1960) [2]. These are shown in detail in Chapter 9. Water movement is also an important aspect before site programme can be formulated; facilities should be located in the best possible location of the site.

# URBAN CONTEXT NEAR GREEN CORRIDOR PROPOSAL

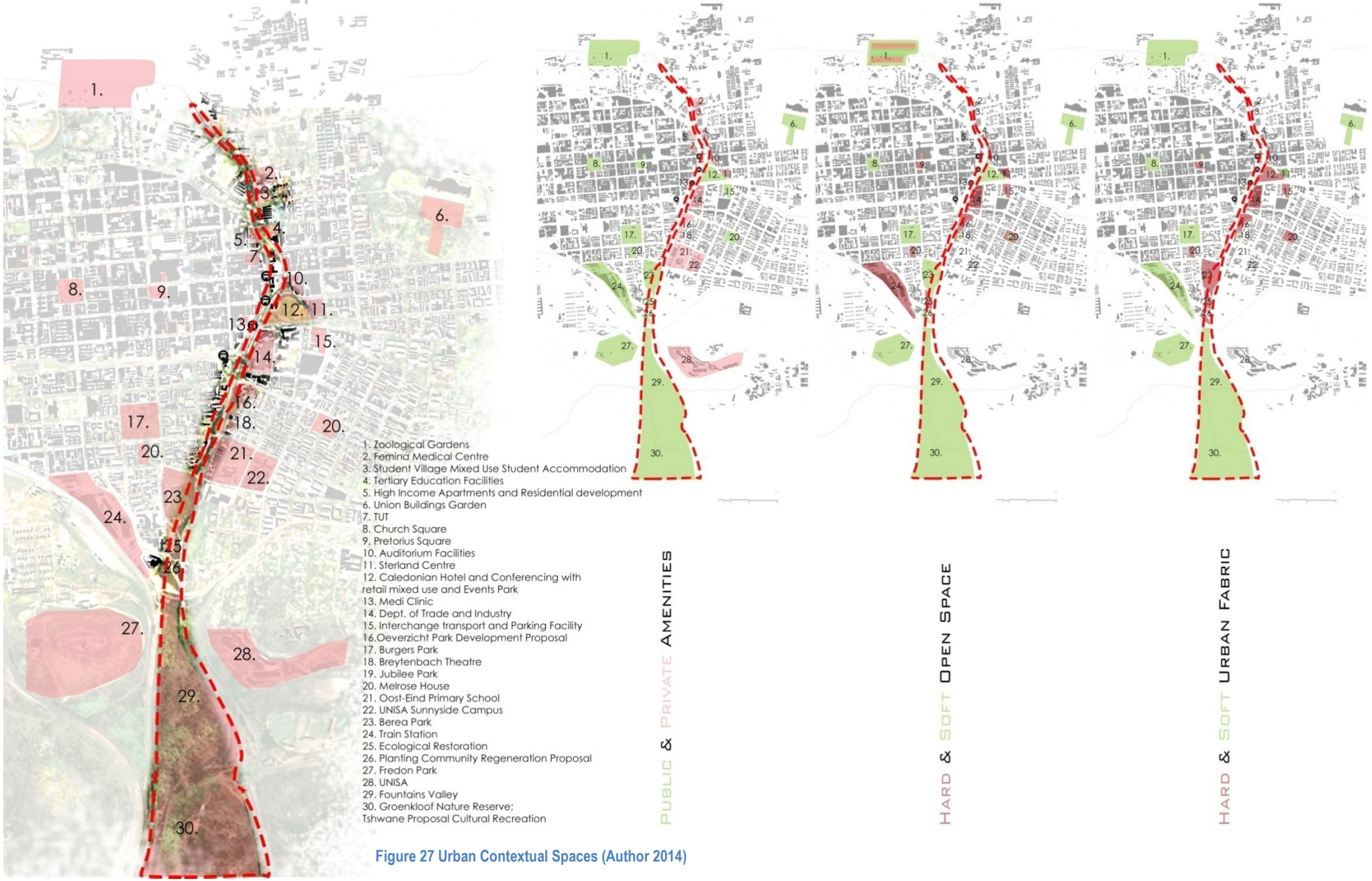



Figure 27 Urban Contextual Spaces (Author 2014)

### 5.1.1. Site inventory and Analysis

**Physical Attributes**

The Apies River as previously mentioned will be regarded as the connector onto which the spatial development will attach. In order to have a proposal that is aesthetically pleasing and systemically sound the conditions of the river needs to be looked at closely. The river is canalised just after the NSAR and Gautrain Bridges and before the bridges the river is in a degraded state. The river needs to be regenerated to enhance habitats and environmental interaction.

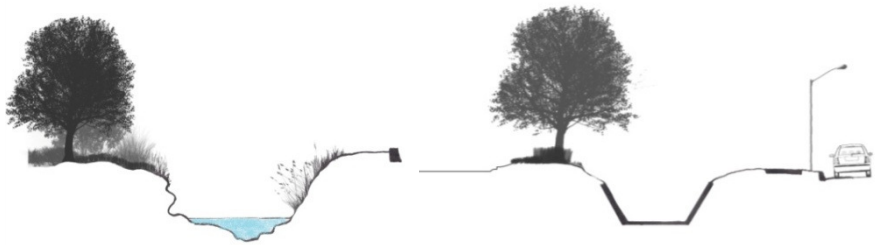


Figure 28 River Bed differs from South to North (Author 2014)

As the Apies River is regarded as the physical connector between the natural and urban environment the spatial attributes needs to be investigated by analysing various scenarios along the river. Spatiality is analysed by means of its quality according to the CSIR's spatial requirement guidelines.

**Biological Attributes**

The Apies River was home to various fauna species such as lions, Vervet monkeys, hyenas and jackals which were all driven away, captured or exterminated for the settling of peoples. One of the earliest settlers wrote about the serenity of the landscape and the pure and crystal clear quality of water in the river.

The focus area runs from the Groenkloof Nature Reserve down to Edmond Street where a change in vegetation is noted. Tree species in the valley included bushwillow (*Combretum sp.*), wild olives (*Olea europaea* subsp. *africana*), stinkwood (*Celtis africana*), wild current (*Sercia pyroides*), 'bontbos' and 'buffelpeer'. According to the book Eugene Marais, 'Versamel Werke', Marais recalls what the Pretoria landscape entailed; dense clumps of thorn trees and lush grass fields from Fountains Valley to where the Lion Bridge stands now and less dense trees to the north. The river was densely vegetated with trees, shrubs, ferns and cotton fields and arum lilies (*Zantedescia sp.*). The site is situated within the Savanna Central Bushveld Biome with two major planting communities on north and south ends. But over time ecological degradation took place. There is now a lack of biodiversity which exists mainly of exotic species.

Existing indigenous plant species on site include the following:

*Celtis africana; Acacia karoo; Combretum erythrophyllum; Barleria macrostigia; Eragrostis lehmaniana; Haleria lucida; Sporobolus africanus; Pollichia campestris; Nidorella hottentotica; Eustachys paspaloides*

These species will be retained if they are in good health and aceptable size and others species will be reintroduced onto the site for optimum specie diversity and support of matrix formation.

Existing invasive plant species on site include the following:

*Category 1: Populus deltoids; Macfadyena unguis; Aruajia serifera; Solanum marifianum; Lantana camara; Xanthium strumarium; Sonchus wilmsii; Sonchus oleraceus; Sida alba*

*Category 2: Tipuana tipu; Morus nigra; Ricinus communis*

*Category 3: Jacaranda mimosifolia; Eleusine coracana* subsp *Africana; Bidens pilosa*

Control of these species by:

1. Prevention
2. Monitoring for invaders
3. Integrated Pest Management (IPM) – biological controls etc
4. Herbicides – short lived
5. Mowing – woody plants and agricultural weeds
6. Cutting – inhibits woody plants
7. Burning – inhibits woody plants and kills herbaceous pests
8. Hand pulling

**Soil Analysis**

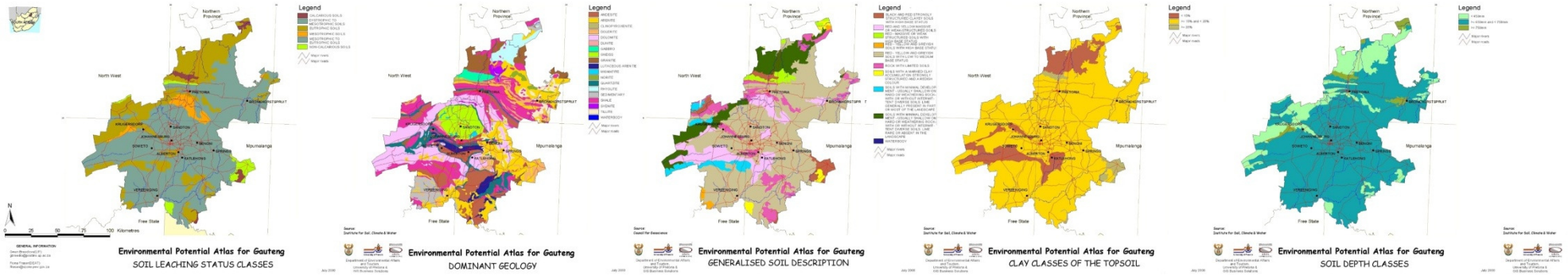
The Genralized soil description is red soils  with a yellow and greyish colour, with low to medium base status and rock with limited soils, meaning it is fine textured soils with a clay percentage of >15% and <35%. The soil various from <450mm to <750mm for most of the city.

According to the above maps and supported by Mucina, L. & Rutherford, M.C. (2006, p. 463) the dominant geology is mafic intrusive rock of the Rustenburg  Layered Suite of Bushveld Igneous Complex. Rocks include gabbro, norite, pyroxinite and anorthosite, and a predominant amount of shale with granite and quartzite.

Because of clay content and fine texture of the soil (<0,002mm particles) the infiltration rate is low (0.001m/h for very fine particles).

The Leaching Status of the soil on Master Plan scale are located in Mesotrophic to Eutrotrophic soils and Dystrophic to Mesotrophic soils, indicating that the soil is more or less fertile with high to low levels of biological productivity.

Figure 29 Soil Analysis (Department of Environmental Affairs and Tourism 2000)



**Cultural Attributes**

Historic Resources:

Around 1835 when the first Voortrekkers settled in the Fountains Valley, approximately 25 million litres of water entered the Apies River on a daily basis. In 1858 water was fed into channels and furrows which supplied water to the homesteads in the area. A water wheel was later installed in 1875 to pump water from the river.

Because of the amount of rain received (between 601 and 800mm per annum), the soil water holding capacity (low to medium holding capacity (Department of Agriculture 2006)) and erosive and dynamic character of the river ecosystem, frequent flash floods led to the channelization of the river in 1909 from Rissik Street to Du Toit Street which was completed in the late 1930's. Further development included a replacement of smaller streets by the now known as Nelson Mandela Drive which cuts through the river at several places. It formed a major connectivity spine from Pretoria southwards.

As urban sprawl increased, additional infrastructural development led to supplementary change of Apies River hydrology. The Apies River basin consists of more than 93% urban area, and drains a total of 742.66 km2 of developed land. Hard surfaces make velocity, capacity and quality of stormwater, running towards and in the river channel, more dangerous.

Moreover "impervious surfaces; the streets, roads and avenues in our cities adds pollution to rivers and streams by improperly managed urban stormwater runoff." (Faha and Kummer 2009:38-39). Even though the water quality is very good in the southern end due to the water springing forth comes from the natural occurring fountains water downstream is highly polluted. Water that enters the urban downstream river ecosystem is polluted with road debris and other harmful pollutants. And according to a study compiled by Adri Venter the Apies River Basin is under severe pressure from a variety of pollution sources. A screening study explored by Venter (2007) indicated that the Apies River Basin is likely to be heavily polluted by faecal bacteria.

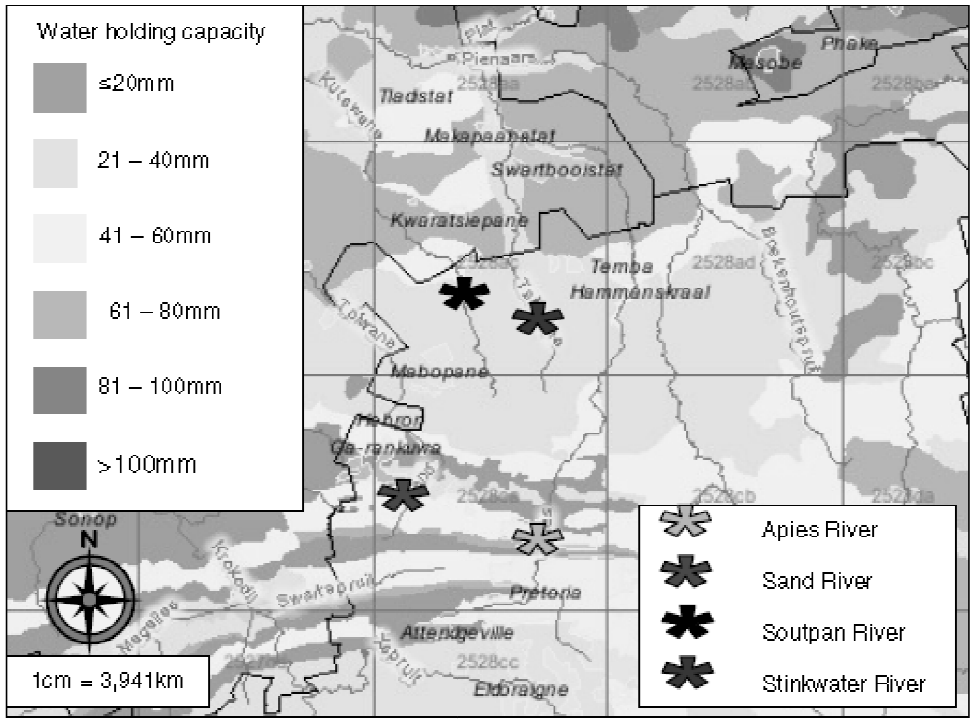



Figure 30 Soil water holding capacity (Venter 2007)

The surface cover and slope edges of the river channel deliminates ecological existence which makes treatment of pollutants like the faecal bacteria improbable. The impervious nature of the concrete channel accelerates the transportation of these pollutants and exacerbates water quality. Treatment of the water becomes a major concern due to the fact that the river supplies water to 2704 households who are now at risk from contaminated surface water (Venter 2007).

The Apies River holds the key to pull the biophysical environment through the city and can be seen as a prominent infrastructural green corridor. It possesses opportunity for an intermediate biophysical network where ecological systems strive and enhance the perceptual quality of the spine and successively enhancing human wellbeing of the everyday city dweller. Spatial development and reintroduction of nature and its natural systems will eliminate existing odours and visual eye sores. The space can become pleasant, accessible and ecologically sound.

# LANDMARKS

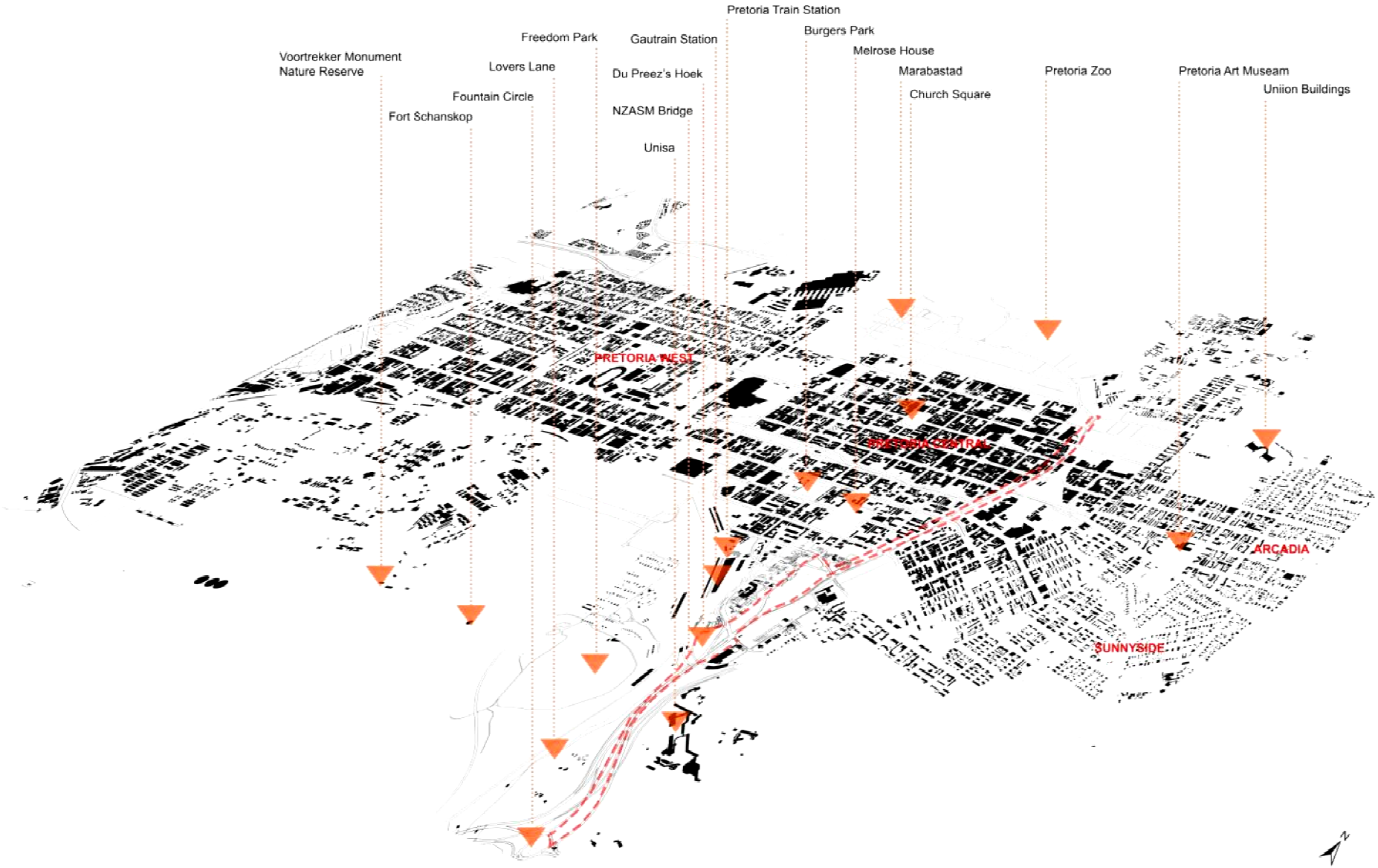



Figure 31 Landmarks and Points of Interest (Author 2014)

### 5.1.2. Apies River Hydrology

The Apies River flows through the city of Pretoria, South Africa. Its source is located just south of the city (south of Erasmus Park) and it flows northward until it drains into the Pienaars River.

The problem of the channelized river is the fact that the water table does not get recharged and ecological existence is reduced which promotes pollution due to the fact that there is no filtration of pollutants which toxicates the entire river system. This implies that the natural drainage of past and present courses should be considered in the design process and landscaped according to such, including the planting of local indigenous species.

The Apies River as an urban river performs a multitude of functions and thus requires management as result of development in the catchment boundary. Further disturbances in the natural balance of nature could result in discomfort, losses and disaster to property and a higher health risks for people.

The National Environmental Management Act (NEMA, Act 107 of 1998) stipulates that development must be socially, environmentally and economically sustainable and sustainable development requires the consideration of all relevant factors; ecosystems and people and their needs, need to placed at the forefront of development concern, and serve their interests equitably.

**Problems**

- Increased surface runoff
- Channelization restricts natural infiltration back into the soil and replaces the habitable landscape
- Increased stormwater inlets and connections to river
- Increased water pollution from street surface
- Vegetation are unable to populate the river banks

**Opportunities**

- Ecological habitation zones can be incorporated
- Stormwater management zones alongside roads
- Adjacent sites can be used to restore the interaction between man and nature

### 5.1.3. Synthesis

- The river edge is zoned for recreational purposes; therefore intervention to make the invisible river, visible can be part of the healing landscape concept.
- Private ownership of some of the sites can should be taken into account but it is suggested that there should be a partnership with the private property owners to ensure that there is a shared a common vision
- There is opportunity along the river to develop a regenerative landscape which indulges the senses to energize ones mood.
- The previously used sports field can be redeveloped to function as a common ground for sport and other mixed uses; this will be part of the physical wellbeing of the users.
- The existing buildings on the Berea grounds are proposed to be restored therefore it will form part of the programme.
- The unconnectedness of the various sites will be connected with a modular streetscaping development strategy.
- Landmarks (figure 29) can be accessed from the green corridor running along the Apies River
- Overall the ecological state of the site can be healed as well as mental and physical wellbeing of its users

Figure 32 Site and Context photos along the Apies River (Author 2014)

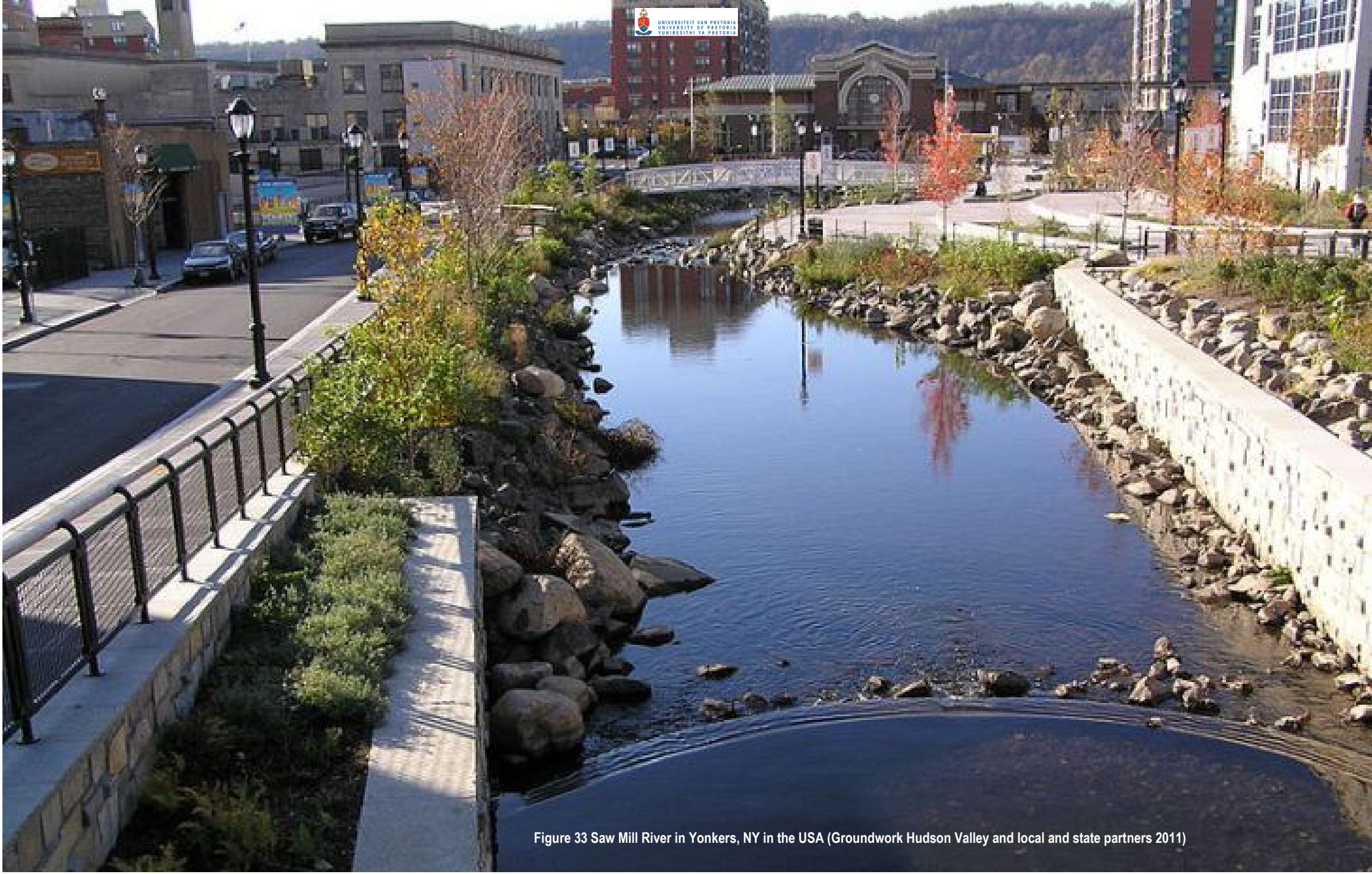


Figure 33 Saw Mill River in Yonkers, NY in the USA (Groundwork Hudson Valley and local and state partners 2011)

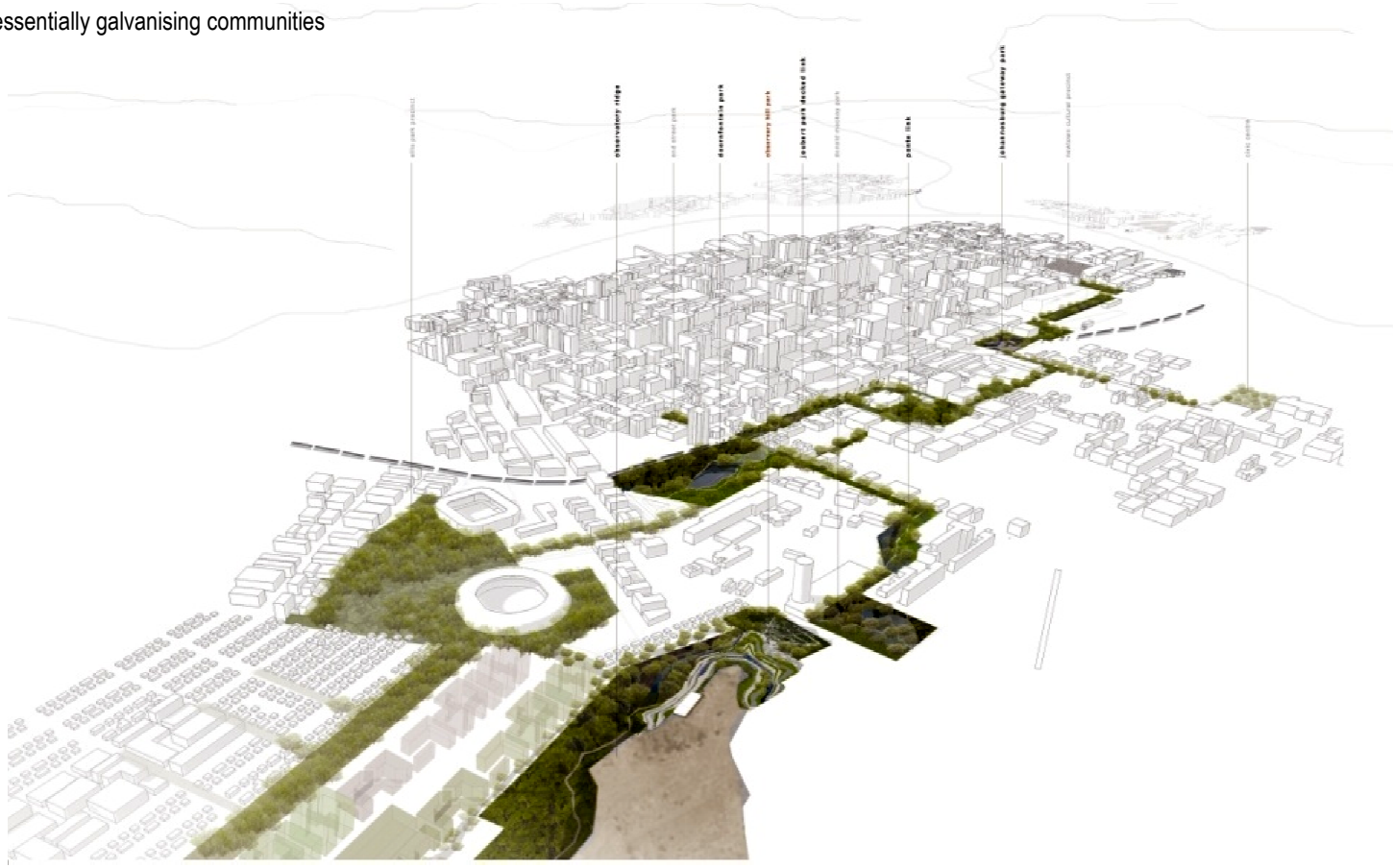
# Chapter 6
# Precedents

## 6.1. Precedent Studies

### *The Seam, CONCEPTUALIZATION AND DESIGN OF A LARGE INNER CITY URBAN PARK*

THE SEAM addresses the goals of unity, connectivity, sense of place, ecosystem, culture, identity and inclusion – an urban park system and landscape for all the people who live, work and visits the inner city of Johannesburg. New circulation pathways, tree plantings, gateways, signage and consistent design elements will shape the link as one park. The concept of 'one long park' connected to its immediate urban and natural environs at either end, invokes a collective and shared sense of ownership – i.e. this is a park for everyone, essentially galvanising communities that are sometimes separated by income, race and lifestyle.

Figure 34 The SEAM (GreenInc & VNL 2009)



### *Tom Hanafan – River's Edge Park*

Directly across from downtown Omaha and at the foot of the newly-completed Bob Kerrey Pedestrian Bridge, the Council Bluffs Riverfront Park is a 36.4217ha public park situated within the broad riparian floodplain of the great Missouri River. Sasaki's master plan for the park capitalizes upon the distinct character of the Council Bluffs side of the river—richly forested, green, and soft—in distinct contrast to the highly urbanized landscape that surrounds it.

The design of the park focuses intensity of public use and development in a core area of the existing site which allows access to the river and also preserves key habitat and riparian floodplain. Strategies to increase the ecological function of the site include nearly 8ha of reforestation, roadside bioswales, porous pavement, diverse native plantings, and parking lot rain gardens. The ecologically sensitive areas north and south of the bridge's landing are reinforced by reforestation and wetland enhancement strategies and accessed via a series of trails and environmental interpretation.

Figure 35 River's Edge Park (http://www.sasaki.com)

Figure 34 River's Edge Park (http://www.sasaki.com

*Shanghai, China – Huangpu riverfront*

A competition project for the client SOM was designed by the Stoss Urban design team.

The project re-imagines 283.28ha of riverfront close to the centre of Shanghai as a new, green, river-based series of neighbourhoods and commercial centres.

The site is a series of denuded wetlands and polluted rivers and creeks, with a few encampments and temples scattered about. The site plan focuses on raising and the cleansing of water resources via wetlands and landscape conditions, and on making the Huangpu Riverfront the generator for new urban villages. Five fingers of water-landscapes are brought into the site and programmed to offer distinct and complementary activities and characters: River Deck, Culture, Exhibition, Sports and Eco Forest.

These green fingers then give rise to vibrant new neighbourhoods at a variety of scales: from an intensely developed new mixed-use and commercial centre / downtown to low- and midscale developments with pedestrian-oriented streets and close proximity to nearby parklands and riverfront. Existing natural and cultural resources are integrated into the plan, thus grounding the new neighbourhoods in the social and environmental histories of the site.

The project was declared co-winner of an international competition and is being implemented in phases over the next decade. SOM out of Chicago and Shanghai was a key collaborator.

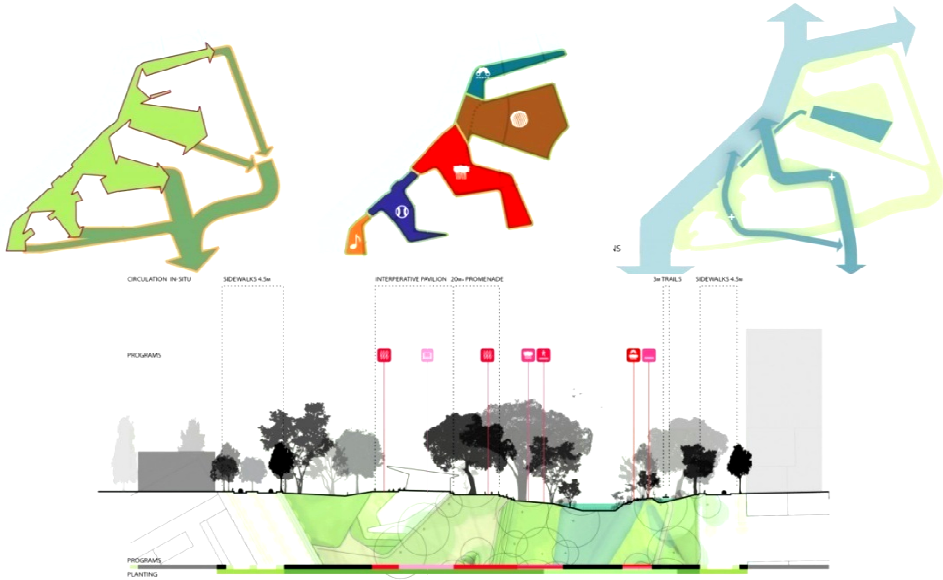



Figure 36 Shanghai (http://www.stoss.net/)

### *The Saw Mill River*

The Saw Mill River in Yonkers' downtown has gone through several transformations and seen many years of intensive land use.

With plenty of community interest in revitalizing the site, Groundwork Hudson Valley formed the Saw Mill River Coalition. The process of daylighting, or removing the cement covering the river and restoring the waterway, presented the best opportunity to provide a community amenity, attract business and begin to undo the ecological degradation.

Furthermore The Saw Mill River Daylighting project is a great example of a community-driven and environmentally-conscious strategy for reclaiming forgotten spaces – with the result being a welcoming public space for new businesses to invest in and for existing residents to enjoy.

Figure 37 Daylighting The Saw Mill River ( http://biofreshblog.com/)

### *The Cheonggyecheon Stream*

Once entombed in concrete and covered with an elevated highway the Cheonggyecheon Stream is now a prized oasis in the middle of Seoul. The long neglected stream has been beautifully restored.

Figure 38 Cheonggyecheon River (http://www.pleasetakemeto.com)

### *Design Competition*

In Queen Village, Soak It Up! asked teams to develop stormwater solutions for the densely knit neighbourhood of alleys and street stubs. A common thread in the finalists' proposals was creating a permeable network of pedestrian and bike routes.

These streets would make way for an increase of street trees and planters, and greened alleys would be re-imagined as linear sponges capable of processing additional stormwater.

Figure 39 Neighbourhood: Greening the Grid – Green Street Infrastructure (http://planphilly.com)

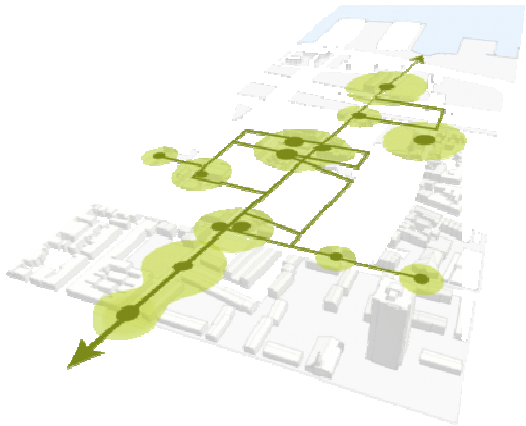
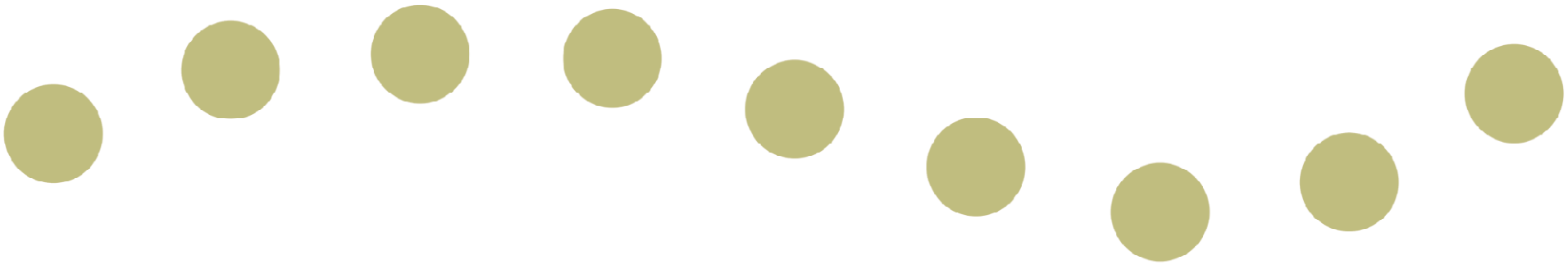


Figure 40 Neighbourhood: Greening the Grid – Green Street Infrastructure (http://planphilly.com)

The common thread between each of these projects is that they utilize space to encompass the best possible aspects of aesthetic design, ecological protection and surface water management. Through innovative restoration and biological mimicry, each of these projects works towards a sound environment improving long term benefits for humans and ecology (Author 2014).



# Chapter 7
# Design Development

## 7.1. Design Development

As a response to the shortfalls of the existing corridor, design decisions are made according to the context of adjacent sites of the Apies River. Ease of access to and from these sites is taken into account by enhancing pedestrian and cycle circulation. A coherent design language will be introduced to the corridor by designing the spaces in accordance with spatial, recreational and aesthetic requirements.

The riverfront of the corridor will be attended to by reintroducing the riparian zone, as well as incorporation of 'infiltration' networks which will draw users from the outer skirts into the green corridor.

The corridor will serve as an attraction where social, recreational and environmental requirements are met. The urban environment will now function as a intermediate network of recreational and environmental facilities where people, plants and animals can coexist.


Figure 41 Functional Diagram (Author 2014)

Table 4 River Scenario's (Author 2914)

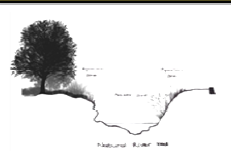
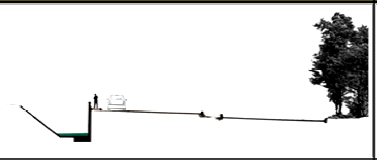
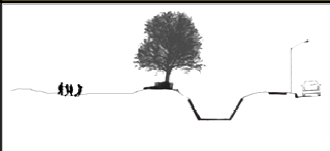
| | Scenario 1 | Scenario 3 | Scenario 3 | Scenario 4 | Scenario 5 |
|---|---|---|---|---|---|
| | Ecological Environment<br><br>Fountains Valley | Historical element & Ecological environment<br>NZASM Bridge within Fountains Valley | Infrastructure<br><br>Railway Bridges & Roads | Intermediate space<br><br>Parks Connection | Typical Urban Environment<br><br>Urban Infrastructure |
| Sections along river |  |  |  |  |  |
| Constraints | ▪Degraded river embankment<br>▪Little opportunity for human interaction<br>▪Lack of accessibility | ▪Degraded river embankment<br>▪Lack of access to the historic bridge | ▪No safety measure<br>▪Vast amount of roadways<br><br>▪Not pedestrian friendly<br>▪River ecology is hardly recognised | ▪Stormwater from roads are polluted<br>▪Degraded sidewalks<br><br>▪No safety measure<br>▪Lost connection to natural systems<br>▪Polluted streetscape | ▪Not pedestrian friendly<br>▪Polluted streetscape<br><br>▪Lack of natural vegetation<br>▪Polluted water in stormwater channel/river |
| Use Frequency | Low | Very Low | Very High | Moderate | High |
| Period | Once Monthly | Almost never | Daily | Weekly | Daily |
| Users' needs (Man as user & Nature as user) | Access<br>Seating<br>Walkways<br>Ecological information | Access<br>Seating<br>Walkways<br>Historical information | Visual Access<br>Ecological restoration<br>Aquatic zone modification | Access to ecology & its systems<br>Riparian zone alteration<br>Ecological restoration<br>Aquatic zone modification | Access to ecology & its systems<br>Ecological reintroduction<br>Riparian zone alteration<br>Aquatic zone modification |


Figure 42 River Edge Scenarios (Author 2014)

The Apies River has different profiles along the entire site. It varies from a natural degraded embankment to a man made concrete channelized system. Figure 30 indicates five typical scenarios which depicts the existing state of the river.

Scenario 1 depicts the natural degraded river embankment which is typical of Groenkloof Nature Reserve and Fountains Valley. NZASM Bridge is depicted in Scenario 2 at the start of the concrete channel. Scenario 3 is where there is an infrastructural node containing railroads above the Nelson Mandela Drive Highway and the channelized concrete river with a retaining edge. In Scenario 4 the channelized river is typically bound by a vehicle zone with a pedestrian zone (sidewalk) adjacent to it and on the opposite edge of the river open space or a park can be seen. And in Scenario 5 the urban environment suppress the biophysical elements of which the importance is disregarded. With each scenario column the constraints are stated in the following row, these problems needs to be addressed when considering space making. Not only should the problems be solved but the frequency of use should be taken into account. The use frequency determines the spatial needs to create an environment which heals the river ecology and systems together with the wellbeing of the users of the site.

Spatial needs are addressed according to users' needs in cooperation with the need to connect with the biophysical environment. It takes into account the ecological environment, with its systems in order to develop a green corridor which will function as the green space network which is required to fulfil the open space requirement according to the CSIR open space requirement guidelines.

As previously mentioned the biophysical environment has the potential to enable Landscape Architecture to heal the lost connections; connections in terms of history, culture and the connection between man and nature.

Table 4 lists which specific spatial connections need to be healed; it is divided into human aspects and ecological aspects and subdivided into what these spaces need. The principles are then developed from the design objectives mentioned in Chapter 2.

The human aspect principles are to:

- create accessible nodes for social opportunity
- ensure archaeological sites / features / structures are features in the landscape
- ensure cultural upliftment
- design to allow city dwellers to associate with the space by acknowledging the past and present
- have accessible links to vegetated sites, Introduce more vegetation into the city
- create lookout points near the water
- the space should function as a retreat for the everyday user/dweller
- create space where nature is accessible by the senses
- Introduce information along the corridor to help people understand nature & its systems
- Introduce man-made features into the natural environment and to make accessibility of a large natural environment possible

These principles will be strategically developed to fit specific contexts, but the overall design will be focused on development of a green corridor as an open space network where not only comfort, familiarity, identification, meaning and security is present but also the creation of a pleasant space where man can experience nature and its systems to ultimately affect ones wellbeing.

The ecological aspect principles are:

- Conserving and regeneration of the biophysical environment
- Provide opportunity for the planting community to thrive in the urban environment
- Strengthen the link between nature and the urban environment
- Link habitat environments

- Enhance existing habitat environments
- Ensure biodiversity within the urban environment
- Treat stormwater runoff
- Treat water upstream to ensure water quality downstream
- Reduce runoff velocity

These ecological principles are intertwined with the human principles where pedestrian friendly and ecologically enhanced green-spaces within the urban environment are created. The ecologically enhanced spaces are in relation to stewardship within the urban environment. Reintroduction of the planting community, and generic and site specific systems will allow ecology to florish.

**Table 5 Iconic information (Author 2914)**

| | |
|---|---|
|  | BRT System Incorporated |
|  | Safe Cycle Routes Introduced |
|  | Safe Pedestrian Access Routes |
|  | Ecological Enhancement / Riparian Zone Restoration |
|  | Aquatic ecology enhancement |
|  | Improving Water Quality / Stormwater Management / Improving River Quality |

### 7.1.1. Design development

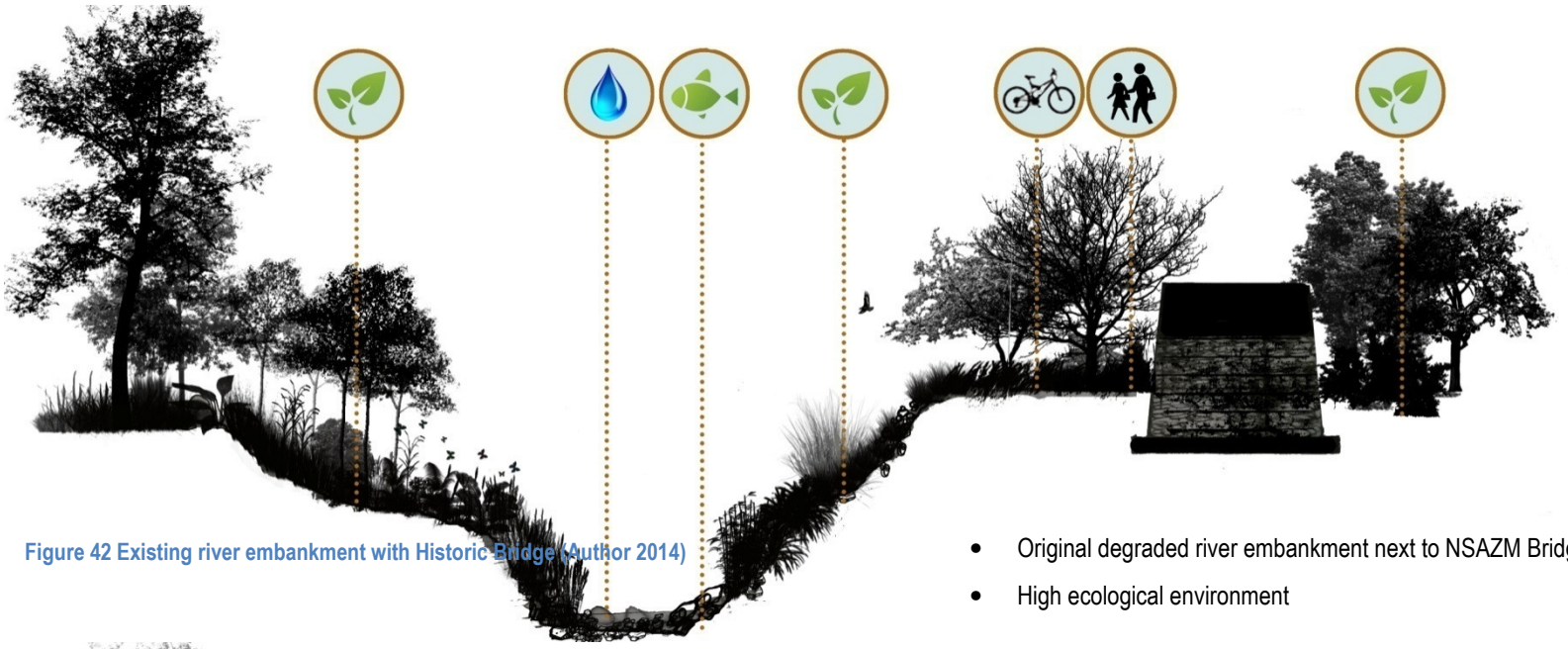


Figure 42 Existing river embankment with Historic Bridge (Author 2014)

- Original degraded river embankment next to NSAZM Bridge
- High ecological environment

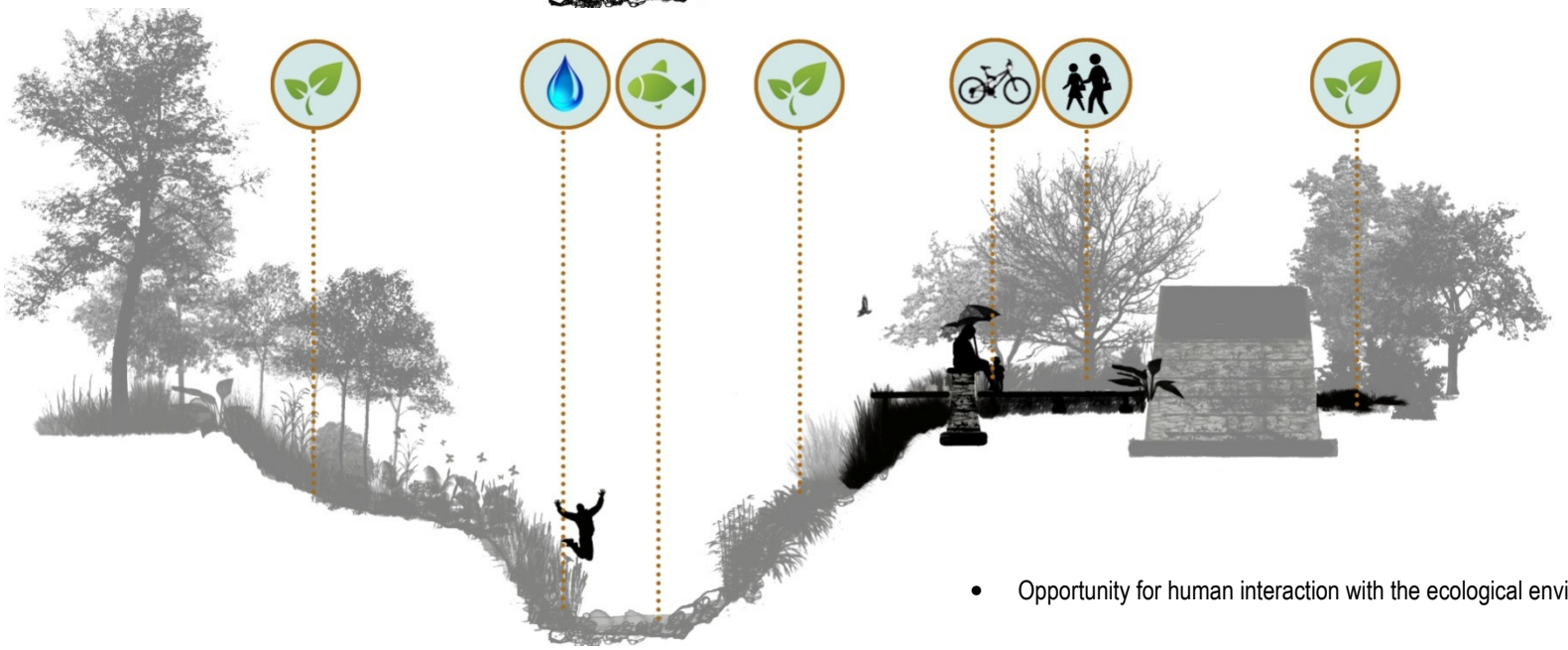


Figure 43 Proposed User friendly space (Author 2014)

- Opportunity for human interaction with the ecological environment

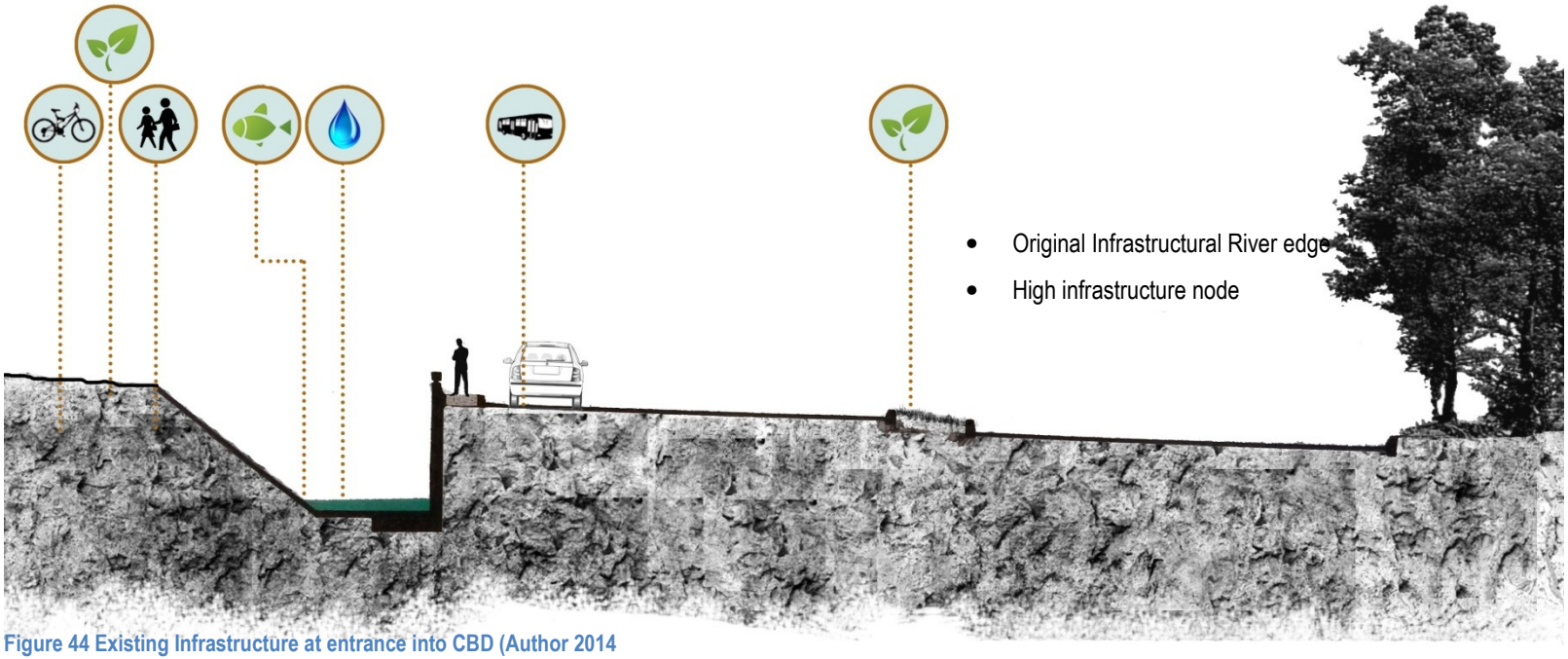



Figure 44 Existing Infrastructure at entrance into CBD (Author 2014

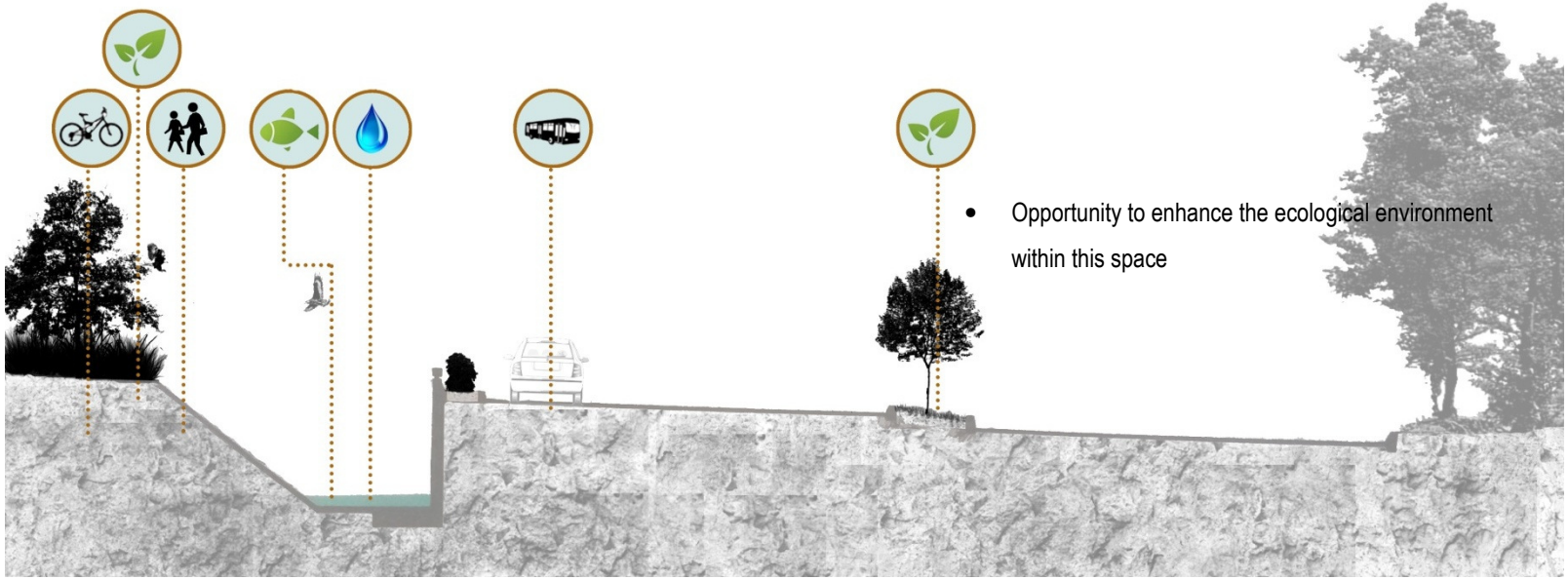



Figure 45 Existing Infrastructure at entrance into CBD (Author 2014)

- Original channelized river bed
- Versatile surrounding environment

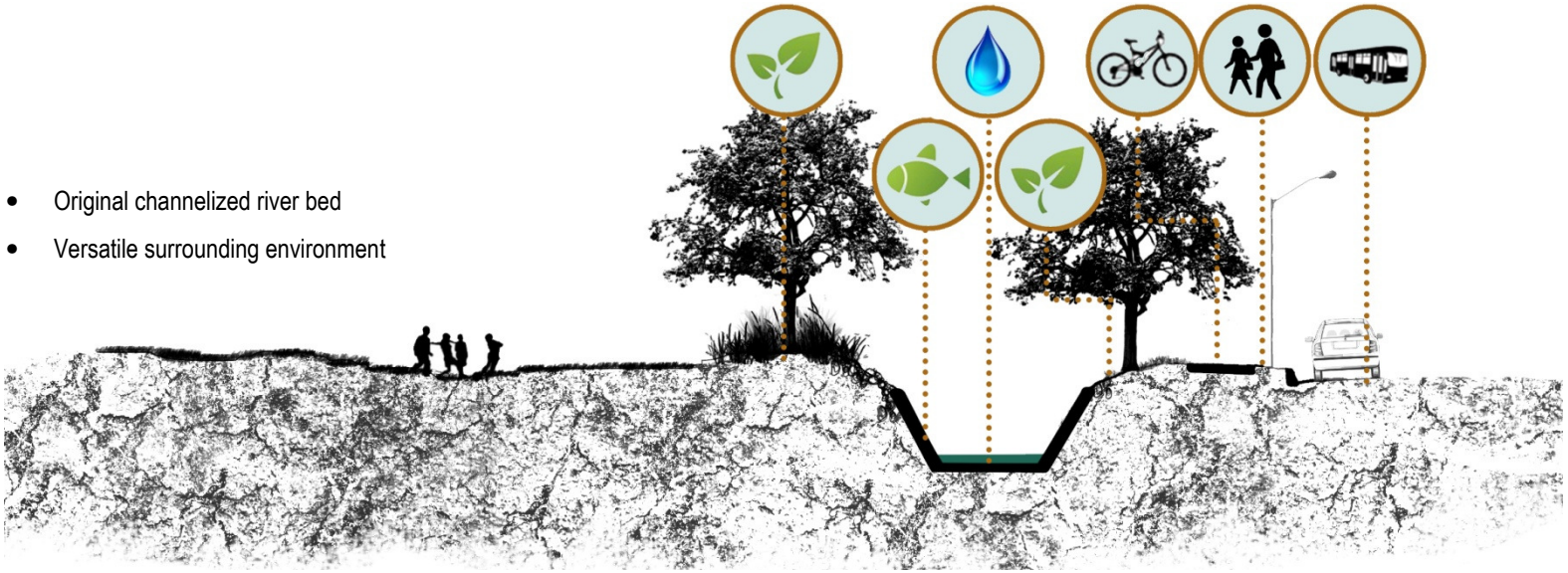


Figure 46 Existing River Along a park space (Author 2014)

- Opportunity to enhance the ecological environment within this space
- Opportunity to incorporate water attenuation systems
- Opportunity to develop visual interaction nodes

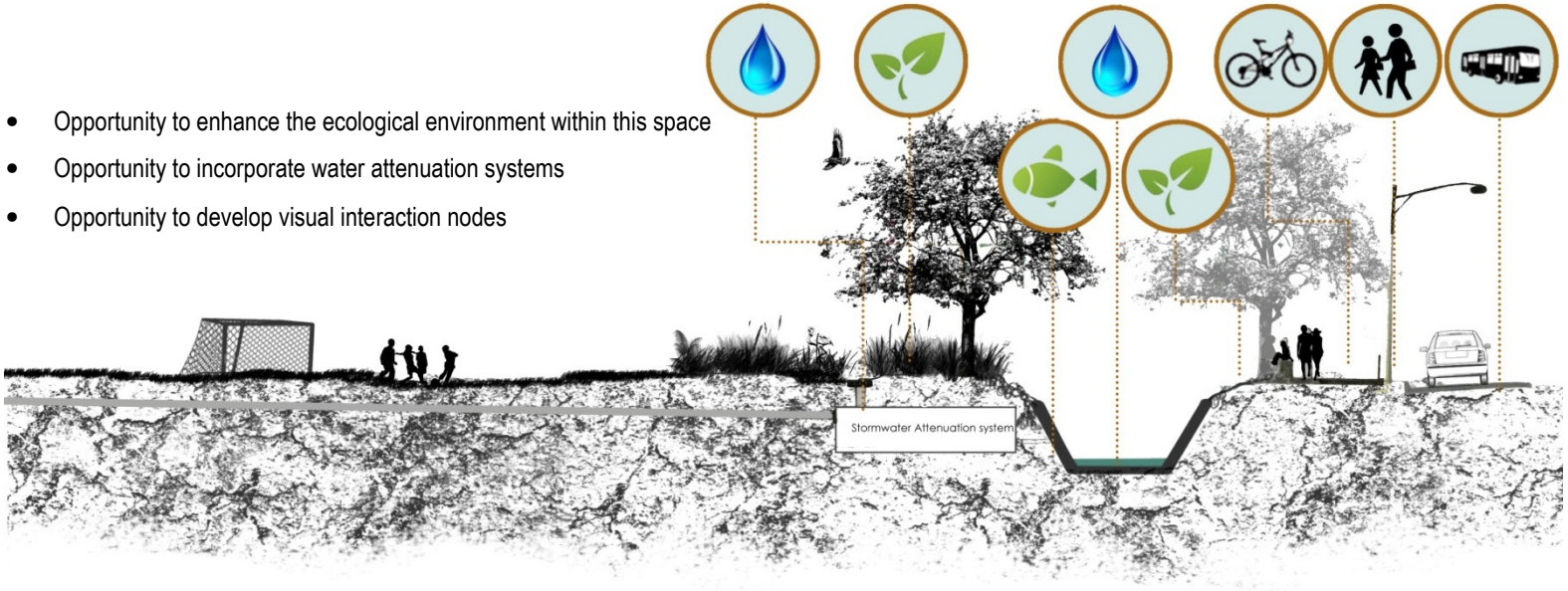



Figure 47 Proposed developments of sites along the river (Author 2014)

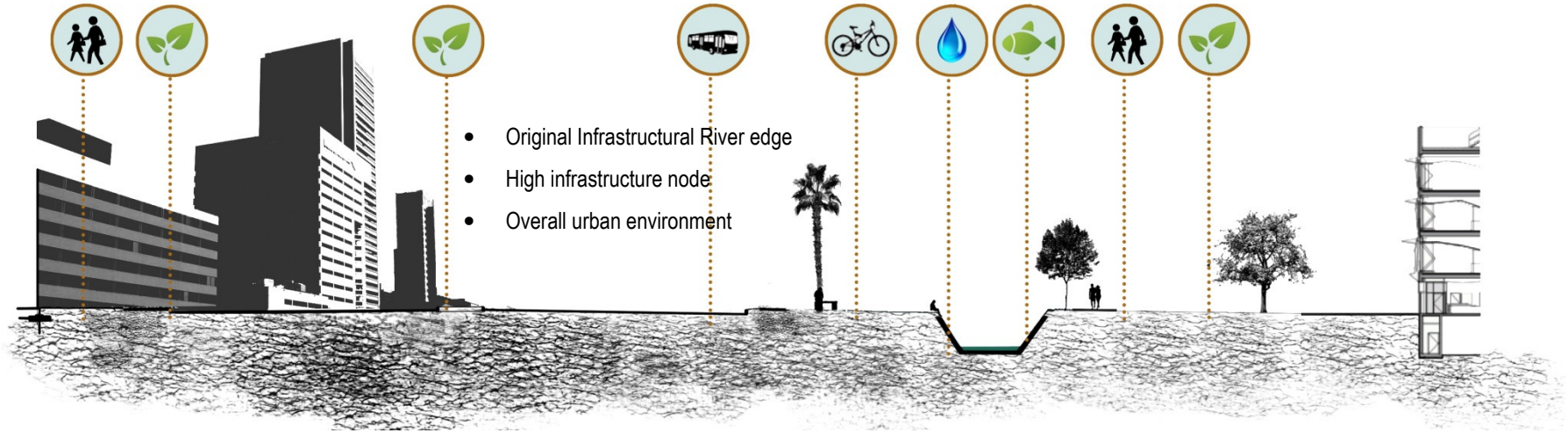



Figure 49 Existing Urban Context (Author 2014)

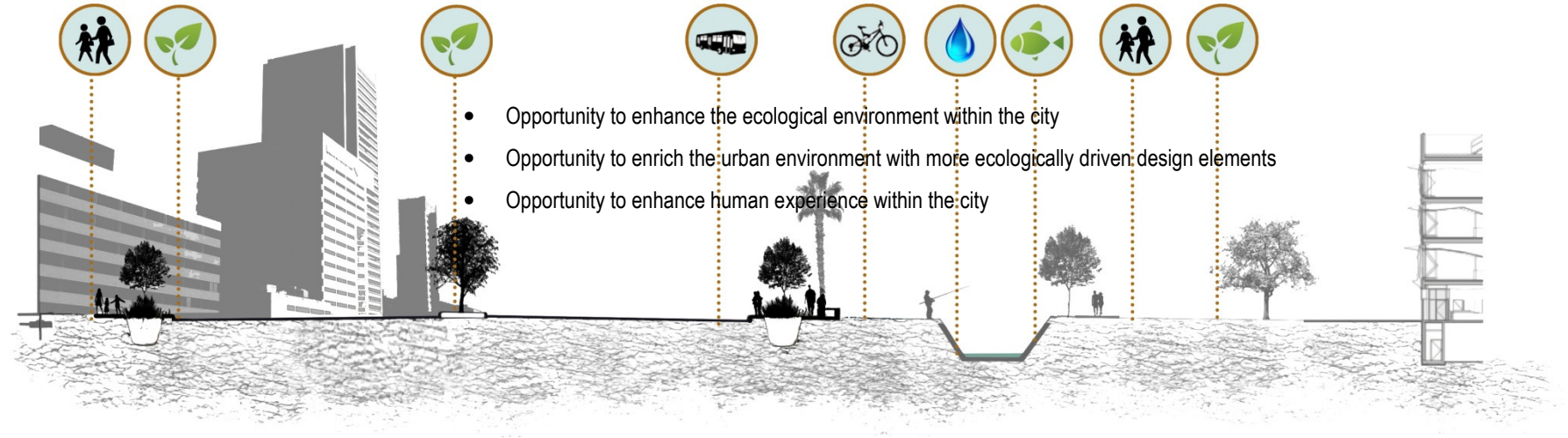



Figure 48 (Proposed Urban Context development with Green Street Infrastructure (Author 2014)

## 7.1.2. Scoring

Connection Bridge

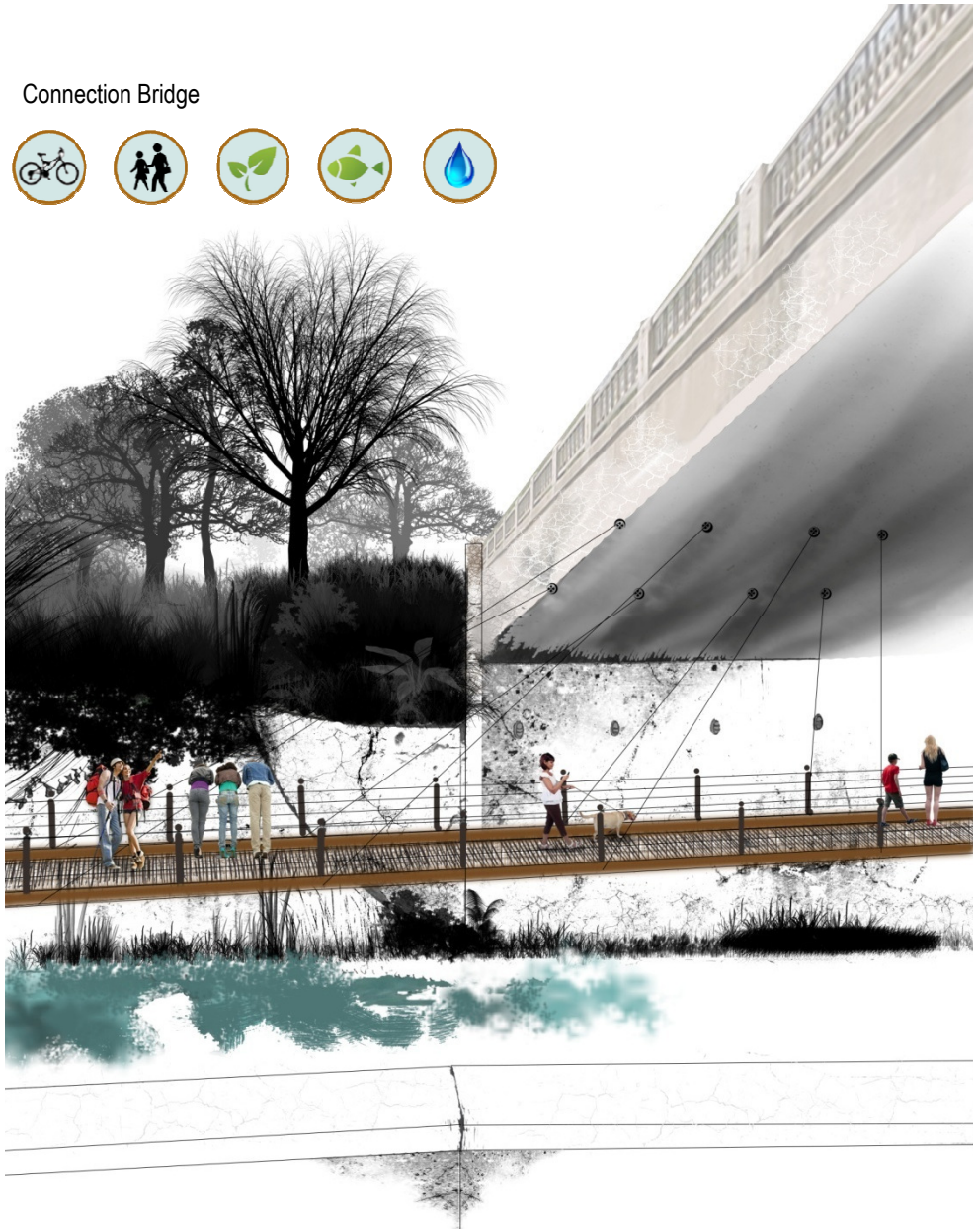


Figure 50 Scoring_Connection to Fountains Valley (Author 2014)

Street widening for ease of access

Pedestrian & Cyclist focused intervention

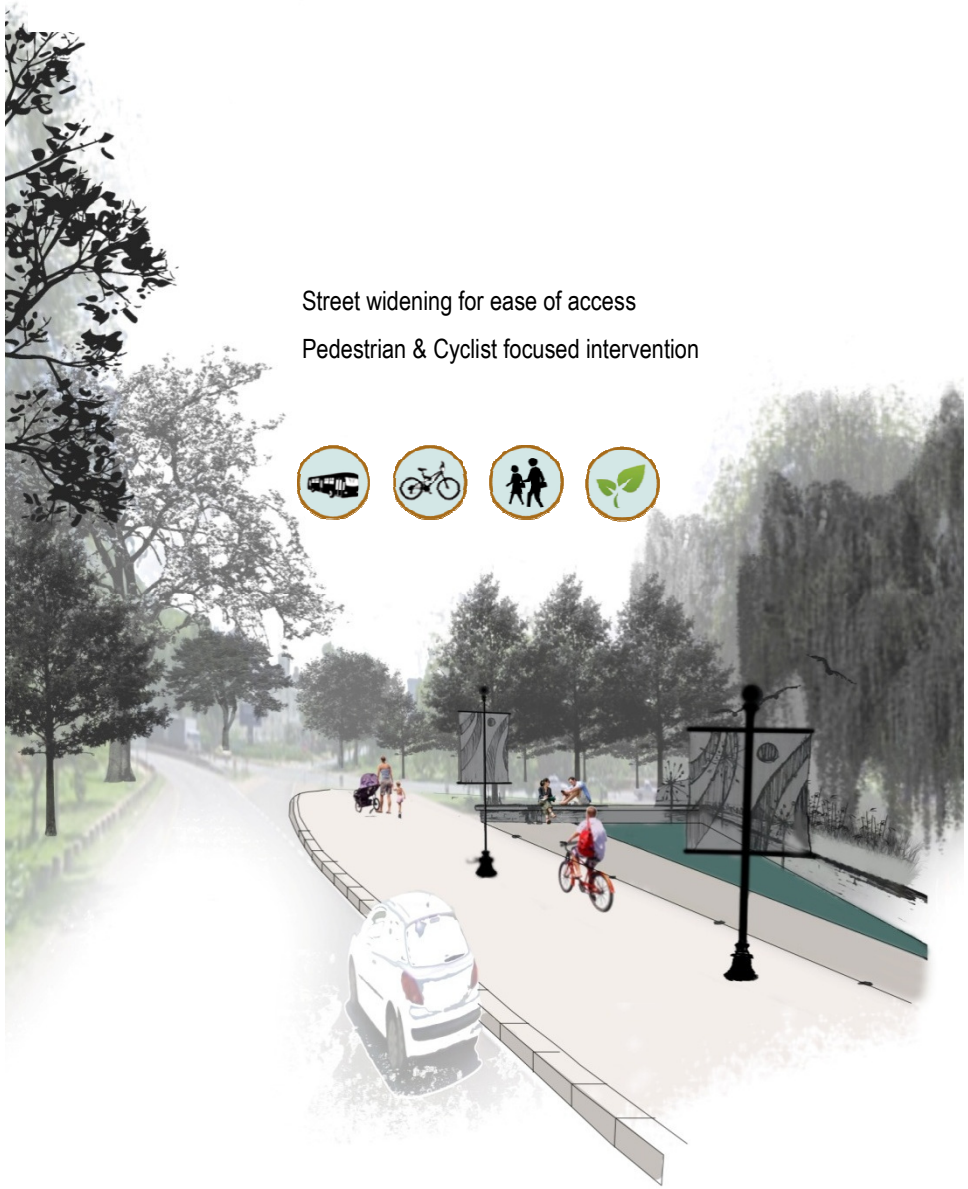


Figure 51 Scoring_Open space as social node (Author 2014)

Ecologically enriched urban spaces

**Figure 52** Scoring_Proposed Urban Development (Author 2014)

Opportunity for active night life within the city by creating accessible event space

**Figure 53** Scoring_Proposed Urban Development (Author 2014)

# Chapter 8
# Detail Design

## 8.1. Design Resolution

### 8.1.1. Master Plan

Figure 54 Master plan (Author 2014)

City planners recognize that urban rivers are usually among the most vivid and memorable features of a city and play a prominent role in shaping the structure, character and identity of urban areas. Innumerable historic paintings of urban waterfronts often symbolize the image of the whole city. But in the nineteenth and throughout much of the twentieth century, the water quality in most urban rivers was so bad that most cities turned their backs on their waterfronts. The widespread interest in urban river enhancement did no emerge until advances in wastewater treatment technology had created a water quality that was sufficiently high to convince cities that their waterfronts had enormous potential for development. (Silvia, J. 2002)

### 8.1.2. Development strategies

Table 5 Strategies (Author 2014)





| What to heal? | Human Aspects | | |
|---|---|---|---|
| | | **Social connection** | |
| | | **Principle** | **Needs Fulfilled** |
| | | Create accessible nodes for social opportunity | Cultural Connection |
| | | **Strategy** | Belonging |
| | | Increase and Improve Right-of-Way Public Space and Green Areas | Physiological |
| | | Improve Streetscapes for Users | Shelter |
| | | | Safety |
| | | **Cultural connection to the city** | |
| | | **Principle** | **Needs Fulfilled** |
| | | Ensure archaeological sites / features / structures are features in the landscape | Cultural Connection |
| | | Ensure cultural upliftment | Belonging |
| | | Design to allow city dwellers to associate with the space by acknowledging the past and present | Physiological |
| | | **Strategy** | Safety |
| | | Create resting points near archaeological sites / features / structures | Discovery |
| | | Create accessible event space where cultural events can take place | |
| | | Man-made features inserted and others emphasized (NZASM Bridge) | |
| | | Creating access into the natural environment via significant sites (Fountains Valley) | |
| | | **Physical connection to nature** | |
| | | **Principle** | **Needs Fulfilled** |
| | | Have accessible links to vegetated sites | Access |
| | | Introduce more vegetation into the city | Belonging |
| | | Create lookout points near the water | Physiological |
| | | Create space where nature is accessible by the senses | Shelter |
| | | Introduce information along the corridor to help people understand nature & its systems | Safety |
| | | The space should function as a retreat for the everyday user/dweller | Discovery |
| | | **Strategy** | Education |
| | | Use Plants to Enhance Significance of Temporal Change | |
| | | Increase Quantity, Density and Diversity of Plant Species | |
| | | Protect Existing and Future Planted Areas | |
| | | Introduce plants with aesthetic appeal | |
| | | Use plants with different scents | |
| | | Use vegetation which attracts birds and insects | |
| | | **Introduce sustainable technologies in the city** | |
| | | **Principle** | **Needs Fulfilled** |
| | | Use appropriate technologies to support a healing approach | Understanding of sustainability |
| | | Make accessibility of a large natural environment possible | Education |
| | | **Strategy** | Discovery |
| | | Optimize Street Lighting and Signage | |
| | | Use appropriate power saving technologies | |
| | | Reduce Visual Clutter by Designing a Modular street post system | |
| | | Use Recycled/Reclaimed Materials | |
| | | Incorporate a Waste Management Plan (Job Creation) | |
| | | Use appropriate materials and fixings | |
| | | Develop and enforce a site protection plan | |
| | | Use appropriate water management technologies | |

| What to heal? | Environmental Aspects | | |
|---|---|---|---|
| | | **Planting community** | |
| | | **Principle** | **Needs Fulfilled** |
| | | Conserving nature<br>Provide opportunity for the planting community to thrive in the urban environment<br>Strengthen the link between nature and the urban environment | Connection<br>Health<br>Access<br>Subconscious understanding of ecology<br>Discovery |
| | | **Strategy** | |
| | | Create green corridors by reintroducing nature and its systems into the urban environment<br>Use Healthy Plant Selection & Planting Practices<br>Plant Species of the Planting Community | |
| | | **Habitat creation** | |
| | | **Principle** | **Needs Fulfilled** |
| | | Link habitat environments<br>Enhance existing habitat environments<br>Ensure biodiversity within the urban environment | Subconscious understanding of ecology<br>Health<br>Access<br>Discovery |
| | | **Strategy** | |
| | | Encourage ecological connectivity and Habitat Creation<br>Use low-maintenance species<br>Create new habitat environment | |
| | | **Water quality** | |
| | | **Principle** | **Needs Fulfilled** |
| | | Treat stormwater runoff<br>Treat water upstream to ensure water quality downstream<br>Reduce runoff velocity | Access<br>Clean water |
| | | **Strategy** | |
| | | Water attenuation system; rain gardens, Bio-retention planters<br>Use Water-efficient Landscape Design<br>Use Catch Basin Inserts<br>Improve water quality<br>Maximize Permeable Paving Areas<br>Use Bio-retention Water Management<br>Reduce Stormwater Runoff<br>Use Vegetated Filters and Buffer Strips<br>Create Absorbent Landscapes<br>Optimize Right-of-Way Drainage<br>Protect Water Source | |

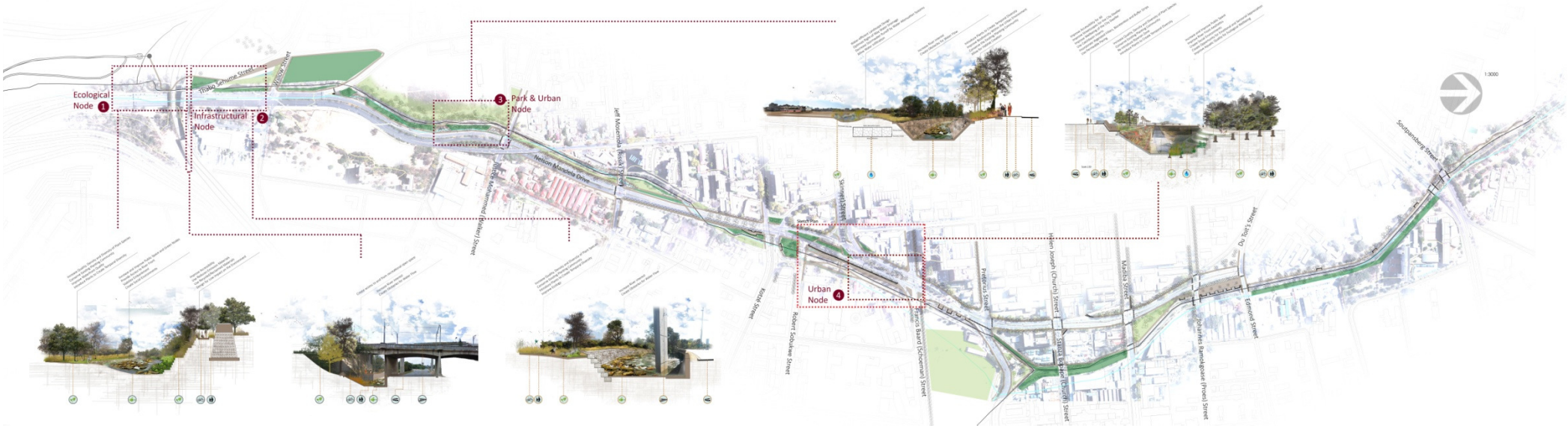



Figure 55 Master plan with Visionary Section Elevation (Author 2014)

All strategies (Table 4) are in accordance with the spatial development in the four different scenario areas (indicate with maroon rectangles) to create aesthetically pleasing, ecological rich and user friendly environments and with the help of many precedents (see Chapter 6) the design ideas are generated (more detail shown further on).

Strategies are applied to various sections along the river. Figures 31-37 depicts how the existing spaces will develop and the following strategies can be applied to one, some or all of the nodes. The project will provide new strategies to enhance watercourses located in urban areas. It will provide enough scope to cover the differing, multi-functional uses of urban watercourses and their adjacent communities across South Africa.

## 8.2. Strategies informing the Design

### 8.2.1. Development of a generic street infrastructural system

Developing a green corridor as an open space network requires consideration of all users. It should serve as a mobility spine for man and nature where nodes are connected by some means. Incorporation of Green Street Infrastructure can serve as the connecting agent as well as to create healthier urban environments.

All of the previously mentioned strategies will be addressed through incorporation of the Green Street Infrastructure. The Green Street Infrastructure according to Leda Marritz the EPA's website entails a vegetated soil area that mimics natural processes to manage water and create healthier urban environments. These healthier environments refer to the infrastructural systems that provide habitat, flood protection, cleaner air, and cleaner water.

The plan is to include a range of soil-water-plant systems that intercept stormwater, infiltrate a portion of it into the ground, evaporate a portion of it into the air, and slowly release a portion of the captured stormwater back into the Apies River Channel. The system will treat "stormwater runoff as a resource to be incorporated into the urban environment instead of as a waste product requiring removal and treatment." (Marritz 2014).

This will all in all benefit ecology as well as human wellbeing due to ecological enrichment and spatial development, as a pedestrian friendly green corridor.

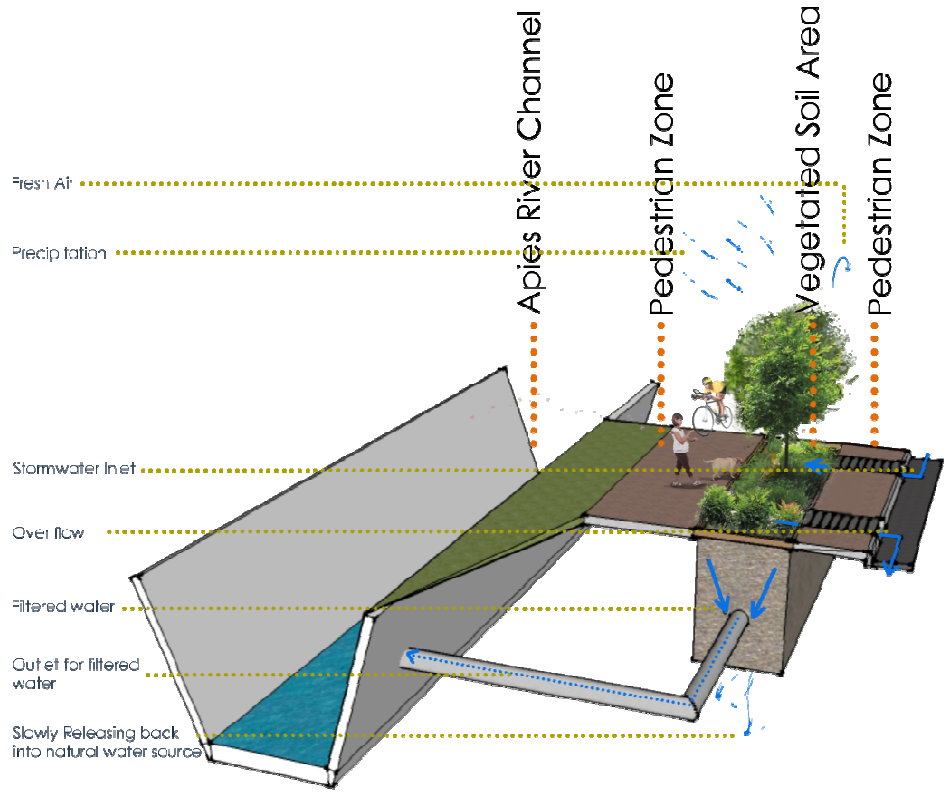



Figure 56 System 1 Sketch up Model (Author 2014)

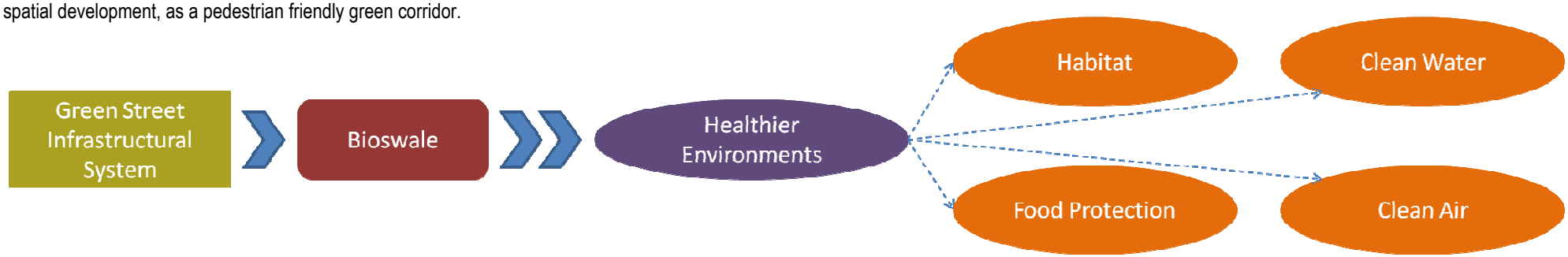



Figure 57 System Engagement (Author 2014)

### 8.2.2. Generic Re-development of a channelized river

The existing condition of the longest part of the Apies River is channelized as previously mentioned. This means that there is no opportunity for any river ecology to thrive. Not only does the impervious concrete prohibit this from transpiring but also the quality of the water within the most part of the river. The water quality is one of the main factors for ecology to flourish; this means that water running into the river channel needs to be treated before it enters the water capturing system. This is done by the previously mentioned Green Street Infrastructural System, where stormwater is treated in the vegetated soil area for better quality water to enter the river channel.

Factors to consider within the Apies River Channel is where the water comes from, the water quality and what the water is used for (where it is distributed to). The river gets fed by a natural fountain source, building air cons, basement parking and of course stormwater during a rain event. This collective water source are then accumulated within the Apies River Channel where various pollutants are present as Floating debris, Contaminants lighter than water, Contaminants heavier than water, Dissolved minerals and Microbes. These pollutants are transported within the channel to numerous water collection points where it is distributed as water for agriculture, water supply for domestic use (in informal areas) which means that 2 704 households are at risk. According to Venter's source; 'using contaminated water for irrigation, recreational or domestic use poses certain health risks associated with water borne diseases'. Therefore water running within the river channel also needs to be accounted for in order to enhance water quality downstream for whichever use necessary.

The following water quality enhancing system is a system working within the river channel bed as a filtering process to produce cleaner water. This system introduces synthetic environments which will allow for the river ecology to thrive. The river ecology will drift from the Groenkloof Nature Reserve, through Fountains Valley and into the urban environment where it will connect to other river ecological nodes to form a network within the river itself. The system will ensure health of the biophysical environment and filter water to a more acceptable state and visual interaction with the river; will serve as a calming agent and uplift human wellbeing.

Figure 59 River bed intervention (Author 2014)

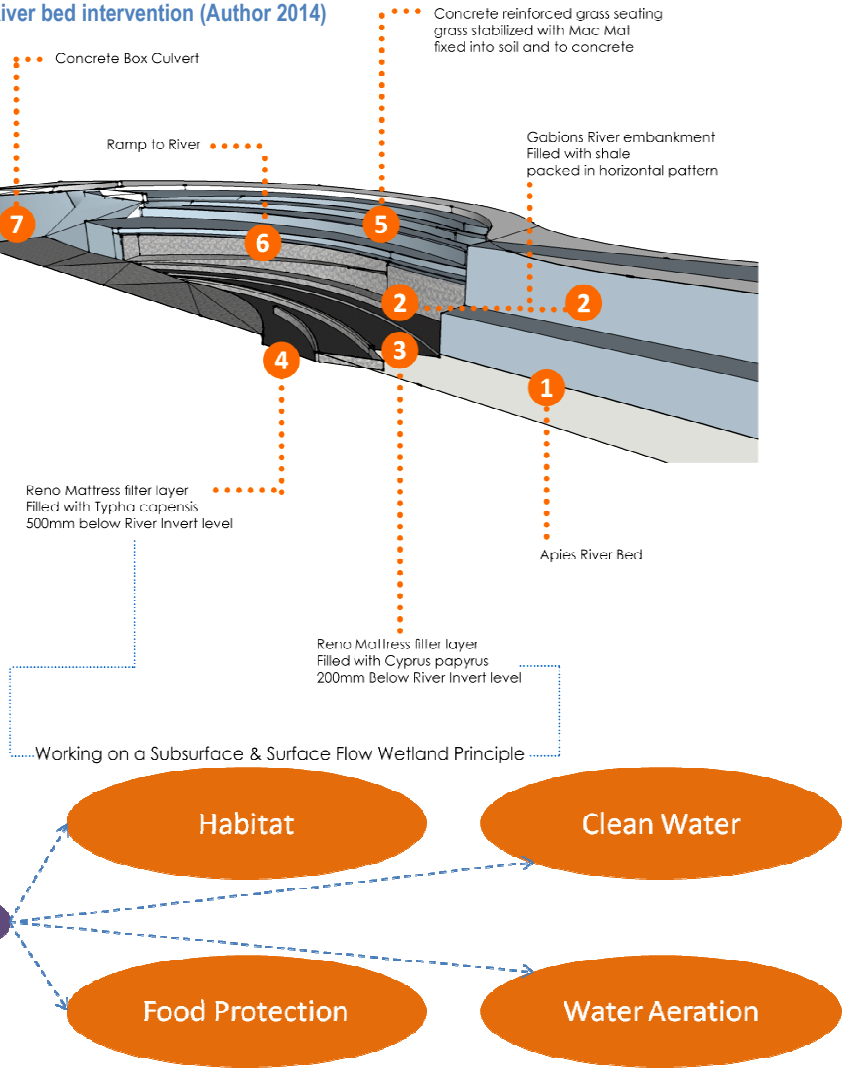



Figure 58 Retrofitted River Bed (Author 2014)

## 8.2.3. Site Specific Systems

### *8.2.3.1. River embankment rehabilitation*

The current situation within Fountains Valley is a degraded river embankment which causes soils to be washed into the river, in turn reducing space for a stable riparian zone. Using a more natural approach to concrete to stabilize the embankment will ensure continuity between the environment in terms of flora, fauna, the river bed, the river banks, the subsurface water and a perfect integration without interruption. This can be achieved by light bank protection by installation of the environmentally friendly Maccaferri Reno Mattresses. These mattresses improve resistance of erosion with the reduction of synthetic or inert materials. It also provides accretion using the material transported by the water flow which promotes plant growth over the structure, thereby promoting a self sustaining process of integration of the eco-system; thus increasing the durability which will outlast the metallic wire life.

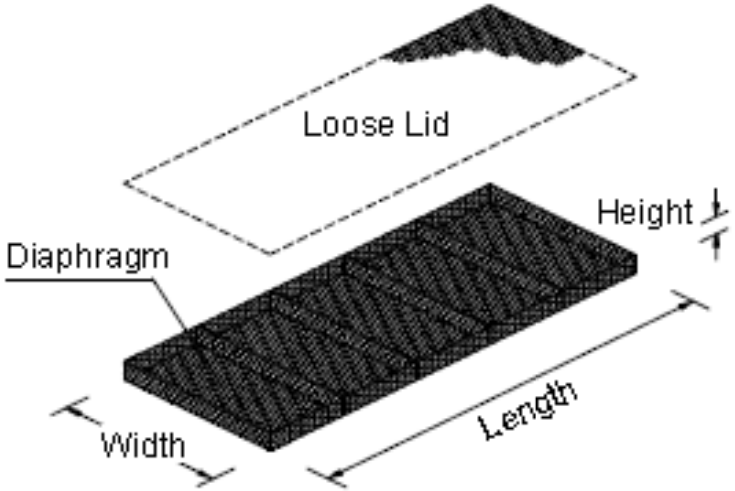



Figure 60 Reno Mattress (Maccaferri)

### *8.2.3.2. Planting Community Restoration*

There is a need for resilience within the urban environment. Planting communities are under severe pressure within our city and needs to be considered when planting selections are made for future development. According to Mucina, L. & Rutherford, M.C. (2006, p. 757 & 784) Pretoria is predominantly situated within the Savana Central Bushveld Region (SV cb) 6 - Marikana Thornveld, this will inform planting choices for the sites along the corridor development and radiated throughout the city. Incorporation of the planting community will ensure habitat creation for fauna to flourish as well.

### *8.2.3.3. Water Attenuation System*

The water attenuation system will be incorporated where sewer line servitude runs underneath a park and gets released into the river system. The attenuation tanks collect surface rain water run-off, which allows the water to be released at a steady rate into the soil or when the tank is halfway filled slowly release water into the river. The tank therefore attenuates, or reduces, the impact of excess water (such as might occur after particularly heavy rainfall) on the drainage system.

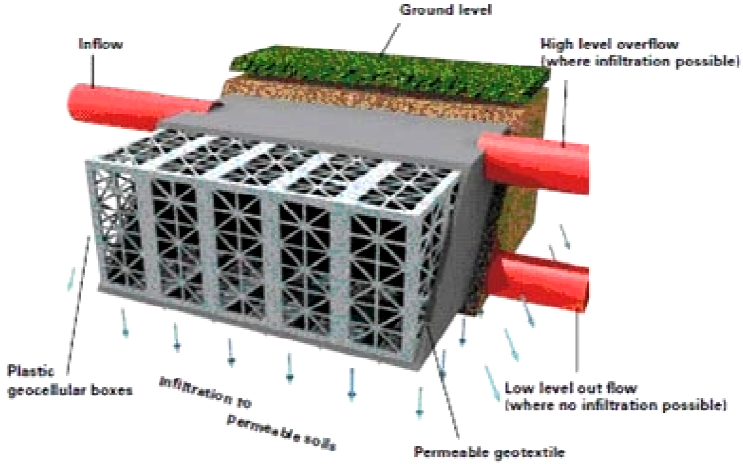



Figure 61 Water Attenuation System (University of Southampton 2009)

### 8.2.4. River hydraulics & Stormwater Strategies

Introducing Bio-swales and filtration systems along all streets and roads to assist in stormwater management, it also provides opportunity for ecology to survive and progress. These bio-swales will also serve as water diverting mechanisms; unabsorbed water will either overflow and exit the bio-swale entering the next or entering the stormwater pipe system leading back to the river or infiltrate the soil deeper to be diverted to sub-surface pipe systems. 20% of the water will be absorbed, 40% will infiltrate naturally and the remaining 40% will be captured into a pipe system leading to rocla water storage systems (installed under vegetated road islands) to be used as irrigation.

The river will also undergo some changes; new edges and surface alteration will give the river a face lift. The river is altered by introducing more natural features like boulders within the river bed, edge alteration by means of cutting through the existing concrete embankments and using gabions to allow for plant to grow.

As the riparian zone is mostly diminished it will be another opportunity to create more ecological friendly spaces which will allow for succession and habitat creation to take place. All in the entire river should have a more naturalistic feel to it.

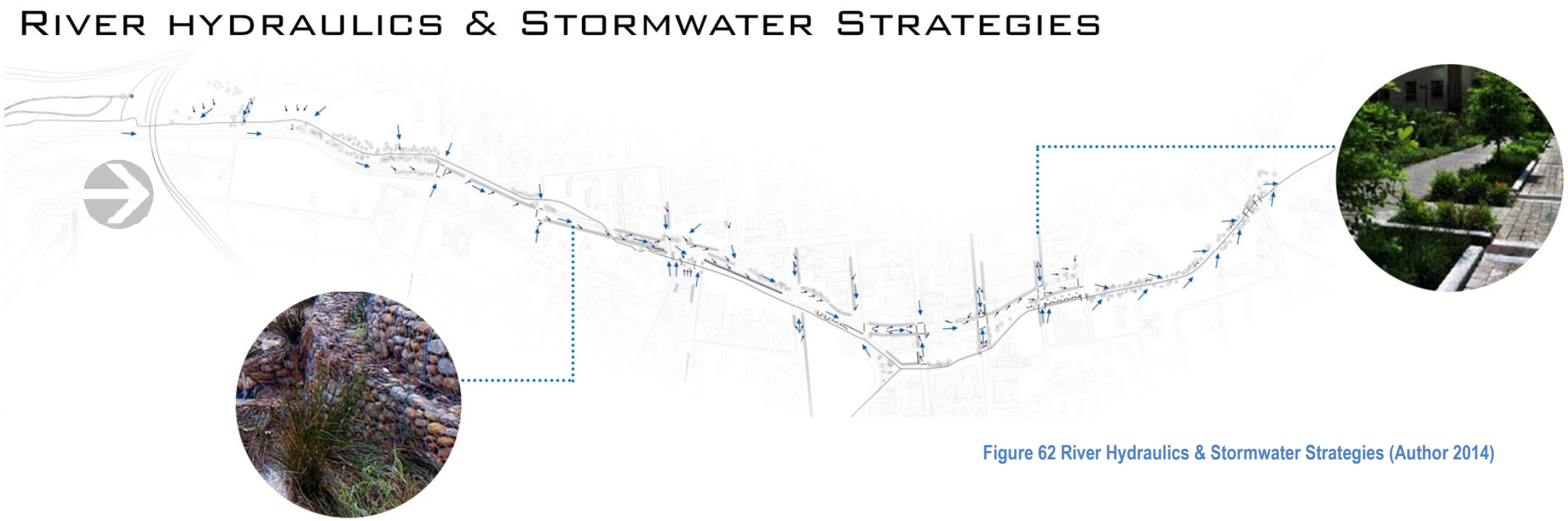



Figure 62 River Hydraulics & Stormwater Strategies (Author 2014)

### 8.2.5. Sustainability Strategies

In order for the proposed green corridor to be sustainable in the urban context, some improvements need to be made. Visually the entire corridor needs tidying up; a modular unit can be introduced to simplify street corners in turn making it more pedestrian friendly. Pollution needs to be taken care of by reintroducing maintenance programmes and ample amounts of litter bins. Pollution in the river needs to be dressed by installation of trash traps where widening will happen, discussed in hydrology strategies, and filtration systems (altering the river bed by cutting into the concrete and inserting Reno mattresses with appropriate planting in them) to somewhat clean the flowing water.

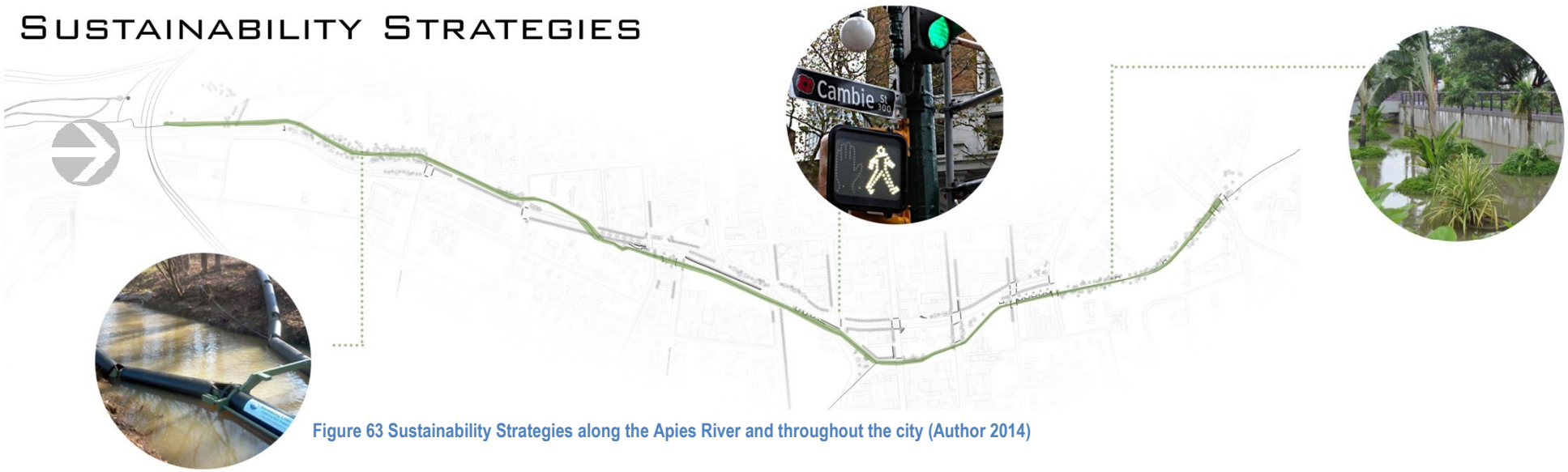



Figure 63 Sustainability Strategies along the Apies River and throughout the city (Author 2014)

### 8.2.6. Planting Approach

The ecological strategy entails restoration of the planting community and reintroduction of riparian and wetland planting. It is creating ecological sound environments where all species can reside and people can find 'refuge' from the busy city life. These environments will be a ecologically enhanced and serve as fulfilling medium for people's biophillic nature wanting to connect to nature and its natural systems. It is fulfilling a subconscious need and a revealing the subconscious understanding of ecology.

According to the site inventory and analysis (see chapter 5) plant and tree species are identified to help with specie selection and grouping. Further soil, climate and water analysis help with detail specie and groupings and placement.


Figure 64 Ecological Strategies (Author 2014)


Figure 65 Master Plan as Reference for Scenarios (Author 2014)

### 8.2.7. Scenarios with Plans and Section Elevations

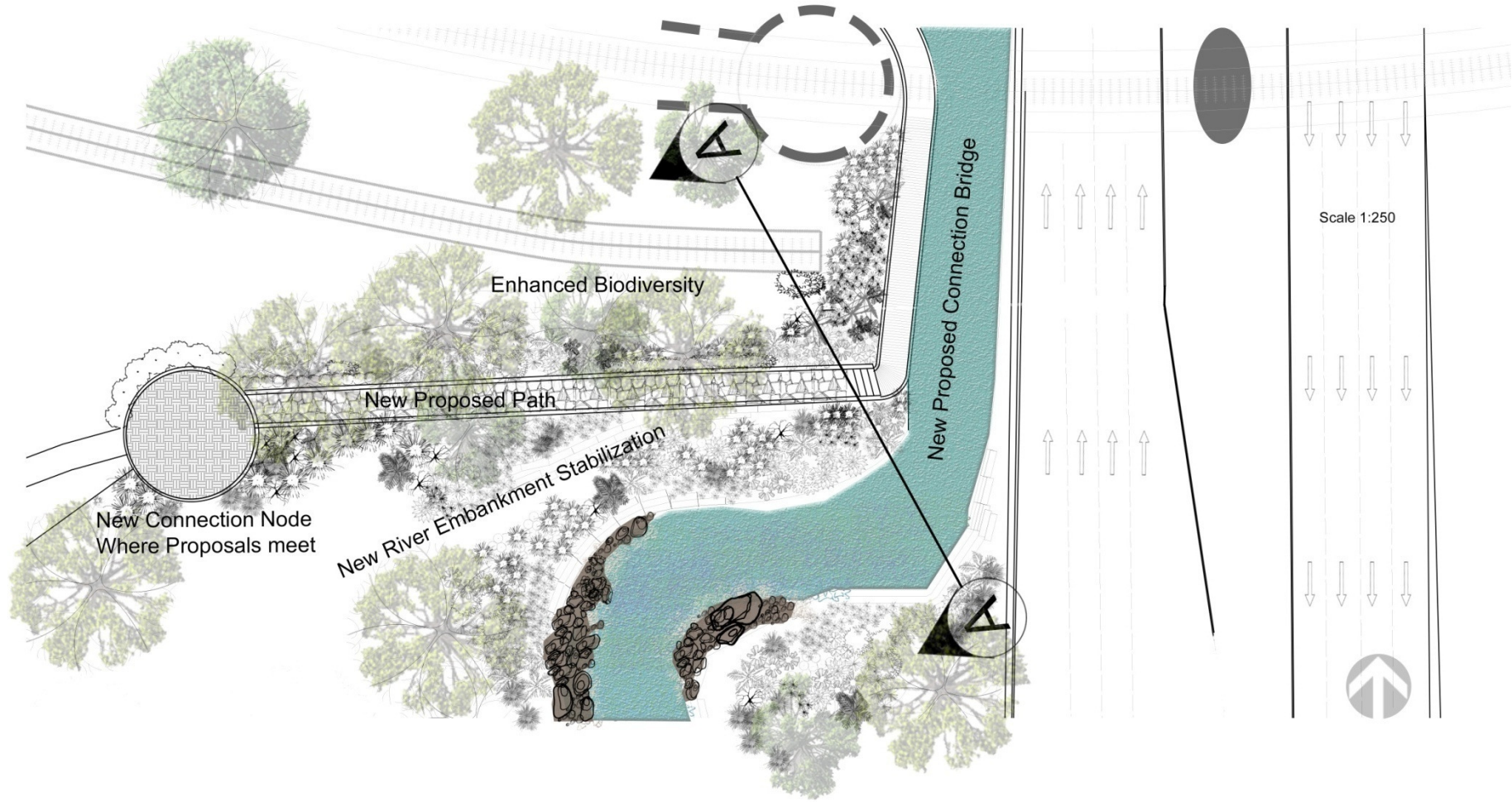



Figure 66 Plan of Scenarios 1_River Embankment Stabilization (Author 2014)

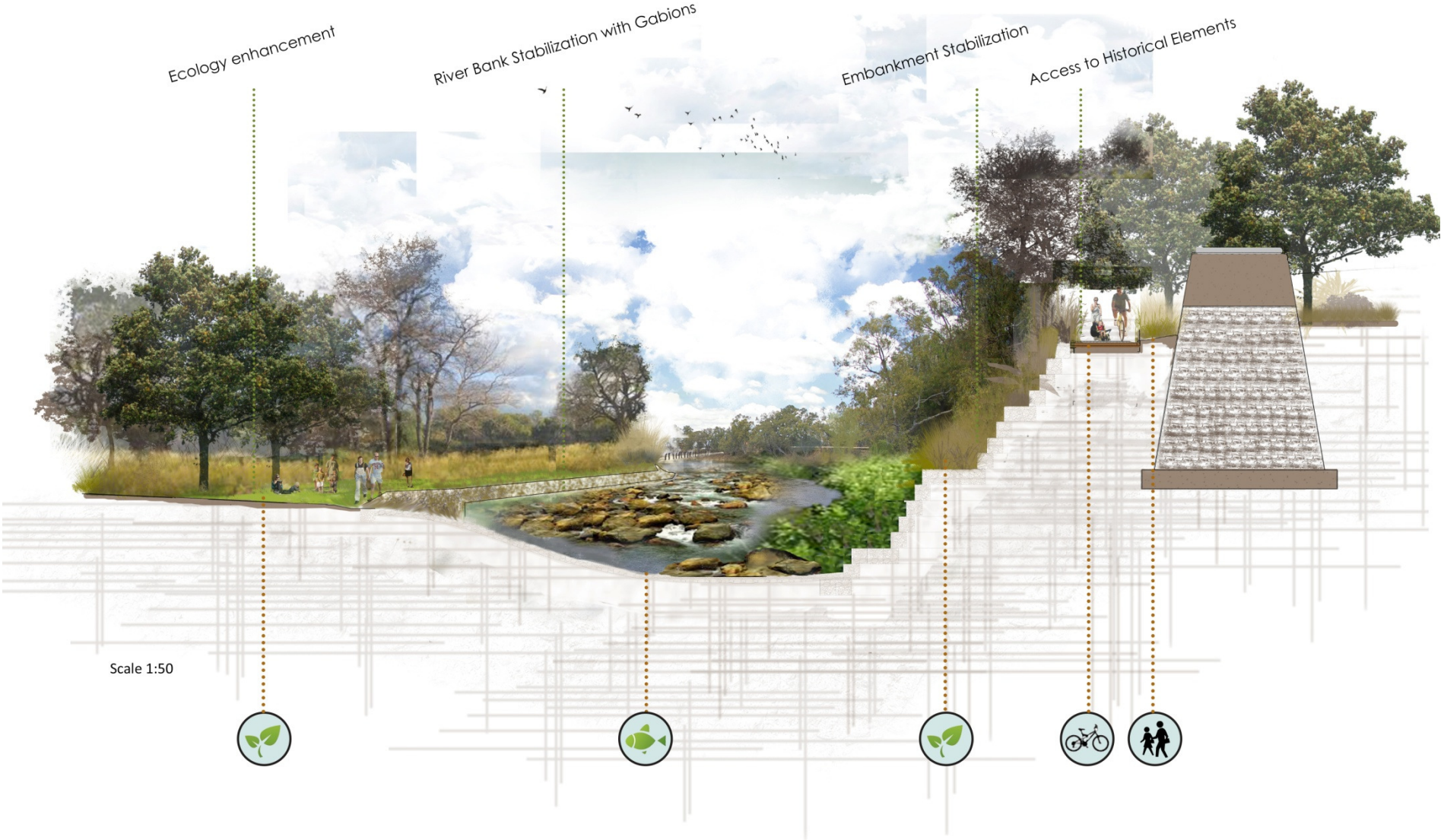



Figure 67 Scenario 1_River Embankment Stabilization

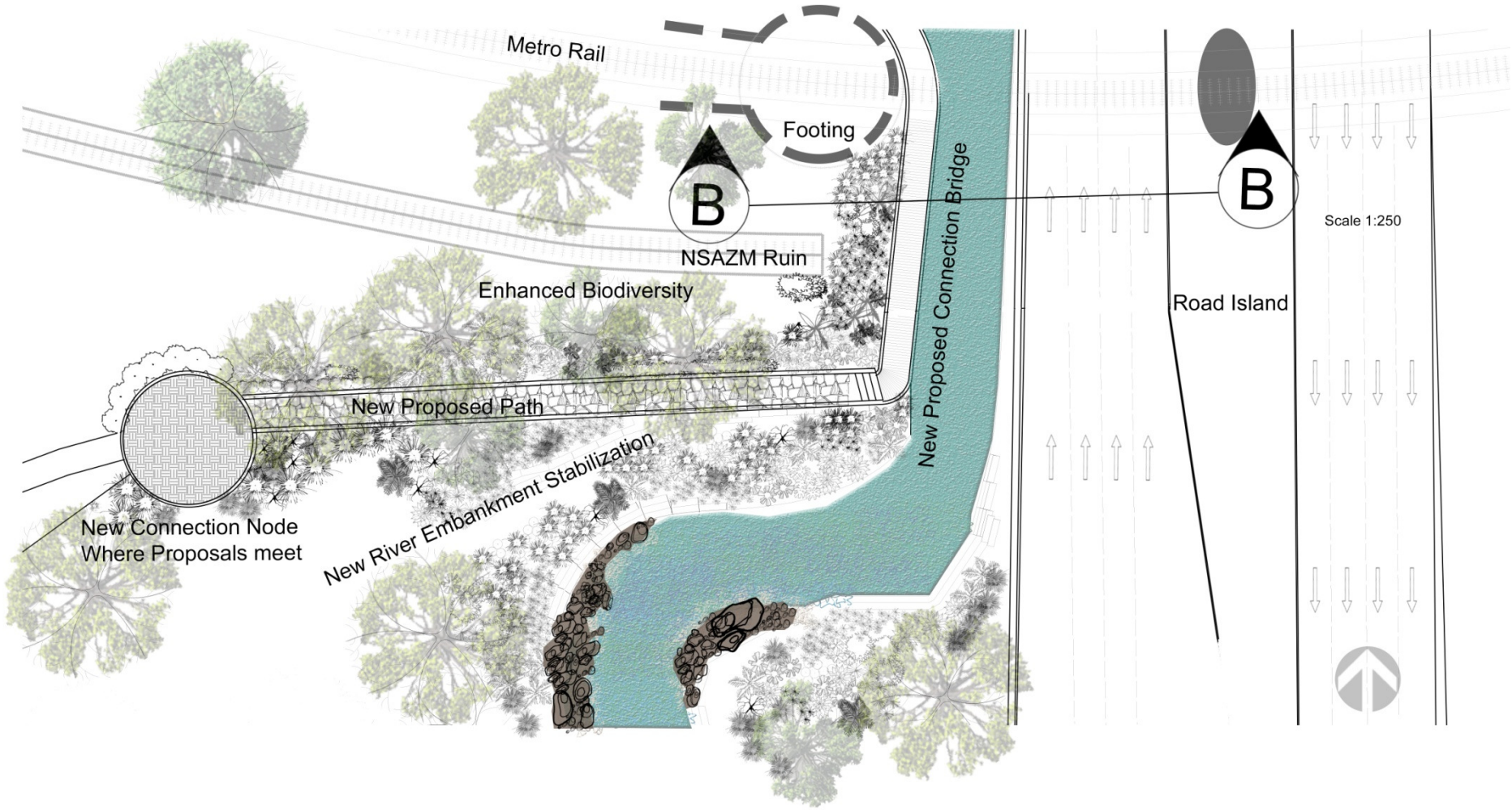



Figure 68 Plan of Scenarios 2_Connection to Fountains Valley via Suspension Bridge (Author 2014)


Figure 69 Scenario 2_Connection to Fountains Valley via Suspension Bridge (Author 2014)

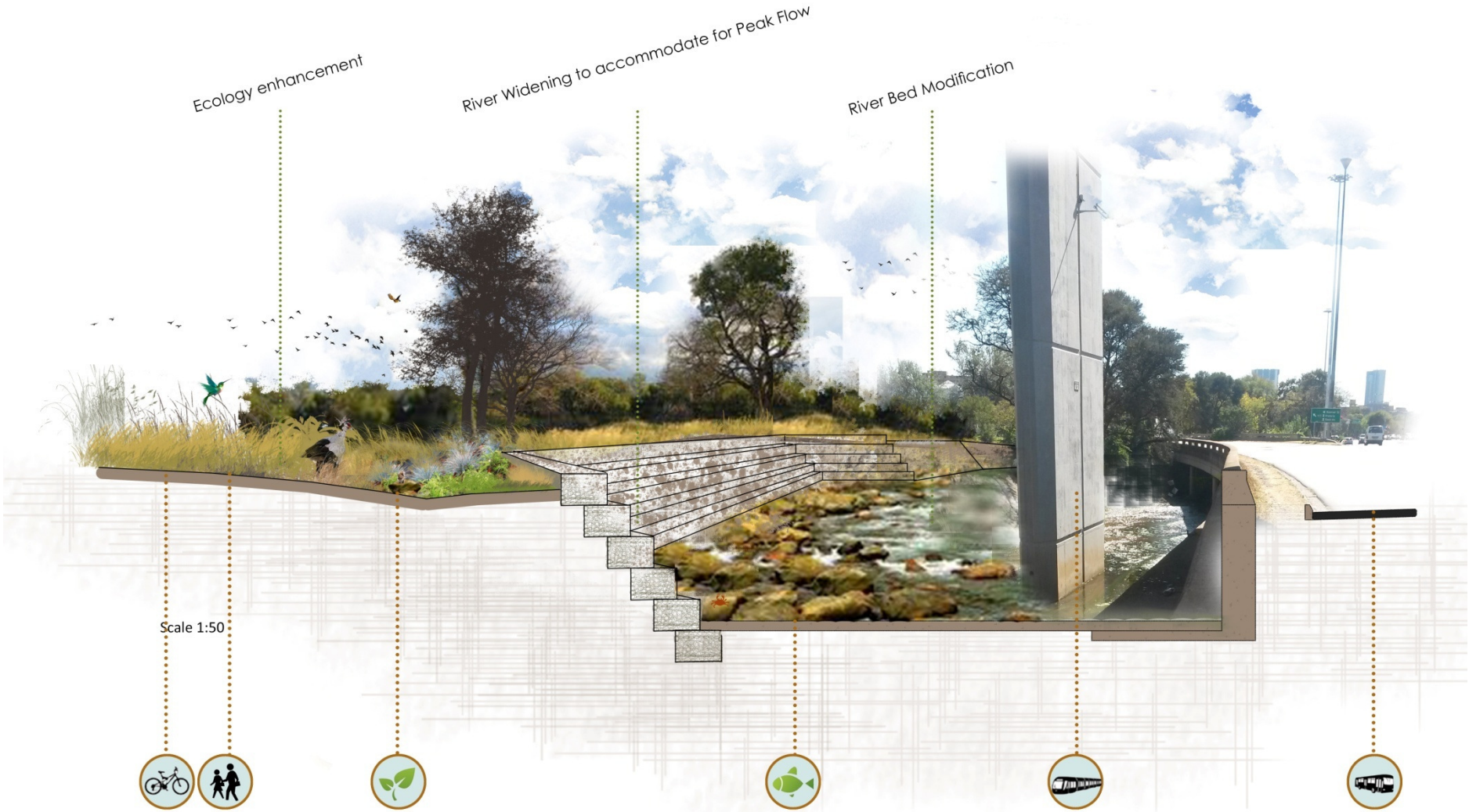



Figure 70 Plan of Scenario 3_River Widening with Terramesh (Author 2014)

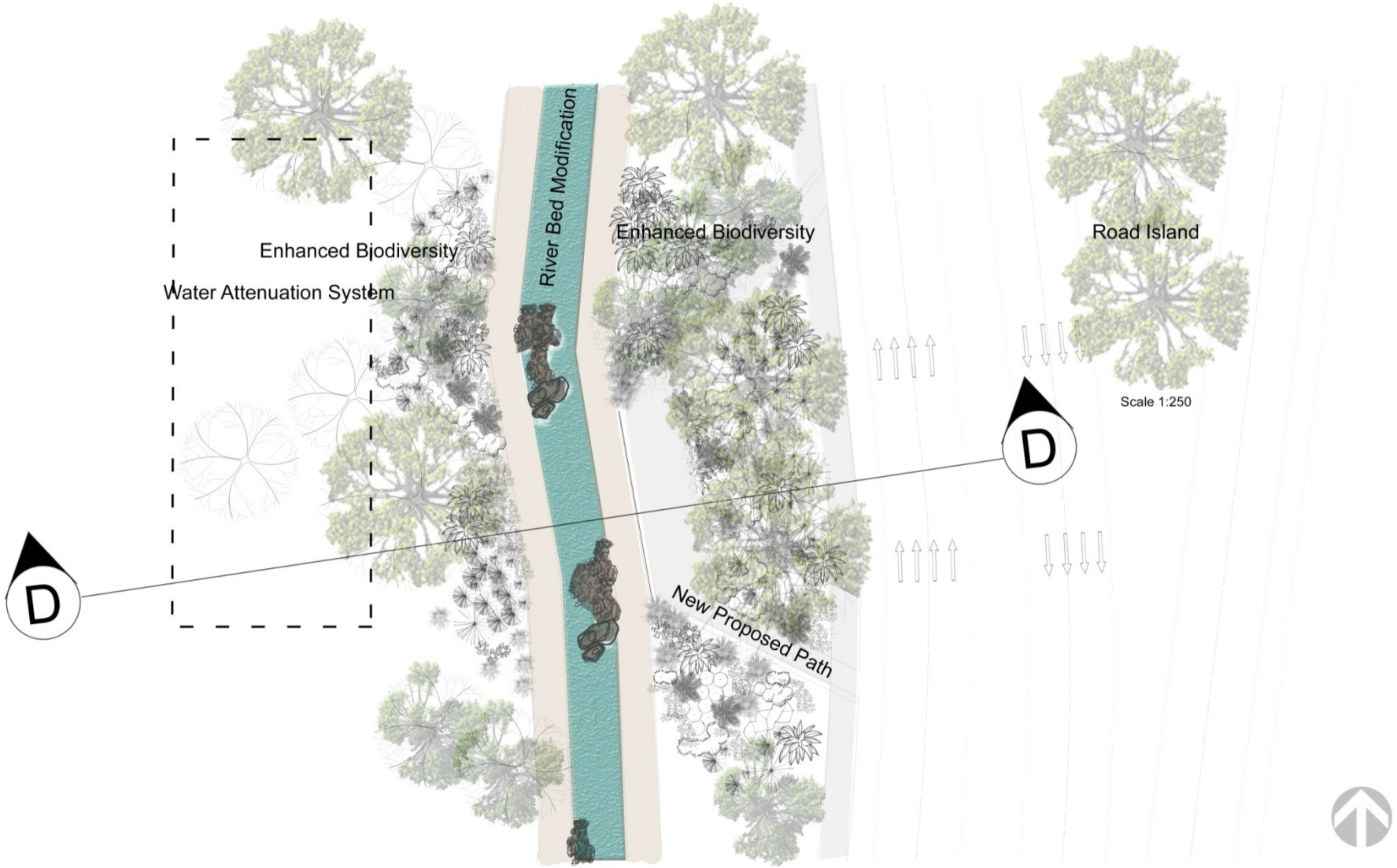



Figure 71 Plan of Scenario 4_River bed Modification & Water Attenuation (Author 2014)

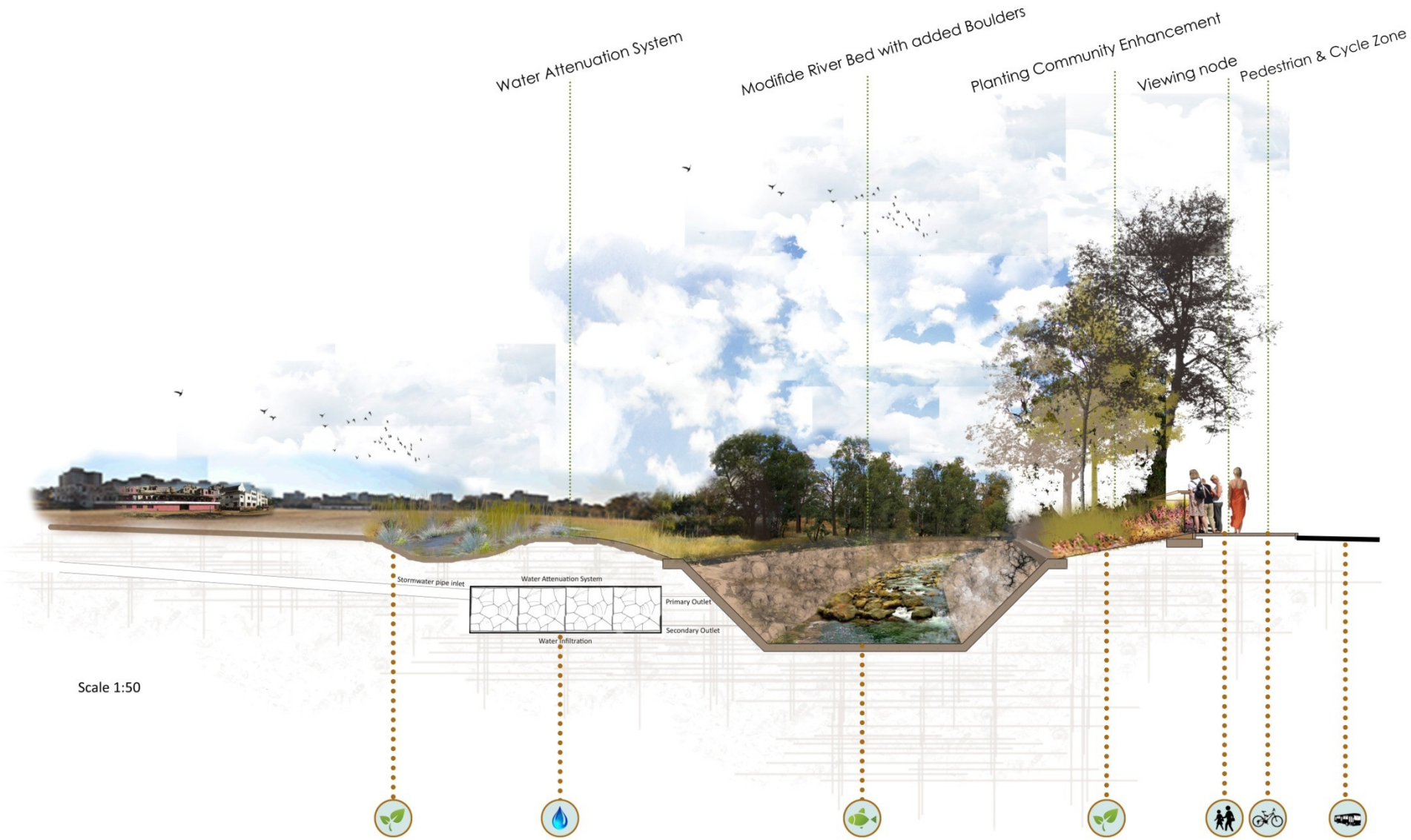



Figure 72 Scenario 4_River bed modification & water attenuation system on adjacent site (Author 2014)

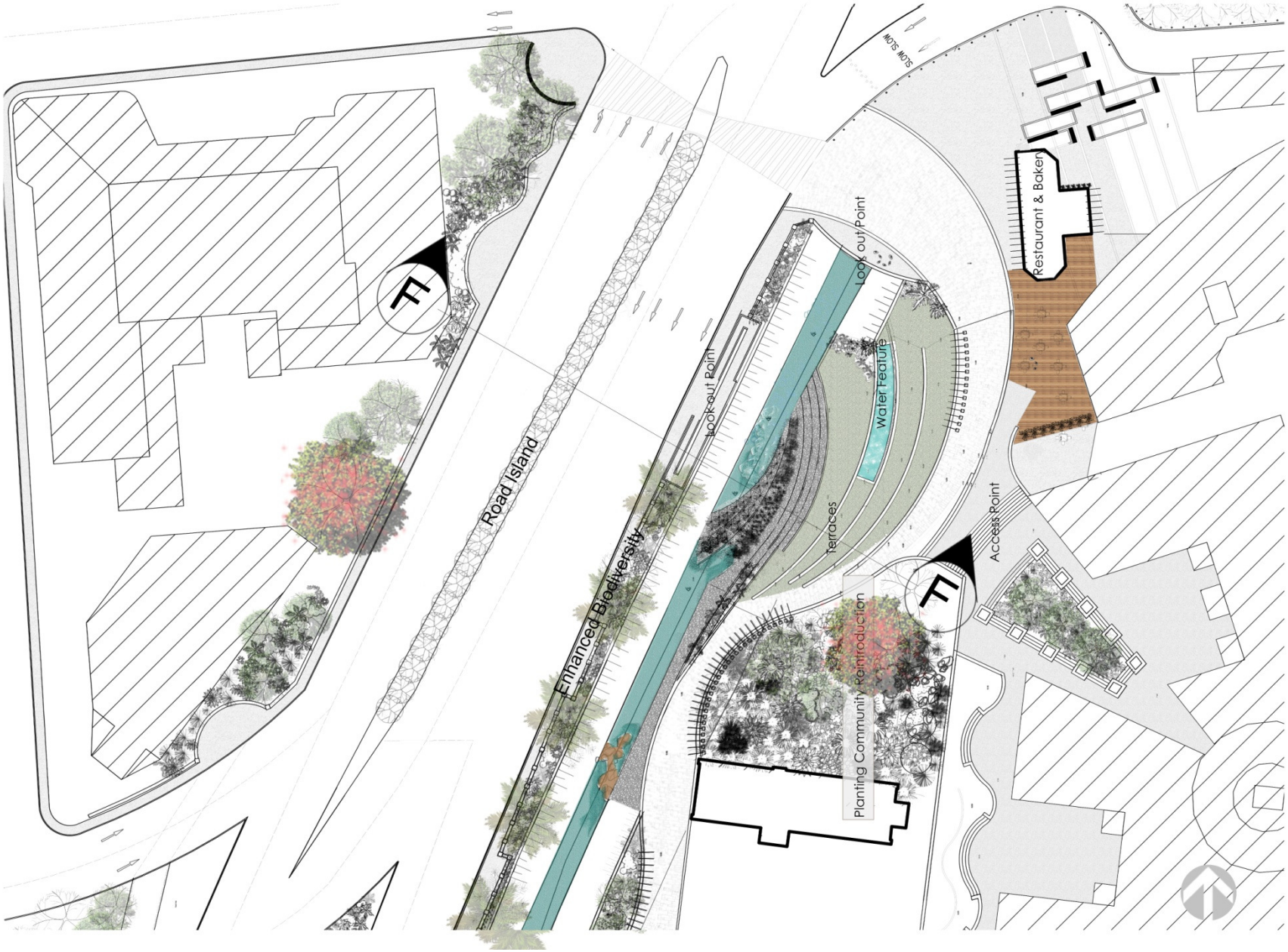



Figure 73 Plan of Scenario 5_River Widening with Terramesh & River Bed modification with Reno Mattress sunken garden (Author 2014)

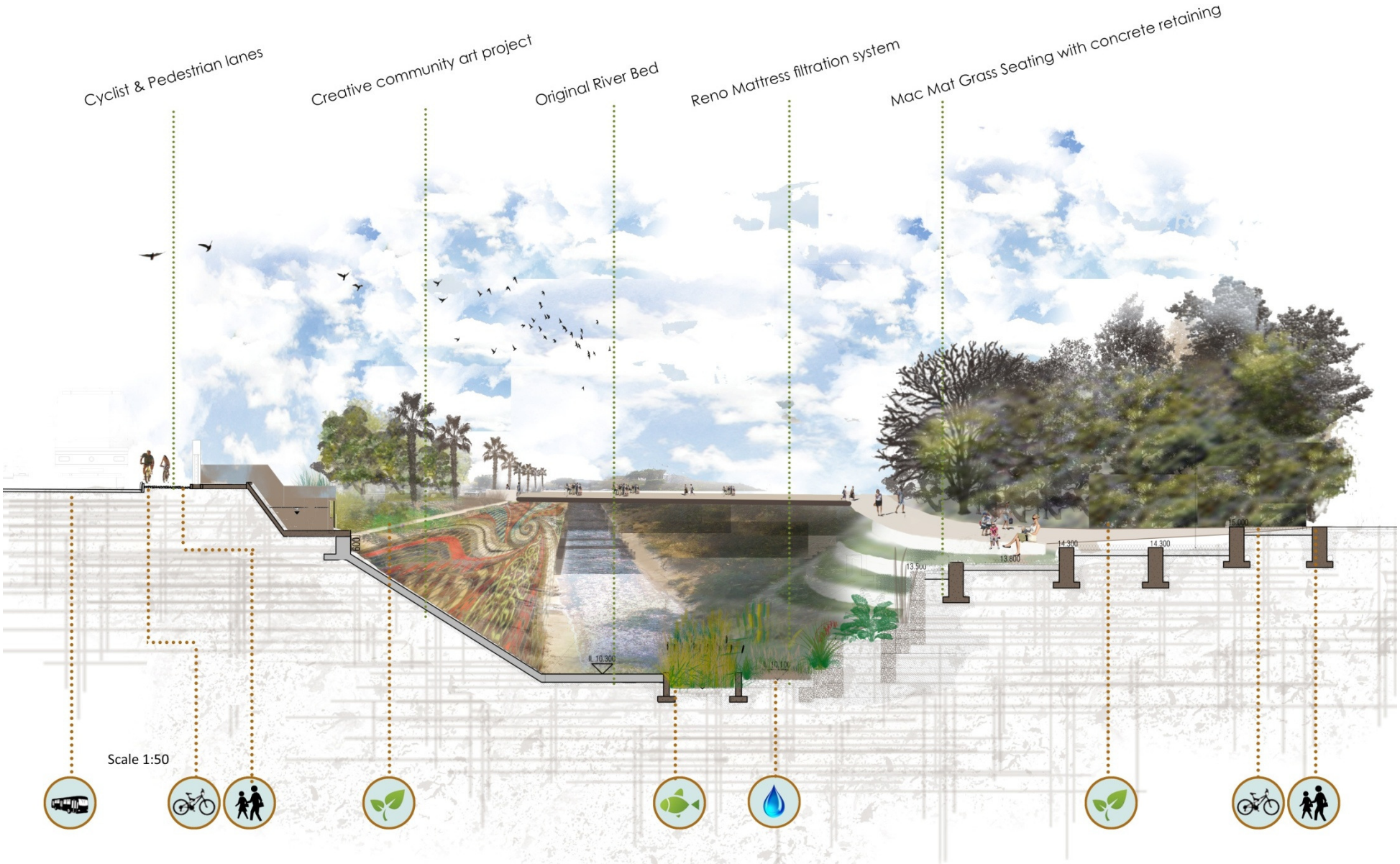



Figure 74 Scenario 5_River Widening with Terramesh & River Bed modification with Reno Mattress sunken garden (Author 2014)

# Chapter 9

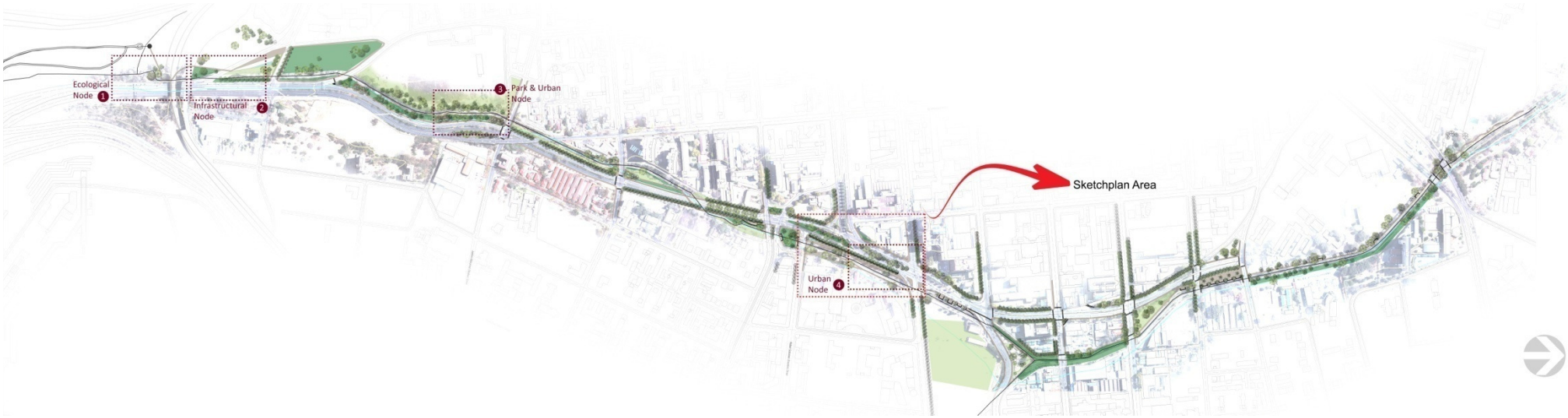
# Site Specific Analysis & Design

## 9.1. The Chosen site

The chosen site portrays what the dissertation is about; to create recreational open space within the urban environment. It is where scenario 4 occurs; it is surrounded by infrastructure, there is little to no ecological presence and it is unutilized space next to a water source. The site has the opportunity to develop according to an ecological approach to successively enhance wellbeing within the city.

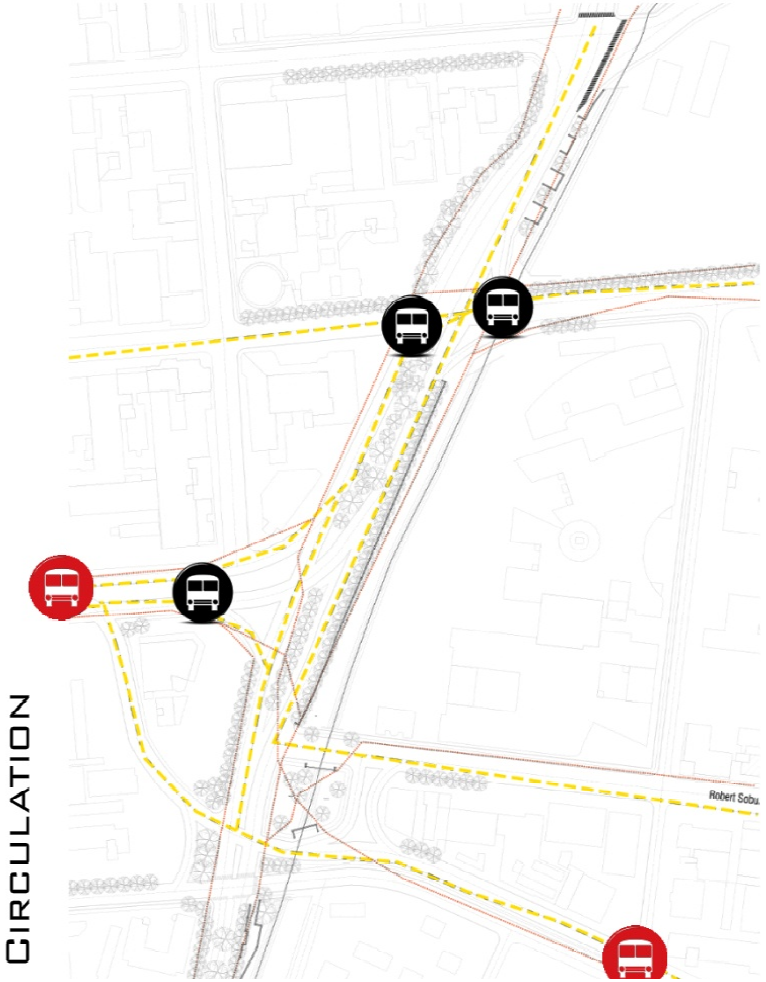
Landscape Architecture will mould the site into a space where human beings can connect to the biophysical environment. Even if it is just passing by and the rhythmic visual glimpses of the space and its spatial elements enhances people's mood.

Figure 75 Master Plan with Nodes & Sketchplan Area (Author 2014)



### 9.1.1. Sketchplan and Adjacent Sites Analysis

Figure 76 Sketchplan Area 1:500_Zoning & Circulation (Author 2014)

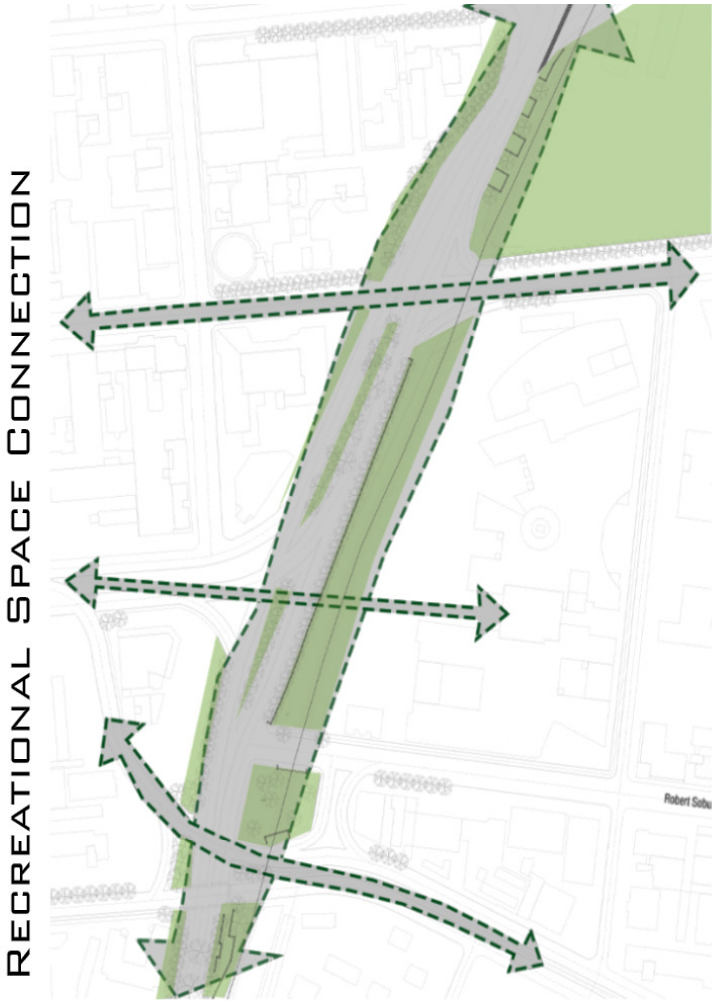



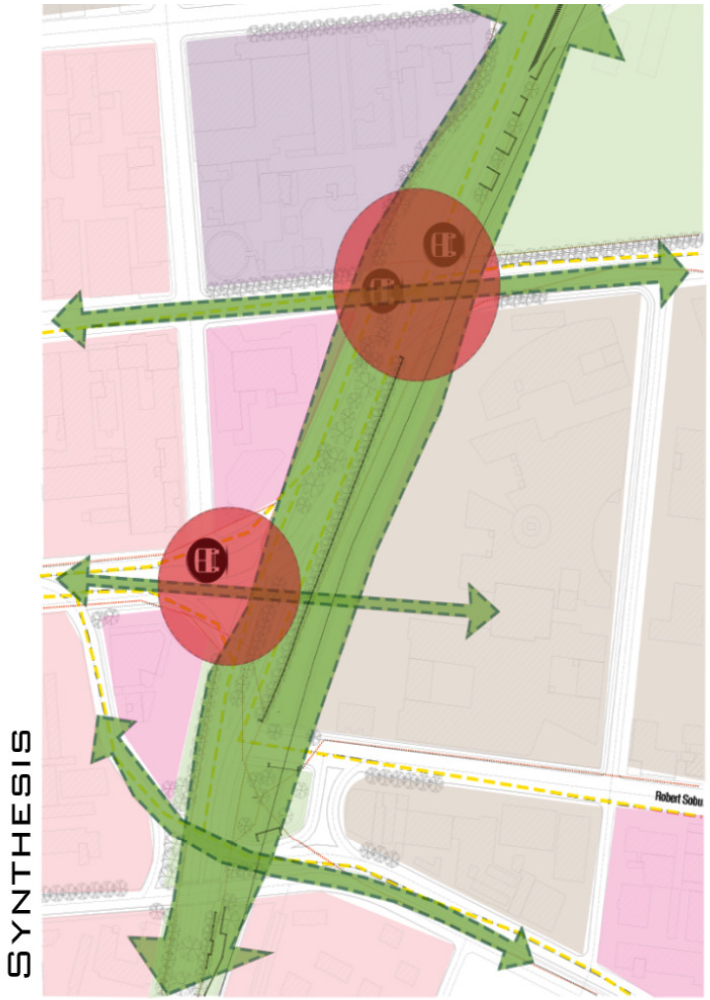

1:500 on A1

The chosen site for sketchplan development is predominantly surrounded by commercial functions. Everyday city dwellers occupy this area which also supports a hospital and The Department of Trade and Industry. The opportunity to incorporate pedestrian nodes and access to ecology along the new green corridor is highly recommended.

The Apies River Corridor possess opportunity for ecological development, where as Nelson Mandela Drive and crossing roads restricts pedestrians and cyclists access. The framework investigates how these connections can be reconfigured to facilitate ease of movement within this corridor of the city. Furthermore to combine human and ecological needs to formulate a sound environment for all.

Figure 77 Sketchplan Area 1:500_Recreational Space & Synthesis (Author 2014)




1:500 on A1

Access and circulation between recreational spaces within the city are poorly articulated. Popular parks, sports fields, playgrounds and other recreational facilities do not accommodate for spill out onto the perimeter. Recreational facilities should allow for visual access by means of axis.

The framework reacts to the site's lost relationship with surrounding sites. Shaping of the landscape is restricted due to the existing slope and infrastructure. The traffic islands in the middle of Nelson Mandela Drive can be redeveloped to accommodate ease of access to and from opposite sides of the road. Crossing roads like Francis Baard and Robert Sobukwe Street should speak the design language of the green corridor; the sidewalks need to decluttered to form linkages to the green corridor. The green corridor can act as a connecting agent linking all neighbourhoods.

Figure 78 Sketchplan Area 1:500_Stormwater Lines & Inlets, Rain Gardens & Bioswale Opportunity (Author 2014)

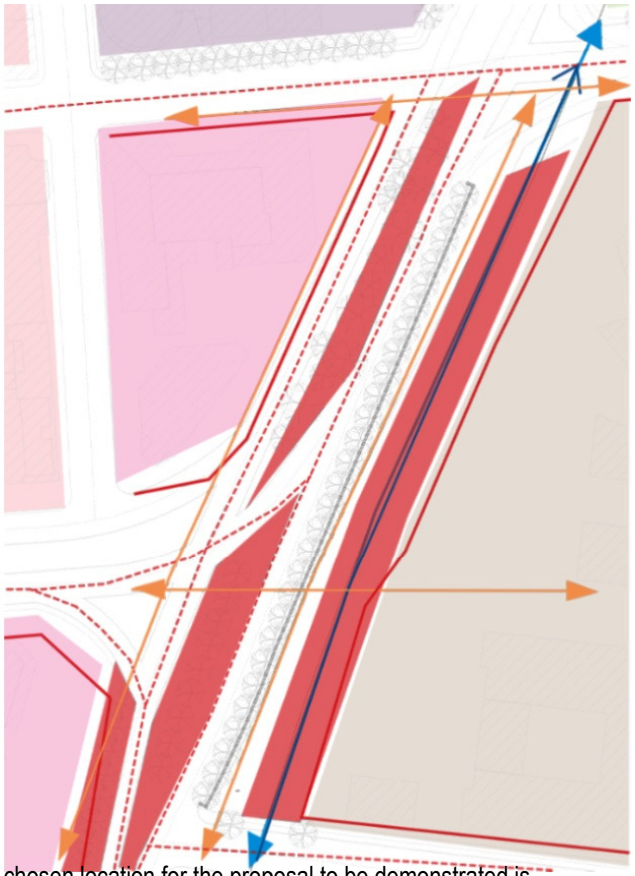

1:500 on A1

Currently stormwater is drained directly into the river system which puts enormous pressure on the river system. Water that cannot filter back into the soil naturally creates peak flow pressure.

Water should be treated as a resource and not as a waste product. Instead of diverting the water straight into the river system, the water can rather flow into a bioswale system and be retained and treated; clean excess water can be diverted to existing stormwater pipes which flow out into the river. Water that passes through this system will be filtered back into the ground water through rain gardens and bioswale systems. Further water treatment can happen within the river channel to promote ecology and micro organism functions.

### 9.1.2. Sketchplan Area

Figure 79 Sketchplan Area 1:250_Site Statement, Boundaries (Author 2014)



SITE STATEMENT

BOUNDARIES

1:250 on A1

The chosen location for the proposal to be demonstrated is bordered by commercial, governmental and residential landuse. The site is divided by roads and has the Apies River as a dominant but rarely recognized feature. The site is predominantly used by the everyday city dweller passing through or by the sites; there is no space for social gathering or acknowledgment of the environment. The sites are now neglected and/or mismanaged. The sites hold opportunity for social and ecological development.

On this site the Apies River acts as a boundary between public, semi-private and private space on this specific site. The department of Trade and Industry is now a privatised department but the landscape surrounding it can be accessed; it is maintained by department maintenance but from the boundary line to the public realm maintenance is non-existent; it is a polluted landscape screaming for intervention. Visibility, safety and ease of access will be attended to.

Figure 80 Sketchplan Area 1:250_Site Analysis, Generic Systems (Author 2014)



1:250 on A1

City dwellers hardly even recognise the existence of the river, going about their own lives. Most of the Apies River can be regarded as a greenfield site, access however to the river itself is prohibited due to safety issues as well as the quality of water. The slope of the non existing riparian zone is about 1:3 which also pose its own space making challenges.

Bio-swales and ecological pond filters as generic systems will be incorporated into the site design. Further bio-swales are proposed for street edges throughout and/or where possible to delay stormwater runoff from entering the river system.

Figure 81 Sketchplan Area 1:250_Visual Challenges, Site Issues (Author 2014)



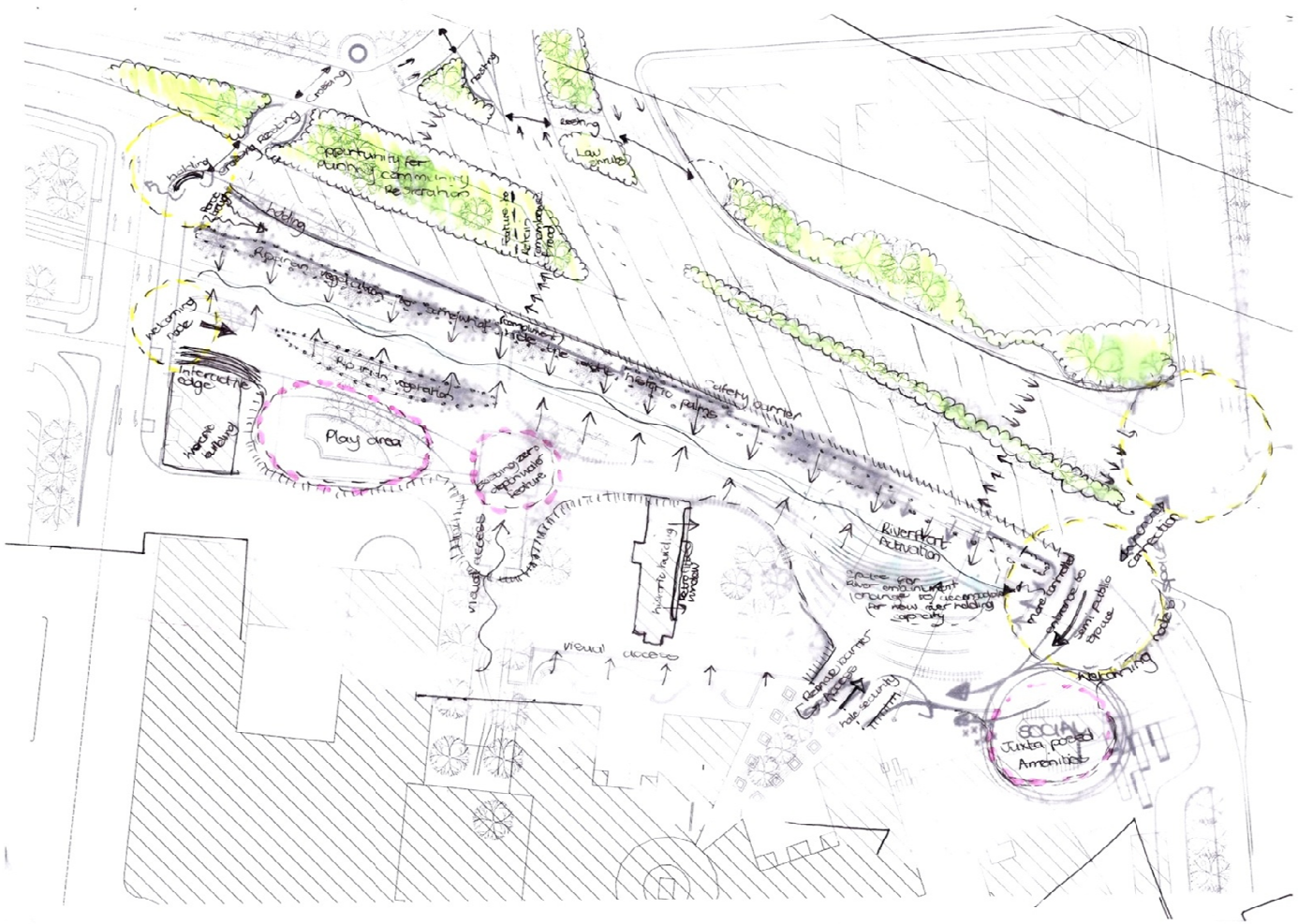
1:250 on A1

The site is cluttered with lampposts traffic lights, dustbins, random signage boards and litter leading to an overall unsatisfactory environment for user to linger in. A clean-up together with a de-cluttering approach is needed. Ecological upliftment will follow to create an all welcoming environment which will fulfil the needs of all.

### 9.1.3. Synthesis of analysis

Within all the above maps a common thread runs through; it cries for help, to utilize the space, to employ semi-private and public space interaction, manage resources, to maximize the use of ecological systems and to all in all create better space for people to pass through, meander within or rest and enjoy.

Figure 82 Parti Diagram (Author 2014)



## 9.1.4. Sketch Plan

*The sketch plan area is selected due to its urban situation*

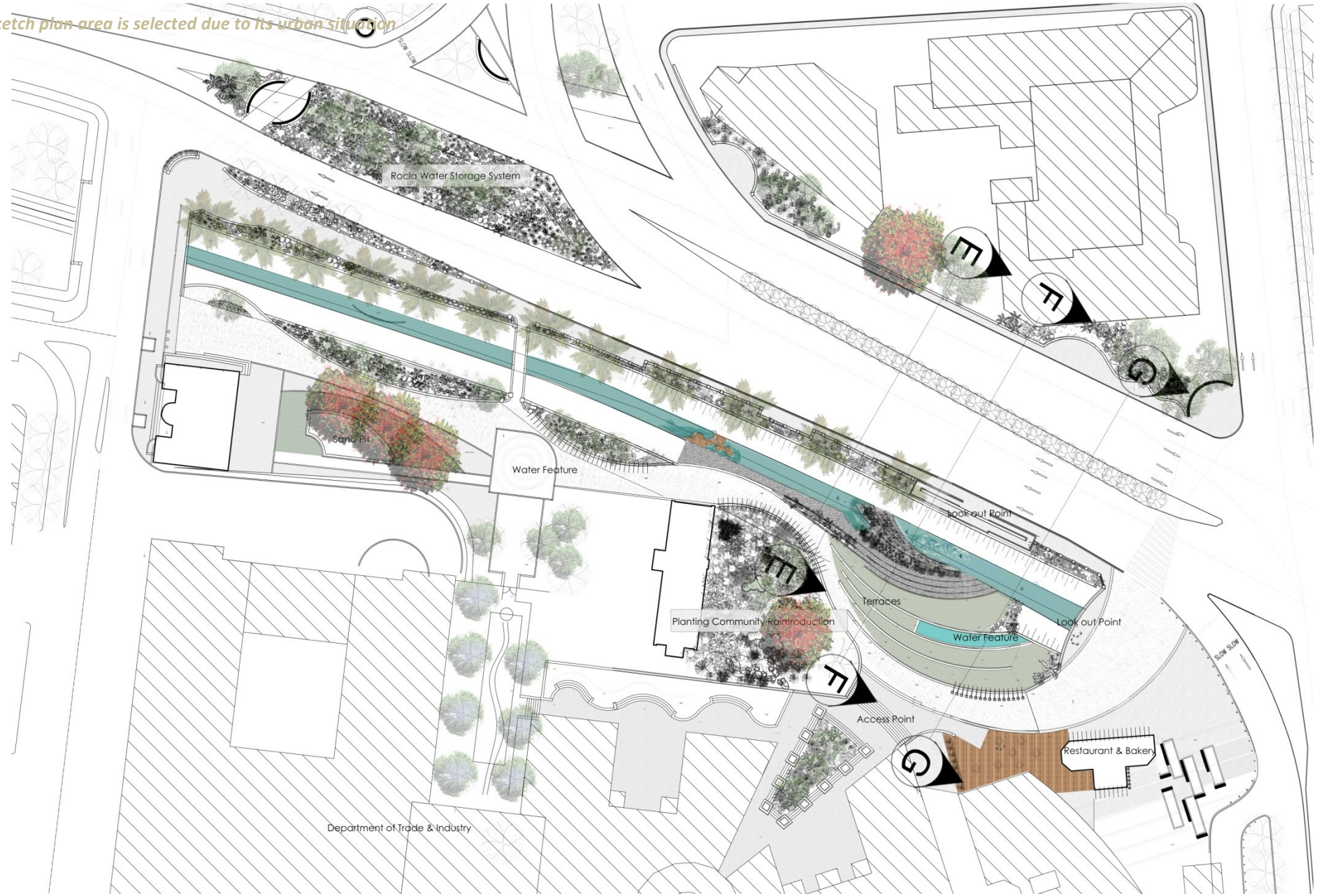



Figure 83 Sketchplan (Author 2014)

### 9.1.5. Long Sections


Figure 84 Channel Modification Section E (Author 2014)


SHADED WALKWAY RE-INTRODUCTION OF PLANTING COMMUNITY

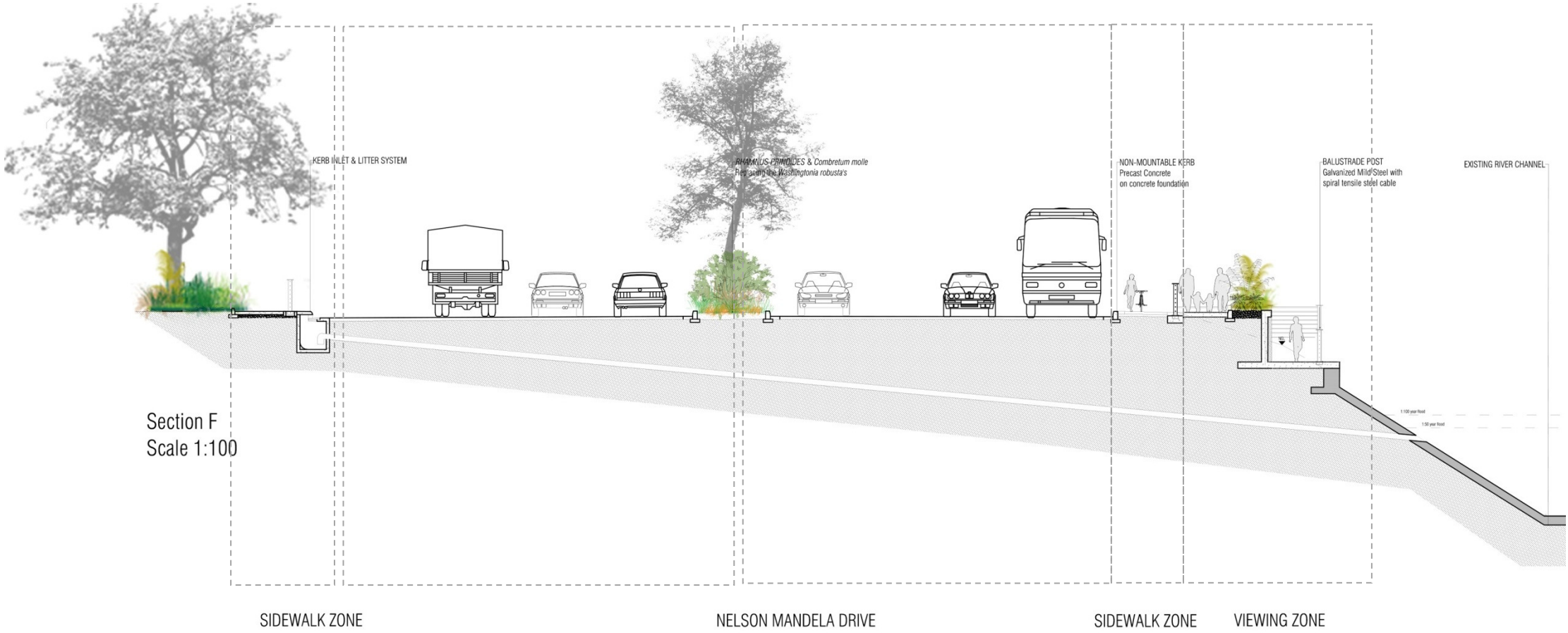
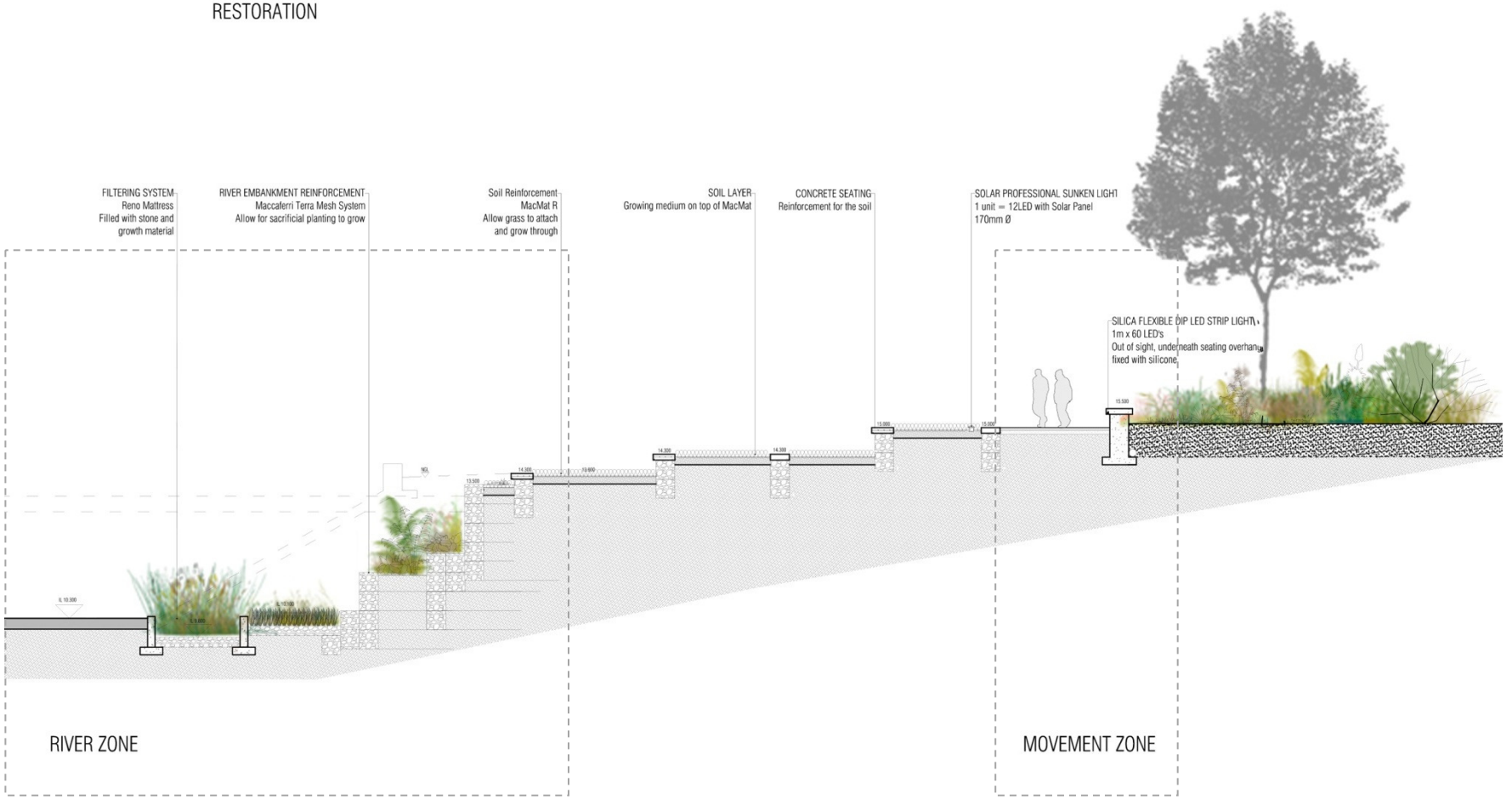



Figure 85 Channel Modification Section F (Author 2014)

RESTORATION



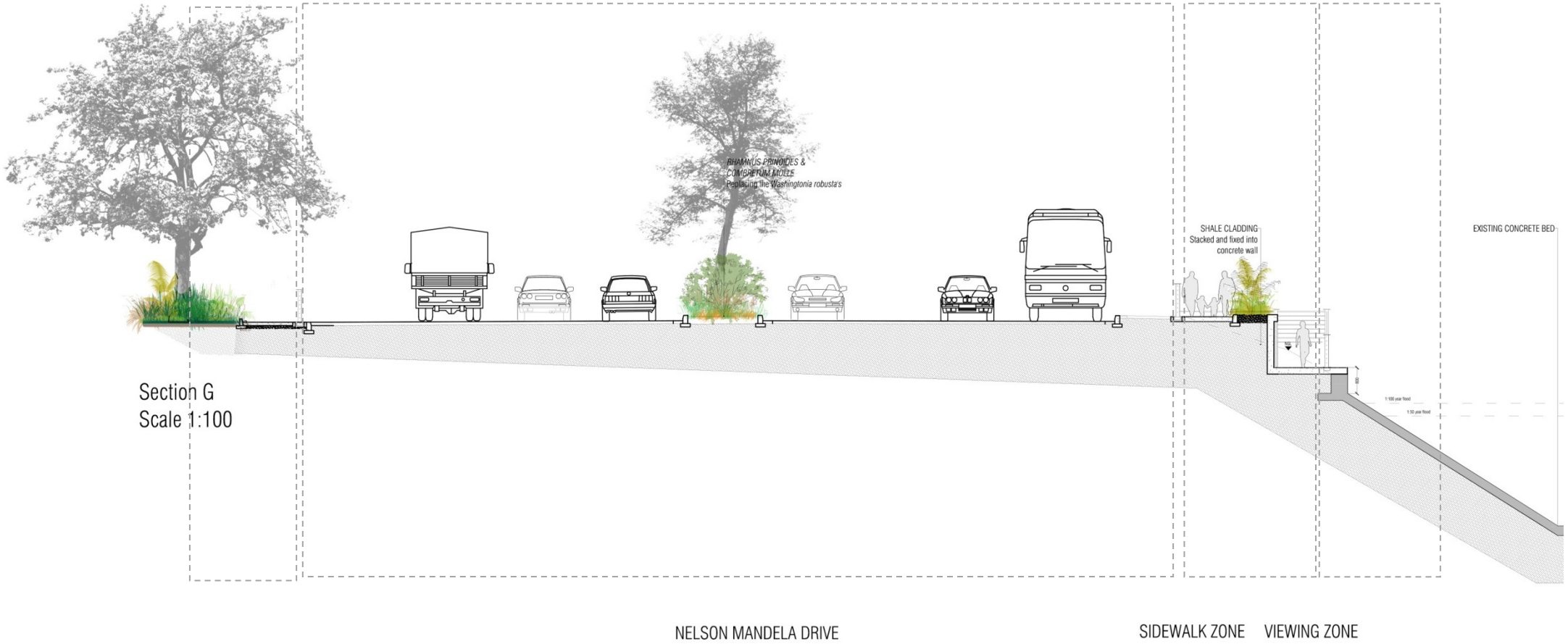
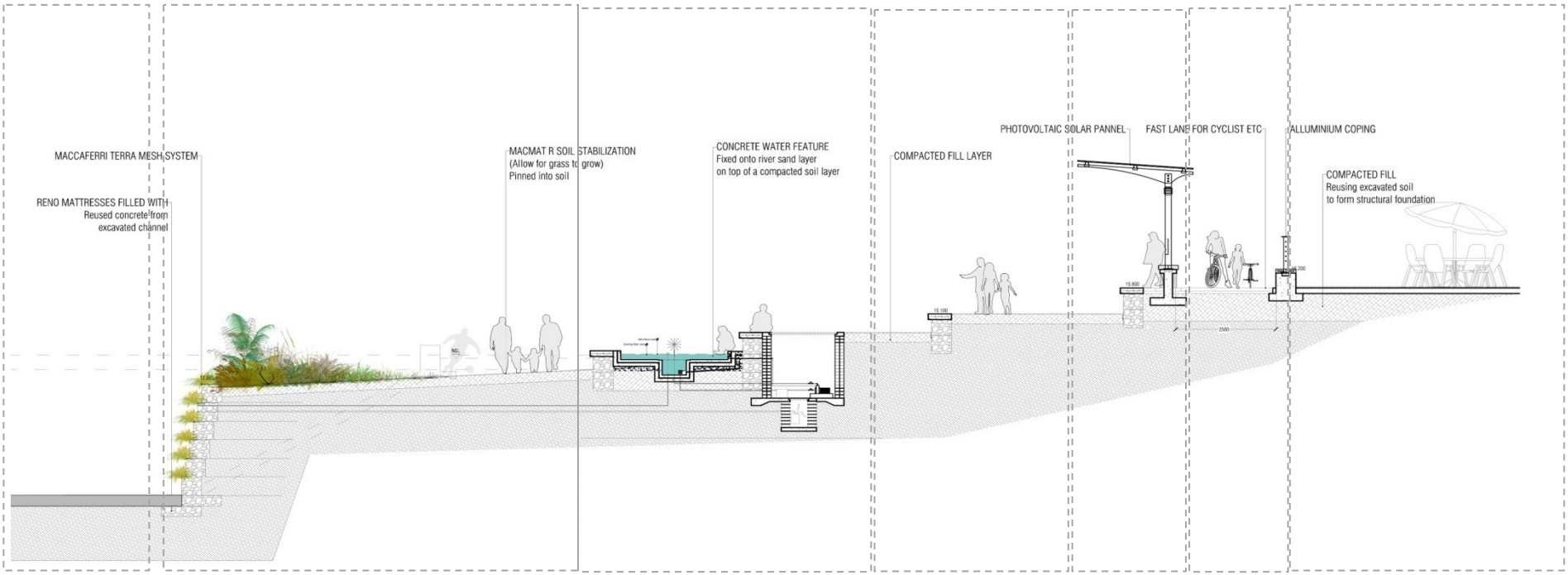



Figure 86 Channel Modification Section G (Author 2014)



# Chapter 10
# Technical Investigation

# 10.1. Environmental Approach

## 10.1.2. Stormwater Strategy: Bio-swale & Filtration System

As previously mentioned in Chapter 8 the stormwater strategy entails the introduction of bio-swale and filtration systems. These bio-swale and filtration systems are used to manage, store and reuse water if needed for irrigation it also provides opportunity for ecology to survive and progress. Each 200m² bio-swale and filter system yields a total of 50.12m³ (50120ℓ) of water. When the sub-catchment (surrounding paving is included it will yield more than enough water to sustain such a system).

The soil plays an intricate part in this system due to infiltration capacity (see soil analysis). Sandy soil will need to be worked into the shale bio-swale filters for the drainage and diversion system to work effectively. The water diversion system comes into play after saturation of the soil. The unabsorbed water will either overflow and exit the bio-swale entering the next or entering the stormwater pipe system leading back to the river or infiltrate the soil deeper to be diverted to sub-surface pipe systems. 20% of the water will be absorbed, 40% will infiltrate naturally and the remaining 40% will be captured into a pipe system leading to Rocla water storage systems (installed under vegetated road islands) to be used as irrigation see figure 52.

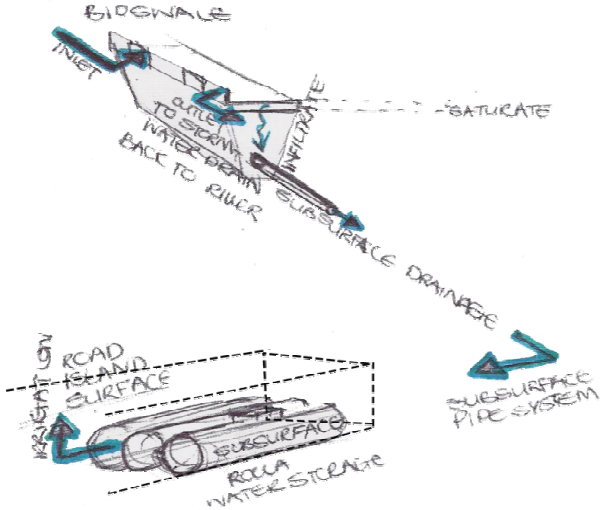



Figure 88 Water diversion system (Author 2014)

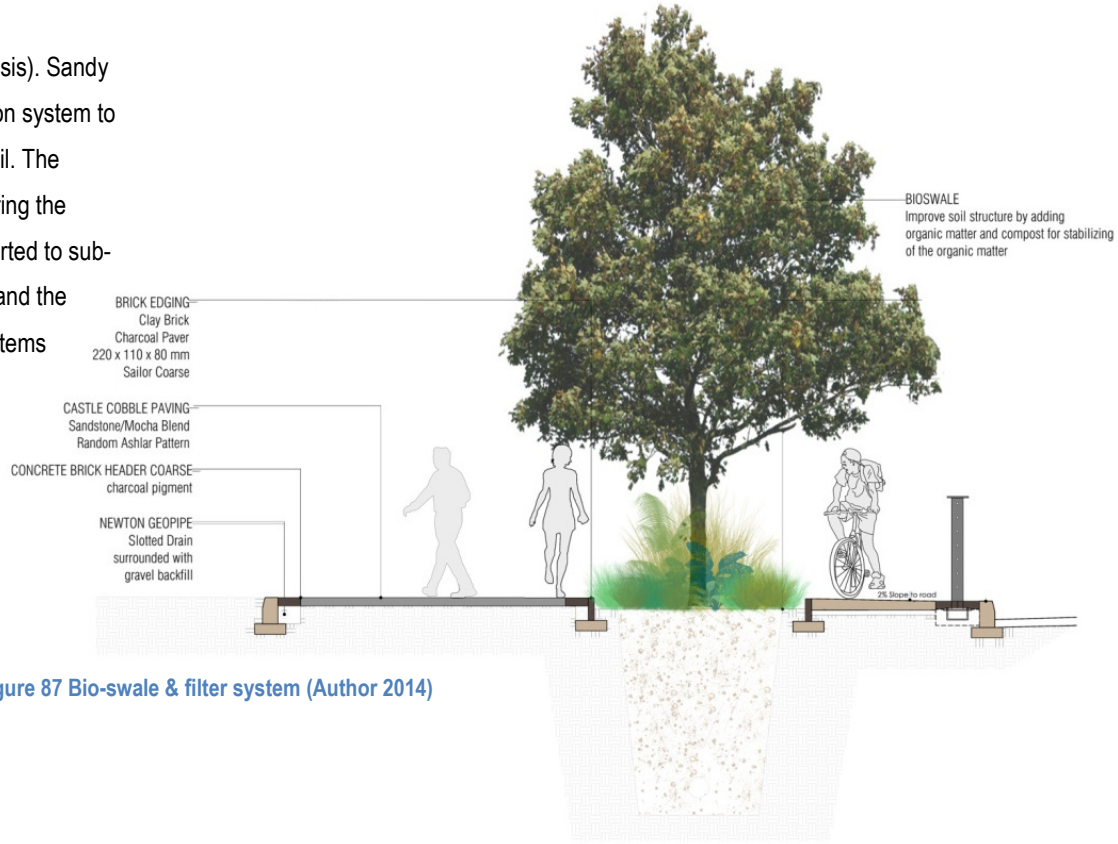



Figure 87 Bio-swale & filter system (Author 2014)

### 10.1.3. Flood Plane Alteration

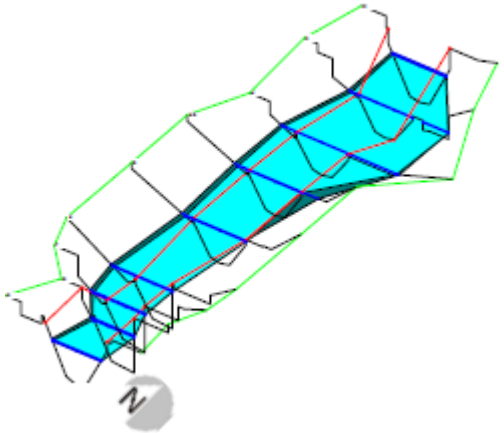


Figure 89 Hydraulic Model (Etsenbeth 2014)

Figure 88 shows the projected flood lines. Figure 89 illustrates Section E – G of the redeveloped channel. The channel sections were used to determine the new flood lines: "Hydraulic modelling done with Hec-Ras Software (version 4.1). Computation done on various cross sections, with steady flow conditions assuming sub-critical main channel flow." (Etsebeth 2014)

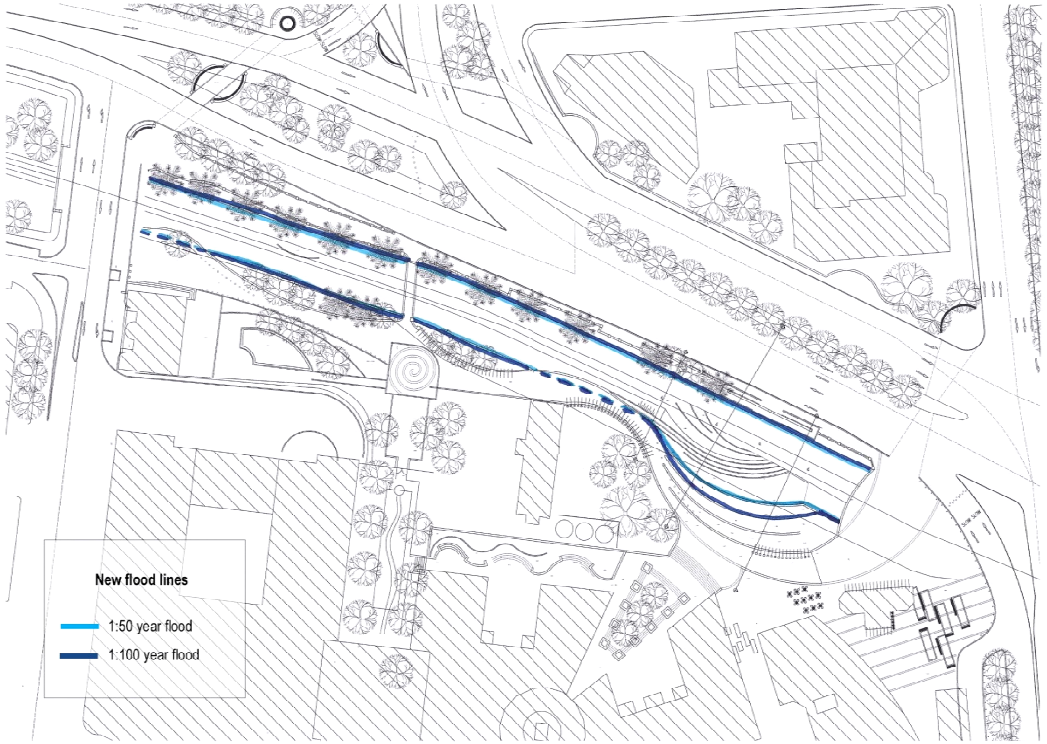



Figure 90 Flood Line Projection (Author 2014)

### 10.1.4. Channel Modification

See Appendix E

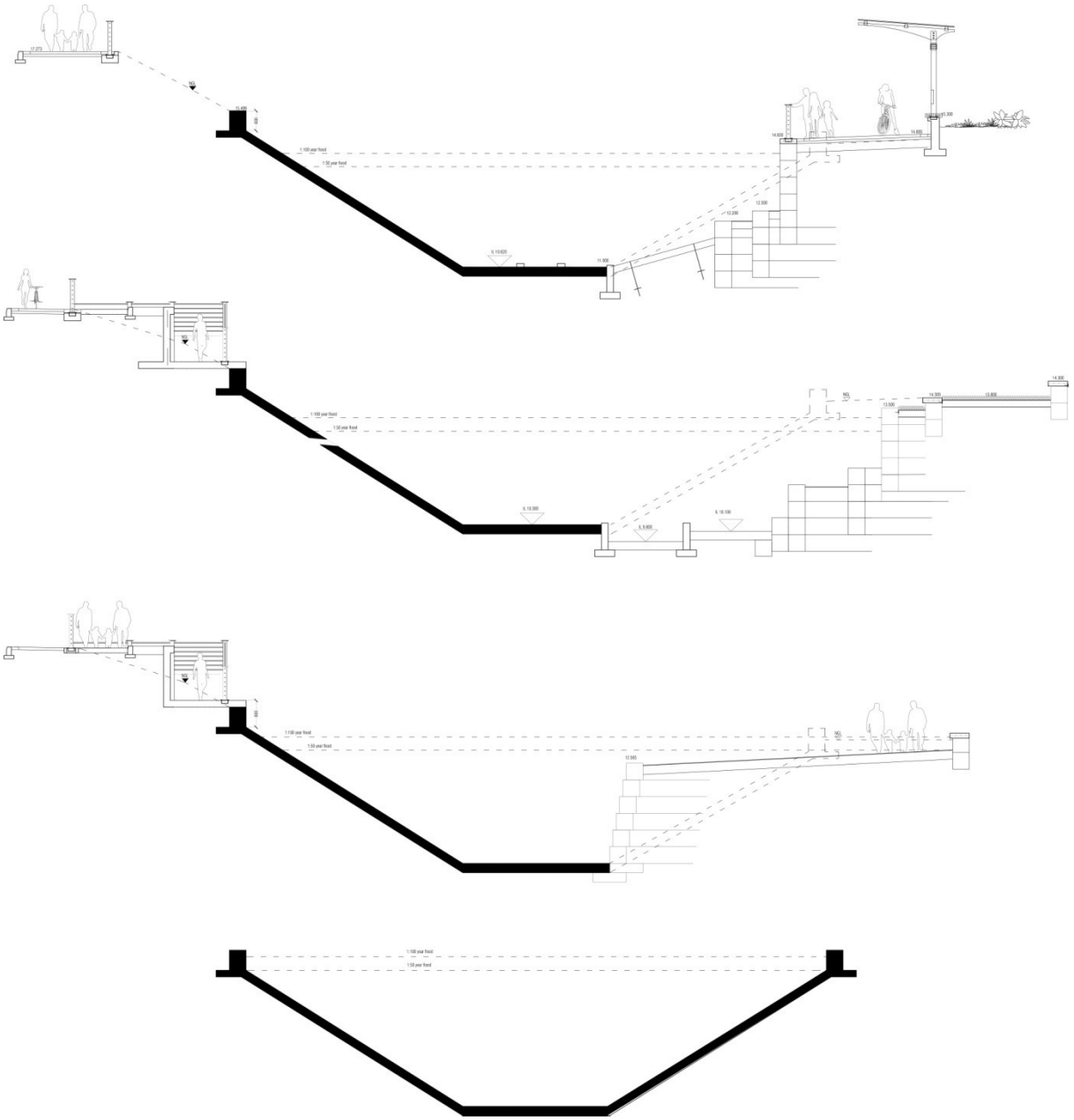


Figure 91 Channel Flood Plane Redevelopment (Author 2014)

### 10.1.5. River Bed Modification and Base Flow System

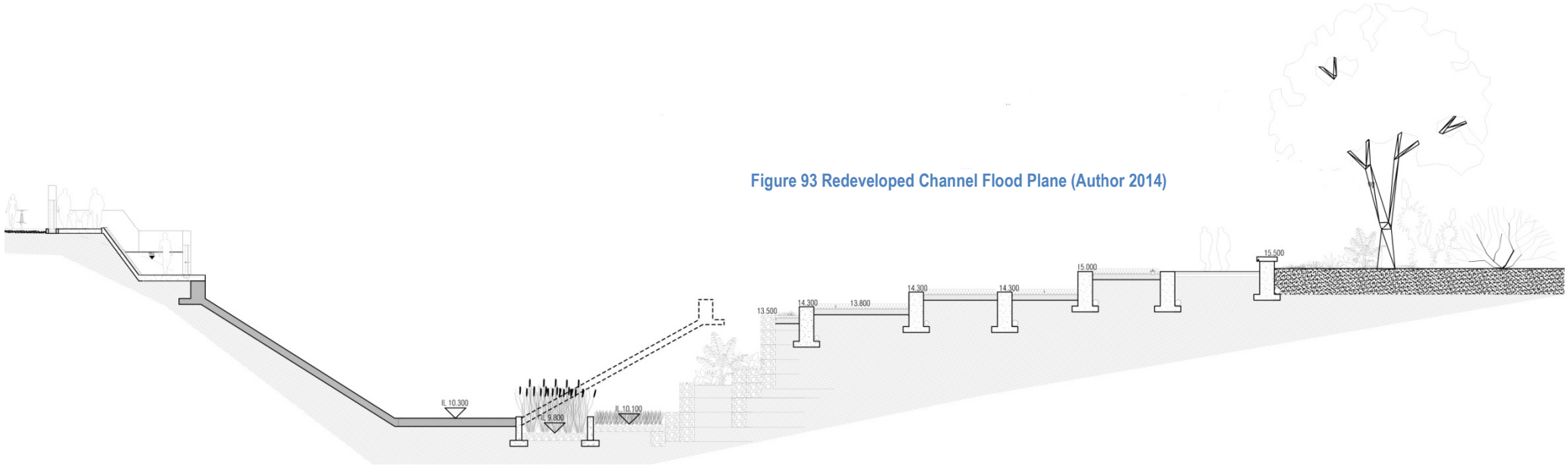



Figure 93 Redeveloped Channel Flood Plane (Author 2014)

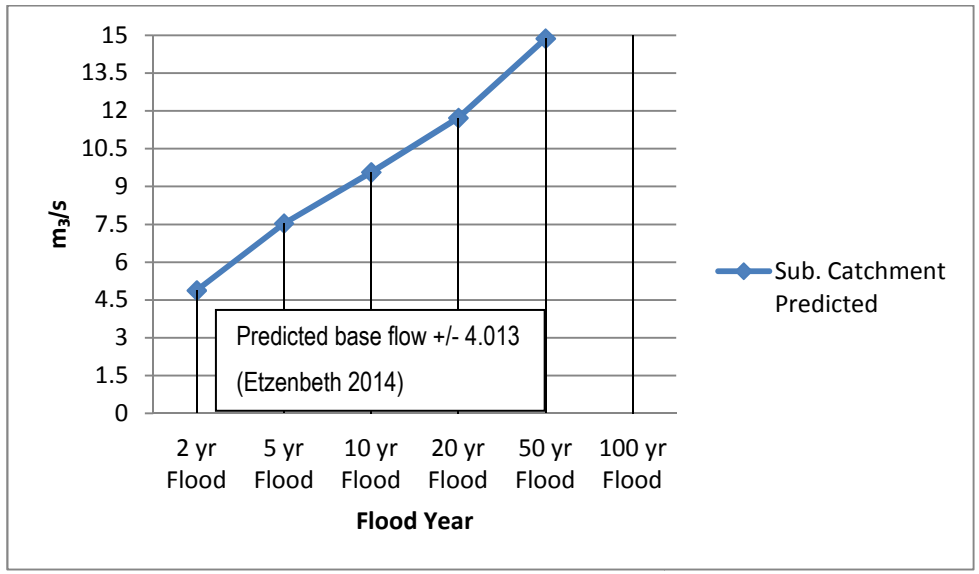



Figure 92 Base flow of Existing Channel (Author 2014)

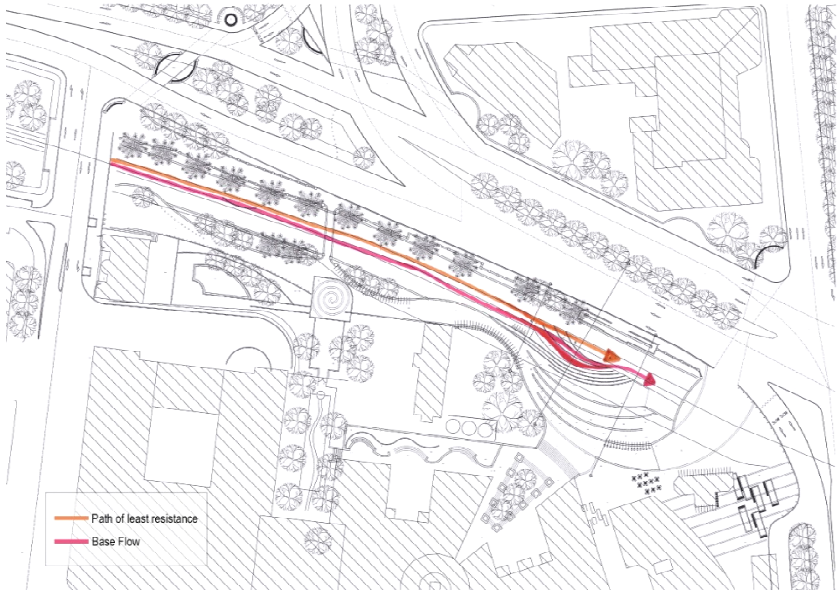



Figure 94 Redeveloped Channel Base Flow (Author 2014)

**Base flow infiltration calculation**

Figure 80 depicts the river flood plane modification include cutting into the concrete to install a Reno Mattress' filtering system, where plant roots can tap into the natural soil surface and some water can infiltrate. Furthermore insertion of boulders will improve aesthetics of the river's flow.

The infiltration rate for the catchment assuming that the particles are 0.002mm will be 0.001m/h. The infiltration rate for 24 hours will be 0.024m (R_infiltration rate x 24 = I_infiltration), and to calculate the volume of water to infiltrate an area of 1m²; (V =A/I) the volume of water to be infiltrated for the area is 0.024m³, this is for a perfect environment without evaporation to be accounted for. When evaporation come into play the volume of evaporation will be subtracted from the volume of infiltration and a true infiltration volume will be calculated.

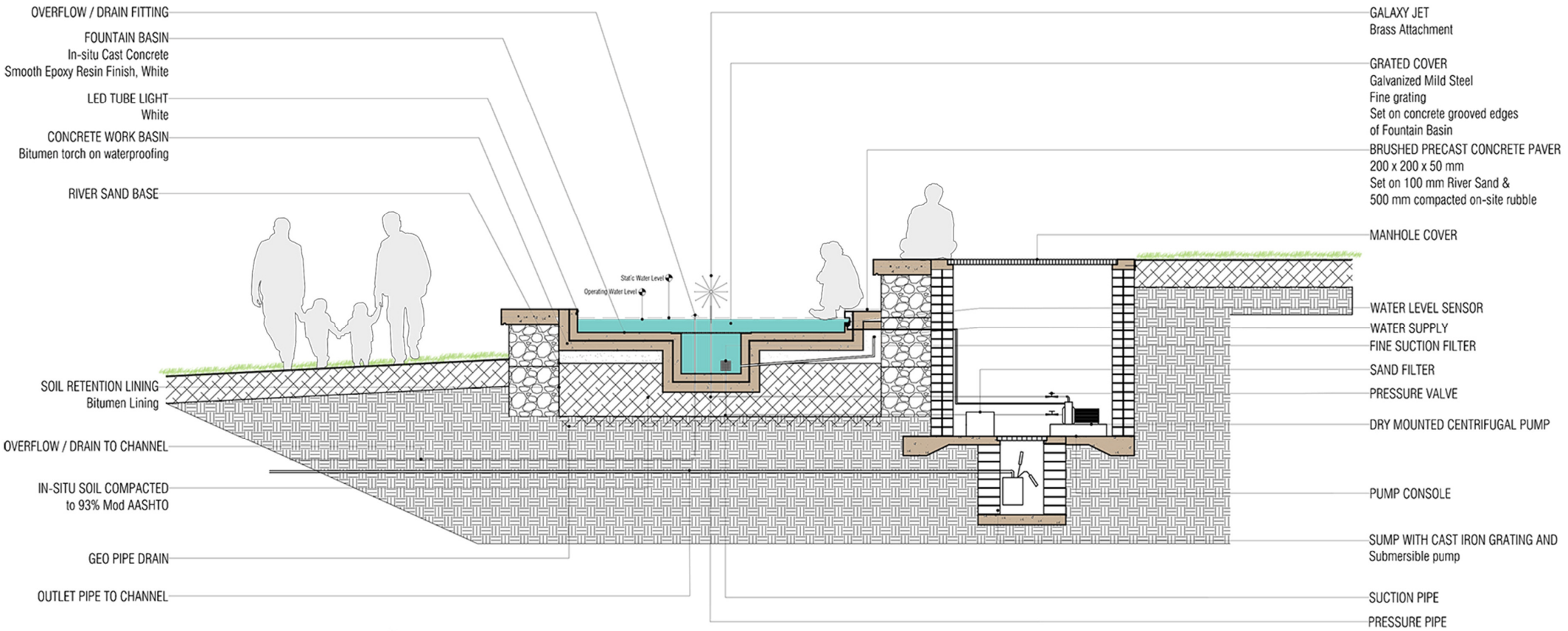
- Base flow = 4.013m³/s (Figure 81)
- Infiltration rate = 0.002086m³/s
- Infiltration rate for the Reno Mattress area (156.5m²) = 0.2984768m³/s
- Therefore the new base flow will be 4.013 - 0.2984768 = 3.7145232m³/s indicating there will be water flowing past the Reno Mattress system allowing for base flow to continue (see figure 82) and the households using the water will benefit from cleaner water.

In order for the proposed green corridor to be sustainable some improvements need to be made. Visually the entire corridor needs tidying up; a modular unit can be introduced to simplify street corners in turn making it more pedestrian friendly. Pollution needs to be taken care of by reintroducing maintenance programmes and ample amounts of litter bins. Pollution in the river needs to be dressed by installation of trash traps where widening will happen, discussed in hydrology strategies, and filtration systems (altering the river bed by cutting into the concrete and inserting Reno mattresses with appropriate planting in them) to somewhat clean the flowing water.

After the channel bed has been modified and the roughness has been increased adjustments need to be made in order for the cannel to maintain its capacity. The following calculations indicate how the roughness affects the capacity of the channel and how the design accompanies for the new volume of water flowing through.

## 10.1.6. Making the Invisible; Visible

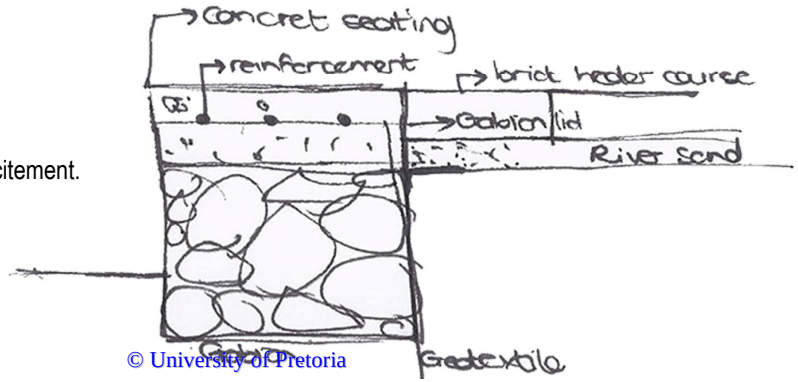
*Haptic experience: Water*




Scale 1:50

Galaxy Fountain Nozzle

The idea is to enhance the senses; touch, smell, sound as well as visual excitement.



### 10.1.7. Water Budget

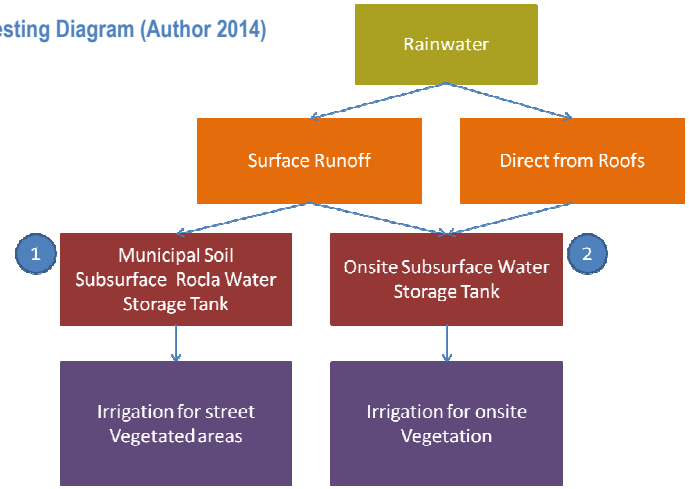
The rainfall season is during the summer months with a total rainfall of 716mm is received per annum. The warm summer temperatures affect infiltration capacity due to evaporation and low winter temperatures can lead to frost which will affect plants if they are not frost resistant, therefore appropriate plants needs to be used to accompany for summer heat and winter frost.

Figure 96 identifies two systems (east and west of the channel) and the surfaces from which rainwater will be harvested. The eastern system, system 2 will utilize water from a onsite water storage tank and the western system, system 2 will utilize mainly surface runoff water stored in a Rocla water storage tank that will be installed in the road island.

Looking at System 1 the budget for water yield and demand the rainfall (m), the area m², surfaces (roughness coefficient), the infiltration rate and evaporation rate comes into play.

The budget is calculated by finding the water remaining in the tanks after the demand is subtracted from the yield. The Yield is calculated as follows: Y_yield (m³) = P_precipitation (m) x A_area (m²) x Coefficient; from the yield the total yield is calculated by subtracting the evaporation. Evaporation is about 0.005mm per day making it 15% per month therefore the total yield is:
Yieldtotal(m³) = Yield - I_infiltration (%) – E_evaporation (%).

Figure 97 Rainfall Harvesting Diagram (Author 2014)




The total yield is calculated to determine the demand (m³) to determine the amount of water needed or surplus from the budget calculation, indicating how many tanks are needed.

This calculation is done by determining the least amount of water available in the tank and then how much can be wasted and when. The histogram of table ? shows water entering the storage system (Precipitation x Catchment Area x Run-off coefficient), the amount used according to the demand (Area x Irrigation depth), and the volume which can be wasted and when, the total of water out (Irrigation + Wasted water) and the remaining amount of water in the tank. The safety factor is determined by the least amount of water in the tank and divided by 4 (assuming that the first week of January are without rain) gives the volume of water needed to be pumped into the system at the start of utilisation.

The Water Budget is tied to the Rainfall Harvesting Plan and Irrigation areas as indicated in Figure 96. Table 6 quantifies the water budget for the onsite water storage tank.

Figure 96 Rainfall Harvesting Plan (Author 2014)

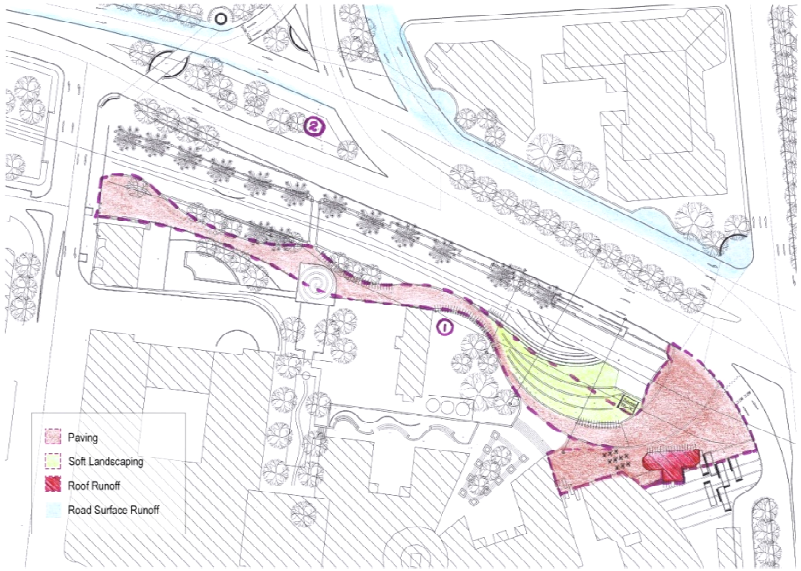
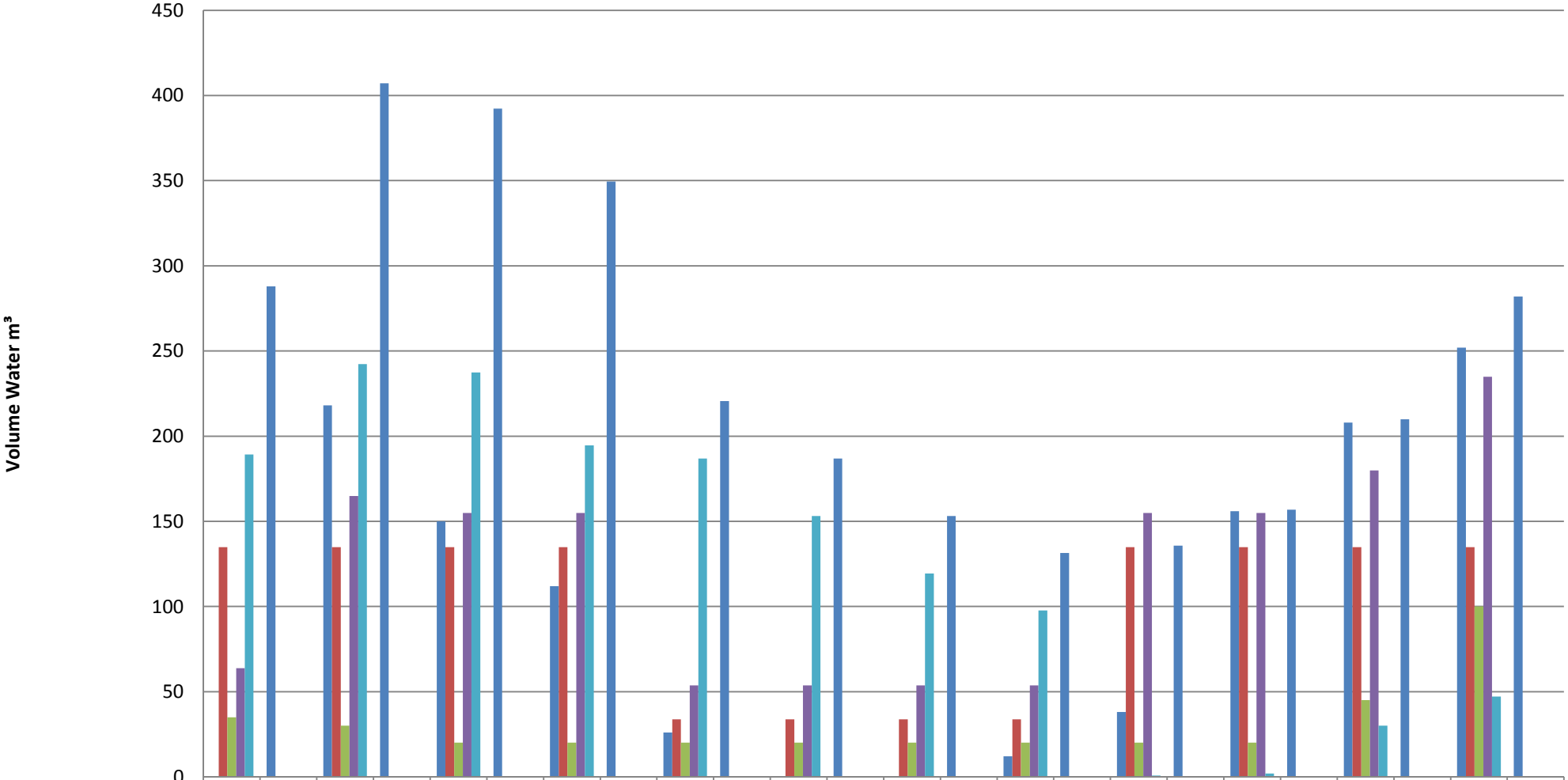


Table 6 Irrigation demand (Author 2014)

| | Year 1 starting with no top-up | | | | Year 2 starting with left over from Year 1 | | | Year 1 starting with 160m³ top-up and wasting excess water as year progresses | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RAINFALL m | IN m³ | IRRIGATION OUT m³ | REMAINING IN TANK m³ | IN m³ | IRRIGATION OUT m³ | REMAINING IN TANK m³ | IN m³ | IRRIGATION OUT m³ | WASTE OUT m³ | TOTAL OUT m³ | REMAINING IN TANK m³ |
| J | 0.13 | **260** | 134.88 | 125.12 | 156+182.92 | 134.88 | 343.2 | 156+28 | 134.88 | 35 | 63.8 | 189.2 |
| | | 0 | | | **478.08** | | | **288** | | | | |
| F | 0.109 | 218 | 134.88 | 208.24 | 218 | 134.88 | 426.32 | 218 | 134.88 | 30 | 164.88 | 242.32 |
| | | **343.12** | | | **561.2** | | | **407.2** | | | | |
| M | 0.075 | 150 | 134.88 | 223.36 | 150 | 134.88 | 441.44 | 150 | 134.88 | 20 | 154.88 | 237.44 |
| | | **358.24** | | | **576.32** | | | **392.32** | | | | |
| A | 0.056 | 112 | 134.88 | 200.48 | 112 | 134.88 | 418.56 | 112 | 134.88 | 20 | 154.88 | 194.56 |
| | | **335.36** | | | **553.44** | | | **349.44** | | | | |
| M | 0.013 | 26 | 33.72 | 192.76 | 26 | 33.72 | 410.84 | 26 | 33.72 | 20 | 53.72 | 186.84 |
| | | **226.48** | | | **444.56** | | | **220.56** | | | | |
| J | 0 | 0 | 33.72 | 159.04 | 0 | 33.72 | 377.12 | 0 | 33.72 | 20 | 53.72 | 153.12 |
| | | **192.76** | | | **410.84** | | | **186.84** | | | | |
| J | 0 | 0 | 33.72 | 125.32 | 0 | 33.72 | 343.4 | 0 | 33.72 | 20 | 53.72 | 119.4 |
| | | **159.04** | | | **377.12** | | | **153.12** | | | | |
| A | 0.006 | 12 | 33.72 | 103.6 | 12 | 33.72 | 321.68 | 12 | 33.72 | 20 | 53.72 | 97.68 |
| | | **137.32** | | | **355.4** | | | **131.4** | | | | |
| S | 0.019 | 38 | 134.88 | 6.72 | 38 | 134.88 | 224.8 | 38 | 134.88 | 20 | 154.88 | 0.8 |
| | | **141.6** | | | **359.68** | | | **135.68** | | | | |
| O | 0.078 | 156 | 134.88 | 27.84 | 156 | 134.88 | 245.92 | 156 | 134.88 | 20 | 154.88 | 1.92 |
| | | **162.72** | | | **380.8** | | | **156.8** | | | | |
| N | 0.104 | 208 | 134.88 | 100.96 | 208 | 134.88 | 319.04 | 208 | 134.88 | 45 | 179.88 | 30.04 |
| | | **235.84** | | | **453.92** | | | **209.92** | | | | |
| D | 0.126 | 252 | 134.88 | 218.08 | 252 | 134.88 | 436.16 | 252 | 134.88 | 100 | 234.88 | 47.16 |
| | | **352.96** | | | **571.04** | | | **282.04** | | | | |

Assume 5 days early Jan without rain: 5 days @ 7m³/day equals 28m³ minimum reserve

Equals maximum tank size required
Minimum water required in tank




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IN m³ | 0 | 288 | 218 | 407.2 | 150 | 392.32 | 112 | 349.44 | 26 | 220.56 | 0 | 186.84 | 0 | 153.12 | 12 | 131.4 | 38 | 135.68 | 156 | 156.8 | 208 | 209.92 | 252 | 282.04 |
| IRRIGATION OUT m³ | 134.88 | | 134.88 | | 134.88 | | 134.88 | | 33.72 | | 33.72 | | 33.72 | | 33.72 | | 134.88 | | 134.88 | | 134.88 | | 134.88 | |
| WASTE OUT m³ | 35 | | 30 | | 20 | | 20 | | 20 | | 20 | | 20 | | 20 | | 20 | | 20 | | 45 | | 100 | |
| TOTAL OUT m³ | 63.8 | | 164.88 | | 154.88 | | 154.88 | | 53.72 | | 53.72 | | 53.72 | | 53.72 | | 154.88 | | 154.88 | | 179.88 | | 234.88 | |
| REMAINING IN TANK m³ | 189.2 | | 242.32 | | 237.44 | | 194.56 | | 186.84 | | 153.12 | | 119.4 | | 97.68 | | 0.8 | | 1.92 | | 30.04 | | 47.16 | |

Figure 98 First Year Water (Author 2014)

## 10.2. Sustainable Approach

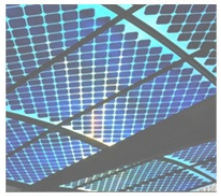
### 10.2.1. Lighting Strategy

Table 7 Energy Budget (Author 2014)

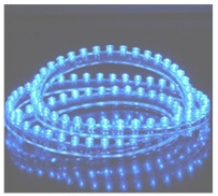
| Daily Average Energy Consumption | kW | h | kWh | Monthly Need |
|---|---|---|---|---|
| Lights (Silica Flexible Dip LED Strip (60LED)) | 2.688 kW | 12 | 32.256 kWh | 968 kWh |
| Lights (Solar Proffesional Sunken LED) | 0 kW | 12 | 0 kWh | 0 kWh |
| Fountain Pump | 0.54 kW | 24 | 6.48 kWh | 389 kWh |
| TOTAL | 2.4 kW | 12 | 28.8 kWh | 1 356 kWh |

| Dailly Average Solar Generation | | | kWh | Monthly |
|---|---|---|---|---|
| Photovoltaic panels | | | 11.52 | 2419.2 |

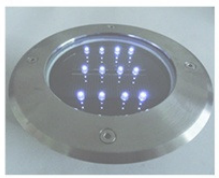
| Energy Budget | kWh / month | | | |
|---|---|---|---|---|
| Generated Energy | 2 419 kWh | | | |
| Consumed Energy | 1 356 kWh | | | |
| TOTAL Balance | 1 063 kWh | Can be sent to Municipal Grid | | |


Photovoltaic Solar Panel


Rhoda LED Amenity Light

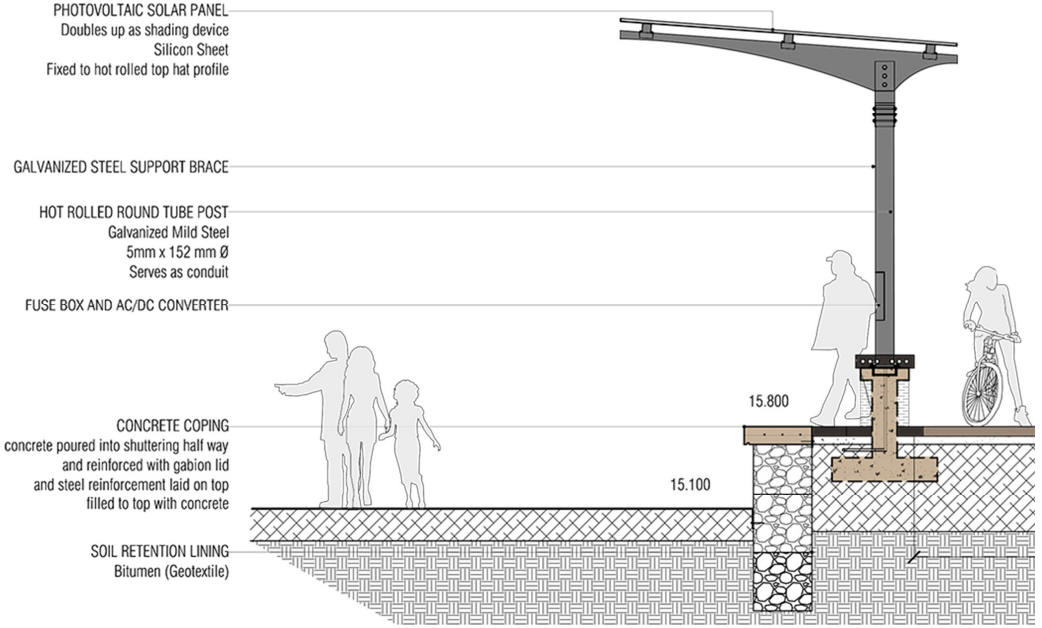

Flexible Silica Dip LED

Centrifugal Pump


Solar Professional Sunken Light


Lotis Frame Wall Light

Figure 99 Photovoltaic Solar Panel Electricity generation (Author 2014)



### 10.2.1.1. Applied Detail

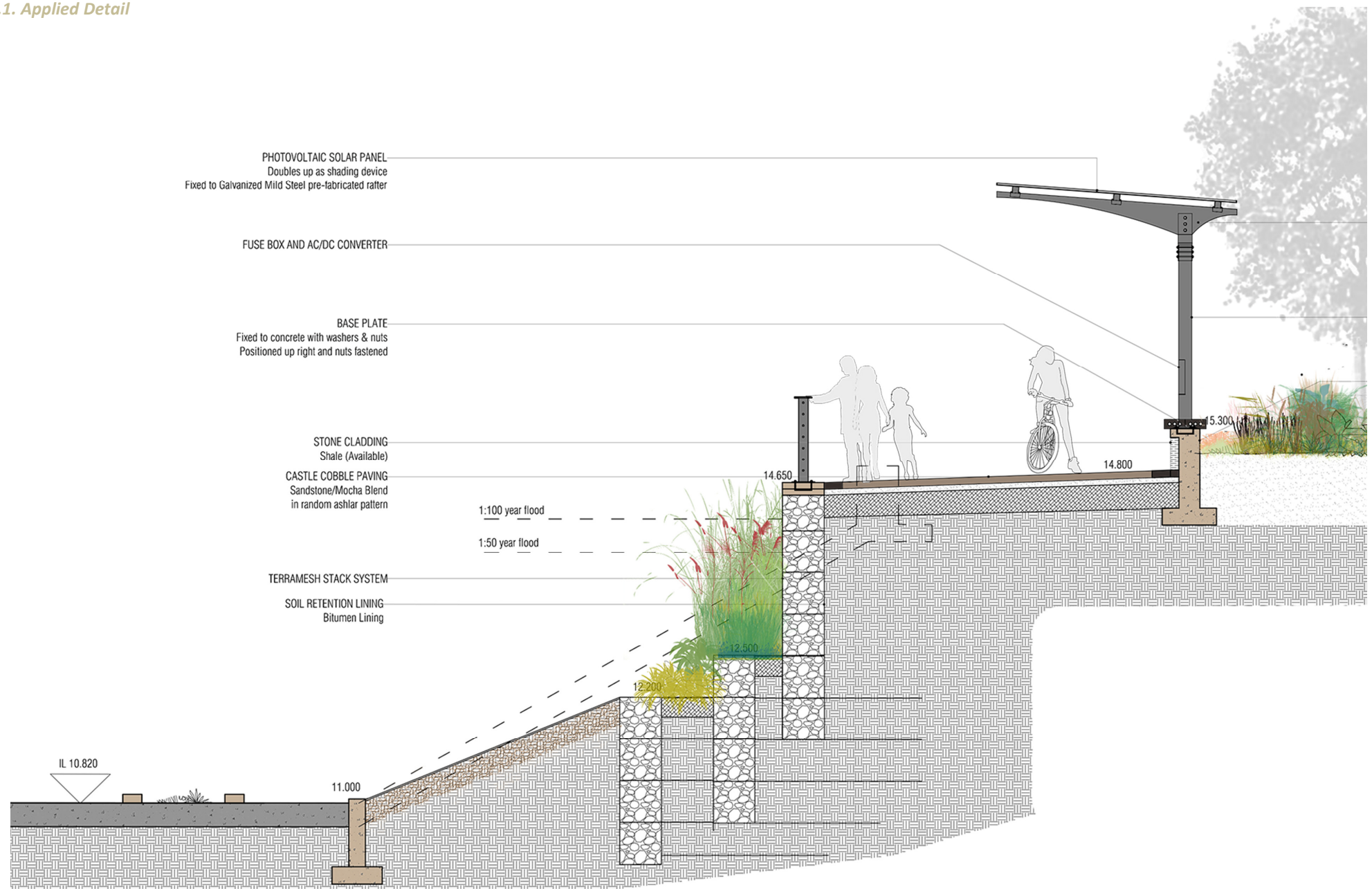
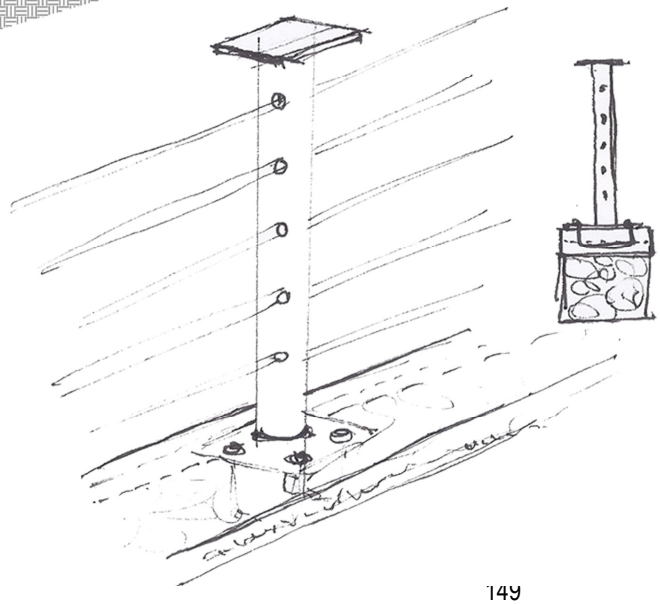
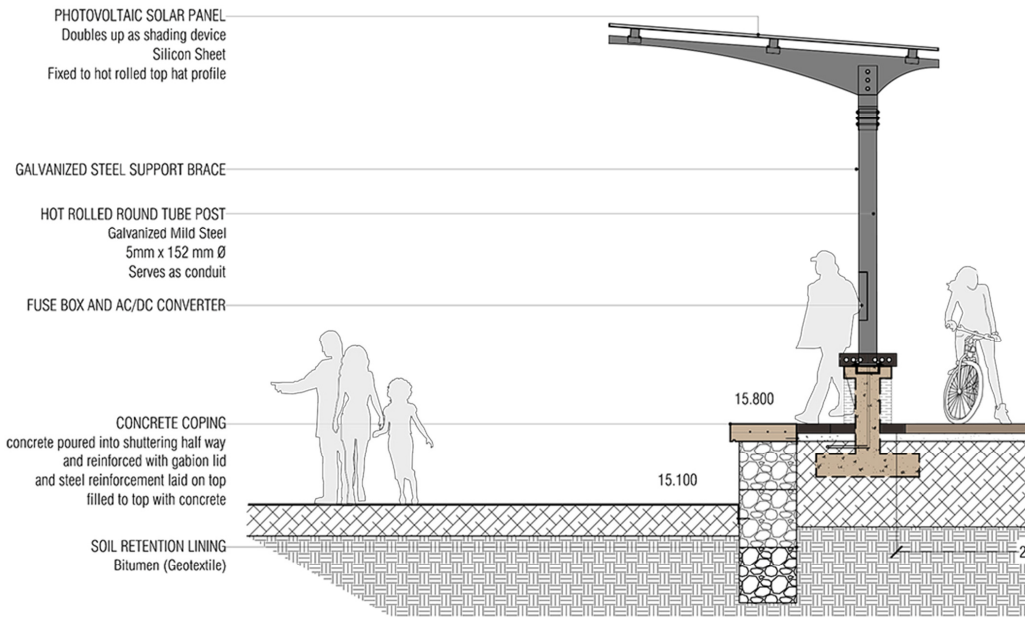


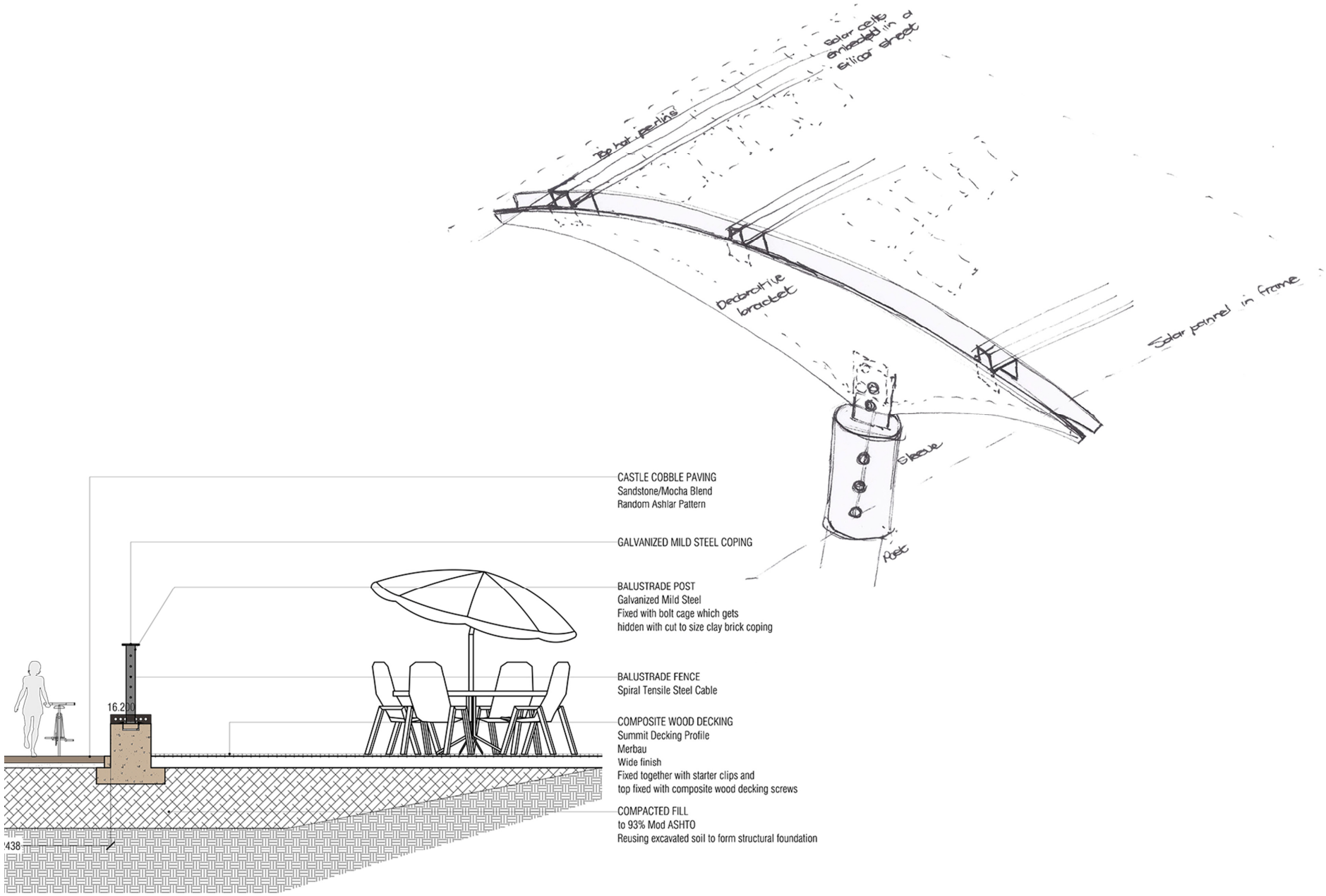

Figure 100 Photovoltaic Solar Panel Electricity generation doubles up as shading device (Author 2014)

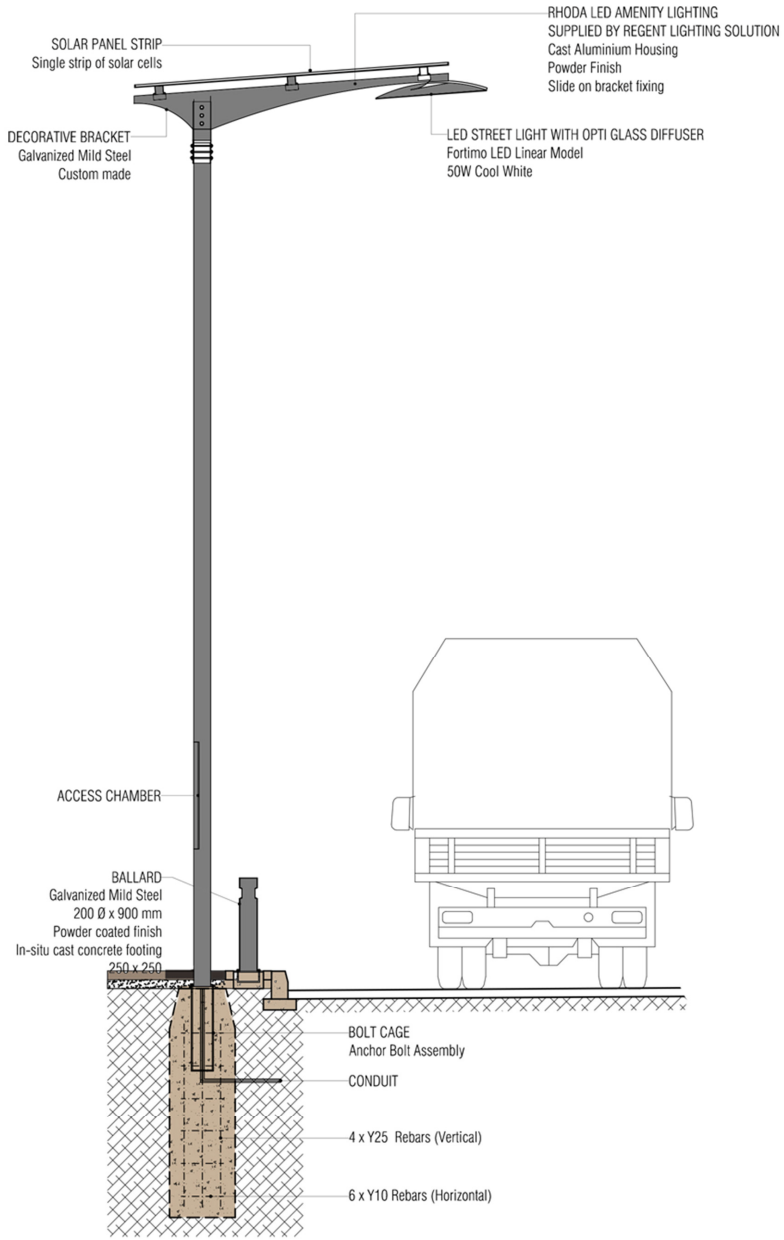






Scale 1:50

Figure 101 Interactive space (Author 2014)






Scale 1:50

Figure 102 Modular Light Post_Reduce visual clutter (Author 2014)

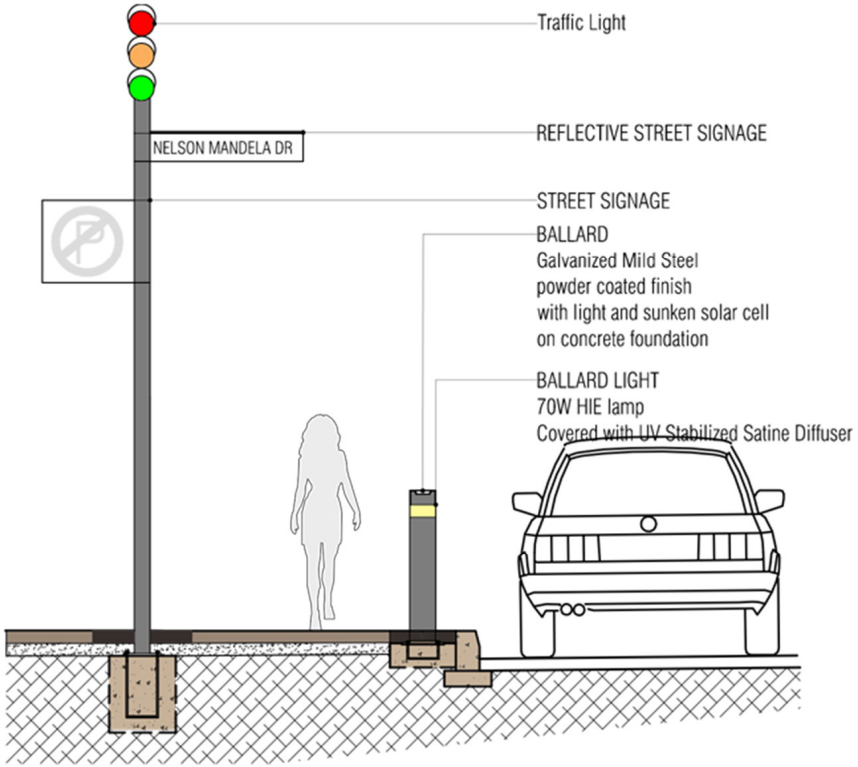



Figure 103 Modular Street Post_Reduce visual clutter (Author 2014)

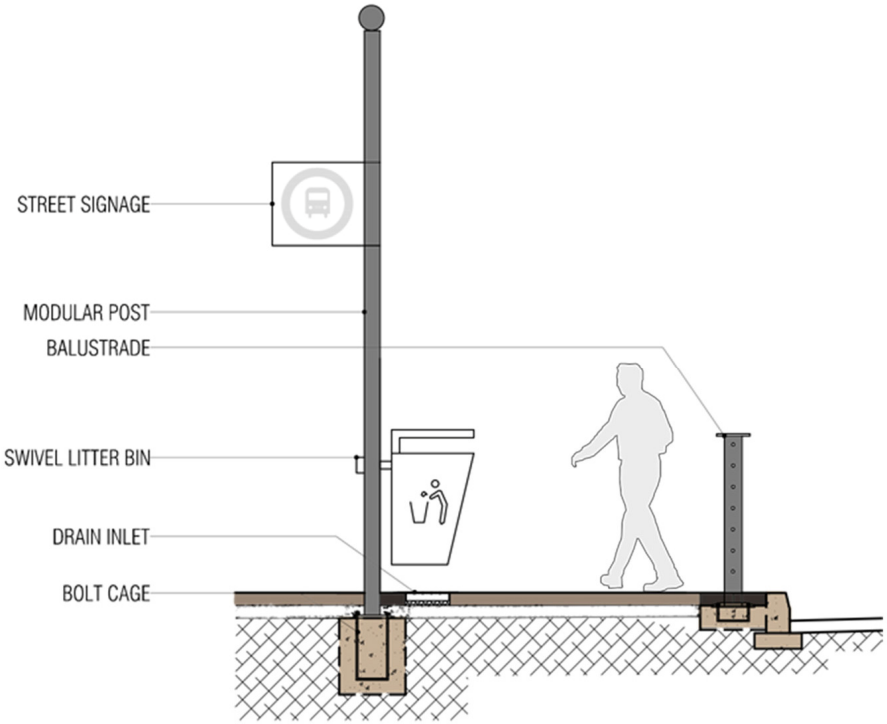



Figure 104 Alternative Modular Street Post_Reduce visual clutter (Author 2014)

## 10.3. Planting Approach

### 10.3.1. Ecological Intent

From the development strategies in Chapter 8 (Table 5) the environmental aspects that needed to be developed, the following ecological objectives was identified:

- Introduce constructed components to support ecology by focusing on enhancing the environment for people, plants and animals alike.
- Incorporate the prominent themes of ecological service analysis
    - Conserving water sources and the system they support while optimizing the use of on-site water and reducing the use of potable water.
    - Reintroducing, conserving and restoring site and region appropriate biomes.

#### *10.3.1.1. Appropriate Biomes*

According to Mucina, L. & Rutherford, M.C. (2006) Pretoria is predominantly situated within the Savana Central Bushveld Region (SV cb) 6 - Marikana Thornveld.

From chapter 5, site inventory and analysis the following plant species are identified:

- Bushwillows (*Combretum sp.*)
- Wild olives (*Olea europaea* subsp. *africana*)
- Stinkwood (*Celtis africana*)
- Wild current (*Sercia pyroides*)
- 'bontbos' and 'buffelpeer'
- Ferns (*Asplenium aethiopicum*)
- Arum lilies (*Zantedescia sp.*).

Further on-site species are identified in chapter 5 and planting selection and groupings for the proposal are informed by the analysis and further micro-climatic situation. Vegetation choice is determined by soil, light and water. The soil of the site and most of the adjacent spaces along the river lies bare, compacted and polluted by rubble. An extensive soil rehabilitation plan needs to be drawn up (not part of this dissertation) and appropriate water strategies are covered earlier in Chapter 8.

**Planting Groupings Selection**

**Planters & Open plane Species**
(Veld grass mix included)
Rock and gravel mulching will contribute to control

- *Gazania krebsiana*
- *Melinis nerviglumis*
- *Sansevieria aethiopica*
- *Bolosanthus*
- *Setaria sphacelata*
- *Acacia sieberiana var woodii*
- *Ornithogalum tenuifolium*
- *Eucomis autumnalis*
- *Bulbine frutescens*
- *Aloe greatheandii*
- *Elionurus muticus*
- *Dombeya rotundifolia*
- *Combretum erythrophyllum*

**Biofilter Species**

- *Agapanthus africana*
- *Searsia pendulina*
- *Zantedeschia aethiopica*
- *Juncus krausii*
- *Crinuum bulbispermum*
- *Hermarthria alissima*
- *Juncus effuses*

**Wetland Species**
Herbaceous species with roots in water

- *Cyperus papyrus*
- *Cyperus latifolus*
- *Echinochloa cabana*

**Terraces Species**
Mac Mat R will stabilize the soil and ensure that planting is not removed with floods

- *Dietis grandiflora*
- *Typha capensis*
- *Chasmanthe aethiopica*
- *Scripus ficionoids*

**The Manicured Lawn Specie**

- *Cynodon transvaalensis 'florida'*

### 10.3.2. Vegetated Zones


Figure 105 Planting Areas (Author 2014)

### 10.3.2.1. Application Detail

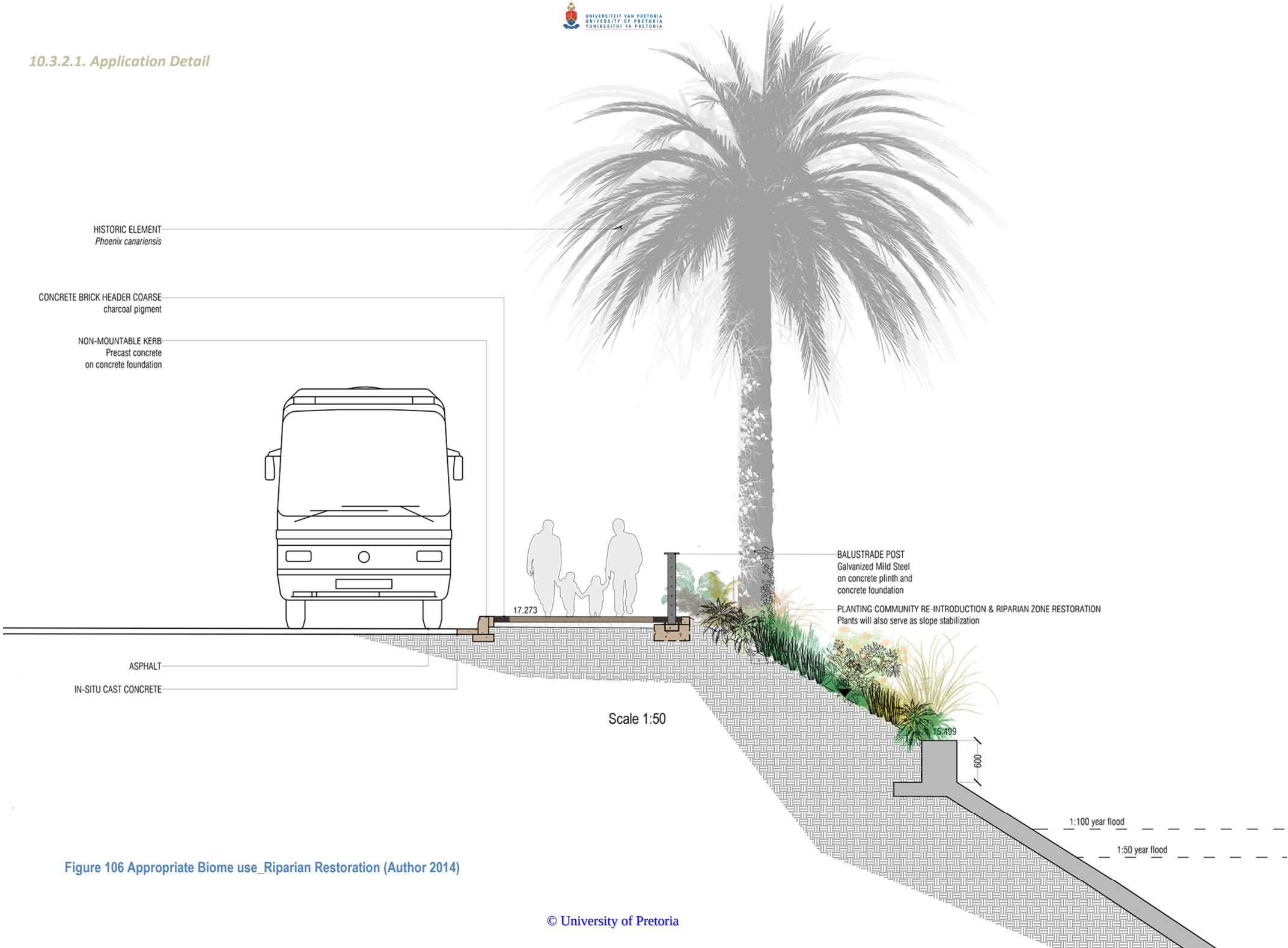



Figure 106 Appropriate Biome use_Riparian Restoration (Author 2014)

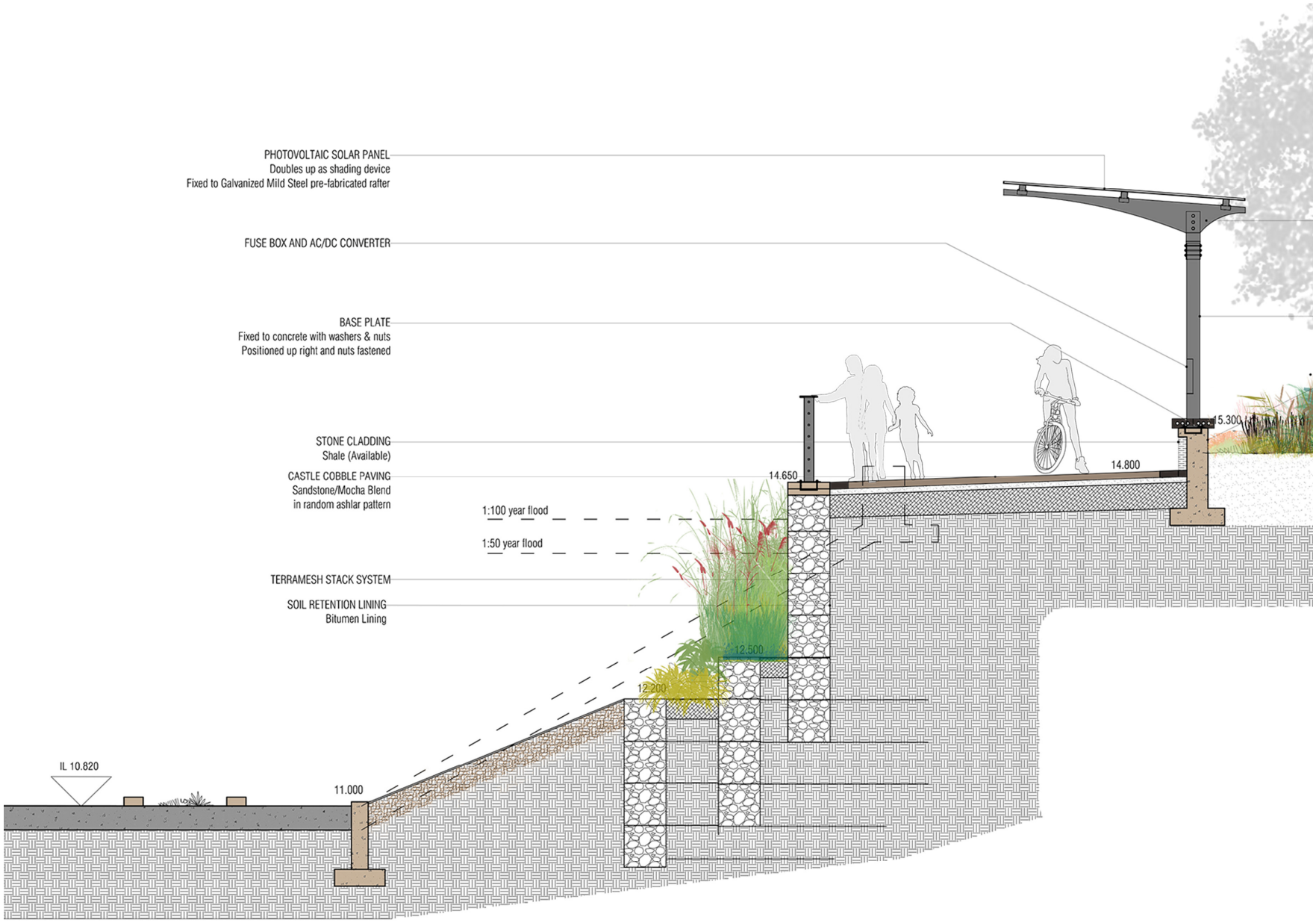



Figure 107 User friendly space_incorporation of planting community (Author 2014)

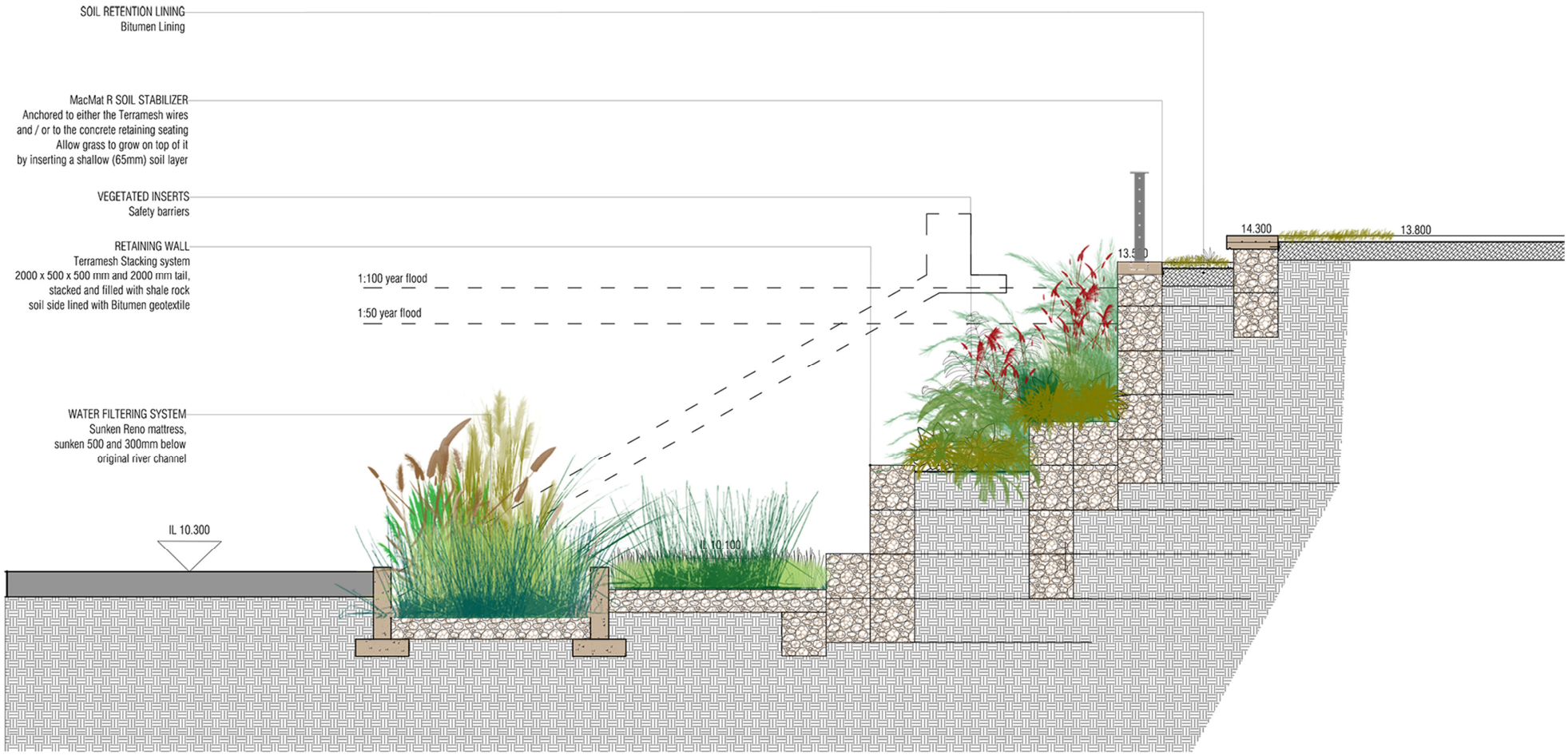



Figure 108 River bed Modification_Riverene Planting in aquatic zone(Author 2014)

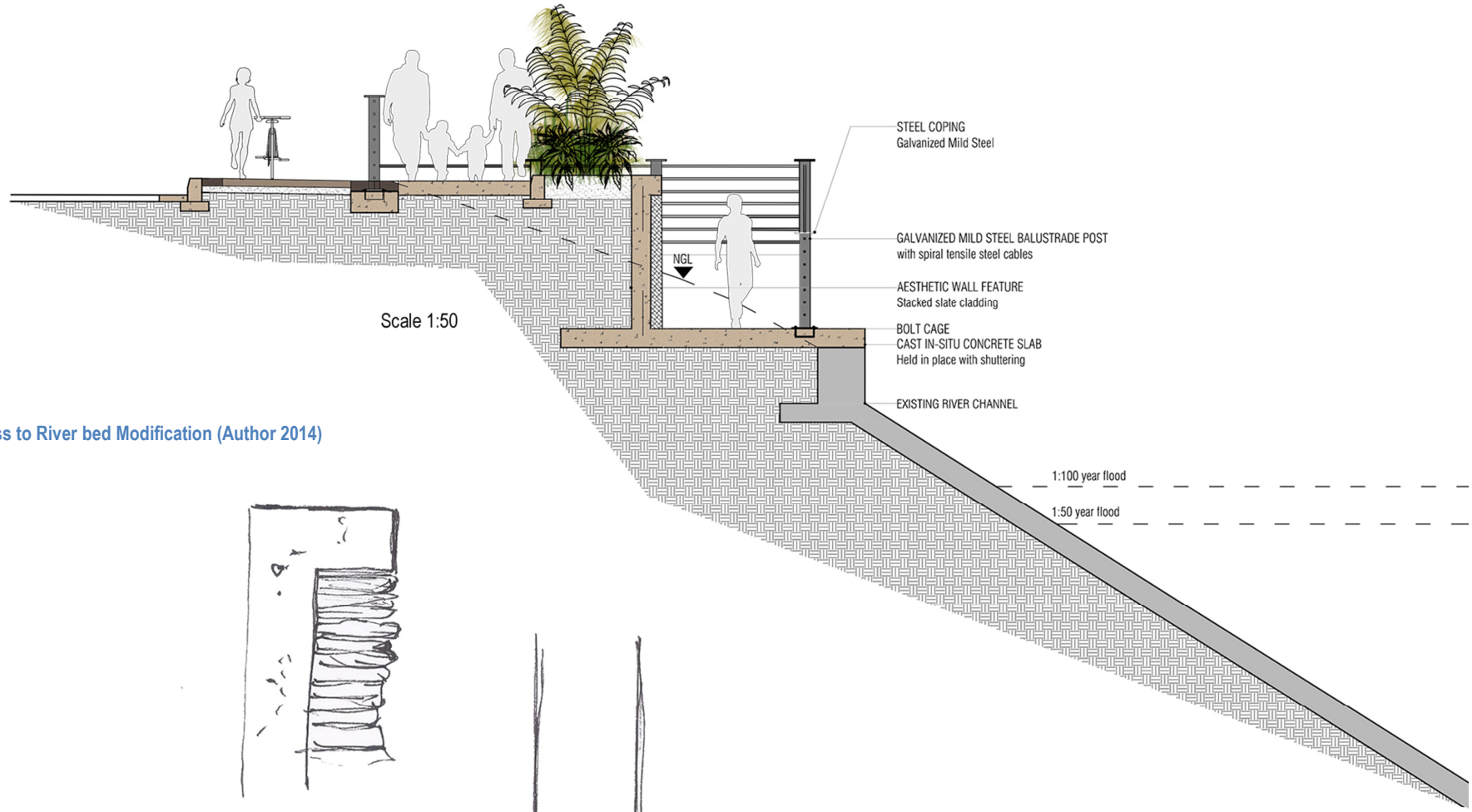
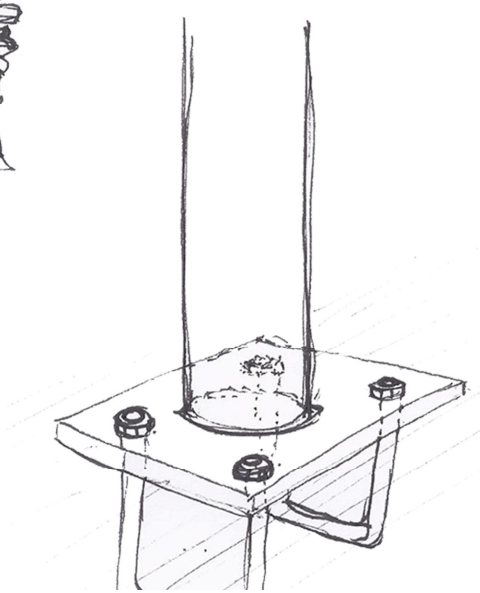



Figure 109 Visual Access to River bed Modification (Author 2014)





*Dombeya rotundifolia*

*Combretum erythrophyllum*

River Bushwillow

*Acacia tortolis*

Umbrella Thorn

*Rhamnus prinoides*

Dogwood

*Setaria sphacelata*

Pigeon Grass

*Melinis nerviglumis*

Bristle-leaved Red top

*Ornithogalum thyrsoides*

Wonder Flower

*Elionurus muticus*

*Eucomis autumnalis*

*Aloe greatheandii*

Spotted Aloe

*Sansevieria aethiopica*

*Bulbine frutescens*

Snake Flower

*Gazania*

Daybreak Pink

*Ledeboria revulata*

Icubudwana

Table 8 Planting Palette (Author 2014)

*Searsia pendulina*
White Karee

*Typha capensis*
Bulrush

*Chasmanthe aethiopica*

*Zantedeschia aethiopica*
Aurum Lily

*Hermarthria alissima*
Red vlei grass

*Crinum bulbispermum*
Orange River lily

*Juncus kraussii*
Dune Slack Rush

*Agapanthus africanus*
Agapanthus

*Juncus effusus*
Soft Rush

*Scripus ficionioides*

The materials chosen are mainly used for their versatility, low maintenance, visual quality, robustness and safety which all relates back to the idea of creating a cohesive, transparent and all visually sound environment that will compliment the ecological elements within the landscape.

Wooden decking (composite wood profiles) is associated with waterside activities and will strengthen the emotive link to the river. Furthermore the shale cladding will emphasise the connection as well as add texture for visual excitement, the cladding will be repeated to add interest and rhythm along the site.

Furniture, details and finished will add a comprehensive flare to the space and will be carried out through the green corridor. Materiality and cohesion of the chosen palette will draw the green corridor together.


Castle Cobble Paving


Composite Wood Decking

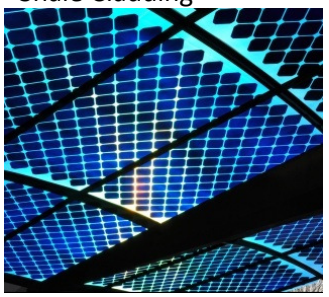

Shale Cladding


Brick Paver Edging


Smooth Finish Concrete


Hot rolled tube (GMS)


Spiral Tensile Steel Cable


Photovoltaic Solar Panel


Rhoda LED Amenity Light

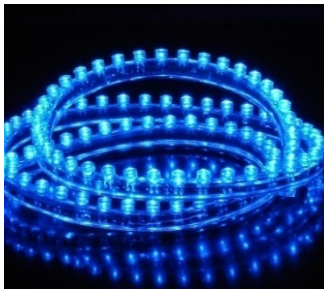

Flexible Silica Dip LED

Table 9 Material Palette (Author 2014)

## Sustainability Rating

### *SITES*

| YES | ? | NO | | |
|---|---|---|---|---|
| 179 | 0 | 0 | TOTAL ESTIMATED POINTS | Total Points: 179 |

| KEY | SITES Certification levels | Points |
|---|---|---|
| **YES** Project confident points are achievable | CERTIFIED | 70 |
| ? Project striving to achieve points, not 100% confident | SILVER | 85 |
| **NO** Project is unable to achieve these credit points | GOLD | 100 |
| | PLATINUM | 135 |

**Table 10 SITES (sustainablesites.org) Healing Landscapes (Author 2014)**

The SITES Rating System is a measuring system using a set of prerequisites and credits to determine sustainability of sites. The system will help develop sustainable landscapes by guiding the land design and planning.

The chosen site was analysed (Chapter 5) and the proposal was then assessed by the SITES Rating System and it scored a Platinum SITES Certificate (Table 10 and full assessment Appendix ), therefore the development proposal will be regarded as a successful design proposal.

# Chapter 11
# Conclusion

## 11.1. Conclusion

### 11.1.1. Themes from the abstract, hypothesis and problem statement

- Human population growth suggests urban sprawl which implies that natural corridors will diminish.
- Limited open space
- Restricted access to the biophysical environment
- Restricted access to recreational space
- Lack of everyday interaction with the biophysical environment will lead to low wellbeing
- The biophysical environment and ecology as the base for *green* Landscape Architecture
- Awareness of the importance of conservation of nature
- Context orientated strategies
- The contribution of a systems approach to site design in the maintenance of ecological function and adding to biodiversity.

### 11.1.2. Findings

*The need for people to connect with the biophysical environment in order to enhance their wellbeing is a well know fact, and it is this subconscious need that inspires to ecologically driven development projects within the city. The biophysical environment is the pillar on which ecosystems stand, it is where ecology and ecosystem services exists on which man is dependant. Landscape Architecture that provides meaningful encounters with ecology and portrays ecosystem services in a green way addresses more than the physical element and reminds man of his reliance on nature.*

*All possible projects are influenced by nature and the importance of nature and all it provides should be portrayed, to understand the dependency of the resources provided for free. These resources should be managed and used strategically to benefit significantly without disrupting the natural cycle of things.*

*Because of the importance of the biological environment in our lives, awareness needs to be heightened; our wellbeing is dependent on interaction with the biophysical environment. The design is influenced by the contextual orientation or the lack thereof therefore it supports and incorporates an ecosystemic approach where ecology is enhanced though the proposal of a green corridor, where the biophysical environment has the opportunity to exist within the urban environment. Provision of these ecological environments will ensure the city dwellers have access to the biophysical environment on a daily basis to fulfil the subconscious need to connect with nature and ultimately benefit their wellbeing.*

*The vivid experience is created through the introduction of ecological environments where water filtration takes place, habitat creation is addressed, planting communities are re-established and all in all the design incorporates textures, rhythms, sounds, smells and tastes (the bakery & Restaurant and edible plants with fruits) to enhance the experience.*

### 11.1.3. Strategies formulated through design exploration

- *Improve Streetscapes through designing an ecologically enriched environment where people can relax, experience and understand the importance of the biological environment and its ecosystem services*
- *Use resources i.e. sunlight to generate energy, and rainwater runoff to capture water for irrigation purposes.*
- *Utilize stormwater by incorporating bio-swale filtering systems as a means of being resource efficient by the changing urban environment but to still be attuned to the natural course of things. It is a functional, space creator and it provides softness to the harsh urban environment.*

- *Make the Invisible River and river ecology visible.*
- *Optimize utilization of resources.*

### 11.1.4. Themes from design brief and objectives

- Finding appropriate space where a response can be created to where the influence of the biophysical environment within the urban environment can be celebrated.
- Enhance and protect resources within the city context.
- Enhance and protect current and future open space within the green corridor
- Improve river front aesthetics; create social environments; create opportunity for emotional and sensorial appreciation and improve aquatic quality for ecological wellbeing.
- Increase and improve public space and entice use throughout the day.
- Expose the ecological, historical and cultural memory of the site.
- Utilize the introduced systems to create diverse ecological components.

### 11.1.5. Findings

The design deals with not only city scale challenges but also global environmental situations and protects and reintroduces the presence of ecologies within the city. This is done by creating a connection and almost removing boundaries between natural and man-made to celebrate our dependence on nature.

Protecting resources within the city will improve the quality of ecologies and enhance current and future open spaces within the green corridor of the city. Increasing the quality, density and diversity of plant species together with conservation of existing planting communities and re-introduction of riparian zone vegetation and introduction of other plants will create an ecologically rich environment where temporal change and diversity is enhanced.

The design encompasses a series of social spaces within the vicinity of the sketchplan as well as throughout the green corridor. The alteration, modification and redevelopment of Apies River Channel will enhance the quality of the river front and allow for ecologies to flourish. This will ensure greater public interest and participation which will benefit the long-term wellbeing of the corridor. The design provides for all day interaction; kids can play after school, students can laze around read and socialize. Pedestrian and cyclist access are provided for to ensure ease of circulation. Resting space is also provided for together with a restaurant and bakery that cater for different income groups and tastes.

# 11.2. Final Presentation

## Concept Development

### Problem Statement

The users of the densely populated city have a need to improve their quality of life. Life within the urban environment can be improved by fulfilling the subconscious need to connect with nature. This can be done by providing adequate interaction with the biophysical environment through open space. It is important to analyse available open space in terms of quantitative and qualitative value in order to determine whether there is enough open space available and whether it is functionally sound to accomplish an enhancing environment.

### Hypothesis

All human beings have the subconscious need to connect with nature. From a more practical point of view; analysis of the current quantity and quality of open space in relation to open space requirements can reveal how landscape architecture can optimize the open spaces to create a connection between humans and the biophysical environment.

According to the Standards for Outdoor Recreational Areas (Moeller 2009) the total recreational area required for a population density of 100000 people is 610 ha. The available open space of 510ha is not adequate. By connecting the natural environment in the south (Groenkloof Nature reserve and Fountains Valley) to the urban environment in the north a functional recreational network can be created. Below the tabel indicates which recreational facilities or spaces are needed for various population densities, but he main focus will be with regard to recreational open space. The functional recreational network will exist by connecting open space and underutilized space with the MDC Proposal to form an intermediate network of the biophysical environment. The aim is to steer away from a mono-functional landscape but to design ecologically functional spaces that will address the public need and be the intermediate biophysical connection between man and nature.

| Recreational Uses | Quantity | Area |
|---|---|---|
| Reservations | 1 | 280ha |
| Large city park | 1 | 160ha |
| Neighbourhood parks | 10 | 100ha |
| Playgrounds | 50 | 40ha |
| Gardens and squares | | 30ha |
| **Total** | | **610ha** |

| Recreational Uses | Quantity | Area |
|---|---|---|
| **Total** | | **510ha** |

The total open space available in Tshwane's urban environment is derived from a measurement acquired from a Tshwane municipal art map.

100000 = 610ha

Open space Requirement

Little space available
Over populated

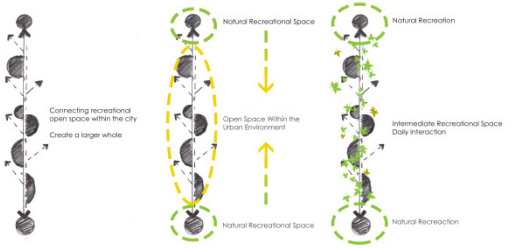
Current situation

Connect open space
Use non spaces

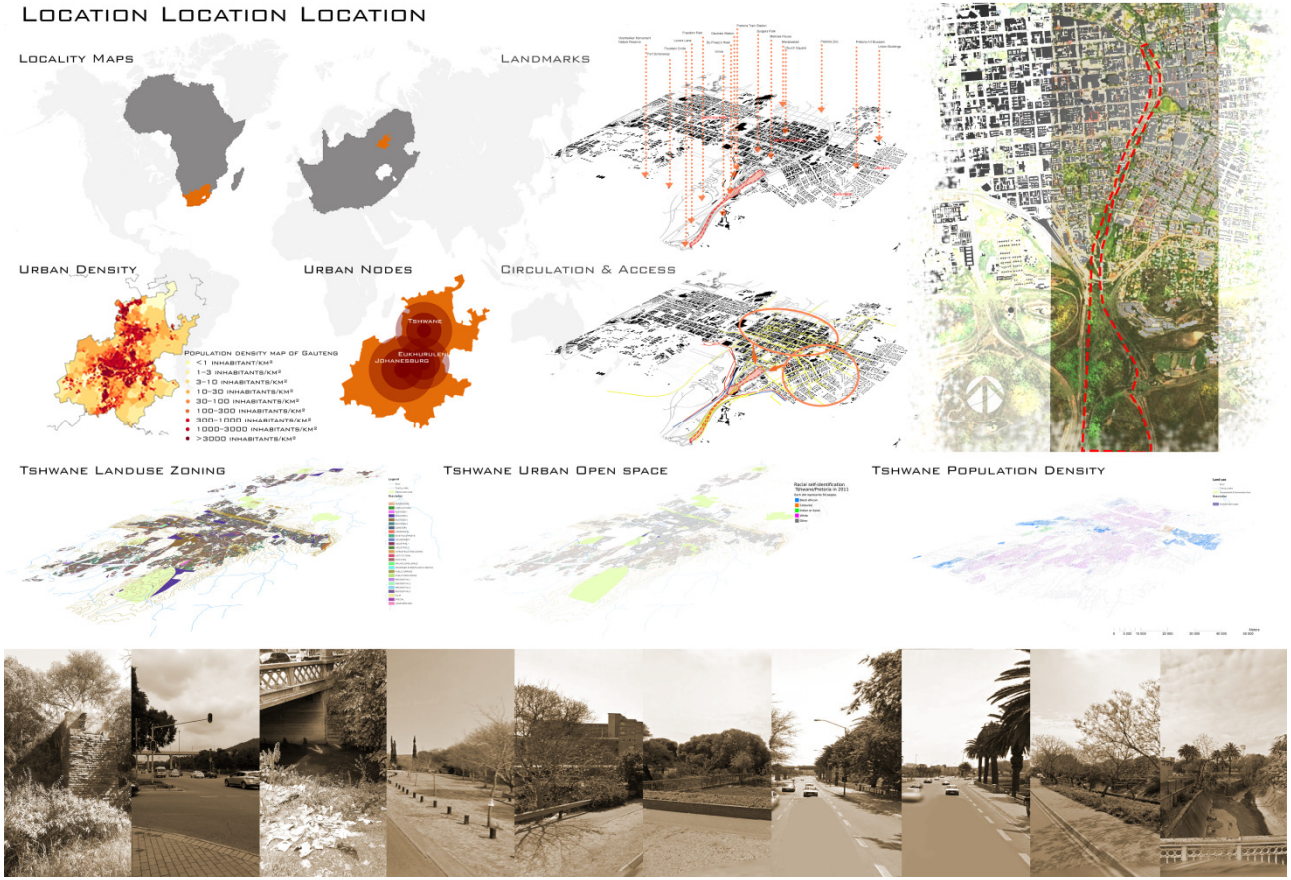
Landscape Architectural Solution

The idea is to connect open spaces within the urban environment to form a larger recreational facility. The connection will be a biophysical network that provides an intermediate connection between man and nature. The northern node is located within the urban environment it is represented with the MDC proposal by Encha Properties as a human recreational facility. The southern node is located in the Groenkloof Nature Reserve and Fountains Valley; it is represented with the Tshwane Natural and Cultural Recreation proposal. The northern and southern nodes are not accessible to one another and have the opportunity to inform an intermediate recreational facility which can become a functional network of open space with interacting facilities.

In order to create a coherent network both proposals should interact with this new intermediate recreational proposal by using the same landscape palette, design language and design elements like street furniture, paving etc.




## Location Location Location



## URBAN FRAMEWORK

Open Space development Opportunity

User Catchment

Pedestrian Movement & Access

Existing Nodes & Development Proposal Nodes

Detached Green Open Space

Proposeals for development & Opertunity

## SYNTHESIS

### STITCHING THE LANDSCAPE

De-fragmenting available open space by creating a linear space with the public realm in mind. Opportunity to provide facility nodes to fulfill the need for open and recreational space provided by the potential the biophysical environment possess.

Within the catchment a population density of ? are present which then has a population threshold that suggests there needs to be particular goods or services provided in the area. These goods and services are indicated in the table below.

| Recreational Uses | Quantity | Area |
|---|---|---|
| Reservations | 1 | 280ha |
| Large city park | 1 | 160ha |
| Neighbourhood parks | 10 | 100ha |
| Playgrounds | 50 | 40ha |
| Gardens and squares | | 30ha |
| **Total** | | **610ha** |

Movement and access to and from public open space is a difficult task for pedestrians. This is due to the city development that focused on vehicular access not really taking into account the fact that most of its users live in a close vicinity of the spaces and places they visit.

In order to promote public access and mobility, linking spaces and places will be the way to go. This will be done by identifying public nodes which can be attached to a larger framework which provides facilities according to spatial needs.

The nodes that are identified supports the idea of a linear development proposal. These nodes are mainly public spaces and nodes that Encha Properties identified for development according to their Mandela Development Corridor.

Opportunity to enforce the standards over a broad area and each development, however small, should be required to contribute proportionally towards larger facilities. The capacity of the mobility corridor or spine to host facilitating nodes is available. These facilities can function as a public realm where mobility and access are high priority. Many of the sites along Nelson Mandela Drive are developed sites with new development proposals as suggested with the Approval of the Mandela Development Corridor (MDC) which runs from Edmond Street to Kotzé Street near Berea Sorts Complex.

The MDC proposal will be accepted within the urban framework and the framework for the development proposal of the entire Nelson Mandela Drive as public open space will be attached to it.

Further up to the South in between Kotzé and Willow Street, lies the Berea Park Sorts Complex and adjacent sites. Two development proposals exist for the Berea Park Sports Ground where the old rugby and cricket fields and club houses were. A Landscape Architectural Proposal of waste management and an Architectural Proposal of Regenerating Berea Park. These two proposals will be adopted according to the CSIR standards for open space development.

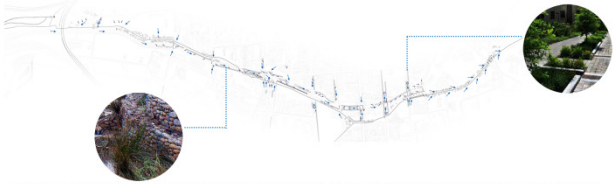
The Berea Sports Complex and bordering sites, even though detached from one another, will form part of the larger public facility. At the Southernmost tip of one of the sites, known as Du Preezhoek, neighbouring Berea Park is where the new Gautrain and old NSAR bridges cuts across, an imaginary detaching agent. At this point, Founts valley Park starts with a development proposal that stretch into the Groenkloof Nature Reserve. This proposal is assuming about recreation in terms of recreational needs. Some recreational facilities include active and passive activity space like braai area, pools etc.

With the proposal of the urban framework I suggest to stitch the fragmented sites together to form a large open space. The open space will have various regenerative facilities to address the need for open space and to connect with nature to regenerate ones wellbeing.

# URBAN CONTEXT NEAR GREEN CORRIDOR PROPOSAL


# Sustainable Strategies

## River hydraulics & Stormwater Strategies



Introducing Biofiltration systems along all streets and roads to assist in stormwater management, it also provides opportunity for ecology to survive and progress. The river will also undergo some changes; new edges and surface alteration will give the river a face lift. The river is altered by introducing more natural features like boulders within the river bed, edge alteration by means of cutting through the existing concrete embankments and using gabions to allow for plant to grow. As the riparian zone is mostly diminished it will be another opportunity to create more ecological friendly spaces which will allow for succession and habitat creation to take place. All in all the river should have a more naturalistic feel to it.

## Environmental enhancing Strategies

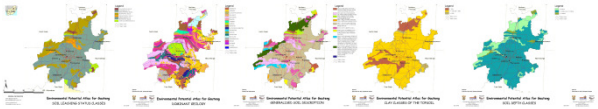
In order for the proposed green corridor to be sustainable some improvements need to be made. Visually the entire corridor needs tidying up; a modular unit can be introduced to simplify street corners in turn making it more pedestrian friendly. Pollution needs to be taken care of by reintroducing maintenance programmes and ample amounts of litter bins. Pollution in the river needs to be dressed by installation of trash traps where widening will happen, discussed in hydrology strategies, and filtration systems (altering the river bed by cutting into the concrete and inserting Reno mattresses with appropriate planting in them) to somewhat clean the flowing water..

## Vegetation Strategies

The ecological strategy entails restoration of the planting community and reintroduction of riparian and riverine planting. It is creating ecological sound environments where all species can reside and people can find 'refuge' from the busy city life. These environments will be a ecologically enhanced and serve as fulfilling medium for people's biophillic nature wanting to connect to nature and its natural systems. It is fulfilling a subconscious need and revealing the subconscious understanding of ecology.

# Analysis

## Soil Analysis



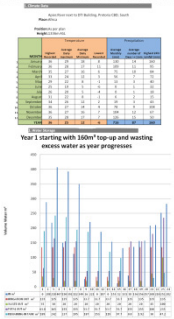
The Genralized soil description is red soils with a yellow and greyish colour, with low to medium base status and rock with limited soils, meaning it is fine textured soils with a clay percentage of >15% and <35%. The soil various from <450mm to <750mm for most of the city.

According to the above maps and supported by Mucina, L. & Rutherford, M.C. (2006, p. 463) the dominant geology is mafic intrusive rock of the Rustenburg Layered Suite of Bushveld Igneous Complex. Rocks include gabbro, norite, pyroxinite and anorthosite, and a predominant amount of shale with granite and quartzite.

Because of clay content and fine texture of the soil (<0,002mm particles) the infiltration rate is low (0.001m/h for very fine particles).

The Leaching Status of the soil on Master Plan scale are located in Mesotrophic to Eutrotrophic soils and Dystrophic to Mesotrophic soils, indicating that the soil is more or less fertile with high to low levels of biological productivity.

## Precipitation Analysis



The rainfall season is during the summer months and for this catchment within the city a total rainfall of 716mm is recieved per annum. The warm summer temperatures affect infiltration capacity due to evaporation and low winter temperatures can lead to frost which will affect plants if they are not frost resistant, therefore approriate plants needs to be used to accompony for summer heat and winter frost.

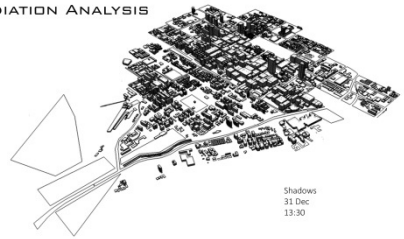
Now when we look at the budget for water yield and demand the rainfall (m), the area m², surfaces (roughness coefficient), the infiltration rate and evaporation rate comes into play.

The budget is calculated by finding the water remaining in the tanks after the demand is subtracted from the yield. The Yield is calculated as follows: Yield (m³) = Pprecipitation (m) x Aarea (m²) x Coefficient, ; then from the yield the total yield is calculated by subtracting the evaporation. Evaporation is about 0.005mm per day making it 15% per month therefore the total yield is:
Yieldtotal(m³) = Yield - Infiltration (%) - Evaporation (%).

When the total yield is calculated the next step is to calculate the demand (m³) to determine the amount of water needed or surplus from the budget calculation, indicating how many tanks are needed.

This calculation is done by determining the least amount of water to always be available in the tank and then how much can be wasted and when. The histogram left shows water entering the storage system (Precipitation x Catchment Area x Run-off coefficient), the amount used according to the demand (Area x Irrigation depth), the volume which can be wasted and when, the total of water out (Irrigation + Wasted water) and the remaining amount of water in the tank. The safety factor is determined by the least amount of water in the tank and devided by 4 (assuming that the first week of January are without rain) gives the volume of water needed to be pumped into the system at the start of utilisation. Detail calculations will follow in the water strategies.

## Solar Radiation Analysis



Shadows
31 Dec
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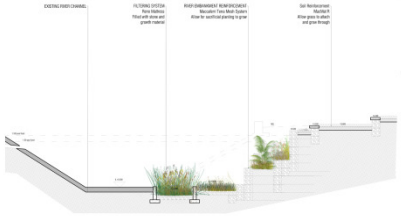
# River hydraulics & Stormwater Strategies


Stormwater Diversion, Filtration & Release

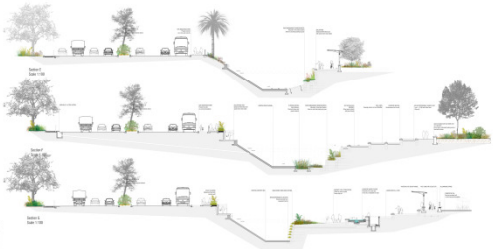



River Bed Modification

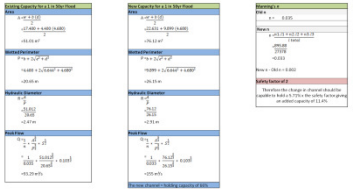


**River bed Modification**

River bed modification include cutting into the concrete to install a Reno filtering system, where plant roots can tap into the natural soil surface and some water can infiltrate. Furthermore insertion of boulders to aesthetically improve the river flow.

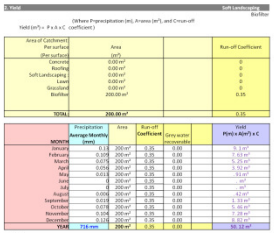


After the channel bed base been modified and the roughness have been increased adjustments need to be made in order for the channel to maintain its capacity. The following calculations indicate how the roughness affects the capacity of the channel and how the design accompanies for the new volume of water flowing through.



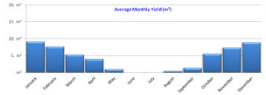






| Area of Catchment | Area | | Run-off Coefficient |
|---|---|---|---|
| Per surface | (m²) | | |
| Concrete | 0.00 m² | | 0 |
| Roofing | 0.00 m² | | 0 |
| Soft Landscaping | 0.00 m² | | 0 |
| Lawn | 0.00 m² | | 0 |
| Grassland | 0.00 m² | | 0 |
| Biofilter | 200.00 m² | | 0.35 |
| TOTAL | 200.00 m² | | 0.35 |

| MONTH | Precipitation (Average Monthly (mm)) | Area | Run-off Coefficient | Grey water recoverable | Yield P(m) x A(m²) x C |
|---|---|---|---|---|---|
| January | 0.13 | 200 m² | 0.35 | 0.00 | 9.1 m³ |
| February | 0.109 | 200 m² | 0.35 | 0.00 | 7.63 m³ |
| March | 0.075 | 200 m² | 0.35 | 0.00 | 5.25 m³ |
| April | 0.054 | 200 m² | 0.35 | 0.00 | 3.78 m³ |
| May | 0.013 | 200 m² | 0.35 | 0.00 | 0.91 m³ |
| June | 0 | 200 m² | 0.35 | 0.00 | - m³ |
| July | 0 | 200 m² | 0.35 | 0.00 | - m³ |
| August | 0.006 | 200 m² | 0.35 | 0.00 | 0.42 m³ |
| September | 0.019 | 200 m² | 0.35 | 0.00 | 1.33 m³ |
| October | 0.078 | 200 m² | 0.35 | 0.00 | 5.46 m³ |
| November | 0.104 | 200 m² | 0.35 | 0.00 | 7.28 m³ |
| December | 0.132 | 200 m² | 0.35 | 0.00 | 9.24 m³ |
| YEAR | 716 mm | 200 m² | 0.35 | 0.00 | 50.12 m³ |




Introducing Bio-swales and filtration systems along all streets and roads to assist in stormwater management. It also provides opportunity for ecology to survive and progress. The bio-swales will also serve as water diverting mechanisms; unabsorbed water will either overflow and out the bio-swale entering the nest or entering the stormwater pipe system leading back to the river or infiltrate the soil deeper to be diverted to sub-surface pipe systems. 30% of the water will be absorbed, 40% will infiltrate naturally and the remaining 40% will be captured into a pipe system leading to roda water storage systems (installed under-vegetated road islands) to be used as irrigation.

**Base flow infiltration calculation**

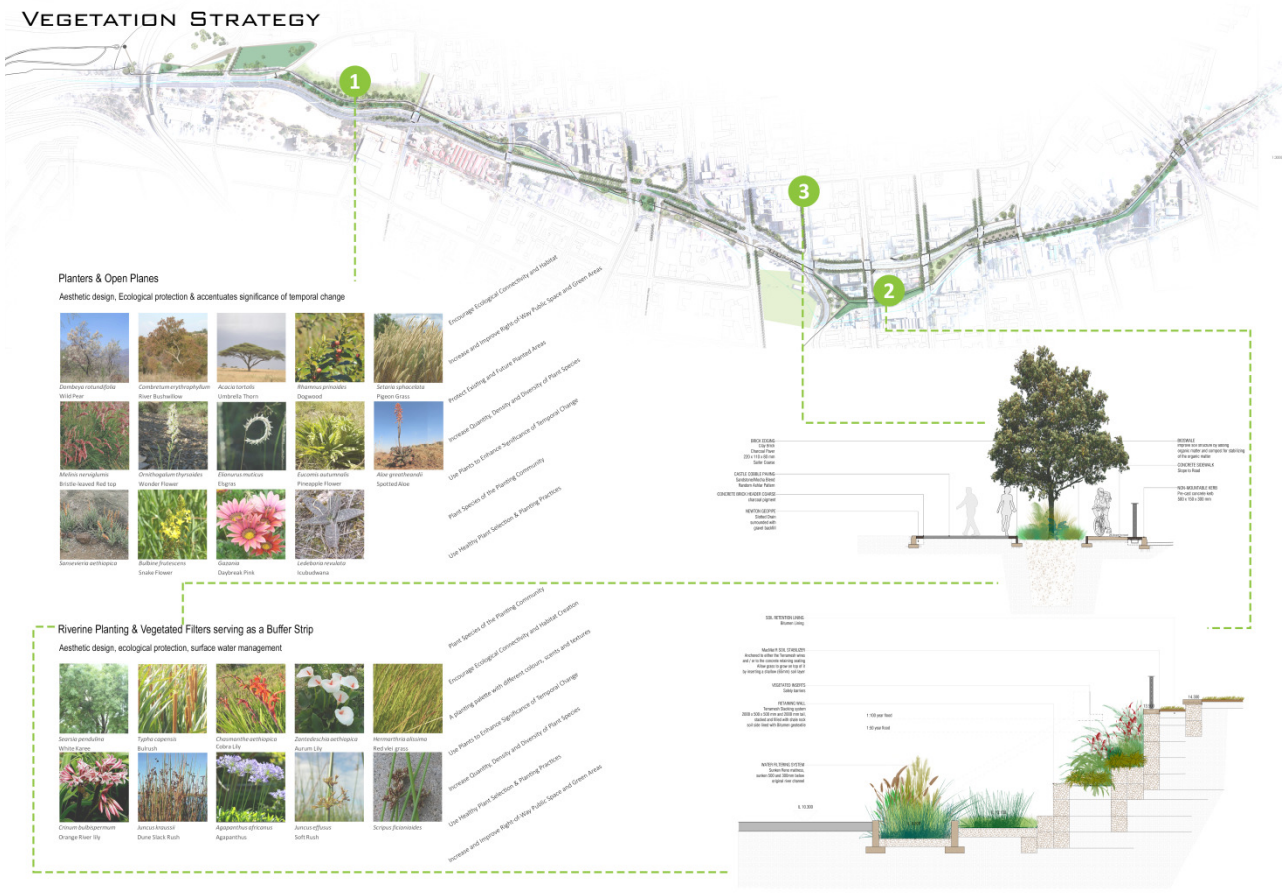
The infiltration rate for the catchment assuming that the particles are 0.002mm in size the infiltration rate will be 0.001m/h. If we then calculate the infiltration rate for 24 hours infiltration will be 0.024m (0 infiltration rate x 24 = infiltration), now to calculate the volume of water to infiltrate an area of (m²) (V =Ai) the volume of water to be infiltrated for the area is 0.024m², this is for a perfect environment without evaporation to be accounted for. When evaporation come into play the volume of evaporation will be subtracted from the volume of infiltration and a true infiltration volume will be calculated.

Base flow = 4.03 m³/h
Infiltration rate = 0.0632484 m³/h
Infiltration rate for the Reno Mattress area (256.5 m²) = 0.2589768 m³/h
Therefore 4.813 - 0.2584 150 = 3.7145150 m³/h there will be water flowing past the Reno system allowing the river not to dry out. The households using the water will now have cleaner water.

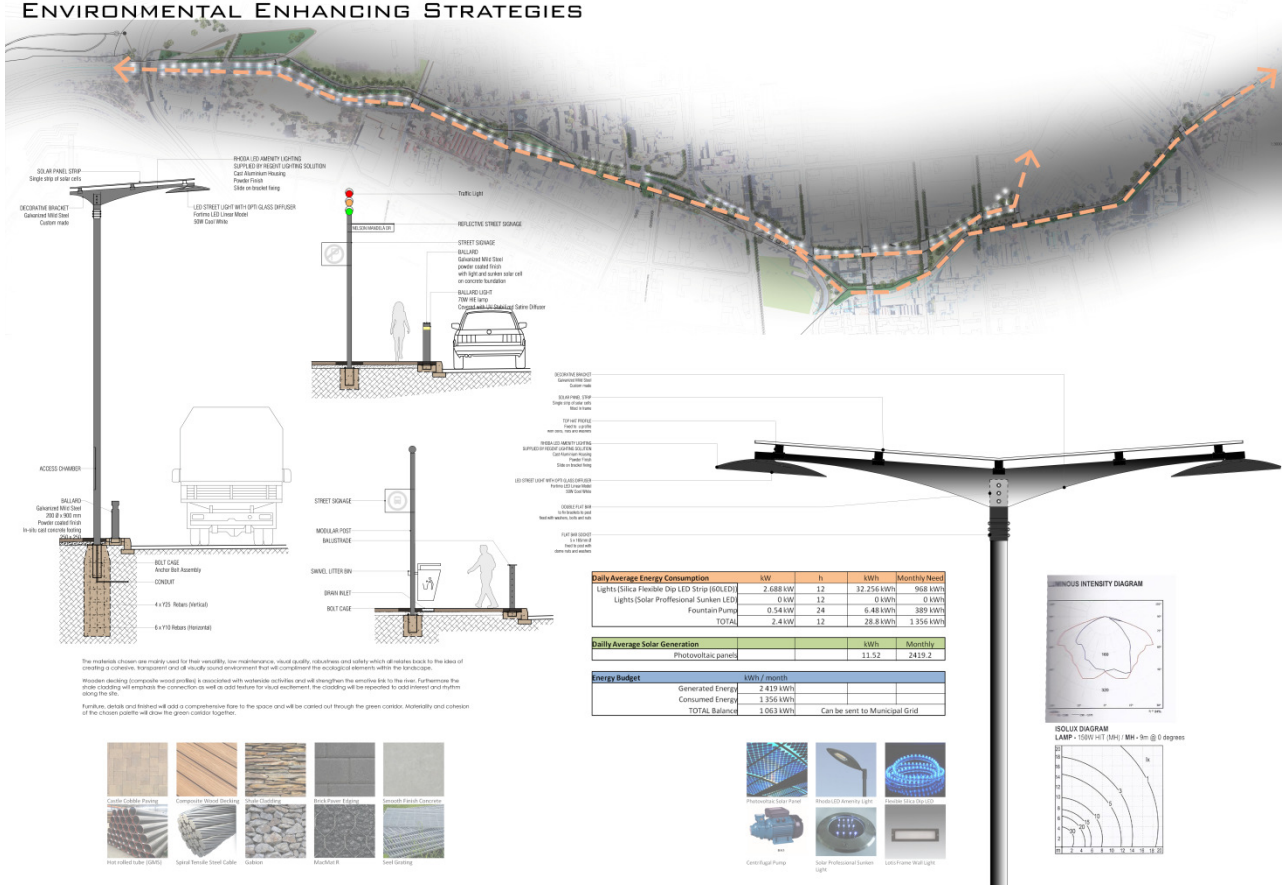
**Invisible Visible**

By incorporating a fountain raised to the level where it is accessible; the invisible river now becomes visible. It will provide more aesthetics to the space as well as a sense of fun and functionality.

Ultimately the water strategy is to divert, filter, store, reuse and utilize the water; flowing from one system into the next or either utilized directly from one system. Furthermore the strategy entails enhancing the river front quality, water quality and human experience.



# ENVIRONMENTAL ENHANCING STRATEGIES

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Wooden decking (composite wood profiles) is associated with waterside activities and will strengthen the emotive link to the river. Furthermore the shale cladding will emphasis the connection as well as add texture for visual excitement. the cladding will be repeated to add interest and rhythm along the site.

Furniture, details and finished will add a comprehensive flare to the space and will be carried out through the green corridor. Materiality and cohesion of the chosen palette will draw the green corridor together.



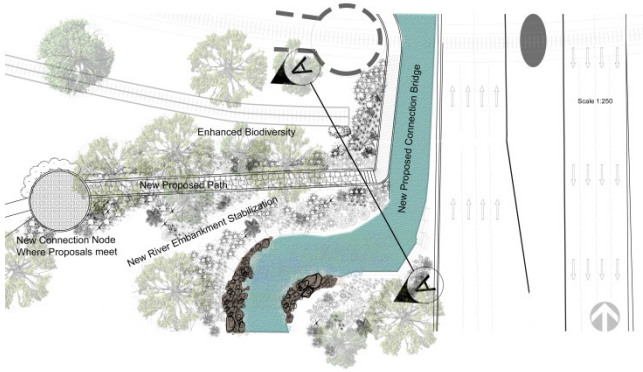


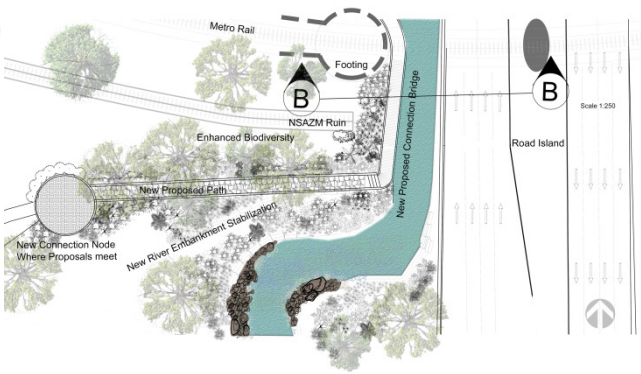


| Daily Average Energy Consumption | kW | h | kWh | Monthly Need |
|---|---|---|---|---|
| Lights (Silica Flexible Dip LED Strip (60LED)) | 2.688 kW | 12 | 32.256 kWh | 968 kWh |
| Lights (Solar Proffesional Sunken LED) | 0 kW | 12 | 0 kWh | 0 kWh |
| Fountain Pump | 0.54 kW | 24 | 6.48 kWh | 389 kWh |
| TOTAL | 2.4 kW | 12 | 28.8 kWh | 1 356 kWh |

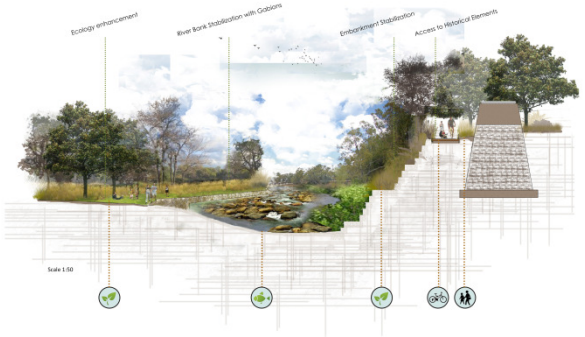
| Dailly Average Solar Generation | | | kWh | Monthly |
|---|---|---|---|---|
| Photovoltaic panels | | | 11.52 | 2419.2 |

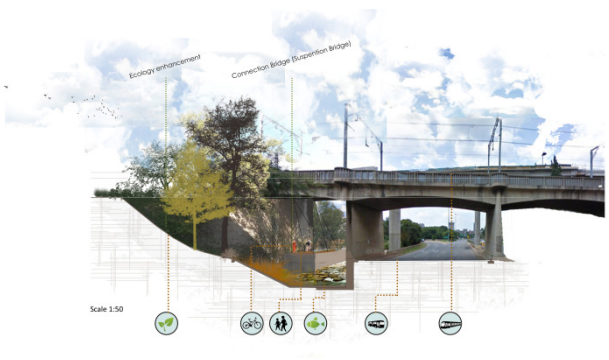
| Energy Budget | kWh / month | | |
|---|---|---|---|
| Generated Energy | 2 419 kWh | | |
| Consumed Energy | 1 356 kWh | | |
| TOTAL Balance | 1 063 kWh | Can be sent to Municipal Grid | |

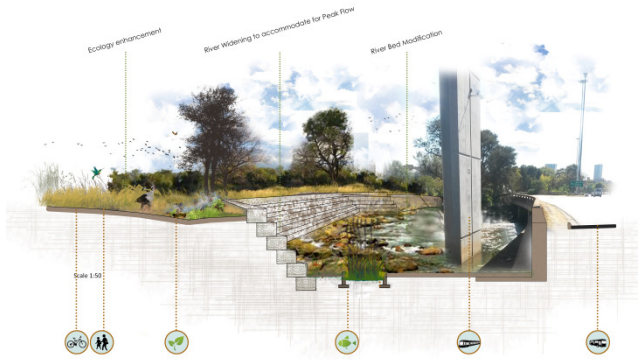


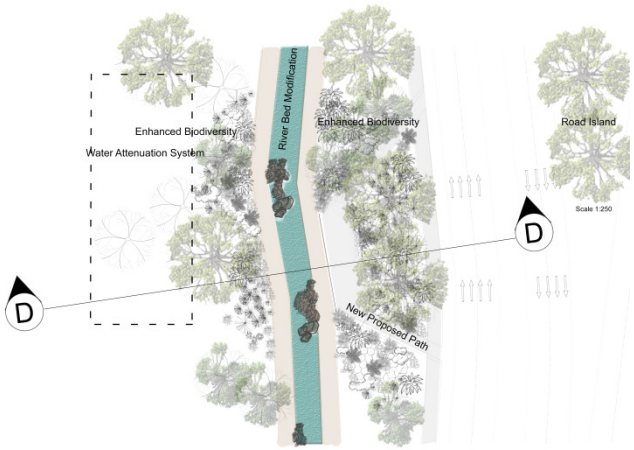



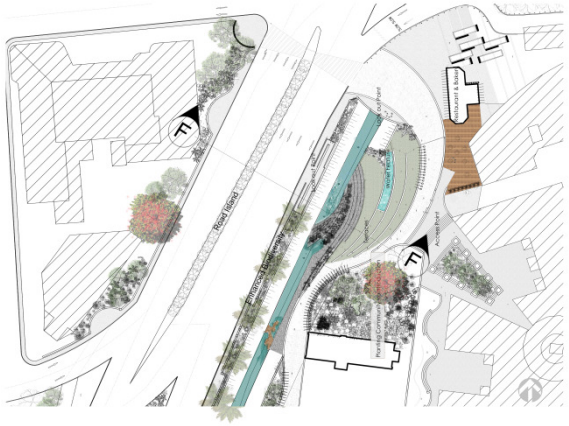


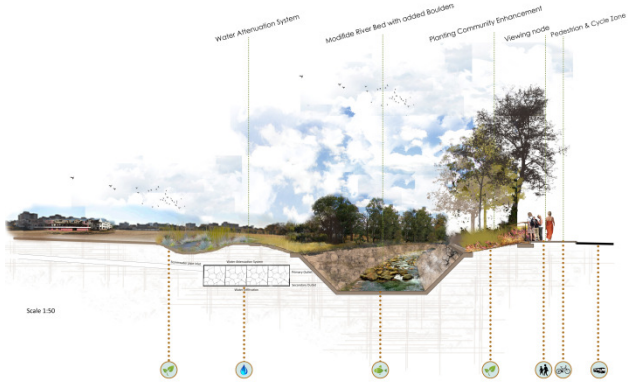


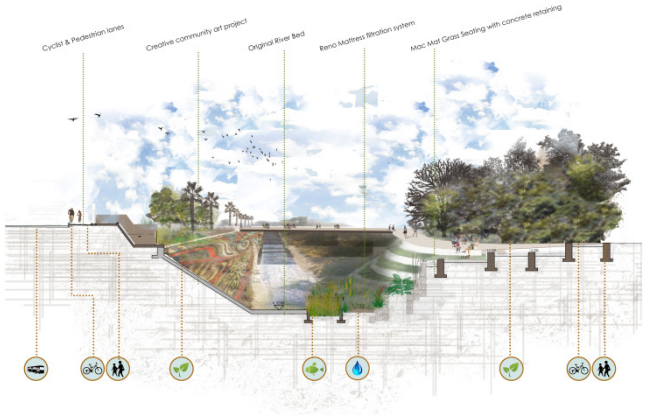





# Healing The Apies River Corridor

## Alter conveying systems

### Apies River Hydrology

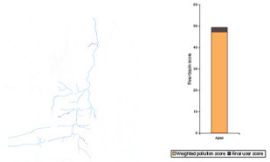
The Apies River flows through the city of Pretoria, South Africa. Its source is located just south of the city (south of Erasmus Park) and it flows northward until it drains into the Pienaars River.

The problem of the channelized river is the fact that the water table does not get recharged and ecological existence is reduced which promotes pollution due to the fact that there is no filtration of pollutants which intoxicates the entire river system.

This implies that the natural drainage of past and present courses should be considered in the design process and landscaped according to such, including the planting of local indigenous species.

The Apies River as an urban river performs a multitude of functions and thus requires management as a result of development in the catchment boundary. Further disturbances in the natural balance of nature could result in discomfort, losses and disaster to property and a higher health risks for people.

The National Environments Management Act (NEMA, Act 107 of 1998) stipulates that development must be socially, environmentally and economically sustainable and sustainable development requires the consideration of all relevant factors; ecosystems and people and their needs, need to placed at the forefront of development concern, and serve their interests equitably.




| River basin | basin area (km²) | Urban | | Rural | | Informal | |
|---|---|---|---|---|---|---|---|
| | | km² | % | km² | % | km² | % |
| Apies River | 796 | 742.68 | 90 | 14.35 | 2 | 39 | 5 |

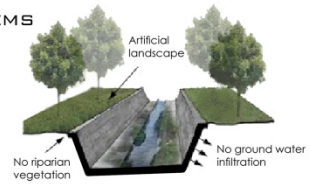
Extent of land-use in the river basin

### Problems

Increased surface runoff
Channelization restricts natural infiltration back into the soil and replaces the habitable landscape
Increased stormwater inlets and connections to river
Increased water pollution from street surface
Vegetation are unable to populate the river banks

### Opportunities

Ecological habitation zones can be incorporated
Stormwater management zones alongside roads
Adjacent sites can be used to restore the interaction between man and nature

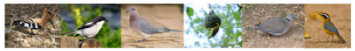



### Ground Cover - Vegetation

Indigenous species
Celtis africana; Acacia karoo; Combretum erythrophyllum; Barleria macrostigia; Eragrostis lehmaniana; Haleria lucida; Sporobolus africanus; Pollichia campestris; Nidorella hottentotica; Eustachys paspaloides

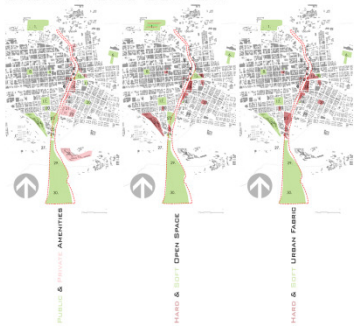
Invasive aliens
Category 1: Populus deltoids; Macfadyena unguis; Aruajia serifera; Solanum marifianum; Lantana camara; Xanthium strumarium; S onchus wilmsii; Sonchus oleraceus; Sida alba
Category 2: Tipuana tipu; Morus nigra; Ricinus communis
Category 3: Jacaranda mimosifolia; Eleusine coracana subsp Africana; Bidens pilosa

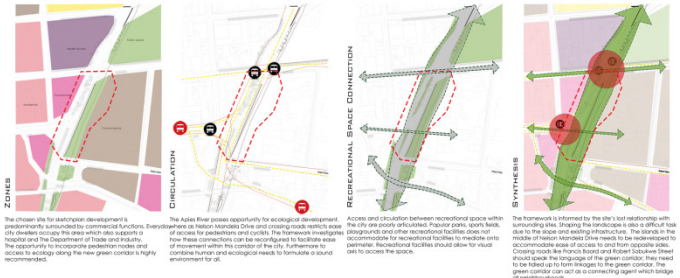
### Habitation - Fauna

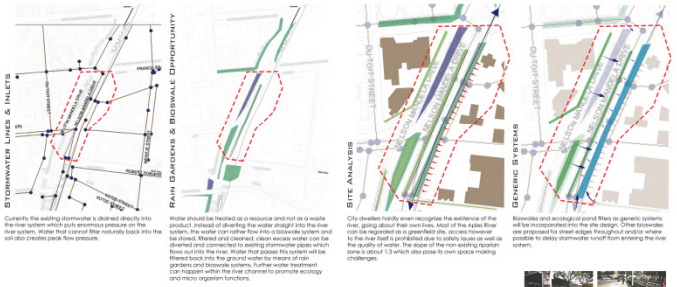


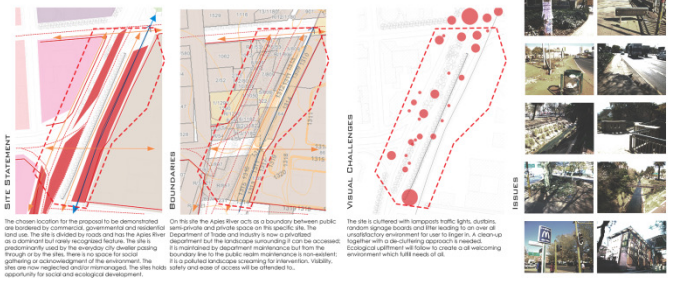
Hoop-hoop
Common Fiscal
Red Breasted Dove
Southern Masked Weaver
Ring necked Dove
Cape robin-chat

### Urban Fabric Context



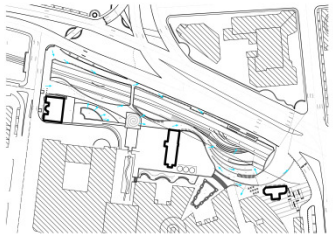



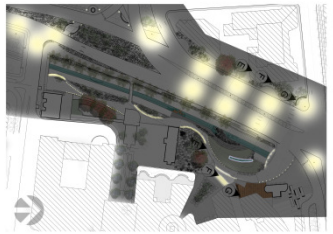



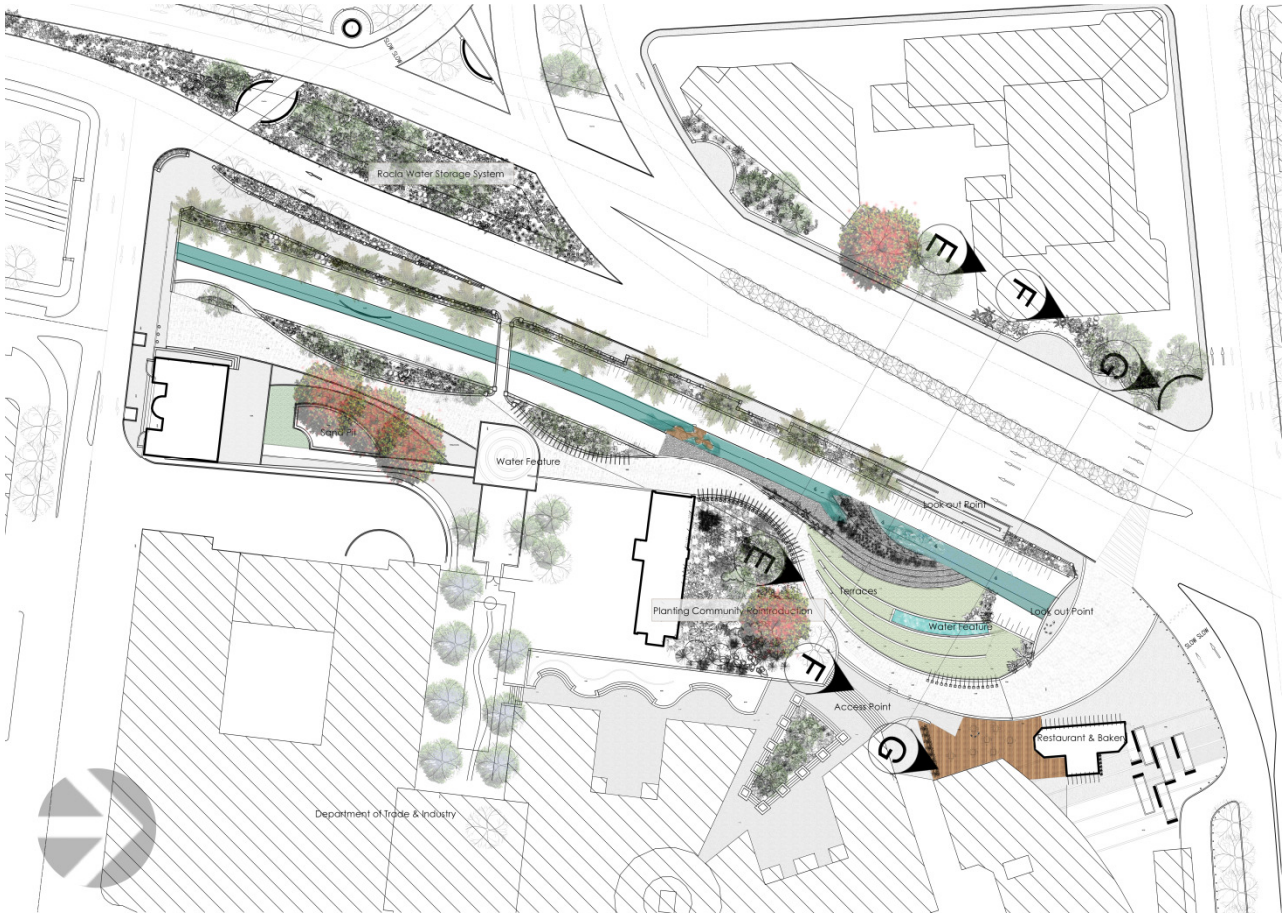

## Parti Diagram

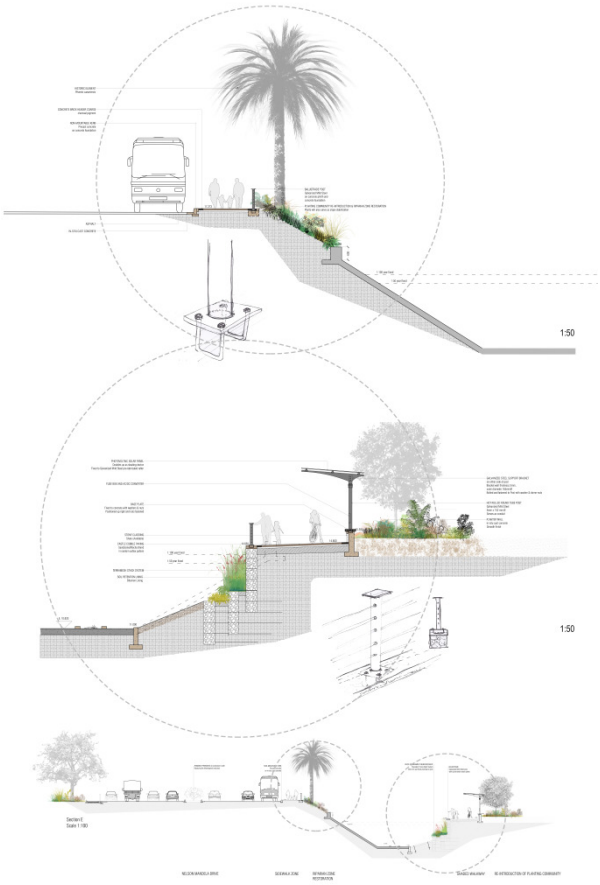
## Heights & Stormwater Plan

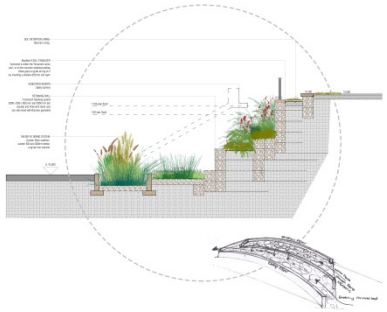


## Lighting Plan







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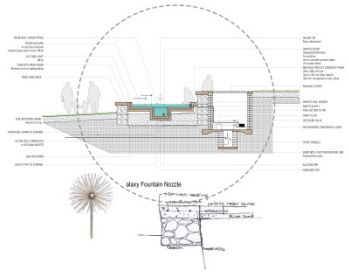


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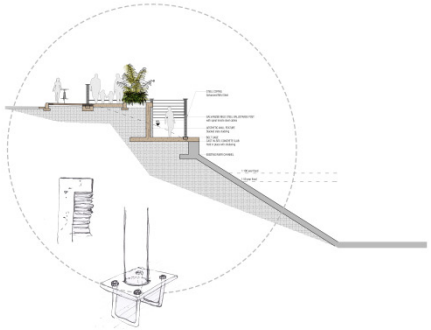

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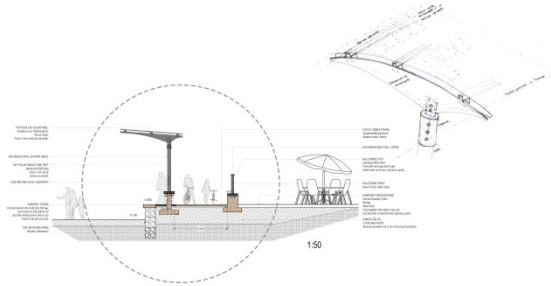

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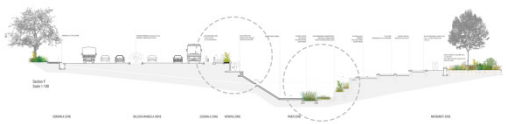

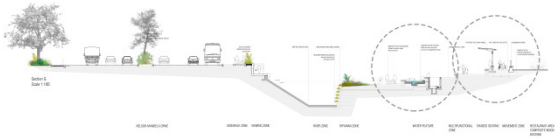

## 11.3. Model

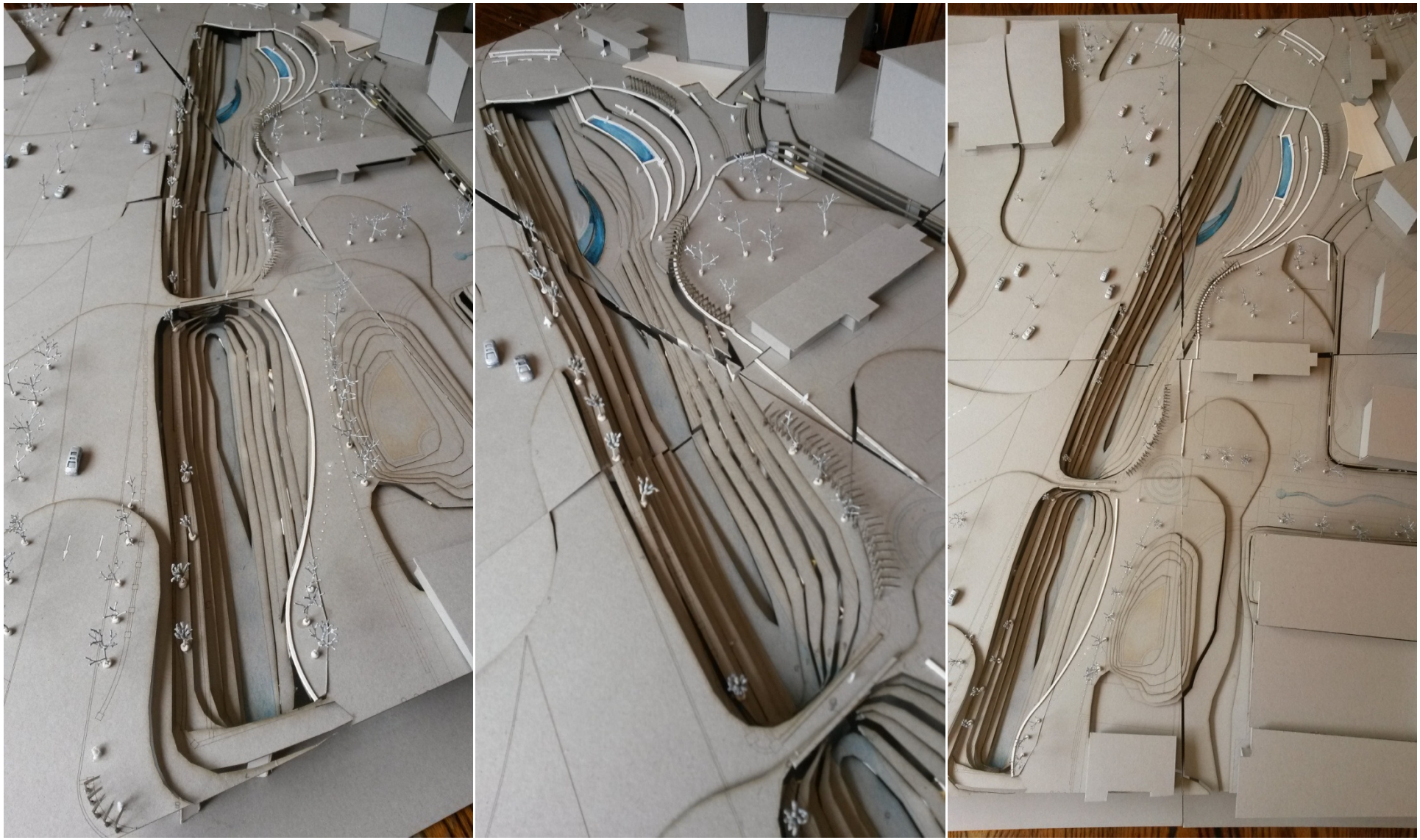

Figure 110 Sketchplan Model

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# APPENDICES

## APPENDIX A

### Table 11 Urban Environment Recreational space needed for a catchment of >1000000 people (CSIR 2009)

| Catchment >1 000 000 | | | | |
|---|---|---|---|---|
| Type of Space | Population | Hectares | Developer contribution | Facility type |
| Tertiary Hospital L3 | 24000000 | 35 | 0 | Regular facility |
| Regional Hospital L2 | 1770000 | 7 | 0 | Regular facility |
| District Hospital L1 | 900000 | 5 | 0 | Regular facility |
| Community Health Centre | 140000 | 1.5 | 0 | Regular facility |
| Primary Health Clinic | 70000 | 1 | 0 | Regular facility |
| Fire Station | 100000 | 1.2 | 0 | Regular facility |
| Police Station | 100000 | 1 | 0 | Regular facility |
| Performing Arts Centre - Major | 0 | 0 | 0 | Regular facility |
| Community Performing Arts Centre | 50000 | 0 | 0 | Regular facility |
| Museum - Large | 500000 | 0 | 0 | Regular facility |
| Museum - Medium /Small | 0 | 0 | 0 | Regular facility |
| Regional Library - Referance | 450000 | 0.56 | 0 | Regular facility |
| Regional Library | 200000 | 0 | 0 | Regular facility |
| Local library | 70000 | 0 | 0 | Regular facility |
| Mobile Library | 0 | 0 | 0 | Regular facility |
| Major Public Events Venue | 1000000 | 2 | 0 | Regular facility |
| Home affairs - Large office | 400000 | 0.5 | 0 | Regular facility |
| Home affairs - Medium office | 160000 | 0 | 0 | Regular facility |
| Home affairs - Small office | 40000 | 0 | 0 | Regular facility |
| Thusong Centre ( Community based "One Stop" Development centres) | 500000 | 0.2 | 0 | Regular facility |
| Labour Office | 500000 | 0.0042 | 0 | Regular facility |
| Magistrate's Court | 500000 | 0 | 0 | Regular facility |
| Municipal Office | 500000 | 1 | 0 | Regular facility |
| Prison and Place of Safety | 0 | 5 | 0 | Regular facility |
| Solid Waste Disposal and Recycling Depot | 0 | 100 | 0 | Regular facility |
| Community Hall - Large | 60000 | 0.5 | 0 | Regular facility |
| Community Hall - Medium/Small (Fringe Areas) | 15000 | 0 | 0 | Regular facility |
| Childrens Home | 0 | 1 | 0 | Regular facility |
| Home for the Aged | 0 | 2 | 0 | Regular facility |
| ITC Access Point | 10000 | 0 | 0 | Regular facility |
| Post Office/ Agency with Post Offices | 20000 | 0.03 | 0 | Regular facility |
| Post Boxes | 0 | 0 | 0 | Regular facility |
| SASSA (Social Service Office) | 500000 | 0.0042 | 0 | Regular facility |
| Social Grant Pay Point | 40000 | 0.0042 | 0 | Regular facility |
| Cemetery - Large | 100000 | 17.2 | 0 | Regular facility |
| Crematorium | 200000 | 0 | 0 | Regular facility |
| University/University of Technology | 1000000 | 8 | 0 | Regular facility |
| Post Matric Skills Training | 400000 | 1 | 0 | Regular facility |
| ABET/Skill Training | 0 | 1 | 0 | Regular facility |
| Special Education | 0 | 0 | 0 | Regular facility |
| Secondary School | 12500 | 5.5 | 0 | Regular facility |
| Primary School | 7000 | 6.2 | 0 | Regular facility |
| Grade R at Primary School | 1000 | 0 | 0 | Regular facility |
| Small Creche/ Early Childhood Development Centre | 3000 | 0.2 | 0 | Regular facility |
| ECD Resource Hub | 20000 | 1 | 0 | Regular facility |
| International Sports Complex | 1500000 | 0 | 0 | Regular facility |
| Indoor Sport Hall (Medium/Large) | 500000 | 3 | 0 | Regular facility |
| Regional Sport Stadium | 300000 | 3 | 0 | Regular facility |
| Sport Complex with 9-12 court sports hall | 200000 | 0 | 0 | Regular facility |
| SportFields | 1000 | 0.56 | 0 | Sports fields |
| Grassed Surface (2 football field equivalent) | 15000 | 0 | 0 | Subset of sports fields |
| Sport complex (Grouping of fields and/or sport complexes) | 60000 | 0 | 0 | Subset of sports fields |
| Grassed Field (2 football fields equivalent) with 500-seat stand | 30000 | 0 | 0 | Subset of sports fields |
| Cricket oval | 60000 | 0 | 0 | Subset of sports fields |
| Athletics/cricket stadium ( Grassed Field and athletics track & stand 3000+ seats) | 60000 | 0 | 0 | Subset of sports fields |
| Combi Court Surface (x2) | 15000 | 0 | 0 | Subset of sports fields |
| Combi Court Surface (x4) | 60000 | 0 | 0 | Subset of sports fields |
| Multi Purpose Sport Hall (2 Court) | 100000 | 0 | 0 | Subset of sports fields |
| Multi purpose sport hall (4 court) | 160000 | 0 | 0 | Subset of sports fields |
| Swimming pool Complex (25 to 33 meter pool) | 80000 | 0 | 0 | Subset of sports fields |
| Swimming pool (50 meter | 1000000 | 0 | 0 | Subset of sports fields |
| Strategic Park | 1000000 | 0 | 0 | Developed parks |
| District park | 100000 | 0 | 0 | Developed parks |
| Community Park With Play equipment | 60000 | 0 | 0 | Developed parks |
| Urban Park | 0 | 0 | 0 | Developed parks |
| Local/ Neighbourhood Park (includes play Equipment) | 15000 | 0 | 0 | Developed parks |
| Play equipment at other facilities | 0 | 0 | 0 | Regular facility |
| Total Parks | 1000 | 0.5 | 0 | Developed parks |

APPENDIX B *Working with the city of Portland, OR, GreenWorks PC has taken up the challenge of converting gray pavement to green oases, protecting the region's ecosystem through more efficient — and more aesthetic — management of stormwater.*

by MIKE FAHA
and SHAWN KUMMER

# GREEN Streets for GREEN Cities

We have paved paradise. According to the nonprofit Center for Watershed Protection, Ellicott City, MD, as much as 65 percent of the total impervious cover over America's landscape consists of streets, parking lots and driveways. Development of urban areas has significantly altered natural processes in which stormwater returns to our groundwater, lakes and rivers. Because by definition water runs off — not through — impervious surfaces, the streets, roads and avenues in our cities add pollution to rivers and streams through improperly managed urban stormwater runoff.

In 2008, the city of Portland, OR, adopted a "Grey to Green" initiative to accelerate the effort to restore watershed health. The Grey to Green program dedicates a $50 million public investment over five years to ensure that Portland protects and enhances its watersheds, rivers and streams from further degradation as the city's population grows.

The specific steps outlined by the city include building 920 new "Green Street" facilities, as well as planting more than 80,000 new trees, adding 43 acres of ecoroofs, stepping up the fight against invasive weeds, replacing culverts that block fish passage and purchasing 419 acres of high-priority natural areas.

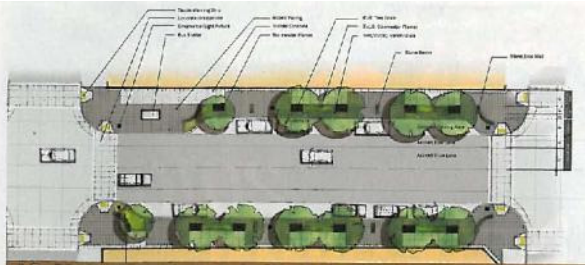
In the first year of its Grey to Green initiative, Portland has constructed eight Green Streets. While the streets have different shapes and sizes, they all have stormwater-management benefits and help to protect watershed health.



**What is a Green Street?** Green Streets transform impervious street surfaces into landscaped green spaces that capture stormwater runoff and let water soak into the ground as plants and soil filter pollutants. Green Streets convert stormwater from status as a waste directed into a pipe to a resource that replenishes groundwater supplies. They also create attractive streetscapes and urban green spaces, provide natural habitat and help connect neighborhoods, schools, parks and business districts.

Green Streets are an innovative, effective way to restore watershed health. They protect water quality in rivers and streams, manage stormwater from impervious surfaces and can be more cost-efficient than new sewer pipes. Green Streets offer many benefits that sewer pipes can't:

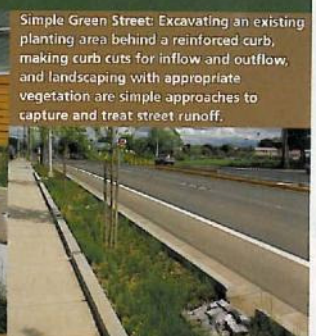
- clean and cool air and water;
- enhance neighborhood livability;
- increase community and property values;
- enhance pedestrian and bicycle access and safety;
- protect valuable surface and groundwater resources;
- add urban green space and wildlife habitat;



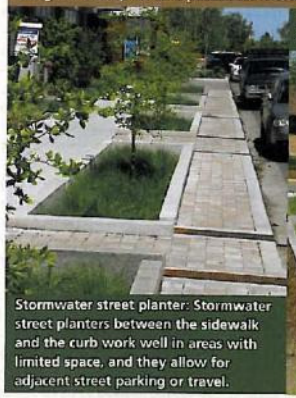
A flexible design incorporates varying lengths of narrow planters, and curb extensions at block corners provide larger facilities on the downslope ends of blocks that are able to hold larger quantities of runoff without having an adverse impact on other sidewalk uses.

**Types of Green Streets**

Stormwater curb extension: Extending into the street, stormwater curb extensions transform the curb lane into a landscape area. Curb extensions can conveniently integrate a ramp for safe pedestrian crossing.



Simple Green Street: Excavating an existing planting area behind a reinforced curb, making curb cuts for inflow and outflow, and landscaping with appropriate vegetation are simple approaches to capture and treat street runoff.



Stormwater street planter: Stormwater street planters between the sidewalk and the curb work well in areas with limited space, and they allow for adjacent street parking or travel.

Rain gardens: Where there is plenty of space, rain gardens are ideal. They can also transform awkward street intersections into safe pedestrian and bicycle crossings.



Figure 111 Green Streets for Green Cities (Faha & Kummer 2009)

# APPENDIX C

Table 12 Biofilter Rainwater Yield (Author 2014)

| Yield | | Soft Landscaping | |
|---|---|---|---|
| Yield (m³) = | P x A x C | | Bio-swale |

| Area of Catchment: Per surface (Per surface) | Area (m²) | | Run-off Coefficient |
|---|---|---|---|
| Biofilter | 200.00 m² | | 0.35 |
| TOTAL: | 200.00 m² | | 0.35 |

| MONTH | Precipitation Average Monthly (mm) | Area | Run-off Coefficient | Grey water recoverable | Yield **P(m) x A(m²) x C** |
|---|---|---|---|---|---|
| January | 0.13 | 200 m² | 0.35 | 0.00 | 9. 1 m³ |
| February | 0.109 | 200 m² | 0.35 | 0.00 | 7. 63 m³ |
| March | 0.075 | 200 m² | 0.35 | 0.00 | 5. 25 m³ |
| April | 0.056 | 200 m² | 0.35 | 0.00 | 3. 92 m³ |
| May | 0.013 | 200 m² | 0.35 | 0.00 | . 91 m³ |
| June | 0 | 200 m² | 0.35 | 0.00 | . m³ |
| July | 0 | 200 m² | 0.35 | 0.00 | . m³ |
| August | 0.006 | 200 m² | 0.35 | 0.00 | . 42 m³ |
| September | 0.019 | 200 m² | 0.35 | 0.00 | 1. 33 m³ |
| October | 0.078 | 200 m² | 0.35 | 0.00 | 5. 46 m³ |
| November | 0.104 | 200 m² | 0.35 | 0.00 | 7. 28 m³ |
| December | 0.126 | 200 m² | 0.35 | 0.00 | 8. 82 m³ |
| YEAR | 716 mm | 200 m² | 0.35 | 0.00 | **50. 12 m³** |

# APPENDIX D

## Demand Irrigation

**IRRIGATION DEMAND-**

**Manicured Lawn**

| | Planting Area ($m^2$) | Irrigation Depth per week (m) | Irrigation Depth per month (m) | IRRIGATION DEMAND ($m^3$) |
|---|---|---|---|---|
| January | 1 108 $m^2$ | 0.020 m | 0.080 m | 89 $m^3$ |
| February | 1 108 $m^2$ | 0.020 m | 0.080 m | 89 $m^3$ |
| March | 1 108 $m^2$ | 0.020 m | 0.080 m | 89 $m^3$ |
| April | 1 108 $m^2$ | 0.015 m | 0.060 m | 66 $m^3$ |
| May | 1 108 $m^2$ | 0.010 m | 0.040 m | 44 $m^3$ |
| June | 1 108 $m^2$ | 0.010 m | 0.040 m | 44 $m^3$ |
| July | 1 108 $m^2$ | 0.010 m | 0.040 m | 44 $m^3$ |
| August | 1 108 $m^2$ | 0.010 m | 0.040 m | 44 $m^3$ |
| September | 1 108 $m^2$ | 0.020 m | 0.080 m | 89 $m^3$ |
| October | 1 108 $m^2$ | 0.020 m | 0.080 m | 89 $m^3$ |
| November | 1 108 $m^2$ | 0.020 m | 0.080 m | 89 $m^3$ |
| December | 1 108 $m^2$ | 0.020 m | 0.080 m | 89 $m^3$ |
| **YEAR** | **1 108 $m^2$ (Average)** | **0.016 m (Average)** | **0.780 m (Total)** | **864 $m^3$ (Total)** |

**IRRIGATION DEMAND -**

**Terrace Planting**

| | Planting Area ($m^2$) | Irrigation Depth per week (m) | Irrigation Depth per month (m) | IRRIGATION DEMAND ($m^3$) |
|---|---|---|---|---|
| January | 578 $m^2$ | 0.030 m | 0.133 m | 77 $m^3$ |
| February | 578 $m^2$ | 0.030 m | 0.120 m | 69 $m^3$ |
| March | 578 $m^2$ | 0.030 m | 0.133 m | 77 $m^3$ |
| April | 578 $m^2$ | 0.030 m | 0.129 m | 74 $m^3$ |
| May | 578 $m^2$ | 0.030 m | 0.133 m | 77 $m^3$ |
| June | 578 $m^2$ | 0.010 m | 0.043 m | 25 $m^3$ |
| July | 578 $m^2$ | 0.010 m | 0.043 m | 25 $m^3$ |
| August | 578 $m^2$ | 0.010 m | 0.044 m | 26 $m^3$ |
| September | 578 $m^2$ | 0.030 m | 0.129 m | 74 $m^3$ |
| October | 578 $m^2$ | 0.030 m | 0.133 m | 77 $m^3$ |
| November | 578 $m^2$ | 0.030 m | 0.129 m | 74 $m^3$ |
| December | 578 $m^2$ | 0.030 m | 0.133 m | 77 $m^3$ |
| **YEAR** | **578 $m^2$ (Average)** | **0.025 m (Average)** | **1.300 m (Total)** | **751 $m^3$ (Total)** |

Table 13 Irrigation Demand

# Appendix E

**Existing Capacity for a 1 in 50yr Flood**

**Area**

$$A = \frac{w + b\,(d)}{2}$$

$$= \frac{17.400 + 4.400\,(4.680)}{2}$$

$$= 51.01\ m^2$$

**Wetted Perimeter**

$$P = b + 2\sqrt{e^2 + d^2}$$

$$= 4.400 + 2\sqrt{6.644^2 + 4.680^2}$$

$$= 20.65\ m$$

**Hydraulic Diameter**

$$R = \frac{A}{P}$$

$$= \frac{51.012}{20.65}$$

$$= 2.47\ m$$

**Peak Flow**

$$Q = \frac{1}{n} * \frac{A^{\frac{5}{3}}}{P^{\frac{3}{5}}} * S^{\frac{1}{2}}$$

$$= \frac{1}{0.035} * \frac{51.012^{\frac{5}{3}}}{20.65^{\frac{2}{3}}} * 0.103^{\frac{1}{2}}$$

$$= 93.29\ m^3/s$$

**New Capacity for a 1 in 50yr Flood**

**Area**

$$A = \frac{w + b\,(d)}{2}$$

$$= \frac{22.631 + 9.899\,(4.680)}{2}$$

$$= 76.12\ m^2$$

**Wetted Perimeter**

$$P = b + 2\sqrt{e^2 + d^2}$$

$$= 9.899 + 2\sqrt{6.644^2 + 4.680^2}$$

$$= 26.15\ m$$

**Hydraulic Diameter**

$$R = \frac{A}{P}$$

$$= \frac{76.12}{26.15}$$

$$= 2.91\ m$$

**Peak Flow**

$$Q = \frac{1}{n} * \frac{A^{\frac{5}{3}}}{P^{\frac{3}{5}}} * S^{\frac{1}{2}}$$

$$= \frac{1}{0.033} * \frac{76.12^{\frac{5}{3}}}{26.15^{\frac{2}{3}}} * 0.103^{\frac{1}{2}}$$

$$= 155\ m^3/s$$

The new channel = holding capacity of 66%

**Manning's *n***

Old n

n = 0.035

New n

$$n = \frac{n1.l1 + n2.l2 + n3.l3}{l\,total}$$

$$= \frac{895.88}{27378}$$

$$= 0.033$$

New n - Old n = 0.002

**Safety factor of 2**

Therefore the change in channel should be capable to hold a 5.71% x the safety factor giving an added capacity of 11.4%

Figure 112 Channel Capacity Calculations (Author 2014)

# APPENDIX F

## SITES V2 SCORECARD SUMMARY

Table 14 SITES Assessment

| YES | ? | NO | | | |
|---|---|---|---|---|---|
| 9 | 0 | 0 | **1: SITE CONTEXT** | **Possible Points:** | **13** |
| Y | | | **CONTEXT P1.1** | Limit development on farmland | |
| Y | | | **CONTEXT P1.2** | Protect floodplain functions | |
| Y | | | **CONTEXT P1.3** | Conserve aquatic ecosystems | |
| Y | | | **CONTEXT P1.4** | Conserve habitats for threatened and endangered species | |
| 3 | | | **CONTEXT C1.5** | Redevelop degraded sites | **3 to 6** |
| 4 | | | **CONTEXT C1.6** | Locate projects within existing developed areas | **4** |
| 2 | | | **CONTEXT C1.7** | Connect to multi-modal transit networks | **2 to 3** |
| 3 | 0 | 0 | **2: PRE-DESIGN ASSESSMENT + PLANNING** | **Possible Points:** | **3** |
| Y | | | **PRE-DESIGN P2.1** | Use an integrative design process | |
| Y | | | **PRE-DESIGN P2.2** | Conduct a pre-design site assessment | |
| Y | | | **PRE-DESIGN P2.3** | Designate and communicate VSPZs | |
| 3 | | | **PRE-DESIGN C2.4** | Engage users and stakeholders | **3** |
| 21 | 0 | 0 | **3: SITE DESIGN - WATER** | **Possible Points:** | **23** |
| Y | | | **WATER P3.1** | Manage precipitation on site | |
| Y | | | **WATER P3.2** | Reduce water use for landscape irrigation | |
| 6 | | | **WATER C3.3** | Manage precipitation beyond baseline | **4 to 6** |
| 4 | | | **WATER C3.4** | Reduce outdoor water use | **4 to 6** |
| 5 | | | **WATER C3.5** | Design functional stormwater features as amenities | **4 to 5** |
| 6 | | | **WATER C3.6** | Restore aquatic ecosystems | **4 to 6** |

| 34 | 0 | 0 | **4: SITE DESIGN - SOIL + VEGETATION** | | **Possible Points:** | **40** |
|---|---|---|---|---|---|---|
| Y | | | **SOIL+VEG P4.1** | Create and communicate a soil management plan | | |
| Y | | | **SOIL+VEG P4.2** | Control and manage invasive plants | | |
| Y | | | **SOIL+VEG P4.3** | Use appropriate plants | | |
| 5 | | | **SOIL+VEG C4.4** | Conserve healthy soils and appropriate vegetation | | **4 to 6** |
| 4 | | | **SOIL+VEG C4.5** | Conserve special status vegetation | | **4** |
| 4 | | | **SOIL+VEG C4.6** | Conserve and use native plants | | **3 to 6** |
| 6 | | | **SOIL+VEG C4.7** | Conserve and restore native plant communities | | **4 to 6** |
| 3 | | | **SOIL+VEG C4.8** | Optimize biomass | | **1 to 6** |
| 4 | | | **SOIL+VEG C4.9** | Reduce urban heat island effects | | **4** |
| 4 | | | **SOIL+VEG C4.10** | Use vegetation to minimize building energy use | | **1 to 4** |
| 4 | | | **SOIL+VEG C4.11** | Reduce the risk of catastrophic wildfire | | **4** |

| 30 | 0 | 0 | **5: SITE DESIGN - MATERIALS SELECTION** | | **Possible Points:** | **41** |
|---|---|---|---|---|---|---|
| Y | | | **MATERIALS P5.1** | Eliminate the use of wood from threatened tree species | | |
| 3 | | | **MATERIALS C5.2** | Maintain on-site structures and paving | | **2 to 4** |
| 4 | | | **MATERIALS C5.3** | Design for adaptability and disassembly | | **3 to 4** |
| 4 | | | **MATERIALS C5.4** | Use salvaged materials and plants | | **3 to 4** |
| 4 | | | **MATERIALS C5.5** | Use recycled content materials | | **3 to 4** |
| 5 | | | **MATERIALS C5.6** | Use regional materials | | **3 to 5** |
| 1 | | | **MATERIALS C5.7** | Support responsible extraction of raw materials | | **1 to 5** |
| 3 | | | **MATERIALS C5.8** | Support transparency and safer chemistry | | **1 to 5** |
| 3 | | | **MATERIALS C5.9** | Support sustainability in materials manufacturing | | **5** |
| 3 | | | **MATERIALS C5.10** | Support sustainability in plant production | | **1 to 5** |

| YES | ? | NO | | | |
|---|---|---|---|---|---|
| 27 | 0 | 0 | **6: SITE DESIGN - HUMAN HEALTH + WELL-BEING** | **Possible Points:** | **30** |
| 3 | | | **HHWB C6.1** | Protect and maintain cultural and historic places | **2 to 3** |
| 2 | | | **HHWB C6.2** | Provide optimum site accessibility, safety, and wayfinding | **2** |
| 2 | | | **HHWB C6.3** | Promote equitable site use | **2** |
| 2 | | | **HHWB C6.4** | Support mental restoration | **2** |
| 2 | | | **HHWB C6.5** | Support physical activity | **2** |
| 2 | | | **HHWB C6.6** | Support social connection | **2** |
| 3 | | | **HHWB C6.7** | Provide on-site food production | **3 to 4** |
| 4 | | | **HHWB C6.8** | Reduce light pollution | **4** |
| 4 | | | **HHWB C6.9** | Encourage fuel efficient and multi-modal transportation | **4** |
| 0 | | | **HHWB C6.10** | Minimize exposure to environmental tobacco smoke | **1 to 2** |
| 3 | | | **HHWB C6.11** | Support local economy | **3** |

| | | | | | |
|---|---|---|---|---|---|
| 15 | 0 | 0 | **7: CONSTRUCTION** | **Possible Points:** | **17** |
| Y | | | **CONSTRUCTION P7.1** | Communicate and verify sustainable construction practices | |
| Y | | | **CONSTRUCTION P7.2** | Control and retain construction pollutants | |
| Y | | | **CONSTRUCTION P7.3** | Restore soils disturbed during construction | |
| 5 | | | **CONSTRUCTION C7.4** | Restore soils disturbed by previous development | **3 to 5** |
| 4 | | | **CONSTRUCTION C7.5** | Divert construction and demolition materials from disposal | **3 to 4** |
| 4 | | | **CONSTRUCTION C7.6** | Divert reusable vegetation, rocks, and soil from disposal | **3 to 4** |
| 2 | | | **CONSTRUCTION C7.7** | Protect air quality during construction | **2 to 4** |

| | | | | | |
|---|---|---|---|---|---|
| 20 | 0 | 0 | **8. OPERATIONS + MAINTENANCE** | **Possible Points:** | **22** |
| Y | | | **O+M P8.1** | Plan for sustainable site maintenance | |
| Y | | | **O+M P8.2** | Provide for storage and collection of recyclables | |
| 3 | | | **O+M C8.3** | Recycle organic matter | **3 to 5** |
| 5 | | | **O+M C8.4** | Minimize pesticide and fertilizer use | **4 to 5** |
| 4 | | | **O+M C8.5** | Reduce outdoor energy consumption | **2 to 4** |
| 4 | | | **O+M C8.6** | Use renewable sources for landscape electricity needs | **3 to 4** |
| 4 | | | **O+M C8.7** | Protect air quality during landscape maintenance | **2 to 4** |

| | | | | | |
|---|---|---|---|---|---|
| 11 | 0 | 0 | **9. EDUCATION + PERFORMANCE MONITORING** | **Possible Points:** | **11** |
| 4 | | | **EDUCATION C9.1** | Promote sustainability awareness and education | **3 to 4** |
| 3 | | | **EDUCATION C9.2** | Develop and communicate a case study | **3** |
| 4 | | | **EDUCATION C9.3** | Plan to monitor and report site performance | **4** |

| | | | | | |
|---|---|---|---|---|---|
| 9 | 0 | 0 | **10. INNOVATION OR EXEMPLARY PERFORMANCE** | **Bonus Points:** | **9** |
| 9 | | | **INNOVATION C10.1** | Innovation or exemplary performance | **3 to 9** |

| YES | ? | NO | | | |
|---|---|---|---|---|---|
| **179** | **0** | **0** | **TOTAL ESTIMATED POINTS** | **Total Possible Points:** | **200** |

| **KEY** | | **SITES Certification levels** | Points |
|---|---|---|---|
| **YES** | Project confident points are achievable | **CERTIFIED** | 70 |
| **?** | Project striving to achieve points, not 100% confident | **SILVER** | 85 |
| **NO** | Project is unable to achieve these credit points | **GOLD** | 100 |
| | | **PLATINUM** | 135 |