AMALGAM: *A FUSION OF THE BUILT AND BIOPHYSICAL ENVIRONMENTS.*

ETHNOBOTANIC RESEARCH CENTRE

PRINSHOF, PRETORIA

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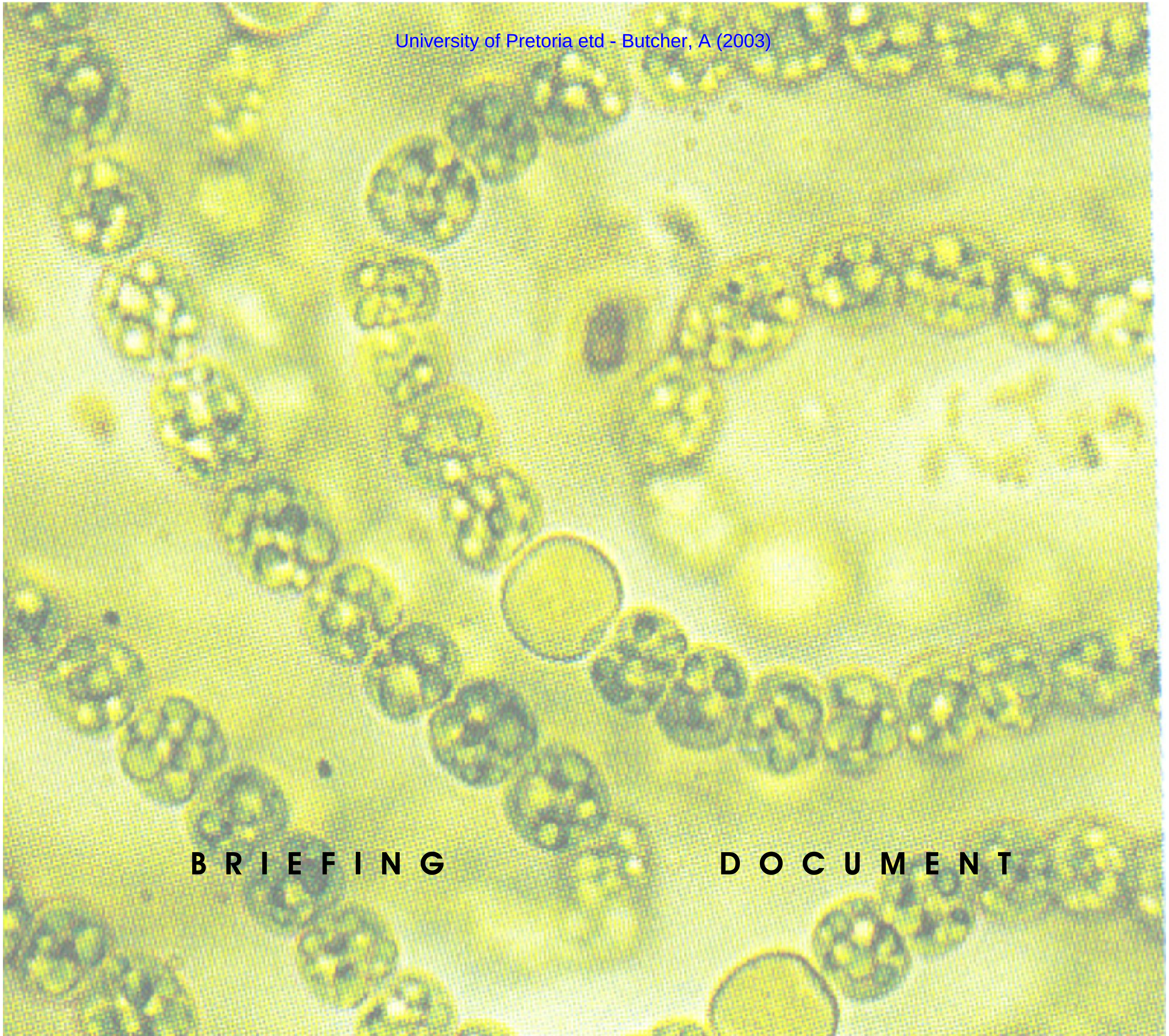
AMALGAM:

B U I L T [F U S I O N] B I O P H Y S I C A L

Overview

This dissertation explores the fusion of the built and biophysical environments within the context of the city. In doing so the biophysical environment contributes to the operation of the architecture in terms of microclimate control, containment, form and aesthetic. The building houses the programme of an Ethnobotanic Research Centre [EBRC], which serves as a place of research into the medicinal properties of indigenous plants and propagation thereof. The building also becomes a point of intervention to prevent the encroachment of the city on the greenbelts of Pretoria.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1. Introduction

1.1 Concern: The Forgotten Culture

Ethnobotany is the study of plants indigenous to a particular area and how the people of that culture use them. The medical use of these plants is the most obvious, but ethnobotany includes the use of indigenous plants for food, shelter, clothing, religious ceremonies etc.

In terms of their medicinal properties, South Africa has an abundance of useful plants throughout the country with over 3000 known wild species and approximately 80% of the black population making use of these traditional medicine systems. More people are involved in the traditional medicine sector than in the western health system (Van Wyk, 1997, p 7).

However, many of these medicinal plant species are being threatened by extinction as a result of over harvesting (www.botany.unp.ac.za/rcpgd/rcpgd.htm). The first reason for over-harvesting is that the habitats of these species are diminishing at a rapid rate due to the encroachment from agricultural, industrial and housing developments. This reduction in the plants' habitat and the increase in the use of medicinal plants places great pressure on these species.

The second reason for over-harvesting is that many of the traditions and taboos associated with medicinal plants have been forgotten with the emergence of modern, urbanised healers. Traditionally, the 'inyanga', who is the herbalist and the 'sangoma', who is the diviner, would be guided by an ancestral spirit through dreams and prayer as to which plants should be gathered and in what season so that the plant can reach maximum potency (Van Wyk, 1997, p 14).

With the loss of these customs, lesser-experienced healers often remove the entire plant when only parts of it are needed, giving the species little chance of future survival. These healers tend to buy many of their products from street 'muti' markets, although this does create job opportunities for gatherers, they unfortunately use the same destructive harvesting methods (www.nbi.ac.za/researc/ethnobot.htm).

Many of the ethnobotanic properties of these indigenous plants are known only to the tribes, or even specifically to the 'inyanga' within the tribe, and are passed on through word of mouth. The extinction of these species will not only result in the loss of unrecorded medicines, but also in the loss of a cultural heritage.

With the reduction in plant numbers, the unsustainable practice of importing these plants has emerged. This however will only put further pressure on the species in these other regions (ibid).

To alleviate this problem of over harvesting, many of the endangered species are being grown on farms; this may reduce the pressure on the wild populations. The negative result remains in that natural vegetation being lost to agricultural development with the alteration in the habitats of other plant and animal species. An awareness of the importance of these plants needs to be created for their protection.

Medicinal plants have always played an important role in African culture, however, unlike in Europe, South America, etc where this culture has been embraced and explored over time, in the past South Africa's traditional culture was ignored and traditional healers became known as 'witch-doctors' resulting in the practice of traditional medicines receiving a negative stigma.

As traditional healthcare gets pulled rapidly further into modern society, a number of problems follow. As mentioned earlier, informal trade has resulted in many inexperienced 'healers' prescribing incorrect combinations and quantities of 'mutis' resulting in illness and even death. Many plants appear very similar leading to difficulties with identification resulting in inexperienced healers often prescribing medicines inappropriately that don't provide any relief from illness. This contributes to the idea that traditional medicine is a sham (Meyer, 2003). Another notable problem is commercial outfits producing 'herbal' medicines that are sold practically anywhere and can be bought without any medical prescription. Certain combinations of herbal and chemical medicines can be fatal (Rothermeyer, 2002).

1.2 Client

The government has realised the importance of this resource in terms of its medical value as well as its cultural significance, the Department of Arts Culture Science & Technology (DACST), which recently split into the Department of Arts & Culture (DAC) and the Department of Science & Technology (DST), awarded an R11 million grant to the Medical Research Council (MRC) and The Department of Botany at Pretoria University (Meyer, 2003) for further research into medicinal plant systems. Currently their research is split between the two institutions. The Medical Research Council Traditional Medicines Research Unit was founded in 1997 and their principal objectives are:

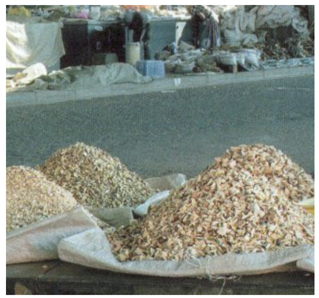
- To establish a research culture, and to introduce modern research methodologies around the use and understanding of traditional medicines
- To create an environment that will attract young scientists and potential leaders in the field (http://www.mrc.ac.za).

The MRC is more concerned with the ethnopharmacology of the chemical extracts in the plants. The Department of Botany do all of the field-work (plant gathering, interviewing traditional healers etc.) and screening and documentation of medicinal plants. By creating a unified facility the research efficiency will greatly improve. These two institutions

1.1 *Asclepias fruticosa*

1.2 *Albizia adianthifolia*

1.3 A forgotten culture



1.4 Urban 'Muthi' markets

are the major clients, however location has resulted in a third, minor client being involved, the Pretoria Technikon.

1.3 Ethnobotanic Research Centre [EBRC]

A research facility is to be established to unify these institutions, the Ethnobotanic Research Centre (EBRC) is to fulfill this function. It will serve as a place for plant research through consultation with traditional healers and laboratory testing. The EBRC will act as an educational tool by exposing the importance of these medical systems, through this, the culture that resides within this practice will be exposed.

Plant propagation will take place within a series of terrariums that specialise in medicinal plants from the climatic zones found around the country, which will be open to the public.

2. Context

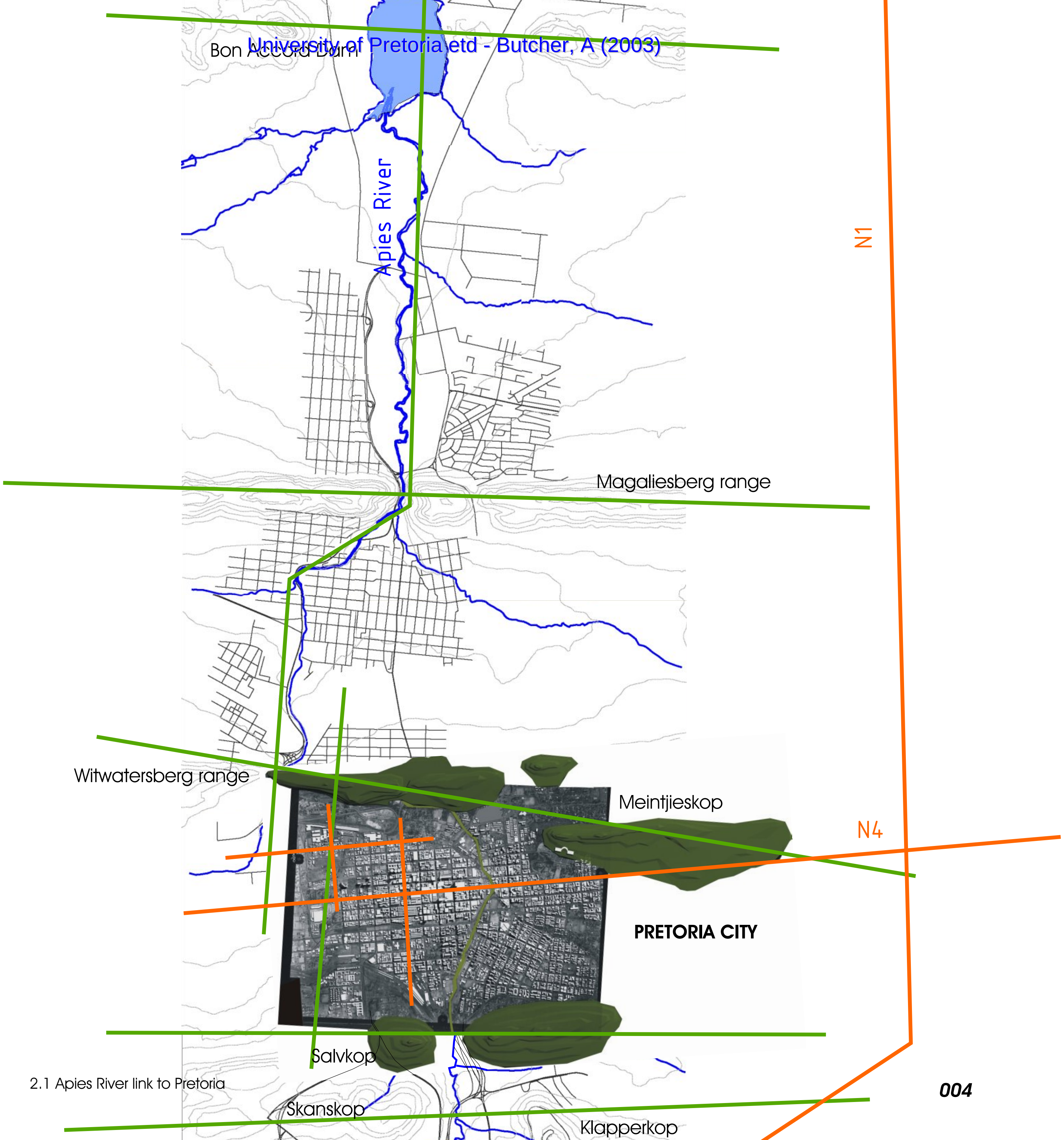
2.1 Macro Analysis

Pretoria city lies between two green belts to the north and south. These greenbelts are linked to a series of parallel greenbelts by means of the Apies River which begins in the Fountains Valley to the south of the city. Along the river there are a number of ecological assests, these include; the Groenkloof Nature Reserve, Wonderboom Nature Reserve, Bon Accord Dam, the three ridges (Salvokop at UNISA, Witwatersberg at Daspoort, Magaliesberg at Wonderboompoort) and tributaries of the Apies, which itself is a greenbelt.

Roads generally run parallel and perpendicular to the Apies River, with two highways, the N4 and the N1 forming the major axis. The N1 links Pretoria and Johannesburg to the South, with the N4 linking Pretoria to Hartbeespoort in the west and Witbank in the east. This axis continued from the micro axis in the city, formed by the crossing of Church and Paul Kruger street. This axis is repeated on a smaller scale within the city at Marabastad.

The environment becomes more rural towards the north forming important regions of indigenous vegetation, which are linked to the city through the mentioned movement spines.

These paths and nodes form the growth/gathering/trade cycle for medicinal plants for Pretoria and its surroundings.



2.1 Apies River link to Pretoria

2.2 View south over Groenkloof nature reserve from Salvokop

2.3 View South over Pretoria from Union Buildings

2.2 Meso Analysis

2.2.1 Green open spaces

Within the city there are a number of formal and informal green spaces The formal spaces are indicated in the open space map (See fig.2.4). Informal green spaces include the ridges in the north and south, the Apies River, Steenhoven Spruit, Walkerspruit and land south of Marabastad undeveloped due to land claims.

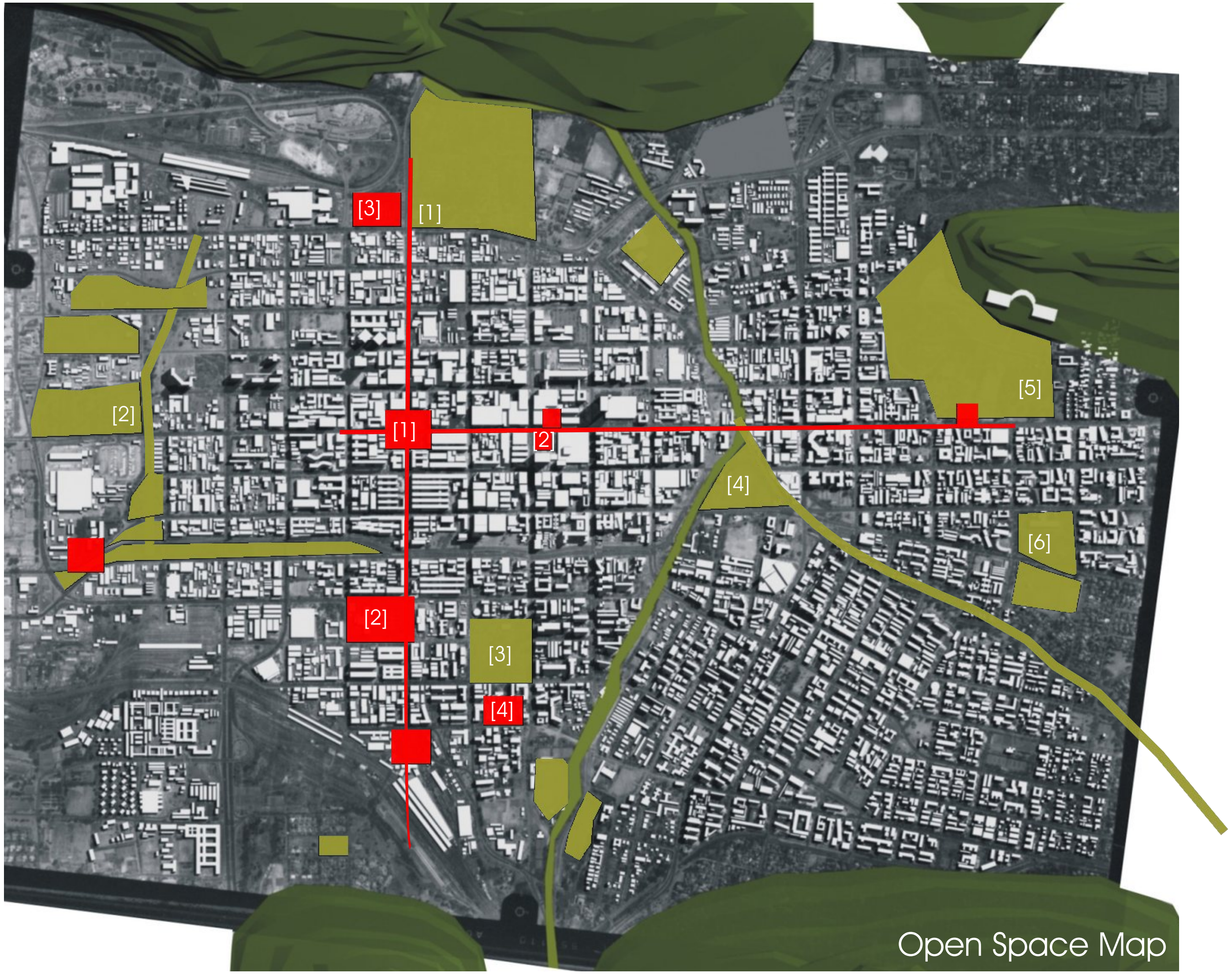
2.2.2 Urban Spaces

While the green spaces surround the CBD, the urban spaces run through it, creating a strong north / south axis linking the public transport nodes of Belle Ombre in the north and the Pretoria train station in the south (See fig.2.4)

2.2.3 Cultural Installations

Places of cultural significance within the city are indicated in the cultural map (See fig.2.5). There is also a line of historical assets that run along the Apies River (figxxx).

If the cultural map and the open space are overlayed, we see a picture of linkage and place (Trancik, 1986, p98). This image indicates an implied cultural ring around the CBD that is intersected with a physical cultural axis. Parallel to this axis in the north south direction, greenbelts inform the edges



2.4 Green and Urban open spaces

Green spaces
1-Pretoria Zoo / Zoological gardens
2-Heroes Acre
3-Burgers Park
4-Calaldonian sports grounds
5-Union Buildings gardens

Urban spaces
1-Church Square
2-Pretorius Square
3-Zoo
4-Melrose House
5-Sammy Marks Square
6-Strijdom Square

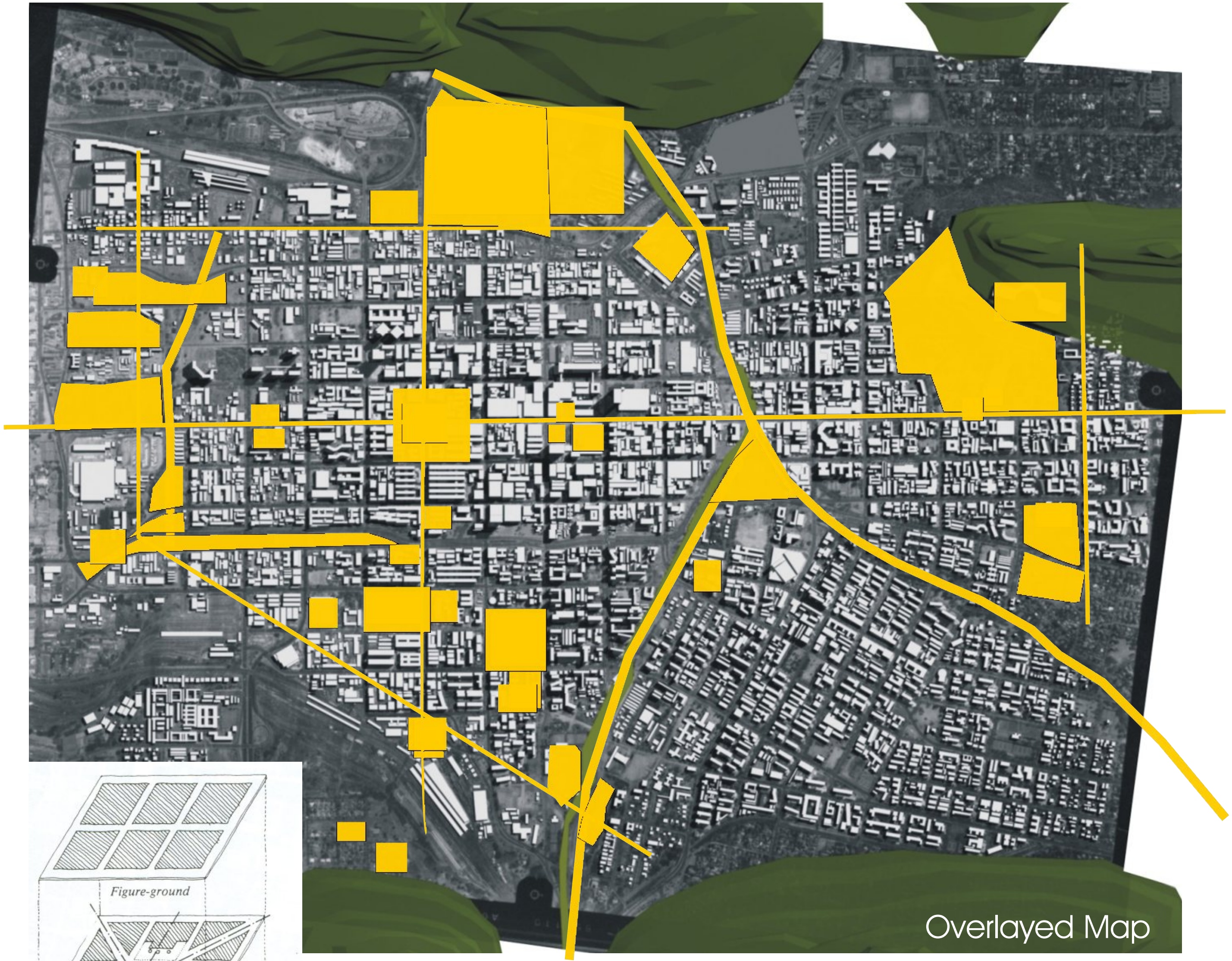
of the CBD.

The cultural axis, due to its link to transport nodes and cultural facilities carries a high pedestrian movement. The cultural ring is not as active as the cultural axis as the installations are not connected through sight lines and paths.

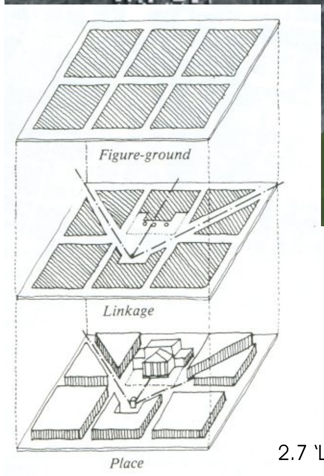
2.5 Cultural installations in Pretoria

Cultural Installations

1-Pretoria Zoological gardens
2-Aquarium and Snake park
3-State Model School Museum
4-Church Square
5-Palace of Justice
6-Old Raadsaal
7-African Window
8-Transvaal Museum
9-Museum of Science and Technology
10-City Hall and Pretorius Square
11-Melrose House
12-Pretoria Station
13-Union Buildings
14-Pretoria Art Museum
15-Oeverzicht Art Village
16-NZASM Houses
17-Paul Kruger's Church
18-Kruger House
19-State Theatre
20-Burgers Park



2.6 Combined maps showing linkage and place



2.7 'Linkage' and 'Place'

Church Street moves through this linkage system and connects to the Union Buildings, creating a sub-axis link to the Pretoria Art Gallery.

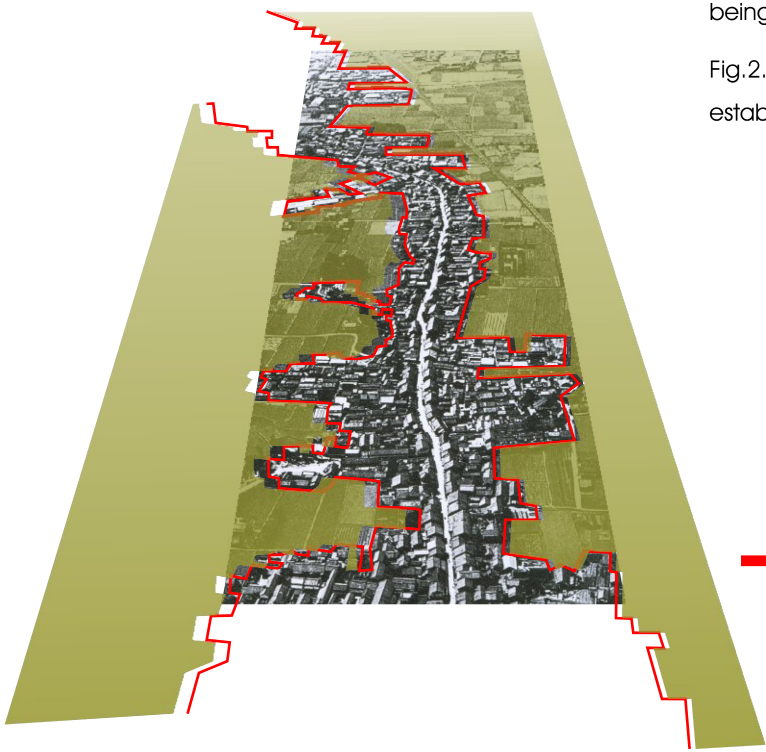
2.3 Urban Form

Many cities in the vicinity of rivers will inevitably develop on the river banks whereby its water can be used for transport, as a food source and channelled for irrigation. Because the river is such an important resource, development along it celebrates the river and becomes an intense spine of activity. Fig.2.8 shows how this type of development has taken place in a Japanese Agrarian rural village. The river starts as the interactive node with further development spreading away from it leaving the town bounded by greenbelts.

The buildings develop with the responsive face towards the source of activity, in this case the river. With the responsive face river facing, interaction with the development and activity spine is assured.

Pretoria can be considered as a relatively young city, only being established 1855. It was not forced to develop on the river, but was rather defined by the river, while water was provided to the city from the Fountains via water furrows. Instead, in part due to its political footings and the knowledge of what a contemporary city should look like, the Pretoria community was established above the river around Church Square on a grid that was defined by openings in the Daspoort and Schurweberg ridges (Fisher. Le Roux. Mare', 1998, p61). Development occurred in the same way as previously mentioned with the buildings responsive face interacting with the activity node of Church Square. As each layer of development occurred, it would inherit the responsibility of being the defensive edge.

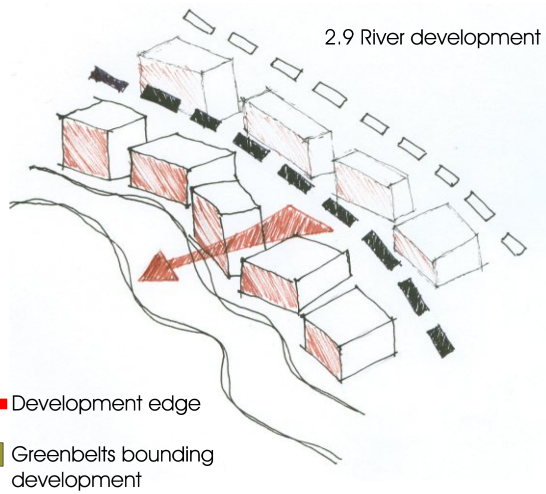
Fig.2.11 shows in 1859 how Pretoria had already been established on a grid system. This development occurred in



Development edge

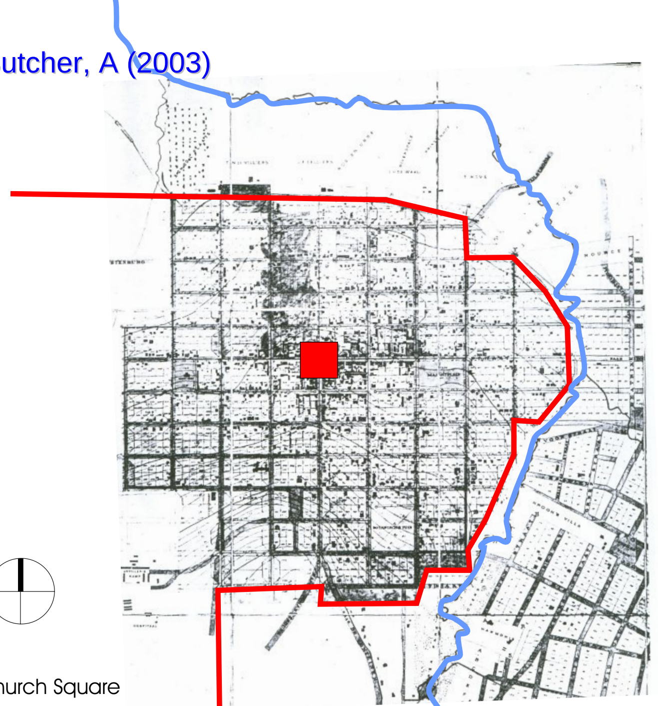
Greenbelts bounding development

2.8 Japanese Agrarian village



2.9 River development

2.10 Pretoria Map 1889



2.11 Pretoria Map 1859

Church Square

Defensive edge of development

an east/west direction due to the steeper gradients of the ridges in the north and south. Fig.2.10 indicates when the development reached the river, already by 1889, the grid pattern was disrupted and could not continue in its conventional manner. With the responsive face towards Church Square, the defensive edge was left facing towards the river. With its back on the river, a number of green spaces where left along the river forming a weak greenbelt, unfortunately with no interaction these spaces became lost, hostile spaces.

Development could only take place in an east/west direction, so it continued in a similar pattern on the eastern side of the river to that on the western side, however, the responsive face was towards the west which allowed for interaction with the river, but the river was never celebrated as a natural resource.

As the city expanded, there would have been little emphasis on preserving the natural environment within the city because of the vast landscape of fauna and flora surrounding it. Development pushed the biophysical environment further and further away leaving a few isolated patches that only remain because they are uninhabitable, these being the Apies River and the ridges in the north and south.

Fig.2.9 shows the idea of how development on a river turns its responsive face to the river while forming a defensive edge behind it. Later development forms its responsive edge to interact with previous development, thus creating an activity spine along the river.

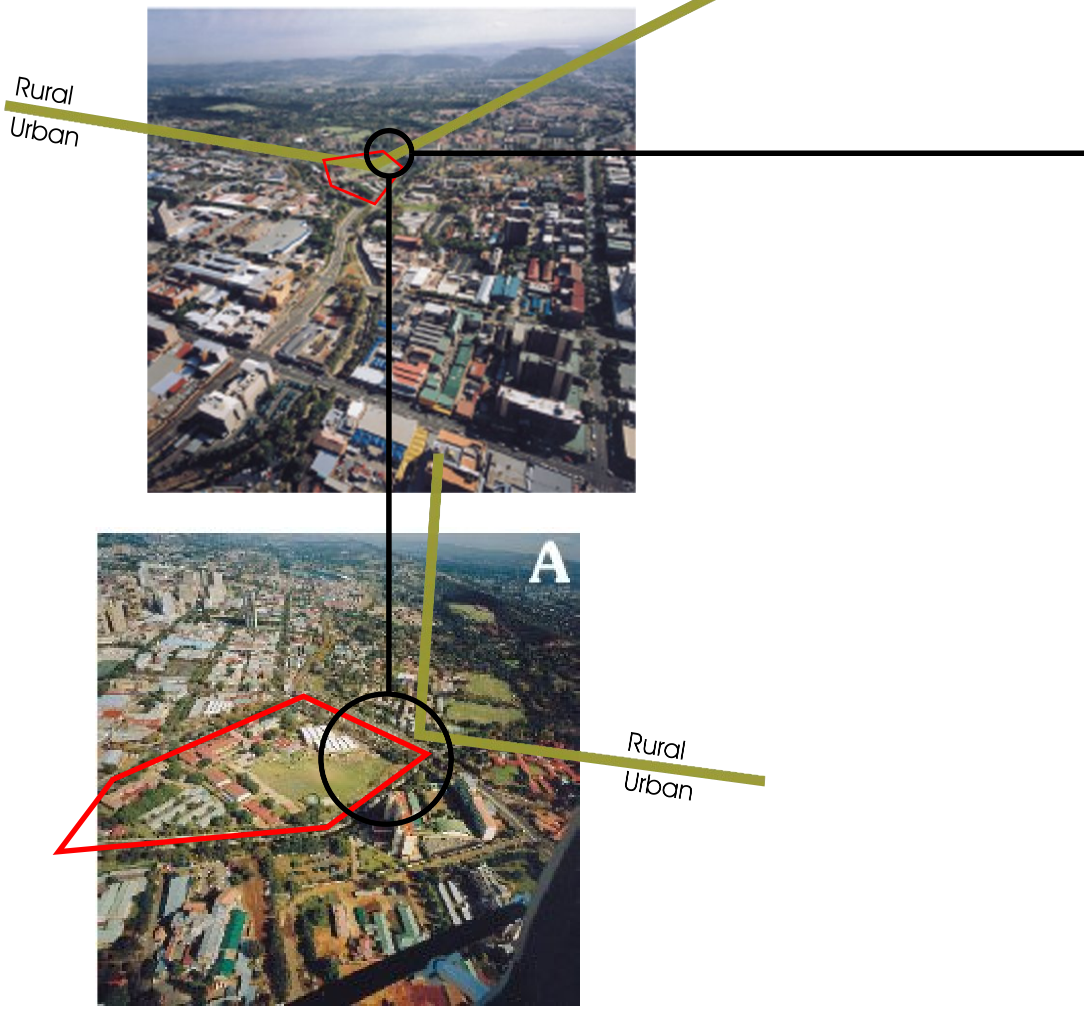
2.4 Site

The reasons for choosing the site are mostly based around maximising resources. Much of the research done with medicinal plants is with highly infectious bacteria, viruses and their related diseases, such as Tuberculosis, Aids etc. (Meyer, 2003). This work is currently done in the isolated laboratories at the MRC, it would not be economical to build more of these laboratories as they have the capacity for an increase in use. For this reason the EBRC needs to be linked physically to the MRC.

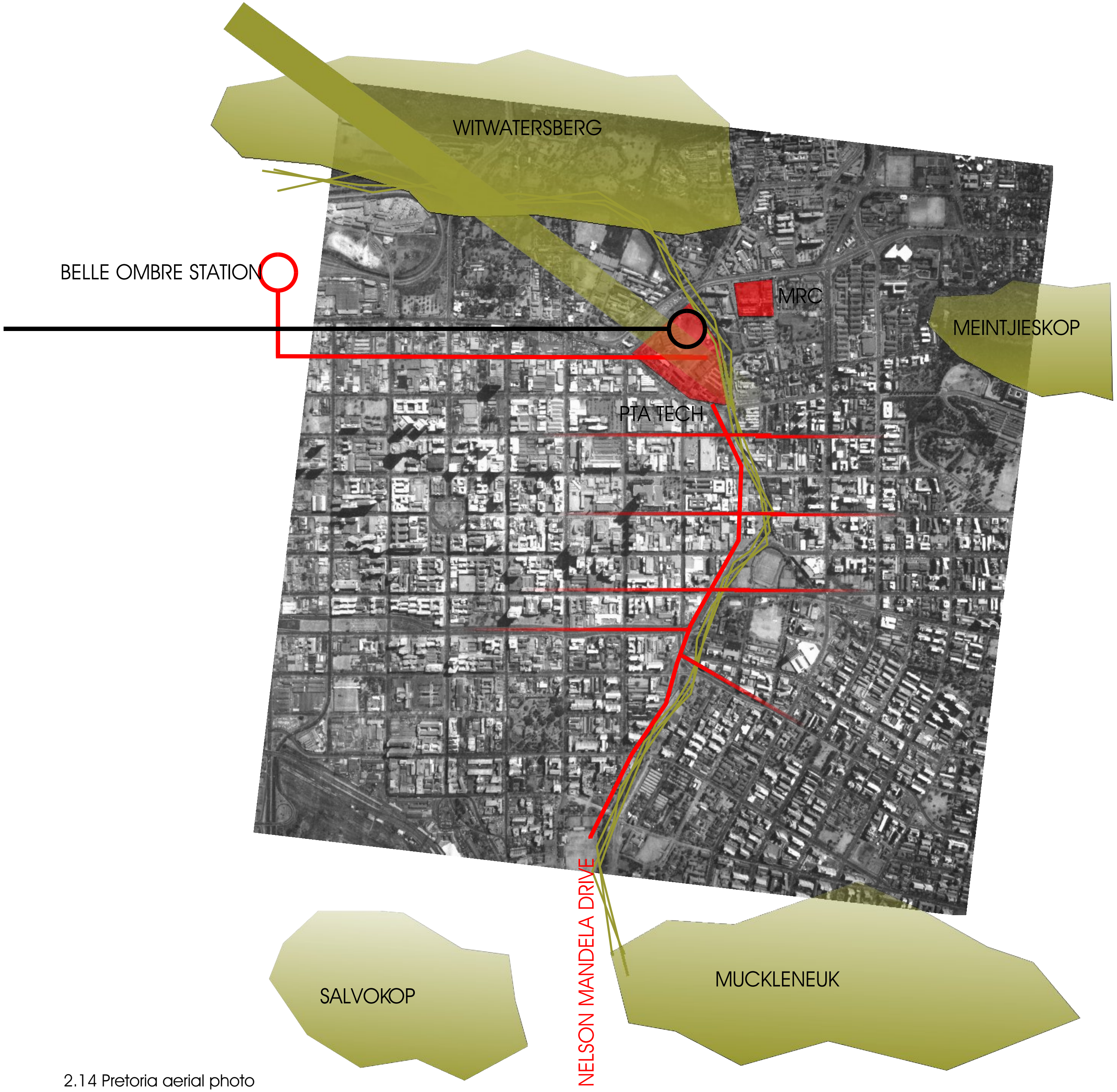
A large component of the EBRC is the plant propagation within the terrariums as well as the open-air medicinal plant cultivation. It would be preferable if the site fitted into an existing greenbelt, while large spaces would be needed for the terrariums. Although brownfields sites are favoured in terms of sustainable development, it is justifiable to use a greenfields site if most of the site will be used to grow indigenous vegetation. In the Apies River Urban Design Framework there is an initiative to reintroduce indigenous plants to the Witwatersburg Ridge. There is an opportunity to continue this throughout the city by being linked to the ridges via the Apies River as at this point the rural environment meets the urban environment. Another advantage of being on the river is the possibility (through damming) of the establishment of a wetland for maximum plant diversity and using the water for irrigation.

There needs to be a strong link to the existing medicinal plant trading node in Marabastad so as to direct this practice in a more sustainable direction. By connecting to Marabastad, there is also the possibility of creating an important link to Belle Ombre train station as it is through this gateway where much of the harvested plants are brought into the city.

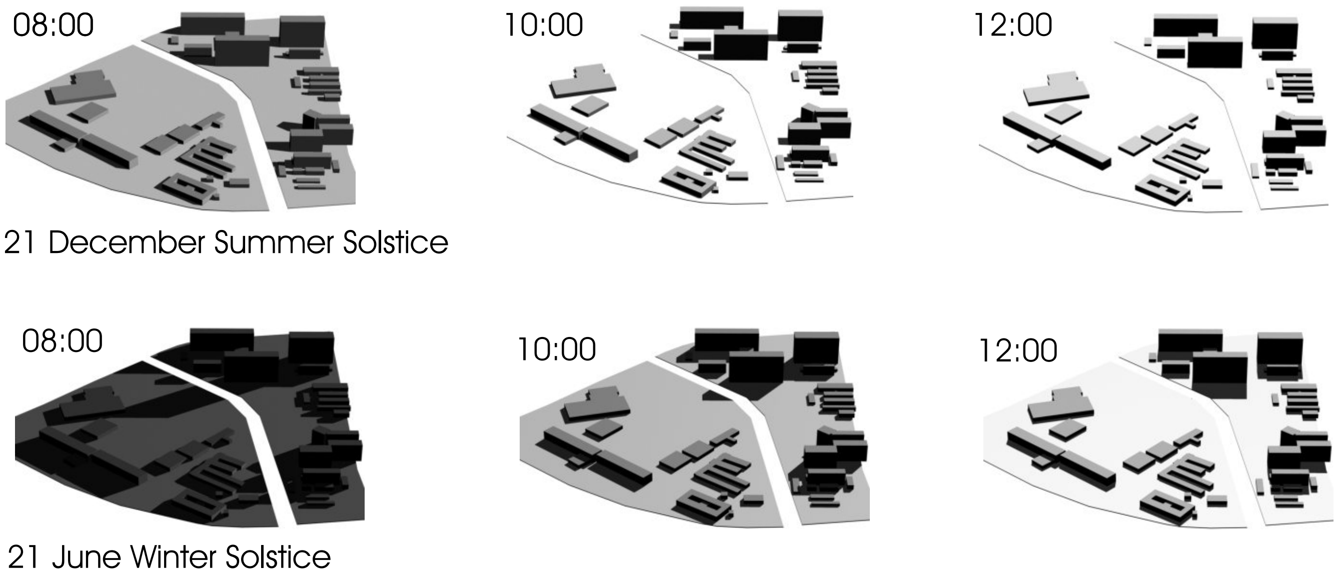
2.12 Site overview from the south



2.13 Site overview from the east



2.14 Pretoria aerial photo

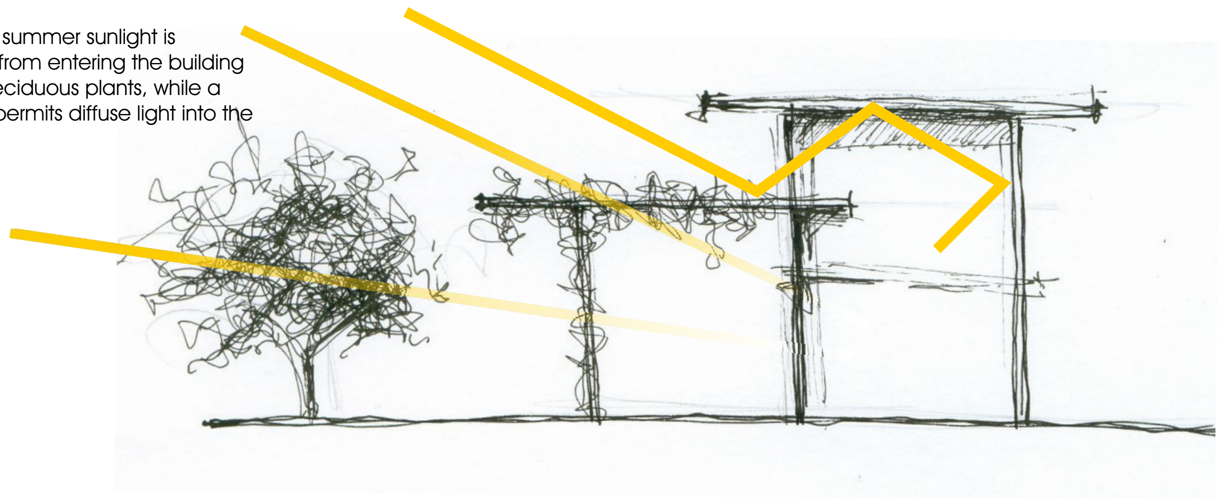


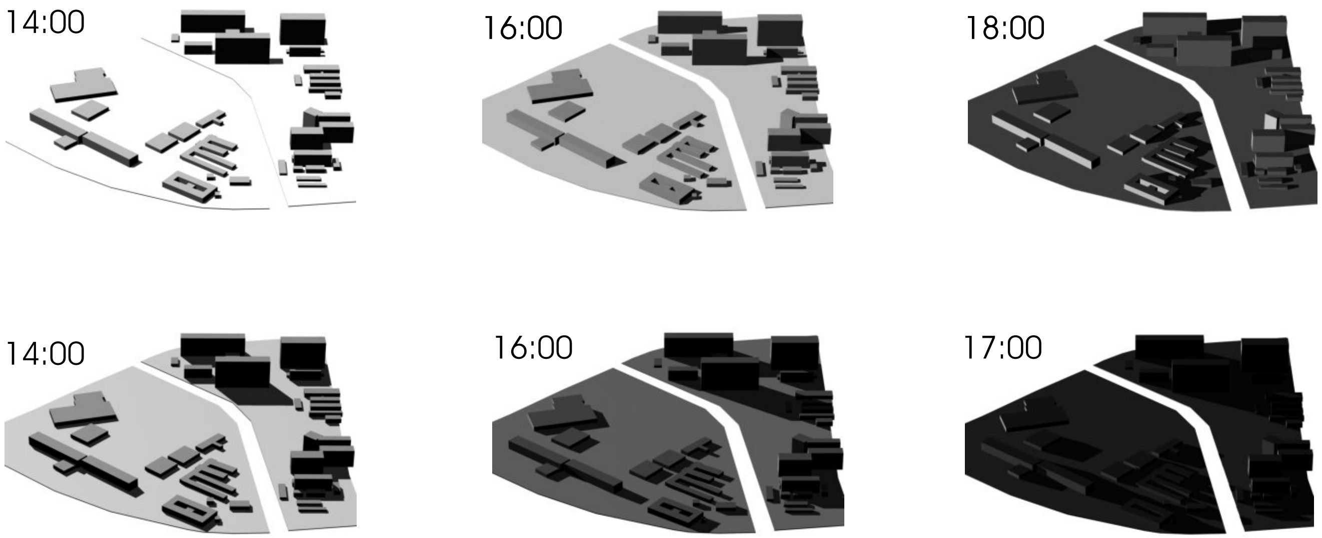
2.5 Sunshine

The Pretoria area receives a very high sunshine percentage with an annual maximum of 80% and a minimum of 67%. This reads as 4.5Whr/m^2/day in mid-winter and 8Whr/m^2/day in mid-summer. Although these figures are high, much of this sunlight is diffuse radiation (AAL 310, 2002, p19).

Due to scattered cloud and pollution, more diffuse radiation is experienced in the afternoon than in the morning. This needs to be considered if solar collectors are to be used, as solar reflectors only absorb direct radiation while flat plate

2.15 Direct summer sunlight is prevented from entering the building by using deciduous plants, while a light plate permits diffuse light into the building.

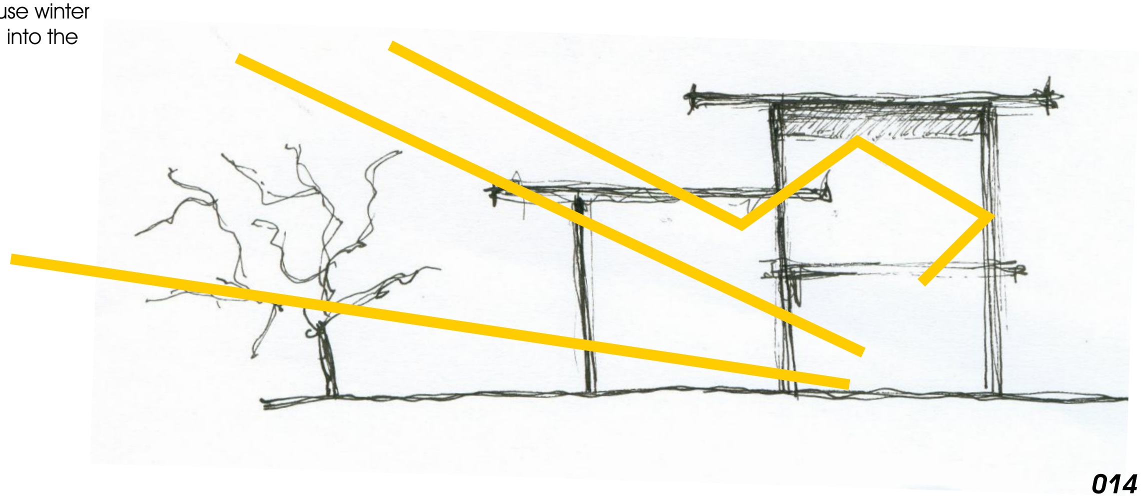




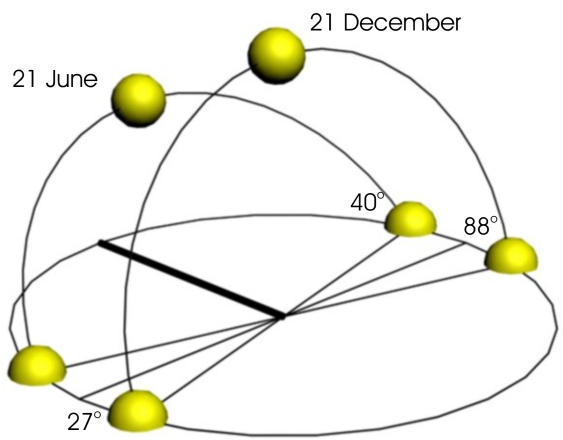
2.17 Shadow paths across the site

collectors can absorb direct and diffuse radiation (AAL 310, 2002, p18). It should also be noted that in summer the south elevation experiences more radiation than the north elevation due to the wide morning and evening azimuth, however the this radiation not very intense (Schultze, 1986, p20).

Fig.2.17 shows the shadow path across the site through 21 December and 21 June. The buildings on the site are all low profile and cast a very small overall shadow. The largest shadow is cast by the old College of Nursing on the east side of the river. The new building should not lie in this shadow



2.16 Direct and diffuse winter sunlight is permitted into the building



2.18 Sun movement path

path as in winter the maximum amount of direct morning sunlight is desired. It is also favourable for no shadows to fall on the terrariums.

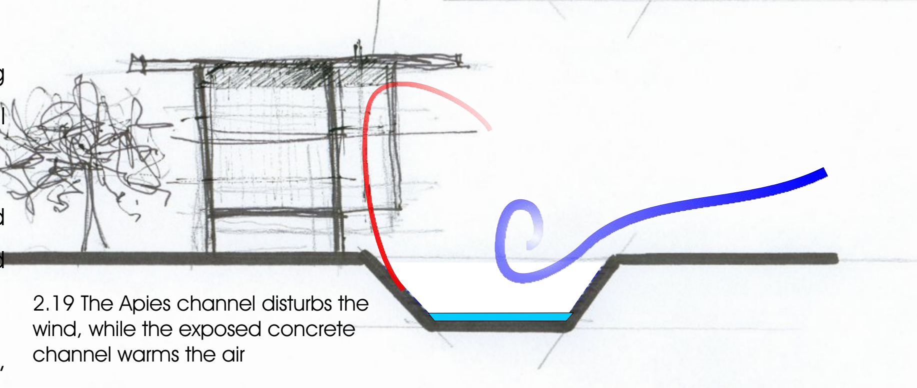
The building form must provide the appropriate sun and shade combinations for the diverse plant species around the building.

The low sun angle in the evenings are almost uncontrollable, using vegetation and large overhangs are a solution, but lessen the amount of natural lighting into the building. Ambient light should get reflected into the building during all seasons by using a light plate, reducing glare and heat gain. In summer, large, permeable overhangs should be overgrown with deciduous vines. Along with deciduous plants around the building, these prevent direct light and heat gain into the building (See fig.2.15). In winter, where heat gain is desired, the plants allow the light through (See fig.2.16).

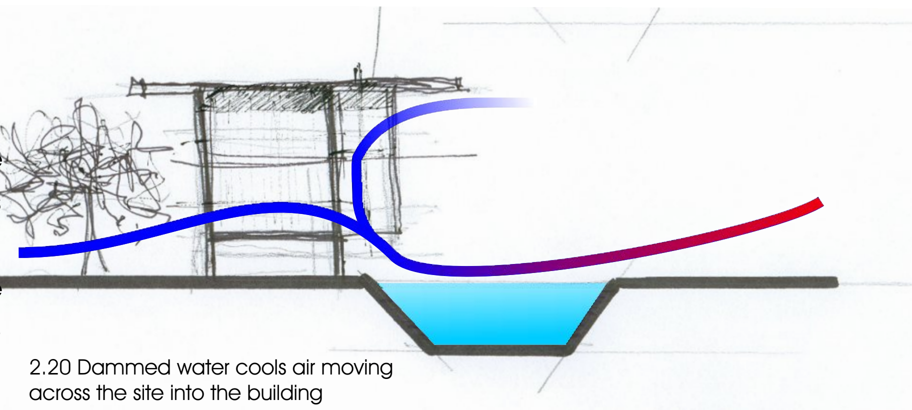
2.6 Wind

In summer the wind direction ranges from east-north-easterly to east-south-easterly and in the winter months it is mainly south-easterly (Holm, 1996, p69). Wind as a major energy source is not viable in Pretoria as an annual average wind speed of 13km/h is required to economically generate electricity (AAL 310, 2002, p26), however wind could be a supplementary energy source if used only in times of high wind speeds.

In such a built up city, the buildings form wind channels that increase the velocity of the wind, however with the majority of the winds in Pretoria being north and south easterly, the



2.19 The Apies channel disturbs the wind, while the exposed concrete channel warms the air

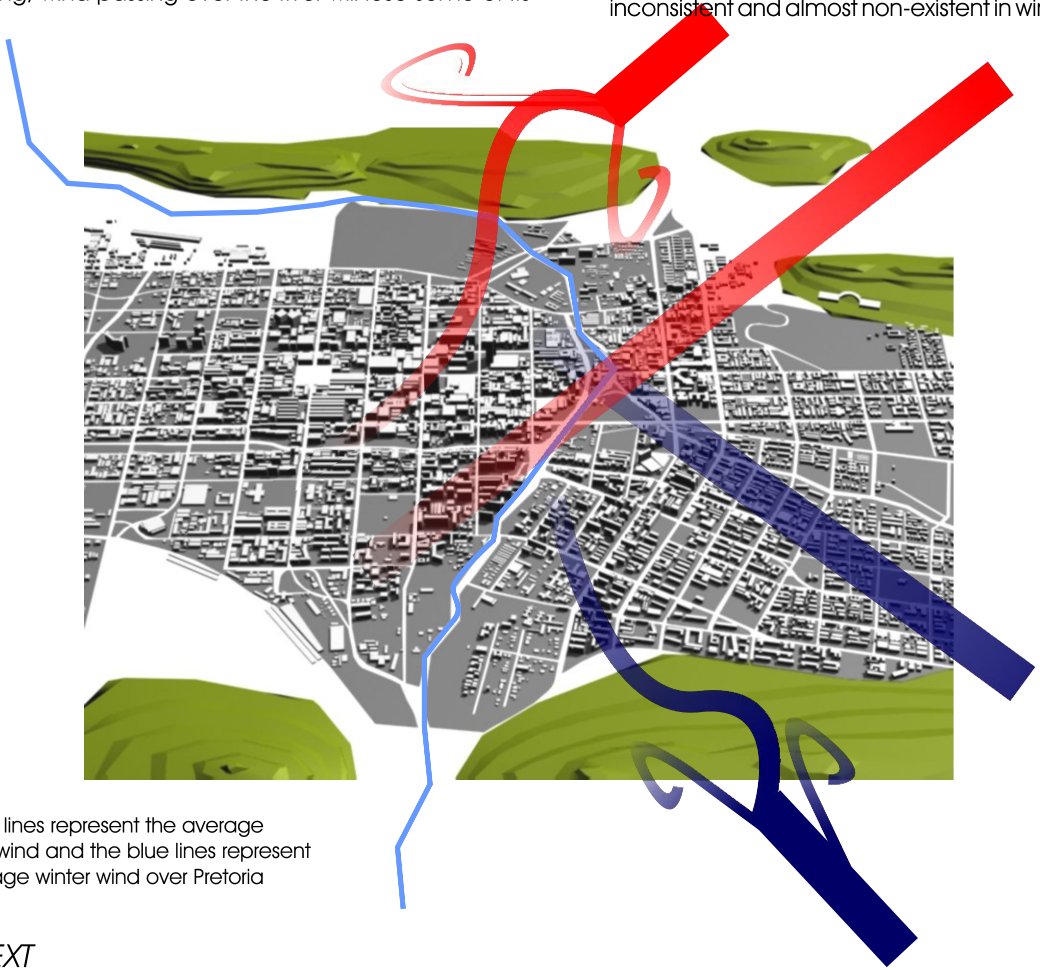


2.20 Dammed water cools air moving across the site into the building wind hits the buildings diagonally reducing the chance of these winds to be channelled. The ridges to the north and south of the city also divert some of the winds, but can channel winds along the base of the ridges into the city.

With the EBRC being on the Apies River, there is an opportunity to employ the wind in conjunction with the river as a cooling system for the building. Maximum utilisation of this system could take place if the river was dammed and the water level controlled. In summer the water level should be raised as high as possible with openings at the base of the building, wind passing over the river will lose some of its heat before moving through the building and in the process cooling the building down (See fig.2.20).

In winter, the water level should be dropped, exposing the concrete channel and minimising the surface area of the water. Wind moving over the river will be disrupted and warmed by the channel preventing cool air from moving through the building (See fig.2.19).

With further investigation, it became apparent that utilising the River for cooling was not a viable option. Firstly the wind in Pretoria is minimal and secondly the water level in the river is inconsistent and almost non-existent in winter.



2.21 Red lines represent the average summer wind and the blue lines represent the average winter wind over Pretoria

2.7 Apies River

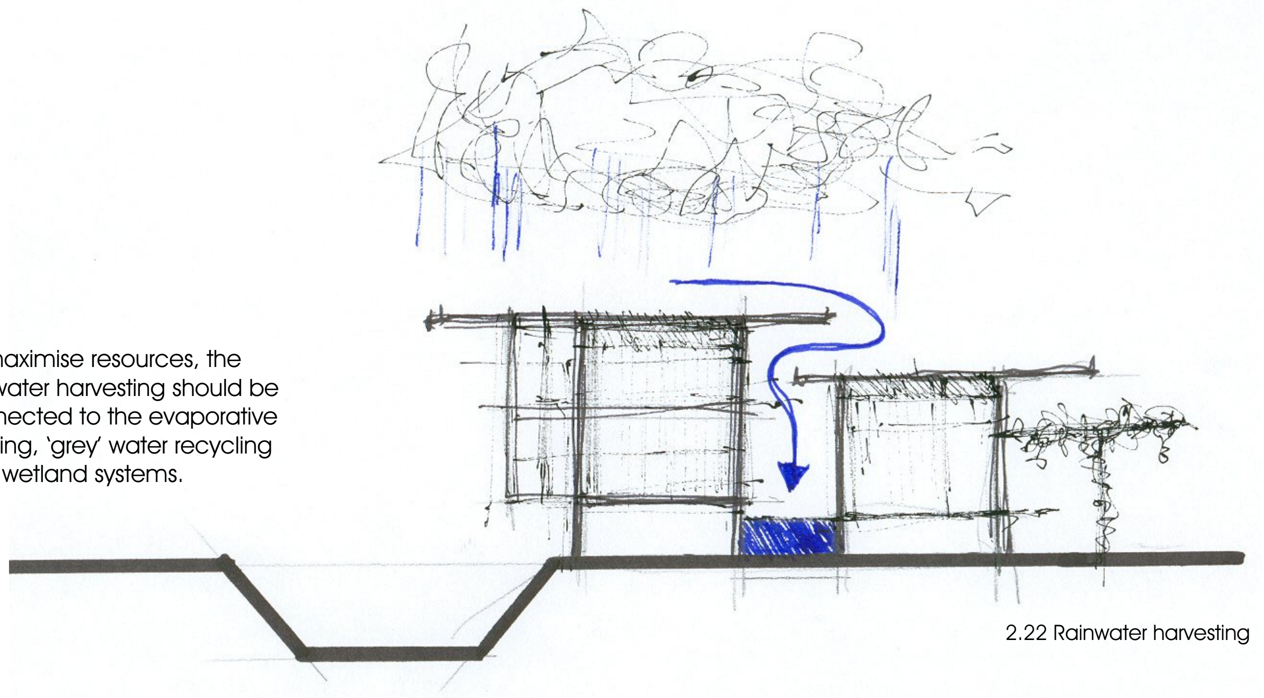
The source of the Apies River is from springs in the Fountains valley that delivers around 26million litres of water a day. The river was canalised with concrete embankments to help drain storm water. This prevents water from being absorbed into the ground ,thus increasing the flow volumes of the river. Another problem is that soil erosion takes place at the end of the concrete channel. In the proposed area, there is an un-located sewer leak into the river, further polluting it (ARUDF, 1999, p18).

On the site there are 50 year flood-lines 15m from the river, these spaces could be utilised as urban green spaces, these are however currently lost, hostile, dangerous spaces. These spaces can be utilised to their maximum if they are used as strong movement corridors and with careful engineering the buildings can pass over the flood-lines.

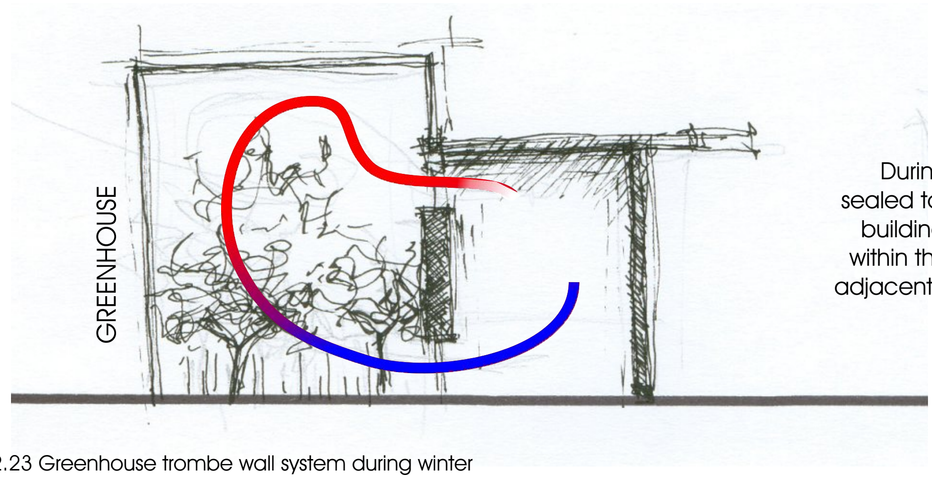
2.8 Temperature

The temperature averages for the months of November to March fall within the thermal comfort zone that ranges from 16°C to 32°C, with an optimum temperature being around 22°C (Holm, 1996, p69). During certain days however, the temperature falls outside of the comfort zone. For example maximum temperatures have been recorded of 38°C in January and minimum temperatures of below zero in winter months. Air temperatures can be manipulated by using the greenhouses as a trombe wall system (See fig.2.23).

To maximise resources, the rainwater harvesting should be connected to the evaporative cooling, 'grey' water recycling and wetland systems.

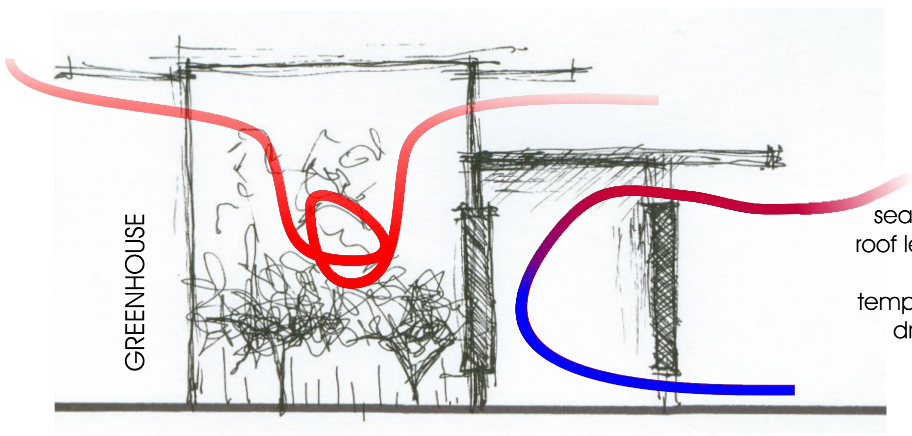


2.22 Rainwater harvesting



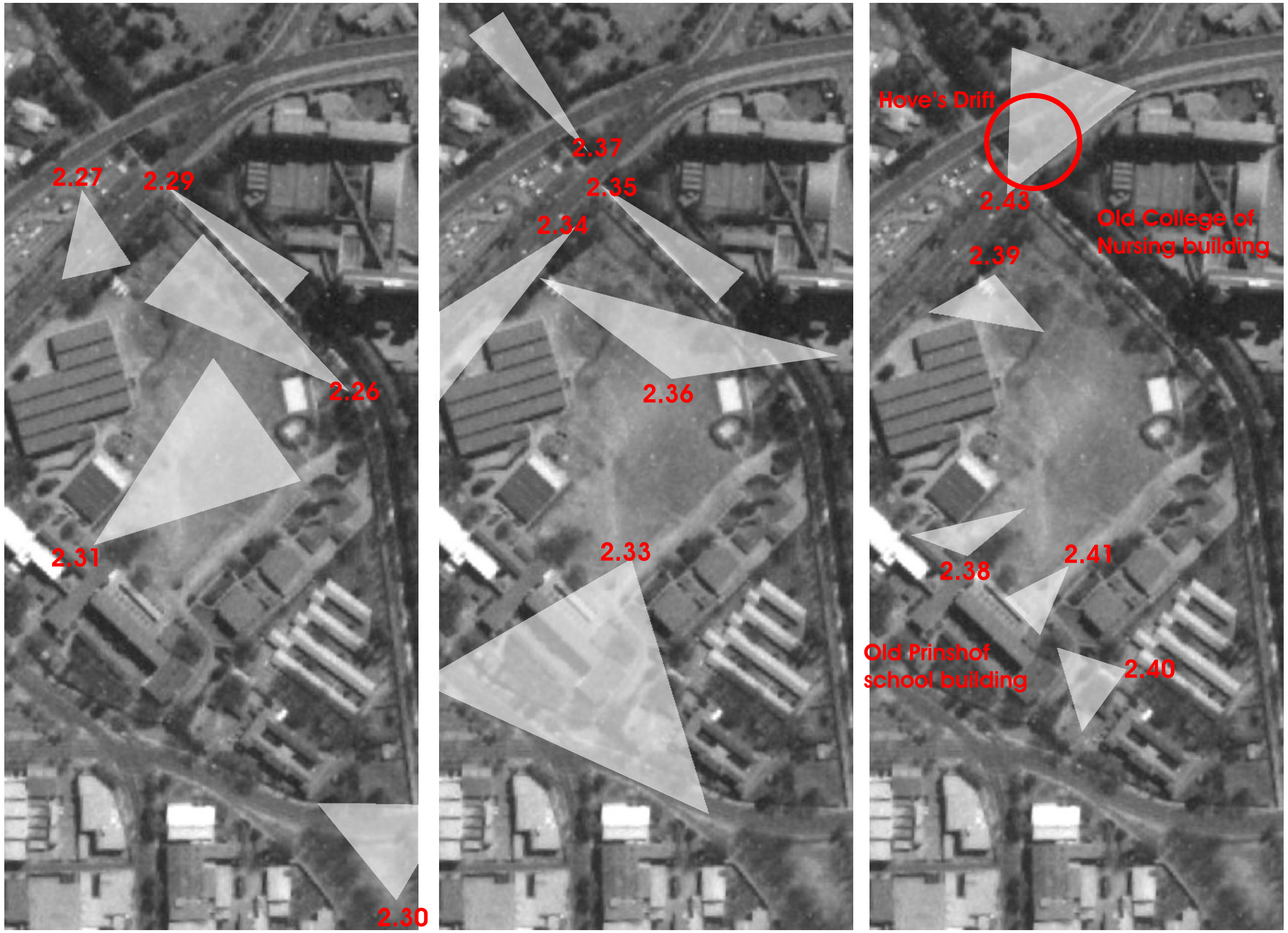
During winter, the greenhouses should be sealed to the outdoors but open to the main building. The high temperatures generated within the greenhouse will move through the adjacent buildings, pushing the cold air back into the greenhouse to heat-up.

2.23 Greenhouse trombe wall system during winter



During summer, the greenhouse must be sealed to the main building with openings at roof level to allow excess heat to escape. With the greenhouse fully ventilated at night, temperatures inside it will drop rapidly at night, drawing heat from the main buildings walls and expelling it.

2.24 Greenhouse trombe wall system during summer



2.25 Photograph references

2.9 Imageability

Pretoria city is made up of a number of different precincts as shown in fig.3.5. The site lies within the Hospital precinct which is mostly made up of medical and educational institutions with a few residential nodes and light commercial facilities bordering the precinct to the south. The Apies River flows through the middle of the precinct tying it to the rest of the city. However the precinct lacks a specific identity of its own and also ignores the potential asset of the river. This is the result of a number of factors:

-The buildings along the river have their backs turned to the river preventing indoor activities flowing out onto the river, blocking views onto the river and closing the river off to pedestrian access.

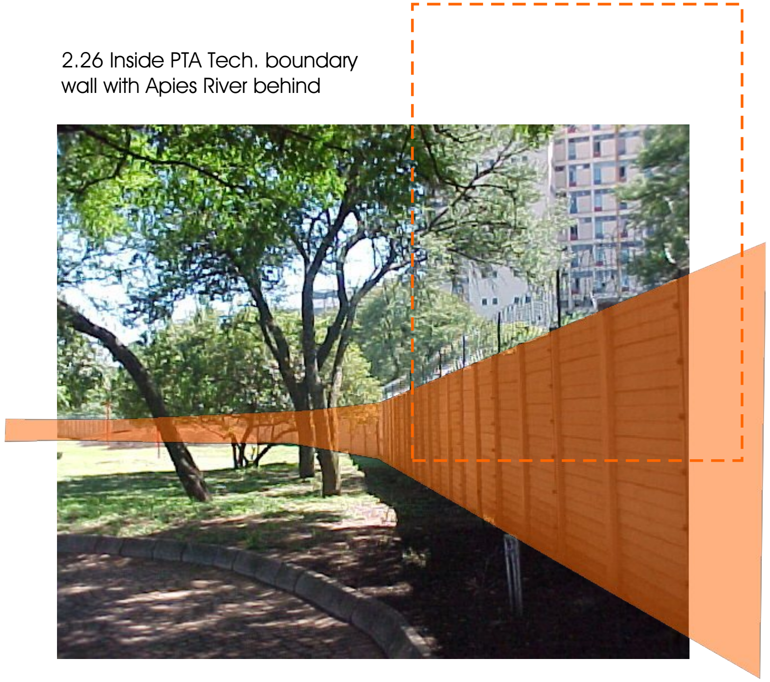
-Many of the institutions are surrounded by high walls or fencing, preventing visual access, so one's eye is drawn to the auto shops, derelict buildings, vacant land and informal taxi-ranks that surround the precinct, creating a negative image of the area (See fig. 2.27)

-These walls also prevent outward views of surrounding areas, separating it from the city, both visually and physically (See fig. 2.26).

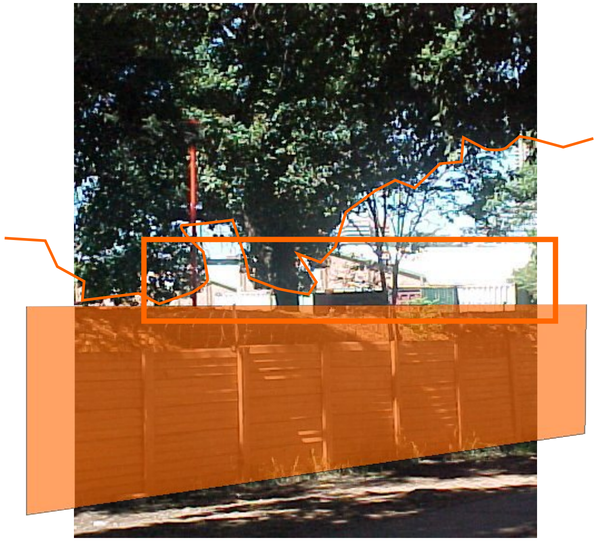
-The institutions take-up large parcels of land that become quite monotonous and leave a number of small, lost spaces. These contribute to a feeling of desolation in the area.

-The sterile atmosphere created by the precinct prevents the natural/cultural image of the zoo from spreading southwards

2.26 Inside PTA Tech. boundary wall with Apies River behind



2.27 Boundary wall on Dr Savage Street with light industrial looking buildings behind



along the river.

-There is a lack of interaction with the natural environments. This leaves them with an un-maintained, hostile feel that contributes further to the negative image of the precinct (See fig. 2.29).

2.10 Social

-The area has the potential of being highly active with the numerous student related installations. The lack of permeability between them and absence of entertainment facilities and social spaces prevent this activity. This potential could be enhanced by the river.

-To the north of the precinct, there is an informal taxi rank that is very littered and neglected, creating a hostile environment towards pedestrians (See fig. 2.34).

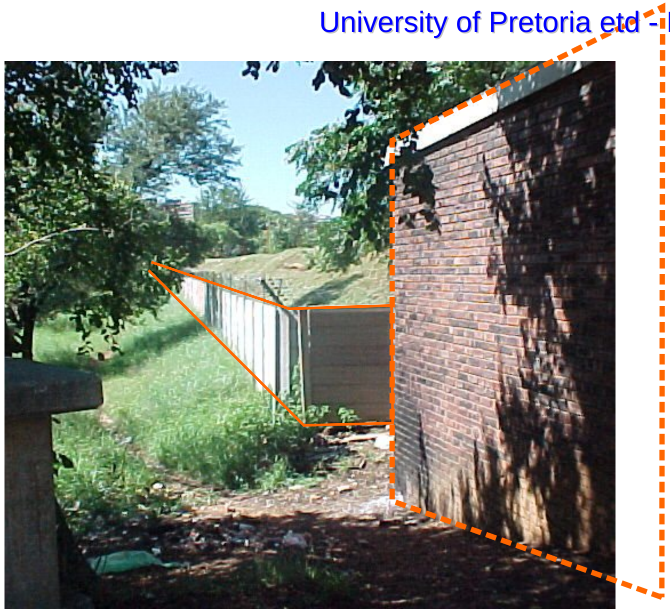
-The Apies river creates a link through the site, at Dr Savage Street. Unfortunately this link is littered, overgrown and along with an un-maintained ablution block, this area has become inhospitable. The river and adjacent spaces are enclosed with walls on each side with no visibility onto it, thus the area has become a dangerous area to walk through, especially at night (See fig. 2.29).

-The Hospital precinct forms part of the boundary to the CBD. Here the grain of the city becomes coarser, this causes the strong flow of energy from the east and south east to become saturated and doesn't move through or past the precinct, resulting in a loss of urban life (See fig. 2.28).

2.11 Movement

-The construction of Nelson Mandela Drive created a number of linear open spaces between itself and the river.

2.28 Loss of city energy through the hospital precinct



2.29 Pedestrian link at Dr Savage Street

Unfortunately these spaces have become disconnected because of east/west traffic, while the traffic volume makes it hard to cross Nelson Mandela Drive. Nelson Mandela Drive terminates abruptly at Struben Street and leaves one with no sense of direction. There is no identity here with only the concrete Technikon wall. There are some interesting buildings that lie just behind the wall, but are not visible. There is no indication that the Union Buildings and Zoo are a few hundred metres east and west respectively (See fig.2.30).

-The road capacity is good and carries a large amount of taxis and cars, unfortunately there is very little access for buses and there are no bicycle paths so public transport in the area is limited. These need to be improved since there is no potential for rail transport, resulting in a great pressure being placed on the roads (ARUDF, 1999, p78).

-Along Nelson Mandela Drive there are pedestrian paths, but there are no drop-off areas for vehicles, which further limits the use of public transport. This pedestrian path is linked to

2.30 No identity at the termination of Nelson Mandela drive. The river is obscured by the PTA Tech. walls

the Taxi-rank, but the lack of crossings on Dr Savage street and uninviting environment along the river prevent the use of the path. High speed traffic along Dr Savage also prevents drivers from taking note of their surrounding environment adding to the lack of awareness and neglect of the precinct.

2.12 Pollution

-Pollution is visible within the river in the form of litter and leaking sewage. Due to the large enclosed land parcels, the precinct is generally unpolluted.

2.13 Environmental

-Much of the vegetation along the Apies River in this area is ground cover of veld grasses with scattered Sweet Thorn (*Acacia Karroo)* trees. There are very few exotic plant species occurring in the area. Although the river is canalled, the soils on banks are still very rich and the potential for vegetation to grow is high (ARUDF, 1999, p77).

-The walls along the river separate a thin line of indigenous vegetation from cultivated lawns. These lawns mostly serve as parking areas for the Technikon and Nursing college (See fig.2.31). Exotic species are also more abundant within the boundary of the campus. The large island created by Soutpansberg Road and Dr Savage street create a wide barrier to the natural environment, preventing the spread of vegetation from the north into the city .

-At Hoves Drift, the river changes from concrete to natural, the high water velocity causes erosion of the banks here, especially in times of flooding. There is a greater number of bird species here and fish begin to occur.

2.31 Green open spaces used for parking areas

2.5.12 Road proposals

Currently there is a proposal for a new road system within the precinct (ARUDF, 1999, p78). This will extend Nelson Mandela Drive to connect to Boom Street and Soutpansberg Road and will line the river with roads on both sides. The idea is to create continuity of movement, however this proposal will lead to a number of problems, namely:

-Pedestrian access to the river will be further limited.

-Traffic speeds in the area will be increased.

-Unusable left-over spaces will increase.

-Many historical elements will de destroyed.

This area is highly sensitive as it forms a boundary between the urban environment of the CBD and the biophysical environment of the Zoological gardens and Witwatersberg ridges to the north. It is in this area along the Apies River that the Biophysical environment moves into the city. The extension of Nelson Mandela Drive will only weaken this link, and further isolate the River.

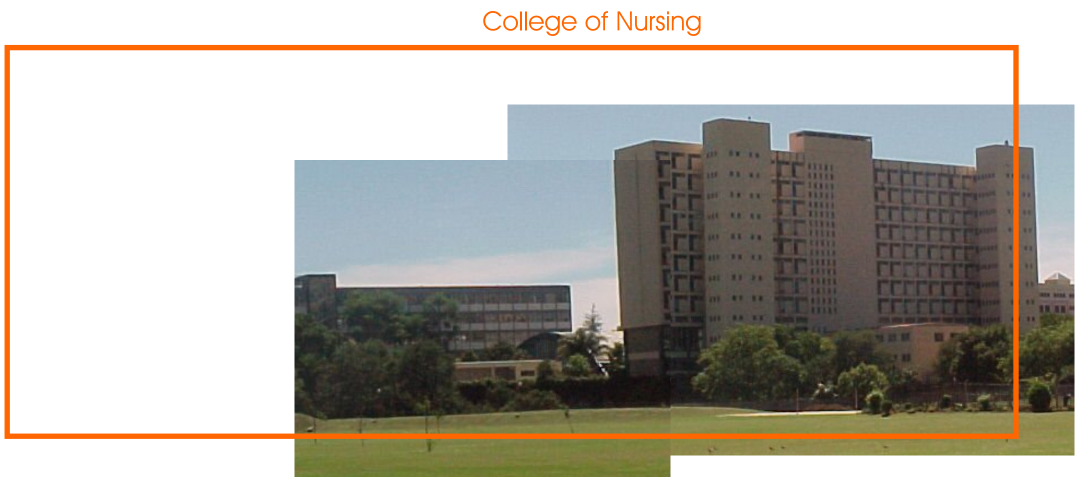
2.32 New road proposals on the site

2.33 The view to the south west of the Pretoria skyline

2.34 Dr Savage Street with the adjacent taxi terminus

2.35 Apies River southwards

2.36 North west view shows the abrupt change of context, from the natural environment of the Zoological gardens, to the urban environment of the College of Nursing.



2.37 Apies River northwards, indicating the change to the biophysical environment

2.14 Buildings

There are a number of historical elements/buildings within the precinct that are rarely noticed. These need to be celebrated to unlock the potential richness of the site and would serve as orientation devices and social activators. These include the old College of Nursing, the old Prinshof School and Hove's Drift.

The old Prinshof school lies on the western edge of the Pretoria Technikon campus and on the east bank of the Apies River lies the old College of Nursing. Both these buildings have been identified to having cultural / architectural importance (see appendix A). These buildings are not to be removed or disrupted and sightlines to these buildings are not to be disrupted.

The other existing buildings on the Pretoria Technikon campus, are mostly light industrial type warehouses and prefabricated structures. The warehouses are used as studios for the sculpture, glasswork, ballet etc. while the old school buildings are used mostly for staff offices. Most of the warehouses have been made more personal to their function through painting (Fig.2.62), but some have not and create the image of an office park (Fig.2.62). The older industrial buildings have more character with their cooling stacks, strip windows etc. than the newer ones.

2.38 Graffiti on sculpture dept. wall

2.39 Glasswork studios

2.40 Older industrial buildings

2.41 Old school buildings

2.15 Hove's Drift

When Pretoria was established, the land that the chosen site sits on was a property called Prinshof, named after Joggem 'Tweeduim' Prinsloo and in the early 20th century the area served as the Prinshof Experimental Station where the cultivation of different types of grass species took place. Property on the west bank was owned by Theodore Hove (1834-1906)(VD Vaal, 1999). A linocut work by Hendrik Pierneef called *Uniegebou Vanaf Prinshof, Pretoria, show what the area looked like in 1925 (Fig.2.46).*

Hove's drift provided access across the Apies River from central Pretoria to the north and in 1932 a bridge was built here by Bain & Proudfoot. In 1935, Dr Savage street, was built across the bridge. The road was named after Dr SR Savage who was Mayor of Pretoria in 1907-1908 (VD Vaal, 1999).

Dr Savage Street carries relatively fast moving traffic, because of this commuters don't see the bridge. The pavements across the bridge are very narrow, and the surrounding environment is uninviting, no opportunity is therefore given to pedestrians to interact with this historical element.

2.42 *Uniegebou Vanaf Prinshof, Pretoria, 1925* by Hendrik Pierneef

2.43 Bain and Proudfoot's 1932 bridge across the Apies River with Dr Savage street across it

3.1.1 The Role of the EBRC within the CBD

The intention is for the EBRC to act as the catalyst in transforming the Apies river into a continuous greenbelt through the city that provides an ecological, cultural and social link from the north to the south of the city. The EBRC needs to 'activate' or 'animate' the river in its context. The greenbelt should form informal cultivation gardens for the EBRC, reintroducing indigenous medicinal plants into the environment. This greenbelt will form a type of urban agriculture whereby the roots, bark, leaves etc can be harvested sustainably. The biophysical environment will be pulled from the ridges (See fig.3.4-7) into the city at the same time directing people along it towards the ridges. The sequence on page 34 indicates the envisioned process of 'animation' that will result from the EBRC.

3.1 Frame 1 - This represents the current condition in Pretoria City with the ridges in the north and south acting as the 'nature rooms' for the city. The Apies River connects these ridges, with scattered green patches along it. Throughout the city similar green spaces occur, but with no coherent link between them.

3.2 Frame 2 - With the EBRC established, its function will pull indigenous vegetation, medicinal plants specifically from the Witwatersberg Ridge. At the same time, because of its abundance of existing medicinal plants, vegetation from Salvokop will begin to spread into the city towards the EBRC, which begins to form the greenbelt.

3.3 Frame 3 - 'Nature Corridors' spread perpendicular from the greenbelt, moving away from the river linking the smaller green patches and cultural installations. The vegetation from Salvokop continues to spread northwards.

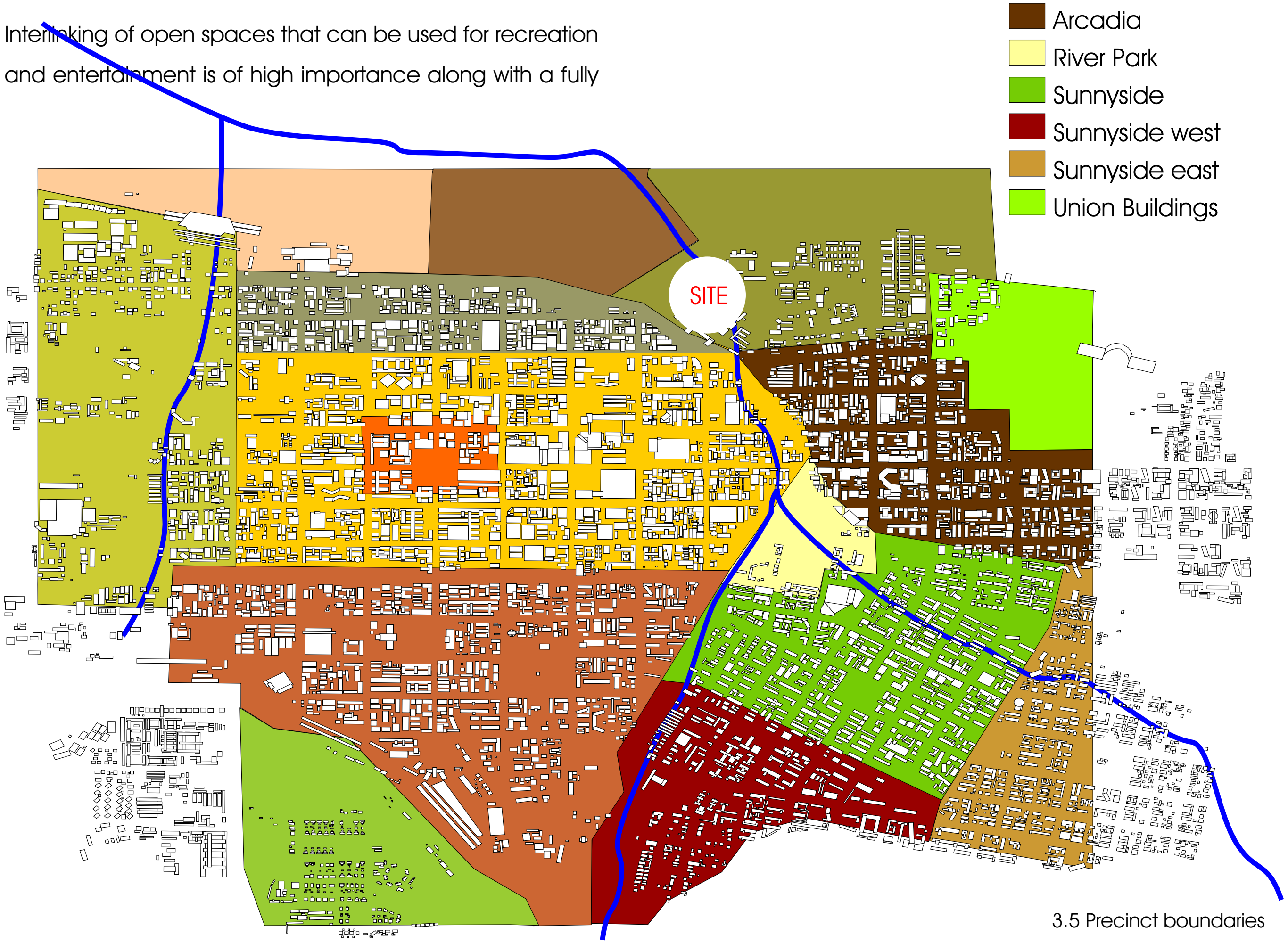
3.4 Frame 4 - The lines of vegetation meet, linking the ridges. The emphasis of migration is now on the 'corridors', which begin to form an east west link, from which smaller 'corridors' spread.

3.2 Existing Frameworks

3.2.1 ISDF

The Integrated Spatial Development Framework (ISDF) is the urban design framework currently being utilised for the Pretoria inner city focussing on its growth and development. The aim of the ISDF is planning and integration of the city's main components; land use, transportation, natural environment and open space.

Interlinking of open spaces that can be used for recreation and entertainment is of high importance along with a fully



3.5 Precinct boundaries

integrated public transport system. There is also recognition of the importance of creating a sense of place and belonging in Pretoria, this is to be assisted by conservation approach to worthy buildings and structures.

The ISDF divides the inner city into sixteen precincts, these are to be labelled and developed according to their unique character. The site for the EBRC falls in the Hospital Hill precinct and is also influenced by development proposals for Struben Street, Boom Street, CBD North, the Zoo and Arcadia.

Proposals for the CBD North and Zoo precincts place an emphasis on Dr Savage Street with requests for a strong gateway feature for the CBD and new entrance to the Zoo linked to the Apies River open space system and public transport systems.

The Struben Street Boulevard stretches from Marabastad in the west to the Apies River in the east and forms a strong link between the Union Buildings, the Zoo and Marabastad. Its development is separated into three areas; through Marabastad, from Potgieter Street to Paul Kruger Street and from Paul Kruger Street to the Apies River (ISDF, 1999, p48).

In the first section where Struben Street crosses D.F.Malan Drive, a gateway element is to be established to emphasize the sight line to the Union Buildings tying them to the rest of the city. The residential street edge through Marabastad is to be developed in such a way that its historical character is maintained (ibid).

In the second section there is an emphasis on the Union Buildings as a focal point by establishing appropriate building lines and heights to define street spaces. There is also encouragement for diversity of land use (residential, retail and office)(ibid).

In the third section the termination of Struben Street is to be emphasised with a new urban square as a focal point on the Apies River. In the Arcadia proposal, this square is to be connected to an inter-precinct 'art-walk' that links the Union Buildings to the Pretoria Art Museum (ibid).

Boom Street runs parallel to Struben Street and shares many of its characteristics. Boom Street links the Steenhoven Spruit to the Apies River with proposals for urban open spaces at both these points of connection. Environmental upgrading required in the Marabastad section is to enhance high activity/ trade image that exists (ISDF, 1999, p51).

The ISDF recognises the Hospital Hill precinct as a largely institutional area with mainly educational and medical facilities. Most of the emphasis is placed on establishing an identity for the precinct along the roads and intersections, unfortunately with little emphasis on making the precinct more permeable and enhancing important pedestrian links. There is also little emphasis on the Apies River that runs through the middle of the entire area.

Many of these principles are repeated in the Apies River Urban Design Framework.

3.2.2 ARUDF

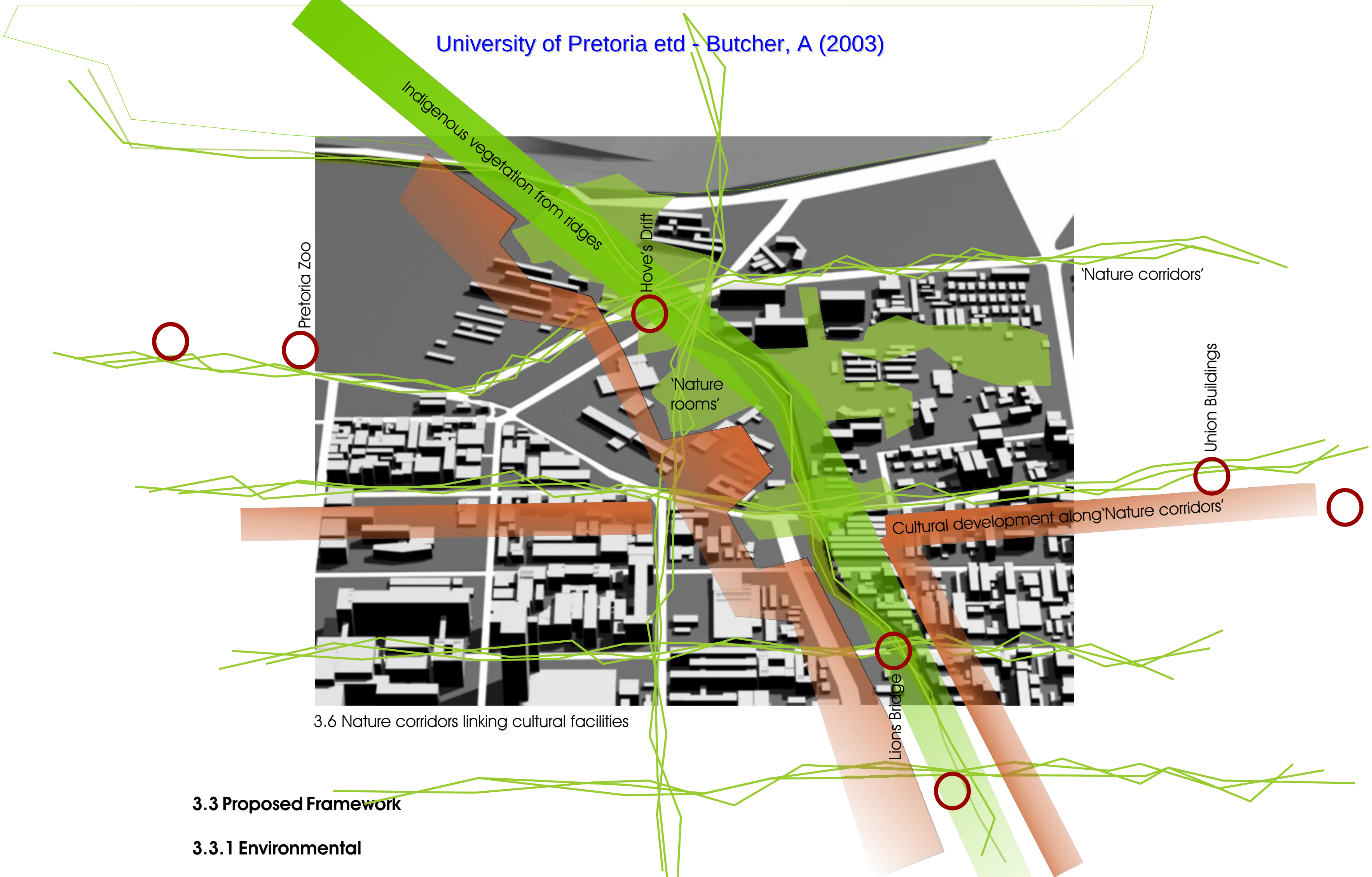
The aims of the Apies River Urban Design Framework (ARUDF) are:

-To exploit the river as a natural and cultural asset to Pretoria by making it an accessible, integrated open space system.

-To turn the river into a place of prosperity and human interaction by creating tourist opportunities and pedestrian activities along it.

-To strengthen the interaction between the river and its surrounding environment by creating an appropriate interface with adjacent developments and by making it user friendly for locals and visitors (ARUDF, 1999, p84).

By integrating the principles of the ISDF and the ARUDF, the following small scale design framework was created.



3.6 Nature corridors linking cultural facilities

3.3 Proposed Framework

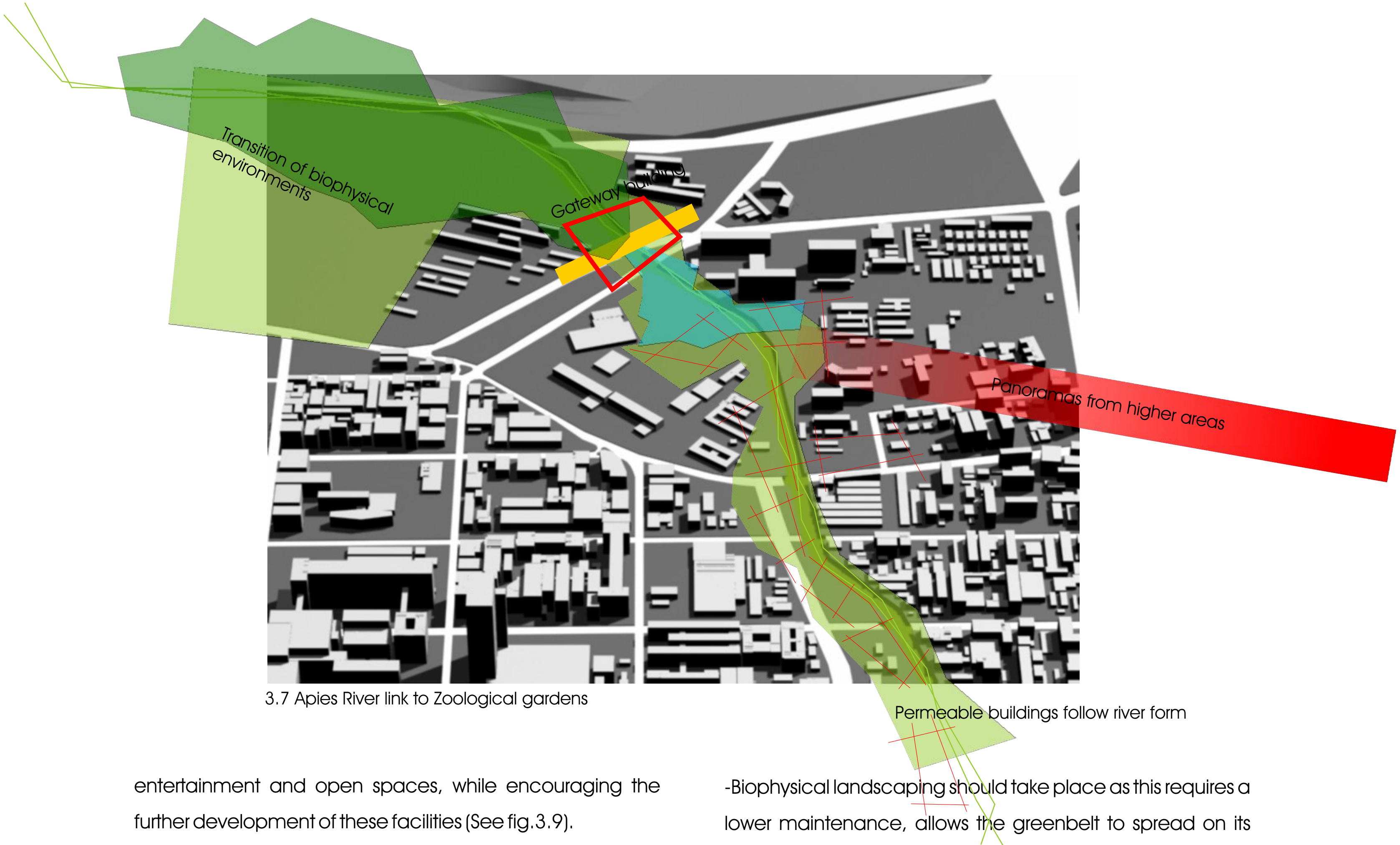
3.3.1 Environmental

-Indigenous vegetation is to be increased on the ridges and pulled through (along with vegetation from the Zoological gardens) the greenbelt, strengthening it and rehabilitating the biophysical landscape along the river (See fig.3.9).

-This indigenous vegetation should include medicinal plants creating the possibility of an urban agriculture within the greenbelt.

-Small nature rooms (Dewar and Uytenbogaardt, 1991, p81) should be encouraged to spread into residual building space creating private social spaces and encouraging pedestrian movement.

-Nature corridors are to be pushed along paths of movement creating strong links between cultural, social,



3.7 Apies River link to Zoological gardens

entertainment and open spaces, while encouraging the further development of these facilities (See fig.3.9).

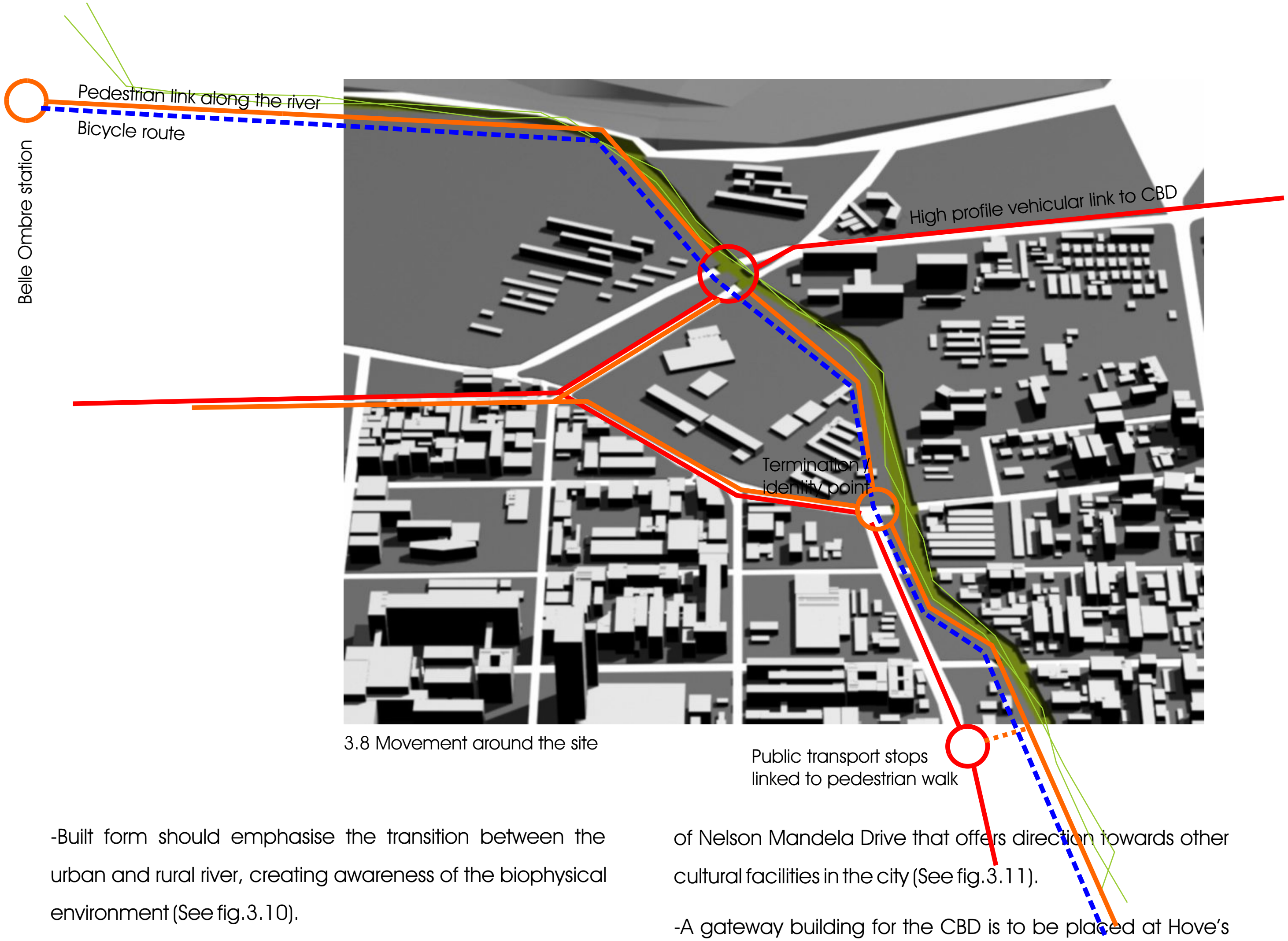
-Built form should be integrated into the landscape creating semi-enclosed spaces for social interaction, integration of indoor and outdoor space and creating a responsive space on the river.

-When possible, trees should be planted rather than shrubs as this allows for visibility through the greenbelt and prevents hiding spaces for undesirables.

-Biophysical landscaping should take place as this requires a lower maintenance, allows the greenbelt to spread on its own and increases the bio-diversity.

-Create a damming system (with early flood warning devices) where the channel changes from concrete to natural to slow the water velocity, preventing erosion at this point (See fig.3.10).

-Use this damming system as an alternate small-scale energy source.



3.8 Movement around the site

-Built form should emphasise the transition between the urban and rural river, creating awareness of the biophysical environment (See fig.3.10).

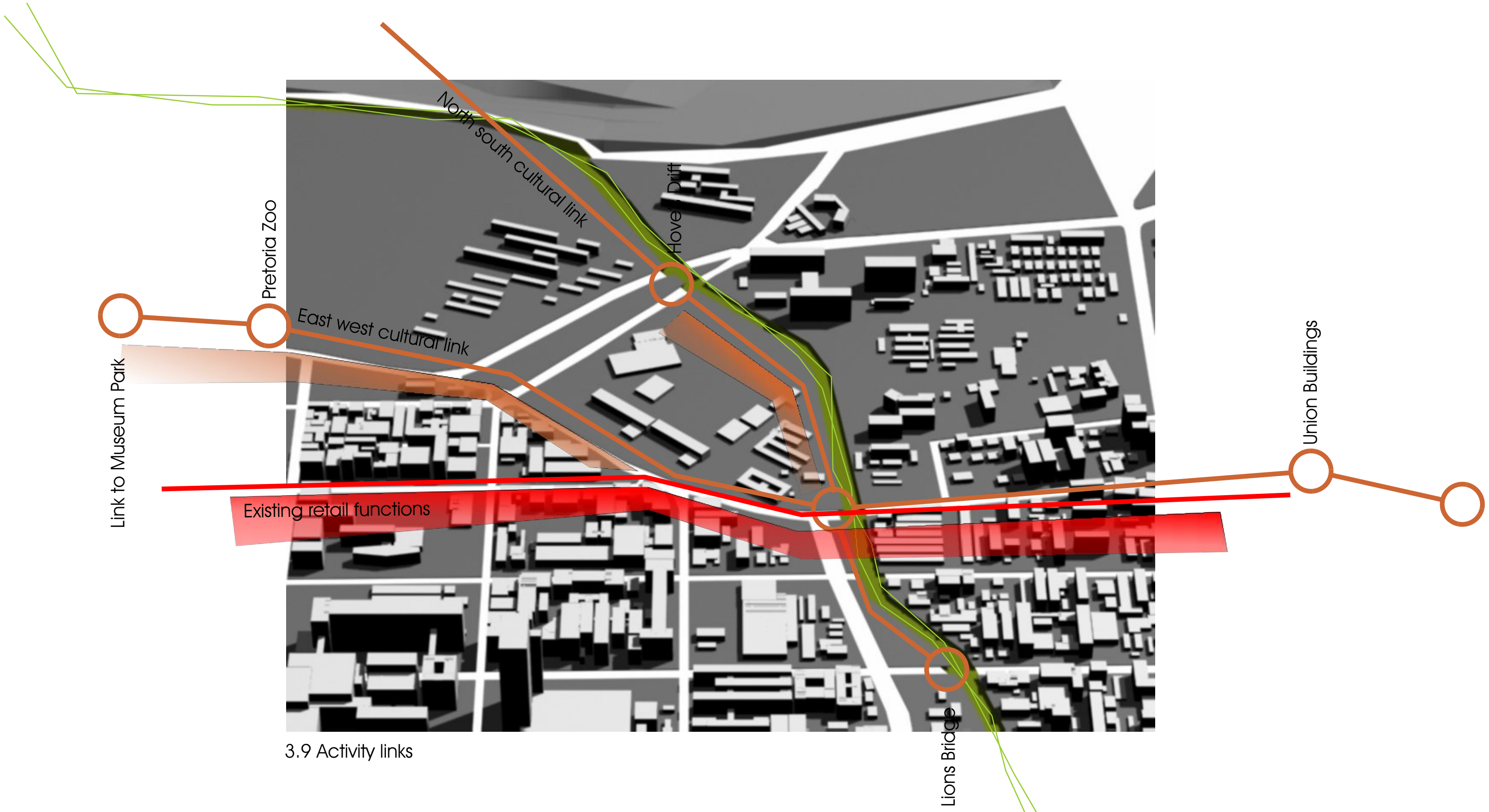
-New buildings along the river should be permeable providing sight lines to the river, especially for the higher areas to the east. Panoramas of the city skyline and ridges should not be obscured.

3.3.2 Movement

-There needs to be a strong identity node at the termination of Nelson Mandela Drive that offers direction towards other cultural facilities in the city (See fig.3.11).

-A gateway building for the CBD is to be placed at Hove's Drift. It should be a mix-use building that facilitates the existing taxi-terminus, and should pull trade activity from Marabastad and push pedestrian activity along Nelson Mandela Drive northwards.

-A strong pedestrian route is needed to link the taxi-terminus to Belle Ombre train station. This route is to continue



3.9 Activity links

southwards to Nelson Mandela Drive.

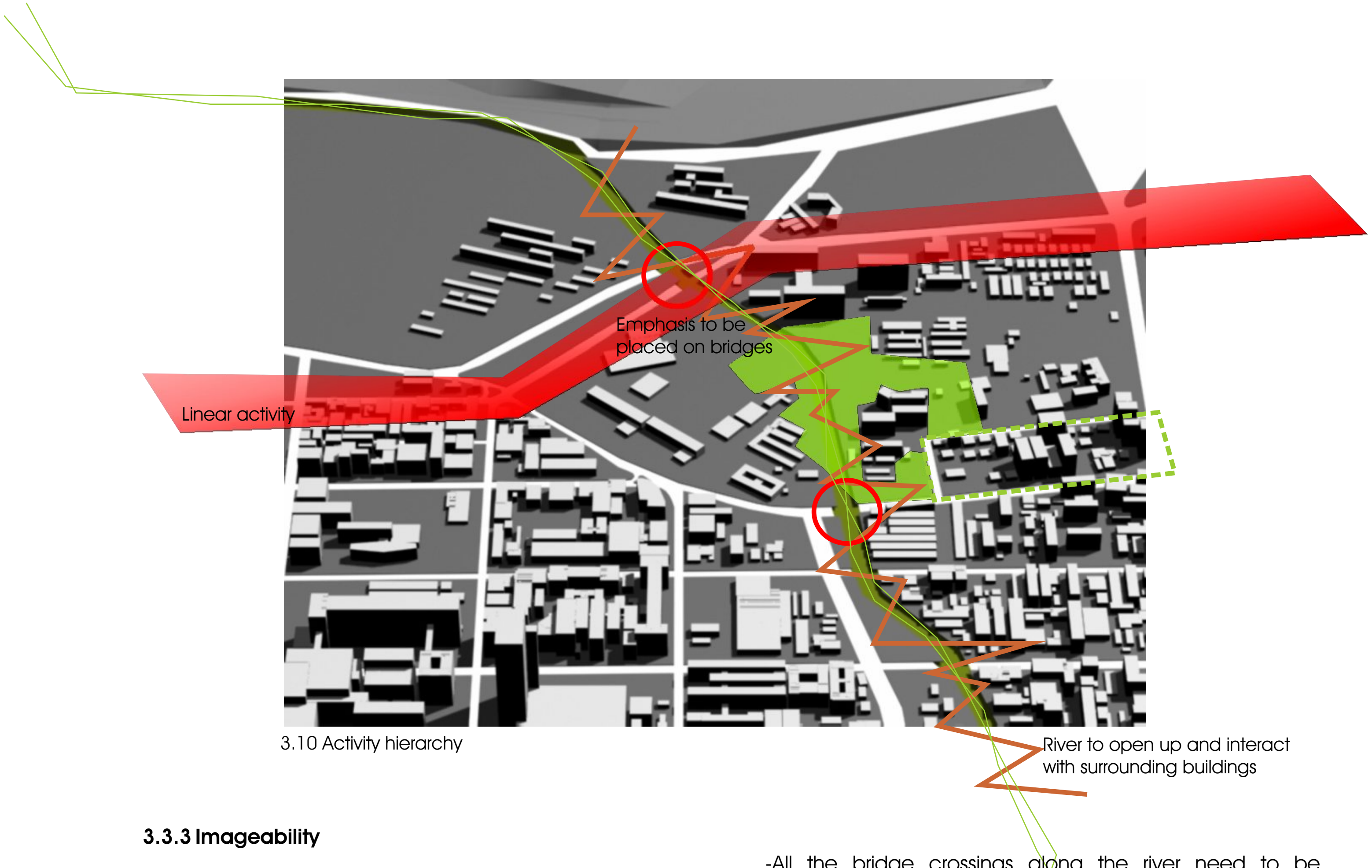
-A bicycle path should follow this pedestrian route to encourage alternative transport methods.

-Car parking should be placed near the river with public transport stops at regular intervals along the river to promote the river as an activity spine.

-Establish an east/west cultural walk from the Zoo / Aquarium (where it ties to 'Museum Park') to the Union Buildings with retail / entertainment facilities to be located along this. Extend this walk to the Pretoria Art Gallery (See fig.3.12).

-A north/south cultural walk exists (See fig.3.17). Where these walks intersect at the Apies River, a strong cultural node is to be formed.

-Maintain the existing retail functions along Struben Street to form a soft edge to define the south end of the precinct.



3.10 Activity hierarchy

3.3.3 Imageability

-A linear focal point or active edge is needed on Dr Savage Street to slow traffic, integrate the two adjacent land parcels and create awareness of the facilities within the precinct (See fig.3.13).

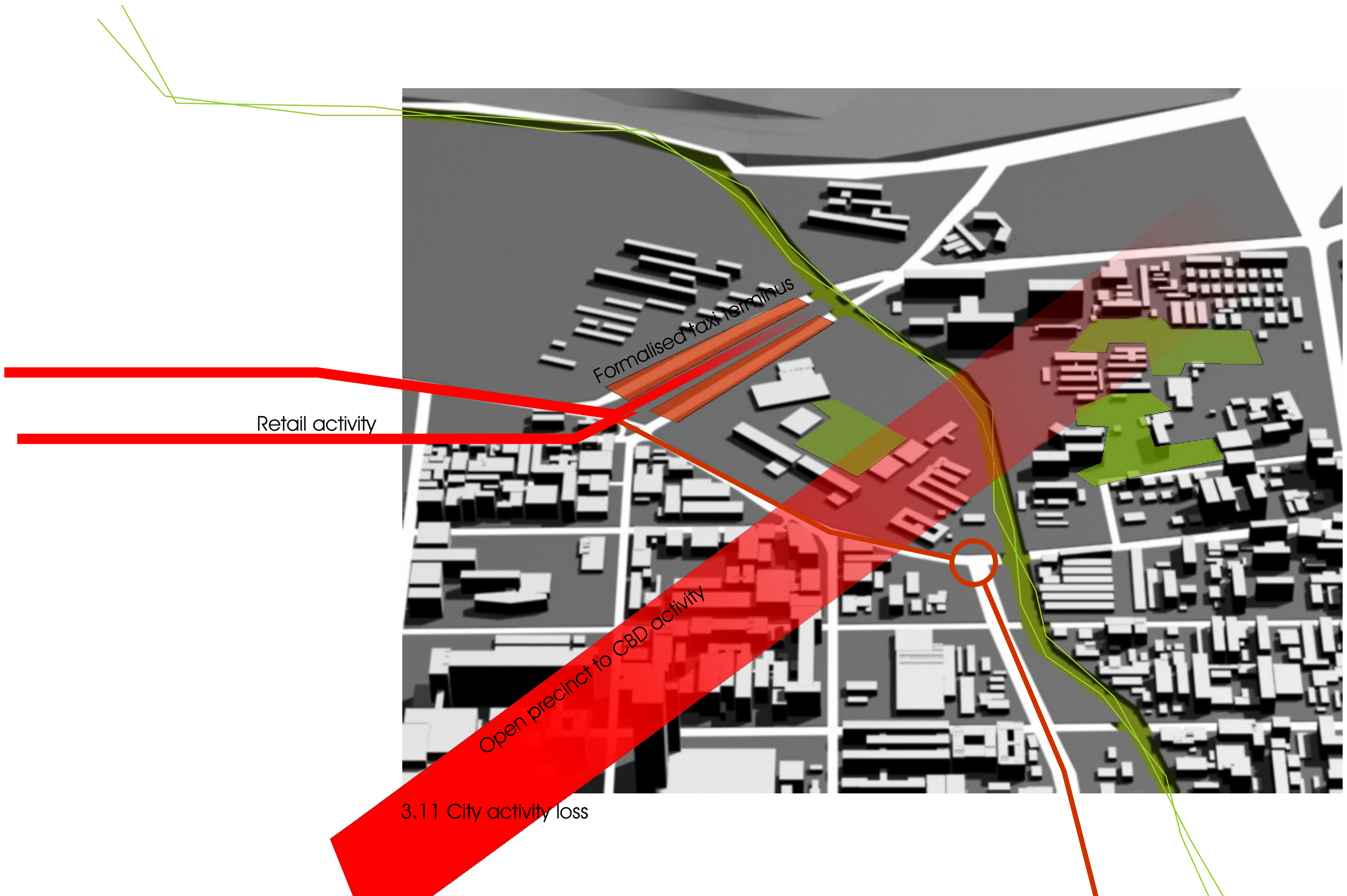
-Perimeter walls need to be both physically and visually permeable, contributing to the imageability of the precinct.

-Existing walls along the river should be opened-up providing views on and across the river (See fig.3.13).

-All the bridge crossings along the river need to be accentuated creating awareness of the river and emphasising its cultural heritage.

-Public amenities, bus stops, street furniture etc. are to be provided along the river. These must reflect the image of the river to form a coherent linear structure.

-The existing residential pocket should be reserved for student accommodation, linking nodes within the precinct. Spaces amongst the existing institutions should be tied to the



3.11 City activity loss

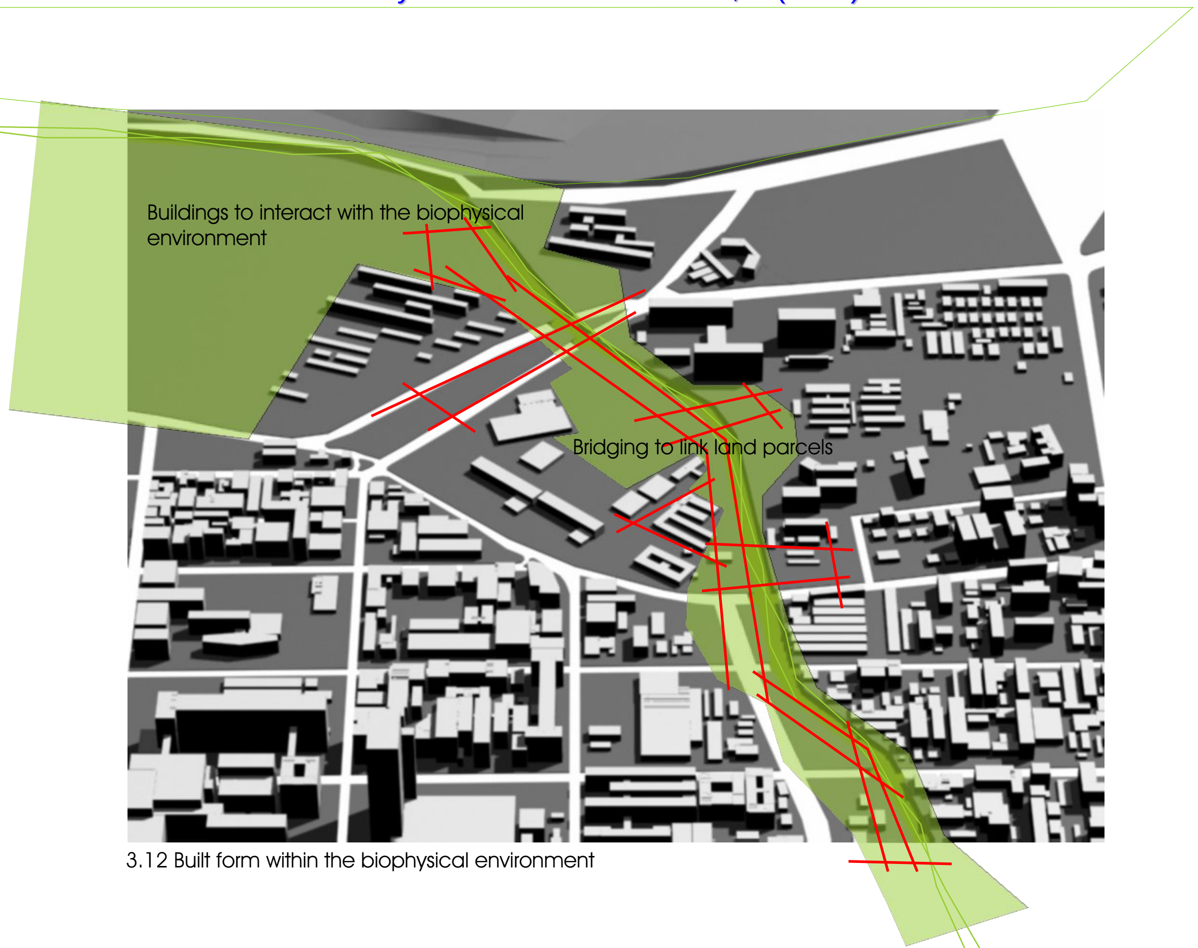
residential pocket with recreational facilities.

-The taxi-terminus at Hove's Drift should be formalised and a retail/trade node should be developed here. This will pull the trade activity from Bloed and Boom Streets into the Hospital precinct and tie these activities to a strong north/south pedestrian route (See fig.3.14).

-Informal taxi stops along Du Toit street need to be moved to this node, opening Du Toit street to stronger cultural / pedestrian route, helping to direct activity along Nelson Mandela Drive.

-The precinct needs to be opened-up to inner city activity from the south-west, however small private spaces should be established for the institutional users (See fig.3.14).

-Existing buildings need to open up onto the river. These buildings should be reserved for mix-use with an emphasis on entertainment and small scale retail on ground level (activities to overflow outdoors) and residential on the floors above .



3.12 Built form within the biophysical environment

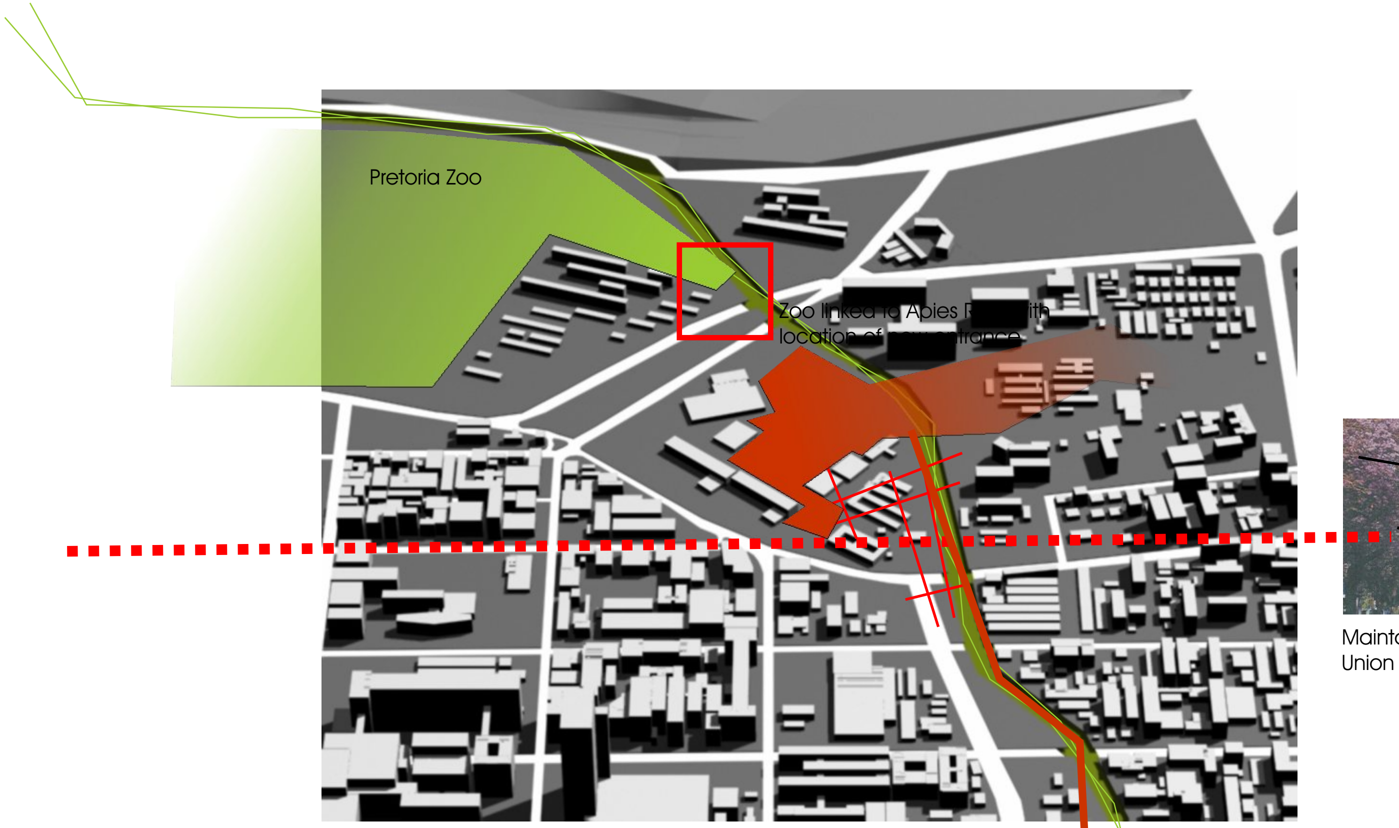
-New buildings are to celebrate the river and interact with the biophysical environment. They should follow the form of the river so as not to create any possible lost spaces (See fig.3.15).

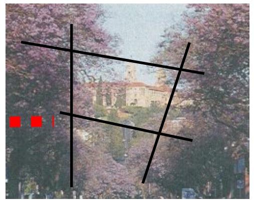
-Flood plains should be reserved for biophysical vegetation and pedestrian movement.

-Bridging should be encouraged within the large land parcels. This will form links across the river and create an awareness of the river.

-Prefabricated structures along the river should be replaced with more responsive, appropriate building types that will enhance the qualities of the green belt.

-Existing historical buildings and those with architectural merit should be emphasised and integrated into the green belt system.





Maintain sight line to Union Buildings

3.13 Implied cultural links

Arts walk linking Pretoria Technikon Arts campus and Caledonian precinct

3.3.4 Cultural

-All the cultural / historical assets (See fig.3.17) along the river should be made recognisable. Relevant information (placards, booths, tours, etc) is to made available within these areas. This will create a strong cultural / educational walk along the entire river.

-The Caledonian precinct is recognised as an arts and culture node, associated facilities must be encouraged to become established here. A link to 'Museum Park' should be established (See fig.3.17).

-The open grounds on the Pretoria Technikon Arts campus should become a public sculpture garden integrated into the greenbelt, from which a strong link must be made to the Caledonian precinct (See fig.3.16).

-Enforce the gateway at Hove's Drift by locating a new entrance to the Zoo on Soutpansberg Street. The recreational activities within the Zoo are to be extended to the new entrance, tying them into the Apies River green belt

3.14 Cultural assets along the Apies River

and pulling them into the city and encouraging pedestrian activity northwards (See fig.3.16).

-The Pretoria Technikon Art Campus and the medical campus should be linked over river (through the sculpture garden) to form a student activity node. A pedestrian link could form between this node and the Caledonian arts node.

-Buildings along the Struben Street Goverment Boulivard must not obstruct any sight lines to the Union Buildings. New buildings on the Technikon Art Campus should frame views of the Union Buildings (See fig.3.16).

4. Precedent Studies

4.1 Linked Environments

-Renzo Piano's Building Workshop offices & UNESCO Laboratory
-Vesima, Italy
-Renzo Piano, 1991

Renzo Piano's workshop building sits on the slopes of the Gulf of Genoa, Italy and serves as the home for the Renzo Piano Building Workshop and UNESCO Research Laboratories (Betsky, 2002, p55).

The main structure of the building is a series of square steel sections that are secured to concrete retaining walls, along which a steel sub-frame runs between the retaining walls and supports the timber floor. The timber floor is reflected by the laminated timber rafters and beams that hold the glass roof panes (Buchanan, 1995, p76). Above these, a system of mechanical louvres and solar cells respond by opening or closing depending on the level of light outside (Piano, www.rpwf.org/frame_workshop.htm).

The building cuts into the slope on which it sits and lies parallel to it (Betsky, 2002, p55). It is tied to the land with a strong fusion between the interior and exterior environments that is formed by the series of terraces that remain uninterrupted from the exterior of the building through the interior. On plan, the building is staggered, forming social spaces on the terraces. Along with the timber structure, interior planting and glass walls, the interior-exterior boundary becomes very blurred.

This indoor-outdoor fusion also occurs perpendicular to the terraces, with outdoor spaces in the form of balconies

4.1 During the day, the building disappears into the slope, while at night it seems to step away from the slope, completely exposing the interior as its own environment.

punching through the roof, providing vistas down the slopes to the coastline. The glazed walls and roof, along with the open plan provide complete permeability, creating an awareness of the land on which the building sits and also the distant surrounding environment.

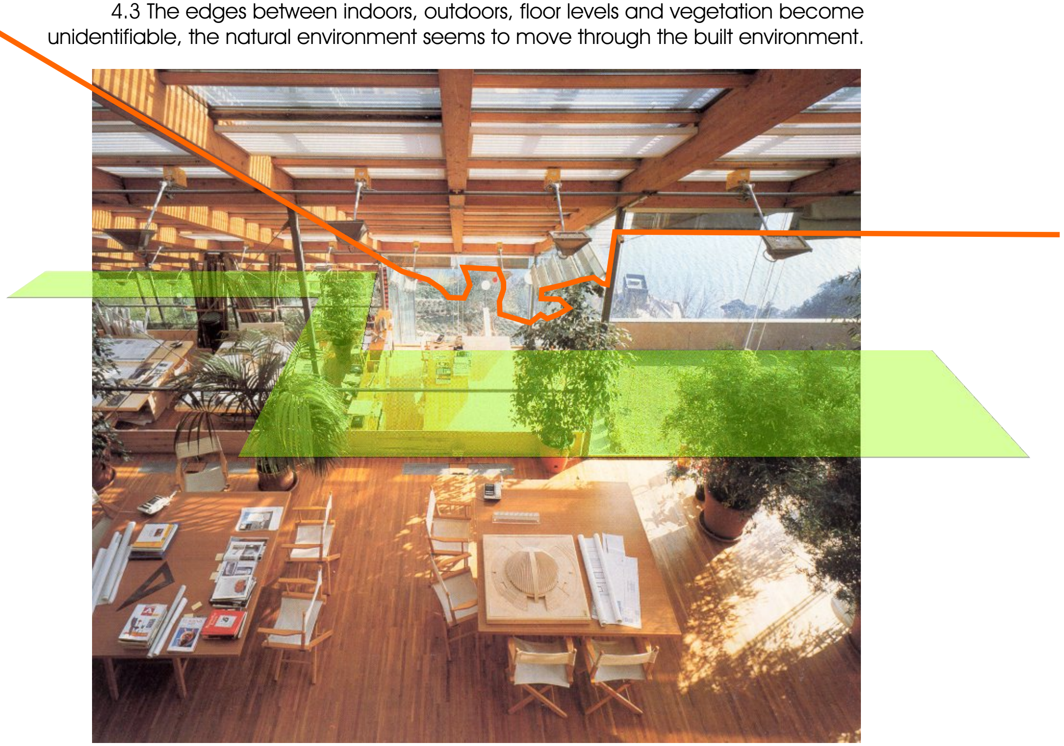
The interior terracing provides a sequence of spaces that create an awareness of the building itself (Piano, www.rpwf.org/frame_workshop.htm). The sequence of spaces may or may not create a hierarchy of uses, but the potential of doing so exists. The terracing of the land is an ancient agricultural practice of the region (Betsky, 2002, p55); implementation of these terraces therefore not only provides a strong physical link to the land but a less obvious cultural recognition emerges.

The transparency of the building contributes to the awareness of the surrounding environment in reverse by allowing the light reflections from the water in the gulf below to scatter within the building.

The retaining walls make a more physical response to the environment by being built in the same rough stone and finished with plaster and a pale pink paint reflective of the surrounding buildings (Buchanan, 1995, p76).

4.2 The natural materials and invisible roof and walls create a refreshing, open environment.

4.3 The edges between indoors, outdoors, floor levels and vegetation become unidentifiable, the natural environment seems to move through the built environment.



4.2 Cultural Identity

-Africa Centre for Health and Population Studies
-Somkhele, Kwazulu-Natal, South Africa
-East Coast Architects, 2002

The Africa Centre, designed by East Coast Architects is a research centre established by the Medical Research Council, University of Natal and the University of Durban, Westville. The centre is involved with office and field based research in health and population problems with its area of study being its immediate surroundings of the district of Umkhanyakude.

The building is made up of two clusters of buildings separated by a 15m water tower. The main building is made up of four research laboratories that enclose a courtyard used for social interaction. The rest of the centre consists of workshops, stores and security accommodation (Digest, 2003, p62).

A number of low-tech sustainable design solutions have been incorporated into the centre, it is through these that the building begins to reflect a regional identity.

The building structure is an exposed concrete frame with concrete block-work in-fill panels that are finished with decorative plaster work, murals and ceramic mosaics done by members of the surrounding community. The water tower is supported by trunks from the abundant Eucalyptus trees in the region. They also form the main roof structure while the saplings are used for shading devices.

Passive thermal controls have been extensively incorporated into the building. It is naturally cooled through 'stack effect' via the water tower, while internal courtyards provide the entire building with natural lighting and air changes. Temperatures are kept down further by minimising solar heat gain with deep overhangs on the north of the building and shading devices on the east and west facades.

Low-volume flush toilets and low-volume water showers are used to conserve water, along with the 'grey' water being used to irrigate the gardens. Sewage is treated on site and

4.4 North & west elevation

the purified water is used for the community vegetable garden while rainwater is collected and stored in tanks.

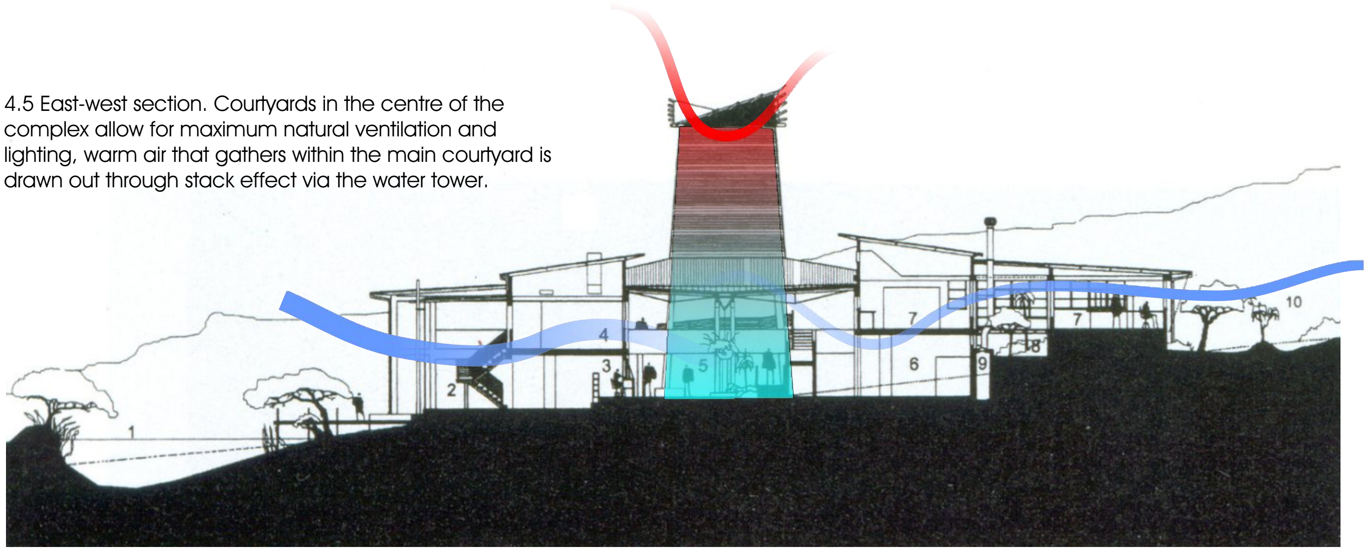
Indigenous plants within the building footprint were relocated off site while a small indigenous nursery provides plants for the site. Medicinal plants are also incorporated into the landscape to emphasise traditional healing methods (ibid).

By implementing these low-tech methods of thermal control and water conservation, they become obvious and possible solutions for the community to use and adapt into their own homes and work places. The centre not only serves the community on a functional and educational level, but provides a sense of ownership, this was achieved by using the community for all of the unskilled labour force and 75% of the skilled staff, while further members of the community were involved in the landscaping, arts and crafts for displays, sun screens, furniture, gates, furniture manufacture and mosaic work (ibid).

4.6 Corner detail. Natural materials used give the building a unique regional quality.

By involving the community on such a large scale, the building starts to develop a regional character of its own, especially with the paint and mosaic work. The use of natural/local materials and colour schemes that reflect the surrounding environment contribute to this character, as well as creating a building that the community can relate to and be proud of.

4.5 East-west section. Courtyards in the centre of the complex allow for maximum natural ventilation and lighting, warm air that gathers within the main courtyard is drawn out through stack effect via the water tower.



4.3 Inclusive Function

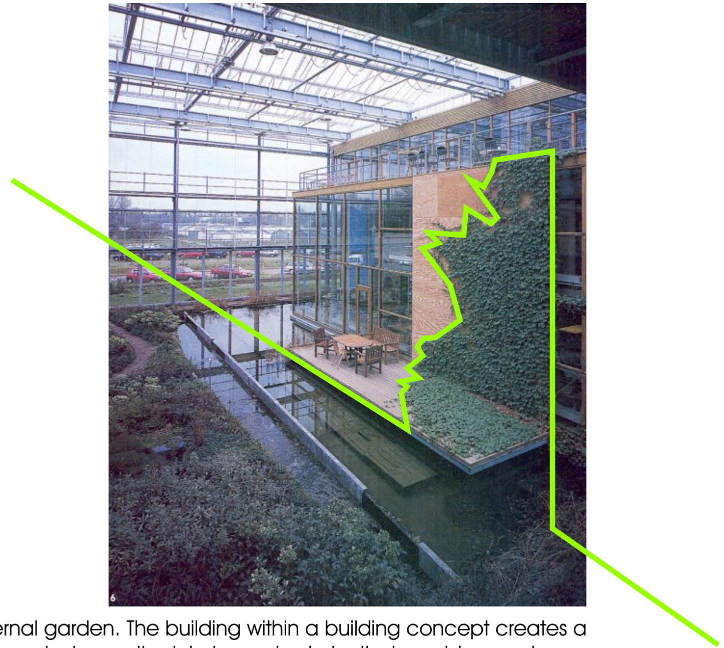
-The Institute for Forestry and Nature Research
-Wageningen, Netherlands
-Stefan Behnisch, 1998

The Institute For Forestry and Nature Research building is located in Wageningen, Netherlands, finished in 1998 by Stefan Behnisch of Behnisch, Behnisch and Partners. The concept was to create a building that could be environmentally conscious without spending any additional money in doing so. The building was also to represent the ecological concerns of the Institute.

The building is E shaped with the fingers housing the library, cafeteria, conference suite and offices while the spine houses the laboratories. Located between the fingers are the two glazed gardens (Metz, 2000, p96). The most important factor with these gardens is how they function within the Institute. The gardens have a multiple layering of uses, they obviously serve the tenants with social and recreation spaces, but are designed as an extension of the workplace and are used for meetings, briefings etc. The gardens are also home to many of the ecological experiments that the Institute undertake. The plants act as climatic buffers by humidifying hot air, cooling it, while in winter they act as solar collectors.

Other sustainable initiatives include rainwater harvesting and 'grey' water recycling for the ponds in the gardens, irrigation and reuse in the toilets. The gardens are enclosed with glazing and blinds are pulled shut at night to prevent re-radiation of solar gain, in summer if the temperatures become too high, the blinds will close and roof vents are opened to create 'stack' ventilation. The extensive glazing

4.7 Internal vegetation. Plants growing on the building continually change the image of the building. These plants are used for research within the institute.



4.9 Internal garden. The building within a building concept creates a giant air-gap between the interior and exterior that provides maximum temperature control. This allows for the use of large expanses of glass that seems to draw the external environment indoors.

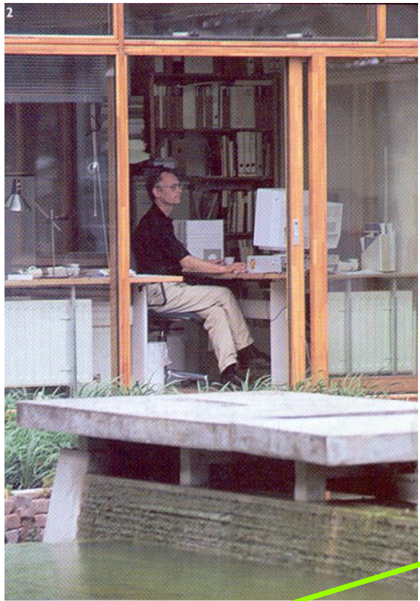
provides large amounts of natural lighting reducing the need for electric lighting, while temperatures are kept comfortable with the double glazing and timber frames.

The focus on the design was to reduce the embodied energy of the building, for this reason large amounts of timber where used because of its regenerable quality, but small sections were specified, thus using pieces that would normally have been thrown away. Sun screens and glass components are off-the-shelf greenhouse components used in a unique way.

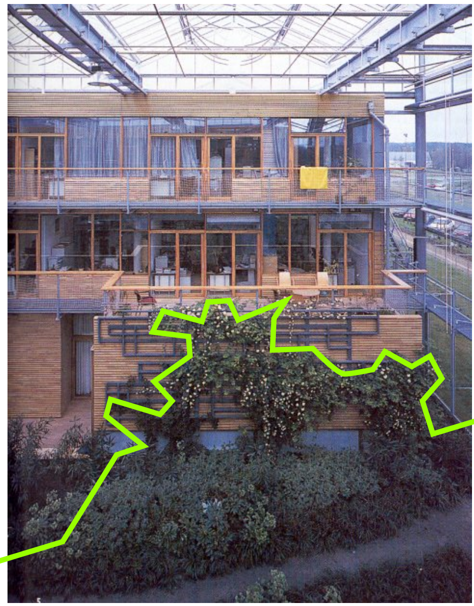
The offices have doors and windows opening directly onto the gardens encouraging manual thermal control and providing comfortable work environments (Blundell-Jones, 2001, p29).

4.9 Internal courtyards. Office activities are encouraged to overflow to the exterior so movement paths become active spaces.

4.10 Office spaces. Large openings give tenants complete thermal control while allowing for interaction with the outdoors.



4.11 Internal-external connection. Vegetation is encouraged to grow over and through the building, giving a relatively simple building form a composition of ever changing forms.



TECHNICAL INVESTIGATION

5. Baseline criteria

5.1 Principles

The design principles behind the Ethnobotanic Research Centre (EBRC) are based on limiting the pressures placed on one of South Africa's ecological resources; medicinal plants. This positive regional impact should however not be contradicted with EBRC generating a negative large scale impact.

To begin to limit the ecological pressures generated through the built environment, the following criteria set in the Sustainable Building Assessment Tool (SBAT) are to be met. Not all of the criteria listed in the SBAT are mentioned in this thesis as they are management issues that only come into effect once the construction process is finished.

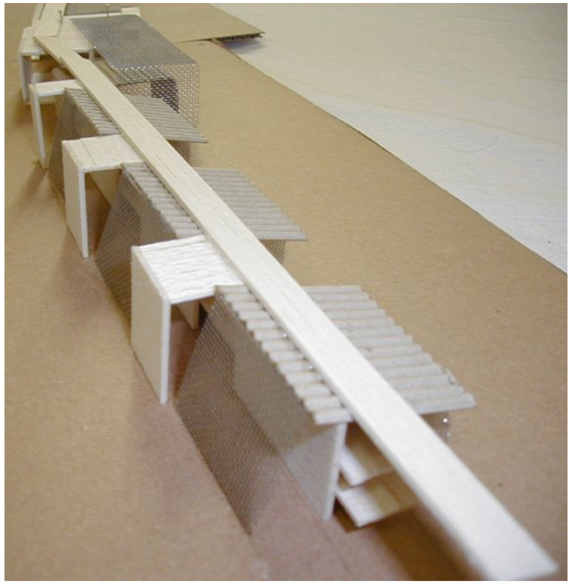
5.2 Occupant Comfort

-Ventilation

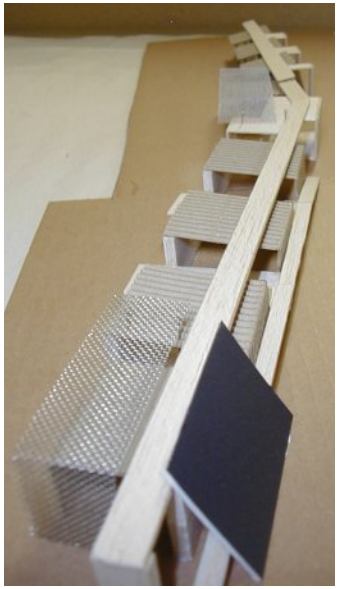
The EBRC is to be ventilated through natural means; the areas that require mechanical ventilation are the physiology labs, chemical store, cold room, kitchens and bathrooms. The chemical store is connected to a separate ventilation system to prevent the spread of chemicals. The physiology labs and cold room need desired temperatures to remain constant and are therefore on a separate HVAC system so temperatures can be controlled accurately.

None of the inhabited spaces in the EBRC exceed a depth of 10metres, which allows for natural cross-ventilation that will occur through fully opening doors and windows. Although Pretoria has very low wind speeds, weather screens will be needed so that windows and doors will never have to be

5.1 Northen perspective [concept model 01]



5.2 Southern perspective [concept model 01]



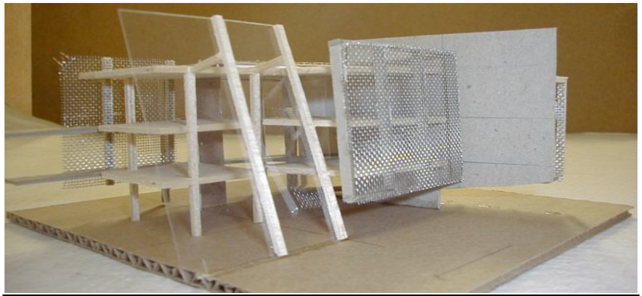
5.3 Perspective [concept model 02]

closed if not wanted. The laboratories are backed by the terrariums, so cross-ventilation will need to be induced through stacks. There is a mechanical backup water cooled system.

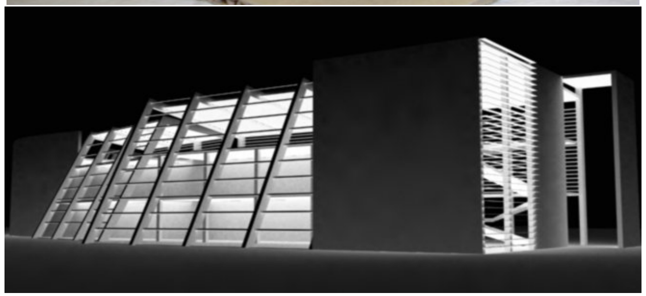
-Thermal comfort

The terrariums serve as a double-glazing system to the laboratories, so maximum natural lighting is provided through the terrariums but because their climates are controlled, high temperatures are not transmitted into the labs. Plant screens enclose the southern façade, creating a cooler outdoor environment in summer and reducing the need to cool the interior. In winter these prevent any cold winds that might occur from penetrating the building.

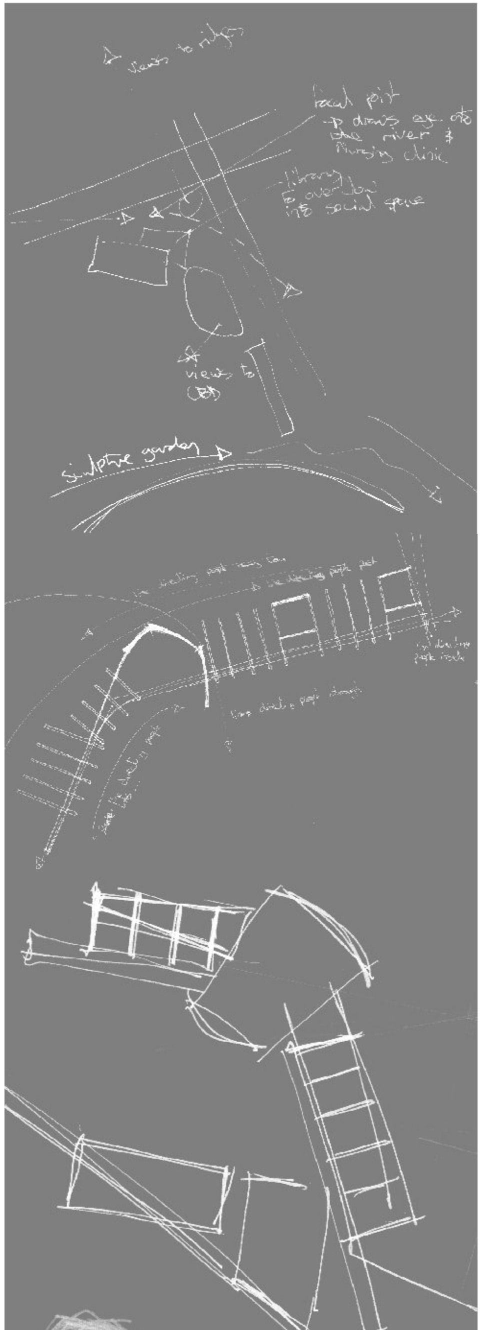
Roof gardens are utilised throughout the EBRC, which help to regulate internal temperatures through insulation and shading. While 60% of the solar radiation is absorbed



5.4 Perspective of first office set [conceptual model 04]

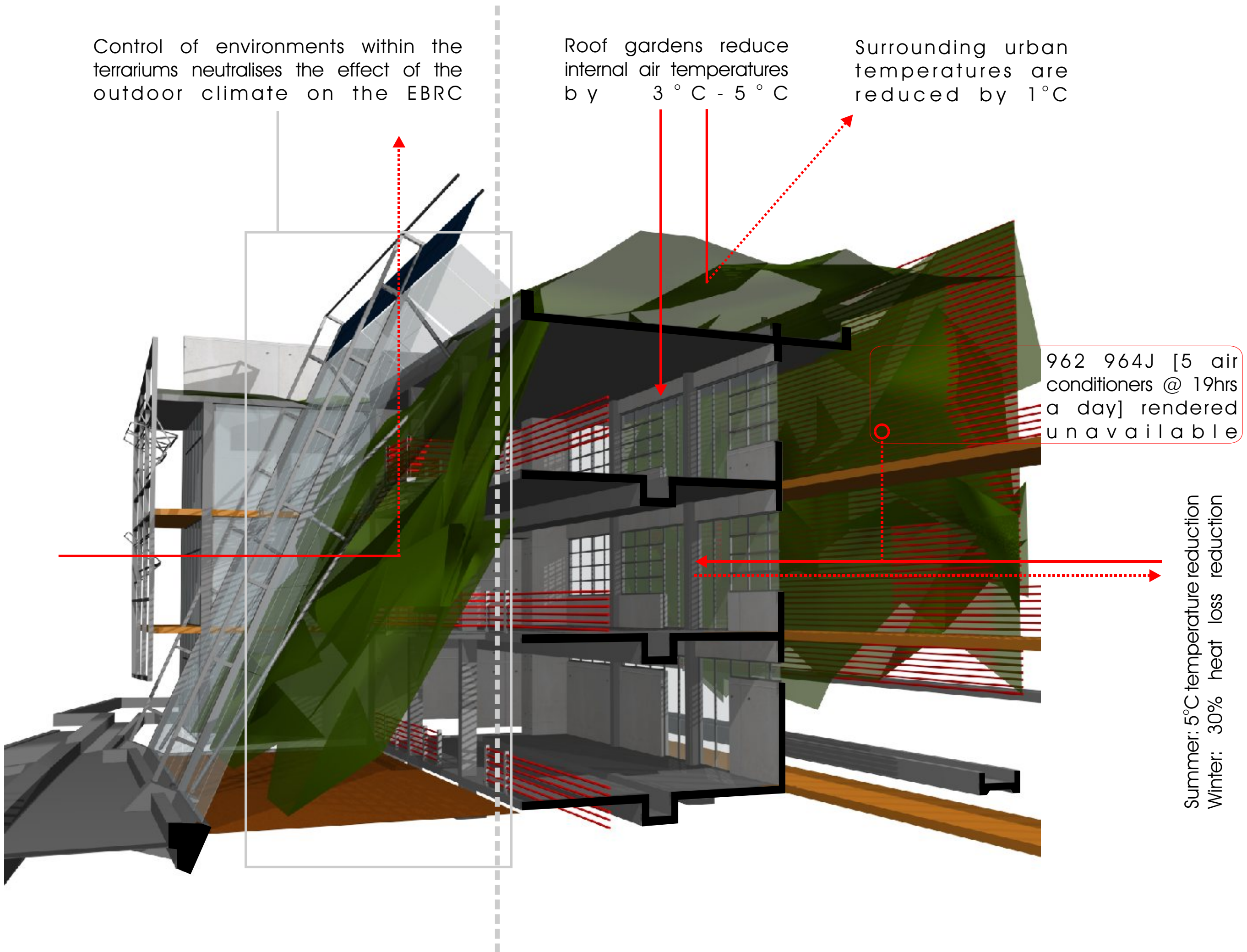


5.5 Conceptual *3D Max* model of first office set



5.6 Design development sketches

5.7 Sectional perspective of final *3D Max* model showing microclimate control



AMALGAM:

MICROCLIMATE CONTROL

through evapotranspiration, exact figures of temperature control are hard to calculate because (Ong B. Lim G, 2002, p3):

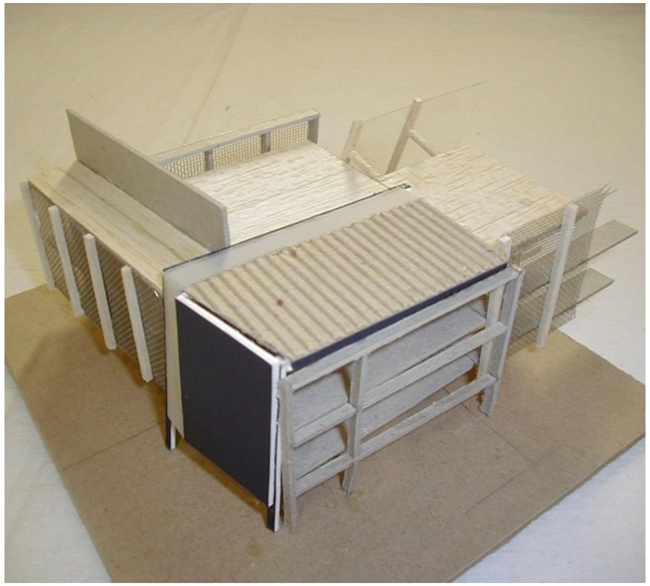
>The soil the plants grow in is not always of consistent density.
>There are usually variable amounts of water in the soil.
>There is a continuous change in root development and soil penetration within the soil.
>There is a continuous change in plant mass and leaf surface area during growth.

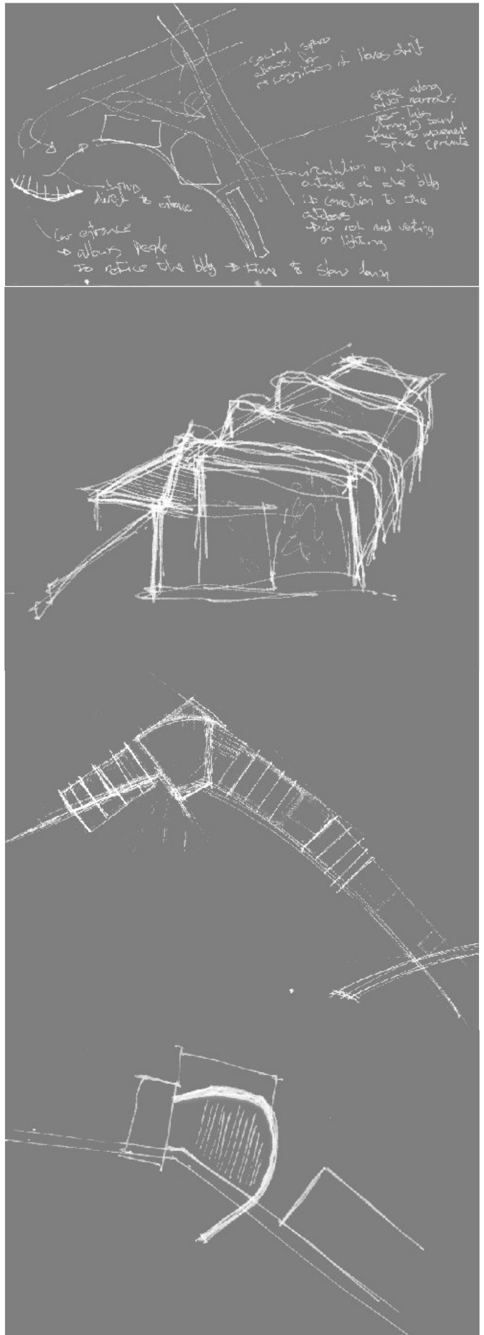
To duplicate the effect of the planted roof, the roof will have to be heavily insulated, shaded and the roof surface aerated. The impact of the plant roofs reduce the internal air temperature by 3°C-5°C and the surrounding urban temperatures by about 1°C (Ong B. Lim G, 2002, p16).

-Lighting

Glare causes high occupant discomfort and occurs when a

5.8 Perspective of entrance [conceptual model 04]





5.9 Design development sketches

bright source is viewed from an area in relative darkness. A room of 3m high and 6m depths should achieve a daylight factor of 1.5-2% at the back of the room to eliminate glare. This is achieved through a 20% glazing to wall ratio (Daniels, 1998, p72).

-Views

The north / south orientation of the EBRC allows for uninterrupted views up the Apies River and across the Zoological Gardens to the Witwatersberg Range to the north. Views of the CBD skyline are to the south. With part of the EBRC being turned to the river, views eastward through the terrariums of the river and Nursing College are achieved. This orientation provides views in the opposite direction of the old Prinshof School building. The library and café with its outdoor seating space are directly orientated to face the bridge over the Apies River.

-Noise

The only areas of the EBRC susceptible to traffic noise are the laboratories in the western end of the EBRC; however the connected terrarium acts as double-glazing, reducing the traffic noise to below 65dbA. Facilities that are infrequently used, such as the cold room, dark room and physiology labs are placed here.

-Indoor / Outdoor connection

The terrariums create a strong visual connection between the internal and external environments and blur the boundary between the two. Physical connections between the indoors and outdoors are made by having all the ground floor facilities opening and directly accessible to the outside.

5.10 Views through the EBRC

All of the movement through the EBRC takes place outdoors along covered walkways on the southern side of the building, which are enclosed with plant screens.

5.3 Inclusive Environments

-Transport

An informal taxi terminus is located directly across from the EBRC over Dr Savage Street and is proposed in the ARUDF to be converted into a formal public transport terminus. The ARUDF also proposes a bus/taxi stop to the south on Struben Street.

Pedestrian movement is encouraged along the length of the site and between the EBRC and the MRC with safe, well-lit and easily identifiable routes.

-Circulation

The maximum height of the EBRC is 3 stories, so mechanical vertical circulation is unnecessary. A ramp is located at the entrance to the building and two stairwells provides vertical circulation in the middle and at the eastern end of the building. All horizontal movement is located outdoors, preventing the need for any artificial lighting or ventilation. These walkways are weather protected by a number of plant screens.

-Furniture & Fittings

All mechanical equipment is to be located against external walls so that the heat released by the machinery can be transferred through the wall to the outside.

5.11 Proximity of other facilities to the EBRC

5.4 Access to Facilities

-Childcare

The close proximity of the childcare facilities in the Femina Clinic omits the need for facilities in the EBRC.

-Banking

Secure banking facilities are located at the Sancardia shopping mall about 400m away.

-Retail

There are no retail facilities within the EBRC but the ARUDF proposes facilities within the transport terminus across Dr Savage Street.

-Communications

All tenants of the EBRC will have access to Internet facilities in the main library. Major postal services are offered at the main post-office at Church Square, which is located about 1km from the EBRC.
1km from the EBRC.

5.5 Participation & Control

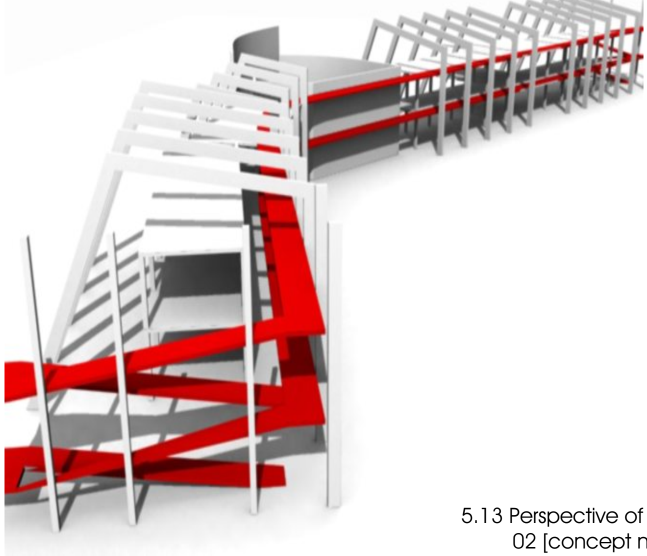
-Environmental control

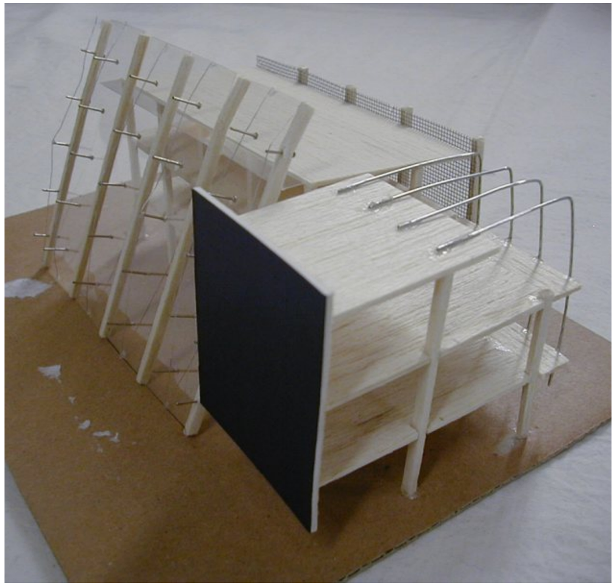
Opening windows and adjustable screens will give occupants a certain amount of control over ventilation and lighting. Task lighting will give occupants control over their immediate space but ambient lighting will be sensor activated at night, which can achieve energy savings between 25-50% (Vishal G. Bansal N, 1999, p81).

-Social spaces

Semi-private space overflows from the cafeteria, with public space adjacent to that along the river. Semi-public spaces overflow from the facilities on the ground floor onto the

5.12 Conceptual 3D Max model indicating horizontal movement through the EBRC





5.13 Perspective of office set 02 [concept model 03] campus gardens.

-Toilets

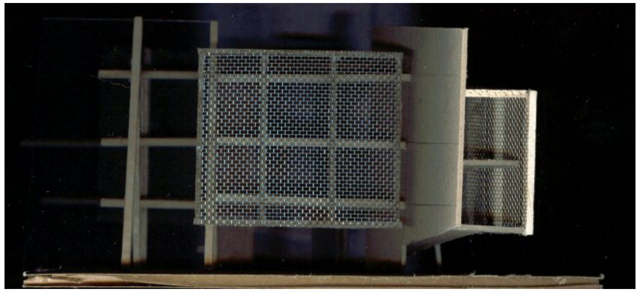
Toilets are located on each floor in the middle of the building, located together.

-Local community

The EBRC is based around awareness of cultures and knowledge transfer so that the community in general is encouraged through the centre. The areas that are physically inaccessible to the public remain visually open so that people are still aware of the activities.

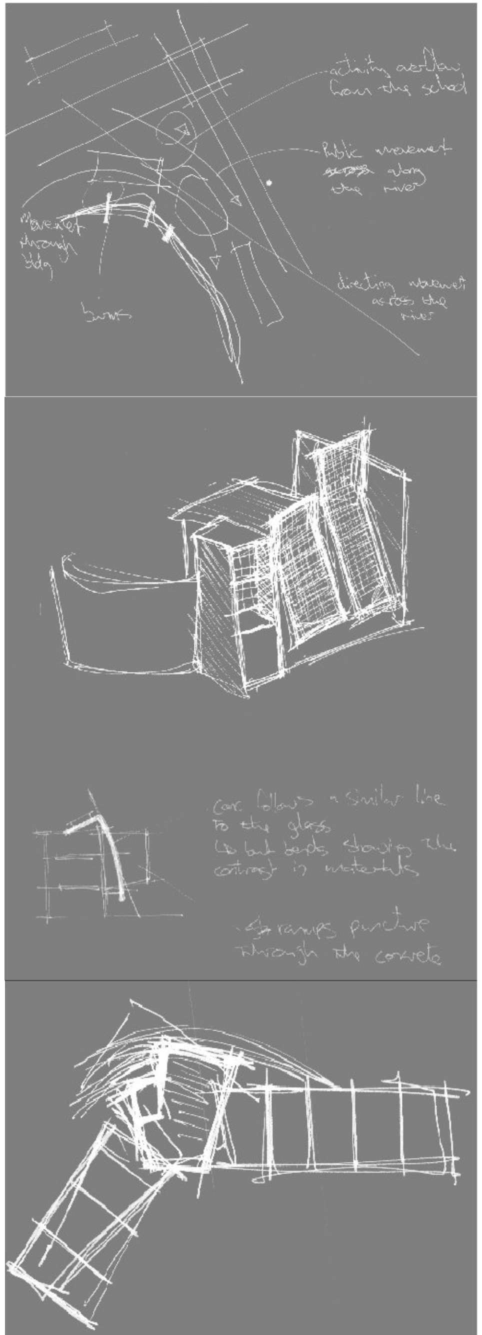
The auditorium is open for public use and the terrariums are open for public viewing. The medicinal plants grown on the site are open to supervised/informed public harvesting.

5.6 Education, Health & Safety



5.14 Elevation of office set 01[concept model 04]

5.15 Southern facade of the auditorium [concept model 04]



5.16 Design development sketches

-Education

Public tours and exhibitions through the EBRC will provide information on medicinal plants, their medical properties, curing properties, parts used, current research findings, etc. A strong emphasis will be made on the origins of use, i.e. the communities that used them, spiritual associations, ceremonies etc.

-Indoor air quality

When the CO_2 content in a room reaches 0,1%, it is considered to be of bad quality. With air intake being from the outside and avoiding the use of re-circulated air, the CO_2 levels can be maintained below 0,1% (Daniels, 1998, p93).

-Exercise & recreation

Large green open spaces that already exist will be retained allowing occupants to utilize.

5.7 Local Economy

-Local contractors

Contractors and workforce based within the Pretoria region will be employed unless expertise from further afield is needed.

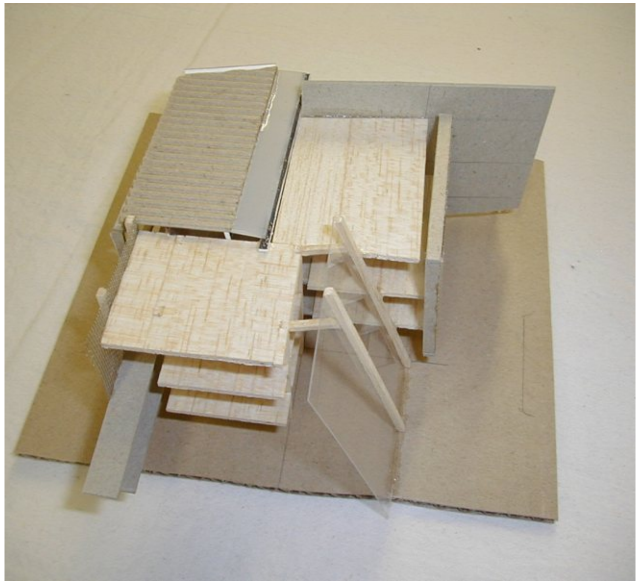
All materials and components are to be sourced within 200km of the site, although certain machinery for the laboratories will have to be obtained from specialised suppliers.

5.8 Efficiency of Use

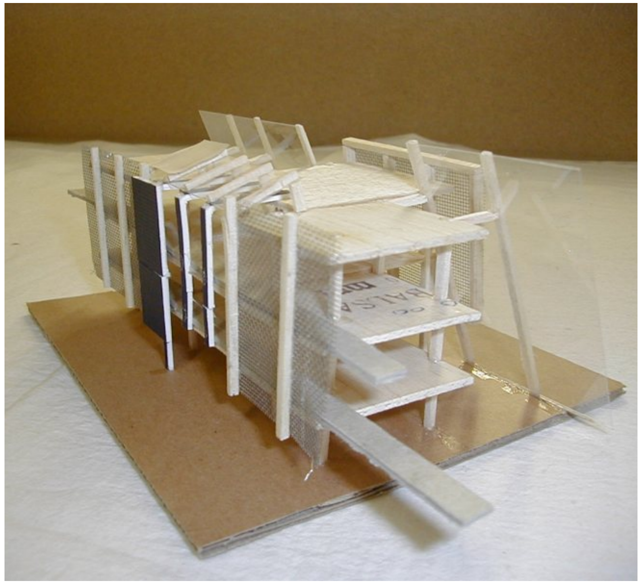
-Occupancy schedule

By integrating the research and general laboratories, use

5.17 Entrance and office set 01 [concept model 04]



5.18 Office set 02 [concept model 04]



thereof will occur after regular working hours and on weekends, creating a possible occupation of more than 50 hours a week.

The library and auditorium too are shared for maximum occupancy and minimum material use.

-Management of space

The offices are the only non-shared working spaces, but are open plan, minimizing the area used and materials needed.

Utilisation of facilities such as the isolated laboratories and waste disposal at the MRC prevents the need for construction of these in the EBRC.

-Disruption & downtime

Photovoltaic panels are used for electricity generation and can serve as backup during power cuts.

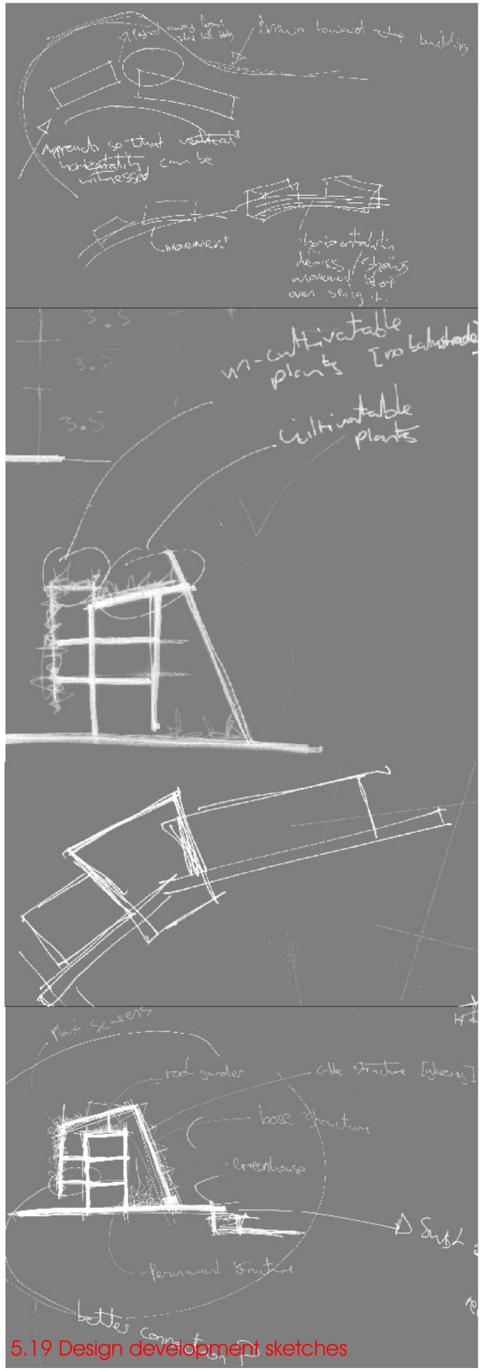
5.9 Adaptability & Flexibility

-Internal partitions

In the Research component the internal partitioning will mostly be of glass, allowing for maximum flexibility, hygiene and natural lighting.

-Structure

The structure is based around a concrete column and slab system on a 5x7m grid. This structure is permanent but allows for flexibility through the infill panels. The terrariums are less flexible in terms of function, but are constructed of an easily dismantled glass and steel structure.



5.19 Design development sketches

-Service spaces

Services run through a series of vertical and horizontal ducts, accompanied by dropped ceilings.

5.10 Capital Costs

-Use of existing

Facilities at the MRC will be shared by the EBRC and vice versa.

-Shared cost

The cost of the EBRC is shared between 4 parties, the MRC, University of Pretoria and the Department of Arts and Culture and Science and Technology. This obviously decreases the individual cost but could create problems with ownership in the future.

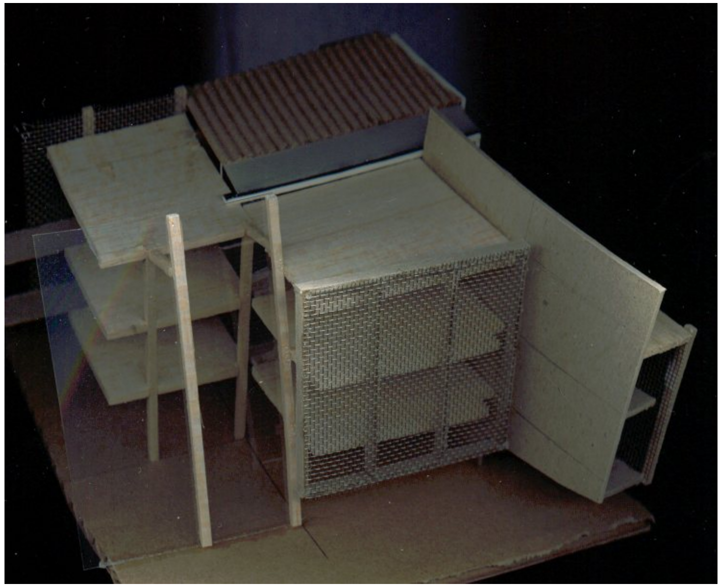
5.11 Water

-Rainwater

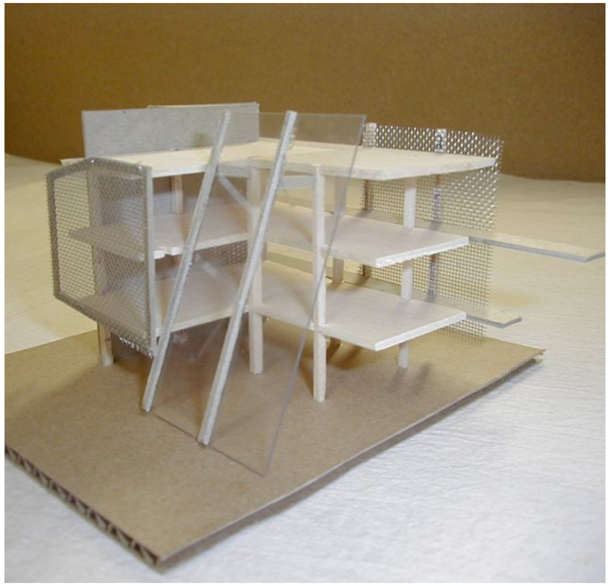
The relatively high amount of vegetation throughout the project requires large amounts of irrigation, it is therefore important to collect as much rainwater as possible. Throughout the site, 8 528kl of water can be collected annually from the roofs of existing buildings alone. This rainwater would otherwise be drained off the site, whereas there is a possibility of collecting that water and releasing it when needed for irrigation. The annual amount of rainwater that can be collected as runoff from the roof gardens is indeterminable as many factors influence this, namely:

>Amount of rainfall in one shower
>Amount of water retained in the soil
>Dryness of the soil
>Amount of vegetation

5.20 South east perspective of ramps [concept model 04]



5.21 Perspective of office set 03 [concept model 04]



Any excess rainwater from the roofs, walkways and landscaping will be directed into the wetland and gray water system, recycled and used for irrigation.

Total amount of collected rainwater:

=collection area x annual rainfall
=1 2183m^2 x 700mm/year
=8 528m^3 / year
=8 528kl / year

Size of rainwater storage A
=collection area x highest months rainfall
=5 112m^2 x 136mm for January
=659m^3

Size of rainwater storage B
=collection area x highest months rainfall
=5 367m^2 x 136mm for January
=729m^3

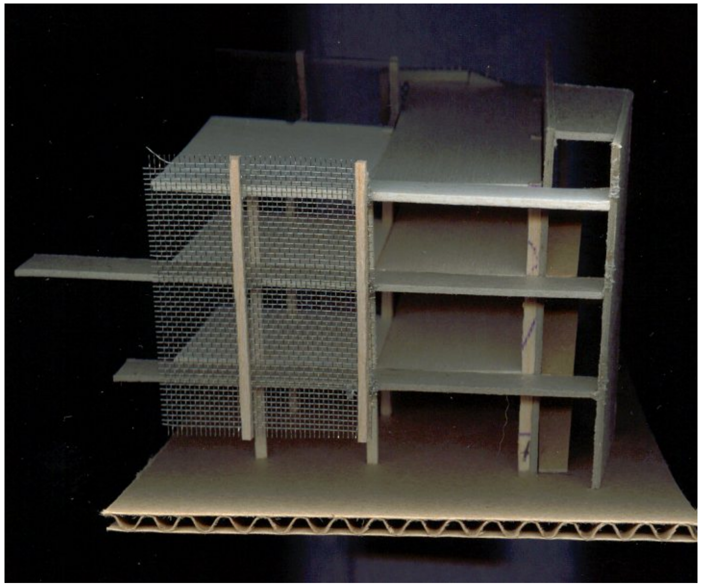
Size of rainwater storage C
=collection area x highest months rainfall
=1 700m^2 x 136mm for January
=231m^3

-Gray water

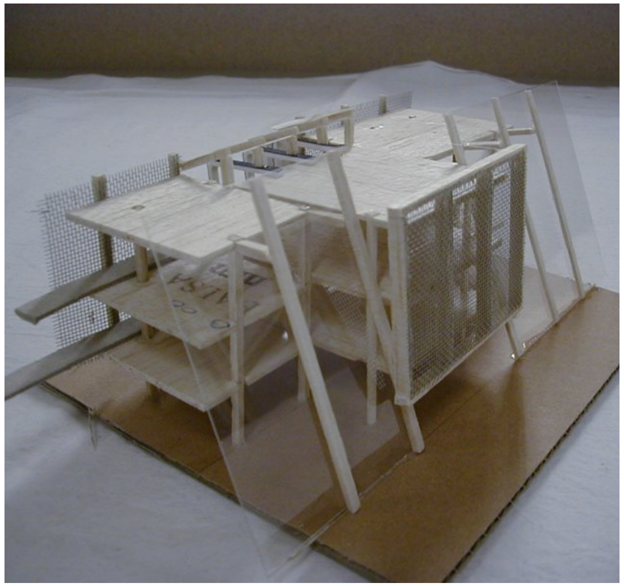
Water from the wash basins will be directed into the wetland, but it is important that organic soaps are always used as a high concentration of soap can kill the aquatic plants. Water from the kitchen will pass through a fat and grease trap before being fed into the wetland. If not, the grease will prevent the water from being aerated and the plants will suffocate. Runoff water from the terrariums and cultivated areas can be directly put into the wetland to get rid of any fertilizers.

The aquatic medicinal plants that are cultivated for research purposes will be grown in the last sections of the wetland system so that they are grown in relatively clean water.

5.22 Southern facade of office set 03 [concept model 04]



5.23 Perspective of office set 03 [concept model 04]



Water consumption:

20l cold water x 137 people per day
=2 740 l/day
and

3l hot water x 137 people per day
=411 l/day

Total water use
=3 151 l/day
=1 150kl/year

The size of the wetland will need to be:

3 151l/day for 7 days (for absorption)
3,15m^3 x 7
=22.05m^3 liquid volume
(this is only 25% of the space, 75% is needed for aggregate and roots)
=22.05m^3 x 4
=88.2m^3
(A depth of 600mm is the maximum depth for absorption, but the depth will be inconsistent for different plant varieties, so an average depth of 300mm will be assumed)
V= A x D
A= 88.2/0,3
A= 294m^2

This is the minimum size of the wetland as an area is needed for aquatic plant propagation.

-Runoff

Impermeable surfaces are limited to walkways and social spaces on the eastern side of the EBRC. Permeable paving is used for parking, this allowing for water to filter back into the water table, which has already dropped due to interference (see appendix C).

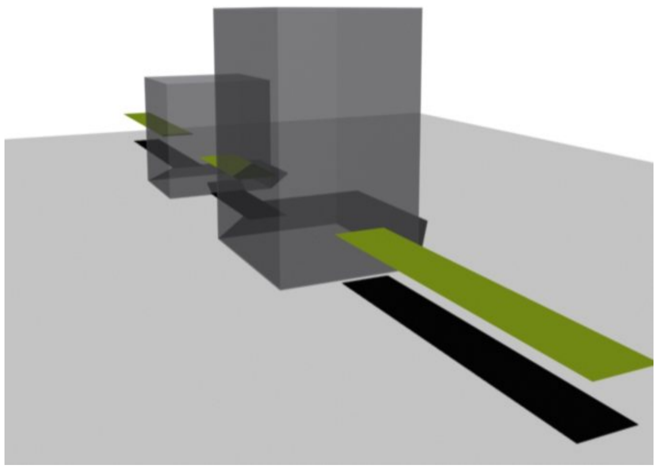
-Planting

Indigenous medicinal plants will be used for soft landscaping as much as possible, reducing the amount of water needed for irrigation.

The water needed for irrigation is:
20mm water per week per m^2
=0.02m / week / 14 000m^2
=280$m^{3/}$ week
= 14 560kl / year

9 678kl of this amount can be used from the wetland while 8 528kl can be used from collected rainwater. This leaves an excess of 3 646kl that can be used in the toilets or returned to the Apies River depending on the season.

5.24 The footprint is replaced by being elevated onto the building. The biodiversity link is broken, however does allow for some species interaction



5.12 Energy

-Environmental control

By pulling the biophysical environment into the interior of he EBRC, internal cooling can largely be increased. Through transpiration, one large tree can eliminate 962 964J of energy. The mechanical equivalent would be 5 average room air conditioners running for 19 hours a day (Lorch, 1998, p136). The difference being that air conditioners only transfer heat from the interior to the exterior, thus raising the urban heat island, whereas plants render the heat unavailable.

-Appliances & fittings

15W fluorescent light bulbs are used instead of regular 75W light bulbs. The lux provided is the same but the fluorescent bulbs produce 60W less heat energy (Aal, 2002, p7).

Throughout the EBRC, reduced flow-rate taps are used which contain a spray nozzle that reduces the water flow rate by 70% (Edwards, 1999, p123).

6l-flushing toilets are used instead of the regular 7.5l toilets.

-Energy sources, Renewable energy

25m^2 of Photovoltaic panels are incorporated into the terrarium facades.

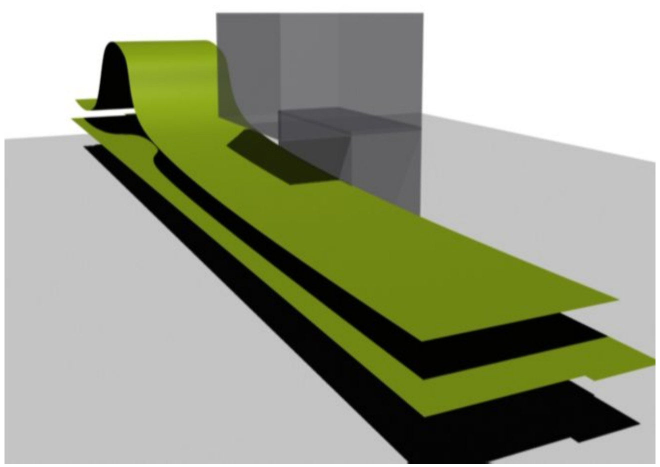
5.13 Waste

-Organic waste

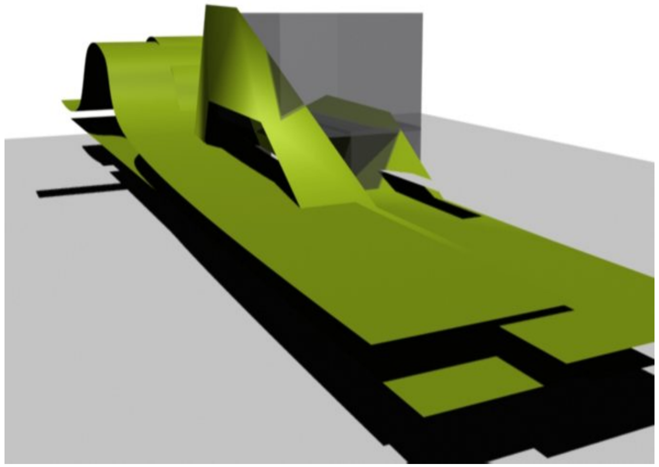
Organic waste from the building as well as biomass left over from research and cultivated plants will be collected on site and used as compost for the plants grown at the EBRC.

-Inorganic waste

5.25 The existing biophysical footprint will be disrupted by the building



5.26 By not limiting this to roof gardens, there is an opportunity for different plant species and further microclimate adjustment



Inorganic waste will be sorted on site at the source through the use of recycling bins.

-Toxic waste

Contaminated and chemical waste produced through research is to be delivered to the MRC (to maximise the efficiency of waste disposal).

5.14 Site

-Brownfield site

Although the EBRC is not built on a Brownfield site, it takes up 4 223m^2 of cultivated lawns that require high-energy inputs and contain few biophysical ecosystems. The EBRC will contribute at least 10 000m^2 of indigenous shrubs and trees that would otherwise not have existed on this site.

-Ecosystems

Roof gardens replace the biophysical footprint now occupied by the EBRC and attempt to continue the existing biodiversity link along the river. This allows for some extent of species interaction and migration. The main function of the roof gardens is to serve as a venue for plant propagation of medicinal plants for research. By placing these plants on the roof they are protected from accidental damage from passers-by.

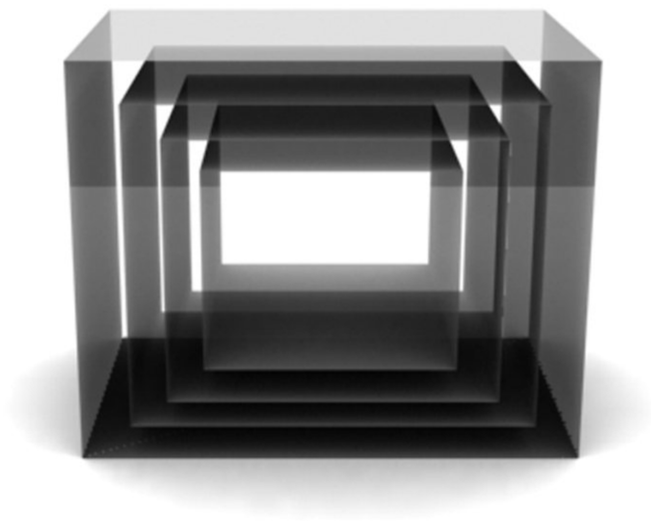
-Landscape inputs

Most of the landscaping is biophysical, limiting the need for fertilizers, pesticides etc. These species also produce about 20 times as much oxygen as a cultivated lawn.

Vegetation on and around the building can improve the microclimate surrounding the EBRC reducing the need for climate control within the building. Façade planting will

5.27 Conceptual *Max model* of terrariums

5.28 Conceptual *Max model* of plant screens and roof gardens



5.29 The building is to made-up of a series of independent layers reduce temperatures in summer by as much as 5°C as warm air that passes through the plants is cooled through evapotranspiration before it enters the building. This works by; cooling the air within the plant canopy which gets transferred to the building, cooling the surrounding air temperature and cooling the plant surface lowering the radiant temperature.

In winter the planted façade can reduce heat loss up to 30% by forming an insulating layer of air trapped within the overlapping leaves (Lorch, 1998, p135).

5.15 Materials & Components

-Material / Component Sources

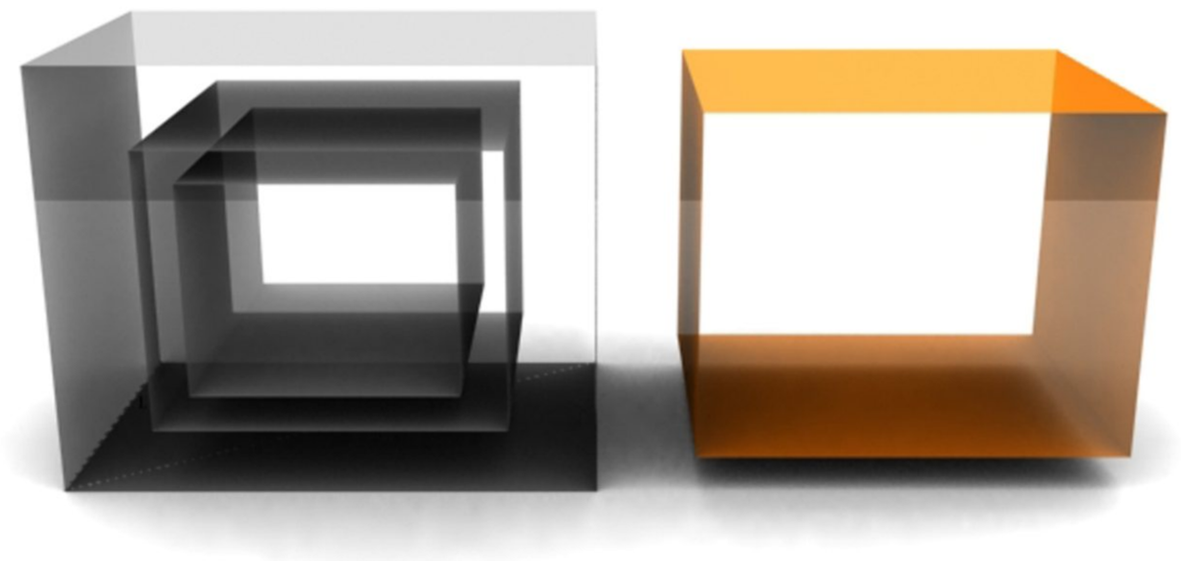
The EBRC is designed for the direct re-use, or 'assembly for disassembly' concept. The principles behind this are (Berge, 2000, p12):

>Separate layers:
The building is made up of layers such as the site, structure, skin, services etc. If the layers need to be renewed, because of their nature, renewal will occur at different periods during the building's life cycle. Each layer is independent from the others allowing for replacement of that layer only.

>Disassembly within each layer:
Components of each layer need to be 'loosely' connected and replaceable. This allows for easy removal and recycling of worn components instead of replacing the entire layer or even building.

>Monomaterial components:
Different materials decay at different rates; when a component consists of more than one material this can lead to premature replacement of that component

5.30 This allows for renovation or removal of that layer only



because one of its materials is worn out. Re-use also becomes difficult, as it is hard to check the quality of composite or laminated materials. It is therefore important that monomaterials are used.

-Steel

Steel is one of the main structural components. It is also used for shading devices, hand railing etc.

Steel generates relatively high waste numbers during production at 601g/kg and 5% of that needing to be taken to special dumps (Berge, 2000, p36). Iron used in the manufacture steel is found near the earth's surface and is extracted through open quarries, which results in large ecological scars and disruption of ecosystems (Berge, 2000, p75).

Steel is protected through zinc coating and galvanizing, both of which are considered as serious environmental polluters. Steel can however be galvanized through an almost pollution free process by electrifying steel which is immersed in sea water, the natural magnesium and calcium forms the protective 'galvanizing' (Berge, 2000, p77). Steel does have a high recycleability value:

>Re-use:
Steel members can easily be disassembled and re-used

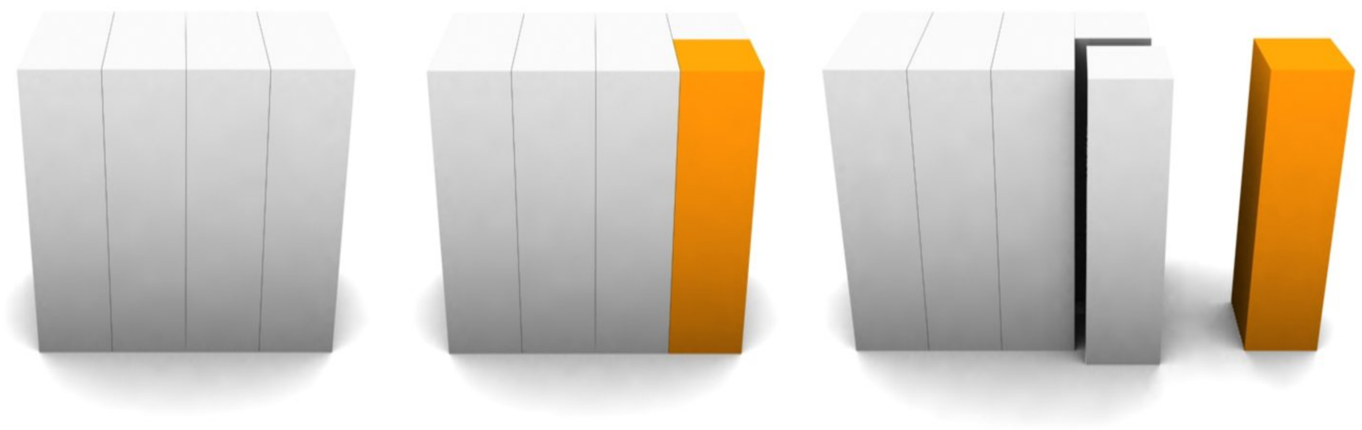
>Recycling:
Steel can be melted-down and remoulded into other components

>Energy recovery:
Steel has no energy generating qualities.

-Concrete

During production fired clay bricks generate 87g/kg of waste and have an embodied energy of 6kJ/Kg, while concrete

5.31 Disassembly within each layer allows for the repair of damaged components without having to replace the entire layer



generates only 32g/kg of waste but has a higher embodied energy of 13kJ/kG. Concrete is used instead of brick on the basis of waste.

>Re-use:
Re-use of in-situ concrete is almost impossible, especially if it is reinforced with steel. Pre-cast members can be reused and are very durable, but larger components become very heavy and need machinery to be moved.

>Recycling:
As with bricks, concrete can only be broken-down into a state used for aggregate.

>Energy recovery:
Concrete has no energy generating qualities but can be used as a heat store.

-Other

Asphalt is used instead of bitumen for waterproofing, as they have an energy consumption of 3MJ/kg and 11MJ/kg respectively (Berge, 2000, p143).

Wool insulation is a renewable resource with a very high thermal capacity at 1.8Kj/kgK. Lower quality wool, which would otherwise be wasted, is to be sourced (Berge, 2000, p299).

5.32 Perspective of terrariums and the labs behind [concept model 04]

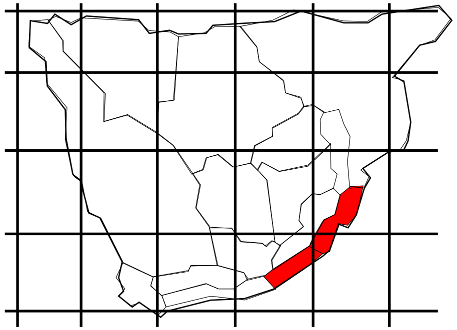
6.1 Climatic Zones

There are three terrariums in the EBRC, each containing two similar climatic zones of the nine zones found within South Africa. These terrariums allow for plant propagation, and therefore experimentation on medicinal plants from around the entire country. Because each climatic zone is different, the 'internal' façade that separates the terrariums from the laboratories will need to be resolved accordingly. Best practice construction technologies from those regions will emerge as appropriate solutions, but it is important to maintain large openings for natural day lighting.

The first terrarium simulates the South-East Coast and Sub-tropical climatic zones. Within these zones temperatures are constantly high and are often 5°C above the comfort zone. Relative humidity can reach 70% and will cause discomfort. The daily temperature range is small at 9°C; this makes temperature control through thermal mass ineffective. For effective temperature control into the laboratories, the façade needs to be of low mass and high insulation. There should be no opening windows so as to avoid the high humidity levels. As with all the terrariums, this terrarium should face north for maximum solar transmittance. However it could face slightly west so that it receives the last solar transmittance of the day, as warm temperatures need to be maintained through the night. For this reason thermal screens will be needed.

6.01 *Acorus calamus*

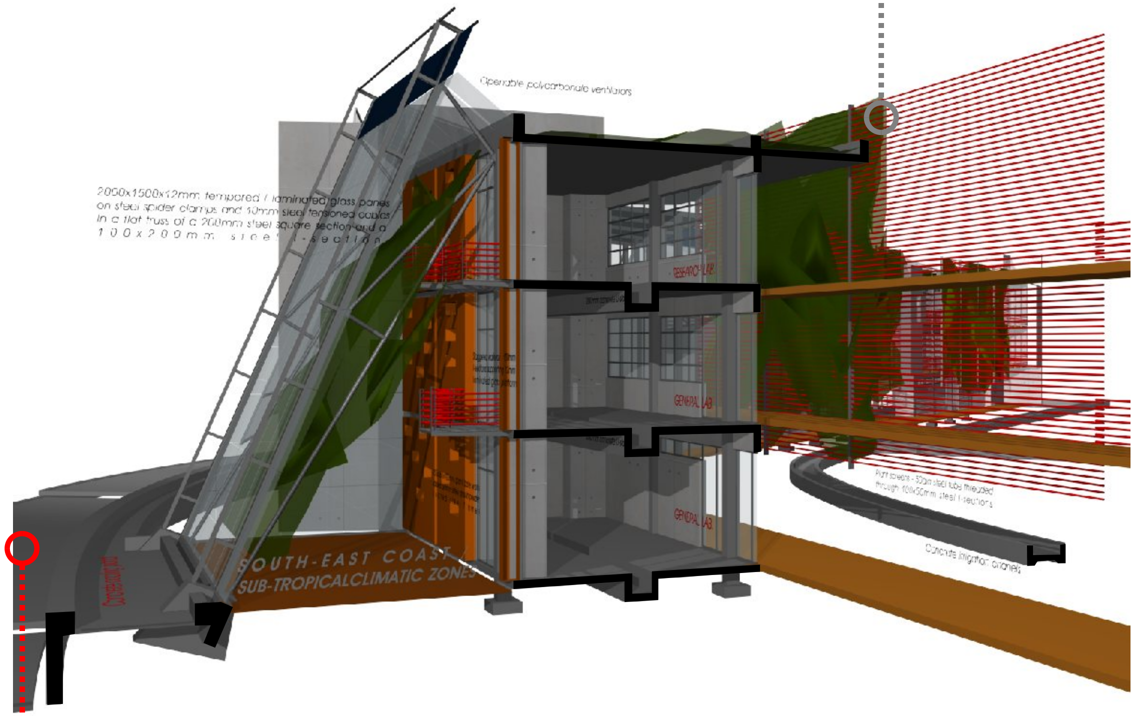
6.02 *Berula erecta*



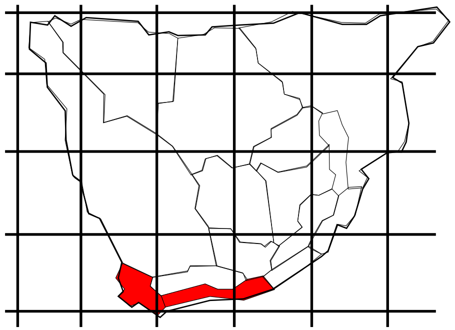
6.03 South-East Coast and Sub-Tropical climatic zone

6.04 *Stangeria eriopus*

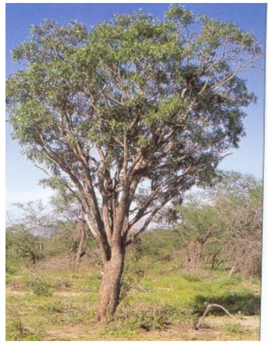
6.05 *Rauvolfia caffra*



6.06 Sectional perspective of final *3D Max* model showing the South-East Coast and Sub-Tropical terrarium

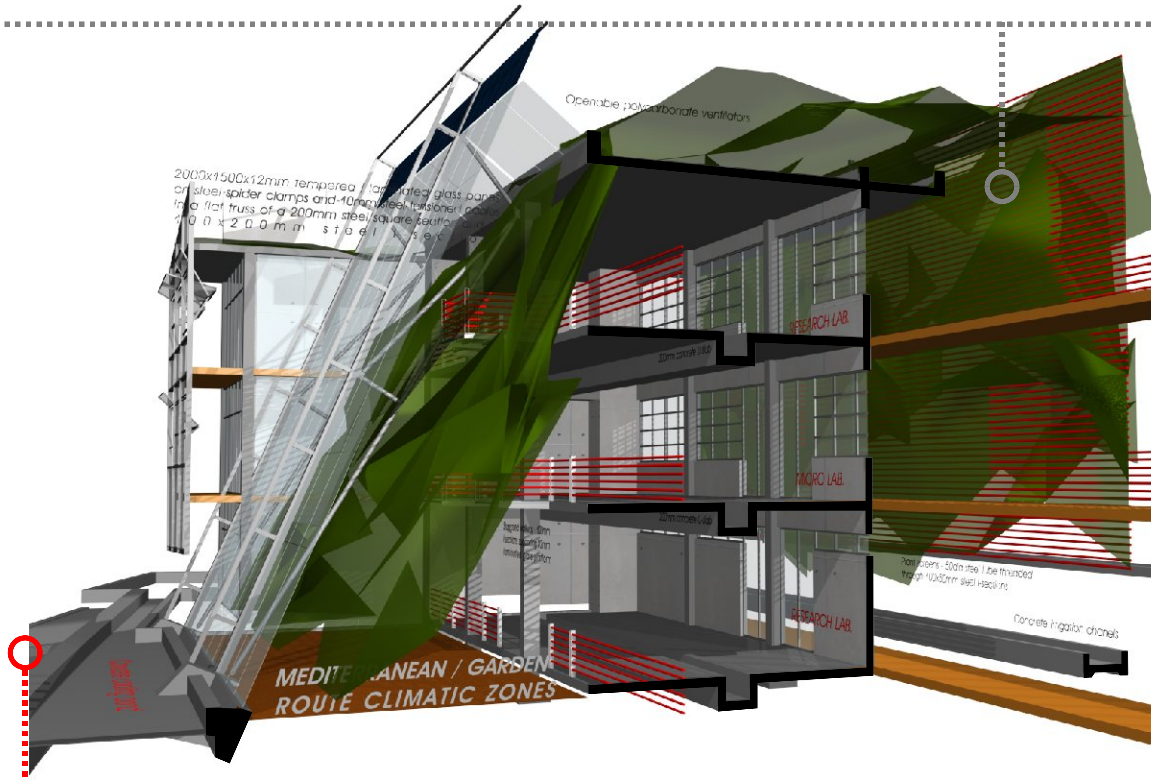


6.07 Mediterranean and Garden Route climatic zones

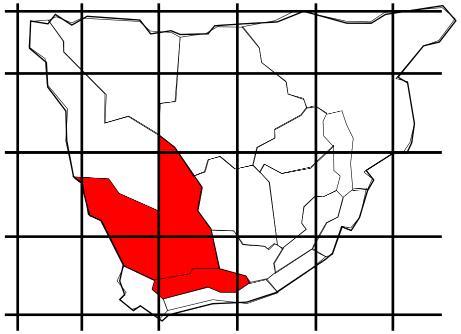


6.08 *Ptaeroxylon obliquum*

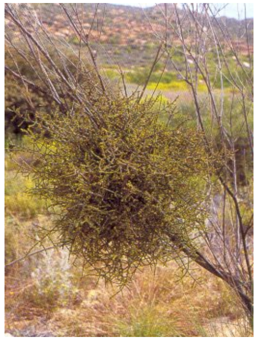
6.09 *Rapanea*



6.10 Sectional perspective of final *3D Max model* showing the Mediterranean and Garden Route terrarium

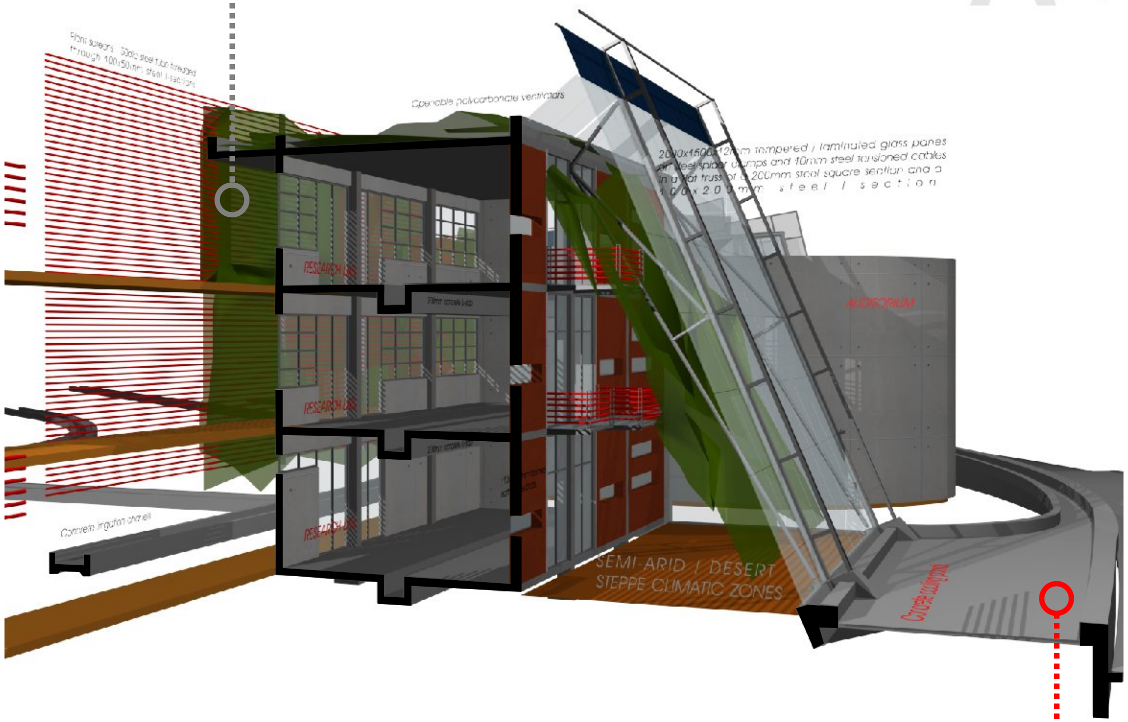


6.11 Semi-Arid and Desert Steppe climatic zones



6.12 *Viscum capense*

6.13 *Aspalathus linearis*



6.14 Sectional perspective of final *3D Max model* showing the Semi-Arid and Desert Steppe terrarium

The second terrarium simulates the Semi-Arid and Desert Steppe climatic zones. These zones have very high average temperatures with large temperature swings of over 18°C. The summer day temperatures can extend above the comfort zone by 8°C and winter night temperatures below by 20°C, so thermal screens will not be necessary. The average monthly humidity level is around 55%, which falls within the comfort zone, this allows for opening windows between the terrariums and laboratories. The large diurnal swing means that high mass construction will effectively contribute to thermal damping. Moisture penetration is not an issue due to the low amount of precipitation and humidity.

The third terrarium simulates the Mediterranean and Garden route climatic zones. The average relative humidity of the Mediterranean zone is 54% and 62% for the Garden Route zone. For this terrarium the humidity levels will be allowed to fluctuate between the two, but not exceeding the comfort zone. The day temperatures are moderate and remain within the comfort zone, while night winter temperatures can fall 14°C below the comfort zone. However if a thermal screen is periodically used when needed (if the laboratories are inhabited at night) then there is no need for any façade between the terrarium and laboratories. High mass construction could be used for thermal damping, but a more desirable environment is created with no construction at all.

Note needs to be taken of the possibility of the climatic

6.15 *Dioscorea dregeana* 6.16 *Bowiea volubilis*

zones within the terrariums changing if research required a different zone. The façade between the terrariums and laboratories should therefore be constructed of cheap, easily dismantled materials.

6.2 Landscaping

The plants on and around the EBRC and especially those within the terrariums are grown for research purposes, so the species of plant will depend on the research being done. The following are therefore just examples of the types of plants that may occur.

In the Mediteranean and Garden Route terrarium: *Rapanea melanophloeos* (Cape beech), *Ptaeroxylon obliquum* (Sneezewood)

In the Semi-Arid and Desert Steppe terrarium: *Aspalathus linearis* (Rooibos), *Viscum capense* (Cape mistletoe)

In the South-east Coast and Sub-tropical terrarium: *Rauvolfia caffra* (Quinine tree), *Stangeria eriopus* (Stangeria)

Climbing plants: *Bowiea volubilis* (Climbing potato), *Dioscorea dregeana* (Wild yam), *Centella asiatica* (Pennywort)

The plants in the wetland, especially those in the top portions of the wetland are grown to cleanse the water, so they would not necessarily, but could be medicinal. In the lower ponds, where aquatic medicinal plants would specifically be grown, the following could be used: *Typha capensis* (Bulrush), *Berula erecta* (Water parsnip), *Acorus calamus* (Sweet-flag).

7. Technical Investigation

The EBRC is defined by the three terrariums that replicate the climatic zones from around South Africa. The simulated environments within the terrariums allow for an investigation into alternative materials and construction techniques that would not normally have been used in this region. These may or may not be the best solutions, but remain alternative, appropriate solutions. The solutions within each terrarium contribute to the uniqueness of each environment and an awareness of regional architecture is established that would otherwise not have been.

7.1 Straw bale [plant matter]

Straw bale construction is a possibility within the South-East Coast and Sub-tropical terrarium as it fulfils the requirements of low mass and high insulation. Comparatively, $1m^3$ of straw weighs 75kg as apposed to brick that weighs $212kg/m^3$. While a 450mm straw bale has a U-value of 0.13, the combination of a 100mm heavyweight concrete block, 75mm mineral fiber, 100mm heavyweight concrete block and 13mm lightweight plaster only has a U-value of 0.40 [the lower the U-value, the greater the insulation] (Amazon Nails, 2001, p48).

The large amount of plant material at the EBRC could become a substitute for straw, as long as the plant material is thin and 150-450mm long (twigs and grasses will work well). To generate this plant material, the cultivated medicinal plants will need to be planted before construction begins. Alternatively, the south-east & subtropical terrarium would need to remain vacant until enough plant material has been generated. Leaves, berries etc are removed as they decompose quickly. The material can be baled in a regular baling machine but needs to be set to maximum compression, creating bales with a size of 450x350x900mm. The moisture content in the plant material should not exceed 15%, and the relative humidity of the environment the bales are in should not exceed 70% which (Amazon Nails, 2001, p12).

Bales are placed on the floor slab of the laboratories with a 225mm clearance from the terrarium floor. Normally this would need to be 400mm for rain protection, but the piped irrigation system prevents water from splashing onto the bales. A 3.375mm polyolefin damp proof course is placed beneath the bales preventing moisture transfer from the concrete. The bales are normally bonded together with two 1mx40diam timber pins every 4 bales, but in this case, connecting the bales at the ceiling became difficult. A 7mm steel cable connected to the steel grill above and below pushes the bales tightly against the glass. The bales are not sealed as rotting would occur and so are brushed with a 5% waterglass mixture for fire proofing and moisture protection (Berge, 2000, p435).

Behind the bales, the laboratories are sealed with safety glass set in powder coated steel frames. Openings in the bale wall are left for natural lighting into the laboratories. The bales above are supported by a 450mm wide steel angle lintel that overlaps a bale by half on each side. Pins, lintols and window frames would normally not be steel as it can cause condensation when air moves through the bales from the indoors to the outdoors environment (Amazon Nails, 2001, p48). In the terrariums however, the air remains indoors so using steel is not an issue.

These bales are a completely renewable resource, can easily be removed or replaced and can be composted at the end of their life cycle.

7.2 Rammed earth

As with the South-East Coast and Sub-tropical terrarium, the Semi-Arid and Desert Steppe terrarium, with its low moisture content and need for high mass construction offers the opportunity for rammed earth construction. As with the plant bales, rammed earth can easily be removed or replaced and all the resources needed for rammed earth construction can be found on site at no cost.

The two types of rammed earth construction considered were Pise' and Adobe blocks. Pise' is a process of constructing one solid structure by ramming 150mm layers of earth at a time between shuttering. Adobe blocks are individual blocks of rammed earth and are placed in a similar method to brickwork. Adobe blocks are the choice method in the EBRC as Pise' is not as flexible and because the walls are infill, ramming would be a problem as there would be no room for ramming equipment with the beams above.

The type of earth required for adobe blocks needs a binding capacity of no less than 0.050kp/cm^2, which can be acquired by having a 30% clay content in the earth (Berge, 2000, p124). There is an abundance of earth within the berms on the site and does have a relatively high clay content (see appendix C); however this will need to be tested before being used in construction.

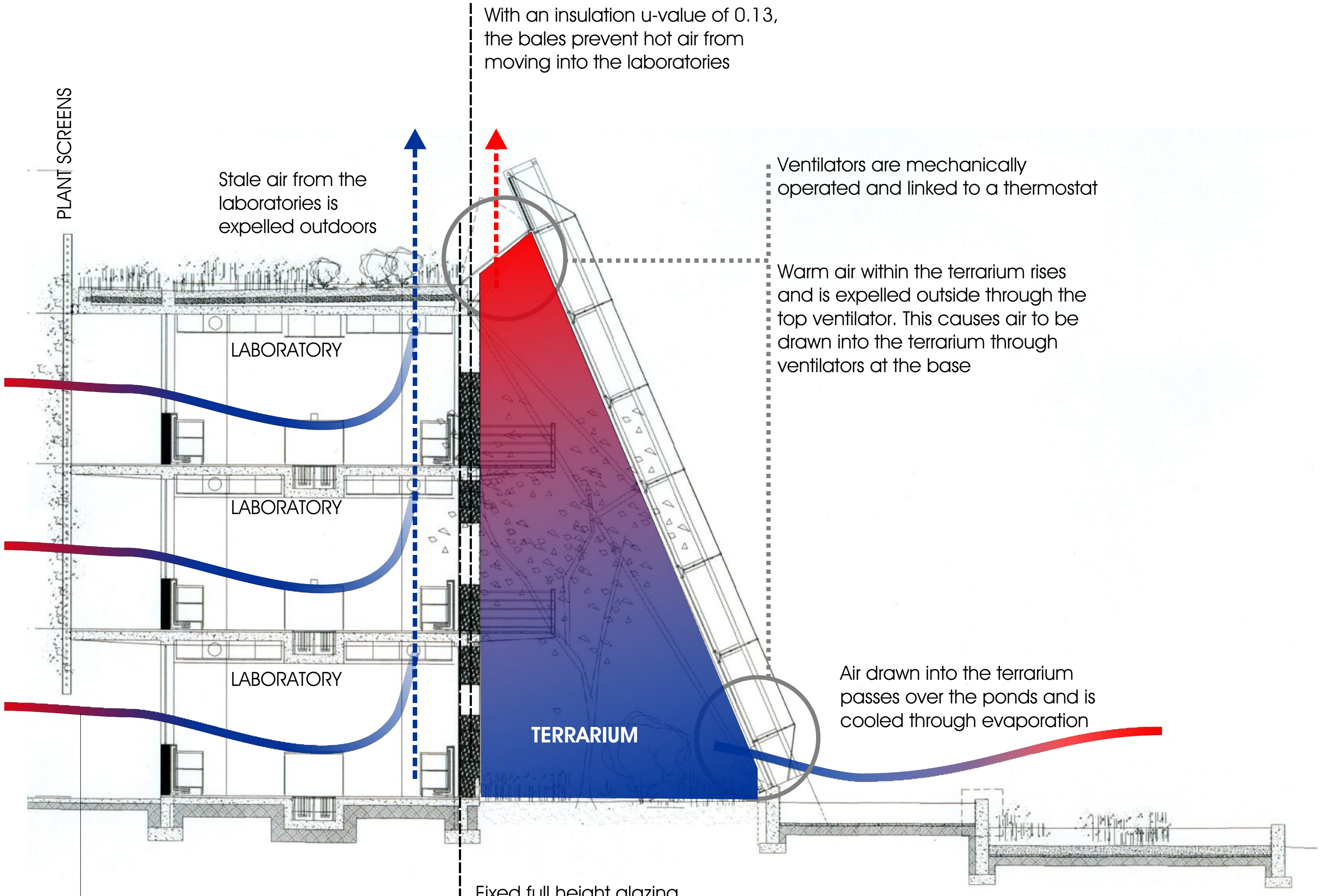
The earth used should not contain any humus, so 20-30mm of topsoil will need to removed; this can be utilised within the terrariums or on the roof gardens. The earth below must be sieved through mesh with a hole size of 10mm. If the soil has a moisture content of between 9.5 and 23%, it can be used immediately, otherwise water will need to be added or the soil will need to be dried (Berge, 2000, p126).

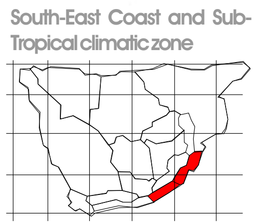
The earth is rammed into timber moulds of 110x320x50mm with either a manual rammer of 6-7kg or a ramming machine that has a compression power of 5hp/hammer. After 2 hours the moulds are removed from the blocks and after 3 days they are stacked for air circulation. After 2 weeks the blocks can be used for construction. Blocks are dipped in a 5% waterglass solution and laid in stretcher bond with a mortar joint of the same earth as the blocks, with wire reinforcement placed on every third course (ibid, p128). The block work sits 150mm above the terrarium floor, and as with the bales, a 0.375mm polyolefin damp proof course is placed between the blocks and the concrete.

On the terrarium side of the wall, the blocks are left only with the waterglass finish. On the laboratory side, the blocks are brushed with clear epoxy to seal the wall but exposing the material.

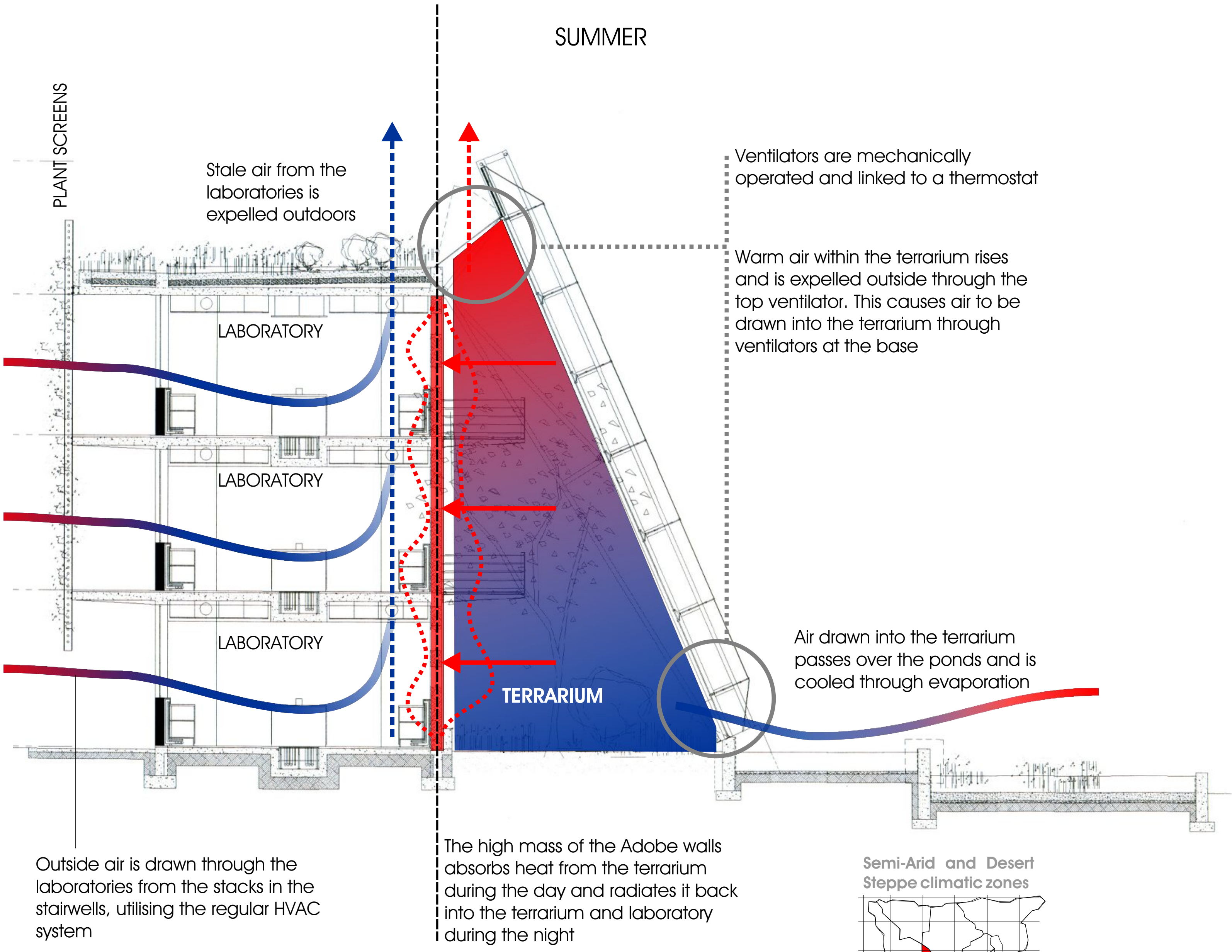
7.3 Terrarium

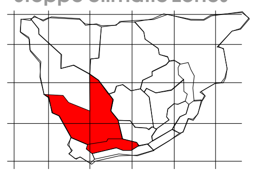
The higher the light transmission into a terrarium, the better the plant growth. Terrariums orientated to the north receive very high solar transmittance levels of up to 70% by having roof pitches of 25° and 65° (Von Zabeltitz, 1999, p30), so to maximize the solar transmittance, the entire wall of the terrariums is inclined at 65°. Glass cladding is preferred to plastic alternatives, not only for environmental reasons. On



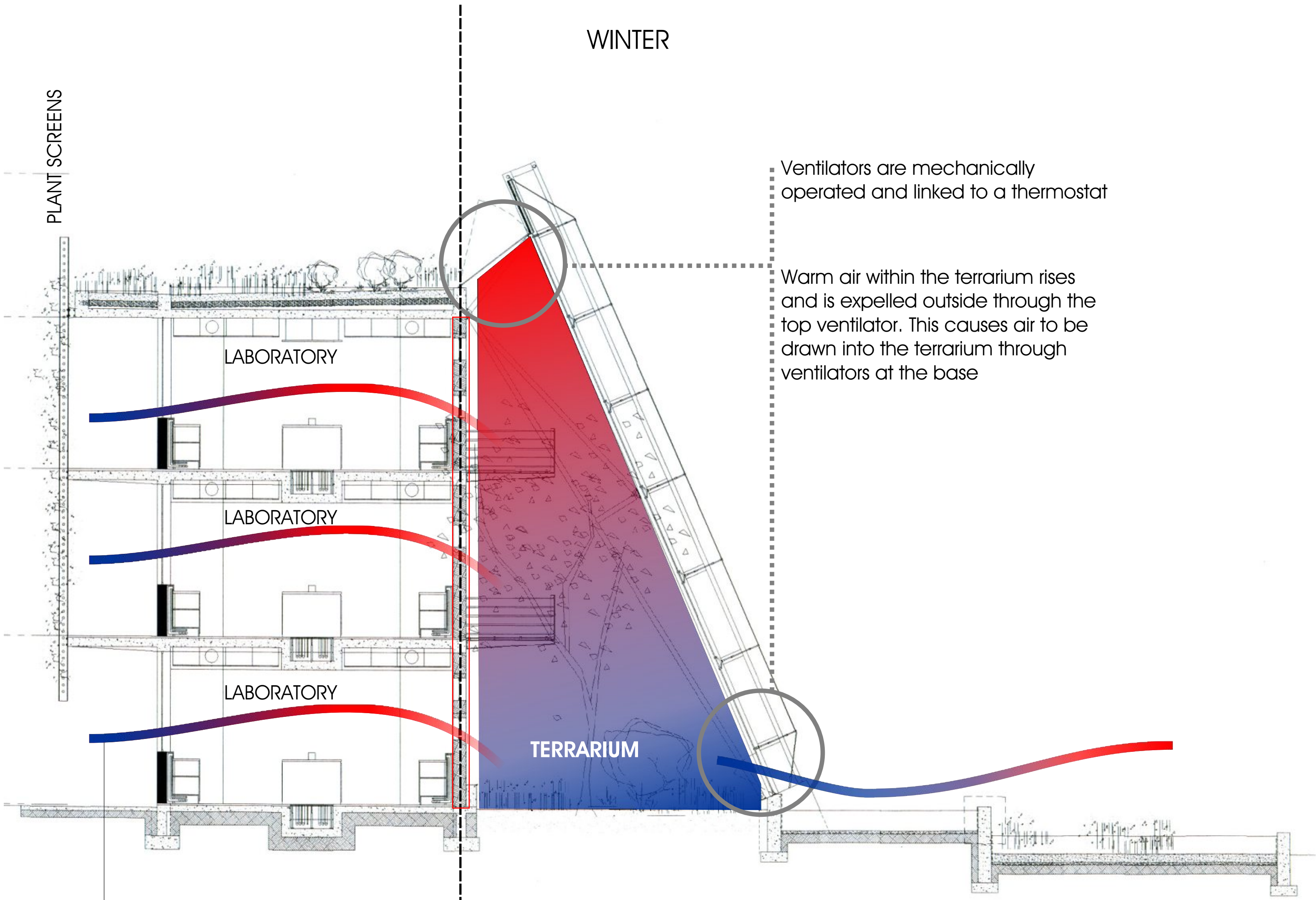


7.1 Ventilation in SE coast / subtropical terrarium





7.2 Ventilation in Semi-arid / desert steppe terrarium in summer

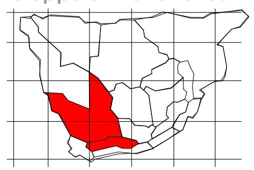


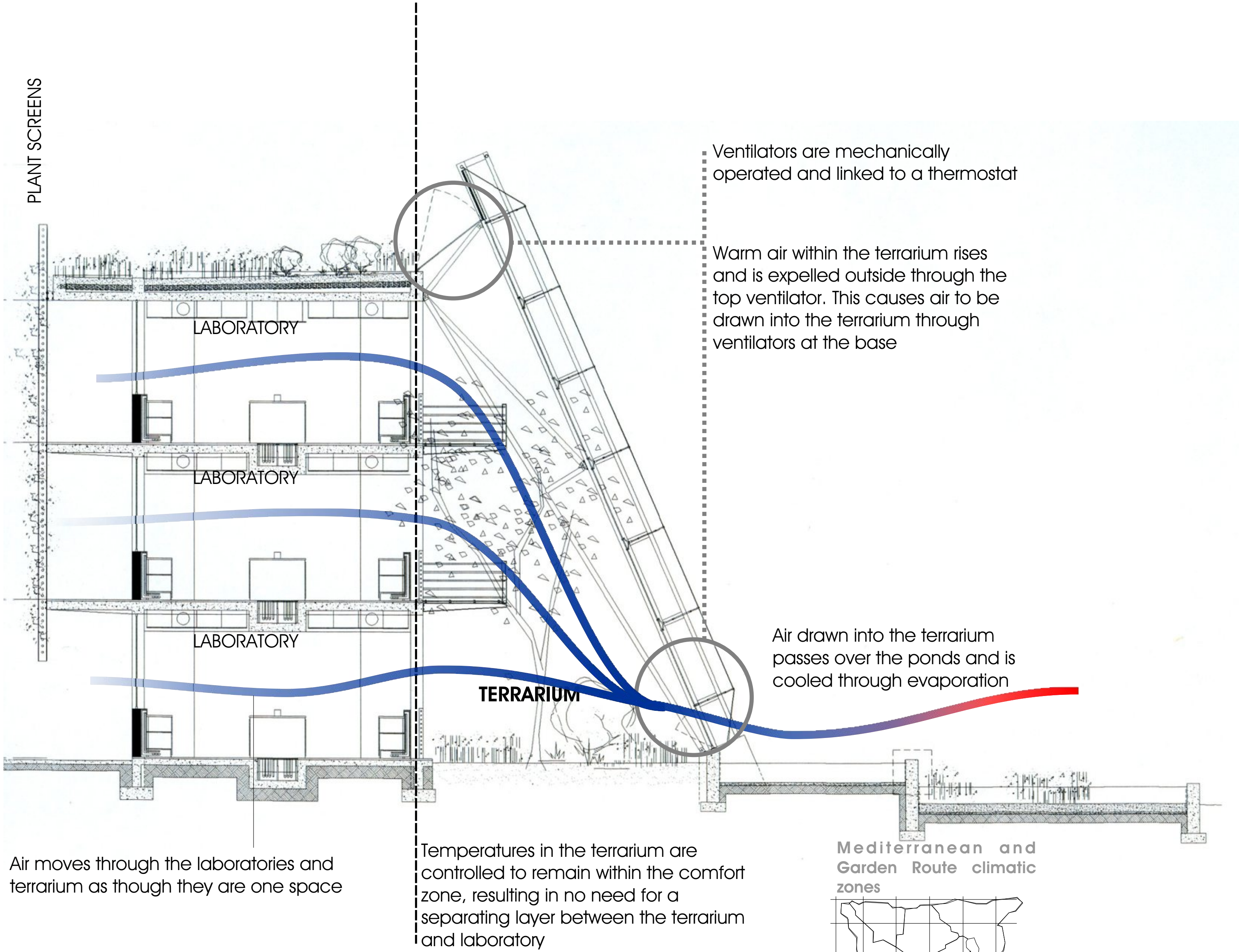
The laboratories are now ventilated independent of the regular HVAC system with the warmer air pushing the cooler air outdoors

Opening windows allows warm air from the terrariums to pass into the laboratories

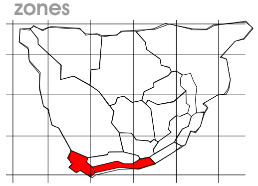
7.3 Ventilation in Semi-arid / desert steppe terrarium in winter

Semi-Arid and Desert Steppe climatic zones





Mediterranean and Garden Route climatic zones



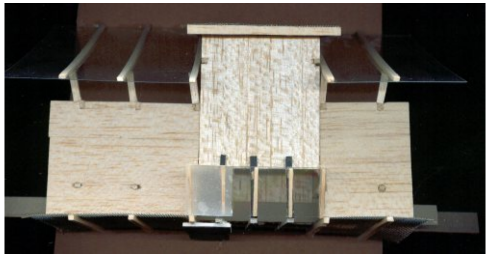
7.4 Ventilation in Mediterranean / garden route terrarium untreated plastics condensation forms and drops onto the plants and can cause fungal growth, while treated plastics have an even higher embodied energy (Von Zabeltitz, 1999, p31). The terrarium facades are 2000x1500x12mm tempered / laminated glass panes, suspended in a high-tension cable system. The glass needs to be tempered to resist breaking where the 'spider' clamps hold it. If the glass did happen to break, because of the angled façade there would be the possibility of the glass falling on people below. For this reason the glass needs to be both tempered and laminated.

Initially the façade consisted of a tensioned cable / mast system with 150mm steel tube masts spanning horizontally across the terrarium façade. This system however cast 23m^2 of shade into the terrariums. This was replaced with a parallel truss system that relies entirely on the tensioned cables to support the glass, maximizing light transmittance. The flat truss is made of a 200mm steel square section and a 100x200mm steel I-section that 'leans' on the main building structure with a 120mm steel tube truss. This system is needed as the steel members in a regular gravity frame system would need to be very large to support the angled glass, which would interfere with the amount of solar transmittance. As the terrariums are windward facing (see Fig.2.21), the system allows the large panes of glass to shift in times of strong winds.

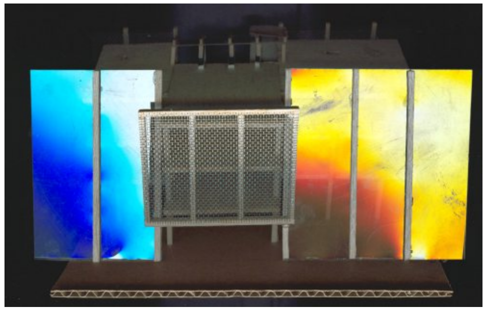
For sufficient ventilation, openings should be 15-25% of the floor area and continuous roof vents are the most efficient (Von Zabeltitz, 1999, p48). The panes at the bottom and the top of the terrarium are openable for ventilation. By extending the glass façade to house a series of solar panels, advantage is taken of the orientation for maximum solar

7.5 Terrarium and library [concept model 04]

7.6 Roof plan of office set 02 [concept model 04]



7.7 Northen facade of office set 02 [concept model 04]



transmittance.

Within the terrariums, steel walkways protrude from the laboratories to form transitional elements, which create places for observation on three levels. These are staggered, allowing trees to grow between them and the platforms are glass plates for maximum observation.

During the night, especially in winter the temperatures within the terrariums can drop below the desired temperature for some of the environments. Thermal screens inside the terrariums are drawn closed at night to prevent heat loss. The screens have a low transmissivity, and long-wave (infa-red) radiation can still enter into and thus heat the terrarium (Von Zabeltitz, 1999, p53). Polyester, felted material is one of the better options for the thermal screens. In terms of heat retention, it does not have the highest energy conservation rating but is sufficient for its purpose; however its energy consumption rating (22MJ/kg) during manufacturing is lower than both polyethylene (67MJ/kg) and acrylic (56MJ/kg) alternatives (Berge, 2000, p143).

Enrichment of terrarium air with CO_2 leads to better plant growth and higher quality plants (Von Zabeltitz, 1999, p59). In the EBRC this is achieved by enclosing the composting area in an airtight container and the CO_2 released by the decaying organic waste is fed through a pipe system into the terrariums, raising the CO_2 levels.

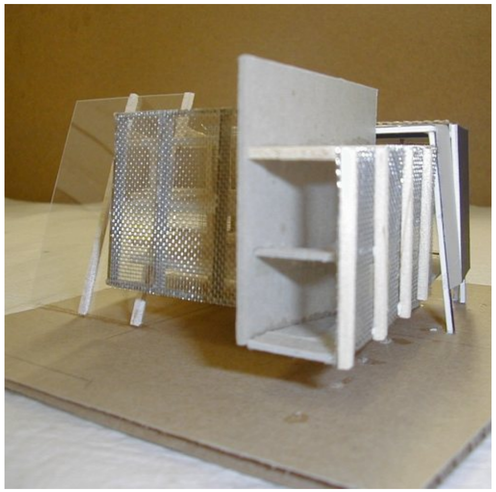
7.8 Roof plan of office set 03 [concept model 04]

7.9 Southern facade of entrance [concept model 04]

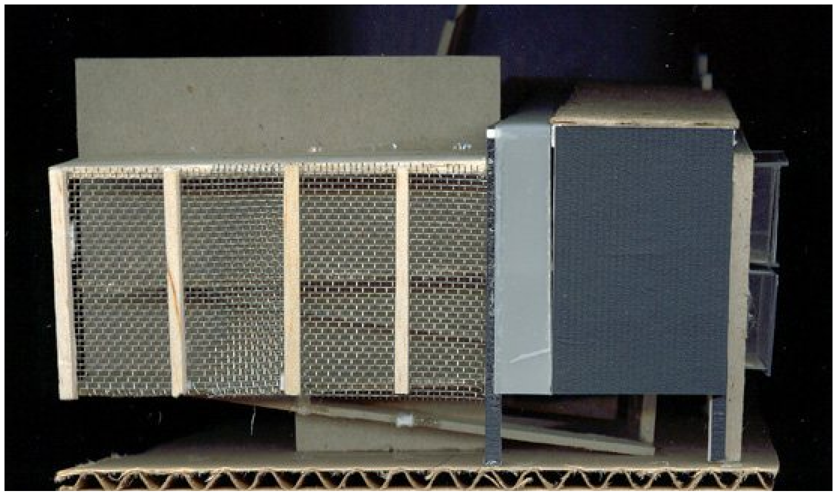
7.4 Laboratories

There are three main laboratory sets, each connected to a terrarium. The function of the laboratories is not likely to change; however the performance within each lab could often change. For adaptability the labs are therefore repetitive modules made up of a 5mx7m column grid, with each lab being 7mx10m. This grid is made up of 300x400mm columns elongated towards the north/south direction to resist in-plane forces from the terrariums. The columns support a system of 300mm beams and 200mm floor slabs. The labs are separated with glass infill panels to allow for flexible, sealed environments. The labs require large service spaces on the floor as well as on the ceiling. Initially a service floor was placed between each level; this however led to wasted spaces and materials. The service floor was replaced with a U-shaped floor slab that drops below the beams. This left a 200mm channel on the floor for gas, water, oxygen, compressed air and electricity conduits to the workbenches above, while a 500mm gap at ceiling level was left for HVAC systems. These U-slabs run the length of each block and are linked by 4 vertical ducts that supply services to the workbenches that flank the exterior walls. These ducts are 200mm concrete and help resist forces from the terrarium façade. The floors are finished with a clear epoxy over a pigmented screed. Parts of the channel that are not covered by workbenches are closed with a corrosion resistant screw-down floor system supported by an adjustable steel pedestal system. This allows for moveable machinery to be placed anywhere along the channel where power points are located. The south facing facades of the laboratories receive no direct sunlight so maximum glazing is used for natural ambient lighting. The glazing is

7.10 Perspective of ramps [concept model 04]



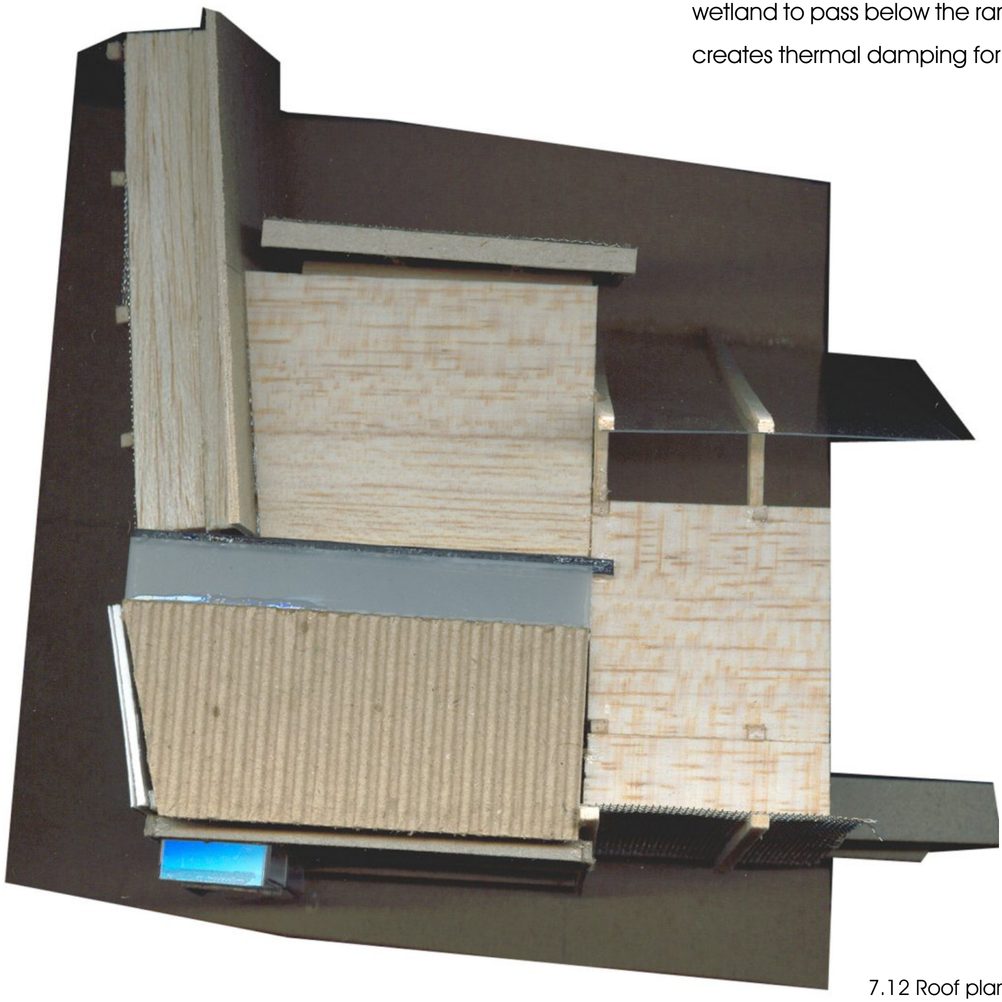
7.11 Ramps on the west entrance [concept model 04]



placed above 1 150m concrete walls, along which workbenches and machinery stand. These walls are finished with a clear epoxy.

7.5 Entrance

Approach to the entrance is both from the south and the west. The west facing side is emphasized by placing the ramps for vertical circulation here, perpendicular to the rest of the building. The ramps are 200mm in-situ concrete that are supported by a series of 200mm square reinforced concrete columns and a 300mm off-shutter / reinforced concrete wall. This wall is stabilized with 2 fins that tie back to the main column and beam structure. The wall follows the angle of the ramps, elevating from the ground towards the northern end with the opening formed allowing for the wetland to pass below the ramps, while the mass of the wall creates thermal damping for the offices behind. The ramps



7.12 Roof plan of entrance [concept model 04] break the rhythm of the 5m-column grid by rotating 7degrees to follow the form of the wetland. GKD 'Luna' stainless steel metal fabric suspended on 75x50mm steel channels serve as weather screens, enclosing the ramps and allowing plants from the roof above to climb down.

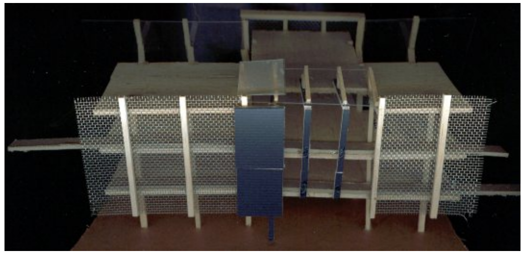
On the southern side, the entrance is defined with a concrete portal structure. A series of glass boxes punch through this structure serving as plant growth chambers and are constructed of 10mm toughened safety glass. The roof is a steel truss structure as apposed to a concrete (roof garden) structure that is used in the rest of the building. This structure tilts-up 5° to the north allowing direct natural light into the entrance foyer, while the growth chambers allow for ambient southern light to enter.

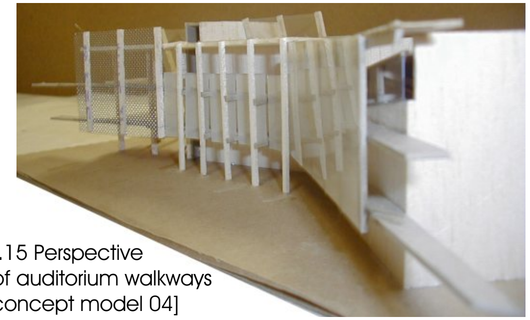
The building is separated into two parts that form two distinct lines that pass past each other connecting the building. These 2 lines make-up the auditorium and are 300mm off-shutter concrete walls with timber acoustic panels mounted internally on 100x50x2mm lipped z-sections. The gap between the panels and the walls are service spaces housing electricity conduits that run into the roof where all lighting and projectors are mounted. The roof is the same steel truss construction as in the entrance foyer. The northern wall of the auditorium extends past the roof while on the southern side; the truss sits on the wall creating a clerestory window that lets daylight into the space. The auditorium faces slightly west, so a series of opaque 12mm laminated safety glass panes, enclose the adjoining walkway, permitting diffuse light and preventing afternoon heat gains.

These panes follow the walkway, which steps back from the five 254x254x14mm steel H-section columns that support

7.13 Perspective of entrance [concept model 04]

7.14 Southern facade of office set 02 [concept model 04]

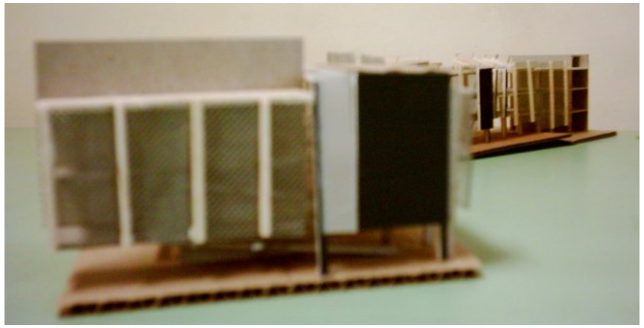




7.15 Perspective of auditorium walkways [concept model 04] the roof of the library and carry the supporting 178x102x8mm steel I-beams of the concrete walkway.

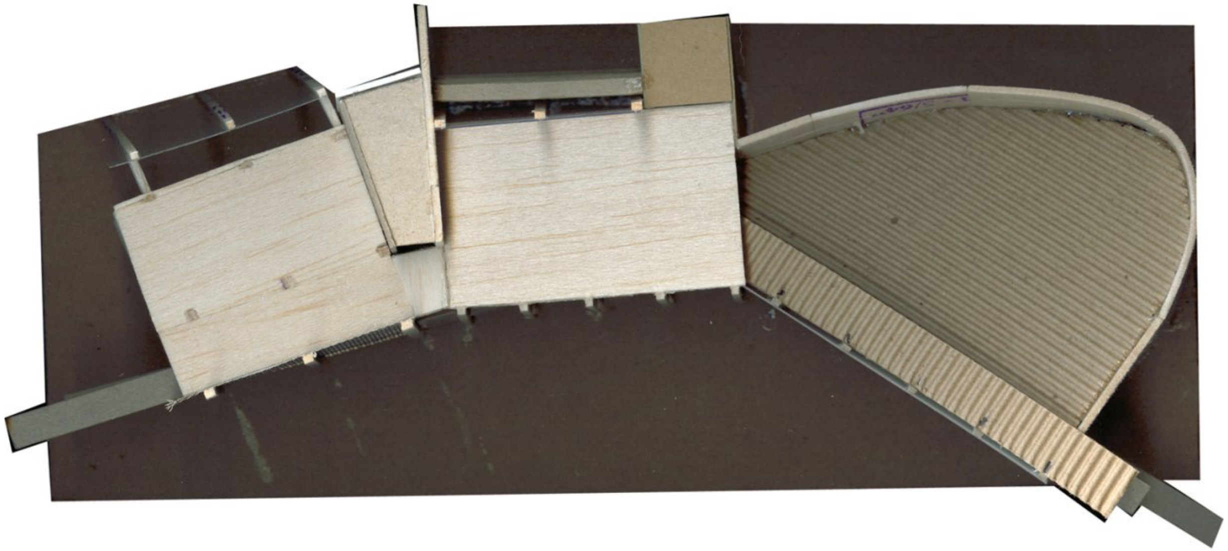
All the remaining walkways are enclosed by steel screens constructed of 100x50mm steel I-sections bolted to the butt of the beams that carry the walkway. 50mm steel tubes are threaded through these I-sections serving a sub-functional role as a balustrade. The functional role is to act as a climbing lattice for the plants from the roof garden above. This serves as a shading device, plant propagation and microclimate control. These screens extend above the roof gardens by1200mm to act as balustrading and below the first floor slab by 1200mm. This defines the edge of the building but blurs the boundary between the interior and exterior environment, allowing people to subconsciously move in and outdoors.

The roof gardens provide protected areas for propagation of medicinal plants. They grow in 70-250mm of soil on 120mm of drainage gravel. Beneath this is a felted protection membrane on asphalt waterproofing. This is laid on the roof slab on top of a layer of screed (minimum of 40mm at its lowest point) that slopes at1:60 to the fulbore rainwater outlets. An expanded metal cage to prevent clogging surrounds these.



7.17 West elevation [concept model 05]

7.16 Roof plan of auditorium and library [concept model 04]



7.5 Library

The northern façade of the library mimics the 65° incline of the terrariums. The smaller glass panes sit in steel frames with tip-up window openings preventing water penetration in times of rain. Two steel sunscreens prevent direct sunlight in summer without inhibiting views onto the river. The lower screen extends over the café that exists on the ground floor providing shaded outdoor seating.

7.6 Ventilation

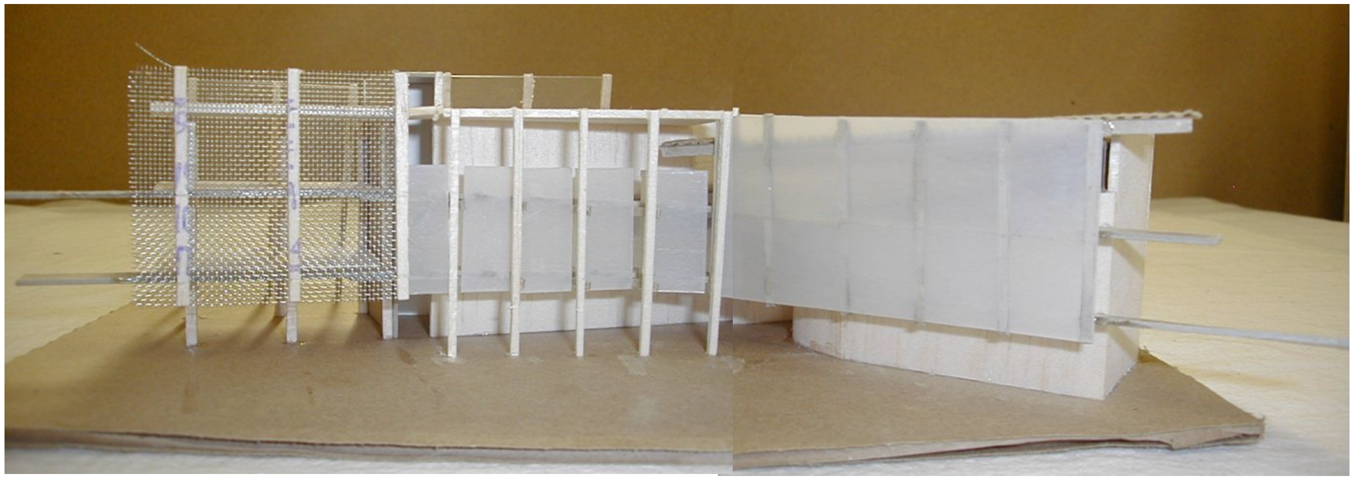
By ventilating the offices through cross ventilation, doors and windows will remain open for long durations. On the southern side of the EBRC, recessing the offices by 4500mm protects openings from driving rain. On the northern side of the EBRC, direct sunlight, driving rain and wind could force openings to be closed. Placing adjustable, tip-up mesh screens on the northern façade prevents this. The frames are constructed of 100x50mm steel I-sections with nylon mesh, keeping the structure as light as possible.

The laboratories are sealed to the north by the terrariums, so cross-ventilation is not an option. By creating a stack-effect in a series of ducts that back the staircases, passive ventilation is achieved. This stack-effect draws air through the laboratories in the same system that the mechanical HVAC system works on. If the air-change rate is not achieved passively, the mechanical system is activated.

7.7 Water

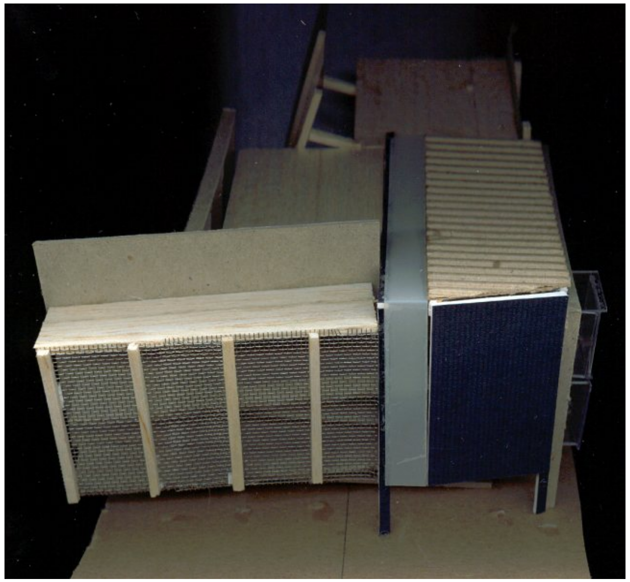
Within the site lie large areas of cultivated plants for community harvesting and research. Rainwater, which is collected from the entire site at 3 locations: A, B and C (see Fig.7.15), is used to irrigate these areas by being periodically

7.18 South elevation of library [concept model 04]

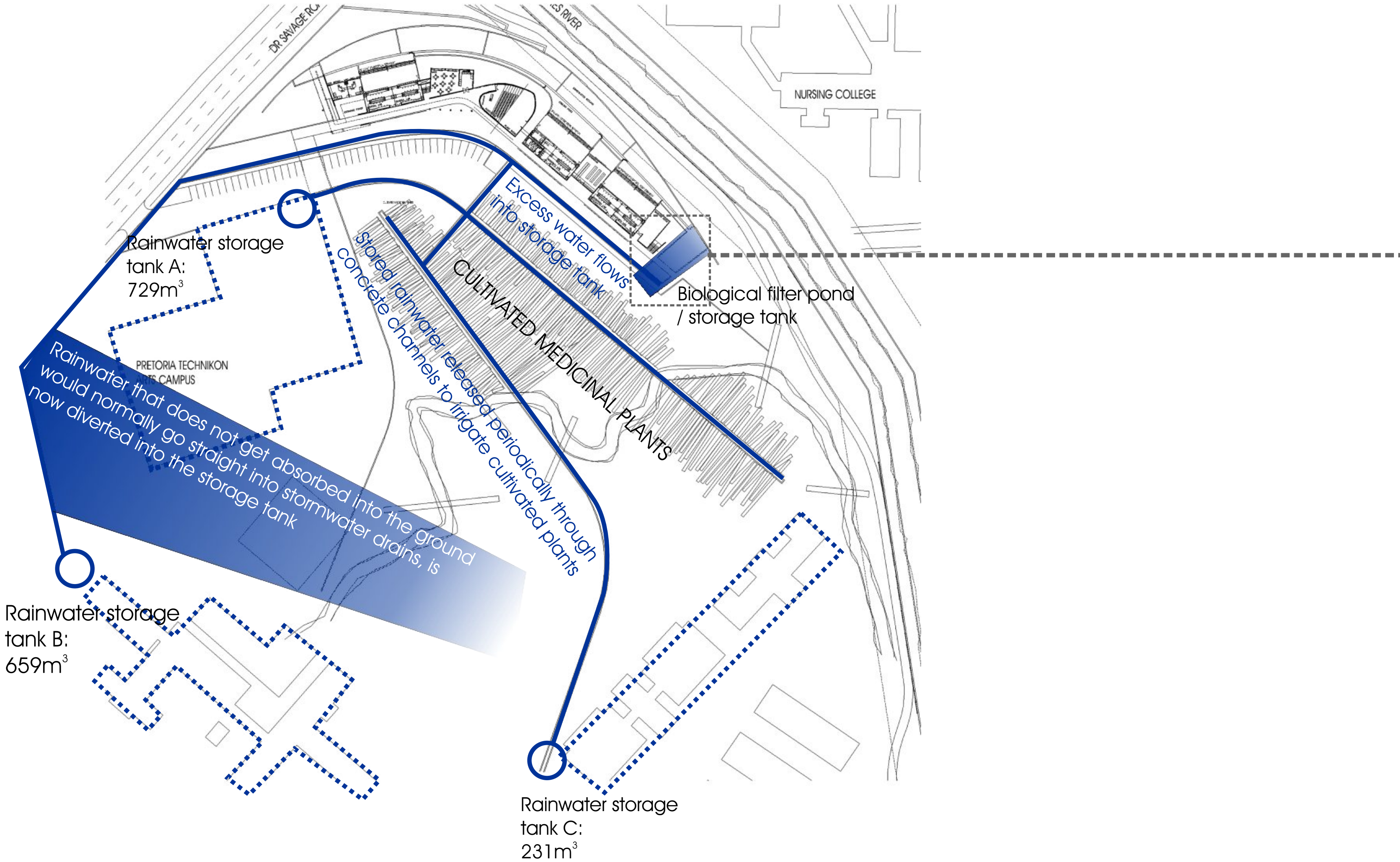


released through a series of concrete channels that permeate within the cultivated plants. Any excess water that is released, ends up in a holding tank at the east end of the building. This tank serves as a biological filtering pond. Grey water from the bathroom and kitchen is placed in this tank after passing through an oil and grease trap, while excess water from the terrariums is released directly into it. Water is released from the grease trap 100mm lower than the level of augmentation, into the holding tank at a 1:60 fall. The water level in the holding tank needs to be a further 100mm lower than the water inlet. Any soaps and oils that may remain float to the surface, so water is pumped from a sump at the bottom of the tank through a solar pump into the first pond of the constructed wetland. Each pond drops 600mm to aerate the water with an overflow depth of 20mm. The constructed wetland is enclosed with 200mm concrete

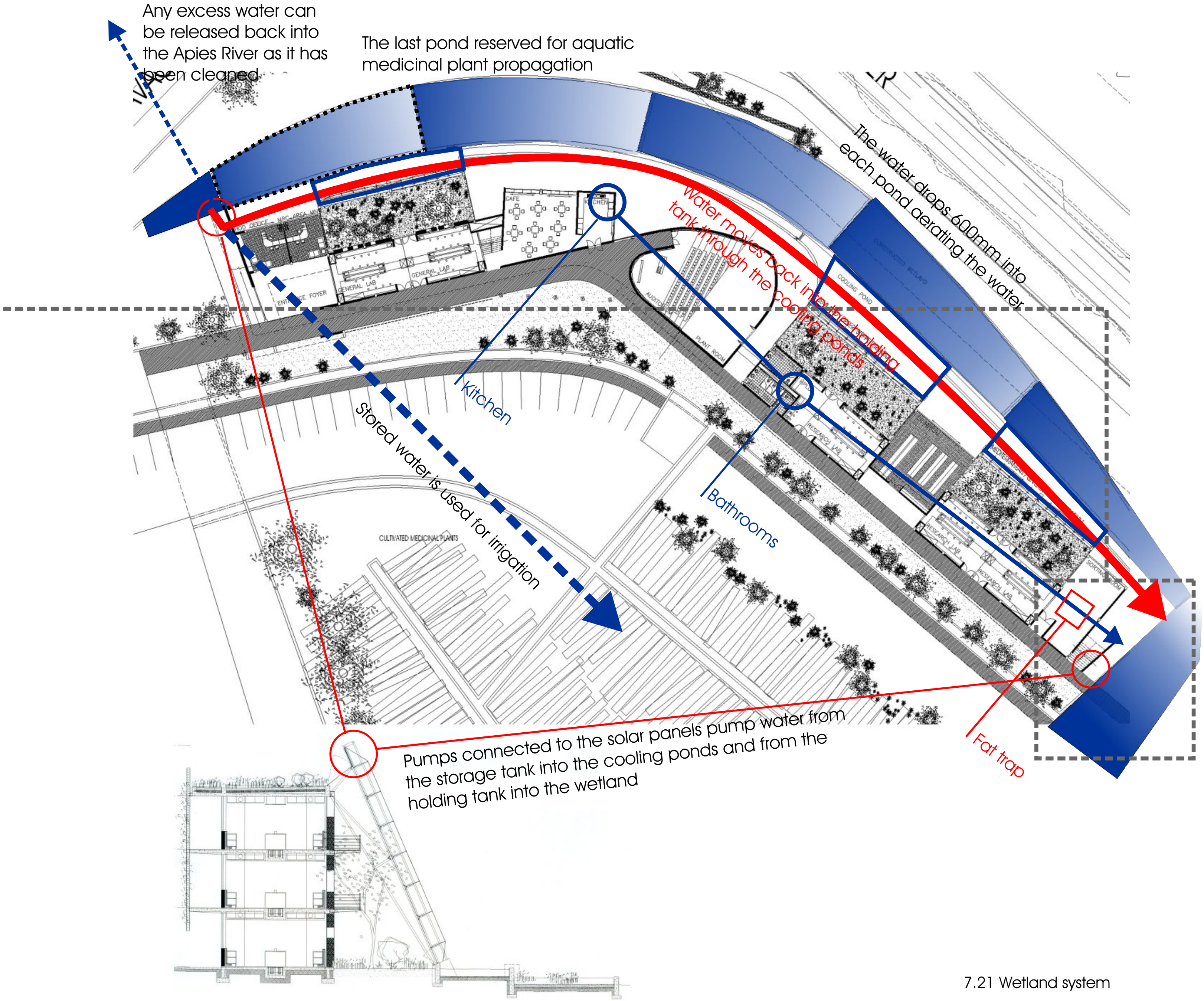
7.19 West perspective of entrance [concept model 04]



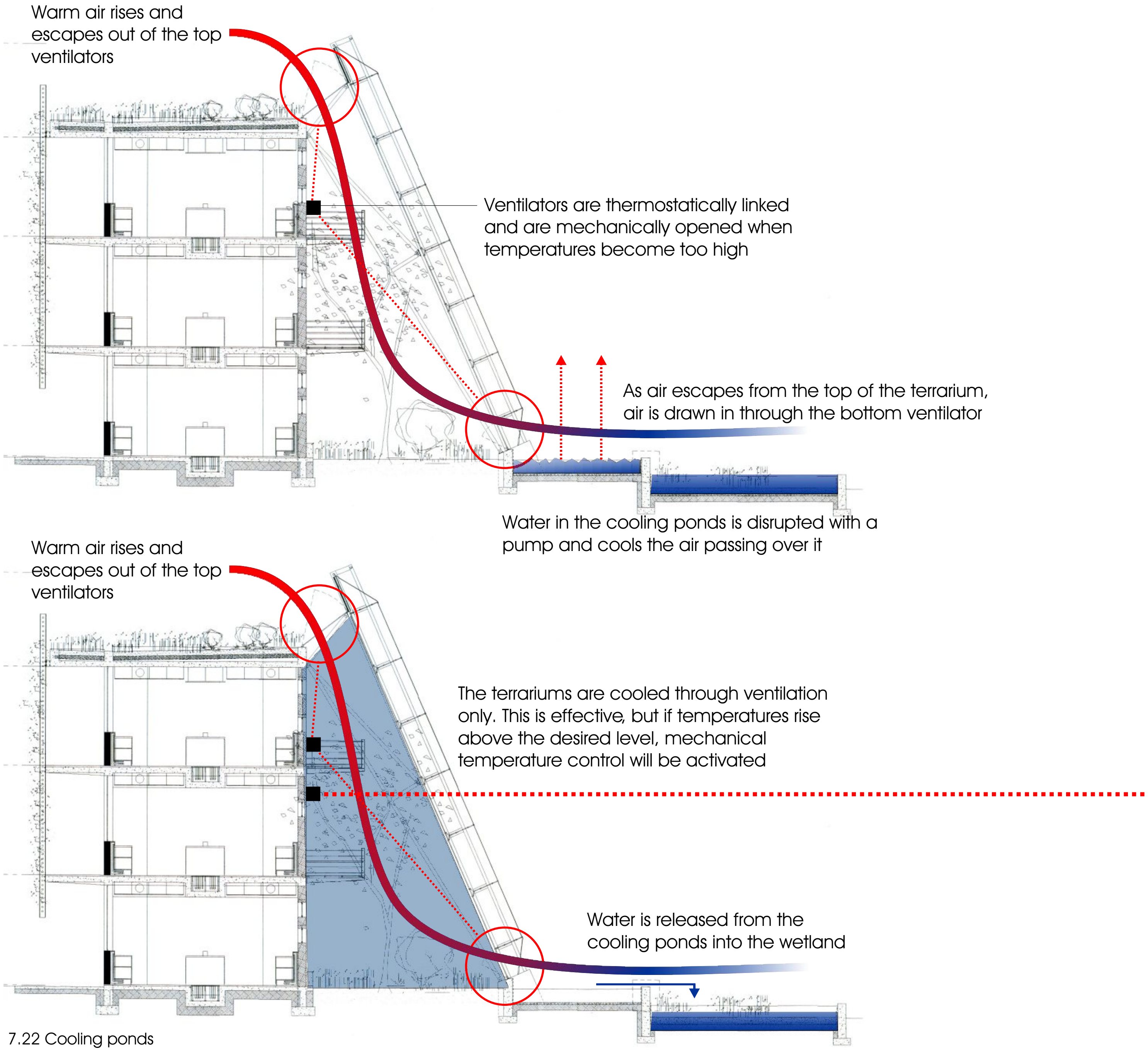
walls. The average water depth is 400mm where the soil depth is 200mm, but does vary as levels of both are adjusted for specific plant preferences. The soil sits on a layer of Bentofix geosynthetic clay liner. Beneath that is a 50mm protective layer of river sand on 200mm of compacted earth. At the end of the wetland, water is kept in a storage tank from which the water is used to irrigate the site. Water is also pumped from here through a solar pump into the series of cooling ponds in front of the terrariums. This water falls back towards the holding tank to keep the water moving in the cooling ponds. This water is disrupted with fountains so that evaporative cooling can take place by air being drawn over the cooling ponds into the terrariums. The ponds can be separated from each other with a closing separating flap and each pond has an outlet onto the wetland. If one of the terrariums needs to be cooled but its humidity level is not to be increased, then the water from the pond is released into the wetland and the terrarium is cooled through stack effect. By closing the flaps that link the ponds, the other terrariums can be cooled by means of evaporative cooling (see Fig.7.17). These separating flaps, outlets and terrarium vents are operated mechanically by being interlinked with a thermostat and humidity detector.



7.20 Water irrigation system

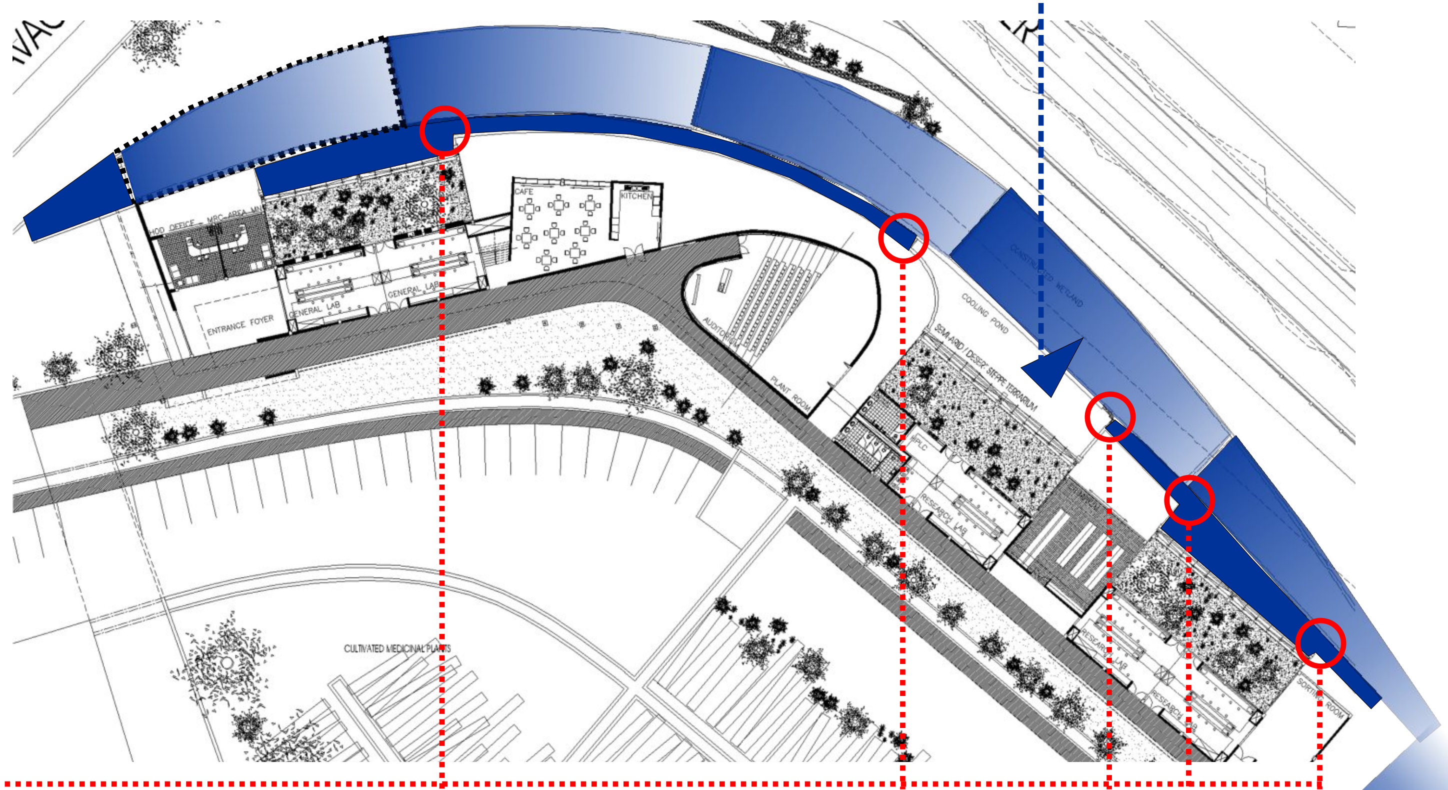


7.21 Wetland system



7.22 Cooling ponds

The released water has already passed through the wetland, so it is clean enough to go directly back into the wetland



Humidity detectors inside the terrariums monitor humidity levels. If the humidity rises above the desired level, water outlet flaps in the cooling ponds are activated, releasing the water into the wetland below

Each cooling pond has its own set of inlet / outlet traps, this means that they can be individually controlled so one pond can be empty while the others remain full of water

With the water from the cooling ponds being put back into the holding tank, the problem of the wetland drying-out is eliminated

7.23 Cooling ponds

DESIGN DISCOURSE

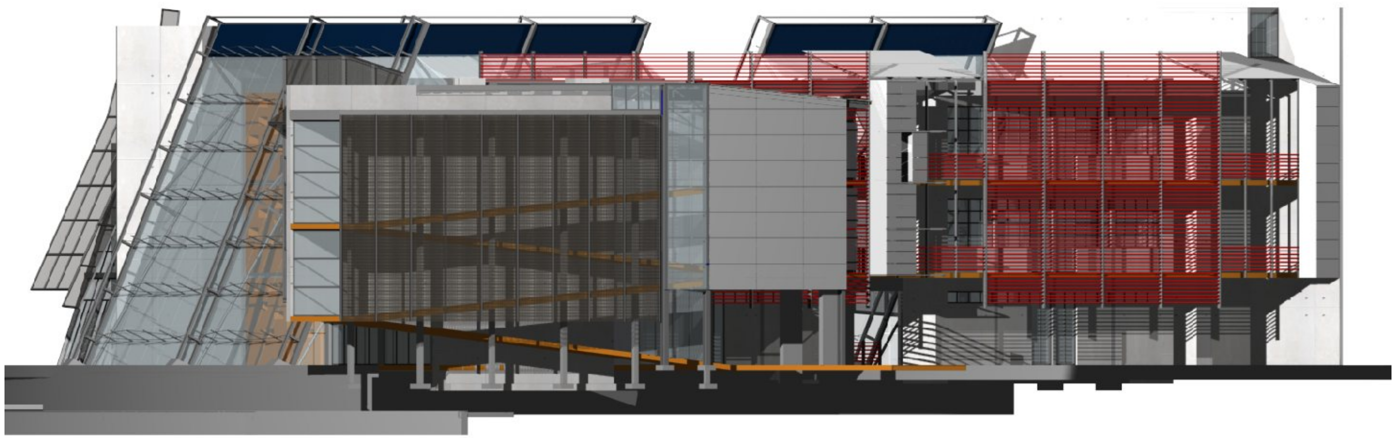
8. Design Discourse

"Nature has become an appendage of urban civilization whose advantages we use every day, but which we hate. We have to learn how to live with that discrepancy. Palliatives are of no use. The dream of untouched nature is over. We have to accept that it will never again be as it once was. The only thing we can do is to build monuments to the new reality so we can recognize the span of urban reality as that of the future. The city is everywhere." (Coop Himmelblau, 1978, p136)

Pretoria City is made up of a number of layers; these are layers of history, development, buildings, monuments, etc. As each of these layers was laid down, a piece of the biophysical environment was replaced, by built form. This replacement did leave the city with a small number of green spaces, which achieve their task as an urban playground but do very little to contribute to any ecological diversity (Hough, 1984, p16). They do not provide an image of the environment outside of the urban context. One assumes that all green spaces within the city make a positive contribution, but these manicured green spaces often require high-energy inputs (Hough, 1984, p16), inputs such as cutting, trimming, weeding and fertilizing. Many of the plant species within these spaces are also exotics requiring larger amounts of water, while the indigenous plant systems in the biophysical environment require very few energy inputs.

Nohl suggests that nature in urban areas is in a sense a letdown (Nasar, 1988, p81). These areas are artificial and do not fulfil their task as an escape from the city. The idealization of being immersed in nature is not fulfilled. This connection to an un-urbanised nature that we refer to is a concept that Schiller (1759-1805) termed the 'totality of nature' (Nasar, 1988, p79).

Many of these spaces do however have very strong cultural links, which represent a piece of heritage dating back to



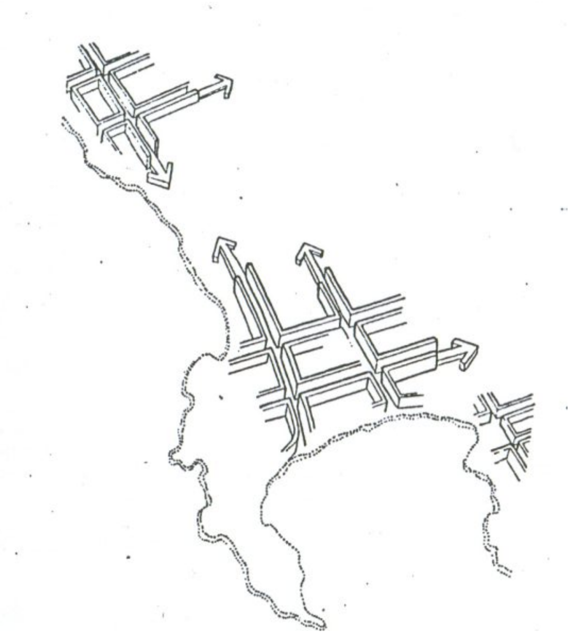
8.1 West elevation of 3D model

about 1850, but almost all layers before that time are absent. Ethnobotanic links, especially medicinal, are some of the remaining layers from that time and some artefacts do remain on the ridges, but are isolated from the rest of the city and therefore from us. It is important to expose all these layers of history as they form the base for a regional identity (Dewar and Uytenbogaardt, 1991, p39).

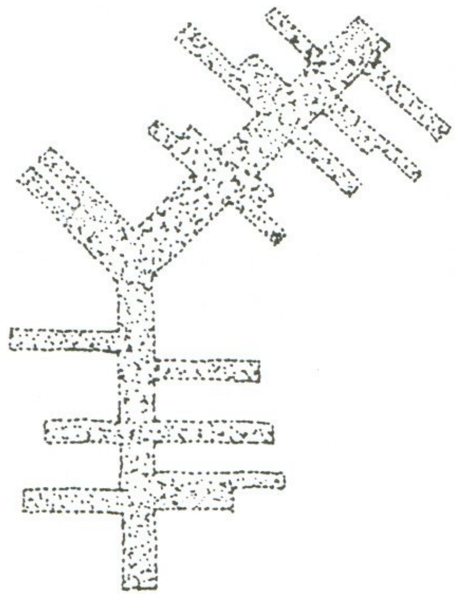
These ridges form what Dewar and Uytenbogaardt (1991, p79) call 'nature rooms'. 'Nature rooms' are natural land parcels that should be maintained so that they are protected from urban development. These 'nature rooms' preserve the urban-rural relationship, and in this case, cultural layers. From these areas, 'nature corridors' need to develop and stretch into the inner city to undefine the boundary between the urban and rural environment. These corridors should coincide with existing cultural installations to form a network of activity systems. As cultural facilities become incorporated into this network, future installations will inevitably tie into it as well. This system will form a mega-structure (Trancik, 1986, p107) creating a synthesis of cultural and physical context. Dewar and Uytenbogaardt, in '*South African Cities: A Manifesto For Change*' (1991, p82), indicate the importance of locating public and social facilities around the nature rooms; the green spaces celebrate these facilities, give them a sense of scale and create a sense of enclosure.

Initial design investigations were based around establishing a continuation of the Zoological Gardens along the river into the city. With the EBRC and its surrounding landscape, this would form a stronger ecological environment that spreads

8.2 Dewar and Uytenbogaardt's concept of 'Nature rooms'



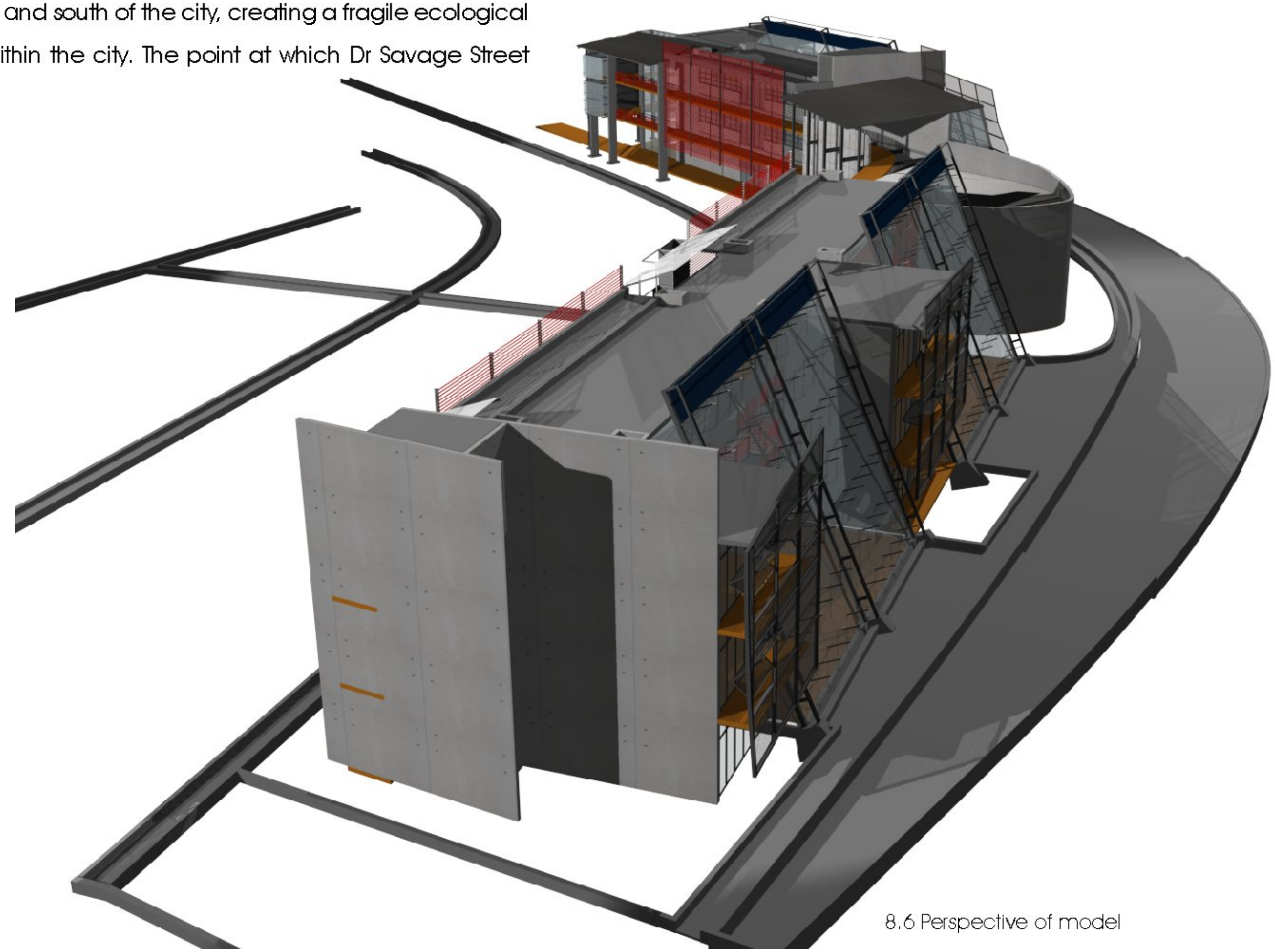
8.3 Maki's 'megaform', an open ended structure whereby linkage is imposed



8.4 Biophysical connections between the EBRC and the ridges

8.5 Movement paths informing the EBRC form northwards onto the Witwatersberg Ridges and southwards penetrating the CBD. The immediate surroundings of the EBRC are used for cultivated medicinal plants and the land opposite the EBRC on the east bank of the river is used for uncultivated medicinal plants, both of which contributing to the awareness of the greenbelt through appropriation (See fig.8.4).

As identified in the context analysis (see page 004), the Apies River forms a greenbelt through the city that links the ridges to the north and south of the city, creating a fragile ecological thread within the city. The point at which Dr Savage Street crosses the Apies River, is where the river and its surroundings take on a more natural form. The biophysical environment is funnelled into the CBD here and development has encroached northwards. To the northwest, development has been restricted by the Zoo and Zoological Gardens. By establishing a strong identity at this point, there was the possibility of creating an awareness of the 'totality of nature' within the city and making it accessible without encroaching

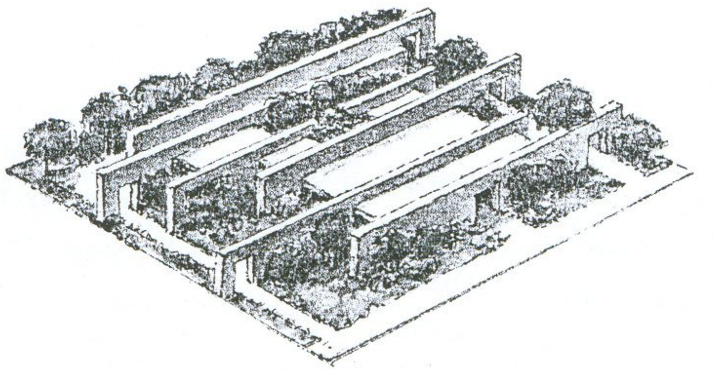


8.6 Perspective of model

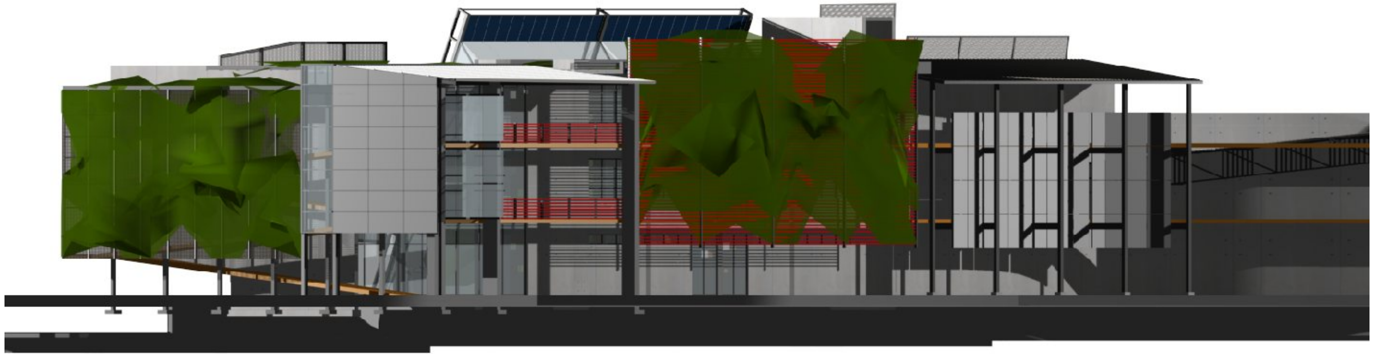
on it. This is demonstrated by Norberg-Schulz's assertion that by 'inhabiting' a landscape, it becomes recognised and understood. People that inhabit the landscape in turn act as the 'guardians' of that space and through interaction reveal the essence of the place (Quantrill and Webb, 1991, p47). This is illustrated by Heidegger's (1889-1976) statement in 'Constancy and Change in Architecture' (Quantrill and Webb, 1991, p47) that: "The bridge…does not just connect banks that are already there. The banks emerge as banks only as the bridge crosses the stream…. With the banks, the bridge brings to the stream the one and the other expanse of the landscape lying behind them. It brings stream and bank and land into each other's neighbourhood. The bridge gathers the earth as landscape around the stream". An analogy to this is that the Apies River greenbelt and the biophysical environment already exist and by means of a number of installations (See fig.3.16) they have been related to human action. At this point along the river, the EBRC is necessary for this relation. How? Norberg-Schulz goes on to say that it is not enough to recognize the landscape but has to be expressed in images that reveal and endure.

The building and the site on which it stands needs to become a landmark to the greenbelt that makes obvious the transition between urban and natural landscapes, but continually attempts to draw the biophysical into the city; in doing so creating a strong dialogue between the architecture and its context. The architecture of the EBRC not only needs to fulfil its functional role of housing a programme

8.7 Wines' concept of 'Passages'

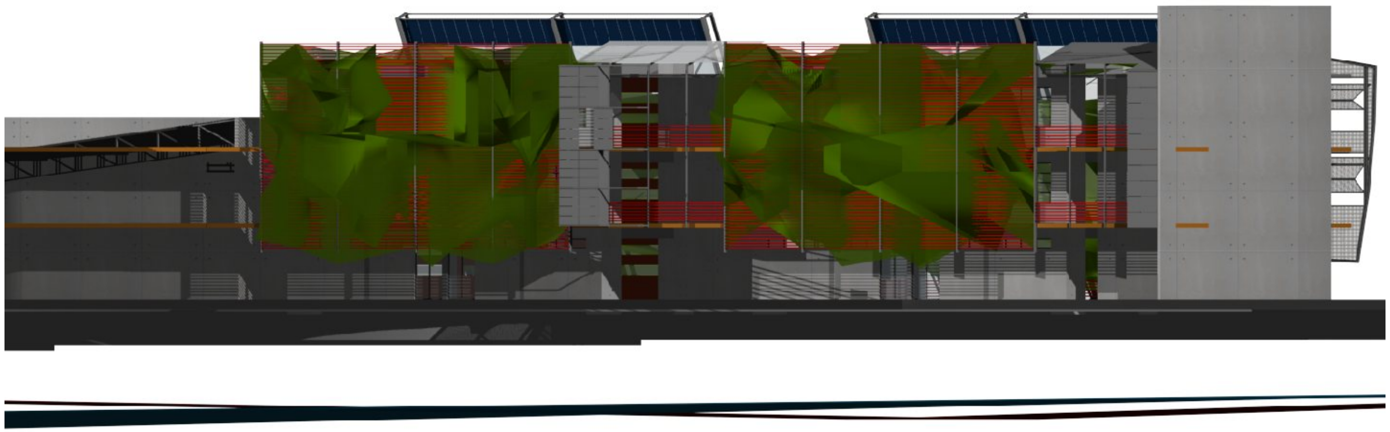


8.8 South elevation of 3D model [with biological envelope]



but also needs to communicate this dialogue to the observer, creating an awareness of the immediate and surrounding context. This communication is prevalent in the projects of SITE, as Wines states: "…the practice (SITE) developed the idea that it might be productive as a way of breaking free from the strictly formalist interpretation of architecture to shift the aesthetic focus from shelter to the capacity to absorb and transmit messages. This suggests that walls, instead of being seen mainly as barriers, enclosures or compositional elements, can serve as information-filtering partitions, or points of passage, that fuse and dissolve traditional inside/outside relationships and incorporate narrative commentaries" (Wines, 1993, 32). In relation to this ideal, Wines himself developed the concept of 'Passages'. He defines this concept as a notion intended to describe a mutational, organic and informal set of connections between building and landscape. In doing so the structure should reflect and engage various aspects of landscape, regional identity, topography and cultural references (Wines, 1993, p33). These ideals suggest a fusion between architecture and the landscape. Wines endorses this by stating: "Buildings conceived as integrations of structure and landscape are mutable, metamorphic and evolutionary, constantly conveying new levels of information" (Wines, 1993, p33). This symbiosis will create a strong contrast in the city; this contrast gives richness to the city and pervasive presence to the landscape" (Trancik, 1986, p106).

To emphasise the synthesis between architecture and landscape, there needs to be a strong union with the ground on which it stands. A study of horizontality in architecture, revealed this association with the building and its immediate landscape. Arnheim (1977, p44) emphasises this: "…'belonging to the ground' comes about not by penetration at right angles but by parallelism, which creates an easy harmony. The building hugs the soil and fits easily into the landscape. At the same time, it is rootless like a boat, it tends to float on the surface of the ground because parallels do not interlock. Contact is all the more tenuous



because the shape of such a building undercuts the vertical dimension of gravitational pull. The building has little weight; it does not press down."

While reposing over the ground does establish a strong connection to the earth, horizontal composition becomes largely affected by visual weight. Visual weight is governed by three factors (Arnheim, 1977, p46), the first being distance. Perceptually, the earth is not the only entity that has a gravitational pull, as any perceived object within a visual field will generate its own gravitational pull. Physically, the gravitational pull from the earth weakens as the distance from it increases. The same is true for the perceptual gravitational pull of an object. For this reason we perceive taller/narrower buildings to be affected less by the pull of gravity, although they do have a larger weight to area ratio than a shorter/wider building.

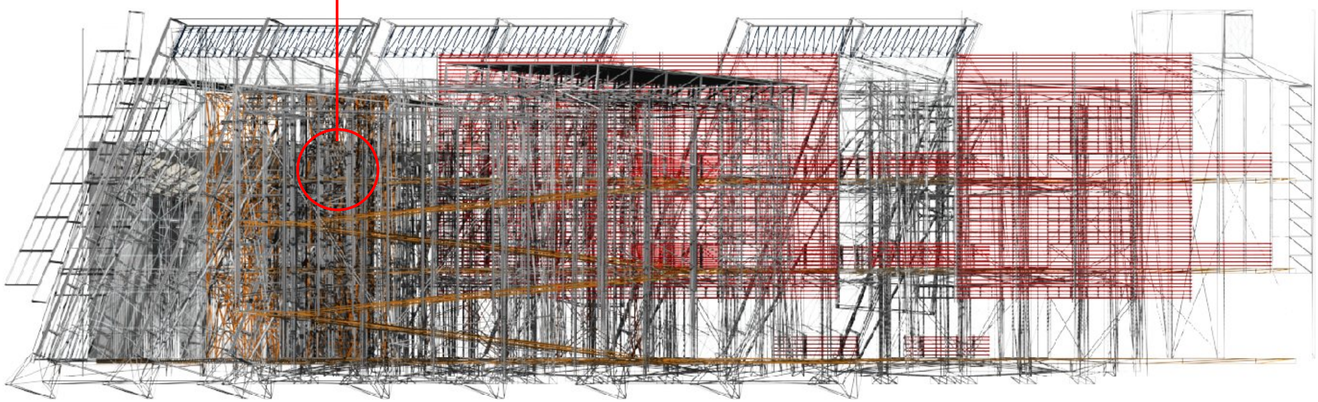
The second factor is load. Physically, the loads on the lower levels in a building are larger than on the higher levels. This is obvious as they support more weight. Because we understand this to be true, we perceive this as visual weight as well; however the lower levels appear physically heavier than those above.

The third factor is potential energy. Physically, the potential energy of an object is amplified with an increase in elevation, and is reflected perceptually. This leads us to believe that an object that is elevated higher than another is heavier than the other.

In the case of a building that is elevated from the ground, it can be said that the interspace (the space beneath the building) affects the visual weight of the building. If the interspace is very large, the structure is perceived to be floating over the ground. If the interspace is small, the building appears to struggle under its own weight to stay elevated.

By reducing the 3D model to its line components, the concept of visual weight is illustrated. With the elements on the ground floor minimized, the building elevates above the ground and a centre of gravity develops where the highest density arises.

8.9 Elevation showing line components



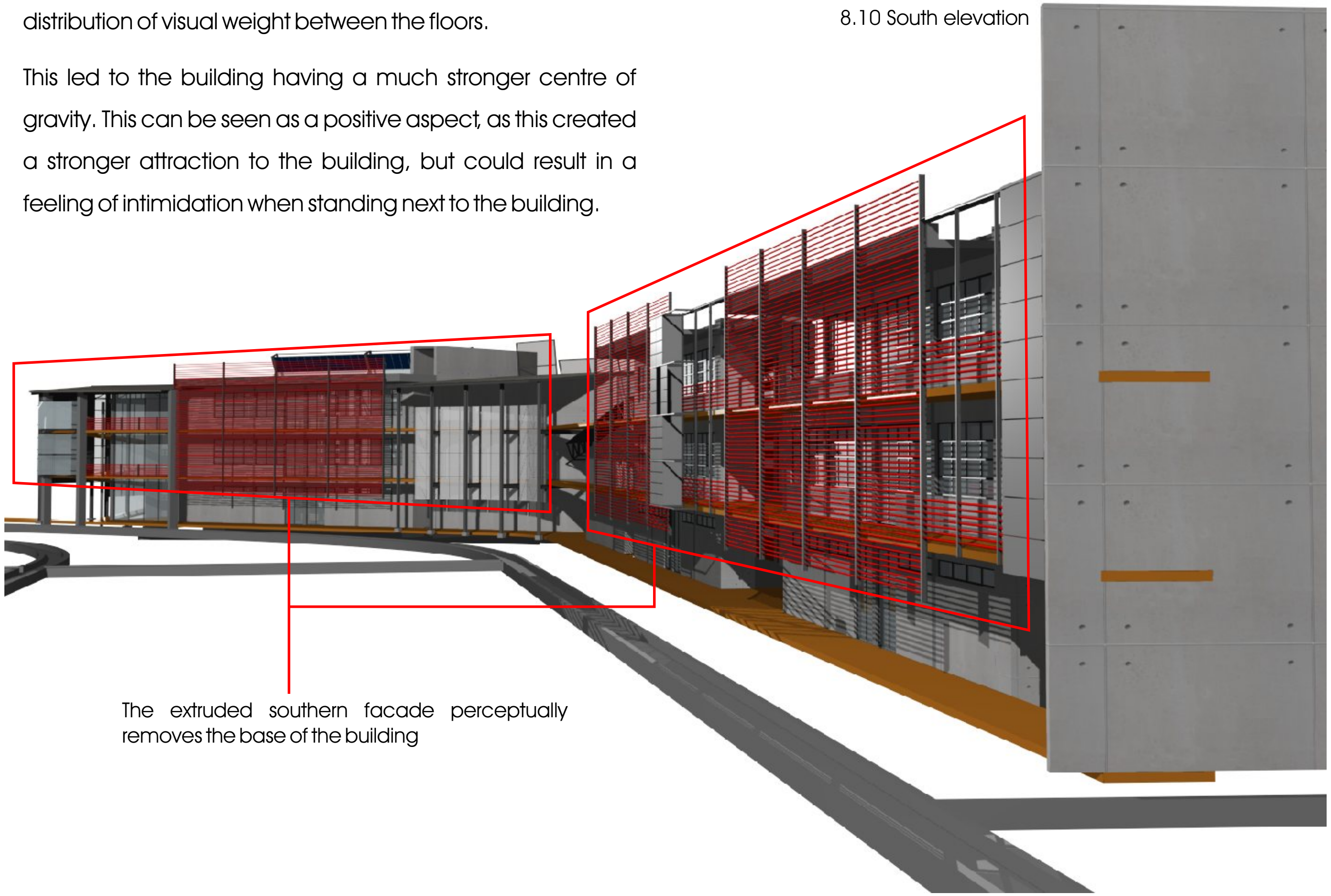
From this, the following deduction was made in the design of the EBRC. To create a strong connection between the building and the ground on which it stands, the EBRC was spread horizontally across the site (see fig.8.7), but remained narrow to limit interference with the flow of the ground water (See appendix C) and for natural ventilation and lighting. This however gave the appearance that the building was applying a great pressure on the ground, therefore the top two floors would be extruded (see fig.8.8), figuratively removing the base, giving the perception that the building was floating above the ground. This also resulted in a better distribution of visual weight between the floors.

This led to the building having a much stronger centre of gravity. This can be seen as a positive aspect, as this created a stronger attraction to the building, but could result in a feeling of intimidation when standing next to the building.

A design approach loosely based on Wines' concept of 'Passages' was adopted. The concept of integrating the landscape and architecture was initially conceived as a purely functional principle of microclimate control and plant propagation. By integrating the landscape and architecture, the building became wrapped in vegetation, a veritable biological envelope. This envelope is in a continual state of growth that constantly morphs and transforms the state of the building.

The envelope is made up of three overall components,

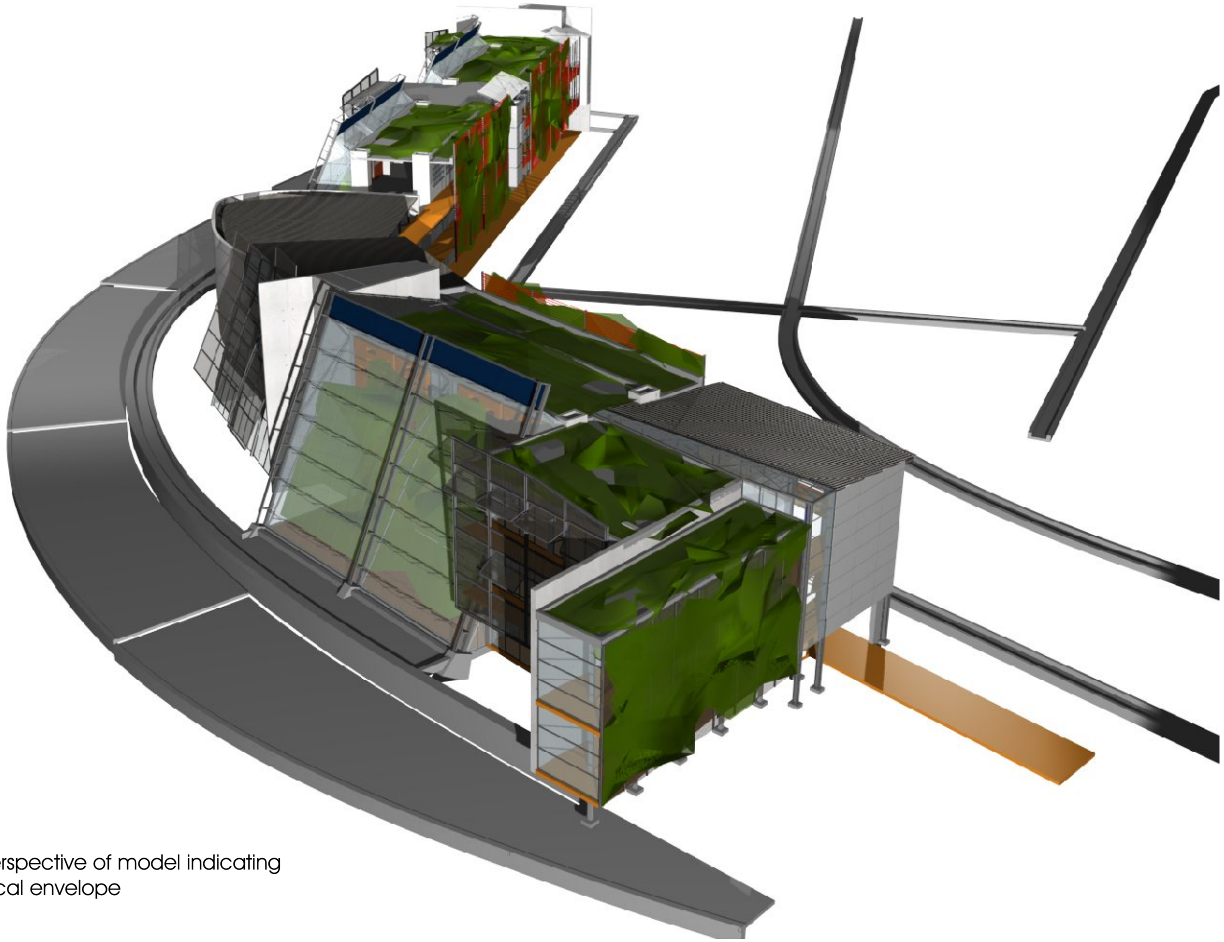
8.10 South elevation



each containing sub-components and sub-functions. The first component is the series of terrariums on the northern side of the building. With each terrarium containing a different climatic zone, the environment therein will evolve differently to the others. As a result of this, the wall in each terrarium will respond according to each habitat. These walls that back the laboratories do not really function as walls, they only function to control temperatures between the two opposite spaces. In essence, the walls function as a response, but the 'wall' in the Mediterranean and garden route terrarium does not even exist. The walls are considered then rather as responsive membranes.

The second component is made up of the roof gardens. These work mutually with the third component, namely the plant screens that enclose the walkways on the southern side of the building. These carry the climbing vegetation down from the roof gardens. All these components are generative responses that have been addressed in greater detail in the technical investigation.

The biological envelope adopts a sub-functional role. It is

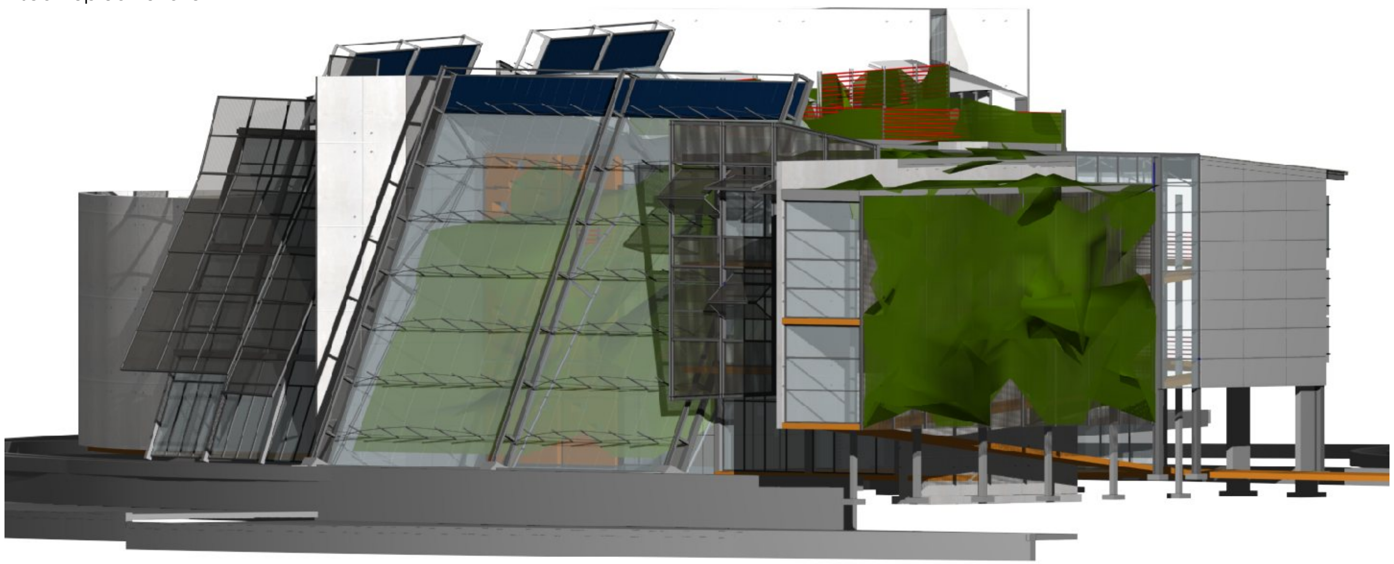


8.11 Perspective of model indicating biological envelope what Wines' refers to as message transmission. Before the design was conceived, it was already determined what the EBRC was to communicate. Beyond its functional role of plant research, the EBRC serves to create an awareness of the greenbelt along the river, an awareness of medicinal plants and the cultures that utilize these ethnobotanic systems.

The biological envelope transmits these messages through symbolic meaning. In terms of semiology, it is determined that the envelope is the signifier of the EBRC and the users and general public are the referent. The envelope does however convey a number of different semiological meanings depending on the three different levels, these being syntactic, semantic and pragmatic (Lang, 1988, p14). Syntactic meaning results from the buildings' location. The referent would probably not understand the generative reasoning behind the biological envelope but would draw parallels with the vegetation on and around the building and surrounding biophysical environment, identifying a superimposed connection and becoming aware of the greenbelt. Referents that participate in the EBRC as occupants or in the collection of medicinal plants will identify the spread of medicinal plants along the river into the Zoological gardens.

The semantic meaning relates to the 'norms' and representation that the envelope signifies. If the referent does not know the function of the EBRC, the semantic meaning would be that the building is attempting to be 'green' or 'sustainable'. As denoted in the technical report, the envelope does contribute to these aspects, but there is not an intention to communicate this message. If the function of the EBRC is known, the semantic meaning

8.12 Entrance and south-east coast & sub-tropical terrarium



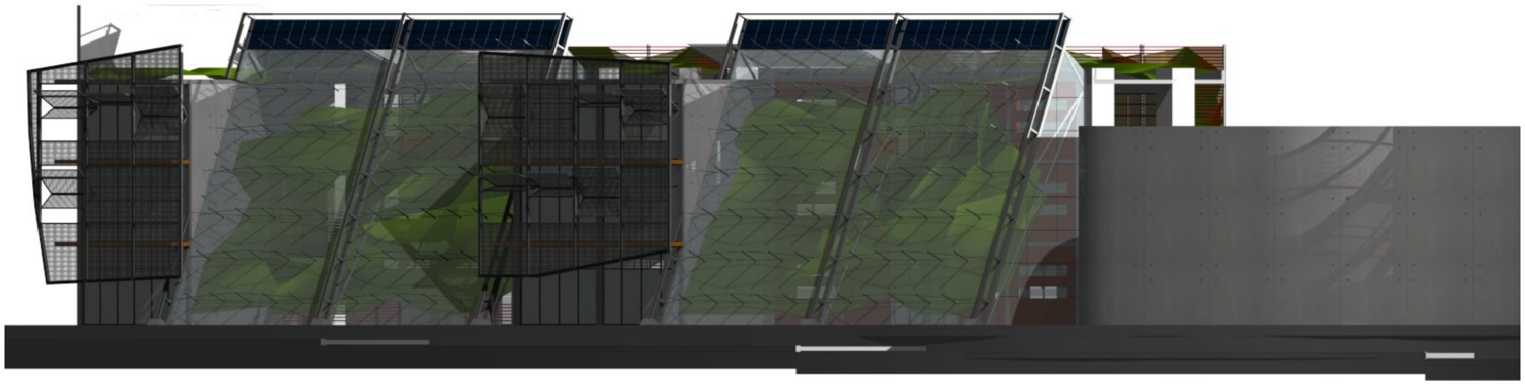
becomes increasingly significant. One would assume that the three terrariums represent different climatic zones and that the plants are grown for cultivation and research. This could be taken further, with the referent questioning the necessity of the cultivation and thus understanding the needs to preserve these plants and their habitats. By observing that the same plants occurring in the envelope occur in greater numbers along the river to the north as apposed to the south, further awareness of the biophysical environment is achieved. The function of the EBRC has to be known before the correct messaging will transpire.

The pragmatic meaning relates the symbol to those who use it. In this case, only the occupants of the EBRC would know for what research purposes the plants are being grown. However this group of referents will experience how the envelope controls the micro-climatic conditions.

The building forms an indirect relationship with the biophysical environment and a direct relationship with the river, in doing so the river becomes animated at this point.

The southern end of the site will be animated with the establishment of the 'Ceremonial Square' at the intersection of Struben Street and the Apies River. The retail and exhibition functions of the EBRC will spread northwards from the 'Ceremonial Square' and will be linked to the main research component through a series of pathways containing ethnobotanic related displays. At the EBRC, this pathway turns towards the sculpture department linking the arts campus to the square. With both gateways to the site being animated, pedestrian activity is drawn through the site without the need for any development between these two points. A series of visual axes linking the two gateways are generated through the landscaping, which guide pedestrian movement along the river. The landscaping extends past the EBRC over Dr Savage Street, indirectly connecting, through a series of visual points, the Zoological Gardens to the 'Ceremonial Square'.

The building lies adjacent to the Apies River, enclosing the pedestrian path. This interface creates an exciting movement passage that is strengthened by drawing the



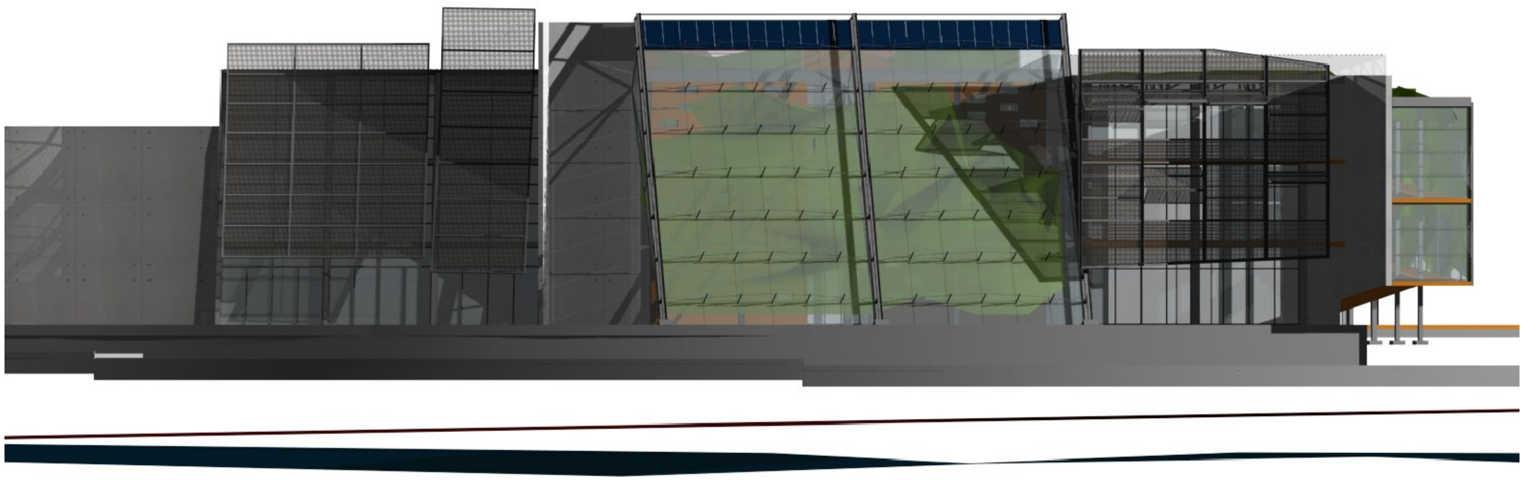
8.13 North elevation

building away from the river in response to the pedestrian line of movement from the new transport terminus. Where the EBRC steps away from the river, an enclosed public space is defined by the road, river and building edge. The upper level of this space allows activity from the EBRC and function from the café to overflow outdoors, while the lower level provides a pause space to the 'nature room' and transport terminus. Now serving as a public space, the bridge at Hove's Drift takes on the function of a gateway. With this recessed, a focal point is allowed to form as an indicator of the EBRC for the fast moving vehicular traffic along Dr Savage Street. This focal point is created through the contrast between the active and inactive planes that first come into view along Dr Savage Street. One's eye is drawn along the façade to where the auditorium curves, directing attention along the river.

The functional areas of the building are organised around two lines of movement. The first being pedestrian movement through the site along the river, the second being the movement through the building. The components of the building are fitted between these two boundaries and respond to the line of movement through the building so that it is not interrupted. The constructed wetland on the northern side of the building curves around the disjointed plan form as a response to a more humanist line of movement.

The steep gradient of the site at the northern edge that used to follow the form of the river now follows the form of the building, creating a less intimidating environment along the river. The gradient is formed with a series of gabions that lead up to the EBRC. The gabions provide seating for the public space adjacent to the river as well as terraces for medicinal plant propagation where disruption will be limited.

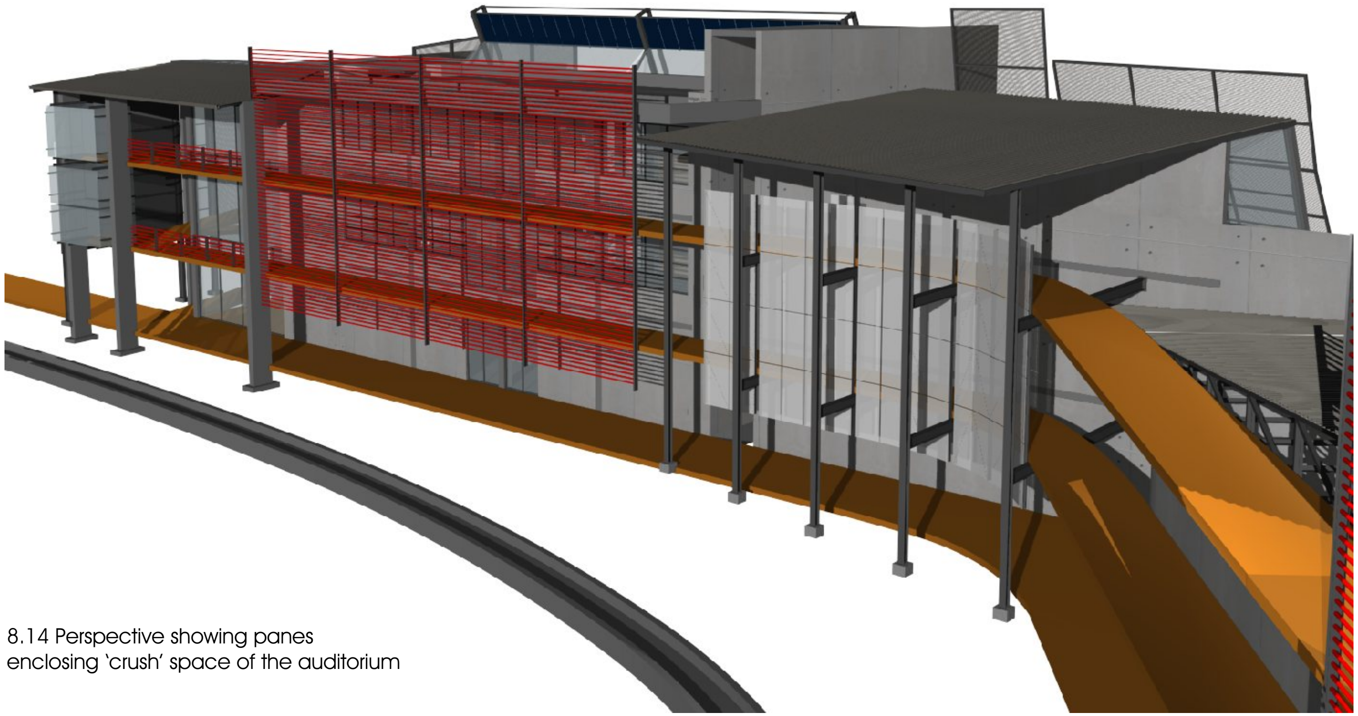
Drawing the EBRC away from the river resulted in the building becoming fractured into two segments, forming a tension point where these two pieces converge. The auditorium is placed at this junction as its loose form articulates these two parts. The northern façade of the auditorium is an extension of the southern façade of the adjacent laboratories, forming a directing wall that originates in the entrance foyer. As the



wall turns back on itself, it forms a positive space that encloses the auditorium, while the negative space forms a gathering place for the auditorium. This space is linked to the café. The columns supporting the roof and walkways above define this gathering space, but do not disconnect it from the outside. The panes above however do attempt to enclose this space. At this point the walkway of the first floor turns to follow the building but remains removed from it, emphasising the line of movement from the entrance to the end of the EBRC.

By placing the walkways outside of the main structure, users are directed outdoors as soon as they move around the building. This ensures a constant connection with the landscape, both physically through the vegetation growing adjacent and visually. Similarly, the ramps at the entrance are contained by vegetation growing on a steel mesh screen. The ramps are placed perpendicular to the elongated form of the building and follow a visual axis northward along the river. This ensures an immediate awareness of the greenbelt upon entry into the building. The steel mesh on the ramps is relatively strong, but is not a static element. Vegetation from the roof will penetrate it and disengage its components to pass through it, altering the aesthetic of the building over time.

With the walkways and screens pulled away from the main structure, the EBRC appears to elevate over the ground. This allows for activity from within functional spaces to overflow into the landscape from anywhere within the building. On



8.14 Perspective showing panes
enclosing 'crush' space of the auditorium

the northern side of the building, the same thing occurs except the outdoor spaces are defined by the series of cooling ponds, maintaining these spaces as semi-private spaces for the occupants.

While the design of the EBRC is based on a generative process, true generative design would need to be achieved through the use of computer technologies due to a vast number of factors that affect this process. Much of the building's dynamic form is related to the generative process. The terrariums are angled at 65° to allow for large amounts of solar transmittance into the terrariums. The reality of the situation might however lead to a different formation, as the exact location of the building; the slight east and west orientations of the terrariums and suchlike would affect the solar transmittance. What does become apparent is that the closer the generative process is followed, the more dynamic the architecture becomes.

The dynamic form evolves from the composition of a series of horizontal and vertical planes. These planes are pulled away from and pushed into the overall structure resulting in a succession of protrusions and voids. The envelope of vegetation continually moves over and behind these planes, puncturing and distorting them and disguising their ordered form. This overlay of planar elements creates a juxtaposition of order and disorder that should create a tension. This does not occur due to the organic aesthetic of the vegetation, but does however create an interest through its dynamic form.

Plants are perfectly ordered as individual components of nature. This is due to their genetic template, but as a result of

8.15 Perspective of ramps [without vegetation]

8.16 Perspective of ramps [with vegetation]

8.17 Perspective of entrance

differences in gene expression patterns, characteristic plant growth will vary in different species. This reveals random growth patterns resulting in an overall lack of order. This is true in what Arnheim says: "…the components of a disorderly arrangement must be orderly within themselves, or the lack of controlled relations between them would disrupt nothing, frustrate nobody. You cannot sabotage a melody unless there is one…" (Arnheim, 1977, p170).

On the southern façade, this assimilation of an orderly and disorderly arrangement is illustrated with the plant screens. The repetitive form of the steel screens become disordered as the plants from the roof gardens form an unsystematic layer over the steel screens. This façade is in constant motion as the vegetation proliferates over the screens, becoming overgrown, being seasonally cutback and periodically trimmed for research purposes. This results in a continual shifting of quality of light and climatic conditions within the building and an interaction by the user through appropriation. These screens generate a sense of enclosure, encompassing the walkways as part of the main structure, but are actually pulled away from the building. These screens are paralleled by the terrariums, but separated by the laboratories. The permeability of both the screens and terrariums allow for a strong visual connection between the internal and external environments. The research process is partially revealed to passers-by with the overlaid imagery of the origin of the plant and experimentation, while from the interior, strong associations are created with the external environment. This permeability of the building allows for an interplay between the internal and external environments. The plants within the greenhouses form an external environment enclosed into the internal environment of the EBRC, while all movement within the EBRC takes place in the external environment. When viewing the building perpendicular to its elongated axis, these environments become very blurred each with the

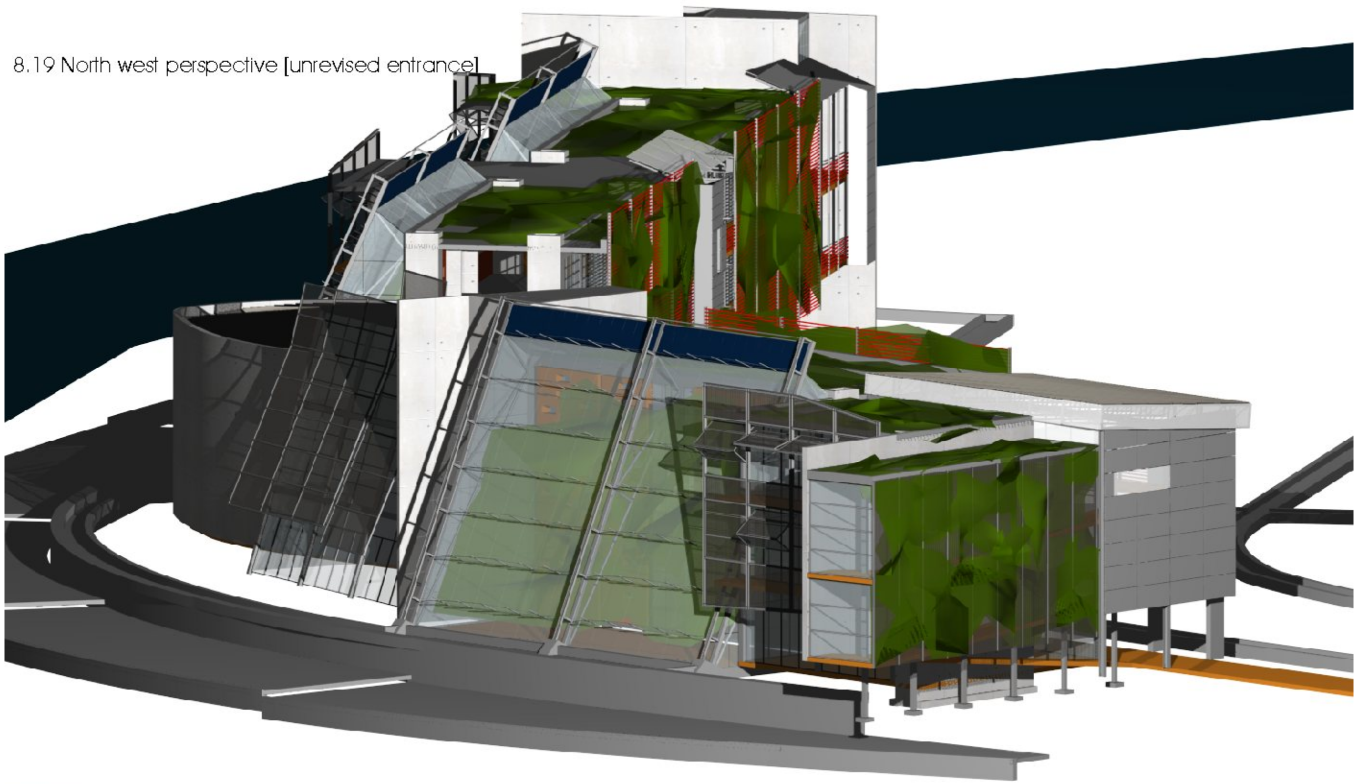
8.18 Perspective of west facade

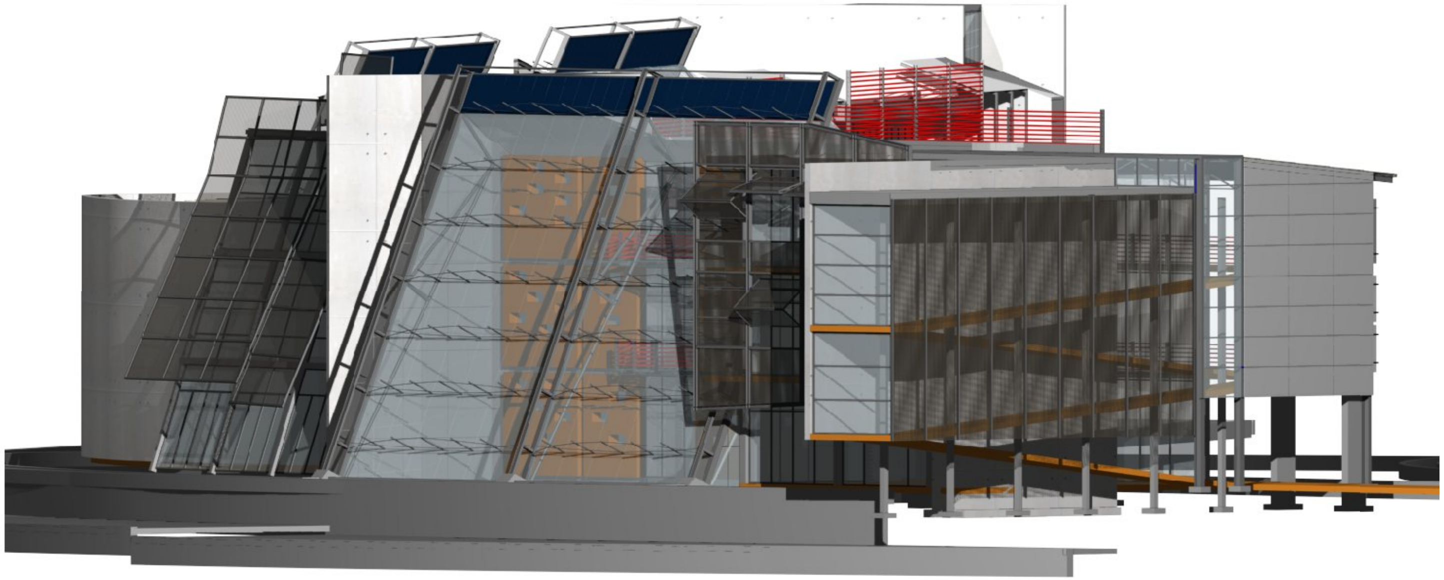
other, and even more so with the backdrop of the CBD to the south and west and the ridges and river to the north and east respectively.

This juxtaposition of layers is repeated on the northern façade in the terrariums with the flat plane of the glass being animated by the continual transformation of the environments behind. The screens over the adjacent offices and library extend past the structure to block morning and afternoon sun, giving the appearance that the terrariums pass entirely behind the screens. Where shadow paths are constant, the screens are chopped and bent. With every bend however, new shadow paths are created so the screens are continually folded and cut. This results in a permanent disordering of elements with no consistency in their form and a more dynamic northern façade that relates to the pedestrian axis. However the rhythm established by the voids and protrusions is maintained.

The building is constructed from simple materials and components. The points at which these components fuse with the landscape, is where the building becomes most exciting. There is a fascination with connectivity of two components that, although are closely associated, are rarely fused. This also generates an interest in the lifespan of the building by observing how the appearance of the building will evolve over time.

8.19 North west perspective [unrevised entrance]

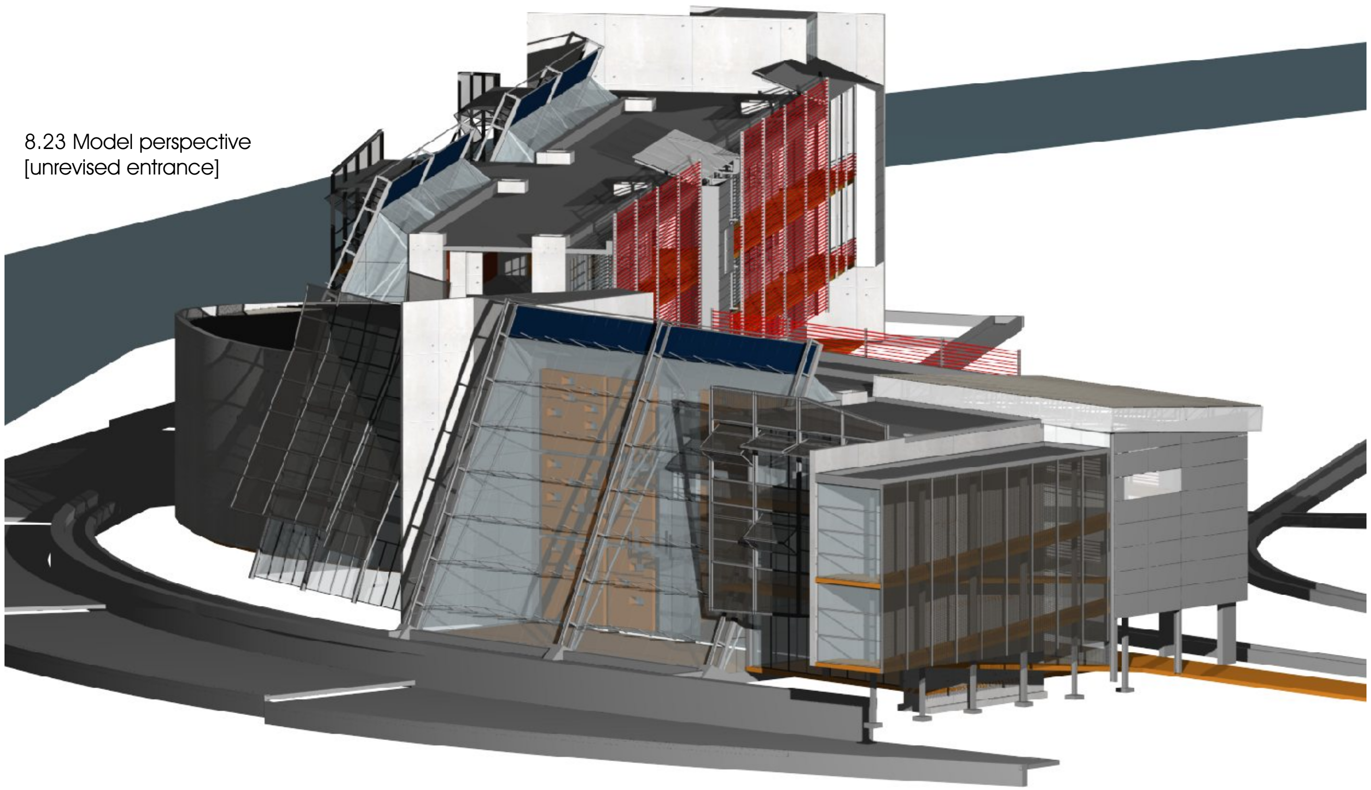




8.20 North west perspective

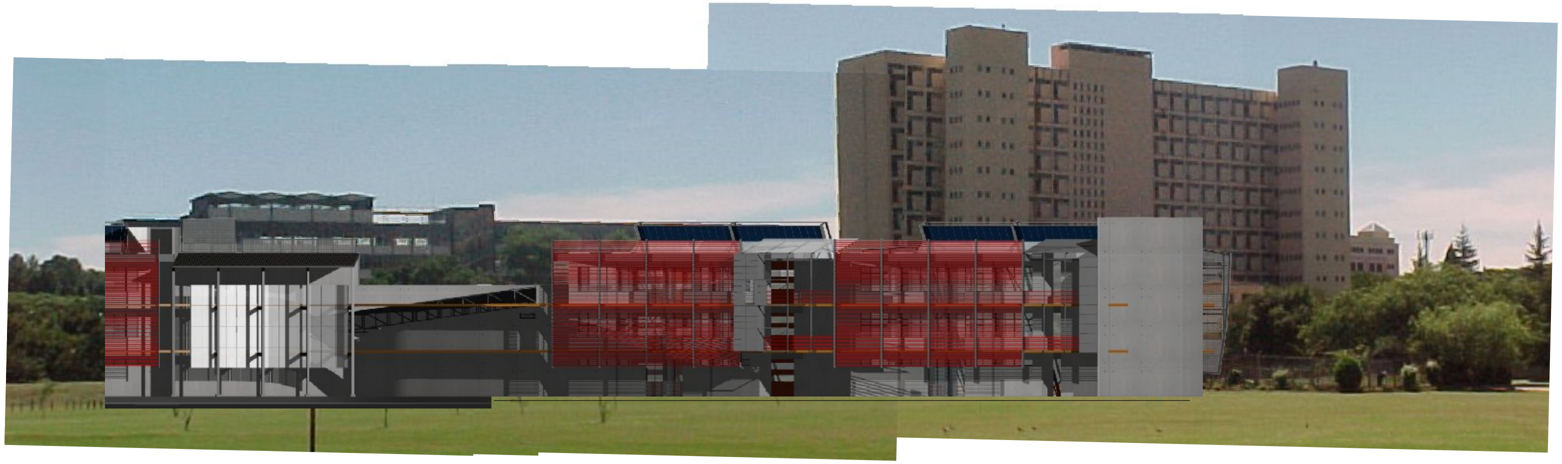
8.21 Perspective of entrance

8.22 West elevation



8.23 Model perspective
[unrevised entrance]

8.24 South elevation [in context]



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Integrated Spatial Development Framework. 1999. Capitol Consortium

Appendix A

Hove's Drift

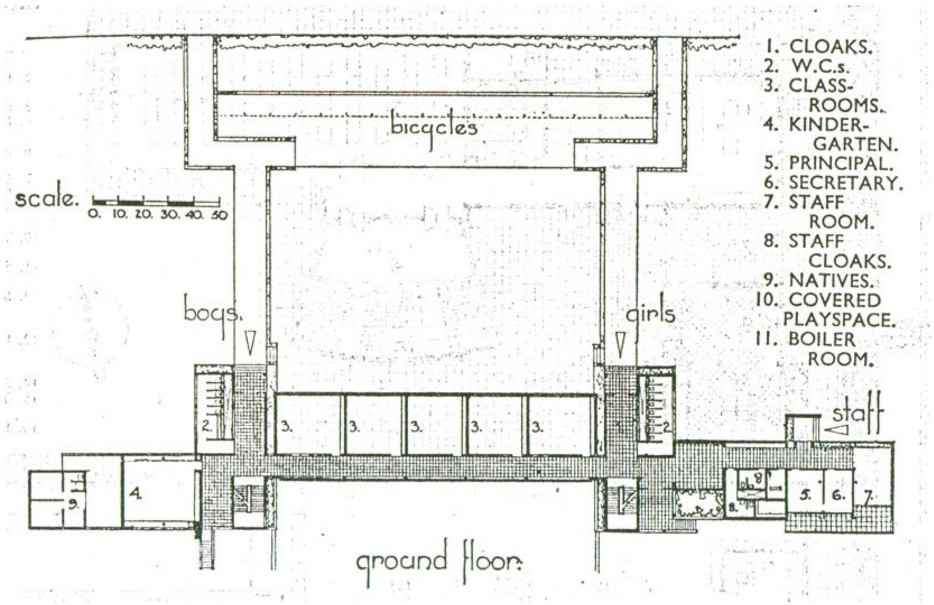
When Pretoria was established, the land that the chosen site sits on was a property called Prinshof, named after Joggem 'Tweeduim' Prinsloo and in the early 20th century the area served as the Prinshof Experimental Station where the cultivation of different types of grass species took place. Property on the west bank was owned by Theodore Hove (1834-1906)(VD Vaal, 1999). A linocut work by Hendrik Pierneef called Uniegebou Vanaf Prinshof, Pretoria, show what the area looked like in 1925 (Fig.2.46).

Hove's drift provided access across the Apies River from central Pretoria to the north and in 1932 a bridge was built here by Bain & Proudfoot. In 1935, Dr Savage street, was built across the bridge. The road was named after Dr SR Savage who was Mayor of Pretoria in 1907-1908 (VD Vaal, 1999).

Prinshof School

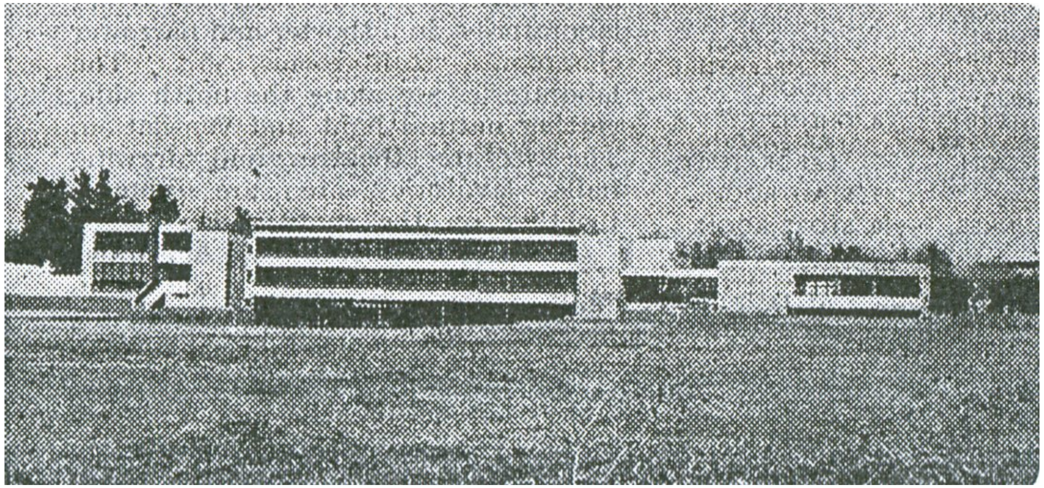
In 1943 the School at Prinshof was built for the Transvaal Provincial Administration. It was designed by Basil South in association with Rees Poole Architects and was said to be a bold example of Modernism (Richards, 1944, pg113).

From the end of 1991, the buildings on the campus had all been abandoned and had been allocated to house 700 exiled children of the African National Congress from Tanzania. During this period of political unrest in South Africa, there had been declarations by faceless bombers of a

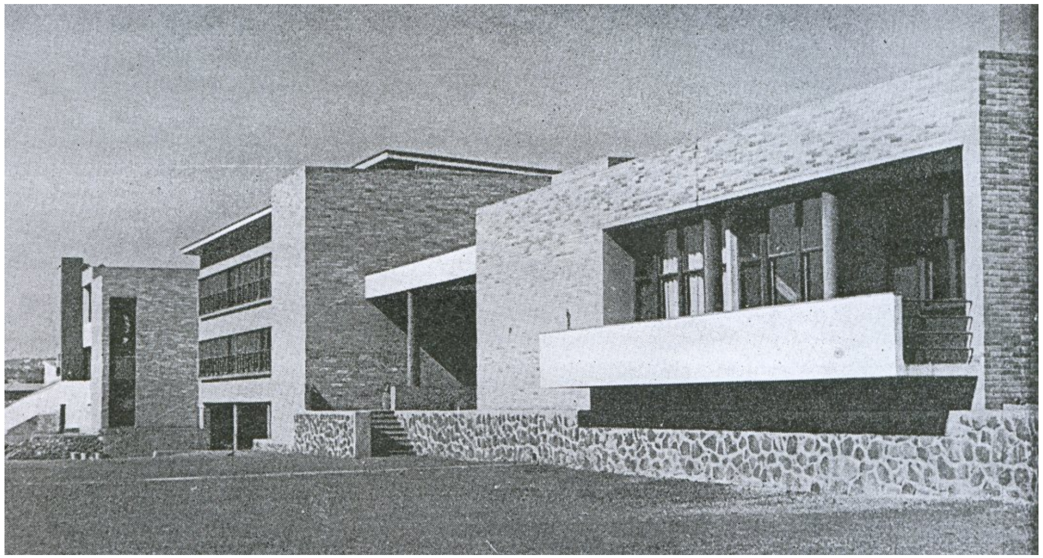


A.01 Ground Floor plan of the original building (Richards, 1944, pg 113) 'scorched earth' policy and became quite apparent when on 15 July 1991 at 1:50am, a bomb exploded from inside a first floor classroom of the main school building partially destroying it. Blame was placed on the Boere-Vryheidsbeweging although they denied having anything to do with the bombing (Dunn, 1991, pg1).

One week later on 22 July 1991 at 1:24am a second bomb exploded on the campus, this time on the boundary of Dr Savage Street leaving a 5m hole in the concrete perimeter wall. The leader of the Orde-Boervolk, although denying involvement, stated that all 'white' schools standing empty



A.02 North elevation of the original building (Richards, 1944, pg 113)



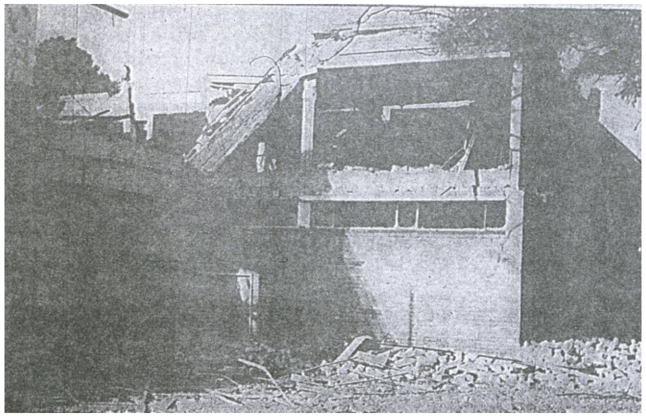
A.03 North west elevation of the original building (Richards, 1944, pg 113) should be destroyed or given back to the white communities (Brand, 1991, pg1). Several right wing groups claimed responsibility for the bombings, however on 11 June 1998 two members of the Afrikaner-Weerstandsbeweging; Andries Stefanus Kriel and Petrus Jakobus Judeel, where granted amnesty by the Truth Commission for the bombing of the Hillview High School. They were also involved in the bombing of the Cosatu House in 1991 and the Verwoerdburg and Krugersdorp post offices in 1992 (www.truth.org.za).

Due to the unrest the exiles where not housed on the Hillview campus, which was given to the Pretoria Technikon in 1992 and now facilitates the Arts faculty and women's dormitory.

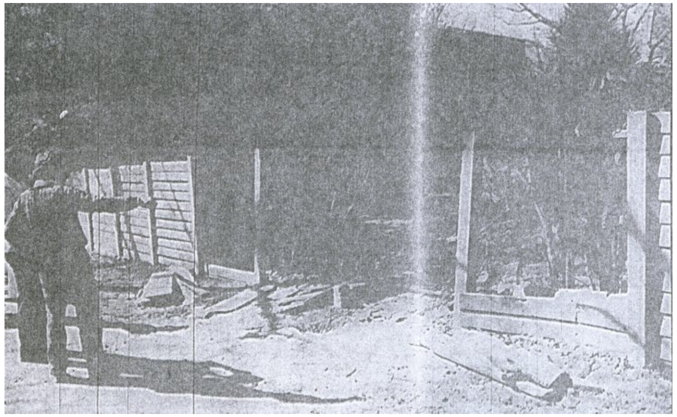
The partly destroyed buildings have been incorporated into the newer buildings but unfortunately the original parts are completely unrecognisable and hidden.

The remaining building is not protected for its historical significance, but because of its architectural merit and history, it needs to conserved. Although the building is being used and does not appear to be under threat from demolition, the additions and colour schemes remove the original character of the building, resulting in the loss of its cultural significance (Burra, 1998, chapt2.2). These can and should be removed since they do not contribute to the cultural significance of the building (Burra, 1998, chapt15.1).

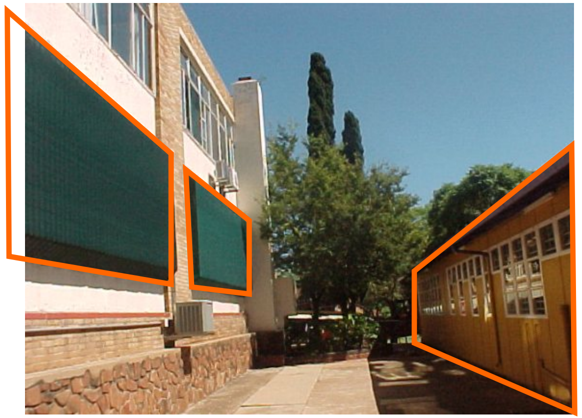
A.04 Damage to the main school building from the first bomb (Wolhuter, 1991, pg1)



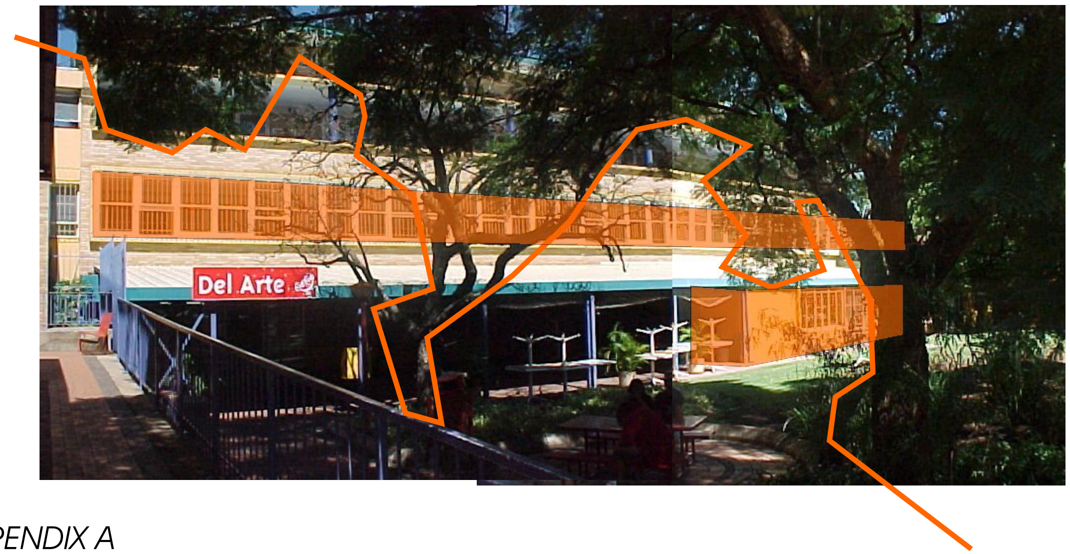
A.05 Damage from the second bomb along Du-Toit street (Pitso, 1991, pg1)



A.06 South elevation of the original building from the entrance to the campus. To a certain extent, the landscaping celebrates the building by framing it, however overgrowth should not hide the building any further. The small prefabricated security hut has no architectural merit and does not respect the *place* behind (Burra, 1998, chapt3.1).



A.07 North elevation. When change is being considered, a range of options should be explored to seek the option which minimises the reduction of cultural significance (Burra, 1998, chapt15.1). Sun shading was obviously a necessity, however the materials used (shade netting) are very inappropriate and reduce the merit of the building. Fortunately their nature makes them very temporary.



A.08 North elevation, showing classrooms and cafeteria. Permanent fixtures that change the character of the building are the strip windows on the ground floor and the cafeteria additions. These should have been designed in such a manner that they stood apart from the building, thus becoming easily identifiable (Burra, 1998, chapt15.1).

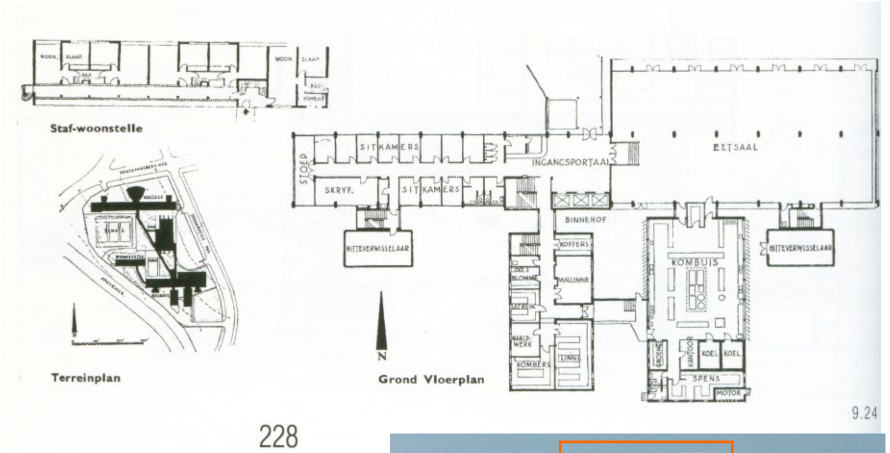
Appendix B

College of nursing:

On the east bank of the Apies river, on Dr Savage street sits the Pretoria nurses college. This series of buildings was deigned by Joubert, Howie, Owens & Van Niekerk in 1965 and is exemplary of Brazilian Modernism with its open staircase, brise soliel, pilotis and the organic form of the lecture and assembly halls. The strong modernists influence in both the Prinshof School and the College of Nursing was probably due to the fact they were commissioned for the Transvaal Provincial Administration, which strongly promoted Modernist architecture at that time (Gerneke, 1998, pg228).

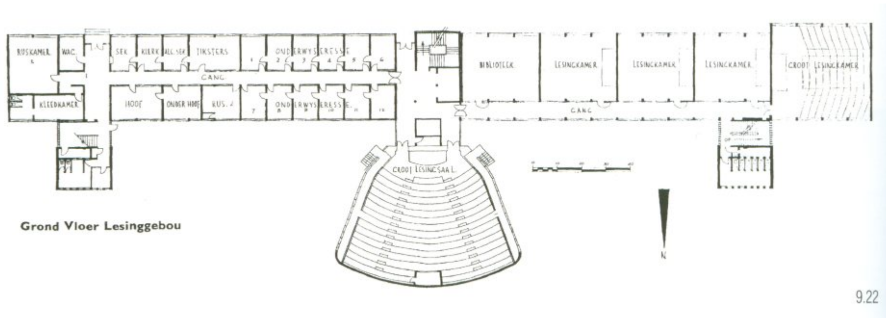
The site plan (Fig.2.56) indicates the original design intended for paths leading to social and recreational spaces along

B.01 Site plan and ground floor plan of staff facilities (Gerneke, 1998, pg228)

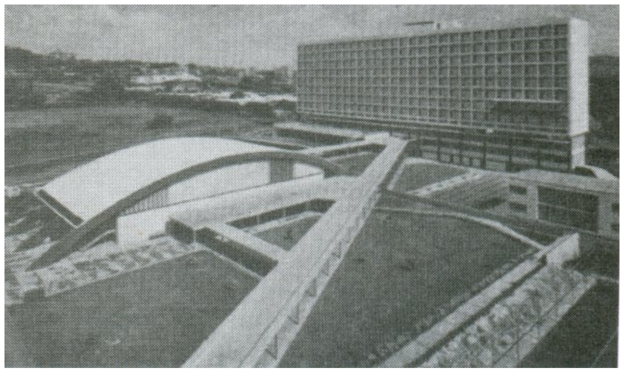


B.02 West elevation from PTA Tech. campus

the Apies river. Even though the river separated the College of Nursing and Prinshof school, these spaces tied the land parcels through activity. Since then, walls have been erected on both sides of the river, separating the parcels from the river and each other. From within the PTA Tech. campus, the walls prevent views to the river (Fig.2.59), while along the river the walls distort views of the Nursing college and hide the campus (Fig.60).



B.03 Lecture hall ground floor plan (Gerneke, 1998, pg228)



B.04 Aerial view of the College of Nursing (Gerneke, 1998, pg228)

B.05 Lecture hall (Gerneke, 1998, pg228)

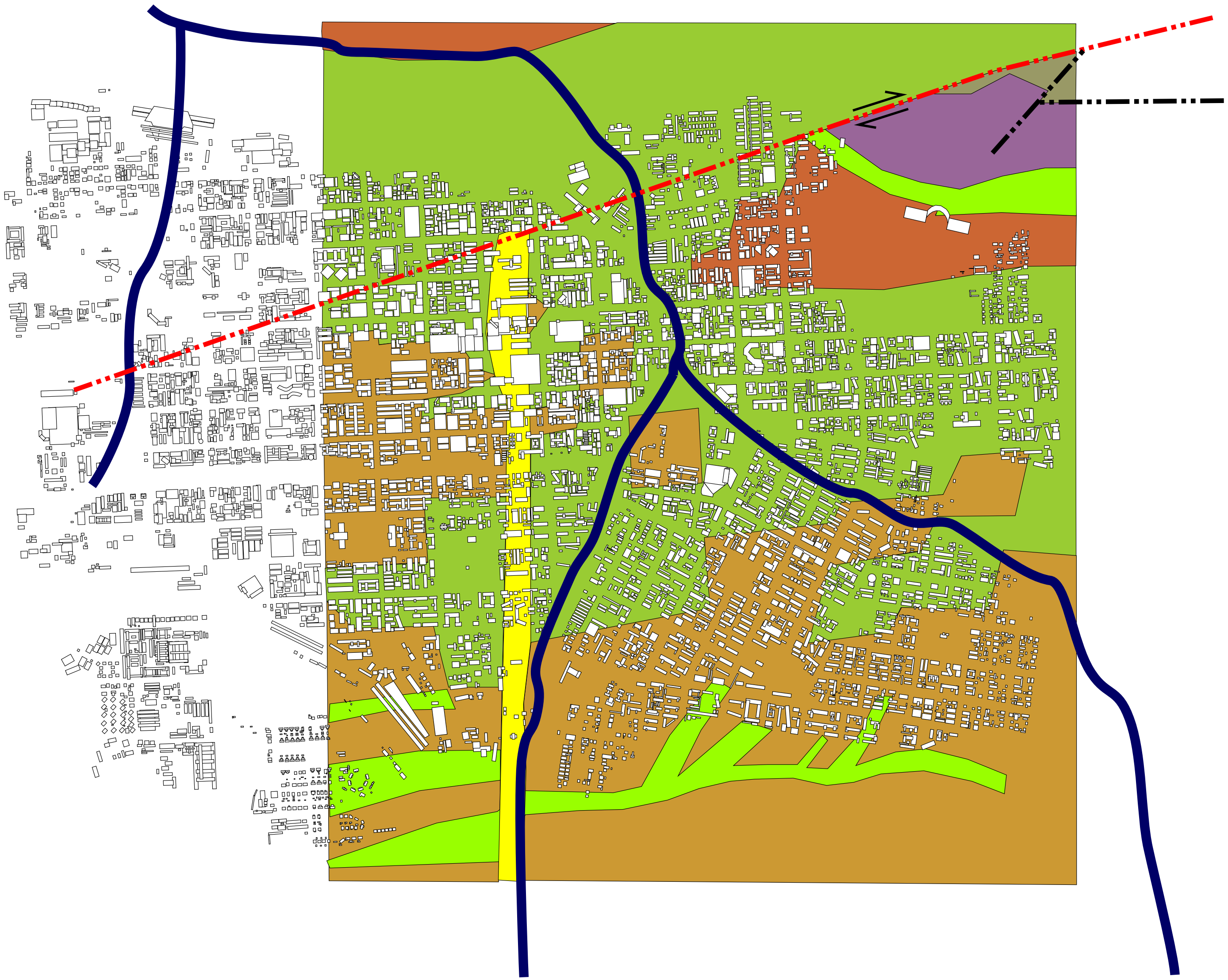
Appendix C

Geology

According to Fig.2.16, the geology of the proposed area is predominantly made up of Igneous rock, more specifically; Hekpoort Andesite. In an un-weathered state, Hekpoort Andesite is extremely hard with a bearing capacity of 1,5Mpa, providing a good footing for structures, unfortunately this does make excavating the rock very difficult.

This rock type is very susceptible to chemical weathering, resulting in the formation of residual soils made up of red and yellow zones, both containing active clays. These usually have a depth of 10m-30m and are medium active, this means that they will produce a heave of 15mm-20mm at the ground surface resulting in the cracking of walls and floors. This chemical weathering gives Hekpoort Andesite a highly variable soil profile over very short distances. A layer of solid rock can be within a few metres of decomposed rock so extensive soil tests should always be taken before construction. Change in amounts of water in the clays due to climatic effect will cause swelling and shrinking of the soil mass, contributing further to heave or settlement (Purnell, 1994, pg16).

Other problems in this region would be that the rock-bed dips northwards at 30 degrees resulting in the southern face of an excavation to slide. The presence of water contributes greatly to this process; fortunately the water table in the Andesite is around 6m depths, this is season dependent so excavation in the drier months would be more favourable. The other problem in the area is Pretoria's major fault line, the Meintjieskop Fault that bisects the study area (Purnell, 1994, pg12). The fault line is not a threat in terms of seismicity, but it is a strike fault, so any structure spanning over the fault will be 'pulled' in two directions.



C.01 Geology map of Pretoria (Purnell, 1994, pg49)

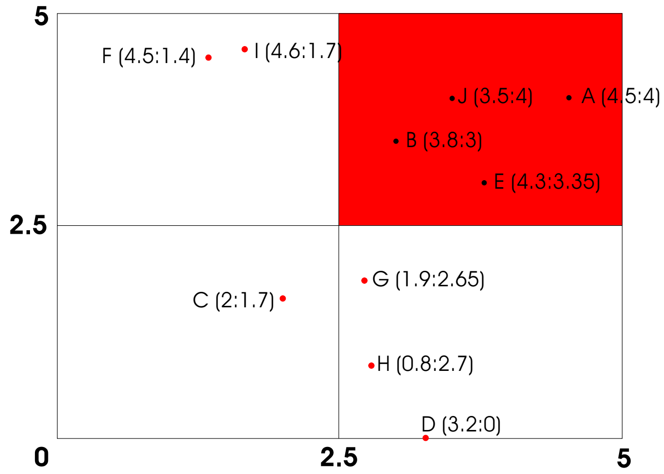
		POWER			LEVEL OF CONCERN			
	STAKEHOLDER GROUP	Influence of Others	Direct Control of Resources	Y-Axis	Technical	Social	Environ-mental	X-Axis
		0.35	0.65		0.2	0.3	0.5	
A	Medical Research Council	4	4	4	4	4	5	4.5
B	University of Pretoria	3	3	3	3	4	4	3.8
C	Pretoria Technikon	3	1	1.7	0	4	4	2
D	Students	0	0	0	0	4	3	3.2
E	Departments of Arts Culture Science & Technology	4	3	3.35	3	4	5	4.3
F	Environment	4	0	1.4	4	4	5	4.5
G	Labour	2	3	2.65	4	2	1	1.9
H	Unions	4	2	2.7	1	2	0	0.8
I	Community	3	1	1.7	3	5	5	4.6
J	Professionals	4	4	4	3	3	4	3.5

Appendix D

Key stakeholder management plans

A - Medical Research Council (MRC)

The MRC has the highest power and level of concern because they are joint clients with University of Pretoria and are co-funding the project. Their major concerns would be during construction, after construction they occupy the building and is up to them to make it function. Concerns before and during construction would be the cost of the project and the time of completion as it is in their interest to occupy the building as soon as possible. A cost analysis would be given to them with an indication of how long it would take for the building to pay for itself. Alternative construction and HVAC systems would have an environmental impact and cost analysis done to encourage the MRC to take a more ecological approach



	RISK DESCRIPTION	PROBABILITY	IMPACT	FACTOR	RISK CATEGORY
	SOCIAL				
01	Removing cultural link from traditional medicinal systems	3	5	15	High
02	Inadequate passive HVAC systems	4	5	20	High
03	Disruption of existing campus atmosphere	4	5	20	High
04	By removing the existing walls, is there a security problem	3	4	12	Medium
05	Salary disputes	2	3	6	Low
06	Isolation of existing land parcels	1	4	4	Low
07	Enclosing the Apies River	1	4	4	Low
	ECONOMIC				
08	Changes in technology	4	5	20	High
09	Size of the building becomes inadequate for the rapidly growing field of medicinal plants	3	5	15	High
10	Contract misinterpretation	3	5	15	High
11	Inadequate staffing	3	4	12	Medium
12	Exchange rate	5	2	10	Medium
13	Delays with construction schedule	3	4	12	Medium
14	Lack of funds	1	5	5	Low
15	Profit deficit	1	3	3	Low
16	Downtime	2	5	10	Medium
17	Complexity of components leading to functional failure	2	5	10	Medium
18	No market potential	1	3	3	Low
19	Adaptability to other functions	1	4	4	Low
20	Availability of materials	1	5	5	Low
21	Discrepancies of ownership between private and governmental departments	1	3	3	Low
	ENVIRONMENTAL				
22	Contamination of Apies River with fertilizers	4	5	20	High
23	Large consumption of water	4	5	20	High
24	Large production of organic waste	5	3	15	High
25	Introduction of invader plant species to the area	4	5	20	High
26	Disruption of water table	3	4	16	Medium
27	Removal of a greenfields site	4	3	15	Medium
28	Damage to the biophysical environment	2	5	10	Medium
29	Legislation	2	3	6	Low
30	Damage to river system during construction	1	5	5	Low

for the research centre.

B - University of Pretoria

The EBRC would house the Department of Ethnobotony for University of Pretoria. The concern for the University of Pretoria would be the same as the MRC, so the same measures would be taken. They would also be concerned with the department not being on the main university campus. It would need to be communicated to them that by locating the Department of Ethnobotony as part of the EBRC;

- Start-up and running costs would be shared with the MRC
- They would have full use of the terrariums
- They would be able to utilize the existing facilities at the MRC
- They would have exposure to the latest research done by the MRC

E - Departments of Arts Culture Science & Technology (DACST)

The DACST will provide R11000000 to the MRC and Department of Ethnobotany, the majority of funding for the EBRC. The DACST would be concerned that the money they are contributing is being used appropriately towards the research of medicinal plants. All expenditures relating to the design and construction of EBRC are to be relayed to the DACST. All research done is to be documented and presented to DACST, along with the integrated costs thereof.

J - Professionals

There needs to be constant dialogue between the professional team involved in the EBRC to minimise any discrepancies during construction. All matters discussed are to be recorded and distributed to all parties involved.

High-risk management plans

Social

01 There is a concern that the cultural significance behind the processing of medicinal plants will be lost with a more scientific research approach. To maintain the cultural ties, traditional healers are to be involved at the EBRC with the cultivation and research processes. Traditional healers are also employed by the EBRC to show the public the correct methods of cultivation and collection of the correct plants.

02 The passive HVAC systems are all to be backed-up with a mechanical HVAC system, but is operated from a management position to prevent unnecessary use.

03 By incorporating the Department of Ethnobotany into the EBRC, the EBRC contributes to the campus atmosphere rather than eliminating it. This is strengthened preserving green spaces around the EBRC and incorporating art displays throughout the site.

Economic

08 Rapid advances in technology result in a continual upgrading of electronics and machinery. By providing loose fitting / moveable workstations, new components and machinery can be fitted, replaced etc with limited interference.

09 The field of ethnobotany is rapidly growing, resulting in increased research. The site on which the EBRC sits, allows

for extensions of the building southwards along the river.

10 To prevent any contractual discrepancies between the professional team and the client, the parties involved are to discuss and explain the entire contract before it is signed.

Environmental

22 To increase productivity, the cultivated plants growing around the EBRC, and those inside the terrariums will occasionally be fertilized. To prevent these fertilizers from flowing into the Apies River, all runoff is directed through channels into the constructed wetland, where the fertilizers are removed from the water.

23 The quantities of plants on the site result in the need for large amounts of water. To limit consumption of municipal water, all grey water is cleaned through the wetland and reused, while all rainwater is collected and used for irrigation.

24 To prevent unnecessary disposal of organic waste from the EBRC, all plant matter is composted on site and is used in the landscaping.

25 With the introduction of plant species that are not indigenous to the region, there is the possibility of these plants spreading and creating an ecological disturbance. To prevent this, all exotic species of plants are to be isolated within the terrariums.

Material	**R/m^2**	**Amount (m)^2**	**Cost (R)**
Research centre / laboratories	4 000	4 400	17 600 000
12mm laminated tempered glass	800	340	272 640
Steel	12 000/ton	24 tons	288 660
'GKD' woven steel mesh	20	480	9 600
30mm steel tube	20/m	4 868	97 352
Painted steel cladding	180	185	33 300
Epoxy finish	80	2 099	167 920
Photovoltaic solar panels	30 000 each	30	900 000
External works / landscaping	40	18 489	739 560
Total			**20 109 032**

Appendix E

Schedule of Accomadation

Space	Function	Pop.	No.	Area (sqm)	Total (sqm)	Specialised Mechanical Equipment
Entrance/Atrium	Information, security, displays		1	70	70	
MRC area manager	Closed office	1	1	30	30	
Dept. Ethnobotany School Head	Closed office	1	1	30	30	
Staff offices	Open plan offices	16	2	100	200	
Kitchen	Staff kitchen		1	12	12	
Lecture hall	Student & public lectures	300	1	230	230	
Seminar room	Staff / student consultation		1	60	60	
Computer lab	MRC & post-graduate use		1	70	70	
Teaching labs	Undergraduate labs	90	3	70	210	
General labs	Plant research & post-graduate labs	24	9	70	630	Spectrophotometer, flashchromotograph, evaporator, fume cupboard, centrifuge rotor
Isolated lab	Plant research & post-graduate labs		1	25	25	Spectrophotometer, flashchromotograph, evaporator, fume cupboard, centrifuge rotor
Dark room			1	35	35	
HPLC			1	25	25	High pressure liquid chromatograph
Physiology lab			2	25	50	Spectrophotometer, flashchromotograph, evaporator, fume cupboard, centrifuge rotor
Herbarium			1	100	100	
Micro lab			2	70	140	Spectrophotometer, flashchromotograph, evaporator, fume cupboard, centrifuge rotor
Sterilization room	Instrument sterilization		1	36	36	Autoclaves, centrifuge

Space	Function	Pop.	No.	Area (sqm)	Total (sqm)	Specialised Mechanical Equipment
Cold room	Isolated storage - plant /abstract /chemical		1	30	30	
Glass store			1	30	30	
Chemical store			1	25	25	
Terrarium 01	South east coast / Subtropical climatic zone		1	150	150	
Terrarium 02	Semi-arid / Desert steppe climatic zone		1	150	150	
Terrarium 03	Mediterranean / Garden Route climatic zone		1	150	150	
Library	To serve as the University Ethnobotany Library		1	180	180	
Kitchen	Staff kitchen			14	14	
Plant room	To house mechanical systems		1	120	120	
Café	Snack bar / coffee shop residents and public		1	125	125	
Sorting room	Sorting of cultivated plants		1	73	73	Grinder, drying machine
Lavatories		WC	Urinal	WHB		
	Male				15	
	66	3	6	6		
	Female				15	
	66	9		6		
	Paraplegic	3		3	6	
Total					3036	